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EDITORIALS

Publicity for Municipal and County Engineers

Municipal and county engineers can greatly increase their influence and the security of their positions by the proper use of dignified publicity methods. Engineers of all classes profit greatly from proper publicity. The engineer who complains that his work is not appreciated by the public is quite likely to boast that he "does not believe in advertising himself." He should realize that the public is not to be blamed for ignorance of his work if he keeps silent about it. It is because of his silence that politicians frequently appropriate the credit that properly belongs to the engineer.

Few engineers like to speak in public, but those who do can make known the interesting features of their work by addressing all sorts of local organizations. This method has the added advantage of personal contact, and gives the engineer of forceful personality the best opportunity to assert himself as a leader in his community.

Those who do not show to their best advantage as public speakers should write of their work. Local newspaper editors, as a rule, are very glad to publish illustrated descriptions of new engineering works, and are even willing to give space to discussions of matters of public policy on which the engineer is especially well qualified to express an opinion. The engineer who does not write of his work for his local papers neglects his best opportunity to exert the influence in his community that he knows he should have. If he keeps the public informed he will find staunch defenders among influential men of all classes. He can acquire a character of support that will make it inexpedient for his non-technical superiors to ignore his recommendations on technical matters.

Local and national publicity are easily linked together and the latter greatly reinforces the former. Many times during the writer's experience as an editor he has published articles, written by city engineers, in this and other engineering magazines of national circulation. Following publication in the national medium marked copies have been sent to the editors of newspapers in the contributor's home city, with a letter advising that if proper credit is given the newspapers are at liberty to reproduce the article in full. When the original article is illustrated the cuts are loaned to the newspaper free of charge. This plan gives the local newspaper an illustrated article of local interest which the local editor is pleased to use if it is not too technical in character and contains news value.

Municipal and County Engineering is ready at all times to extend this form of co-operation to its engineer readers who are in the public service. There is nothing novel in the suggestion. It has often been done with benefit to all parties and harm to none.

It is obvious that the publication of an article by a city or county engineer in a journal of national circulation adds greatly to the engineer's prestige at home when the article is subsequently reprinted in the local papers with credit to the author and the national engineering journal in which it appeared. The fact that the article was accepted for publication by the journal of national circulation is assigned more weight than it deserves, perhaps, but the fact remains that this is construed as an indorsement of the professional attainments of the engineer and unquestionably adds greatly to his influence in his home community. Engineers are invited to contribute articles pertaining to their work, with these, as well as other, considerations in mind.

The Engineer and Construction Equipment

Except where construction work is carried on by day labor, the direct purchase of construction equipment by the engineer is rare, but it is a fundamental, and common, error to assume from this that the engineer is without influence in the purchase of machinery used on contract jobs and paid for by contractors. On contract work the engineer, if sure of himself, very often rises superior to the role of referee between the owner and the contractor. He becomes the adviser of the contractor in the interest of the contractor as well as in the interest of the owner.

The right-minded engineer does not want to see the contractor lose money. It is not enough that the owner should be protected in securing full value for his money, but the contractor is also entitled to a fair profit on every job. Assuming that the bid is high enough to make a profit possible, it certainly is a right and legitimate function of the engineer to help the contractor realize the profit.

The engineer is not likely to attempt to run the contractor's business for him. Such an attitude is indefensible and would draw a quick and stern rebuke. But the engineer can make friendly suggestions on many points which do not affect the quality of the work, but do affect the contractor's profits. The engineer has the advantage of perspective from his comparatively detached viewpoint. He gets a clearer view of some things than the contractor himself. In such matters it is well within the province of the engineer to counsel with the contractor.

Even where the contract and specifications do not give the engineer any authority with reference to the equipment used on the job, he very frequently can render a great service to the contractor by suggesting the use of additional construction plant units. Many engineers are close students of plant selection and performance and are well qualified to advise with contractors in this matter. The giving of such advice is recommended because it is thought to be in the best interest of all parties.

Intolerance

We believe that the salaried engineers of this country are rapidly making up their minds to take such steps as may be found necessary to improve their economic position. Undoubtedly many are still holding back, waiting for something to happen—a miracle perhaps. But the majority of engineers on salaries are rapidly acquiring a very wholesome determination to look out for their own kind while "pushing the world up hill" and "planting a flower in the other man's garden."

Various measures calculated to safeguard the engineer and to increase his earnings have been under discussion for several years. There are both national and local organizations laboring to achieve these ends.

It is only natural that there should be various remedies prescribed and various doctors to administer the remedies. Now there is nothing more natural than that doctors should disagree, but they do not need to get violent about it.

We hope that as this movement gains momentum the various schools of thought will not adopt intolerant attitudes toward each other. If they do, the engineer will be set back a few more decades. It is too early for any man, or any group of men, to say that certain measures and certain forms of organization are the only ones that promise success. Until the end of our labors for the engineer comes clearly into view let us adopt a tolerant attitude as between the advocates of the various plans and proposals brought forward to assist him. The spirit of intolerance, if allowed to come in, or to stay in, will defeat the efforts of all.

Municipal Engineers Are Interested

Municipal engineers are interested in the movement now under way to increase their compensation and the security of their positions. There are many evidences of this, one of the most significant being the request for a large number of copies of the June number of this publication for distribution in an important city where this question is being agitated at this time. That particular number contained an unusual amount of matter useful to municipal engineers in this connection.

It is a hopeful sign that engineers are at last genuinely interested in their own welfare and are emerging from the conversational stage to the stage of action. Municipal engineers, and other engineers in the public service, should give special attention to their economic status during the present year while they have the advantage of organization help from the American Association of Engineers.

The Engineer and Overtime

In the hearing on the pay of professional engineers in railway service, before the Board of Wages and Working Conditions, United States Railroad Administration, held March 31-April 2 of this year, in Washington, the testimony of all engineer witnesses, whether called by the American Association of Engineers or not, was against overtime pay for engineers. This fact should be somewhat reassuring to those who feel that the engineering profession is being trade-unionized.

The demand for payment for overtime work is probably the one thing more than any other that has tended to prejudice the general public against trade-unionism. Most people work overtime occasionally, or frequently, or habitually, and do not seek extra compensation for doing so. The farmer and the business man alike work long hours, and it has ever been a characteristic of the engineer that he is not a clock watcher. He is still willing to work very long hours, it seems, when work is heavy, and he does not ask extra pay for it. What he does seek is better compensation from month to month, not from hour to hour. The average salaried engineer is just as willing as ever to work from 8 to 12 hours a day, and even longer, if need be, without any thought of "time and a half for overtime," but he is no longer willing to work month after month for all sorts of hours, in all sorts of places, for his board and the glory of service—and to get experience.

Fees, Salaries, Wages

In the discussions of engineers' compensation, now receiving so much attention, it is to be hoped that there will be no bad feeling engendered between engineers who work for fees and those who work for wages. It is well to recognize the possibility of such ill feeling sufficiently far in advance to prevent its becoming an accomplished fact.

Engineers who work for fees have a tendency to look with disfavor on the movement to increase the salaries of engineers. One reason for this is that fee engineers usually are employers of salaried engineers. They have the natural disinclination of all employers to increase wages. With this attitude we have scant sympathy, for the engineer who works for a fee can increase his fee with a great deal less trouble than is experienced by the salaried man in living on his same old salary in these days of inflation. If the great mass of salaried engineers can succeed in getting their compensation increased, surely the much smaller group of vastly more experienced and more influential men who work for fees should do proportionately as well.

Another reason why the fee engineers look with disfavor on organized efforts to increase salaries is that they fear the lowering of the profession to the level of a trade. This is rather a complex matter. Perhaps to some engineers engineering is a profession and to others a trade. The engineer who works for a fee is undoubtedly a professional man, but there are many who assert that the wage-earning engineer is not. There was a time when the fee engineers were relatively more numerous than at present. Then they were the leaders in thought in all matters pertaining to engineers and engineering. They established certain guiding principles for engineers, designed to serve the needs of the fee engineer, and it is the inability of the modern salaried engineer to follow these guiding principles and live comfortably at the same time that has at length caused him to think less of words and traditions and more of increased compensation. So long as nothing is done to injure the public we do not see that the fee engineers need be overconcerned about the efforts of the salaried men to secure a fair wage.

Any bad feeling between fee and salaried engineers would be most unseemly and should be avoided. Each class needs the other. There can be no real conflict of interests between them.

Speaking of words, as we were a moment ago, it was once our privilege to hear an address by Theodore Roosevelt. It was a fine speech, of course, but we long ago forgot what it was all about. Only one sentence in the address has embedded itself in memory. Here it is: "It is better to work for $20 a week in wages than $12 a week in salary."

A Slander on New Mexico?

The Federal State Director of the U. S. Employment Service for the State of New Mexico recently sent out a letter to military camps about employment conditions in that state. Here is the introductory paragraph: "In case any men from the State of New Mexico are stationed at the camp where you are making your headquarters, we ask that you call their attention to the fact that there are very few opportunities to secure employment in this state at the present time." Then follows a polite hint that the young men who were good enough to fill New Mexico's military quota go to some other state for jobs. Fine business! This should help greatly in the recruiting for the next war

Some Broader Aspects of Rain Intensities in Relation to Storm Sewer Design

By Robert E. Horton, Hydraulic Engineer, 57 N. Pine Ave., Albany, N. Y.

(Concluded from June Number.)

Mechanism of Thunderstorm Rain Intensities—Simpson's Theory of the Thunderstorm—Suspension Storage

The primary requisite for thunderstorms is a violent uprush of moisture-laden air. This condition may be induced by the warming of the air near the ground abnormally on a calm, clear day, thereby producing a buoyant instability. Days favorable to thunderstorms are likely to occur during the passage of the center of a low-pressure area over a region. Convectional thunderstorm conditions are most likely to occur where the topography favors the formation of a moist, stagnant layer of overheated air near the ground surface, as, for example, over a sandy plain, or sometimes over a shallow lake. Oftentimes some outside impetus is required to start the convective action with sufficient strength to produce a thunderstorm.

The advance of a low-pressure area, especially under conditions where there is a barometric trough or "squeeze" with a marked wind shift line, is very likely to supply the necessary additional condition.

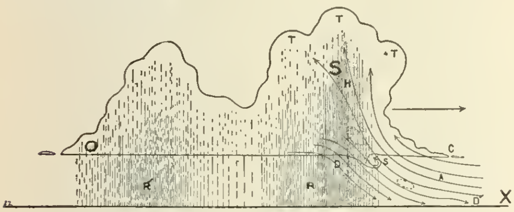


FIG. 6. IDEAL CROSS SECTION OF A TYPICAL THUNDERSTORM.

A, Ascending Air; D, Descending Air; C, Storm Collar (Sturmkragen); S, Roll Scud; D Prime, Wind Gust; H, Hail; T, Thunderheads; R, Primary Rain; R Prime, Secondary Rain; S, Region of Suspension Storage. (After W. J. Humphreys, Monthly Weather Review, June, 1914.)

It follows that as a cyclonic storm traverses the country, thunderstorms will develop in conjunction with it in regions where the advancing cyclone finds the conditions most favorable.

The facts cited above suggest an inquiry as to the special mechanism of the thunderstorm which produces these high rain intensities. Some years ago Lenard discovered that electricity is released when water droplets are broken up by an air current; this phenomenon may doubtless be explained in accordance with the modern electrical theory of matter. The application rather than the cause of this fact is of special interest here.

As the result of a remarkable field research in the Himalayas, Dr. Gilbert T. Walker, Meteorological Department of India, found that the known facts as to lightning are concordant with the theory that lightning is the result of the release or separation of electricity from rain drops in accordance with the Lenard effect, and to produce lightning in the high atmosphere requires that there shall be a mass of water droplets held in suspension or driven upward and broken apart by an ascending air current. That ascending air currents are a characteristic feature of thunderstorms is revealed in many ways.

(1) From the well-known convectional origin of such storms.

(2) From the observed form and nature of the cauliflower-headed cumulus clouds from which thunder and lightning emerge.

(3) From the observations of the few persons who have undergone and survived the thrilling experience of passing through the heart of a thunderstorm cloud in a balloon.

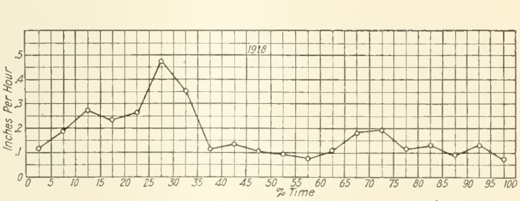


FIG. 7. THUNDERSTORM INTENSITY CURVE BASED ON 22 STORMS IN 1918.

Fig. 6 illustrates a typical longitudinal section of a thunderstorm.

The phenomena take place as though the observer was stationed at some point X, and the storm moved from left to right past him.

First consider the storm as if it were stationary. An uprush of air begins near the ground, at the storm front, as indicated by arrows. Rain is condensed above some level, oc, and all, or nearly all, the precipitation formed by the ascending gust is carried upward and held in suspension.

The rain condensed from and entrapped in the ascending air gust of a thunderstorm may descend slowly, or it may ascend, depending on the relation of the size of drops to the velocity of the ascending air current. The retarding of the rain tends to concentrate all the rain condensed over a given locality in a layer of air of much less thickness than the height of ascension of the gust which produces it, since most of the rain is condensed out relatively near the lower level of condensation.

When the storm front has passed the observer the suspended rain, no longer sustained by a sufficiently strong air current, rapidly descends, and it is undoubtedly the rapid precipitation of this suspended storage which produces the highest rain intensities for short durations. The larger drops will probably be mostly at lower levels in the suspension layer, and will also fall fastest and so reach the ground first. They will

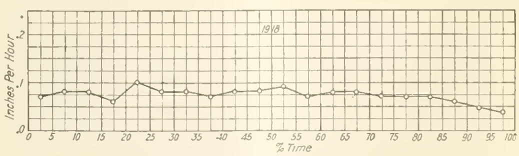


FIG. 8. NON-THUNDERSTORM INTENSITY CURVE BASED ON 80 STORMS IN 1918.

be mingled with a larger proportion of smaller drops as the rain continues, a fact observed by Bentley & Lenard. The supply of large drops may perhaps be replaced by coalition of smaller drops. The phenomena are complicated by violent eddy motions in the ascending current, and by the horizontal motion of translation of the storm bodily over or past the place of observation.

Apparently it is the breaking up of ascending raindrops in the formation of suspension storage which produces lightning, and the precipitation of this suspension storage plays an important role in relation to high rain intensities of short duration.

As a rule, the greater the temperature inversion by which a thunderstorm is constituted and sustained, the greater will be the force and thickness of the frontal convectional wind gust which produces the air current and suspension storage. The thicker and stronger the ascending wind gust, the higher the cumulus clouds will rise, and the thicker and denser will be the layer of rain suspension.

In violent thunderstorms, as suggested by Bentley, snow and hail may play an important part. The existence of either or both of these affects and probably increases the possibilities of suspension storage. A thunderstorm is often spoken of as "backing up." This is not really the case, however. A thunderstorm often travels in two sections, as indicated in the diagram, Fig. 6, and there may be a lull with only gentle precipitation between two periods of high rain intensity.

In the case of purely convective thunderstorms, where the rain is mostly produced from the air overlying the locality where the rain falls, or is derived from nearby localities, there is a limit to the amount of precipitation which can be produced at a given place from a storm which travels progressively across the country. This limit is not far from the total amount of vapor contained in a column of air overlying the place where the rain falls. This amount is commonly 2 to 3 ins., but may be as great as 4 or 5 ins., in the case of warm, humid air. Greater amounts of precipitation must involve the transport of moisture from the surrounding regions. This condition not infrequently occurs where thunderstorms accompany cyclonic storms.

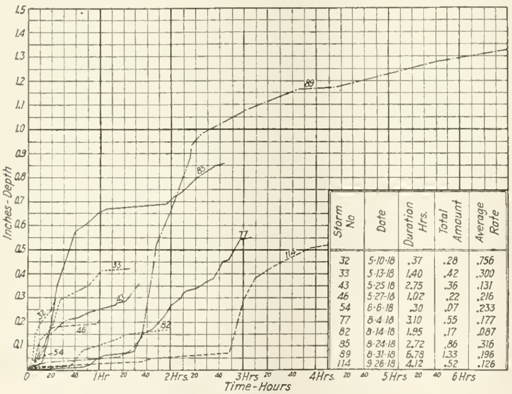
The important fact is that nature sets an approximate limit to the total amount of precipitation in purely local thunderstorms, while no such limit of amount exists in the case of cyclonic storms. A stalled cyclone, whose eastern advance is blocked by a high pressure area in front of it, may produce heavy rain more or less continuously for several days. Rain produced by the upward deflection of moisture-bearing wind against a mountain slope may continue as long as the wind lasts, as in the case of the winter monsoon rains, on the mountain slopes fronting the Bay of Bengal, in India. Even in such rains nature sets a limit to the intensity, which, although not definitely known or fixed, is apparently never exceeded in a given locality.

An attempt at explanation in full of the causes of the limitations of rain formation and intensity would lead us far afield in the mathematical phase of physical meteorology. The statements here made as to the meteorology of rain intensities are mainly intended to point out more salient features of the subject, and may appear unsatisfactory and incomplete to professional meteorologists.

Characteristics of Thunderstorm and Non-Thunderstorm Rain Intensities

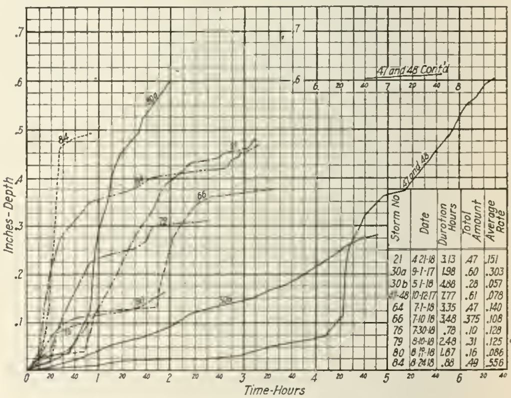
The relation of rain intensities occurring in thunderstorms, or storms of a similar type, as compared with other storms, is illustrated by the following data and diagrams, obtained from a recording gage record of storms during the period April to October, inclusive, in the years 1917 and 1918, at the laboratory of the writer near Albany, N. Y.

Fig. 7 shows the average intensities in inches per hour of 22 thunderstorms in 1918. Fig. 8 shows the average intensity of 80 non-thunderstorms, recorded in the same season. The vertical scale for non-thunderstorms is twice that of thunderstorms, and the diagrams illustrate clearly the higher intensities which ordinarily prevail in thunderstorm rains. In general the intensity curve for non-thunderstorm rains resembles somewhat an arc of a parabola with a flat crown, a maximum occurring about one-fourth of the time from the beginning to the end of the storm.



Storm No	Date	Duration Hrs.	Total Amount	Average Rate
32	5-10-18	.37	.28	.756
33	5-13-18	1.40	.42	.300
43	5-25 18	2.75	.36	.131
46	5-27-18	1.02	.22	.216
54	6-6-18	.30	.07	.233
77	8-4 18	3.10	.55	.177
82	8-14-18	1.95	.17	.087
85	8-24-18	2.72	.86	.316
89	8-31-18	6.78	1.33	.196
114	9 26-18	4.12	.52	.126

FIG. 9. CURVES OF PRECIPITATION OF TEN FAIRLY TYPICAL THUNDERSTORMS.



Storm No	Date	Duration Hours	Total Amount	Average Rate
21	4 21-18	3.13	.47	.151
30a	9-1-17	1.98	.60	.303
30b	5 1-18	4.88	.28	.057
47-48	10-12-17	7.77	.61	.078
64	7-1-18	3.35	.47	.140
66	7-10 18	3.48	.375	.108
76	7-30-18	.78	.10	.128
79	8-10-18	2.48	.31	.125
80	8 10/11-18	1.67	.16	.086
84	8 24 18	.88	.49	.556

FIG. 10. GRAPHS OF TEN NON-THUNDERSTORMS OF THE THUNDERSTORM TYPE.

In the case of thunderstorms, the main maximum occurs after the lapse of 25 to 30 per cent. of the duration of the storm, and there is a secondary lower maximum at about 70 per cent. of the duration of the storm. This second maximum corresponds to what may be called the second section of a thunderstorm. It may be noted that the curves in Figs. 7 and 8 are plotted on the basis of a horizontal scale of time, expressed as a percentage of the total storm duration. In this way storms lasting only a few minutes are averaged in with others lasting several hours. The study of the rain intensity graphs in many thunderstorms indicates that this method of averaging will give more correctly the mean characteristics of thunderstorms than could be obtained by averaging the intensities occurring actually at corresponding times from the beginning of the storm. The reason for this is illustrated by Fig. 9, which shows the curves of precipitation of ten fairly typical thunderstorms. It will be noted that the graphs for typical thunderstorms are essentially similar geometrical figures. In other words, the graph of a heavy thunderstorm, if plotted on a reduced scale, may often be very nearly superimposed on the graph of a much lighter thunderstorm. The same phases occur in both, and the rain intensities during corresponding phases are similar, but the duration of each phase of a heavy thunderstorm, and consequently the total precipitation which it produces, is much greater than in the case of a light thunderstorm. This similarity in characteristics of light and heavy thunderstorms would be anticipated from a consideration of the mechanism of thunderstorm rain intensities.

It may be noted that about equally high intensities occur in short and long storms for short time intervals, but high intensities for long time intervals are of course wanting in the case of short storms. The relative frequency of equal intensities of different durations is apparently about proportional to the relative frequency of thunderstorms of different durations.

In general, each graph of a thunderstorm rain or of the portion relating to the first section of the thunderstorm may be considered as made of four phases: (1) The initial phase—this may start with a sudden dash of large drops and high intensity, but of extremely short duration, or the rain intensity may be moderate throughout this phase.

The second phase comprises the first long continued period of high intensity. The first phase may be wholly wanting, or may be merged into the second phase, in which case the storm starts with high intensity, which continues for some time.

The third phase is a period of very light intensity. This is usually of shorter duration than the other two phases. At the end of the third phase three things may happen: (a) The storm may end suddenly, or (b) there may be a short dash of rain of fairly high intensity, though commonly less than the second phase, or (c) there may be a second well-developed

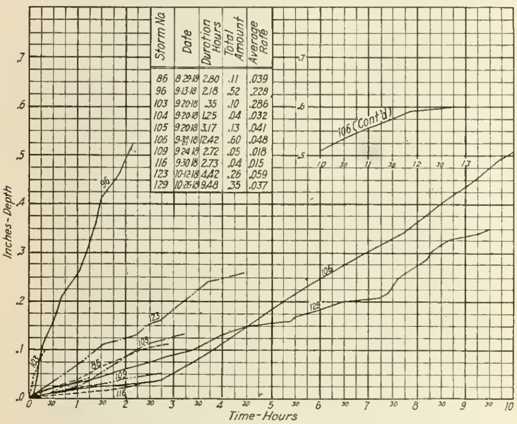


FIG. 11. RAIN GRAPHS OF TEN NON-THUNDERSTORMS OF THE LINEAR TYPE.

period of high intensity. This fourth phase of a thunderstorm, when present, comprises what is popularly referred to as the "clearing-up shower." Very commonly it marks the passing of the last portion of a thunderstorm, and is quickly followed by sunshine.

It is not infrequently the case that a second section of the storm follows the first, its first and second phases corresponding to the third and fourth phases of the first storm, with the latter continued. The second section is in all respects similar to the first, and its intense phase may develop equal intensity and duration to that of the first section. Inasmuch, however, as the second section is absent in probably three out of four cases, the average intensity in the second section, taking all storms together, is very much less than that in the first section of the storm.

Maximum rain intensities sometimes occur in non-thunderstorms. Non-thunderstorms may be classified as regards the rain intensities which they produce, and their distribution throughout the duration of the storm, as of two types: (1) Non-thunderstorms of the thunderstorm type. In Fig. 10 are shown the graphs of ten such storms, none of which were accompanied by thunder audible at the observing station. They occurred, however, under conditions generally favorable for thunderstorms, and some of them on days when there were thunderstorms at points not far distant. Very likely these storms were for the most part produced by convectional action, in a manner similar to the production of thunderstorms.

The second type of non-thunderstorms may be called the linear type, in that the graph of accumulated rainfall is in general approximately a straight line. Fig. 4 illustrates the rain graphs of ten non-thunderstorms of this type. Storms occur showing every possible graduation in type of graph, from the pure linear to the typical thunderstorm type, but well developed graphs of one or the other of these two types are more common.

It is true that thunderstorms having purely linear types of graphs, and those with intermediate types, also occur, but variations from type in the case of thunderstorms are much less common than in the case of non-thunderstorms.

The Inconstancy of Rainfall Rates; Rain Intensity in a Tropical Storm

One of the characteristics of rainfall is its lack of constancy. It is unusual for heavy rain to continue at a uniform rate for even as much as half an hour without interruption.

From a study of rain intensities in New York City for a period of 45 years, Hufeland (Engineering News, Sept. 7, 1916, page 454) found 280 cases where the average intensity

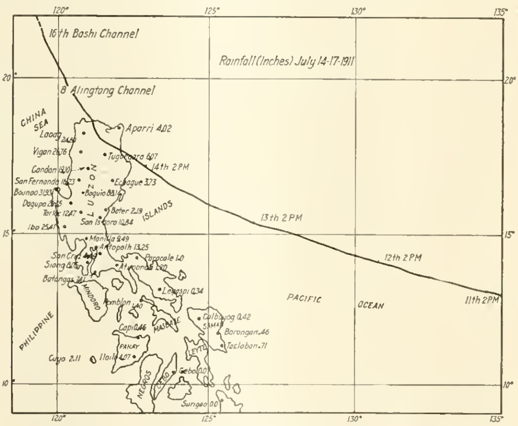


FIG. 12. APPROXIMATE TRACK OF TYPHOON, JULY 11-17, 1911, SHOWING RAINFALL IN INCHES JULY 14-17, 1911.

for 30 minutes' duration or over was excessive. Of these there were only 18 cases where the excessive rate was practically continuous and constant for 30 minutes or more, and only one case where there was a constant excessive rate for as much as 70 minutes.

Considering only periods of excessive intensity in which the rate was nearly uniform, Hufeland found that in 94 per cent. of the cases which occurred in New York City in the 45 year records, the duration did not exceed 25 minutes, and it exceeded 30 minutes in only 4 per cent. of the cases.

Figures 12, 13 and 14 illustrate the inconstancy of rainfall rates, even in the case of cyclonic storms of the greatest severity. This storm is remarkable in that it is probably the heaviest for which there is a continuous graphical record of the rainfall rate. Figure 12 shows the track of the storm. This occurred on July 14-17, 1911, and produced a total rainfall of 88.2 ins. at Baguio, on the Island of Luzon, in the Philippines, in four days.

Figure 13 shows a copy of the graphic record, for July 14 and 15, from the official report of the Philippine Weather Bureau. The zigzag lines in the lower diagram are the record from the Friez tipping bucket recording rain gage. Baguio is located between Mt. St. Thomas and the west coast of Luzon.

The heavy rainfall was produced by wind from the China seas blowing eastward against and deflected upwards by the west slope of Mt. St. Thomas, which rises to an elevation of 7,530 ft. In order to show the fluctuation in rate of the rainfall during this storm, the rate for each 5-minute period for the 24 hours from noon, July 14, to noon, July 15, was computed from the recording gage record. The plotted results are shown on Fig. 14. Here, as in most intensive storms, the highest intensity occurred near the beginning of the storm, although there were numerous 5-minute periods in which nearly equal intensities occurred. It will be noted that an average rainfall rate of 1½ to 3 ins. per hour persisted continuously for 20 hours or more. The rain intensity fluctuated in periods of about 20 minutes from crest to crest. This fluctuation was undoubtedly due to gustiness of the wind, and is a feature common to intense rains in all localities.

The rain recorded is that caught by a rain gage with a horizontal funnel exposure. The rainfall was accompanied by a fairly constant wind, having a velocity of about 60 miles per hour. Assuming, for illustration, that one mile of wind velocity produces one degree in deflection of falling rain from a vertical line, and taking into account the abrupt west slope of Mt. St. Thomas, it is evident that the actual amount of rain interception on the west slope of the island per unit of projected or horizontal area must have been very materially greater than the amount indicated by the rain gage record.

The enormous rainfall of this storm was produced by long continuation of high rain intensity, yet the maximum intensity for short intervals was not greater than frequently occurs in regions where such storms are unknown.

The difference in rain intensities for short time intervals in different places appear to be more a matter of frequency than of amount. The records of rainfall of India contain about 2,800 instances of rainfalls of 10 ins. or more per 24 hours, yet, so far as can be ascertained without recording rain gage records, the intensities for intervals of 5 minutes to one hour are not often greater than those frequently experienced in the United States, although equal 24-hour rains are rare in this country.

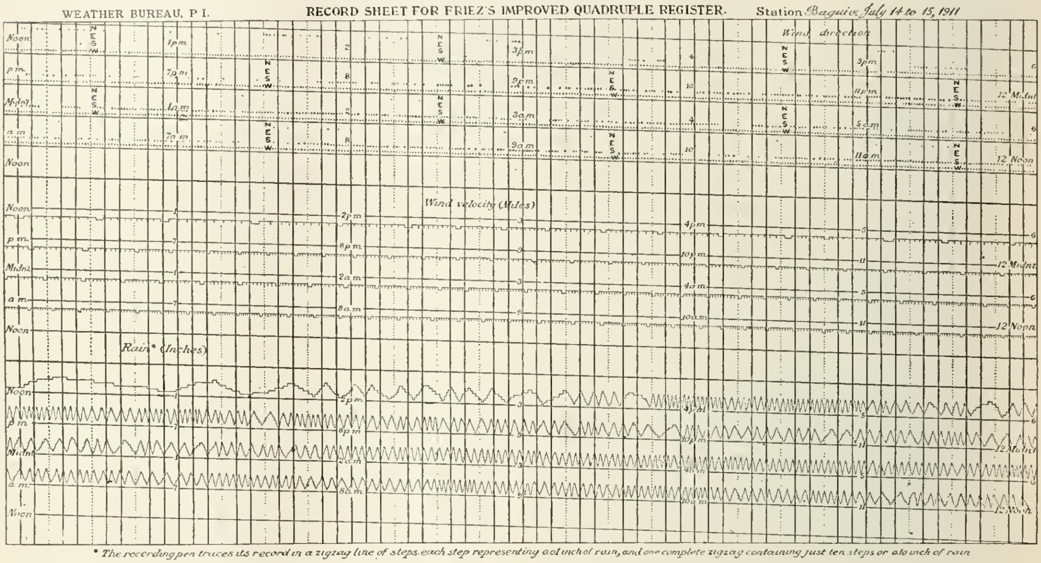


FIG. 13. RECORDING GAGE SHEET FOR BAGUIO STORM, JULY 14 TO 15, 1911.

New York Rain Intensities

In the older method of deriving a rain intensity curve as illustrated by Fig. 1, by drawing an approximate envelope of the points plotted on the diagram, practically all the data except those for higher intensities are disregarded—furthermore, as already pointed out, this method does not necessarily lead to homogeneous curves, that is to say, the resulting rain intensities for different durations shown by such a curve may not be of equi-frequent occurrence.

In order to illustrate the method of analysis and plotting of a record of rain intensities by which the resulting curves are not only homogeneous or equi-frequent throughout, but which correspond to a given or chosen exceedance interval, the records of rain intensity for a period of 45 years, taken at the City of New York, have been analyzed, and the results are summarized in Table III. In this table the first, second and third highest, etc., of the observed rain intensities for each of the time intervals indicated in column headings have been arranged in order of their magnitude. For intensities less than the ten highest the averages of groups of five successive values have been taken, and these are given in the table opposite the number corresponding to the order of magnitude of the median of the five values in each case.

The data in each column of the table corresponding to a

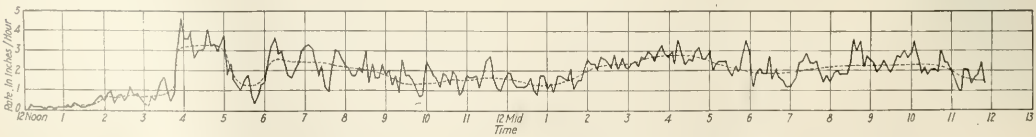


FIG. 14. RATE OF PRECIPITATION AT BAGUIO, PHILLIPINE ISLANDS, JULY 14-15, 1911.

TABLE NO. III—SUMMARY OF MAXIMUM AVERAGE RAIN INTENSITIES FOR SHORT INTERVALS AT NEW YORK CITY, 1869-1913, 45 YEARS

No.	Exceedance Interval	5 Min.	10 Min.	15 Min.	20 Min.	30 Min.	40 Min.	50 Min.	60 Min.	80 Min.	100 Min.	120 Min.
1....	45	9.00	8.22	8.00	6.93	5.22	4.38	3.84	3.40	2.70	1.88	1.33
2....	22.5	8.04	7.20	6.40	6.00	5.12	3.93	3.32	3.02	2.20	1.44	1.31
3....	15	7.80	6.12	5.00	4.35	4.08	3.69	3.17	2.68	1.65	1.36	1.21
4....	11.25	7.44	6.00	4.88	4.20	3.30	2.70	2.88	2.66	1.62	1.29	1.10
5....	9	6.96	5.70	4.68	4.05	3.16	2.60	2.14	1.90	1.47	1.23	1.07
6....	7.5	6.48	5.16	4.60	3.93	3.00	2.49	2.04	1.85	1.46	1.20	1.07
7....	6.43	6.36	5.16	4.56	3.81	2.98	2.40	2.04	1.74	1.44	1.20	1.06
8....	5.62	6.00	4.98	4.52	3.78	2.90	2.18	2.00	1.72	1.39	1.20	1.01
9....	5	6.00	4.74	4.20	3.45	2.30	2.10	1.99	1.68	1.37	1.13	.96
10....	4.5	6.00	4.68	4.12	3.21	2.30	2.07	1.90	1.60	1.36	1.11	.96
3 Mean....	15	7.85	6.65	5.79	5.11	4.18	3.46	3.07	2.73	1.93	1.44	1.20
8 Mean....	5.62	6.17	4.94	4.40	3.64	2.70	2.25	1.99	1.72	1.40	1.17	1.01
13 Mean....	3.08	5.98	4.44	3.46	2.97	2.22	1.86	1.67	1.51	1.25	1.00	.82
18 Mean....	2.27	5.38	3.80	3.10	2.54	2.09	1.68	1.47	1.32	1.02	.82	
23 Mean....	1.96	4.94	3.56	2.91	2.40	1.90	1.59	1.36	1.18	.94		
28 Mean....	1.61	4.78	3.34	2.76	2.32	1.80	1.47	1.25	1.12	.88		
33 Mean....	1.36	4.44	3.19	2.66	2.23	1.73	1.40	1.21	1.07			
38 Mean....	1.18	4.22	3.07	2.60	2.11	1.65	1.37	1.16	1.01			
43 Mean....	1.04	4.18	3.00	2.56	2.02	1.59	1.32	1.12	.96			
48 Mean....	.94	3.88	2.94	2.46	1.97	1.54	1.26	1.07				
53 Mean....	.85	3.60	2.83	2.37	1.94	1.48	1.18	.98				
58 Mean....	.78	3.60	2.70	2.29	1.85	1.41	1.11					
63 Mean....	.71	3.43	2.66	2.18	1.76	1.36	1.06					
68 Mean....	.66	3.36	2.60	2.07	1.72	1.34	1.00					
73 Mean....	.616	3.24	2.53	2.01	1.63	1.26	.96					
78 Mean....	.58	3.24	2.48	2.00	1.57	1.20						
83 Mean....	.542	3.09	2.40	1.98	1.51	1.13						
88 Mean....	.511	3.00	2.40	1.94	1.50	1.06						
93 Mean....	.484	3.00	2.30	1.90	1.50	1.02						
98 Mean....	.459	3.00	2.28	1.78	1.48	1.00						
103 Mean....	.437	3.00	2.20	1.66								
108 Mean....	.417	3.00	2.11									

given time duration form a basis of a frequency curve of rain intensities of the given duration. The data are plotted on the diagram, Fig. 15, on which triangles have been used to designate the ten highest actual values, and circles to designate the means of the groups of fives for each duration. The resulting curves somewhat resemble parabolic arcs, and can be represented approximately over a considerable range by straight lines on logarithmic paper.

As a result of extended study of frequency phenomena in relation to rainfall, floods and other hydrologic data, the writer has become convinced that such frequency curves are not truly parabolic and that the application of parabolic formulas or other similar expressions which indicate the possibility of infinite rain or flood intensities of any given duration if only the time limit is made long enough, are incorrect, and may lead to gross misconception, if applied beyond the limit of the data from which they are derived.

The writer has found that frequency curves of rain intensities and flood intensities can, in general, be represented with considerable accuracy, by at least two, or perhaps more empirical equations having such forms as to indicate a finite maximum or limit which the rain intensity or flood magnitude approaches, as the exceedance interval approaches infinity as a limit.

Without going into details as to the method of developing the formula or deriving the constants, the expression used to represent the frequency curves of rain intensities shown on Fig. 15 is

$$i = a\left(1 - e^{-kT^n}\right)$$

in which e is the base of Napierian logarithms, T is the exceedance interval in years, and a, k and n are constants for a given duration of rainfall. The constants a, k and n are different for each curve, that is to say, for each rainfall duration. They are functions of the rainfall duration in minutes, and are related to the rainfall duration in the manner indicated on Fig. 16. The values of the constant a indicate the maximum value which the rain intensity of any given duration approaches as a limit as the exceedance interval is indefinitely increased. For illustration, the limiting rain intensity which may be expected at New York City, as shown by the diagram, for different durations, is as follows:

5 minutes, 13.9 ins.
10 minutes, 13.0 ins.
15 minutes, 12.2 ins.
20 minutes, 11.4 ins.
30 minutes, 9.8 ins.
40 minutes, 8.4 ins.
50 minutes, 6.8 ins.
60 minutes, 5.75 ins.
80 minutes, 3.60 ins.
100 minutes, 2.2 ins.
120 minutes, 1.5 ins.

The frequency-intensity curves for different durations computed from the general formula above given are shown by the curved lines on the diagram, Fig. 15.

The formula above given is in the form of a frequency equation. It can, however, readily be thrown into the form of a rain intensity equation for any chosen frequency, that being the form of expression most commonly used in storm sewer work. The formula appears complex, but when one becomes accustomed to working with exponentials, the solution of such an equation is as simple as that of an ordinary parabolic equation with a fractional exponent and which is usually solved by logarithms. For practical purposes a diagram is to be preferred to the direct solution of rain intensity equations

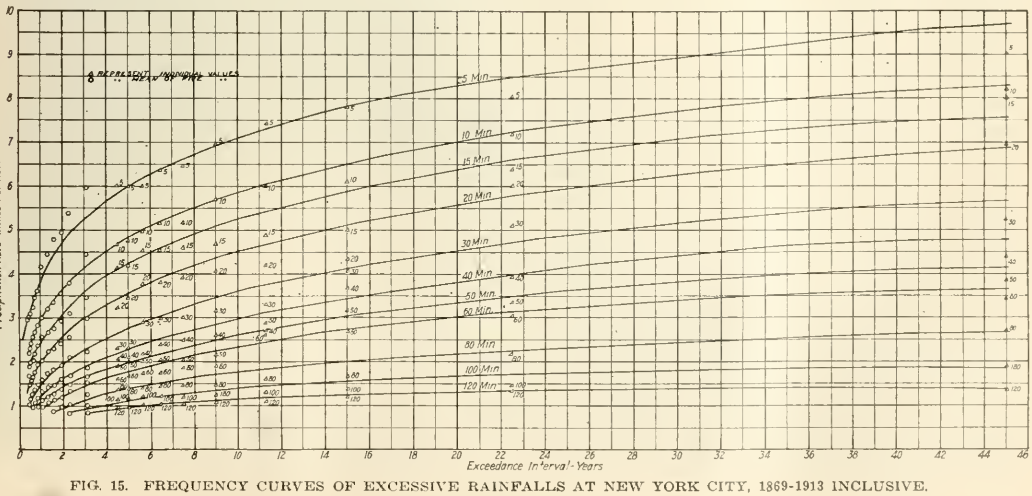


FIG. 15. FREQUENCY CURVES OF EXCESSIVE RAINFALLS AT NEW YORK CITY, 1869-1913 INCLUSIVE.

in most cases. The principal advantage claimed for the form of equation here given is that it enables one to determine the apparent limiting values approached by rain intensities of different durations. These limiting values are not obtainable directly from the data, or from the curves derived therefrom by any method of plotting, without deducing the frequency equations.

It may be noted that the constants in rain intensity equations derived by this method are determined by selecting from the curve for a given duration three pairs of values of the variables. Two of these pairs of values may be taken from the left-hand portion of the diagram, where the locations of the curves are fairly well defined by numerous plotted points. It follows that by this method of analysis and use of rain intensity data weight is given in a large measure to the more numerous and better established points on the diagram corresponding to intensities of relatively frequent occurrence, as well as to the higher observed and less frequent intensities.

Conclusions

(1) Excessive rain intensities for short time intervals mostly occur in thunderstorms, or in storms of the thunderstorm type.

(2) Rainstorms producing maximum intensities are mostly the result of violent uprushes of warm moisture-laden air as the result of convectional overturning of overheated air near the ground surface. Such conditions are indicated by the occurrence of cumulus "thunderhead" clouds, thunderstorms, and hail storms.

(3) These conditions may occur on warm, still, clear days, often known as "weather breeders"; thunderstorms, however, most commonly occur in favorable places along the course of, and during the passage of a general cyclonic storm, and in their most violent form during the passage of a barometric "trough," or "squeeze" with a marked "wind shift line."

(4) The occurrence of thunderstorms and high rain intensities are conditioned by (a) high temperature, (b) moist air, and (c) other favorable atmospheric conditions, probably at the cloud level and not fully understood.

(5) As a result thunderstorms and excessive rain intensities vary in frequency and magnitude as a rule under the same conditions that produce variations in rainfall. They are most common in tropical latitudes, and decrease toward the poles owing to decreased temperature, and their occurrence is mainly limited to the summer months. They usually decrease proceeding inland from the coast as the moisture content of the air decreases.

(6) Excessive rain intensities and the occurrence of thunder and lightning are the results of a common cause—violent ascentional air currents. They commonly occur in conjunction, but either may occur without the other.

(7) The occurrence of thunder affords, however, quite positive proof of the existence of suspension storage and the sudden precipitation of such storage is probably a usual cause of the highest rain intensities for very short intervals up to say 5 or 10, or perhaps 20 minutes.

(8) The highest rain intensities for somewhat longer intervals, say 15 to 45 minutes or 1 hour, seem mainly to be controlled by the occurrence of storm gusts or pulses.

(9) Excessive rain intensities for still longer intervals as 1 hour to one or more days are the result of general cyclonic storm conditions. Here the effects of suspension storage and of individual gusts become relatively unimportant.

(10) Under these conditions it is obviously difficult to devise any one simple type of rain intensity formula that will actually represent average rain intensity and duration relations over any large range of time intervals. It appears, however, that the relation of rain intensities to duration under each of these three conditions partakes in a considerable degree of an exhaustion phenomenon, so that all these types of intensities may follow similar laws, but with different coefficients and limitations—furthermore, two or even all three of the above described conditions precedent for rain intensities may operate in the same storm, so that it is possible to represent rain intensity—time relations over considerable time intervals by a single empirical formula.

(11) The amount of suspension storage which can be sustained by an ascending air current, and the rate at which it can be precipitated, are limited by natural physical conditions. In fact the velocity of ascending convectional currents seems to be practically limited by the relation between buoyancy and rate of ascension, as a result of the tendency of a mass of air to ascend when the point of instability is reached, thus naturally restricting the building up of air masses capable of ascension at more than a certain critical rate. It follows that there seems to be a fairly definite and fixed maximum limit

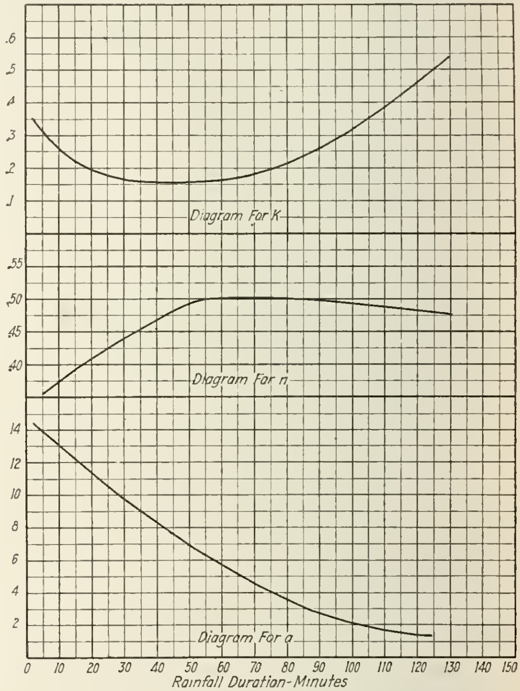


FIG. 16. CONSTANTS IN RAIN INTENSITY-FREQUENCY FORMULAS FOR NEW YORK CITY, 1869-1913.

of rain intensity for short time intervals, as say 5 minutes, which is not likely ever to be greatly exceeded. This limit seems to correspond to an intensity of 10 or 12 ins. per hour for a 5 minute interval, throughout most of the eastern United States.

(12) It is notable that this limit of maximum rain intensity due to storage suspension does not appear to vary greatly in amount, even between places having quite widely different annual rainfall and thunderstorm frequency. The important difference in the characteristics of rain intensity at different stations in Eastern United States seems to be mainly one of frequency rather than of magnitude. For example, the limiting or maximum rain intensity for 5 minutes to be expected in two locations may be about the same, but the frequency with which an intensity approaching this limit will occur in two places may be widely different—the frequency of occurrence of intensities approaching the limiting value being as a rule greatest in regions of numerous thunderstorms and high annual or seasonal precipitation.

(13) While the reasons are not so apparent as in the case of suspension storage, there is some statistical evidence, derived from the study of equi-frequent rain intensities of long durations, at various places, that tends to show that there are maximum limits of rain intensity for long as well as for short durations—in other words, it appears that there are certain intensities for say, one-half hour, one hour, or two hour durations which for practical purposes may be considered as never exceeded in a given locality—furthermore, these limiting intensities may be quite similar in different localities, although the frequency of lower intensities may be greater in regions of heavy rain and high thunderstorm frequency than elsewhere.

(14) It is possible by proper statistical methods to determine the limiting values of rain intensities of different durations from an analysis of observed intensities and frequencies, and such a determination appears to furnish results of more definite value than are to be obtained by the usual methods of use of rain intensity records heretofore applied. The conception of a maximum intensity of a given duration which is approached as a limit as the exceedance interval increases has an important bearing on the application of rain intensity to storm sewer design.

(a) It represents the maximum rain intensity of a given duration for which it may be necessary to provide sewer capacity in extreme cases.

(b) It may not be necessary to provide for the limiting rain intensity in all cases, owing to economic conditions. If the maximum or limiting intensity is not provided for, then its value indicates the extent to which the sewer capacity may be exceeded at rare intervals.

(c) The limiting intensity for a given duration represents a value beyond which it is never necessary or advisable to go in providing storm sewer capacity.

(15) Unit rain intensity may be defined as the intensity for a given duration having a given exceedance interval, as for example the 5-minute intensity of one year exceedance interval. The use of unit intensity furnishes a proper basis of comparison of rain intensity conditions in different places. If unit rain intensities for different places are compared respectively with thunderstorm frequency, total precipitation during the summer or thunderstorm months, and with annual or total precipitation at the same places, it will be found that there is usually a fair degree of correlation between unit rain intensity and thunderstorm frequency, unit rain intensity and summer precipitation, and summer precipitation and thunderstorm frequency, respectively. The correlation between unit rain intensity and annual precipitation is appreciable, but materially less than the others mentioned, for the reason that annual precipitation reflects the effect of thunderstorm rains to a much smaller degree than does the precipitation during the summer or thunderstorm months.

(16) At a given station the greatest single storms, the greatest daily maximum rainfalls and the greatest intensities for short intervals usually occur in years having the highest total annual precipitation.

(17) The writer has not attempted in this article to give definitive formulas of general applicability for the expression of the relation between rain intensity, duration and frequency. It is hoped that the results given will suggest and encourage further study along similar lines, such as may afford a more complete basis for generalization. The requirements for a rain intensity formula based on investigations thus far made may be stated as follows:

(1) It should indicate a finite intensity for zero duration and for the minimum exceedance frequency.

(2) For a given duration, the rain intensity should approach a finite maximum or limiting value as the exceedance interval increases.

(3) This maximum or limiting value should decrease as the duration interval of the rain increases.

(4) A single general type of formula should be applicable over extensive geographic areas and to regions varying in amount of seasonal precipitation and thunderstorm frequency.

(5) The formula may contain constants whose values in turn can be expressed either in terms of unit rain intensity, thunderstorm frequency, or total precipitation during the thunderstorm season.

(6) The form of expression should be such as to give the required intensity in terms of duration and exceedance interval, so that when the constants are known for a given location, intensities of varying duration but of the same frequency can be determined directly on the one hand, or intensities of the same duration but of varying exceedance intervals can be obtained directly on the other hand.

A Review of Recent Progress in Brick Pavement Design and Construction

By Clark R. Mandigo, Consulting Engineer, Western Paving Brick Manufacturers Association, Dwight Bldg., Kansas City, Mo.

Engineers who have been interested in pavement construction and design for the past 15 years are familiar with the truly remarkable improvements made in all classes of pavements during that time. This progress, while rapid, has been taken usually step by step and is not realized except in retrospect covering a number of years. Necessity, of course, has been the mother of invention in this case; the enormous increase in the amount and character of traffic as well as in the amount of paving have kept municipal engineers on the jump. Progress has relegated to the by-ways certain types of pavements which were extensively used 15 years ago, but it has failed to bring forth any out-and-out new type which has proved of any particular worth. The substantial development, as was prophesied by eminent engineers, has been entirely in the improvements of types of pavement existing at that time.

Great Progress Made With Brick Pavement

In no case has greater progress been shown than in one of the oldest types of pavements—brick. Because improvements in brick pavements have been continuous, gradual and prosaic rather than spectacular, the truth of the above statement is not generally realized. Then, again, the modern brick pavement is still called brick pavement and to the average man that means the particular brick pavement he sees the most frequently regardless of when it was built rather than the latest type of that pavement. Brick pavements have, of course, advanced with other types of pavement as a result of the accumulation of engineering knowledge in regard to materials and methods of construction, but great progress has also been made in the manufacture of the brick themselves and in the details of construction which can be credited to this type of pavement only.

Improvements in Brick Making

At the manufacturing end, modern machinery, expert technical advice, and specialization have much increased the quality and uniformity of the product. It used to be thought that any one could start a brick plant near any convenient bed of shale and with temporary buildings, inexpensive equipment and common labor turn out a brick suitable for either building or pavements. Nowadays there are many industrial plants representing large investments of capital in permanent construction, and the latest machinery, employing high priced labor and management, which specialize in paving brick. Since the manufacture of paving brick does not depend on any secret or patented process and the raw materials are found in many sections of the country, the sale of the finished product depends entirely on furnishing the best material at the lowest price. The positive rattler test which is standard throughout the United States, enables engineers to select the material with assurance as to its quality without regard to its place of manufacure. These factors have tended to a gradual improvement in the quality of paving brick on the market, the elimination of the unfit, and have made possible the development of the niceties in design and manufacture which make brick desirable for all classes of streets and roads. Only a few of the most important improvements need be mentioned.

The Vertical Fiber Brick

As the result of experiments made by C. Fuller, a ceramic engineer, at the Buffalo Paving Brick Plant in Kansas, a number of plants placed the so-called Vertical Fiber Paving Brick on the market in 1912. This type of brick has been so successful that the entire product of the Western manufacturers at present is vertical fiber brick and it was adopted last year as the standard paver of the National Manufacturers Association. Briefly these experiments showed that the tempered shale was built up in the forward part of the augur machine in a series of spiral layers, and that in being pushed through the "former" and die these layers became long superimposed cones the axes of which were the center line of the clay column. The particles of shale themselves have a tendency to arrange themselves with their longest axes in the same direction. The vertical fiber brick are designed to be laid so that these axes are perpendicular to the pavement wearing surface, while the older types of paving brick are laid with these axes parallel to the surface. In an imperfect or weak brick this difference is quite noticeable, but is of minor importance in perfectly vitrified brick. The vertical fiber brick is not repressed and the spacing of the wires on the cutter determine the depth of the wearing surface. The die remains the same for all depths of brick and where lugs are required they are formed as bars by grooves in the die. This explanation may clear up some confusion that seems to exist among engineers who are not familiar with this type of paver. There are, however, many other advantages to this method of manufacture.

Sizes of Brick

The brick is non-repressed which makes it stronger and freer from structural defects such as laminations. It may be made any depth desired and therefore a depth wearing surface obtained to fit economically the class of traffic it will support. Commercially they are made in 2½, 3 and 4 in. depths, of which the 3-in. depth is used in the majority of cases due to the economies of manufacture in handling. The 3 in. depth brick has proved amply strong for the heaviest loads and densest traffic and are economical for roads and residence streets though many 2½ in. brick are used for these lighter traffic streets. The 4 in. brick is now used in the middle west in only a few of the largest cities. The brick are all 4 ins. wide and 8½ ins. long. In other types of paving brick, it is very difficult to make a brick less than 3½ ins. in depth, since the depth of the brick is determined by the height of the die and a long narrow die gives a clay column of unequal density and torn corners.

In the vertical fiber, the reticulated wire cut surfaces are a plane and one of these is uppermost in the pavement making a gritty surface which affords a good foothold for horses and a good grip for auto tires. The brick are as large as can be conveniently handled thus reducing the number of joints. Only 35 are required to lay one square yard of pavement. All four edges exposed to traffic are square, making a uniform width of joint from top to bottom on all sides. They are piled on edge in the kiln and therefore all warps, kiln marks, etc. come in the joints on the pavement and not on the wearing surface, making a much smoother, more even surface. On account of the greater proportion of square edges per unit of weight, the allowable abrasive loss in the standard rattler is usually fixed at 24% for a 3 in. depth brick. It has been found that this limit gives a better quality of brick material than 21% test on the old standard repressed block. The vertical fiber brick is especially adapted to bituminous fillers in which case a lugless block is usually specified. As the process of manufacture is not patented in any respect, practically every paving brick plant is now manufacturing the vertical fiber brick and it composes the entire output of the plants in the middle west.

VIEW OF 4-INCH VITRIFIED VERTICAL FIBER BRICK BLOCK PAVING, WITH SQUEEGEED ASPHALT FILLER, ON SOUTH MAIN STREET, JOPLIN, MO.

Improvements in Construction Methods

In recent years many improvements have been made in the methods of constructing brick pavements. In no feature of the design of pavements are engineers further apart at present than in the foundations necessary to carry the loads. Experiments are now under way which will give valuable information regarding this phase of the subject. It is well to remember in this connection that the function of the foundation is the absorption of impact and the distribution of the loads over the subgrade. A more thorough knowledge of soil conditions and treatment about which so much has been said and so little known is of great importance. There is much to be criticized in the present methods of design, especially on country roads. Too much emphasis is apparently being laid on the beam bearing strength of the foundation and not enough attention paid to the distribution of the loads coming near the edge of the pavement, for example: Due to the shock absorbing and load distributing qualities of the sand cushion and brick wearing surface it is usually assumed that brick requires 15 to 20% less thickness of foundation than a soft wearing surface and it is probable that future experiments will point the way of taking still further advantage of these characteristics. The development of the monolithic brick pavement is comparatively recent and has much to commend it in its economy in load carrying capacity. It is especially adapted to country roads, but is of course a rigid slab type of surfacing and subject to some of the inherent defects of that type.

The substitution of the cement-sand cushion and the reduction in its thickness has removed the risk of the thick plain sand cushion where cement grout is used as a filler for the brick. Where bituminous filler is used a thin plain sand cushion is used, since the elastic joints give each brick an opportunity to remain properly bedded in the cushion.

Bituminus Fillers

Within the last ten years, bituminous fillers have again come into use and in the middle western states for example, are now used almost exclusively in brick pavements. The changed character of traffic and the use of asphalt instead of pitch, has eliminated any objections which formerly held against this type of joint filler. An asphalt can be obtained at a reasonable cost, which is pure, has a high melt point, is little affected by changes of temperature, is adhesive, elastic in cold weather, and long lived. Only the best quality asphalt should be used. Formerly bituminous fillers were poured from cone cans, the specifications requiring that none should "be spilled on the surface of the brick." In spite of every precaution joints poured individually in this manner settled in warm weather. The accepted method of applying asphalt filler today, is to flush the hot filler over the surface from cans or buckets and move it back and forth with squeegees until the joints are full. A coating of sand absorbs the surplus remaining on the surface. This surface coating acts as a mastic reservoir for keeping the joints full as they settle in warm weather so that by the time it has worn off, the joints are completely and solidly filled. This surface coating is therefore simply an incident to the proper filling of the joints and is not intended as a carpet or wearing coat.

Advantages of Asphalt Filler

In addition to its waterproofing qualities, the asphalt filler is easily and simply applied and there is no expense of protecting or curing it with the attendant possibility of damage by rain, frost, heat or premature traffic. The pavement is ready for traffic as soon as the filler is applied. Plumber's cuts or other openings in the pavement are easily repaired. The chief advantages, however, of an asphalt filled brick pavement are: (1) it provides a resilient, easy riding surface which is not slippery under any ordinary conditions of weather, grade or class of traffic; (2) it eliminates noise; (3) all expansion or contraction troubles are done away with; (4) it absorbs shock and impact, and (5) it makes a semi-flexible wearing surface which allows for slight readjustments between the individual brick or readjustment of a portion of the surface to conform to changes in the condition of the sub-grade, the foundation, or the sand cushion.

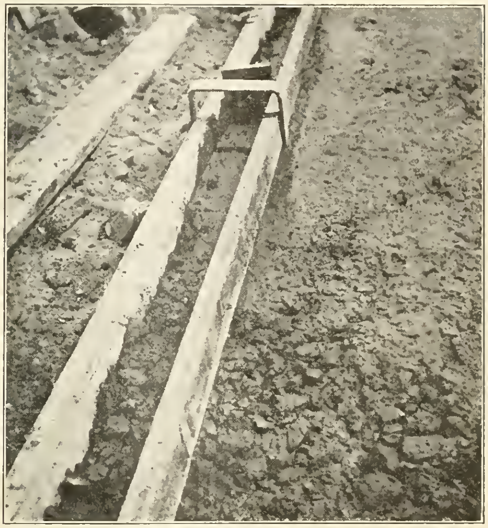
It was expected at first, that brick pavements with asphalt filler would require some maintenance of the joints. Pavements 8 to 10 years old under various classes of city traffic, however, look better than when just laid and the joints as a rule remain full. In fact this type of brick pavement has shown even less expense for maintenance than cement grouted brick, since there are no cracks formed and no bricks chipped or sheared from expansion strains.

Integral Curb on Country Highways

On country highways, the bituminous filled brick pavement requires some sort of an edging. This is usually provided by a flush concrete curbing 6 to 12 ins. wide, built at the same time and integral with the concrete base. By using the same mixture as is used in the concrete foundation, this edging can be built cheaply. Half inch joints in the curbing are usually provided at intervals extending down to the top of the foundation to provide for surface expansion and drainage of the sand cushion.

It is not intended in this article to discuss all developments in brick pavement design and construction as many of them are familiar to every engineer, but to mention some of the details of constrution of a type of brick pavement the use of which has been more or less sectional for a number of years, due no doubt to the fact that very little has been written about it in the technical press.

There is no question that a well manufactured brick of as large a surface area as can be conveniently handled, a



FORMS SET FOR INTEGRAL CURB FOR A KANSAS BRICK ROAD WITH ASPHALT FILLER.
Shows Method of Suspending Front Form, a 2x4 to Curb by Spacers and Clamps from Rear Form.

depth proportional to the amount and character of traffic and true in shape and size, laid on a sand cushion of an inch or less in thickness, on a suitable foundation, joints as narrow as possible, and filled with a good grade of asphaltic cement, and laid so that the joints are at an angle to the direction of traffic, makes a brick pavement as different in appearance and in service from brick pavements laid 15 years ago as the 1919 model automobile is different from the auto of that time.

Road-making Plans of Indiana for Near Future

To the Editor:

In regard to the road-making plans of Indiana in the near future, I would say that at the present time we have a considerable force of engineers employed in the preparation of plans and specifications for the 1919-1920 work. It is expected that there will be available for the work during these two seasons approximately $17,000,000 including both the State funds and funds furnished by the Federal government under the Federal-aid act.

We have been busy since the 6th of May organizing the State Highway Department and preparing standard specifications for the approval of the United States Bureau of Public Roads, together with detailed plans for several projects which it is proposed to construct in 1919-1920.

We will advertise soon for bids on approximately 46 miles of improved roadway. Alternate bids are asked for concrete, monolithic brick and bituminous concrete. Other lettings will follow as soon as the plans are completed until approximately 100 miles are let. This mileage will cover the available funds that the Commission will have for work during the seasons of 1919-1920.

The work this year, therefore, will be making the surveys, preparation of plans for roads and projects to cover the work for 1920 which will be a large portion of the work carried on by the Commission in the next two years. In addition to organizing and equipping survey parties and designing department for road work, we have organized and equipped a bridge department to take care of 20 ft. span of which there are quite a number on the state highways to be constructed. The Indiana Law requires that bridges of over 20 ft. span be let separately. Also that plans be prepared for both steel and concrete bridges and ultimate bids asked for on each. This involves double engineering.

The Commission and the Director are busy complying with the provisions of the law which requires that the Indiana State Highway Commission shall designate a system for the entire state before April 20, 1920. We are now engaged in making field inspections to locate the system properly to include county seats and all cities of over five thousand population.

Very truly yours,

H. K. BISHOP, Chief Engineer,

Indiana State Highway Commission.

Indianapolis, Ind., June 23, 1919.

Compensation for Municipal Engineers

To the Editor:

The subject of compensation for civil engineers is worthy of discussion and if there is any way to improve conditions, it certainly would be appreciated by the profession: even today, the wage of the engineer, in many cases, is far below that of the most ordinary mechanic and but little above that of common labor.

The engineering profession does not rank today with other professions; this condition was not so pronounced, back in the "80's," yet the greatest change has taken place since 1914, or the beginning of the world war, causing a shortage of common labor, a slackening of public work and the sudden rise in all commodities, leaving the engineer, with an open profession, to fight for an existence.

Almost all professional men, having a closed profession, have advanced their charges for service, in proportion to the increased prices of commodities. Trade unions have advanced their wages in accordance with their ability to raise, so the engineer, with an open profession, must plod along through all financial depressions and political storms without a murmur.

The laws of our state, fix the salaries of the city engineers; these salaries were fixed in the year 1905. The salaries range from the meager sum of $1,000 to $3,500 per year, according to the class of city, and but little change has taken place since then, except possibly an occasional engineer landing in the poor house.

Consider the cost of living at the present time, the increase in wages to skilled and common labor since 1905, and then observe the difference between "law and justice," as far as the engineer is concerned.

Now as to the municipal engineer entering politics in order to better his condition, I question the practicability of this course. Having been employed by our city, "with the exception of one year," since 1902 as city engineer, also serving as a member of the Board of Public Works in conjunction with the office of city engineer for several years, I find that politics and efficiency do not work well together. I am heartily in favor of classifying the profession, and for any fair method of increasing its compensation.

Very truly yours,

T. E. PETRIE, City Engineer.

Marion. Ind., July 2, 1919.

Recommendations Pertaining to Street Openings and Pavement Restoration

A committee report on "Pavement Restoration and Street Openings" was made and approved at the recent annual meeting of the National Highway Traffic Association. Messrs. B. H. Wait, W. T. Chollar and J. B. Vandever composed the committee and their report was substantially as follows:

Unfortunately, a very large percentage of street openings occur in the large cities where traffic is heavy and such openings cause a maximum of inconvenience. The committee investigated the subject from the following angles:

First—Reducing the number of street openings to a minimum. Second—The issuance of the permit and the placing of responsibility for the work. Third—Proper execution of the work and the care of traffic while such work is under way. Fourth—The restoration of the pavement.

In order to gather information on present methods, a questionaire was sent out to all of the largest cities in the United States and about 65 replies were received. These showed lack of uniformity in methods as well as ordinances relating to the work.

After studying these over the committee did not attempt to recommend uniform ordinances, specifications, or methods. They did, however, recommend the following procedure:

Recommended Procedure

FIRST—In order to minimize the number of openings:

(a) Keep detailed records of all sub-surface structures laid in order to do away with openings made to locate such structures.

(b) Rigid inspection by the city of the construction of all sub-surface structures, whether privately or publicly owned, in order to insure the best construction and to lessen the number of openings to repair leaky joints, etc.

(c) Approval by the city department in authority of all plans of sub-surface structures in order that they may be laid where there will be a minimum amount of disturbance of the pavement for present and future work.

(d) Separate systems to be laid under sidewalk areas where practical. If this cannot be done that all surface connections to all property be required previous to placing of the pavement.

SECOND—Issuance of the permit and placing responsibility for the work.

(a) Permits to be granted by the city department in authority to licensed plumbers, contractors, and public service corporations only after the submission and approval of detailed plans of the work to be undertaken.

(b) Cash deposit to be made to cover the estimated cost of the work to be done by city forces and,

(c) Bond to be required to indemnify the city against legal action due to accidents or other causes.

THIRD—Wherever it is practicable it is recommended that the city complete all work subsequent to the excavation and laying of the mains or conduits, including back filling, temporary pavement where necessary, and permanent pavement.

Where this is impracticable, that the back filling be done under city inspection by the person, firm or corporation to whom the permit is issued.

FOURTH—Restoration of pavement.

No restoration of permanent pavement should be done by the contractor but all of this work should be done by city force to be paid for from the cash deposited previous to starting the work by the person, firm or corporation to whom the permit was issued. If impracticable for the city to follow back filling closely with permanent pavement, suitable temporary pavement should be placed by those doing the work and permanent pavement be placed by the city force as soon as practical after completion of the back filling.

In the opinion of the Committee it is very important that the city's portion of every activity in connection with plans, permits, construction, etc., should be handled by the Highway Department or similar department of the city. This will result in less "red tape" and consequently—less delays.

It is the opinion of the Committee that in the majority of cases, if the work is properly done, that permanent foundation can be placed immediately following the completion of the back filling. In such cases, the depth of the foundation should be made from 4 to 6 ins. deeper than the ordinary depth of the pavement foundation on the street.

The width of cut in the foundation should be from 1 to 2 ft. wider than the width of the trench, depending on soil conditions and the top of the trench excavation should be beveled back so that the new foundation will have a bearing against the side of the trench.

The committee is of the opinion that whenever practical it should be required that all cuts be made of standard widths and that precast slabs of the standard widths and sizes be made up and stored ready for placing and grouting as soon as the back filling is completed. In small openings this will allow the city force to place both foundation and pavement surface in one operation, resulting in earlier completion of the work and less inconvenience to traffic.

Some Features of Hydro-Electric Engineering Practice and Possibilities

By H. de B. Parsons, Consulting Engineer, 22 William St., New York City

Generation of power is accomplished by use of water, coal, gas and oil. Of these natural resources, water probably offers the most attractive features, as it has capacity for operating very large generating stations, picturesqueness in its surroundings, and requires interesting preliminary study. Furthermore, suitable control and regulation of flowing water will relieve "power shortage" which was shown to exist by the recent war.

The growth of science, through experimental and research work, and its application to the uses of mankind during the past 75 years has been bewildering. Judging the future by the past, bold indeed would be the man who would care to predict or deny what the next century may show.

The commercial employment of electricity was not accomplished until the last third of the nineteenth century. Suddenly, as if by magic, electrical improvements and developments followed one upon another, and electric energy became a source of light, heat, power and traction. Both high tension and alternating currents came into use as a natural sequence of increased knowledge, and at once it became feasible to transmit the mysterious "electric fluid" over long distances at commercial rates. Hydro-electric plants were developed for the purpose of generating and transmitting current across country to distant points. The present commercial endeavor is electrically to connect generating stations on the same and on different watersheds, and to operate all as a single system under one control. This unity of operation has the advantages of reducing drop in voltage due to line resistance, saving in overhead charges, and enabling the peak loads of some plants to be carried by others.

One Development Serves 84 Cities and Towns

The developing and electrically connecting of different watersheds has progressed to a marked degree in some western states, and the aggregate of water power under one control, both developed and owned or controlled for future development, is large. One such company has about 340,000 kilowatts (454,000 h. p.) capacity, of which 212,500 kilowatts (283,300 h. p.) has been developed and is being operated over about 1,900 miles of transmission lines, furnishing light and power to some 84 cities and towns. Under proper management this unity of operation will show economies over any plan of separate operation.

During the recent war in Europe, the public demand for fuel conservation encouraged a similar plan in the eastern states, and the growth of such interconnection of power plants will increase as time advances. There is a steady increasing demand for light, traction and industrial power. Many new enterprises will require current for recovery of nitrogen from air, for electro-chemical processes, and for utilization of waste products. In consequence, some water powers, previously of little commercial value, have become financially inviting projects because the electric current generated can be transmitted for 200 miles or more and sold at profitable rates.

Cost of Water Power Development

The cost of developing a water power is high, and ordinarily varies from two to five times that of a steam plant of equal capacity. A large proportion of the first cost is for construction of dam, head race, tail race, riparian rights to secure lands that will be flooded, rights of way for and construction of transmission lines. Consequently, interest forms a heavy annual fixed charge per horsepower. Interest is especially heavy if only a portion of the possible power-generating apparatus be installed. Dams and pondage should be constructed for full development, although the first demand might be only for part power. Water wheels, generators, and transmission lines can be added as required, but dams, races, and pondage are most difficult to enlarge after first construction.

Potential Water Power

The potential power of falling water depends on temperature, altitude and latitude. Loss of weight due to temperature and diminished force of gravity from high altitudes and low latitudes, are small and can be neglected in estimating power available. Although the kilowatt is the same everywhere, the foot-pound varies, since the local weight of a "pound" changes at different places, due to altitude and latitude. Consequently, the kilowatt is a better unit of measurement than horsepower. A horsepower is taken at 0.746 kilowatts, equivalent to 550 ft. lbs. However, on the equator at sea level the equivalent would be 551.70 ft. lbs., and on latitude 60 degress at 5,000 feet elevation 549.52 ft. lbs.

To determine approximately the amount of electrical power that can be delivered at the end of a transmission line, the following formula will be found useful for preliminary work:

$$\text{Kw. delivered} = 0.055\ H.\ Q.$$

in which H denotes head of water fall in feet
Q denotes water discharged in cu. ft. per second

Transmission Lines

A transmission line costs, complete, including right-of-way, about $2,000 to $2,500 per mile, and at the present time the average cost is about the same for wooden poles and for steel structures. Lumber is getting scarce, and as suitable wooden poles are difficult to obtain, the increasing cost soon will prohibit entirely their employment. Steel has many advantages over wooden poles, such as flexibility—since it does not break by snapping—ability to withstand strains, smaller number per mile, and longer life.

The loss in transmitting electric power (volts times amperes) varies as the square of the current. In consequence, the higher the voltage the less will be the loss in power when transmitting the same amount of energy. For long transmissions the voltage is always high, and varies in common use from 30,000 to 125,000 volts. Alternating current is employed because it can be transformed economically by "stepping up" from generator voltage transmission, and again "stepped down" from transmission at the point where the power is used.

Weight of Copper

The cost of copper wire is a large item of transmission cost. The size of copper wire is determined by the "drop" or loss in voltage allowed. The weight of copper in pounds per kilowatt delivered at 10 per cent. energy loss in line, can be closely estimated at

$$28 \left(\frac{\text{Distance in miles}}{\text{Volts in thousands}}\right)^2$$

For any other loss in per cent., correct above result by multiplying by

$$\frac{10}{\text{Assumed loss in per cent.}}$$

Disadvantages of Water Power

Hydro-electric power is subject to annoying variation, to which steam power is not. Causes which reduce the value of water power in comparison with steam power, are floods, which frequently raise the tail water so as to reduce the effective head; variations in stream flow; droughts; ice; breaks in transmission lines caused by wind, sleet, and lightning; and line loss of voltage due to load (the higher the load the greater the loss). Many of these items can be offset in part by an auxiliary steam plant, but the interest on such a plant adds to the fixed charges.

Advantages of Water Power

The development of a water power, like any other business enterprise, must compete in the market for capital. Unless the enterprise is attractive in its returns, capital will not be readily obtainable. As a water-power plant has many attractive features, when compared with steam, the difficulty of obtaining capital is largely offset. Operating costs are capable of being estimated accurately, as the cost of water is largely interest plus taxes plus depreciation, while for steam the price of coal and cost of delivery are continually rising and can only be approximated for future years. When examined and reported on by competent engineers, capital will be much reassured. All things being considered, the features of good water-power developments always will be attractive, and the attraction will grow rather than diminish.

Available Water Power Five Times Greater Than Developed Steam Power

In the United States the developed water powers are capable of generating probably 6,000,000 h. p. while the water powers not as yet developed, but capable of development, could generate perhaps 50,000,000 h. p. without storage and 200,000,000 h. p. with storage.

It has been estimated that the aggregate power generated in steam plants in the United States is between 26,000,000 and 40,000,000 h. p. In addition, there are about 60,000 steam locomotives, with a maximum capactiy of about 36,000,000 h. p., of which about 4,000,000 h. p. may be in actual daily service. These two classes would give about 40,000,000 h. p. as the total for steam. In other words, developed water powers amount to only about one-seventh of the steam powers, although the available power is nearly five times that of steam now in use. The potential water powers are not evenly distributed throughout the various states, but are in greater magnitude where coal is lacking. The distribution has been estimated in percentage of total potential water power in the United States, as below:

New England States—Maine, Vermont, Massachusetts, New Hampshire, Rhode Island, Connecticut........ 3%
South Atlantic States—Delaware, Maryland, Virginia, South Carolina, Georgia, Florida.................. 6%
Southwestern States—Arizona, New Mexico, Texas Oklahoma, Arkansas, Louisiana.................... 6%
Pacific States—California, Oregon, Washington.......43%
All other States..42%

These percentages mean that there could be developed, in approximation only, in the New England States, 3 per cent. of 200,000,000 h. p.; and do not necessarily mean that there is in use now 3 per cent. of 6,000,000 h. p. in these States.

No matter what the load, fixed charges on a water-power station remain practically the same. In other words, a water-power plant operates at very little variation in expense from no load to overload. With steam plants there is a much greater variation, as fuel and some labor are saved when power is not being generated.

Water Power Variables

Water power is inferior to steam power, because a river does not flow uniformily throughout the year. A large percentage of the maximum power can be generated only during a few monthly periods when the river is high, and must be sold as secondary or even as tertiary power at low rates per horsepower. Again, river flow is not uniform during successive years, as the dry weeks do not occur always in the same calendar months in consecutive years, so that secondary power cannot be promised in advance. This uncertainty also affects the selling price of power. As interest and depreciation remain the same, irrespective of the quantity of power produced, it is self-evident, when full power cannot be generated, that fixed charges are a large proportion of the selling price of primary power. As secondary power sells at prices from one-half to two-thirds of that for primary, the proportion of fixed charges on secondary power is even heavier. It is still more so on tertiary power.

Steam plants can be located where desired. Water plants cannot be so centrally located, and must have transmission lines which are expensive to maintain. Fuel and labor costs have risen rapidly in the past few years and have brought many water-power projects within reach of successful commercial development.

Investigating Business Chances

Before a water power is developed, careful study should be made of the project to determine whether it will pay. Often the market price at which electric current can be sold, is not enough to cover the cost of generation, transmission, upkeep, fixed charges, and depreciation; and yet it might be advisable to develop a water power by relying on future increase in demand for current and on increase in cost of generating power by other means. Thus, it readily can be seen that there is a large chance for error in making a forecast, and, under all circumstances, proposed developments should be carefully examined and reported on by competent engineers of experience in these matters. A forecast of future business and how a development should be made, are more important than mere estimates of cost of construction. The selling price of hydro-electric power should be lower than that for steam power to meet competition successfully.

Due to variation in river flow and obstruction from ice, etc., the water power available is below the yearly normal for a part of the year and above normal for the balance. Consequently, water-power developments that are designed to meet a fairly steady load are frequently augmented by auxiliary steam plants. These steam plants should be located where fuel can be readily and cheaply delivered.

In this connection, it is well to remember that *reliability* of power is much more important than *cost* to many industries, and that selling price is governed largely by the former.

Study of Stream Regimen

The study of stream regimen to determine the flow available for power development is a very interesting subject and one liable to considerable error if the data are not carefully compiled. The maximum flow of a river is of less interest for power than the minimum flow. It is especially of interest in determining the requisite length of spillway at the dam. When sufficient spillway is not provided, the flow over the crest at times of high flood will produce excessive pressure on the dam and has been a cause for failure. It is good practice to provided an excessive spillway rather than one that is too short.

Obviously, the mean and minimum flows are of most interest. The mean flow selected is one used to determine the size of a development that might profitably be installed. The mean should be for a number of years, and be studied in connection with the minimum. If the actual minimum occurs at very long intervals, it would be safe to use some record higher than the very lowest. The minimum selected is extremely useful in determining the amount of primary power, that is, the amount that can be sold under contract for delivery every day for successive years. This primary power naturally is the most valuable on account of its regularity, and commands the highest price per kilowatt.

The Federal Government and some state authorities have established gauging stations at various points on important streams. These records are of value, when taken in connection with rainfall and watershed areas, in reaching conclusions as to what would be the normal flows at points other than the gauging stations. On the same stream, the records of two or more gauging stations can be interpolated for intermediate points. On other streams, a careful study of the watersheds and rainfall, used with reference to gaugings on adjacent streams, will be the best method in all probability. If there are no gaugings in the neighborhood, additional research work and study of terrain for run-off will have to be undertaken to reach conclusions as to stream flow.

Run-off

While rainfall is a good guide, it cannot be trusted entirely, as the run-off varies through wide limits on different watersheds. It is difficult to determine the true run-off on theoretical considerations alone. The best guide, of course, is actual measurement over a period of years, which unfortunately is not feasible for most projects on account of the time required.

If the data will permit, it is best to arrange each yearly flow in the form of a curve, using ordinates as flows in cubic feet per second, and abscissa as days in the year. Then arrange the daily flows in order of wetness. If only monthly figures are available, arrange the curves in similar manner, that is, the monthly flows in the order of wetness. A mean curve covering a number of years then can be drawn. On this mean curve, have a vertical scale in kilowatts corresponding to flows. The operating capacity of the development would be about that represented between 60 to 65 per cent. of the year. The ordinate of the curve at the percentage of time selected would represent the "flow of development" or the "kilowatt development," and a design for this capacity, in all probability, would be the one best suited to make a fair return on the investment. Special consideration, such as a very uniform streamflow throughout the year, might increase the "flow of development" to over 65 per cent., and vice versa, for some classes of manufacturing industries it might pay to develop to even a greater capacity than that shown at 60 per cent. of the year.

During 60 per cent. of the year, water is running to waste over the spillway, but as this water is only available for a portion of the year and not always for a continuous period, it would not pay to install machinery to use it and have the machinery idle for the remaining 40 per cent. of the year.

Storage

On rivers which have a great variation in flow, storage of water, that is, regulation of flow, will greatly increase the primary power that can be obtained throughout the year. Storage of flood waters, to be released after the stream flow has fallen to some predetermined rate, is expensive and can be carried out only by co-operation of all power users on a stream, or under Federal or State control. A chief expense is the cost of lands to be flooded. These lands frequently contain villages and cemeteries that could be purchased only by condemnation. Cost and difficulty of obtaining flow lands for storage, have delayed the regulation of many important streams.

Federal laws as well as the laws of some states discourage, rather than encourage, a proper hydro-development for the universal benefit of the nation. It must be recognized that power streams are chiefly interstate in their flow; that their tributaries may be also interstate; that their waters are required for potable uses, for irrigation and for navigation, as well as for power; and that power development must not be the sole factor considered. Streams are used for drainage also, and deleterious pollution will be restricted, no doubt, as time progresses and requirements demand.

The country is getting densely settled in certain parts, and industries requiring large amounts of power are centering in localities. Power is needed for such industries and for these densely populated communities. In order to conserve natural resources of coal, wood and oil, and to relieve the railways of unnecessary transportation of fuel, water power can be substituted, but the use of the streams should be along a well thought-out public policy. Such a policy for the use of water—potable, industrial, irrigation, drainage, and power—has not yet been formulated. It is important, therefore, that hydroelectric developments should be studied under a broad aspect of national and state considerations, so that every development of the waters can be made to best serve the need of industries and communities with the least injury to any.

Power Sites on Government Lands

In order to develop many of our streams for their best use, a part of the public domain would be required. Government lands can be used only under revokable permits, and no good plan for recapture has been promulgated. Capital will not develop and then have its work taken from it before it has had a chance to reimburse itself. Special acts of Congress are required whenever a navigable stream is affected. By a suitable arrangement of dams and locks, it would be possible to develop many streams for power generation and make them navigable by canalization. Private capital hesitates to take risks when hampered by recapture clauses, and so far the Government, although wanting the developments, will not assume any share of the hazards.

It would seem possible to have the Government so act as to encourage private development along some pre-arranged plan or policy for the national good. Also, it would seem possible to have the states act in unity so as to assist such a national development and not hamper the situation by petty jealousies. A proper plan or policy would produce cheaper power for the users. The people at large would benefit. Water power is self-continuing, while all the mineral fuels are not. The more we can save our mineral resources of fuel—coal and oil—for auxiliary purposes to aid the water generating stations in dry seasons, the richer and more prosperous will our country be.

Value of Water Powers

There is a universal sentiment that power generated by falling water is always cheap, and, as a corollary, that all water powers are valuable. Those who have studied the matter recognize both the truth and fallacy in this idea. If the potential energy in falling water could be recovered at low cost, the power would undoubtedly be cheap and valuable, the value depending on the nearness of the falls to the market where the power could be sold. The value of electric energy, like other commodities, depends on the demand and on its cost delivered. Other things being equal, geographical location has an important bearing. An isolated water power, far from any center of demand, cannot be as valuable as one near such a center. For instance, Niagara Falls is extremely valuable as a power-generating fall, but similar falls situated in a desolate uninhabited country would command little or no value. Again, when a number of powers are located in one district, either on the same or adjacent watersheds, and can be electrically connected together and operated as a unit, they have inherent values due to this fact which must be considered when appraising them.

The value of a water power is in reality the sum of the value for water rights and of the reasonable cost of development. Any monetary figure placed on water rights would take into consideration the location of the power, character of the stream, regulation or no regulation, future possibilities, and similar considerations.

Water rights are the rights to make use of the water flowing past an owner's land. If the water cannot be used, there are no water rights. The water rights belong to the land abutting the stream, not only at place where the fall occurs, but also to those lands which are required for pondage.

These rights could be appraised at a figure based on capitalizing the annual saving, if any, by the use of the water to generate power over cost of generating power by other means. A transmission system would come into this consideration, because a steam plant, for instance, with which the water plant would compete, would be located at or near the place where the power would be used. The capitalizing should be at some percentage high enough to cover risks of development and future possibilities of competition.

When no annual saving is shown, water rights can have no present development value, although they may have a future possibility that would entitle them to some value. This con only be determined by careful study on the part of one well qualified to act.

The cost of the development is not a serious matter to estimate. Consideration, however, should be given to whether the development is a proper one and whether it is efficient. For instance, in some localities a wooden dam would be deemed sufficient, while in others a masonry dam with ornamental features would be demanded.

If a development exists which is inefficient, it may reduce value because its removal for better improvements would cost money that would bring in no return on the capital. In fact, there are many developments which could be redeveloped with advantage and any saving in fuel by so doing would be a step toward conservation of national resources.

Conclusion

In conclusion it appears that developed water powers have only one-seventh the capacity of steam plants, while the country's resources are such that the available water power with storage exceeds the present demand for power nearly fivefold. Why not have a nation-wide plan and policy to encourage the use of water power to the fullest extent and conserve mineral fuels, which cannot be replaced, and also relieve the railways from carrying those fuels needlessly long distances?

Some Suggested Changes in Concrete Sidewalk Specifications

By Charles E. De Leuw, of Gates & De Leuw, Engineers, 1742 Monadnock Block, Chicago, Ill.

Concrete sidewalks are probably the simplest construction with which the municipal engineer is ever engaged. Sidewalks are usually constructed as an appurtenance to some major improvement, and in many places they are put in by the local contractors with no supervision whatsoever by the engineer. The average city engineer does not take the design of sidewalks very seriously and is inclined to slide the work through as speedily as possible. The simplicity of the construction is responsible for the lack of attention.

Concrete sidewalks as they are now built will hold together a good term of years. It is true that they buckle, crack, sink and disintegrate in places but it does not cost a great deal to build a new one. However, if we consider the total of the sidewalk construction done in the average city during the average season, we will realize that the volume of the work is sufficient to make it worth while devoting some thought and time to bringing our specifications up to date. This is not intended to be a general indictment of municipal engineers. Their practice has simply been to follow the standards generally accepted on a very minor portion of their work, and the writer has been guilty of the same error of omisssion.

Elimination of Cinder Foundation

When we come to consider the chances for improvement of concrete sidewalk design we find our greatest opportunity in elimination of the cinder foundation. Sidewalk specifications almost always call for a bed of cinders from 6 to 10 ins. in thickness to be laid under the concrete. Why do we use cinders? Does a mass of this material, subject to decomposition in the course of time, provide a more substantial foundation than the soil? Unless it does offer a greater bearing value than the soil, or unless it provides underdrainage not otherwise obtainable, cinders are a useless expense. It would be a difficult matter to find a properly drained soil which has less bearing value per unit of surface than cinders. Sidewalks have very modest requirements as far as bearing value of foundation is concerned so we must look to the matter of drainage to find a *raison d'etre* for the cinder foundation.

Underdrainage og Sidewalks

A bed of coarse cinders, drained and connected properly to a suitable outlet, will admittedly provide splendid underdrainage for sidewalks. While we always find the bed of cinders, how many times do we find any connection, proper or otherwise, to an outlet? With no outlet a cinders bed is useless and in some instances worse than useless. Let us consider the case of a sidewalk to be built in a porous soil: Unless drain tile or an outlet is provided, the porous soil provides the outlet for the water collected in the cinders, the function of the cinders being merely to collect and hold the water until drained off through the soil. In case the walk is to be laid in a dense, compact soil the cinders foundation with no outlet will collect the water and hold it in place underneath the walk, thereby greatly increasing the damage done by freezing and thawing. The contention of the writer is that most soils have sufficient porosity to provide all the underdrainage necessary for concrete sidewalks. In the rare event that the soil is of too fine a texture to provide underdrainage, cinders or gravel should be placed on the subgrade to a depth of 6 ins. and tile outlets provided at the sumps in the sidewalks. These tiles should be led into a catch basin or adjacent gutter.

Expansion Joints

Another thing often neglected in concrete sidewalks is the proper provision for expansion joints. It is common practice to leave a thin joint at 5 or 6 ft. intervals, but experience has shown us that these alone are insufficient. In the course of a few years these narrow slits become completely filled with dirt and debris, which prevent their serving the purposes of expansion joints. Where no other provision for expansion is made, we are certain to find the walks buckling or pushing the curb out at the street intersections. The writer has found that it is wise to place a ½-in. joint the full depth of the walk at 50 ft. intervals. This joint should be filled with some bituminous filler to prevent the admission of dirt and other non-elastic material.

One Course Concrete Recommended

It is a matter of common knowledge that in the field of Portland cement concrete pavement construction, the two course pavement is practically a thing of the past. As municipal engineers have found one course concrete pavements to be the best practice, so will they find one course cement concrete sidewalks to be the best practice, when they give the matter their attention. The principal defect in the two course walk, is that regardless of the care used in construction, there will always be a plane of weakness between the base and the top. Certainly no method of construction has been devised which will give complete coherence between the two courses. The many existing walks with loose or cracked tops are eloquent testimonials to that fact. Place the same amount of money in a 1-2-3½ one-course Portland cement concrete sidewalk that you now put in your standard sidewalk with its mortar top. You will have less thickness, but much greater strength and longer life.

Summary of Recommendations

To sum up the suggestions given above, the writer recommends: the elimination of the cinders foundation unless the soil is impervious, when some porous foundation should be provided, preferably gravel or crushed stone, and connected up to a good outlet; the placing of ½-in. expansion joints every 50 ft. of walk; the construction of one-course walks. The elimination of the bed of cinders will save a substantial proportion of the cost of this work. The construction of one course work will not save any appreciable amount but will secure more substantial and lasting work. These recommendations are not made unadvisedly. They are made after some study and actual trial by the writer under varied conditions.

Notes on Road Foundations, Drainage and Culverts

By U. W. Christie, County Engineer, Dufferin County, Ontario, Canada

When we consider some recent failures in what were previously considered good roads, the problem of the immediate future is going to be the development of adequate foundations to handle the heavier class of traffic, said Mr. Christie in addressing the recent annual convention of Ontario county road engineers and superintendent.

Failures have largely been the result of weak foundations at the time frost is coming out of the ground, when the water content of the soil is high and foundations are consequently weakened. What degree of weakening is permissible under any conditions before failure is reasonably certain, is not known because we never know, even approximately, the factor of safety in the bearing power of our subgrade.

Moisture Content of Subgrade

Some studies by an engineer interested in public roads give the following interesting data: Clay below a concrete pavement contained 19 per cent. by weight, or about 46 per cent. by volume, of water. In another case clay contained 12.7 per cent. by weight. Clay loam under an asphalt pavement on a 7-in. concrete base contained 13.6 per cent. by weight, or about 33 per cent. by volume, of water. A sand cushion on a concrete base under wood blocks, may contain as high as 12,7 per cent. by weight of water.

The above figures are roughly the natural water content of the various materials under the given conditions.

Movement of Capillary Water

The following table shows the height to which capillary water rises in certain soils in 24 hours:

Light sandy soil	14 ins.
Gravelly soil	16 "
Decomposed granite (loam)	21 "
Heavy granite loam	16 "
Heavy clay loam	11 "
Heavy lava ash	16 "
Pure sand	9 "

In one day the capillary water moves upward about one half its apparent final limit. In three days it moves about two-thirds its apparent final limit. In some soils the movement upwards in the first two hours is as high as one-third of its movement for 30 days. In pure sand it rises in one-half hour approximately one-half as high as in twelve days. The movement is more rapid at the start in light soils, and slows down rapidly. After three days the movement is exceedingly slow in pure sand. In heavy soils the movement is uniformly slower and more sustained. In light soils the per cent. of water in the soil decreases rapidly with the height above the source of water, while in some heavy soils the water content is strikingly uniform at different depths.

Horizontal capillarity occurs with much faster water movement and greater uniformity of moisture content. The speed and distance vary with different soils and ranges from 7 to 33 ft. in the first 24 hours.

Capillary Action

The rapidity with which capillary occurs when there is a free source of water makes it necessary to remove this source with the greatest promptness if a substantial road foundation is to be maintained.

If it is absolutely necessary to allow water to stand or flow along a road embankment for even a few hours, the height of the subgrade above the surface of the water and its distance horizontally from the water source must be considered. Should we have a wetted side drain for only one day at a time, a height of subgrade of 18 ins. will in all probability be sufficient, and should the horizontal distance to the drain be large the 18 ins. may be reduced, but if the wetted side drain is to remain for a considerable time the height might have to be increased as much as two or three times the above figure.

Surface Drainage

The road builder should not only strive to get the water out of the road foundation into the side ditches as quickly as possible, but he should also strive to get the water out of the side ditches and off the road as quickly as possible.

Culverts should be built at low points and ditches should be constructed with a uniform grade to and from them, both culverts and ditches should be kept free of all obstructions that will impede the free flow of water. A special effort should be made each fall to remove all trash and debris collected at entrances and outlets of culverts.

A Dry Subgrade

A dry subgrade is a good foundation for almost any of the ordinary bases if it be properly shaped and rolled prior to surfacing. Thus a ridge road is always a good road with a side hill road, if proper outlets are opened, a close second, the secret being that they are easily drained and, consequently, are generally either naturally or artificially sufficiently drained. On the other hand a swamp road is invariably a bad road, as nature has not provided for a dry subgrade and artificial drainage is difficult and expensive, and in the past has been greatly neglected. In many cases a canal or canals have been dug along the side or sides of the road, and these though they have no proper outlets, are used as dumping grounds for the neighboring farms. Before road construction is attempted such drains must be carried to outlets and if the water cannot be lowered sufficiently a foundation not seriously affected by capillary must be built. Such a foundation might consist of a layer or two of field stone, 8 to 12 ins. thick, covered with crushed stone or coarse screened gravel. Probably a telford foundation would be better, but hand placing of stones is a tedious and expensive job and, at the present prices of labor, is, except in extreme cases, not warranted. If the conditions be somewhat more favorable and the traffic not too heavy, a layer of from 4 to 6 ins. of coarse crushed stone might be sufficient. In any case tile sub-drains must be placed at intervals, depending upon conditions, leading to the side ditches, and if these sub-drains are not too expensive they cannot be too frequent. On side hills which are wet one tile drain 4 or 6 ins. in diameter, placed on the high side at a depth of 3 or 3½ ft. and bedded in gravel will usually be sufficient, but on wet cuts, two side drains will be required.

Vehicle Load on Roads

If we consider the maximum load allowed on county roads, that is a vehicle weighing 12 tons with a maximum pressure of 650 lbs. per inch of tire width and that two-thirds of the load or 8 tons are carried on the rear axle, we have a weight of 4 tons per rear wheel which would require a tire width of over 12 ins. Now if we assume that the pressure is carried downward at an angle of 30 degrees with the vertical, and that a gravel subsoil will support 8 tons per square foot, firm clay, 4 tons per square foot, damp clay, 2 tons per square foot, wet clay, 1 ton per square foot, and wet yielding soil only ½ ton per square foot, we would require a depth of crushed stone of approximately 3½, 6, 9½, 16¼, and 25 ins., respectively, in addition to the wearing surface.

In the last two cases a condition is met, which requires special consideration. If this heavy class of vehicular traffic were very limited it appears that the reasonable thing to do would be to prohibit its use on the road during wet seasons. On the other hand if this heavy vehicular traffic represented a fair proportion of traffic it would appear that the road should be made to accommodate it. Special draining should be resorted to or it might even be necessary practically to bridge the soft places by using a telford base.

The cross-section of the road should be continually changed to meet continually changing conditions of subgrade.

Location and Size of Culverts

Culverts are placed on the line of natural or artificial watercourses and generally at right angles to the center line of highway as this saves in cost. It is not good practice to place all culverts at right angles to the center of the road as there are conditions arising in which such an arrangement would not at all apply to the drainage requirements, and it is well to remember that the object of a drain is to facilitate drainage and a culvert being part of a drain, has like duties to perform.

It is not safe to depend upon any general simple rule to determine the size of a culvert as conditions are so different. The size depends upon the rate of rainfall, the extent of area drained, the rate of slope, the character of the soil, the shape of the area, the presence or absence of bush, and the season. A small area will require a proportionately larger culvert than a larger area, a circular or square drainage area will require a larger culvert than a longer narrow area. A well defined valley requires a larger culvert than one consisting of a flat slope. In warm weather the size depends upon the porosity of the soil and the extent of evaporation. On sandy soils 30 to 50 per cent only of the rainfall will reach the culvert and on heavy clays, 90 to 100 per cent. Long, heavy rains will saturate any soil until nearly the entire rainfall will run off. Frozen ground will give 100 per cent. run-off, to which should be added allowance for rain melting snow. If all the rain falling on an area reaches a culvert in 30 minutes and if the maximum rainfall recorded in 30 minutes is ¾ in., the rate of rainfall to use in designing a culvert for that area, would be a rainfall of 1½ ins. per hour.

Small Culverts

Small culverts are usually pipe, either cement, vitrified clay, cast iron or corrugated metal, with an upper limiting size of about 30 ins. diameter though much larger sizes may be procured. Be sure to lay all pipe with a grade dropping to the down-stream end and that the conditions at the lower end of the culvert will carry off water as fast as the culvert discharges. All pipes should have a covering of at least 1 ft., and where the traffic is heavy the covering should be at least 2 ft. If the fill is not less than 2 ft. or more than 10 ft., double strength vitrified sewer pipe may be used; these are made in lengths of 2, 2½ or 3 ft.

If the soil is firm, for pipe up to 15 ins. in diameter, excavate about 1 ft. wider than the over all diameter of the pipe and about 8 ins. below grade. Fill the extra excavation with well-packed gravel and bed the pipe thereon, being sure to secure a proper bearing throughout the entire length of pipe. Lay the pipe to the true line and grade, beginning at the down-stream end and facing the bell ends up stream. Caulk joints with oakum and fill in the remainder of the joint with a mixture of 1:1 sand and cement. In back filling place the material in thin horizontal layers and tamp well under and for some distance above the half height of pipe, but be careful not to tamp too much just above the pipe. For pipe 15 ins. in diameter and over, excavate about 3 ins. below the bottom of the pipe and about 6 ins. wider than the outside diameter of pipe and place and joint as for smaller pipe, but fill the extra excavated space with concrete of the proportion of 1 cement, 3 sand and 5 screened gravel with no stones exceeding 1½ in. in largest dimension or if suitable pit run gravel is available use in proportion of 1:6. The pipe must be bedded on the concrete and the concrete well packed around the pipe and brought to the half height of pipe filling the entire excavation. Above the half height of pipe it slopes up to top of pipe where it has a minimum thickness of 3 ins. above the pipe. For a 15-in. pipe this requires slightly over 5 yds. of concrete to the 100 ft. of culvert. Cast iron pipes, on account of their great weight and present cost, are not much used.

Metal Pipe Culverts

Corrugated metal culverts are much used in highway construction, as corrugation gives a very high strength in proportion to the weight of material. They are made in sizes from 8 to 84 ins. in diameter and in two styles, semi-circumference section and complete circumference section in lengths up to 40 ft. Longer lengths are obtained by fastening two lengths together by using corrugated metal collars supplied by the makers. All corrugated culverts should be galvanized.

All pipe culverts are better if provided with cement concrete end walls which should in general extend two feet below the invert of the pipe and reach to a height above the pipe to hold back a fill with a side slope of 1½:1. Such a wall at the end of an 8 in. pipe would be 4 ft. 2 ins. long, and would contain 0.77 cu. yd., at the end of a 10 in. pipe would be 4 ft. 10 ins. long, and would contain 0.92 cu. yd., at the end of a 12 in. pipe would be 5 ft. 6 ins. long and would contain 1.08 cu. yds. and at the end of a 16 in. pipe would be 6 ft. 10 ins. long and would contain 1.42 cu yds.

Concrete Culverts

Probably the best material for culverts over a 2 or 3 ft. span is reinforced concrete. A combination of steel and concrete constitutes a form of construction possessing to a large degree the advantages of both materials without their disadvantages. Steel is a material specially well suited to resist tensile stresses, and for such purposes the most economical form—the solid compact bar—is well adapted. To resist compressive stresses steel must be made into more expensive forms, consisting of relatively thin parts widely spread, in order to provide the necessary lateral rigidity. A serious disadvantage in the use of steel in many localities is its lack of durability.

Concrete is characterized by low tensile strength, relatively high compressive strength, and great durability. It is also found that steel well covered by concrete is thoroughly protected from corrosion. Concrete is also a comparatively cheap material and is readily available is most localities.

The Design and Construction of Granite Block Pavements in Cincinnati

By H. F. Shipley, Principal Assistant City Engineer in Charge of Highways, City Hall, Cincinnati, Ohio

Granite has been extensively used as a paving material in Cincinnati for the past 34 years, the first granite block streets having been laid in 1885. Up to that time the only hard surface roadways which had attained any general use were macadam and cobblestone paving or "Bowlder Paving" as locally named.

Macadam composed of native limestone was used on practically all suburban and residential streets, while the cobblestone paving had come to nearly universal use on all streets in the business portions of the City. Both these forms of pavement survive in Cincinnati; macadam, although frowned upon by city officials, is still favored by developers of suburban property on account of cheapness; bowlder paving is scarcely ever used on new work.

Early Granite Pavements in Cincinnati

The granite blocks for the first paving laid in Cincinnati were obtained from various sources, some from Missouri, some from New England, some from Virginia and some from North Carolina, but in a very few years the development of the Georgia quarries around Lithonia practically drove all other granites out of the local market both on account of the ease with which the Georgia product can be worked and on account of favorable shipping facilities and freight rates. The only other granite which has had any considerable use here since the Georgia granite came into use is that from Mt. Airy, North Carolina, and this has been used to a small extent compared to the Lithonia granite.

From the begining of granite paving in this City until about 1910 there was little or no change in the general character of the work. The blocks were large size, being from 12 to 14 ins. long, 4 to 6 ins. wide and 6½ to 7½ ins. deep. The best of the blocks were fairly well dressed but a considerable percentage was rough and of size differing greatly from the average. The base consisted of 6 ins. of natural (Louisville) cement concrete made of large stone and surfaced on top in only a rough fashion. The bed consisted of sand varying from 2 to 3 ins. in depth. The joints which averaged about ¾ in. and often exceed 1 in. were filled with pebbles and then poured with coal tar pitch. The pitch usually penetrated the pebbles to a small depth only. There was a general opinion that granite paving was durable, but a well-grounded certainty that it was rough and noisy.

Changes Introduced in 1910

In 1910 steps were taken to modify radically the character of our granite paving. A smaller block was adopted and the inspection as to uniformity and trueness of dressing was made much more rigid. A base of Portland Cement Concrete was provided, smooth and true to proper grade, the blocks were placed on a thinner sand bed with close joints and with stringent requirements as to getting the joints poured in such manner that the pitch penetrated deeply into the pebbles so as to produce water tight joints. Rolling by steam roller was substituted for ramming as previously practiced.

VIEWS OF GRANITE BLOCK PAVEMENTS IN CINCINNATI, OHIO.

Top Row: Block-makers Recutting Blocks on Eastern Avenue in 1919—Recut Blocks Piled on Sidewalks on Eastern Avenue in 1919—Pavement of Recut Blocks on Eastern Avenue in 1919, Before Rolling or Filling Joints. Bottom Row: Close up of Preceding View—Pearl Street Paved with Recut Blocks in 1916—Colerain Avenue Paved with Recut Blocks in 1915.

Bituminous Filler Now Used Again

Up to 1912 paving pitch and pebbles had been exclusively used as joint filler, but at that time cement grout as a filler came into favor and was largely but not exclusively used during 1912 -13-14 and 15 since which time we have swung back to the bituminous filler for the larger portion of our work.

Present Specifications

Our present specifications require that the blocks shall be not less than 7 nor more than 10 ins. in length, not less than 3½ nor more than 4½ ins. in width and not less than 4¾ nor more than 5¼ ins. in depth. The blocks are divided by width in two classes; blocks 4 ins. wide and over are classed as thick block, those under 4 ins. as thin block. It is required that the two classes be used on different portions of the work, and with this end in view it is required that the two sizes be separated at the quarry and shipped in separate cars.

This separtion of the sizes is a source of continual dispute and trouble on the work, as the Contractor's men are constantly getting the two sizes mixed. The trouble we have in this regard led us at one time to specify that the blocks should not vary more than ½ in. in width between the limits of 3¾ and 4¼ ins. but the quarry people claimed that it was not possible to fill this specification without such a large percentage of culls that the cost of the paving would become prohibitive, and we therefore abandoned this requirement in favor of the allowance of 3½ to 4½ ins.

Thick Blocks Superior to Thin in Dressing

It has been our experience that under such a specification the thin blocks are distinctly inferior in dressing to the thick blocks. This is probably due to the way the blocks are handled commercially at the quarry. The operator pays the blockmakers so much a thousand for making the blocks, but sells them to the contractors for so much a square yard in the street. It being therefore to the operator's advantage to have blocks of the maximum permissible size, he requires the block maker in getting out the blocks to aim at the maximum, rather than the average size. This results in the narrow class containing the larger number of irregular blocks, because this class contains those which split too narrow to begin with and those which split too wide and which are trimmed down on this account. Blocks which split irregularly can never by subsequent dressing, be made as smooth and perfect, except at excessive cost.

Base and Paving Bed

Much greater care is taken at the present time to see that the top of the concrete base is exactly parallel to the paving surface and the sand cushion is specified to be 1 in. in depth instead of two as formerly. While our general specifications provide for the use of sand-cement bed, if required, this practice although of several years standing for brick and wood block paving, has never been enforced for granite paving. We have noted the opinion of many engineers as to the shifting of sand-bed, and have seen plenty of evidence of this in the older paving, but in the work laid the past five or six years where the joints are completely filled with either cement grout or paving pitch and pebbles, we have been able to detect no signs of weakness which can be attributed to the sand bed and have therefore been unwilling to go to the extra expense and trouble of paving on the sand-cement bed. It is possible that further experience may cause us to change our opinion in this respect.

Rolling Instead of Ramming

Several years ago, about the time of general revision of pavement specifications, we adopted the practice of rolling granite pavement with steam roller as a substitute for hand ramming, and this has remained our practice ever since. The advantages of rolling are that every block is reached and bedded, and that the surface grade is truer and smoother than appeared to be possible with hand ramming. This disadvantage of rolling is that there is a very considerable tendency to tilt the blocks and disarrange the paving unless the joints are well filled with pebbles, and this latter practice is fatal to a thorough subsequent filling of the joints with grout or bitumen. On this account we have been considering lately the advisability of going back to hand ramming instead of rolling and probably would do so if we can develop rammermen of sufficient skill and conscientiousness to do a thorougly workmanlike job in this respect.

Joint Filling

The thorough filling of the joints between the blocks is one of the vital requirements of granite paving. Opinion is divided as to the merits of cement grout and bituminous joints and it is well recognized that both kinds of joints have advantages and disadvantages. The cement joints protect the edges of the blocks and hold them firmly to grade better than any bituminous joint. On much used thoroughfares (and streets paved with granite are always such) we find that it is exceedingly difficult to keep traffic off the pavement after being laid the length of time necessary for good results with grout; in fact on our narrow and busy streets we have found this practically impossible. The necessary wait while grout is curing, besides its inconvenience results in considerable delays in the prosecution of the work. When cuts have to be made in the street subsequent to paving the expense of repaving is greatly increased owing to the great loss of blocks broken in being taken up, and it is also very expensive, tedious and often impracticable to keep the repaved places barricaded and guarded the required time for curing.

Grouting is a process with scarcely any factor of safety in the way of slightly inferior work; it demands absolute perfection in every stage. No matter how careful the inspection there may be some places and some batches not quite up to the standard and these result in weak places unable to withstand the tremendous stresses set up in solidly cemented surfaces. All such places soon manifest themselves by cracking, breaking and spalling of the blocks and holes soon result expensive to repair and practically impossible ever to be made as good as the balance of the street. In this city the present practice has been to wash out the pebbles about one-half way down from the tops of the blocks after rolling and before grouting. This is done by a stream of water from a hose with a nozzle. We then give a first coat of grout of neat cement and follow with one or two coats of one to one mixture. The first coat of neat cement is a departure from former practice and is expensive but seems to be very effective in overcoming some of the difficulties we have experienced with grouted pavements.

In the bituminous joint we have gone through a gradual evolution. In former times we merely filled the joints with pebbles to a depth 1 in. from the top and poured in the paving pitch; next we filled the joints only slightly over half full with pebbles and then we poured the pitch to the top; next, after filling the joint half full with pebbles we poured the pitch, added more pebbles and poured again and then added a covering of torpedo sand. This we called doubled pebbled and doubled poured work and it produced a very good joint if conscientiously carried out. Our next improvement was to give a light coat of pebbles after the second pouring, squeegee a flush coat of pitch over the entire surface and then cover with torpedo sand; this we call "Pitch Filler and Flush Coat" and it is a most excellent process. This year we have adopted the pitch-mastic method in which we mix equal parts of hot fine sand and hot pitch and squeegee into the joints; preliminary to the application of the pitch-mastic we see that the pebbles are raked out half way down the joints and pour the joints with straight pitch to the tops of the pebbles. We do not favor the pitch-mastic method without this preliminary pouring.

We are not entirely certain that this will produce a better joint than the "Pitch Filler and Flush Coat" method but it looks very good so far. It is our experience that pitch for granite paving must be of quite low melting point. We are using it around 110 degress and this makes it necessary that as much mineral matter as possible be incorporated.

Re-Cut and Redressed Blocks

Several years ago some of the old granite streets were taken up and repaved. In this work the depressions were merely filled with sand, the blocks repaved and the joints grouted with cement. This gave us a pavement considerably better than the old one which was full of holes and depressions but by no means a pavement suitable for modern conditions. Neither did it have great lasting qualities as the sand bed was altogether too thick and non-uniform, also as the old blocks were badly rounded at the edges, the grout filler ran out to feather edges on the blocks and soon began to chip off. In taking up the old blocks preliminary to this repairing, it was found that while the edges were worn the blocks as a whole had lost very little depth after 25 years service. This led us to adopt the method of recutting the blocks before repaving. The old blocks are as a rule about 12 ins. in length and 6 to 7 ins. in depth; in recutting they are napped in two transversely to the original length, the napped planes forming the paving faces for the new blocks. The blocks are then trimmed all around with reel until we have a block about 6 ins. long, 5 ins. deep and from 3½ to 5 ins. wide which when paved and produce a remarkably smooth and pleasing surface; new blocks have to be extremely well shaped and well dressed to make as good a surface. Before paving we clean off the old concrete base which we usually find to be extremely rough and uneven and give it a "skim" coat of fresh concrete varying in depth from 1 to 5 ins. The surface of the new concrete is 6¼ ins. below and parallel to the new paving surface and the balance of the work proceeds as in new granite paving. It is found that many of the old stones are so rough and defective that it is not possible to form good recut blocks from them and this results in a deficiency which has to be supplied by new blocks. This deficiency has varied on different streets from 18 per cent. to 35 per cent. of the total area depending on quality of old stones. At the time when most of our work of this kind was done the going price for new granite paving was $3 per square yard and for the recut block paving the price was about $1.75 so that figuring on a basis of 75 per cent. recut to 25 per cent. new the resulting pavement cost on an average of $2.06 per square yard. At the present time prices are about 35 per cent. higher.

Efficient Control of Small Sewage Treatment Works

In the control of small sewage treatment works, as in large ones, efficiency in combination with economy is the goal to be arrived at, said James H. Edmonson in addressing the Institution of Municipal Engineers of Great Britain.

The author has frequently seen when visiting sewage works that the effluents leaving small works are infinitely better than those leaving larger ones—in fact, in the author's opinion, many of the effluents are too good, if such can be the case, and consequently economy must have suffered to attain this high degree of purity. This probably arises through insufficient knowledge of the sewage treated and effluent obtained, and consequently the sewage has been put through more processes or treated on a larger area than is really necessary to produce a satisfactory and stable effluent. If, however, systematic records, not necessarily of a highly technical character, were kept, they would be of great assistance in determining any further treatment, and also satisfy those responsible of the results obtained day by day.

Measurement of Sewage Flow

The quantity of sewage delivered at the disposal works is of the first importance. This is fairly simple to determine on a small works without going to the expense of fixing a recorder. Good approximate results can be obtained by the use of a rectangular weir or V-notch, and recording the depth flowing over same every hour or half-hour. The effluent can also be recorded by fixing a rectangular weir at the outfall from each channel or main channel from the filters, as at the Southall works.

The quantity of tank effluent each bed, filter or plot of land treats can often be approximately estimated by recording the number of hours each unit works per day, providing a practical test has been previously carried out of the quantity each unit treats per hour. In cases where pumping is necessary, the time the pumps are at work usually gives a true record of the flow, any appreciable increase being due either to loss of efficiency of the pumps or increase in flow.

Measurement of Sludge

The measurement of the sludge at the time of cleaning the tanks—which is easily accomplished—along with the number of days such tank has been at work, is of considerable value. Any appreciable increase may be due to increase of flow, which should be accounted for above or increased strength of sewage. On the other hand, should there be an increased flow of sewage delivered at the works while the production of sludge is normal, of course eliminating storm water, it will probably be found to be due to subsoil water leaking into the sewers or some other sudden discharge into the sewers.

These, with many others, which are particularly adapted to individual works, are common-sense records, and are no doubt kept by many. There are in addition, however, a few chemical and physical tests which can easily be applied, and in conjunction with the above records will enable one to have a small works under thorough control.

Refined and Approximate Analysis

You will no doubt be familiar with the items of analysis the analyst presents when reporting on the examination of a sample of sewage. The results given are usually expressed in parts per 100,000, and even then some of the figures are small decimals, which can hardly be arrived at by simple or rough-and-ready methods. There are methods, however, which approximate to one or two of the tests if not the figures. One of the principal tests which can be so approximated is the 4-hour's oxygen absorption test. This is carried out by placing a known quantity of the sample under examination in a standard solution of acidified potassium permanganate (containing available oxygen) which will oxidize any organic matter present. As is well known, potassium permanganate solution has a brilliant purple color, which gradually disappears with the loss of its available oxygen, being colorless when all the oxygen has been absorbed. Upon this characteristic a simple test has been devised. Other tests are presence of nitrates, turbidity, odor and stability, which will be briefly described along with the necessary chemicals and apparatus, which can be obtained at a very nominal cost.

Some Simple Tests

Oxygen Absorbed.—Apparatus and chemicals required: One pair of apothecary's scales, one or two weights totalling 0.4 gramme, one litre graduated flask, 10 c.c., 25 c.c. and 100 c.c. graduated cylinders, pure sulphuric acid, potassium permanganate, and a stock (6-8 oz.) of stoppered bottles.

Solution.—Weigh out on the scales of 0.4 gramme of potassium permanganate, and place in litre graduated flask, and dissolve in a little good tap water; add 100 c.c. of sulphuric acid and allow to cool. When cool, make up to the litre mark with water.

Method.—Place in a stoppered bottle 100 c.c. of sample to be examined and add 10 c.c. of the acidified solution of potassium permanganate. Note how long it takes for the color to entirely disappear. With crude sewage this may occur in a few minutes; with a good effluent it may take some hours.

Presence of Nitrates in the Effluent.—Apparatus and chemicals required: One Nessler tube, a solution of 1 per cent. brucine sulphate and sulphuric acid. Place 5 c.c. of effluent in the Nessler tube and add 2½ c.c. of brucine solution, thoroughly mix and add 2½ c.c. of strong sulphuric acid down the side of the tube, which will settle at the bottom. If a pink zone forms, gradually changing to amber, nitrates are present—the more marked the reaction the more nitrate present.

Turbidity.—Apparatus required: Piece of white cardboard with black lines ruled across, a ground bottom Nessler tube at least 6 in. in height and 1 in. in diameter, graduated up the side. Shake the sample thoroughly and slowly pour into the Nessler tube, which is placed on the paper, until the black lines are obscured. A satisfactory effluent should show a depth of 4 or more inches.

Should Have No Offensive Odor

Odor and Stability.—Apparatus and chemical required: stoppered bottles and a solution of methylene blue. A good effluent should have no offensive odor at the time of sampling or even after being kept in a stoppered bottle in absence of air for four to six days at a temperature of 80 degrees F. The stability can be estimated by tinting the sample in the bottle with about six drops of methylene blue solution before placing on one side or in an incubator. Examine the sample daily, and should the color persist until the fourth day one can be satisfied of the stability of the sample. If an effluent has a deficiency of dissolved oxygen and nitrates it is invariably found that it is charged with an excess of organic matter, and consequently will be found to be unstable, emitting a disagreeable odor, and discoloring methylene blue upon incubation. If the color persists for four days it is usual to record it on the record sheet with a + sign; if it disappears within four days with a — sign.

While advising that such records and elementary tests would prove of great assistance in the control of small works, and which can easily be carried out by any intelligent workman, the author would certainly recommend that periodical samples be submitted to an analyst and his report compared with the results obtained on the works. By such means the manipulator could fix his own limitations to the elementary tests just described.

Conclusion

In conclusion it may be mentioned that in considering an analyst's report the following four tests are usually taken as standards:

1. The 4-Hours' Oxygen Absorption Test.—A permissible effluent should absorb less than 1.40 parts per 100,000; a good effluent under 1.0 part.

2. The Albuminoid Ammonia Test.—A permissible effluent should contain less than 0.10 part.

3. Suspended Solids.—The Royal Commission recommends that a final effluent should contain less than 3.0 parts per 100,000.

4. Dissolved Oxygen Test (oxygen absorbed from tap water in five days at 65 degrees F.)—The Royal Commission recommends that a final effluent should not absorb more than 2.0 parts of oxygen per 100,000.

Organization of the Asphalt Association

Representatives of the principal asphalt producing companies of the United States and Canada have completed the organization of an association, the name of which is to be "The Asphalt Association." Its purpose will be to disseminate information pertaining to the uses of asphalt with particular reference to highway and street paving, cooperating with city, county and municipal officials and with scientific bodies and colleges seeking to bring about the most effective methods in the use of this well-known material.

The officers elected for the ensuing year, are as follows: President, J. R. Draney; Vice President, W. W. MacFarland, and Treasurer, N. G. M. Luykx.

The Secretary, who will be the active officer in charge of the affairs of the association, is J. E. Pennybacker, formerly Chief of Management of the U. S. Bureau of Public Roads and during the war period, Secretary of the U. S. Highways Council.

The New York office will be located at No. 15 Malden Lane. Other offices will be established soon at Chicago and Atlanta and ultimately in Canada and other cities in the United States.

With city and highway expenditures for this, and next year, estimated to reach in the vicinity of a billion dollars, asphalt, a most important constituent in the construction and maintenance of roads, is attracting wide-spread attention.

Personnel

Prominent federal, state and municipal engineers are included in the staff of the Asphalt Association. There will be a Research and Technical Department managed by Prevost Hubbard, Chief of the Research and Testing Division of the United States Bureau of Public Roads prior to his affiliation with the Association. Mr. Hubbard is one of the foremost authorities in the United States on research work in all classes of bituminous materials and is the author of standard text books on the subject. He is also thoroughly conversant with the nature and uses of all other road materials as their study and development came directly under his control in connection with his government duties.

Field Engineers who will devote their attention to aiding State, county and municipal authorities in the working out of their highway problems, include Fred W. Sarr who was Deputy State Highway Commissioner of New York in charge of the maintenance, repair and reconstruction of all State and county highways comprised in New York's great system. No engineer in this country has had a closer insight into the questions of durability of types of highways, the service conditions which highways must withstand, and the relative cost of capital outlay and up-keep of all types of highways than Mr. Sarr, during his past 20 years.

A. T. Rhodes for years Street Commissioner of Worcester, Mass., and later Field Secretary of the Granite Paving Block Manufacturers Association and, who is Vice President of the Massachusetts Highway Association will look after the New England territory and other eastern points. Mr. Rhodes' practical experiences include the design and installation of the city asphalt plant at Worcester and the construction of the asphalt pavements of that city. His general engineering experience has familiarized him with all types of highways.

At the Chicago office of the Association, J. B. Hittell, formerly City Engineer of Chicago and President of the Illinois Society of Engineers will be in charge of the work of the Association in the middle western states. Mr. Hittell is admittedly one of America's foremost engineers and has made an enviable record in municipal work.

Shortly a branch office will be established in Atlanta and at other points and announcements will be made of the engineers selected for the various posts.

Asphalt Surfacing of Old Macadam Roads

Saving the many thousand miles of waterbound macadam roads on main routes of travel by utilizing the existing surfaces for foundations will be a field in which the interests of the tax payers and the furtherance of the asphalt industry will happily be the same. Digging up old macadam roads and disregarding the materials thus assembled at a cost of millions of dollars is a form of extravagant waste which it is a patriotic duty to prevent.

Lines of Activity of the Association

Utilizing local materials to the fullest extent in combination with asphalt should yield immense savings to tax payers by cutting down freight costs on imported materials. This phase of construction will also be given close attention by the Association.

Improvement in methods, speeding up of deliveries, betterment of product, aiding the working out of thorough inspection facilities, obtaining and giving out useful data to the public officials, engineers and contractors will form some of the other lines of activity of the organization.

Garbage Disposal by Feeding Successfully Practiced at Lansing, Michigan

By E. C. W. Schubel, D. V. S., Superintendent Garbage Department and Hog Farm, Lansing, Mich.

The method of collection being carried out in Lansing is what may be called the "can collection" system—the collector takes up the full can and leaves an empty one. This system is an advantage to the householders because they have no cans to wash, but is undesirable to the city from the standpoint of economy. It costs the city more than $1,500 a year to wash and disinfect the cans.

The can collection has another disadvantage because a great many householders are very indiscreet in what they place into the garbage can. They place such articles as glass, broken crockery, floor sweepings and tin cans into the cans with the garbage. This cannot be detected until the cans are emptied at the disposal place.

Handling the cans so often causes a rapid depreciation. The city is buying the cans at present from funds derived by making a rental charge of $1 per can per year. Many cans will not last a year. Freezing weather causes the greatest depreciation on cans.

A tank collection which is being contemplated before the next fiscal year will eliminate this mixture of garbage and rubbish, decrease the cost of collection and give more frequent service.

On account of the increase of requests for service since the close of the war and the increased activity in building operations, the equipment is so limited that only weekly collection is being given to the residental sections of the city while daily collections are given to the restaurants, hotels, cafes and other eating places.

Collection with Motor Equipment

The collection is made entirely with motor equipment. It includes one Duplex 4-wheel drive truck with a 3½ ton capacity, with a trailer of like capacity. When the truck is used for collection purposes, it will carry from 150 to 200 cans, but when used for transporting the cans of garbage from the city to the farm it will haul from 350 to 500 cans when using the trailer. This mode of transporting the garbage is used in winter or when the roads are impassable for the smaller trucks.

The equipment also includes two 1-ton Ford trucks with a capacity of each for 55 cans; two 2-ton Reo trucks with a capacity of each for 115 cans; and one 1-ton Republic with a capacity of 60 cans. To this equipment there will be added one or two more trucks during the coming year.

On the Duplex truck, three men are used for collection. On the other trucks only two men are used. At the present time, the collection is being made with eleven men.

VIEWS SHOWING THE DISPOSAL OF GARBAGE AT LANSING, MICH., BY FEEDING TO HOGS.

Top Row: A type of the 2-Ton Motor Truck used for collection. The Stack Can or Can with Flaring Top is used as it is considered the best type—Shows the possibilities of Ground Feeding, especially on Sandy Soil which gives good Drainage and absorbs the Excess Water in the Garbage. Bottom Row: Providing a Wallow of Fresh Water. Unclean Wallows are conducive to Disease—These Feeders made 105 Pounds Gain from February 15 to June 19. They Sunned themselves on Sand Hill during Cold and Muddy Season and were ready for Market One Month before the rest of the carload.

The service is becoming more general as those people living in the outskirts of the city are beginning to ask for service. It shows that people are beginning to be educated to want better sanitary conditions.

Garbage Fed to Hogs

The garbage from the city is being fed to hogs. This method of disposal has been highly satisfactory and very profitable considering the investment.

The idea of feeding the garbage to hogs was brought to a realization by a number of our public-spirited citizens, including former mayor, J. G. Reutter, Alderman Lewis Neller, Alderman John McClellan and Ex-Alderman Frank Young, who backed the proposition with their money.

Feeding Found Profitable

After the proposition proved a financial success, they turned over to the city on November 1, 1917, a herd of hogs numbering 213 valued at $4,000 and several buildings valued at $1,000. Since that time additional buildings and equipment costing over $1,200 have been purchased, the herd increased to 400 hogs valued at over $12,000 and $5,000 in the treasury with which to buy more hogs. Building up the herd has been entirely dependent upon the profits derived from the sale of hogs.

A report compiled recently by the city comptroller showed that on May 1, 1919, the project had made a profit of about $8,500. This was based on a price of about $18 per hundred pounds for the hogs, when in reality the hogs could have been sold for $20 per hundred pounds. If a sale had been made of all hogs on hand, the profit for the past fiscal year would have been more than $10,000.

As soon as the herd can be increased to 800 or 1,000 head and kept at about that number, the profit from feeding will be from $12,000 to $18,000, dependent, of course, upon a high price for hogs. There is every indication that the demand will be enormous from the European countries for years, as it will take those countries a number of years to build up their herds again.

Those cities boasting of other methods of disposal cannot show much greater profits when the investment is considered.

Ground Feeding Preferred

When a farm is purchased where the feeding may be done upon the ground, the uneaten portion of the garbage will be converted into fertilizer by plowing it under the soil and then sowing a crop on this ground. This will increase the profits from garbage disposal.

The garbage is fed as it comes from the city directly to the hogs upon the ground or upon cement platforms.

Feeding upon the ground is preferable as upon platforms a certain amount remains uneaten and so must be hauled away while that which remains upon the ground uneaten may be plowed under.

The test of the practicability of the feeding method of disposal is the selling possibilities of the pork produced. There is no benefit in feeding if the pork is unfit for food or if a popular prejudice will prohibit it from selling freely.

There is undoubtedly a prejudice in the public mind against "garbage"—not particularly against garbage-fed pork, nor reduction or incineration plants, but against the word "garbage,, and anything connected with garbage. One might say its disposal was regarded as an illicit business. It is not strange therefore that there is so little general knowledge of the possibilities of garbage utilization and particularly of the feeding method.

If garbage-fed pork is inferior to grain-fed, the price paid by the packers, who are naturally adverse to paying full price for an inferior product, should indicate the fact. When selling our hogs to the Detroit market, they have always brought the top of the market.

I have never seen any market which discriminated against hogs fed upon garbage. When cases of "softer" pork have been noted, it has generally been found that the animals were improperly raised.

An objection often raised to garbage-fed hogs is that such hogs are likely to be infected with trichinosis or tuberculosis. There are no data available to support such claims; isolated cases have been found, as with grain-fed stock, but this is no evidence that garbage-fed hogs, as a class, are any more susceptible to either trichinosis or tuberculosis than grain-fed.

Rate of Garbage Consumption

About one hundred animals, ranging from pigs to big sows, will eat a ton of garbage per day. This means an average of 20 pounds per animal per day.

At this time of the year, hogs make very good gains in weight. Under proper conditions, they will gain from ½ to 1 pound, and even more, per day. A carload marketed in Detroit last week gained a little more than 100 lbs. from the middle of February to the 19th of June or about 125 days. This time included some very bad weather for hogs.

Householders should be required to keep garbage free from cans, papers, sawdust, oyster shells, glass, etc. Garbage mixed with any of these foreign materials is refused collection or the can is taken up and no service given. Numerous losses can be traced to such foreign matter, particularly such finer particles as readily become embedded in edible materials. Two objects which find their way into the garbage can in considerable quantities are the very thin glass from electric light bulbs and phonograph needles.

Garbage not Sorted

There is no sorting of garbage done on our farm. All hogs get an opportunity to get some of the garbage from eating places. Hogs make the most rapid gains on garbage coming from eating places as they have the greatest variety of refuse food.

In the winter, all the cans are placed in the boiler room where the cans are allowed to thaw out before the garbage is placed upon the feeding platforms or upon the ground. Frozen garbage is unsafe to feed.

At the farm, we have always fed raw garbage in preference to cooked garbage. In the first place, a sterilizing apparatus could be installed only at considerable expense; secondly, cooking destroys a greater part of the food value of garbage. Sterilization of garbage destroys the opportunity for selection. Hogs will balance their own ration much better than man is able to do. Cooking also incorporates objectionable matter with the edible garbage.

It is not necessary to supplement the feed of garbage with grain. It would not be economical nor would there be any particular advantage gained in the quality of the pork or the price paid. Feeding small numbers in separate pens is preferable. This prevents piling up in the winter time. There is no attempt to feed any particular breed of hog. There have been most losses among white hogs and the least among red ones. Raising pigs for feeding upon garbage should be entirely divorced from that part of the farm devoted to feeding of garbage.

Hogs should weigh at least 100 pounds before they are placed exclusively upon the feed of garbage. Most of the feeders are bought in the larger stockyards where a better selection can be made.

Some Discouraging Features of Feeding

The feeding of garbage has its discouraging features as well as those of an advantageous nature.

Hog cholera used to be the cause of great losses among hogs feeding on garbage, but this can easily be prevented by the serum-simultaneous method of vaccination. No hogs are placed upon the farm until they have been treated with serum and virus.

The greatest losses have been due to hemorrhagic-septicemia, a form of contagious pneumonia which is usually brought into the herd through the introduction of new stock from stockyards which always are infected premises. This disease can be prevented to some extent by the use of bacterins.

Other losses occur from salt poisoning, vegetable poisoning, ptomaine poisoning and mineral poisoning. Some of the losses are due to the carelessness of the householder.

Unfavorable sanitary conditions have been the cause of losses, that is, the deep mud and filth which hogs have to wade during the rainy season or in the breaking up of the ground in the spring when the frost leaves the earth in a muddy condition, cause the hogs to become more susceptible to disease, especially respiratory troubles.

Sandy soil which allows the escape of the water and keeps the feeding ground free from mud is the most desirable for feeding conditions. Hogs fed on sandy soil made such gains during the past few months that they were ready for the market about one month sooner than those fed upon the clay soil or upon the feeding platforms.

Summary

In summarizing, the following comparisons of garbage-fed hogs with those fed grains may be made:

1. Garbage-fed hogs show a slightly greater shrinkage in long shipments than grain-fed.
2. Garbage-fed hogs dress away very little more than grain-fed.
3. With proper management, the meat produced is equal, and cannot be distinguished from that of grain-fed hogs.
4. Garbage-fed hogs are exposed to cholera constantly so immunization is indispensable.
5. Cholera in garbage-fed hogs may be associated with secondary infections but can be controlled by immunization.
6. Garbage-fed hogs are not peculiarly susceptible to trichinosis and tuberculosis.

The secret of success with garbage-fed hogs is, as with grain-fed hogs, largely one of management. The man behind the hogs is a prime consideration. It requires hard work, no little knowledge of hogs, and a large amount of common sense to raise garbage-fed hogs. Cities undertaking municipal hog-raising and feeding must remember that the pigs are to be fed on garbage; *not on politics.*

The foregoing paper was presented before the League of Michigan Municipalities on June 26, 1919.

The Future of the American Association of Engineers

Abstract of Presidential Address by F. H. Newell at Annual Convention

"Without vision the people perish,"—without a clear view of our paths of progress toward a definite end we wander aside to attractive fields, and do not reach our object. We must have the vision of achievement; without being visionary we must have the clear view to direct all our efforts to a definite end. What is it that we see in the distant future and what is the road we are called upon to travel?

In the far distance we see a great organization with members in every county and town in the United States: A hundred thousand prehaps—as stated by some of our members, who claim that there are this number of engineers, mainly young, vigorous men, and some of mature years—who have not become identified with other engineering societies.

With a great number of widely distributed members working together sympathetically, though perhaps in different ways—there will be brought about the realization of many of our dreams of a better society and fairer economic conditions for the educated, experienced technician and professional man, whom we know as the engineer.

More than this we can see larger results to the public in better health, comfort and prosperity such as are made possible by the fact that the engineers are enabled to use their skill more effectively for the public good.

While we may solace ourselves with occasional glimpses of this distant vision we must give most of our present thoughts to the character of the road we are traversing, to its difficulties and to its diversions, not shutting from our consciousness the need of careful preparation and of effective action in overcoming the obstacles which loom in front of us. In order to gage our ability to meet these obstacles we may well look back over the road we have passed and verify our position by back sight, then project forward the results of our observations. For this reason it is desirable to briefly take our bearings on what has happened and thus more definitely fix the futnre path.

Taking a Backsight

The A. A. E. has completed its fourth year, it has safely passed the dangers of childhood and has already assumed certain characteristics foreshadowing a somewhat definitely fixed future development. It now seems hardly worth while to ask why it was started, but, for the purpose of the more definite backsight we may properly call attention to what is now almost ancient history.

The A. A. E. owes its birth to practically nation wide dissatisfaction with conditions as they began to appear less than a decade ago. From about 1910 there was a general increasing restlessness among the members of Engineering Societies accompanied by a tendency to criticise, but no well defined course of action. There was a call for better co-operation among existing societies and for larger recognition of the needs of the younger members. Many efforts were made to work reforms within the established organizations.

It was not then generally recognized that the plans of all the existing engineering societies were patterned upon a single model, and that one not adapted to fully cover the needs of its members. This model was regarded as the only practicable form of organization. The ingenuity of the engineer, so marked in other lines, was here in his own social affairs conspicuously absent. Prolific in inventions in other lines he was extraordinarily short sighted in the contents and form of his associations.

The real reason for this deep but vague unrest as now fully recognized—is economic. It is the fact, often denied, that the engineers of the present day as a body are wage earners. Their societies were formed originally to meet the needs of the then dominant group of independent practitioners or non-wage earners. Today these men while largely in control form a small minority. The great bulk of annual dues comes from real wage earners, who demand something more from their societies than technical papers, such as they have been receiving.

Though the need was known to be great yet the very proposal to form a new organization to meet the need, differing radically from the old, was regarded as presumptuous, as an attack upon honored conventions—almost as sacrilege. The word "bolshevik" was not then known among English speaking people but the projectors of the new scheme were denounced in the nearest equivalent terms. The lightest charge laid to their doors was that of "forming a labor union." It was assumed that any engineer who would condescend to have anything to do with an aasociation which could be compared to a labor union must have sunk to low levels.

By force of imitation—though designed for different ends. the organization of the A. A. E. in its original form tended to follow quite closely that of older societies. There was a radical indifference, a characteristic which is becoming more accentuated—namely the recognition that it was formed primarily to promote the social or human interests of the engineer as distinct from the technical. The A. A. E. has set for its first duty that of the development of the economic and political welfare of its members.

The fact that it is meeting a real need is best shown by the remarkable growth under conditions where though surrounded by older and more experienced competitors, it has outstripped them in rate of progress.

The conditions which have existed were well expressed by the retiring address of George H. Pegram from the presidency of the American Society of Civil Engineers in January, 1918. He stated that this society had joined in the formation of the Engineering Council designed to reach the 30,000 engineers in the four national societies. He adds: "But other steps are necessary. It would seem that an organization should be formed devoted to the material interests of the younger men, draftsmen, instrument men, inspectors, etc., with such association with the older engineers that their development and progress may be encouraged; in brief, an alliance of all engineering interests which would be in harmony with similar organizations in nearly all lines of endeavor."

How Do We Differ?

Our vision or evidence of things hoped for may perhaps be clarified by comparing this nascent giant with the older national societies. Primarily, as just stated, these are technical, and as such are concerned more with the strength and uses of stone and steel than with more immediate human affairs. Their main expenditures and chief pride are in high grade technical publications. These have been of inestimable value, especially in the days before the development of the great technical publishing houses. In comparison, the A. A. E. spends its funds not for technical articles but for purposes immediately concerned with the individual welfare of its members, notably in lines of employment and in other industrial relations.

The older societies have in their New York offices, spacious assembly and committee rooms with luxurious furniture, and the evidence of wealth; they have a magnificent library, rivaling that of the city of New York, across the street. All of this, laudable in itself, requires an expenditure and overhead cost which forms a serious burden and possibly detracts from the services which might otherwise be rendered.

The A. A. E. has no intention of acquiring such offices but conducts its business affairs on strictly business principles renting only such quarters as are absolutely necessary and thus making available for the service of its members a larger return on their annual investment.

Most of the older national societies are distinctly New York in viewpoint, while their officers resent the inference contained in the designation of "New York Society" yet they have not only a large proportion of their members in New York but are distinctly Eastern in attitude, while in contrast, the A. A. E. partakes more of the character of its principal center, namely, Chicago, in that it is nearer the center of population, of industry and American needs. It has some of the western initiative and the breeziness frowned upon by our Eastern cousins. It is characteristically a young man's society, initiated, operated and controlled by young men, not by any one faction, though maintaining certain group characteristics.

But comparisons are apt to be invidious and give offense where none is intended; suffice it to say that the A. A. E. has shown itself aggressive, even militant in seeking to advance the interest of its members, and to maintain the consciousness of common needs and aims.

Our Station

After taking the backsight where do we find ourselves? What does the engineer need, what is it that is attracting great numbers into the A. A. E. and which is not being found in the other societies?

First, and foremost, is the need of adequate compensation.

Second, is the need involved in the phrase "self expression."

"But," say many of our good friends, "if you begin to talk about wages and conditions of employment you are forming a labor union." "We in the past have carefully avoided anything which might point toward commercialism or tend to lower our professional standards; moreover we believe that the younger men should be satisfied; they are getting as much as we did at their age."

The whole matter of wages, according to orthodox opinion, has been regarded as one too explosive to be handled by a technical society. It is a shock to some of our older associates to have pointed out the fact that other professions in so doing have, in England at least, not lost their dignity nor standing in public esteem. As pointed out in Engineering-News Record of April 10, 1919, "All the devices by which the trade unions attain their ends have been practiced by professional association. As soon as professionals began to be employed at salaries they took to collective bargaining and insisted upon a standard minimum remuneration, refusing to accept employment, resorting to the boycott and even the strike. This is particularly true of the teachers and doctors, and in one or two cases their associations have been registered as trade unions. Professional associations have practiced militant action by resorting to political pressure, and this has become an important feature of the modern association."

Wages

A review of present conditions of employment of the great mass of men designated as engineers, who make up the assumed hundred thousand non-members or non-active members of engineering societies, shows that many of them are underpaid, notably those who are in the employ of railroad companies. There the effective action of the A. A. E. and its colleagues is already producing results. A still greater number are in public employ, in federal, state, county and city work. They are occupying positions of responsibility, but the public is usually ignorant of the fact that it is dependent upon their judgment and skill for the safe conduct of its daily affairs, of transportation, of lighting, of heating, of water supply, of sewage and innumerable other details. The cry has come up again and again from such underpaid men for some consideration but in return they have been "given a stone" in the form of a report showing the large earnings of the members of the A. S. C. E., for a time stopping efforts in this direction.

Why Underpaid?

The answer is perfectly obvious. It is because by education and by tradition the engineers have been cautioned against things which savour of commercialism, they have not been taught that under modern conditions no body of men can be assured of equitable treatment unless it takes measures toward group self-protection, unless it organizes to present the claims of its members to the public and takes effective steps such as those followed by the older professions of law and medicine.

Without organization and without a broad outlook which comes from such action, scattered individuals have not been able to get a wide enough viewpoint properly to appreciate their own conditions. They have felt that something is wrong and have been correspondingly restless, whether in or out of the other societies. Moreover they have not fully appreciated the fact that money values have changed, that gold has depreciated and that while all living expenses have advanced, yet those wages which have been set by custom and sometimes by law have been left untouched for a half century.

Many curious things have been revealed by the studies recently entered upon by the A. A. E., showing that railroads and municipal officers set what was in old times a liberal salary or wage but since the days of our own Civil War have persistently refused to modify these. Even now the wages of engineers or surveyors in some localities are fixed at $2.50 or $3 a day or at amounts less than those demanded by a carpenter or mason. Through all these years and in spite of the pressure brought to bear to study and report upon these conditions the engineers as a body pursuing their dignified course, have looked beyond these immediate needs and have passed by safely on the other side.

Results of Underpayment

But what are the results of these conditions of underpayment? They have been obvious in the mental attitude as well as in physical condition of the engineers themselves and have been reflected in a lowered or indifferent public opinion. While the true compensation of an engineer must not be expressed wholly in terms of money and while he receives many things which cannot be given a cash value, yet there exists the condition that the public at large and public officials necessarily judge and grade a man according to the compensation he receives. This is an inexorable law, although a man may possess the highest engineering and executive ability and yet if he does not receive a commensurate salary he finds himself handicapped at every turn, not merely for lack of the ready money but because he is deprived of his corresponding status in the eyes of those about him. He cannot take the leading part to which his abliities entitle him and where he can be of corresponding value to the public.

Do not mistake me, however, I do not wish to imply that because a man is poorly paid that this is proof that he is deserving of larger wages. This no more follows than does the inference that because a man is poor therefore he must be honest. What I am trying to emphasize is the fact that it should be our business to see to it that every possible effort is made on behalf of wage earning engineers that they do receive a compensation in money or in other values commensurate with their just deserts, at the same time being absolutely certain that they are really "delivering the goods." Because a man insists that he is underpaid there is no necessary conclusion that he is doing more than that for which he is paid. It is up to him to prove that he is "100 per cent efficient and then some!"

Self-expression

But what beyond wages does the engineer need; what is it that he has been demanding? It is the opportunity for more complete expression, for doing those things which are demanded of him by modern conditions but from which he is withheld by lack of facilities, particularly by lack of organization effective in its dealings with civic duties.

In reply to this it is vigorously asserted that some societies have afforded such opportunities. Here is where there is a distinct difference of opinion:—those of us who have worked for a generation under the written and unwritten laws which have prevailed among older engineering associations have slowly come to see that these have recognized only a narrow range of activities; we have been restrained unconsciously by the assumption that there is only one standard and that any departure from this is anathema. With especial care safeguards have been erected against any activity which looks toward the civic or political duties of the engineer. Of late it is true that these have been relaxed somewhat but long years of intimate association leads to the thought that should the competition of the A. A. E. be relaxed, there would be a tightening of the limits.

Repeating again the fact that these comparisons are not intended to be invidious, it is here asserted that to bring about a real self-expression of the great mass of wage earning engineers there must be a broad movement along entirely new and modern lines of thought, as typified in the A. A. E., not hampered by traditions but following a free form to be developed by experience.

What Are We Doing?

First, service to our members when they need service, and through them service to the public. Service to the members is that of getting together men of common interest such as arise from common surroundings, education and experience and which causes them to have a common viewpoint. By mere association and by numbers each gains strength to render service to others and especially through better conditions of employment, made possible by united action, by publicity, by discussions, and by effective mingling in public affairs.

We can do those things for each other and for engineers in general which singly they cannot effect.

Already by its aggressive methods the A. A. E. has forced tardy recognition of the claims of many of the underpaid, for example, it was not until the officers of the A. A. E. had appeared before the Railroad Wage Board with digested data that there was hope of relief.

These statements, mind you, are made simply as recitals of fact to illustrate the point that it has been only through generously offered aid that former leaders, held by conservatism, have been willing to depart from their narrowly defined grooves of activity. There is every reason to suppose that, should the A. A. E. stop tomorrow, these other groups would drop back to their former placid course.

But even if the A. A. E. should stop it would have justified all of its expense and efforts in stimulating larger activities and recognition of the possibilities of such activities among engineers as a whole.

Quantity

Our effort from now on should be for quantity; in numbers is strength, and with strength the ability to accomplish our aims. In saying this we do not ignore quality; we assume at all times that engineers must be men of good character and of high ideals. It is by bringing such men together, by gaining strength and self-confidence of the mass, that many of the better qualities of the individual may be developed.

The objects we strive to obtain, those of higher social and economic conditions among engineers, that they may more largely benefit humanity, can be had only through large numbers of citizens acting in unison. The leaven of high ideals of service represented by the founders of the association, to be effective, must have the mass on which to act; it is this massing of men which results in ultimate effectiveness.

Generous Competition

We are willing to compete for membership in a fair and open field. The greatest stimulus to efficient and economical conduct of engineering affairs, as in the case of all similar human enterprise, comes through magnanimous competition, through playing the game squarely and letting the best man win on his merits.

It is true that there is danger of competition degenerating to strife, or that in the exuberance of young spirits there may be things said and done which are to be regretted. This is one of the inevitable but not irremediable conditions which are to be plainly faced. It is far better to run the risk than to abstain from good achievement through fear of giving offense.

Some of our acquaintances regard the entrance of the A. A. E. in their locality as an intrusion upon their private preserves. They say in effect, "We have already started a local branch of a national society or a local club, and you have no business coming into our town seeking members among the group who should come to us." Here is a question worthy of consideration. Its answer rests upon the assumption as to whether priority gives exclusive rights. The question is similar to that in other enterprises where one business has been established and another seeks an opening alongside or across the street. The man who has had a monopoly naturally feels that his rights are being infringed upon.

When we come to specific statement of these matters it is usually found that the existing organizations have been founded upon a radically different concept. They have been following along a rather narrow line, giving primary consideration to material or technical details as contrasted with the human, namely, the economic and social welfare, which is the main object of the A. A. E. The more definitely these distinctions are pointed out, the more obvious it is that instead of being of the nature of an intrusion, the entrance of the A. A. E. into local fields has a stimulating effect.

Missionary Efforts

We are distinctly a missionary organization, sending out our members, literally as well as figuratively, into the highways and byways, to bring in all men of good character who are properly classified as engineers, and who, because of their characteristically retiring attitude, have held aloof or have been unconsciously isolated from contact with their fellows. There are in nearly every community two, three or a half dozen or more engineers, each living something of a hermit life as regards his social or professional relations, unaware often that other men of similar education and tastes are within easy reach. It is our aim to get such men to know each other and to gain strength for good in the community by association.

While each by himself may have a certain influence, the two or three acting together will have several times as much strength, and so on in an increasing geometrical ratio.

Education

This is an educational movement, not only of the members, but of the public. The mere act of bringing together men of similar experience and tastes is in itself an education to them not only in mechanical lines, in "shop talk," but, more than this, in the practice of active citizenship.

We strive to stimulate study of the live topics of local, state and national importance and try to maintain an intelligent interest in the big things around us, those which grow out of large applications of engineering data. While we do not ignore the small matters of technical details, yet our daily thought should be on the big things which influence our own lives and of those about us. Our activities and our publications should be devoted to those matters which affect the largest number as contrasted with the technical affairs, important in themselves, but which concern only a few. These are being well handled by other organizations.

Principal among our educational features should be those of the duties of citizenship. These are larger in the case of the engineer than of any other one class of citizens, for the destructive activities of war as well as the constructive work of peace are creatures of his brain. He has been content in these to take the subordinate part, but with corresponding loss of efficiency to humanity. The fear of doing something outside the narrow limits of his profession has deterred him from spontaneously assuming his full share in civic affairs.

This educational movement on the part of the A. A. E. performed by it or forced upon the attention of its competitors should be the greatest movement in the history of engineering. We may well claim the credit of taking and maintaining the lead, for it is an open secret that had not this young society come into the field there would have been little backing for progress along these essential lines.

Our duty is to be militant in missionary and educational lines—even aggressive in the same sense as the "church militant" of modern times, ready to champion the cause of the individual engineer wherever we have evidence to show that he or his associates are suffering under oppressive conditions—turning on the sunlight of publicity and taking such action as may be possible.

Foresight

Having taken our backsight and viewed our surroundings, it is now possible for us to take the foresight for the year ahead. Our immediate object, as just stated, is quantity of members. We should include every engineer of good character who has the community of interest and of thought which arises from the common education and experience, bringing together those of similar habits of thought, and who, though isolated in the past, can work together effectively.

We should strive not merely for the advantage of these members, but for the good of the whole profession and of the public. This must be done immediately through taking up the questions of employment, of better conditions for service, extending aid not only to the great body of engineers in the employ of the railroads, but to the even larger number of men in public service, concentrating if necessary for a time on these great groups. Through service to them we can most effectively serve all.

We should co-operate with our neighbors in other organizations doing our part, for example, in aiding in the formation of a Department of Public Works. This, though a large question is in itself not as important to our members as is the question of better conditions of employment in any department of public works whether national, state or municipal.

Our slogan for the present may be "engineering for engineers." We must do all that we can to prevent the continuance of conditions such as those where the great public engineering operations are directed primarily by politicians, lawyers or business men who as executive superiors attempt to dictate to the engineer what he should do. Let us specifically demand that the next Secretary of the Interior shall be an engineer, and that in every Department of Public Works—state or city—the chief shall be a qualified engineer. Nor should we be discouraged if at first our efforts meet with little success. We must remember that by long acquiescence in the appointment of other than engineers to leading engineering positions we have permitted the public to have a wrong conception of engineers, one which can be removed only after protracted effort.

Nor should we be disappointed if in gaining numbers of engineers we find that many remain as members for only a short time. This condition is inseparable from an organization with our aims and ambitions. Many will join in the hope of immediate personal benefit and when this is gained they will depart. The membership should be free to thus come and go—its steady growth testifying, however, to the fact that as a whole the great body of engineers are content and are taking an altruistic interest in larger affairs.

All great popular movements of this kind must necessarily change with the shifting of human interest and our organization must be elastic while remaining effective.

One principle should be fixed, viz., that we should strive to aid each member in building himself up in his own community and co-operate with him in helping others in his vicinity, thus strengthening all. To do this, the broadest possible local autonomy should be provided so that each small group may take advantage of those conditions which are peculiar to its environment and which lead to ultimate success. Each member should feel a sense of proprietorship in the association as a whole and consequent responsibility for the success of all.

With these thoughts in mind—with the vision of large possible achievement—let us press forward enthusiastically and energetically, gathering to ourselves more and more members not merely for the sake of numbers but because with numbers we may achieve the high ideals set for us in raising the standards of living and of ethics and through these widening our opportunities for service and our influence for the material and spiritual welfare of the nation.

Summary of a Forthcoming Federal Report Entitled, "Economics of the Construction Industry"

The following summary of a forthcoming report entitled, "Economics of the Construction Industry," has been prepared by the Division of Public Works and Construction Development, Information and Education Service, Department of Labor, Franklin T. Miller, director:

In January, 1919, the Division of Public Works and Construction Development was organized as a branch of the Information and Education Service of the Department of Labor. Its purpose was to be the stimulation of the interest of the Nation in public and private construction with a view to the creation of buffer employment for labor during the period of transition of manufacturing industries from war to peace production. It was charged with the securing of data for the use of the construction industry, but its activities were also to comprehend a study of the economic conditions affecting industry as a whole.

In conformity with its purpose it has given wide publicity to the material which it has gathered on prices and price tendencies in the construction industry, and to such other information as it believed was of immediate value for the construction industry and for general industry. Its findings are contained in "Economics of the Construction Industry," now in press. In the following paragraphs a brief summary of these findings is presented, which it is hoped will provide conviction for those who, on the threshold of an era of business prosperity, still hesitate. On the basis of its study it has come to the conclusion that construction in 1919 can be justified on financial grounds. It rejoices to find such a widespread acceptance of its views as is evidenced by the remarkable resumption of construction activity of the last three months. It looks to public officials and private and speculative builders everywhere to maintain or increase the present activity, for it feels that by so doing they will not only be securing a reasonable return on their investments, but that they will also be relieving the unprecedented shortage in housing, supplying needed employment, and allaying much of the industrial unrest incident to a period of readjustment.

The New Commodity Price Level

1. Most people believed that the high level of prices reached during the war was caused merely by the extraordinary demand for commodities, which exceeded the supply. With the end of the war and with war demand a thing of the past, they quite naturally expected a sharp drop in prices and a price level approximating in a short time the pre-war price level.

2. It was also commonly believed that the industrial capacity of the world had been greatly expanded under the stimulation of war orders, and that this expansion would bring sharp competition between rival concerns in time of peace. Furthermore, it was thought that there would be after the war great armies of unemployed workmen, who would be compelled by necessity to accept work at low wages; that there would be sharp competition among the leading nations in international trade; and that buyers generally, looking forward toward an era of lower prices, would postpone buying. In the light of these considerations it was but natural for people to expect a great fall in prices, and even to fear an industrial panic.

However, the expected great fall in prices has not occurred, and it is not likely to occur for the following reasons:

3. The rise in prices during the war was not merely the result of a great demand for goods and of a scarcity of certain goods. It was largely brought about by means of inflation of the currency by the governments at war and by the neutrals, either by the direct issue of paper money or by the issue of bonds. Although war orders are now largely a thing of the past, the extension of credits still exists as a continuing cause of high prices. There is little to indicate an early contraction of credits.

4. World production in general during the war, contrary to a widely held view, was not abnormally large. This is shown by statistics of world production of leading basic materials of industry, such as coal, petroleum, iron ore, and of cotton, sugar, wool, wheat and other agricultural products. Consequently the abnormal consumption of goods for war purposes has depleted the stocks of commodities of the world.

5. Armies of unemployed, in the United States at least, have not materialized, and an actual labor shortage is in prospect. Wages are not likely to be lowered.

6. Buyers since the armistice, although showing a desire to wait for lower prices, have been compelled to buy to meet their daily needs. During the war, because of scarcity of commodities and high prices or because of patriotic self-denial, they did not buy in advance of need, as is customary in an era of rising prices. Consumers' goods are in great demand and retail trade is now moving in great volume.

7. If the production capacity of industry should be greatly increased, lower prices would not necessarily follow. If there is a strong enough demand for commodities, prices need not fall, no matter in how large volume commodities are produced. There is every reason for expecting such a strong demand. The world is now suffering from a great shortage of durable goods—buildings, transportation facilities and industrial equipment. Furthermore, people, both in the United States and Europe, have a stronger desire for consumers' goods than ever before. This is true partly because of the scarcity of certain goods during the war period, and partly because of the new experiences through which tens of millions have passed, which have awakened in them desires for goods and services they never enjoyed before. Along with greater production of goods there is likely to go further extensions of credits rather than contraction. Neither the credit system of the United States nor that of the world has reached the limits of its power of expansion.

8. Business men of the United States need not hesitate to plan for an immediate period of business prosperity. No period of depression and no collapse of values need to be feared. The man who goes full speed ahead will gain an advantage over his procrastinating competitor which will far outweigh any possible slight decline in costs of production.

For a fuller discussion of the effect of inflation on prices see "The New Price Revolution," by Prof. Irving Fisher, Yale University. Prof. Fisher's paper is briefly summarized in the following paragraphs:

9. Prices are not going to fall much, if at all. We are on a permanently higher price level, and business men should go ahead on that basis.

10. The general level of prices is dependent upon the volume and rapidity of turnover of the circulating medium in relation to the business to be transacted thereby. If the number of dollars circulated by cash or by check doubles, while the number of goods and services exchanged thereby remains constant, prices will about double.

11. The great price changes in history have come about in just this way. The price revolution of the sixteenth century was a result of the great influx of gold and silver from American mines. A similar increase in prices all over the world occurred between 1896 and 1914, following the discovery of rich new gold fields and the introduction of cheaper methods of mining.

12. The present rise in prices has resulted from the great extension of credits by the countries at war, and a more economical use of gold reserves as a basis of credit, and not from any great increase in the gold supply of the world. In the United States, however, the supply of gold has been greatly increased because of our large excess of exports of commodities, and our present gold reserves would permit of a much greater expansion of credits than exists now.

13. There is a little likelihood of a fall in prices in the United States. The gold reserve, which is now the basis of our currency, is not likely to leave the banks and return to general circulation, since this is contrary to monetary experience. No great outflow of gold is to be expected through international trade, since our exports are likely to exceed our imports in the reconstruction period, and we no longer will have large interests and freight payments to make to Europe. Prices are higher in Europe than in the United States, and hence no influx of cheap goods is to be expected. Further issues of bonds or treasury certificates by our Government and loans placed by European countries in this country will tend to further increase our present credit structure. Against any considerable reduction in bank credit the whole business community would rise in arms.

Cost and Supply of Building Materials

14. Government restrictions and decreased demand reduced the production of most building materials in 1918. This reduction necessitated the operation of plants below their normal capaciiy and increased the proportion that fixed charges bear to total costs.

15. Curtailed production during the war resulted in low stocks of many building materials at the signing of the armistice.

16. As a result of the increase in the cost of living and of competition with essential war industries for labor, the wages of workmen in the building materials industries were raised. In some industries, largely because of abnormal labor turnover, the efficiency of labor was reduced and labor costs mounted out of proportion to other costs.

17. Costs of raw materials, transportation, fuel, taxes, sales and other items that make up total costs have all increased.

18. The increased cost of building materials as a whole must generally be considered in the light of curtailed production, low stocks, increased costs of labor, transportation, fuel and plant maintenance.

19. Past experience has shown that prices of building materials fluctuate less rapidly than the prices of raw materials used in manufacturing industries, such as metal ores, hides, etc., and than the prices of commodities that are consumed from day to day, such as food and textiles. Building materials are not likely to respond rapidly to any but a marked reduction in the general price level.

20. A marked reduction in the price of building materials is dependent upon the reduction of the items mentioned under 18. It is not to be expected that wages, the largest single item in costs, will be reduced in advance of a reduction of the cost of living. In view of the mounting operating expenses of the railroads it is not likely that transportation charges, a very large element in the cost of building materials, will be lowered. With the maintenance of the general price level the price of building materials as a whole can not well fall.

21. The index number for lumber and building materials (not including metal products) was in April, 1919, 184; for building materials, including iron and steel production, 189; for commodities other than building materials, 211; for all commodities, 203; for farm products, 228 (100=July 1, 1913—June 30, 1914).

22. Building materials are relatively low in price.

New Low Level Record Reached in Trinidad Asphalt Lake Soundings

Recent borings made in the famous asphalt lake on the Island of Trinidad have reached a new low level record of 150 ft. The previous record, made in 1893, was 135 ft. On both occasions the asphalt was found to be of uniform character throughout.

These latest attempts to find the bottom of the great mass of asphalt were conducted by George A. Macready, geologist, at the instance of Dr. Clifford Richardson, who has studied this asphalt wonder for many years.

Great difficulties attend any attempt to sound the lake, as it is in constant, though almost imperceptible, motion. The pressure of the mass of asphalt at any great depth against the drilling apparatus causes it to bend and the deflection from the perpendicular is so great that further boring is prohibited.

In the borings which have just been made a core of asphalt was taken by driving a small pipe into the pitch and then withdrawing it with its contained core of pitch. Following this, a pipe of 2 ins. diameter was driven to the lowest depth to which the core was taken and the material forced into it by driving was removed by means of a water jet and bit. Another core was taken below the 2-in. pipe in the untouched pipe. The deepest of these borings was taken at the center of the pitch lake and the asphalt was found to be of uniform character throughout. After completion, this hole was observed to have shifted at the surface 25 ft. in six weeks; a survey showed the movement to exist as deep as 100 ft., and there was a suggestion that the direction was reversed at a depth of between 25 and 50 ft. The other borings, not at the center of the lake, shifted to a lesser extent. The movement of the asphalt seems to be similar in many respects to the ascending and descending currents in a kettle of boiling water.

The problem presented is difficult of solution, as it seems to be impossible to find any material which will withstand the bending strain imposed upon it by the pressure of the mass of semi-solid asphalt.

The Austin Mixer Loader

The Austin mixer loader, which eliminates shovelers, is adapted for use either with end or side loading paving mixers.

The loader, by means of the power shoveling and measuring machines, requires only three men for its operation and will load and deliver more material in accurately measured batches than can be run through the mixer at capacity. In this manner the drawback of the past, where the mixer was delayed in its action, due to shovelers, is eliminated so as to reverse the action.

The fact that the Austin automatic loader can be used for loading wagons, etc., when not in use as a loader for mixing purposes, makes it valuable to the paving contractor who continually is requiring a loader in connection with his work.

The action of the loader is as follows: A continuous running belt conveyor is arranged to feed the concrete mixer loading skip or hopper. This continuous running belt conveyor is operated with a hopper cooled gasoline engine and equipped with traction, friction clutch controlled.

The material is arranged in wind-rows either side of the belt conveyor on the road to be paved and the automatic oscillating shovels are arranged on either side of the belt conveyor and in front of the material wind-rows.

The oscillating shovels work back and forth through the material piles arranged automatically according to their widths with the self-feeding loader for the buckets. This loading device consists of two eccentrically mounted discs that continually sweep through the material with a range of 5 ft., 6 in. Mounted over these discs are a series of curved feeding blades that carry the material from the pile to the bucket path automatically withdrawing from the load so that the buckets have a clear sweep across the discs for loading. The shovel rapidly eats away the material pile and advances forward continually. The measuring hopper is fed from the shovel by means of a belt taking the load of the buckets and one man located between the two shovels trips the measuring hopper doors and allows the measured material to be discharged onto the continuously running conveyor which carries it into the mixer loading hopper or skip. The Austin mixer loader is manufactured and marketed by the F. C. Austin Co., Inc., Chicago, Ill.

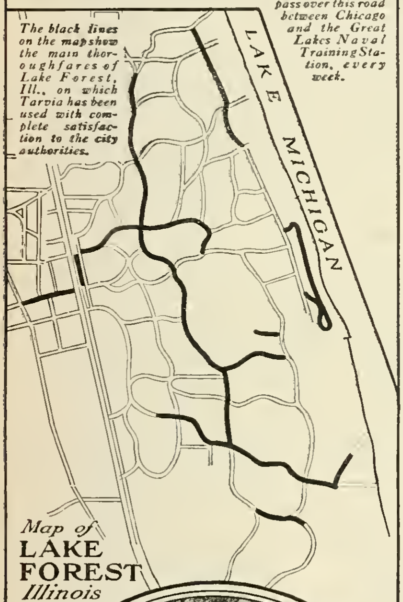
City Planning in Bethlehem, Pa.

The City of Bethlehem, Pa., which was incorporated July 17, 1917, is now making great progress in city improvement. Some 7 months ago the City Planning Commission of Bethlehem retained Frank Koester, Consulting Engineer and City Planning Expert, 50 Church St., New York City, to make a study of the city and surrounding territory prior to preparing a report of a comprehensive city plan. The many civic improvements made in the neighboring City of Allentown within the past few years are the results of Mr. Koester's city planning report for Allentown, made in 1915 and this lead to his engagement by the City of Bethlehem.

Mr. Koester's report has recently been accepted by the City Planning Commission of Bthlehem. It covers, among other features, Interurban Arterial Highways, City Streets, Sidewalk improvements, Bridges and Bridge Approaches, Street Railways, Parks and Play Grounds, Proposed Great Ground Plan, Homes for Industrial Workers, Promoting New Industries, Civic and Educational Centers, and City Sanitation. Special attention is paid to a most extensive park and play ground system, and the City of Bethlehem has, in the meantime, acquired large tracts of land for this purpose.

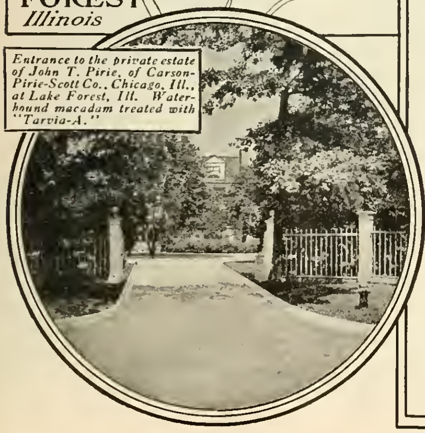
A driveway on the Lake Forest, Ill., estate of Mrs. C. H. McCormick. "Tarvia-X" two-course penetration and surfaced with "Tarvia-A."

A section of Sheridan Road, Lake Forest, Ill., 18,000 square yards of which have been Tarviated. Thousands of vehicles pass over this road between Chicago and the Great Lakes Naval Training Station, every week.



The black lines on the map show the main thoroughfares of Lake Forest, Ill., on which Tarvia has been used with complete satisfaction to the city authorities.

Entrance to the private estate of John T. Pirie, of Carson-Pirie-Scott Co., Chicago, Ill., at Lake Forest, Ill. Water-bound macadam treated with "Tarvia-A."



Tarvia

Preserves Roads
Prevents Dust—

An ideal road material for private estates and public roads—

THE photographs on this page show three Tarvia drives in beautiful Lake Forest, Illinois.

The black lines on the map show the extent to which Lake Forest has adopted Tarvia for its main thoroughfares.

Tarvia roads are ideal for beautiful suburban sections. Their firm, smooth surface "sets off" perfectly the lawns of beautiful green turf, with their borders of shrubbery and their canopies of lordly trees.

And besides adding materially to the attractive appearance of a section, Tarvia roads add to its "liveability," because they are clean and mudless and dustless.

Whether for the heavy motor truck traffic on main highways or for private driveways such as are here pictured, Tarvia roads are, above all, *a good investment.* They help to keep down taxes because they are low in first cost, and, being waterproof, frost-proof, and automobile-proof, they require little outlay for maintenance.

That is why the mileage of Tarvia roads grows by leaps and bounds every year. Tarvia today is the most popular road-making material in America.

Special Service Department

This company has a corps of trained engineers and chemists who have given years of study to modern road problems. The advice of these men may be had for the asking by any one interested. If you will write to the nearest office regarding road problems and conditions in your vicinity, the matter will have prompt attention.

Write for illustrated booklet and further information

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Personal Items

Lieut. Colonel George A. Johnson and Major Webster L. Benham have formed a partnership for a general consulting engineering practice under the firm name of Johnson & Benham. Offices at 150 Nassau St., New York City, and Firestone Building, Kansas City, Mo. Colonel Johnson is still in the service but anticipates discharge during the coming autumn. He was originally officer in charge of the water and sewer section of the M. & R. Branch of the Construction Division of the Army. Later he succeeded to the position he now occupies as second in command of this branch which has sole jurisdiction over the water supply, sewerage and sewage disposal, electric light and power, ice and refrigeration, heating, highways, railroads, buildings, fire departments and systems in several hundred military establishments in the United States and dependencies. Prior to Colonel Johnson's entrance into the service he was engaged in a Consulting Engineering practice at 150 Nassau St., New York City. Major Benham was discharged from the service on May 1st, 1919, having served with the Construction Division of the Army since October, 1917, as officer in charge of utilities and Construction Quartermaster at Camp Funston, Kansas. Later he was appointed regional supervising utilities officer for the camps in the southwest, in addition to his other duties, and on March 24th, 1919, he was ordered to Washington as assistant to the chief of the construction division. Prior to his entrance into the service he was president and chief engineer of the Benham Engineering Company, Consulting Engineers, Oklahoma, City, Okla. The new firm will handle the various phases of design, estimates and supervision of construction, operation and maintenance in connection with problems of water supply and purification; sewerage and sewage disposal; investigations of epidemics; electric light, heat, power and refrigeration systems; water power development; roads and pavements; reports and appraisals; and public utilities management. Until Colonel Johnson leaves the service, Major Benham will be the active head of the firm.

Trade Notes

Announcement is made by the Barber Asphalt Paving Company, Philadelphia, that following the promotion of Mr. Charles W. Bayliss, formerly manager of the street and road department, to vice president in charge of sales, the following changes in organization became effective June 1, 1919: Mr. J. E. Morris, manager street and road department, Philadelphia, Pa.; Mr. H. M. Stafford will succeed Mr. J. E. Morris as assistant manager in charge of the Eastern district, with headquarters at Philadelphia; Mr. F. F. Massey is promoted to succeed Mr. Stafford as assistant manager, in charge of the Southwestern district, with headquarters at Memphis, Tenn., and Mr. G. R. March is promoted to succeed Mr. T. H. Morris as sales manager of the Iroquois department.

Sauerman Bros., Monadnock Block, Chicago, Ill., announce the return of Major D. D. Guilfoil to his former position as sales engineer. Major Guilfoil came back from France in command of the First Battalion, 108th Regiment Engineers, on May 23, received his discharge at Camp Grant on June 7, and was back at his old job on June 9. The 108th Engineers, composed mainly of Chicago men, participated in the Somme and Meuse-Argonne offensives, and, following the armistice, was a part of the army of occupation in Luxembourg.

The Southern Asphalt Association, comprising the principal public works contractors engaged in laying asphalt pavements in the South Atlantic States, opened offices in Atlanta on June 1st, in the Healey Building of that city. The Association will be conducted in the interest of asphalt roads and pavements in the South Atlantic States. The purpose of the Association is to create a wider and better knowledge among public officials and tax-payers of the utility and advantages of asphalt for road and street purposes. This is to be accomplished by a general publicity campaign. In addition, the Association will endeavor to keep experienced and skilled workmen steadily employed by putting them in touch with the members of the Association who have need for their services. Mr. Walter Ely, president of the Ely Construction Company, Augusta, Ga., has been elected president of the association, and Mr. W. R. Mayrant, general manager of the Simmons-Mayrant Company, Charleston, S. C., has been elected vice president. The following board of directors have been elected to serve for one year and will determine the policy of the association: W. S. Ely, W. R. Mayrant, R. M. Hudson, president of R. M. Hudson Company, Atlanta, Ga., Fred L. Connor, president of Murray Construction Company, Knoxville, Tenn., and W. R. Dunn, of the Dunn Construction Company, Birmingham, Ala. Mr. J. M. Woodruff, who recently resigned the position of manager of the publicity and paving departments of the Standard Asphalt & Refining Company, a subsidiary of the Cities Service Company, has been engaged as general manager of the association and assumed his duties on June 1st.

The Tarvia Road Book, for highway engineers, contractors and road builders has been issued by the Barrett Company. This is a valuable technical handbook of real value to anyone with a practical interest in good roads. It gives quantitative data on various kinds of road and pavement materials per unit of length. It also gives Tarvia specifications. A copy will be sent free to any interested person who applies at the nearest Barret office. It measures 3½x6 ins. and contains 72 pages.

Two new bulletins have recently been issued by the T. L. Smith Co., Milwaukee, Wis. One relates to Smith Pumping machinery and the other to the Smith Paving Mixer. Each bulletin measures 7½x10¾ ins. and contains 16 pages. In the pump bulletin the Smith force, centrifugal and diaphragm pumps are illustrated and described and their special fields of usefulness enumerated. The same character of information is given for Smith gasoline and kerosene engines. Information is given on the selection, purchase and operation of pumps. There are three pages of hydraulic engineering data. The bulletin on the Smith Paving Mixer illustrates and describes every part of the mixer and points out its advantages.

The H. W. Clark Co., of Mattoon, Ill., manufacturers of water works equipment, now occupy their new factory just completed at Mattoon, Ill. Their former plant was destroyed in the tornado of May 26, 1917. Since the tornado and prior to moving into their new plant, they operated in temporary quarters and succeeded in taking care of their customers and in holding their business together. The plant comprises an engineering and drafting department, pattern shops, gray iron foundry, brass foundry, blacksmith shops, machine shop, sheet iron works, and Nickel plating plant. It is located on two spurs from the Illinois Central Railroad, being supplied with two tracks, one for incoming material, and the other for outgoing finished products. The H. W. Clark Co. has been in business for more than 25 years, and their line is well and favorably known throughout the country.

"Spring Rains and Floods" is the title of a folder calling attention to the fact that there have been several typhoid fever epidemics directly traceable to contamination of water through surface wash and the run-off of melting snow. All surface water supplies are subject to this form of pollution and should, therefore, be sterilized as the interesting folder states. It is issued by Wallace & Tiernan Co., Inc., 349 Broadway, New York City.

WATER WORKS SECTION

The Design and Operation of the Water Filtration Plant at Camp Meade, Maryland

By C. R. Potteiger, Captain, Q. M. Corps, Officer in Charge of Water Filtration and Pumping Stations, Camp Meade, Admiral, Maryland

When the site for the location of Camp Meade was selected, the question of water supply was very important. It was originally intended to use the water from driven wells for construction purposes, and it was expected from the statements made by the geological experts in the state of Maryland, and of the U. S. geological survey that water could be obtained in copious quantities from this source.

Wells Tried and Abandoned as Source of Supply

The geological authorities advised that there were three water bearing zones or sheets of water underneath this territory, one at a depth of about 100 ft. at Annapolis Junction, dipping to 170 ft. at Naval Academy Junction; another zone 200 ft. deep at Annapolis Junction and about 315 ft. deep at Naval Academy Junction, and a third zone probably as deep as 350 ft. at Annapolis Junction and from 500 to 600 fet. deep at Naval Academy Junction.

As a result of this information it was decided to drill eleven wells at various locations throughout the cantonment which were widely distributed and available for delivering water into the distribution system in the various sections in the cantonment.

Considerable trouble was experienced in getting sufficient quantities of water from these driven wells to supply the camp during the whole of the construction period and during the first few weeks of the period, when the drafted men first came to camp.

In a report by the supervising engineer to the construction quartermaster on Oct. 23rd, 1917, there was indicated in the various wells a total available quantity of water of 1,008,000 gals. per day. A total of 453,000 gals. were reported as being available through high head pumps, 173,000 gals. available through medium head pumps, 288,000 gals. available at wells not equipped with pumping machinery and 94,000 gals. per day available through installation of a larger equipment.

The wells were abandoned as a source of supply and the project adopted contemplated the pumping of water from the Little Patuxent River, with low life pumps to the filtration Little Patuxent River, with low lift pumps to the filtration camp, to a hill, at an elevation of about 300 ft. north of the cantonment site.

Supply From Little Patuxent River

The Little Patuxent River from which the water is drawn for the use of the Cantonment has a drainage area above Welch's Bridge of 126.8 square miles with an estimated population of the water shed area of about 6,900. It lies for the most part in Howard County, Md., of which it constitutes the central and southeastern portion. The extreme southeastern portion of the drainage area is situated in Anne Arundel County. The area has an extreme length from the headwaters of the Middle Patuxent River, the principle tributary of the Little Patuxent, to the intake of approximately 21½ miles. The main axis of the watershed area extends from the northwest to the southeast. The average width of the drainage basin is 5.9 miles.

The area is largely devoted to agriculture with few villages and few manufacturing plants. The different farmhouses are provided with privies and have no direct connection to this stream.

Characteristics of the Stream

The flow of the Little Patuxent River is flashy in character. The river responds promptly to rainfall upon its watershed, and falls rapidly after storms have passed. It is estimated that the river flow at Welch's Bridge is, at the extreme minimum 4.01 M. G. D.; ordinary minimum 6.01 M. G. D.; and the average daily flow calculated from daily averages for 16 years, 111.9 M. G. D.

The waters of the Little Patuxent River have an extraordinary range in turbidity, and vary in that respect with extreme rapidity. Readings of raw water turbidity are taken every two hours at the filter plant laboratory and records are available for the whole period of the year 1918. During this time the average daily turbidity ranged from a maximum of 4,000 p.p.m. to a minimum of less than 10 p.p.m., the mean value of the period having been 210 p.p.m. The maximum turbidity observed on any individual sample was 5,500 p.p.m.

The alkilinity of the raw supply is variable, reaching a maximum of perhaps 45 p.p.m. during dry periods and a minimum value of less than 5 p.p.m. during floods. At times of low turbidity it is necessary to increase the alkalinity by dosing with hydrated lime which reacts with the required doses of coagulant. The lime is added in solution and suspension directly into the suction lines of the pumps at the low lift pumping station.

Analysis of Raw Water

Analysis of the water in the Little Patuxent at Welch's Bridge as made by the Maryland State Department of Health is as follows:

	Minimum	Maximum	Average
Turbidity	10	1900	428.365
Total Solids	86	1938	511
True Color	20	64	365
Free Ammonia .	0	0.07	0.038
Total Abl "	0.05	1.28	.31
Chlorine	3.2	5.9	4.22
Nitrates	.0	.7	.27
Nitrites	....	trace	....
Hardness	4.0	40.0	21.1
Iron	.4	30.0	5.5
Alkalinity	11.0	31.0	23.0

Bacteriological analyses show that the waters of the stream are seriously polluted. This pollution is indicated both by the large numbers of organisms developing as a total count on standard nutrient agar incubated for 24 hours at 37° C. and by the large numbers of B. coli present. The total agar count during the period of February 1918—January 1919 inclusive varied from a maximum of 86,000 per c. c. to a minimum of 40 per c. c., the average number being .332 per c. c. The number of B. coli presumtively determined have varied from probably more than 1,000 to 0 c. c., and have roughly averaged 63. The numbers of B. coli reported must be considered as rough estimates only. It may be definitely stated, however, that B. coil are rarely absent in 1 c. c., of the water and generally present in 0.1 c.c.

Elements of Water Supply Works

The existing water supply works consist of the following principal elements:

A timber crib dam about 7 ft. in height above the original bed of the stream on the Little Patuxent River at Welch's Bridge at the west central limits of the camp reservation.

Two separate, concrete, screened, intake chambers on the left or east bank of the stream.

A low lift pumping station on the east bank of the river with three electric motor driven, centrifugal, pumping units forcing water to five coagulating tanks at the water filtration plant. The total nominal capacity of these pumps operated singly is about 3,300 gals. per minute, or 4,750,000 gals. per 24 hours. Their capacity operating in pairs, or all together is considerably less, due to friction losses in the pumping main. Two additional pumps each having a pumping capacity of 1,650 gals. per minute have been delivered to the plant, but to the present time have not been installed. One of these is driven by a 75 h. p. motor, direct connected and the other by a 75 h. p. Van Blerck gasoline engine, direct connected.

Lime storage house and lime tank house, lime solution and dosing apparatus, located on the left bank of the Little Patuxent River at the low lift pumping station.

Design of the Rapid Sand Filter Plant

A complete rapid sand filter plant involving:

One mixing tank and five coagulating tanks, nominal capacity 100,000 gals. each.

Six Roberts Filter Company's rapid sand filters, high rate wash type, capacity 500,000 gals. per 24 hours each, complete with effluent controls, loss of head gauges, etc. (Two additional filters of the same type and capacity have been started, but the construction of these filters was stopped before the equipment was completed. A very small amount of work will be necessary to equip the plant with an additional million gallon filter capacity.)

Alum storage house, solution tanks and dosing apparatus in head house at filter plant.

Two chlorine dosing apparatus of the Wallace & Tierman Company's manually controlled wet feed type.

Two clear water tanks at the filter plant, nominal capacity 100,000 each.

Two additional clear water tanks have been started and very little additional work will be required to complete this equipment.

The high lift pumping station at the filter plant with three electric motor driven pumping units, forcing water through a Venturi meter directly into the distribution system, and into equalizing tanks about 2.0 miles distant on Hill 300. The total nominal capacity of these pumps operating singly is about 3,600 gals. per minute. Their capacity operating in pairs, or all together is considerably less. This station is also equipped with one Worthington centrifugal pump, having a capacity of 1,650 gals. per minute, directly connected to and driven by a Van Blerck six cylinder gas engine. An additional motor driven pump has been delivered to the camp, but has not been installed in the station. This pump is a direct connected centrifugal pump driven by a 150 h. p. motor.

Two wash water pumps located in the high lift pumping station near the filter house, and connection for washing with use of water from force mains of high lift pumps and distribution system. The capacity of these pumps is about 1,400 gals. per minute each, or approximately 2,000,000 gals. per day. Their capacity operating together is about 2,800 gals. per minute, or 4,000,000 gals. per day.

A complete distribution pipe system arranged to receive water by the so-called direct-indirect method, comprising 20.1 miles of pipe, mostly wood stave, varying in size from 6 to 12 ins. in diameter.

Four elevated equalizing tanks having a nominal capacity each of 100,000 gals. and four elevated equalizing tanks having a nominal capacity each of 200,000 gals. These tanks are located on Hill 300 near the extreme northerly limits of the camp.

A well equipped chemical and bacteriological laboratory, located in the head house of the filter plant.

Operation of the Plant

The operation of the water filtration plant was taken over from the contractors on Nov. 20, 1917. At that time there was no personnel in the Utilities Detachment, and the first proposition was to secure, if possible, men from the 79th Division, who had previous training along the lines required for the operation of the water filtration plant and pumping stations. At this time the pumping stations were being operated by the contractors, who worked two men in each station on twelve-hour shifts, while the filter plant was being operated under the direction of the Roberts Filter Company in the same manner.

Men having the proper qualifications were selected from camp organizations for the operation of these plants. The general idea at all times in selecting men for this department was to secure men either with mechanical, chemical, or a civil engineering training. For the operation of the filter plant especially, it was desired to secure college men, for it was easily seen that this station would require the services of trained men.

For the first six months of the operation of the plants, practically all of the time of the officer in charge was spent in the filter plant and pumping stations supervising the operation of these plants. During the period when the contracters were operating the plant practically no records had been kept on the operation of the plant and it was necessary to work out new forms and systems for all the sections of this work.

Organization of Forces

The work of the pumping station and filter plant is divided into three shifts of 8 hours each. The first shift working from midnight to 8 a. m., the second from 8 a. m. to 4 p. m., and the third from 4 p. m. to midnight. At the pumping stations two men are assigned to each shift, consisting of an engineer, and an oiler, as his assistant. At the filter plant each shift consists of a filter operator and an assistant filter operator. After April 25th, 1918, a laboratory was installed and two men assigned to work in this department. These were a chemist and bacteriologist in charge and an assistant chemist and bacteriologist.

The authorized strength of the filter plant and pumping station was 23 men, distributed as follows:

Low lift pumping station:	3 Engineers.	3 oilers.
High lift pumping station:	1 Chief mechanic in charge of the station.	
	2 Assistants who act as alternating engineers and oilers in the pumping station.	
	3 Engineers.	3 oilers.

The filter plant has authorized for the laboratory:

1 Chief Chemist and Bacteriologist.
1 Assistant Chemist and Bacteriologist.
3 Filter operators, 3 Assistants.

The operation of the plant has been under the direct observation and direction of the officer in charge of filtration who is an assistant to camp utilitiets officer, who is responsible for the operation and maintenance of all the camp utilities.

The operation of the plant is now being changed to a civilian basis subject to civil service regulations and properly trained men are being secured for the operation of the plant and laboratory. The organization will be changed somewhat since more work will be expected of the individual men on the new basis.

Plant Operated at Outset by the Contractors

While plant was being operated by the contractors the rate of filtration was constantly varying, and was determined entirely by the operation of the effluent valves, although all the filters were equipped with Simplex rate of flow controls. All six filters were operated simultaneously, and during periods of low consumption or when only one pump was being used at the low-lift pumping station, the effluent valves were throttled in order to maintain a constant head on the filters. This level was maintained at aproximately 12 ins. below the top of the staves.

The average time of operation during this period was from 5 a. m. to 11 p. m. and the plant was entirely shut down from 11 p. m. to 5 a. m. Readings on the amount of water in storage on Hill 300 were taken by two men, who were stationed at this point, and who read the depth of water in the tanks every hour.

From Sept. 19 to Oct. 15, 1917, the alum was fed from a single temporary 6x6 ft. alum tank, placed on the filter floor, with two temporary feed lines running to the sedimentation tanks. On Oct. 15 the two alum tanks each 6x6 ft. were permanently located on the third floor of the filter plant and permanent connections were made from those tanks to the sedimentation tanks. In March, 1919, these tanks were replaced with two 10x6 ft. tanks with improved orifice feed tanks and mechanical stirrers, and all alum fed directly to a mixing tank, though a secondary feed has been provided.

The amount of alum was regulated entirely by the appearance of the floc to the sedimentation tanks and in the water as it came to the filters. No records whatsoever were kept of the amounts of either alum or chlorine added during any given period of time. The lime mixing tanks at the low-lift pumping station were not in operation at this time, and there was only one day during the latter part of October, 1917, when any attempt was made to increase the alkalinity of the water.

From Sept. 15 to Oct. 5, 1917, the filtered water was sterilized by running the solution of calcium hypochlorite into the effluent main. A 50-gal. barrel containing the calcium hypochlorite solution, strength unknown, was placed beside the effluent main. The solution was run into the main through a ¼ in. pipe, and the quantity or rate of flow was regulated by a pet cock on this line. A certain number of drops per minute were added into the main pipe line, giving a theoretical dosage of chlorine equivalent to 5/10 parts per million. This crude apparatus was replaced on Oct. 5, 1917, by two Electro-Bleach wet-feed chlorinators.

Accurate Records Kept by Utilities Detachment

When the plant was taken over by the Utilities Detachment the system, however, was changed with respect to the fact that immediately on taking over the plant accurate records were kept on every phase of the operation. The rate of filtration had not been definitely calibrated and there were no means of knowing how much water was actually being filtered in a day.

An attempt was made immediately on taking over the plant to secure accurate data on the addition of alum, and from the beginning the Hazen scale was used in determining the amount of alum to be added, supplemented by the appearance of the floc in the water. Using approximate pumping records the alum added for the first three months averaged about 0.5 gr. per gallon.

Chlorination

Chlorine was added by an arbitrary setting on the Electro-Bleach machine. This rate was so adjusted as to deliver 0.5 parts per million of chlorine. But from the beginning, before the filters had been calibrated, the chlorine was calculated from the amount of water pumped by the low lift pumping station. This, however, did not take into consideration the amount of water which overflowed down the overflow pipe in the sedimentation tanks, nor did it take into consideration the throttling of the valves on the effluent line. This error was responsible for the irregular addition of chlorine to the water, with the consequent noticeable chlorine taste in the water as delivered to the camp at some times, while at other times there would be absolutely no taste or odor. The adjustment of the chlorine machines, however, was such that at no time could there possibly be an addition of chlorine of less than .5 parts per million, though while the valves were throttled, quite frequently chlorine was added in large excess because the machine was not regulated to the change in rate of filtration.

New forms were introduced in the operation of the filter plant in February, 1918, the installation of which helped considerably toward keeping the plant in better shape in that it made it absolutely necessary for each operator to pay careful attention to every stage of the operation and make an hourly record of every addition of coagulant and of every change in the treatment. Together with this change in forms many minor investigations were carried out in order to determine the characteristics of each filter, rate controller and pump in this installation.

Laboratory Control

In the water filtration plant laboratory determinations are made of the turbidity of the raw water every two hours, and of the applied water and filtered water every hour. Determinations of the alkalinity of the raw water are made every two hours, and of the treated water every hour. Bacteriological samples are taken from each filter effluent and of the chlorinated water twice daily, and of the raw water once each day. Samples are taken from various taps throughout the camp at frequent intervals, and it is aimed to have at least one sample of tap water analyzed each day. Check bacteriological examinations are systematically made in the sanitary section of the Base Hospital Laboratory upon samples of the raw, filtered and chlorinated water, and of water from the various taps in the cantonment.

In the filter plant laboratory the bacteriological work consists of a total count at 24 hours, incubated at 37°, and a total count at 48 hours incubated at 37° for 24 hours. In the Base Hospital Laboratory all counts were made at 37°, and a total 48 hours. Presumptive tests for B. coli are made on all samples at both the filter plant and base hospital laboratories. Endo confirmations are made on each tube showing gas, by the base hospital laboratory, and quite frequently Endo confirmations are made at the filter plant laboratory.

Special investigations are made at frequent intervals by the chemists and bacteriologists in the laboratory, in order to determine any necessary changes in the operation of the plant and to check all stages of the operation.

Filter Washing

The filter washing is by the high rate water method without mechanical agitation or the addition of air. The rate is normally that produced by the operation of the two wash pumps, and may be expressed by a vertical rise of 25 ins. per minute, measured above the sand.

In their original installation the filters were equipped with only the circular wash trough, and considerable trouble was experienced from mud balls, due to the fact that the distance of horizontal travel from the center of the tanks to the troughs was too great for effectively removing the mud. This trouble has been remedied by the installation of a cross-trough in each tank, in order to decrease the horizontal distance from any point in the tank to the wash trough. These troughs were built across each filter on a diameter terminating half-way between the two wash water outlets. The usual length of washing is approximately four minutes, but due to the formation of mud balls before the cross troughs were installed, the filters were very frequently washed from 5 to 15 minutes, with a resultant very high percentage of wash water used.

When the plant was originally taken over the time of washing was determined entirely by the reading of the loss of head gauges, the point of washing being usually a reading of about 9 ft. It was very shortly found that these loss of head gauges were not accurate, and considerable trouble was experienced if the filters were allowed to reach a loss of head of 9 ft. as shown on the loss of head gauges, before being washed. A rough general rule for the washing of the filters was, therefore, devised, based upon the turbidity of the raw water, recognizing the lack of efficiency of the coagulating tanks.

Coagulant and Lime Application

On account of the rapidly changing turbidity and alkalinity of the raw water, the matter of coagulant and lime application requires the most careful and vigilant attention. With rising stream and increasing turbidity, effective coagulation is more readily accomplished than with falling stream and turbidity. The earlier turbidity is coarser and the colloidal clay present is much more readily agglomerated and subsides more rapidly than the finer matter, containing a much larger proportion of colloidal material, which obtains later after the first flush of the storm waters has passed.

Liquid Chlorine Application

In the earliest operation of the purification plant it was attempted to treat the filtered water with a minimum dosage of 0.3 parts per million (2.5 lbs. per million gallons) of liquid chlorine. This dosage was increased to 0.5 parts per million and since about August 14, 1917, the nominal dosage has been 1.0 parts per million (8.35 lbs. per million gallons). This very large dosage has been deemed necessary in view of the contamination of the river water and the tendency of the filters to break through unexpectedly, probably due to the too great effective size of the filtered sand.

Filters

The six filters installed at this plant have a rated capacity of 3,000,000 gals. daily. These filters are equipped with a Simplex rate controller, which however, does not have a graduated beam. The distance between the inner face of the counter weight and the outer edge of the sleeve of the lever, determines the adjustment on these rate controllers.

The consumption of water in the camp during the period this plant has been operated has varied from a minimum of 1.24 million gallons to 2.65 million gallons daily, the average daily consumption having been 1.98 million gallons. This wide variation in consumption has been due in part to the extreme changes in weather which have been experienced during this period. In order to accommodate these changes in consumption it became necessary to overload the capacity of the filters, and for several months the filters were constantly overloaded about 15 per cent.

It has been the policy of all the operators at this plant to run the filters at as low a rate as possible, in order that the filters should not be overloaded, but until the additional storage tanks were installed on Hill 300 it was impossible to run the filters at a rate which was not injurious to them.

Troubles and Obstacles Encountered

There were many things peculiar to this plant experienced in its operation, and it was in the surmounting of these obstacles that the most experience was gained and the operation of the plant made more efficient. The following are some of the various troubles and obstacles encountered.

a. Lack of Storage Capacity

Lack of storage was easily the most important of the obstacles experienced in the operation of this plant. The total storage at this installation was 400,000 gals. as a maximum, and at the normal rate of consumption and filtration this allowed a maximum of five hours reserve storage. Although the total daily consumption never exceeded the capacity of the plant, the peak loads of consumption, which occurred normally at each meal and in the evening between 8 and 10 p. m. greatly exceeded the capacity of the plant, and on some days the rate of consumption for several hours reached a rate of 5,500,000 gals. per day. The effect of these high rates of consumption, coupled with the very small amount of reserve storage, made it impossible for the plant to supply the water required in camp and maintain a reserve supply in the storage tanks.

As a remedy for this condition various orders were published by Headquarters relative to the consumption of water, with the object of prohibiting bathing except during stated intervals, in order that the reserve supply might not become exhausted and greatly increase the fire hazard in this camp. In addition to these bulletins as published by Headquarters water conservation posters were designed by this Department and posted conspiciously in all the latrines and kitchens in camp.

Another attempted remedy was to decrease the amount of water passing through the various fixtures in the camp by inserting in each outlet a small lead plug with an opening approximately ⅛ in. in diameter. The normal pressure in camp varies directly with the elevation, from 50 lbs. at the Base Hospital at the extreme north end of camp to approximately 100 lbs. at the south end of the camp. The installation of these lead plugs decreased the amount of water passing through the fixtures, and consequently decreased the amount of water wasted.

In Nov. 1918 four 200,000 gal. tanks were built on Hill 300 to supplement the storage and as result of the additional storage it was possible to operate the filters at a lower rate and to maintain enough water in storage at all times.

b. Mud Balls

Considerable trouble was experienced in the operation of the filters due to the large amount of mud balls that formed on the surface of the filters, and due to various deficiencies in the installation of the water works. Among these causes were:

Lack of Sedimentation; Poor Washing—The sedimentation capacity of the plant at that time was 200,000 gals., which at a maximum rate of flow allowed a sedimentation of only one hour. This very short period of sedimentation required the addition of extremely large quantities of alum in order that sedimentation might take place before the water reached the filters. With, however, the extremely high turbidities that are found in the waters of the Little Patuxent River following storms, it was found impossible to have all the mud deposited in the sedimentation tanks, and consequently it has frequently been found that the water as applied to the filters had a turbidity as high as 300, with the consequent formation of large quantities of mud balls.

The equipment as installed provided only the circular wash trough, and the distance from the center of the filter to the wash trough was too great for proper removal of the dirty water. Consequently a large amount of mud was allowed to remain in the filter from time to time, which gradually accumulated and resulted in the formation of mud balls. Part of the time, when most trouble was being experienced in the formation of mud balls, one of the two wash water pumps was out of service and it was necessary, in order to get the proper rise, to wash with water from the mains. It was impossible in this way to secure the desired rise in the wash water, and it was during this period that considerable trouble was experienced with mud balls.

The washing of the filters has been considerably improved by the installation of center cross troughs in each of the six filters. These troughs have also materially decreased the amount of wash water required and have increased the uniformity of the wash.

c. Alum Apparatus

Considerable trouble was experienced with the alum apparatus installation. The most serious trouble was the corrosion of the galvanized iron by the alum solution. The first installation of piping from the alum tanks was a lead lined galvanized iron pipe, but the joints were not properly made, and in a very short time the iron between these lead joints was eaten away and the apparatus began to leak very badly. The new alum apparatus installation has removed these difficulties.

d. Chlorine Apparatus

The most serious trouble experienced with the chlorine apparatus was due to the type of machines installed. This installation consisted of two machines of the Electro-Bleach type, which after a very short period of service became unserviceable. The guages on these machines were found to be inaccurate, and in consequence the addition of chlorine was very irregular. Due to large amounts of impurities in the chlorine gas the machines became clogged, and repeated efforts to clear them were of no avail. The defects in the chlorine apparatus resulted at times in a very irregular addition of chlorine to the filtered water.

These machines were replaced by a Type B. wet-feed, manual control Wallace & Tiernan chlorinating apparatus. These machines had a capacity of 50 lbs. per day and were installed in duplicate. With this installation it was possible to adjust the amount of chlorine added very accurately, and no further troubles have been experienced with the addition of chlorine since their installation.

e. Mechanical Troubles

The principal mechanical troubles resulted in a decreased water supply, on account of the fact that it was impossible to pump water to the filter plant. In most cases where this condition existed the trouble was due to interruptions to the supply of electric current to the camp. The interruptions, which were of frequent occurrence, ranged in duration from a few minutes to five hours.

As a result of electrical storms two of the 2,200 volt motors were burned out at the Low Lift Pumping Station, in August, 1918, and after that time considerable trouble was experienced in keeping the pumping equipment in working order at this station. To prevent any further trouble in having motors out of service extra equipment has been installed in each of the two pumping stations. One unit in each station consists of a gasoline-driven pumping engine, each having a capacity of 1,650 gals. per minute. These additional units were further supplemented with the addition of 800,000 gals. reserve storage, which has served to relieve any shortage of water due to mechanical troubles of any sort.

f. Loss of Head Guages

Some trouble was experienced with the loss of head guages as installed at the Filter Plant, the principal trouble being their unreliability. The faults were not so much in the design of the guages as they were in mechanical difficulties. The copper wire which supported the floats became corroded very quickly by the chlorine gas which was liberated in the filtered water and was likely to break at a time when most needed. This wire would also at times jump the wheels due to the fact that the weights would catch on the flooring or on the sides of the pipe, and in this way would wrap around the cogs outside the wheel and put the loss of head guages completely out of service. The presence of mud balls on the filter was a cause of irregular filtration and the loss of head guages themselves gave a false sense of security, due to the fact that although the filters were likely to break, the loss of head guages themselves might show a loss of head of not over 5 or 6 feet.

The unreliability of the loss of head guages had the effect of giving the filter operators a false security, in that they had been disposed to depend on the loss of head guages entirely for their indication as to the proper period when filters should be washed. These guages frequently stuck, showing a loss of head of about 5 or 6 ft., and, even though carefully checked, the operator was likely to overestimate the capacity of his filter, with the result that the filter would break and deliver a poor grade of water to the camp.

In order to determine when the filter should be washed a time limit was put on each filter, depending on the raw water turbidity. At no time was the filter supopsed to run over 24 hours, with a normal raw water turbidity of less than 50.

g. Sand

The sand that was installed in the filters was found to be too coarse to give good results when the filters were operated at a high rate. Analysis of the sand made in the laboratory of the Montebello filters in Baltimore showed the sand from the surface of the filters to have an effective size of 42 mm. and a uniformity coefficient of 1.19, while sand from a depth of 18 ins. below the surface had an effective size of 48 mm. and a uniformity coffiecient of 1.59.

The effect of the coarse sand in the filters was that the mat of the filters broke under the high rate of filtration. The result of this was that a certain amount of fine colloidal matter was allowed to penetrate through the filters into the effluent water, and unless the addition of chlorine was considerably increased the bacteriological counts in the water delivered to the camp were high, and in several instances resulted in contaminating the whole water supply.

h. Contaminated Water Supply

There were several causes which tended to contaminate the filtered water supply in this camp. Uncovered clear wells and reserve storage tanks on Hill 300 were a contributory cause of this contaminated water supply, in that these tanks frequently served as a resting place for birds, and particularly pigeons, in the vicinity of Hill 300, and the water supply was in many instances contaminated directly by the dejecta from these birds. These conditions were remedied first by covering all the storage and clear well tanks, in this way preventing any outside contamination, and, second by the purchase of new chlorinating equipment, which enabled the operators to chlorinate at a more uniform rate. The amount of chlorine was increased to 1½ parts per million during the periods when the water showed fecal contamination, which in this manner was quickly eliminated.

i. Algae in Storage Reservoirs

The presence of algae was caused by having the tanks exposed and uncovered, which made conditions very favorable for the growth of algae. The only effect noticeable was the presence of a slight odor at the tanks on the Hill, but which was not noticeable in the water supply as distributed to the camp. The tanks were thoroughly scraped out, the algae growth removed and the tanks treated with a solution of copper sulphate as a disinfectant, and covered. No trouble has been experienced with algae growths in these tanks since that time.

Records

A card system for records of the pumping stations and filter plant has been installed. On these cards the pumping station operators are required to note the time of starting and stopping of each pump. The revolutions per minute, the vacuum and pressure on each pump are required to be recorded every hour. At the low-lift station when lime is being added a record is made each hour of the lime added. On these cards are also entered any extraordinary happenings pertaining to the operation of maintenance of the pumping stations. During the period of construction a daily progress record on this construction is entered on the daily record card.

At the filter plant in the same manner is recorded the time of starting and stopping of each pump in both stations, as well as the time of starting and stopping of each filter as it is put in service or taken out of service. Every hour a record is made of the amount of chlorine added to the effluent, the amount of alum added to the raw water, and the amount of storage, the amount of water consumed, the alkalinity of the raw water and the turbidity of the raw, applied and filtered waters. At each hourly reading a record is made of the loss of head as shown on the loss of head guage for each filter, and the rate of filtration is recorded, depending on the setting of the rate controller.

Reports

A summary of all the daily records is made on a large blue-printed form, originated by this organization, which gives a complete record for the month of the operation both at the filter plant and pumping stations. This report includes the chemical and bacteriological record, as well as the plant operating data.

Costs

Operating costs have been figured for the whole period of operation since the work was taken over by this detachment. The costs as computed for the year 1918 do not include repairs and supplies, but are based only on the total pounds of alum, lime, chlorine, coal, power costs and salaries. The average cost per thousand gals. filtered during the year 1918 was 7.6 cts.

Alum cost $1.85 per 100 lbs.; lime $12.75 per ton; chlorine, 8.6 cts. per pound and coal $5.80 per ton.

The general operation of the Camp Meade Filter Plant is favorably comparable with any mechanical filter plant of its size in the country. Operating costs are a trifle high due to double pumping and large amounts of coagulants necessary for the water.

The original installation was inadequate for the needs of the camp, but the additional equipment authorized and installed during the latter part of 1918 has made ample provision for any emergency.

Some Experiences Gained in the Private Ownership of the Public Water Supply Works at Council Grove, Kansas

By Louis L. Tribus, of Tribus and Massa, Consulting Engineers, 15 Park Row, New York City

(Mr. Tribus has been for twenty odd years engineering adviser to the Council Grove Water Supply Co.; its owners all being Eastern men who invested unwisely, but in good faith, being misled by the promoters.—Editor)

The recent sale to the city of Council Grove, Morris County, Kansas, of the privately owned water system closes the first volume in the history of an interesting little plant, which in some ways is typical and in others unusual, a plant having capacity of about one-half million gallons per 24 hours.

In the decade, 1880 to 1890, hosts of villages, small towns and partly grown cities fell to the blandishments of water works promoting syndicates and enterprising individuals.

Some instances there are where honorable dealings prevailed, suitable construction ensued and happiness continued, but many are the unfortunate cases where these desirable features are lacking.

Occasionally, condemnation proceedings bring to light some such unfortunate conditions, but usually they remain locked in the memory of gulled investors, who try to forget their losses and do not desire to exploit their mistakes or deficient judgment.

Council Grove is a case in point, except that its construction work was good in quality.

Volume II of its history can only be written after the lapse of coming years as a municipally owned and operated utility.

Source of Supply

The Neosho river is a flashy western stream, flowing through rolling farms and grazing lands, over a limestone rock bed and between (usually) banks of rich black silt.

In the course of a few days, and without any regularity of season, it changed from a bank full, swiftly flowing stream, fifteen or more feet deep, to little more than a trickle from pool to pool.

Nature has developed these pools, through the deposit of cementitious gravel, making dams or riffles at about ½ mile intervals.

Man has taken advantage of them and for Council Grove's supply has raised them higher; in one instance with a masonry core and paved top and slopes, and in another with a rock-filled crib and planked structure.

Until within a year or two almost enough water has been thus impounded to tide over dry spells, unless the demand was too great, then great anxiety followed until rain or thaw brought relief. On parts of two days the city actually was without fire protection, for the water fell too low for the pumps to reach it; but surely a pretty good record for a region of droughts and a life of 32 years.

With the topographic and geologic conditions as noted, variation in quality of water is not surprising. At low stage, very high in alkalinity and moderately clear (spring flow chiefly); in flood, low in alkalinity and high in everything else that can find passage in an active Kansas stream; turbidities then running up to 5,000 parts per million and over.

The first elements of the original plant consisted of the usual steam pumping station, drawing water (untreated) from the lower pool (or reservoir), with some storage above the crib dam, before referred to; some 4½ miles of good sized cast iron pipe lines; a wrought iron standpipe 20x80 ft., surmounting the one eminence in the city, and an all important fea-

VIEW OF THE WATER SUPPLY WORKS AT COUNCIL GROVE, KANSAS.

Left to Right: Pressure Filter House (1898)—Old Boiler and Pumping Station—New Filter House—Coagulation Gallery and Sedimentation Basins (1915)—Old Receiving Well at edge of Neosho River.

ture, a 25-year franchise and hydrant contract; the latter carrying terms, strange to say, just, both to the city and the prospective company.

Water Rates Copied Bodily from St. Louis, Mo.

The rates, however, authorized in agreement under, but not required by, the franchise, were taken bodily from those in effect in St. Louis, fair perhaps in that large city, but scarcely one-third of what they should have been for a small place like Council Grove.

It was quite within the legal powers of the mayor and commissioners to arrange with the company from time to time for an adjustment of these rates to meet conditions of the day, but no justice could ever be secured for the company; the attitude of the officials being "if the company made a bad bargain let it take the consequences—we know a good thing when we see it—we have the best plant in Kansas and the lowest rates, let the company get better terms if it can, etc., etc."

Without filtration, it can be well imagined that the use of water was limited chiefly to lawn sprinkling (and fertilizing, though the rates did not consider that valuable feature), street flushing and such manufacturing as could not

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With the ever increasing cost of labor, wouldn't it be much better to err slightly on the side of "ample capacity" and save this expense of replacement?

The Cast Iron Pipe Publicity Bureau

1 BROADWAY **NEW YORK**

secure enough from shallow driven wells; the two railroads were large users for locomotive boilers, but of necessity not desire. Housholders depended largely on roof collected rain water and shallow wells, but both very precarious sources; they denied themselves, almost wholly, sanitary conveniences.

After Ten Years

After waiting in hopefulness for some 10 years or so, the unfortunate and largely uninformed non-resident owners of the plant, misled by the promoters, found a costly non-earning property on their hands and the necessity of providing additional storage and filtration, or risk losing the whole investment.

By the way, it should be noted that the same mayor, now in the chair, after several breaks in continuity of service, and into whose official hands the present plant falls, was in office when the original franchise was granted in 1886, approved the plans for the first plant and to him and his followers is largely due the disgust, that has caused the sale at a sacrifice, so as to end such unsaticfactory relations as have obtained for years past. Good treatment and honorable dealings have been consistently met by vacillation, repudiation and injustice. These comments are strong but fully justified and should be an integral part of the record.

Improvements Made to Plant in 1898

In 1898, additional storage was provided and a rapid mechanical pressure filter installed.

These facilities satisfied the slowly increasing consumption, but housewives could scarcely get themselves to use "that nasty river water," even though it came clear from the tap, as long as roof washings instead, would hold out. It may be said in extenuation, however, that the roof water was "soft" and the public supply "hard," and that when heated the latter, though clear, did at times smell of its early days.

When, however, the shallow driven and dug wells gave evidence of outhouse contamination, and the city, in its growing pride, achieved a sewer system, the Board of Health asserted itself, closed the wells, ordered sanitary facilities, sewer connections, and through force of necessity, water services.

The company began to get increased business but with existing rates, increased expense also, out of proportion to the increase in revenue.

More Plant Improvements in 1911

The end of the franchise came in 1911; the city gave formal certified notice of its intent to acquire the system; its officers agreed upon a fair price, them the voters diligently misled, repudiated the action and the officials discontinued to pay hydrant rental until forced by the court either to acquire the property and pay the claims or extend the franchise and contract, for a 20-year term. It chose the latter, and the company in accepting, and compromising on past earned hydrant rentals, agreed to enlarge the treatment plant and forthwith did design and build, what perhaps has been the most effective purification plant of its size in the West; a plant where at all times the river water, foul as it sometimes flows, is transformed into a clear, sparkling, safe, sterile beverage. Sulphate of Alumina as the reagent, sedimentation and finally filtration and sterilization with Hypochlorite of Lime, briefly covers the process, but intelligent handling has been the controlling factor. The noteworthy feature in the process, is the use of coagulant at different points in the travel of the water through the plant, so adjusted in doses as to avoid large quantities, yet to cause precipitation of sedimentary matters, at, so far as possible to determine, just the right places, and save undue work of the gravity mechanical filters.

A "clear water" well holding 50,000 gals, and a standpipe 160,000 gals., fairly well equalize the fluctuating draft and steady the pumpage.

Rather interesting, as showing good material and careful handling, is the fact that the two compound Davidson steam pumps installed in 1887 are still working smoothly and doing their daily duty in 1919, and the pair of original tubular boilers, still approved by the insurance inspectors, is still in service, though augmented by a new and larger boiler set in 1915.

A "Scrap of Paper"

In 1915 the company went to a large cash outlay to provide the additional facilities, under a "Gentlemen's Agreement" with the city officials, to the effect that immediately following successful completion and satisfactory test, the city would authorize a revision upward of domestic and manufacturing rates, so as to produce a reasonable income on the total valuation of plant in service.

So as to be perfectly fair the company asked the State Board of Health, which had power to approve or reject the plans, to take charge of the test of the finished plant.

Such test was held, and in June, 1915, the Kansas State Board of Health gave formal approval by certificate, yet in spite of many requests, submission of revised schedules of rates, etc., the officials failed to accord any changes, or even formally to consider and discuss the subject, but now after the ripe plum has fallen, one of the first steps taken, is a movement to amend the charges.

Oh, What's the Use!

A course of legal action might have been instituted at large expense, and through ultimate appeal through court and Public Utilities Commission, justice might perhaps have been secured; but the Kansas Public Utility Laws only contemplate redress to a Water Supply Corporation after all other possible actions fail, so that the company saw only extra expense ahead, with an uncertain result for the future and no equalization for the costs and losses of the past.

Financial Summary

A brief summary in general percentages may be more enlightening and illustrative than the totals of dollars involved:

Original investment plus later capital expenditures..	100%
Of the original investment probably 30% was virtually misappropriated or misapplied by the promoters, so that the investment value of the present plant would be, to total outlay, say................	83%
Allowing for depreciation, though the upkeep has been in general excellent, the fair percentage for present value of total invesment, though not crediting the plant with all the present high prices, but a fair mean of the past five years, would be......	70%
Accepted in full payment by the company; percentage of total invesment, about....................	40%
Percentage of depreciated real value as paid by the city, about	57%

In computing these values, no allowance is included for "going value," "recovery of franchise," or any other "intangible" asset.

Non-Resident Owners Highly Taxed

The city has taxed the company for years, upon an equal or greater valuation than the sum finally paid for the system, yet taxation in general through the city has been more nearly on a 50% basis, though theoretically perhaps on full value system—comment, non-resident ownership.

Some of the losses, for an average of less than 3% net has been realized on the original outlay during the 32 years of operation, could have been saved through a still greater capital invesment for more economical machinery, and probably by litigating rates years ago, but in view of the long-distance ownership and the unsatisfactory dealings with some of the city officials, the company has been ever disinclined to send more good money after bad, except as imperatively necessary, and finally took the loss rather than continue a very unsatisfactory holding.

GROUND HOGS

—because they open up trenches quickly and neatly! Look them over.

A—This is the Ladder Type P & H Excavator making a ditch thru hardpan and boulders for a contractor down in Illinois. It's a powerful machine, fabricated of steel thruout, designed for sewer digging and general heavy trenching to 20 feet in depth.

B—Is a Wheel Type P & H Excavator opening the ground for a drain pipe-line. This is the outfit for pipe-line, conduit, and farm drainage excavation. Built of steel for light weight and flexibility; digs trenches 7½ feet deep to 28 inches wide.

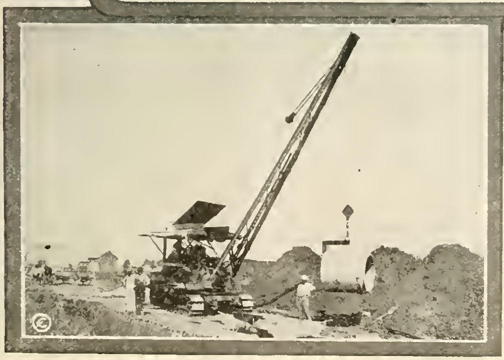
C—A machine with a multitude of uses—the 205 Dragline P & H Excavator. What it will do: Excavate open or sloping bank ditches, clean out old ditches, dig cellars and holes, strip coal, grade streets, backfill trenches, load or unload coal, crushed rock, screenings, sand or gravel, and last, but not least, it is a complete, portable locomotive crane with a lifting capacity of 3500 pounds.

D—Getting the dirt back is sometimes as troublesome and costly as getting it out. This machine makes it easy and does it in a hurry on one man's time. Just the outfit for city streets where work must be done with uniformity and dispatch. The P & H Backfiller has capacity to take care of the largest sizes of trench excavators.

You may not need P & H Excavating Equipment right now, but write for Bulletin X and keep it handy.

PAWLING & HARNISCHFEGER CO., Milwaukee, Wis.

P&H — excavators, — backfillers, tampers.



In some other states, public utility commissions are beginning to treat the relationships between communities and their citizens and public service corporations on a basis of mutual interest and justice, so there is hope for the future, but many a case like that described herein has gone into unwritten history, but some day a never failing retributive justice will even up the irregularities.

Council Grove will now spend probably $25,000 in further changes—electrifying the pumping, extension of sedimentation basins, additional storage, etc., and the citizens will have to pay higher rates or higher taxes.

So far as many experiments have demonstrated, the Neosho river is the only possible source of adequate water supply, so the continued history of the works will be of interest to sanitarians, particularly, as changing the color of water with malt preparations, becomes a process of the past, and bright, clear, sparkling beverages, without foam, become more popular; of course Kansas has for some years past stood for water alone.

Points for Engineers and Investors to Consider

Most reports of water systems tell of new plants just built or extended—the foregoing facts and review, however, may not be amiss, and may emphasize to engineers, the desirability of more thoroughly studying a community's personnel, franchise terms, probable earnings, possible financial conditions, existing laws and trend of opinion, etc., as well as the more technical ones of supply and construction possibilities and costs.

Successful Use of Cement Joints for Cast Iron Water and Gas Mains

By Stephen E. Kieffer, Consulting Engineer, Mechanics Insitute Building, San Francisco, Cal.

In the construction (just completed) of the United States Housing Corporation Project No. 581, at Vallejo, Cal., for the Mare Island Navy Yard, a very successful use was made of cement joints in laying the cast iron water and gas mains.

The decision to use cement instead of lead for the joints was arrived at after a very careful study of the whole situation, taking into account the records of the best practice available, particularly on the Pacific coast. The saving in cost of cement over lead, at its then maximum war cost, was not the material factor in this case that it might be on a private project in peace times, and received little consideration.

The Construction Methods Employed

The methods of construction used and results obtained are interesting.

Oakum or jute not being regarded as satisfactory to use with cement it was decided to use hemp rope, and discarded slings made from ½ and ¾ in. tarred rope were obtained from Mare Island Navy Yard. These were old, dried out and very stiff, and after being cut into required lengths for use were unstranded and the strands loosely retwisted and rolled by hand, thickness depending on the size of joint to be caulked.

It is considered that upon the use of this particular type of packing rests the success of the work, since this—rather than the cement binder—is relied upon as the water and gas tight element in the joint.

Great care was taken to see that all pipes as laid were solidly blocked in order that there would be no movement of the pipe line during and after making the cement joints and earth was tamped around and over the pipes between joints.

One and sometimes two strands of the retwisted hemp rope was inserted in the bell of the pipe and this rammed in hard by caulking. A mixture of cement and sand, in the proportion of two parts cement to one part clean sharp sand with enough water added to make a dry paste which when balled and squeezed in the hand would barely exude moisture, was then inserted in the bell, pressed in first by hand until the bell was about half filled, and then caulked as a lead joint would be caulked, until the caulking tool would barely penetrate the cement and the joint would ring. More of the cement paste was then inserted and the caulking repeated, leaving the joint filled to within ½ in. of the face of the bell. A strand of the retwisted hemp rope was then laid around the bell and this caulked in flush with the face of the bell. The joint was then wiped with cement paste containing sufficient moisture to mould and was bevelled off.

Each joint after making was kept wet, by covering with pieces of old sacks, for at least 36 hours, after which the pipe line was slowly filled and allowed to stand under normal pressure which was never greater than 70 lbs., for at least two days before the test pressure was put on.

Two thousand feet of 10-in. water main and 400 ft. of 8-in., 6-in. and 4-in. pipe were included in the first test and 50 per cent. of the joints leaked after subjecting same to the normal pressure. These leaks ranged from a slight sweating to a steady drip which filled the bell holes and covered the pipe. During the following three days most of the leaks stopped and we decided to cover and backfill the whole pipe line, as the character of the ground was such that any leak would come to the surface, and let the pipe line remain under normal pressure for a week or two before putting on the test pressure of 125 lbs. The dry hemp rope undoubtedly absorbed moisture and swelled, thereby stopping all leakage. All leaky joints took up with two exceptions both of which upon being cut out and examined were found to have been very carelessly made. These were remade and the line when tested showed no leakage.

As the work progressed and workmen, who were unskilled Italian laborers, became more proficient the work was not only speeded up but better results obtained.

Remarkable Results Secured

A total of 20,770 lineal feet of 4, 6, 8, 10 and 12-in. cast iron pipe was laid on this project for water and gas distribution and only six defective joints had to be cut out and remade. When the pipe line could be drained the joint was remade with cement, but a few joints were cut out and remade with lead wool in order not to delay progress.

As it was necessary to pave the streets immediately upon completion of the sewer, water and gas mains and services, the pipe lines were subjected to a severe test on account of the heavy teaming and heavy steam roller working on the subgrade, but not a single leak developed. The paving was completed in January and the first leak has yet to develop.

To anyone familiar with pipe laying and maintenance using lead joints this record should appear remarkable.

As far as could be ascertained from observation and cost records kept, the labor cost using cement joints should be slightly less than for lead joints. The cost of cement and sand per lineal foot on small sizes of pipe is negligible and the money saved on this project was considerable as the price of pig lead when this work was started was almost at its highest peak.

The author was project engineer for the United States Housing Corporation, and Mr. Philip Schuyler, Asso. M. Am. Soc. C. E., was assistant engineer in direct charge of construction.

The Need and Cost of Covering the Clear Water Basins of the St. Louis, Missouri, Water Works

By Cornelius M. Daily, Engineer in Charge, Supply and Purifying Section, Water Division, Department of Public Utilities, 34 East Grand Avenue, St. Louis, Mo.

The water supply for the city of St. Louis is taken from the Mississippi river whose turbidity varies from a maximum over 5,000 to a minimum of 8 with an average of over 1,200 and the water has a bacterial content on gelatine at 20 degrees C., varying from a maximum of 100,000 to a minimum of 3,000, per cubic centimeter. This water by chemical treatment and filtration has its turbidity and bacterial content reduced to a degree comparable to the purity of some manufactured articles, advertised as 99.99 per cent. pure. Can this purified water be stored in uncovered reservoirs without losing some of its virtuous qualitites?

This question may be truthfully answered yes or no depending on conditions, such as the duration of the time of storage, circulation of the water, its temperature, etc.

Local Ideas of "Clear Water"

Prior to May 1915, the date the filter plant was put in operation, the thought of covering the clear water reservoirs was dimissed as a passing fancy, if such a thought ever occurred to anyone, a reason for this supposed thought, or lack of thought, was the fact that the name clear water reservoir was a misnomer. The common standard of clear water prior to 1904, when chemical treatment was started, may be described as water in which mud would not settle in a glass during the time the observer was drinking it. If mud settled in the glass during this time the water was considered not clear. A higher standard of clear water was in vogue from 1904 to 1915. The name clear water during this period was applied to water with a lemonade hue and capable of standing in a glass several hours without a deposit of mud in the bottom.

Sunlight only penetrated a few feet in clear water of these standards, algae and organisms were unknown in the reservoirs and a few thousand, more or less, bacteria per cubic centimeter did not matter a great deal. The people were accustomed to it and with a feeling of contempt for modern improvements, like the hunter who preferred a sawed off trunk of a tree rather than a new rocking chair presented him by his friends, they complained of bad taste of the water when the filter plant was first put in operation and water of zero turbidity was furnished them.

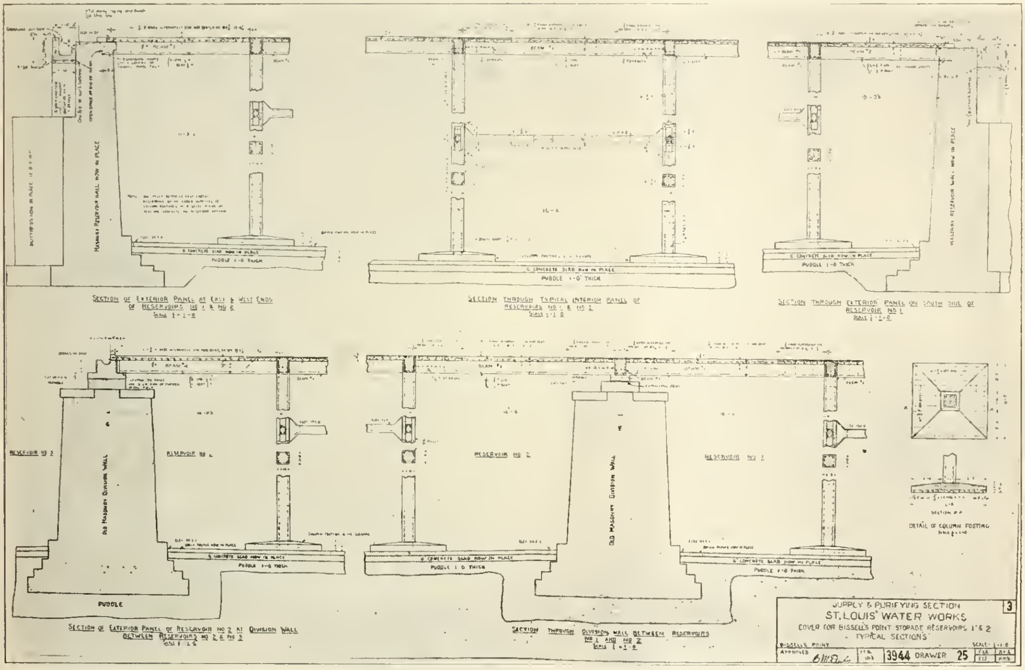
Organisms Present in Uncovered Reservoirs

Since 1915 the clear water reservoirs are holding water of zero turbidity, sunlight penetrates to the bottom, algae growth clings to the sides and bottom, and where the circulation is poor, organisms in multitudes abound. These organisms are described by our chemist, Mr. Graf, as ranatra quadridenta, water beetles, aphodius fossar, hydrophilus piceus and dysticus marginalis. Diatoms, protozoa, rotifera, crustacea, daphnia and snails. Diatoms have been known to be in the clear water in such quantities that it would clog a filter bed in a few hours if allowed to pass through it.

Various attempts to kill the organisms with a treatment of copper sulphate (1 part in 3,000,000) was more or less of a failure in hot weather, as it usually leaves a musty odor in the water and immediately the bacterial content rises to an alarming number, as many as 60,000 per cu. cen. have been found. Chlorine has been added to the water after the treatment of copper sulphate, but to get good fresh water the remedy relied upon to give satisfaction is to waste the water with its menagerie, clean the reservoir and start over again. This has been done many times since 1915 and probably will continue in warm weather until the last of the clear water reservoirs are covered.

There are seven clear water basins uncovered in St. Louis, one at Baden holding 25,000,000 gals. of water, four at Bissell's Point holding 50,000,000 gals. of water and two at Compton Hill holding 85,000,000 gals.

A small basin holding 10,000 gals. at the filter plant was covered in 1916 after considerable trouble was experienced with algae growth on the sides and bottom. Since it was covered no further trouble developed.



TYPICAL SECTIONS OF PROPOSED COVER FOR BISSELL'S POINT STORAGE RESERVOIRS NOS. 1 AND 2 OF THE ST. LOUIS WATER WORKS.

The reservoir at Baden holding about ½ day supply gave a great amount of trouble during the summers of 1915, 1916 and 1917 from organisms, but was not troublesome last year when all the water used at this station entered the reservoir, at one side and taken out at the other instead of floating on the line leading direct to the wet well, where the pumps draw their supply, as it did from 1915 to 1917. At Bissell's Point the reservoirs hold about 2/3 day supply and our experiences with the organisms and bacteria are similar to the ones encountered in the Baden reservoirs.

It is evident that with a small supply reservoir where the entire water is changed every day little trouble would be experienced from organisms; algae, on the contrary, would not be affected and in time might be troublesome. The water at all times would be exposed to contamination by bacteria.

At Compton Hill the reservoirs hold about 85,000,000 gals. and act as a storage pressure reservoir for the low pressure distribution system. Trouble with organisms and bacteria has been experienced each summer since the filter plant was put in operation. Circulation is impossible and water may remain in parts of the reservoir for days serving as a quiet breeding place for all organisms. The rapid multiplication of these organisms may be assisted by a partial development of the organisms in the water pumped from Bissell's Point reservoirs but the fact remains that ideal conditions are found in the Compton Hill reservoirs for their growth.

I do not mean to convey the impression that it is unnecessary to cover clear water reservoirs when the water is allowed to stand for only a short time, for bacteria is carried by the wind, by animals and birds into open reservoirs and may become more dangerous than the organisms.

Types of Cover Considered

Our water commissioner, Mr. Wall, had caused several types of reservoir covers, as early as 1916, to be designed and their costs estimated. Three general schemes were investigated. The first was a wooden roof, the second a concrete roof with 2 ft. earth fill, and third a concrete roof without any fill.

The wooden roof could only be considered a temporary structure and the maintenance cost was high and the scheme was abandoned for a permanent concrete construction.

A concrete structure supporting a 2 ft. earth fill is very desirable but costly and several types were designed.

The concrete construction not supporting an earth fill was found to be much cheaper and leaving aside the question of a park on the reservoir site, it is the most desirable cover.

Estimated Cost of Various Concrete Covers

The estimated cost for the various concrete covers based on present day prices are listed below for Bissell's Point and Baden reservoirs. The cost is given per square (100 sq. ft.):

Flat slab, groined invert footings for 2 ft. earth fill..	$ 93.50
Flat slab, groined invert footings A. K. M. E. system for 2 ft. earth fill	97.00
Flat slab cover and footings for 2 ft. earth fill	108.00
Beam and slab, two-way reinforcing for 2 ft. earth fill...	107.50
Flat slab, reinforced footing, without earth fill	70.00
Beam and slab, two-way reinforcing, without earth fill..	64.00

From the above figures it is evident that the beams and slab two-way reinforcing without earth fill is the cheaper construction.

An ordinance for appropriating money to cover Baden reservoir and two of the four at Bissell's Point with concrete beam and slab two-way reinforcing is now under consideration by the Board of Aldermen and should the appropriation be made St. Louis will have taken a long step in furnishing its people with pure and wholesome water.

The accompanying illustration shows typical sections of the proposed covers for Bissell's Point reservoirs. The proposed covers for Baden reservoir are identical excepting the footings which are plain concrete extending to bed rock a few feet below the bottom of the reservoir

Design and Construction of the Water Supply System of Camp McClellan, Alabama

By Maurice R. Scharff, Assoc. Am. Soc. C. E., Asst. Chief Engineer with Morris Knowles, Inc., Jones Bldg., Pittsburgh, Pa.

The water supply system of Camp McClellan, Alabama, described in this article, is the system designed and installed for the originally authorized National Guard Camp for one division, constructed during August, September and October, 1917, during which period the writer served as engineer in charge for Morris Knowles, Inc., Supervising Engineers; subsequently after the writer was called to active service with the Corps of Engineers in France, extensions and additions were made to the distribution system; and at the time of the signing of the armistice, a project for a new impounded supply, and reconstruction of a considerable part of the system, to take care of proposed enlargement of the camp, was under consideration. But, in general, no extensive changes were made in supply works or the distributing reservoir, so that substantially the works described herein have continued to serve the camp up to the present time.

Basic Requirements Controlling Design

The basic requirements for the water supply of the camp were largely fixed by the instructions to constructing Quartermaster issued by the engineering division of the department of cantonment construction at Washington. This inclnded the specification that the system should be capable of delivering an average of 30 gals. per capita on any one day and a maximum for one hour of 2.85 times the average. It was, of course, expected that the quality of the supply should be unexceptionable.

The original instructions covered the construction of the camp to contained about 34,000 men, which at 30 gals. per capita would require an average daily supply of 1,200.00 gals. per day. It was not clear whether the instructions contemplated that this should be the average or the maximum daily consumption to be provided for; or, if for the average, what allowance should be made for seasonal and weekly variation in daily draft. It was believed, however, that there would be a substantial variation in daily draft, and it was finally concluded that the safest plan would be to take the prescribed per capita allowance as an average and make provision in the design for an excess of 50 per cent. on the day of maximum draft. The system was, therefore, designed to provided a maximum daily delivery of 1,500,000 gals.

Source of Supply

The rapid study of the situation made upon the writer's arrival on the ground on June 16, 1917, led to the conclusion that the only source from which a sufficient supply could be obtained within the time limit fixed by military necessity was the system of the Alabama Water Company, which supplied the city of Anniston.

This system takes its supply from Coldwater Spring, located about seven miles northwest of Anniston—one of the great limestone springs of the lower Appalachians, with a minimum flow of about 25,000,000 gals. per day. The pumping station, at the beginning of the construction of the camp, contained two old Holly steam pumps, each of 3,000,000 gals. per day capacity (one of which was removed and sold for scrap in August, 1917, while the other was held in reserve as a spare); and a 10-in. Worthington turbine pump, direct connected to an electric motor and designed to deliver 3,000,000 gals. per day against a pressure of 165 lbs. per square inch.

The pumping station delivered water through a 20-in. cast iron main to a 7,000,000 gal. distributing reservoir, from which a 16-in. main supplied the distribution system. A 10-in. main of the distribution system supplied an industrial plant and a small village at Blue Mountain, and on this main, the nearest to the camp site, it was determined to make the connection for the camp supply, reinforcing the distribution system sufficiently to deliver the required quantity to this point.

Pumping Equipment

The new construction included the installation of three belt connected electric motor-driven centrifugal pumps in the Coldwater pumping station of the water company—a Buffalo pump, designed to deliver 1,500 gals. per minute against 430 ft. head; an Alberger pump, designed to deliver 1,035 gals. per minute against 430 ft. head; and a Hill pump, designed to deliver 1,750 gals. per minute against 430 ft. head; the construction of a 10-in. reinforcing main 6,500 ft. long, tapped into the water company's 16-in. main under pressure by means of a Smith tapping machine; the installation of a booster pumping station including three pumps—two of them (one a Hill, the other an Alberger) designed to deliver 500 gals. per minute each against 225 ft. head and direct connected to electric motors; and a Buffalo pump, originally designed to operate at 1,500 r. p. m. and to deliver 1,050 gals per minute against 430 ft. head, but belt connected to an electric motor so as to operate at 1,040 r. p. m., and to discharge about 1,000 gals. per minute against 225 ft. head; the construction of a 10-in. cast iron force main 25,000 ft. long; distribution systems for the divisional camp, the base hospital and the remount depot, containing 5,790 ft. of 10 in. pipe, 8,870 ft. of 8 in., 61,900 ft. of 6 in., 2,560 ft. of 4 in., 5,080 ft. of 3 in. and 98,975 ft. of smaller service lines; and a distributing reservoir of 800,000 gals. capacity, originally designed to be lined with concrete, but constructed without lining on account of the unusually impervious character of the material in which it was excavated.

Influence of Time Element on Design

The conditions under which this work was done, illustrate very well the controlling influence exercised by the time element in the cantonment construction work, and the extent to which designs and construction methods were controlled by considerations other than those which would apply in ordinary practice. The choice of the source of supply, for example, was absolutely limited by the time element. For, while later studies for the enlargement of the camp went into the possibilities of spring supplies, deep well supplies and impounded surface supplies, all of these had to be ruled out from the first consideration because of the obvious impossibility of assuring a supply from these sources prior to the arrival of the first troops.

The design of the reinforcing and force mains were similarly affected. The water company's distributing reservoir was located at such an elevation as to give a static head at the camp site of over 50 lbs. per square inch. The largest size of pipe which there was any possibility of obtaining within the requisite time, however, was 10 ins. in diameter, and this size was selected on the basis of possible deliveries, without regard for the fact that theoretical computations appeared to indicate that a larger size might have been more economical. With this size of pipe, it was estimated that, at the assumed maximum daily rate of draft, 1,500,000 gals. per day, a pressure of not less than 30 lbs. per square inch could be maintained at the site selected for the location of a booster station, which would be sufficient to maintain domestic service to the sections of the city and suburbs dependent upon this portion of the distribution system; and that by raising the pressure at the booster station to 130 lbs. per square inch this quantity could be delivered to the camp with a resultant pressure at the camp site of 50 lbs. per square inch.

Another feature of the Camp McClellan water works system which was controlled entirely by the time limit set for completion was the location of the 10 in. supply main, which followed, for the greater portion of its length the existing tracks of the Southern Railway and the connecting line constructed for the service of the divisional camp. A location approximately 4,500 ft. shorter would have been available by following some of the existing country roads, but as these roads were practically impassable for heavy traffic, it would have been impossible to complete the delivery of the pipe within the time limit fixed by military necessity.

Foundry Renders Great Service

The rapid delivery of the pipe required for the 32,000 ft. of reinforcing and supply mains, and their completion and connection within ten working days must be ascribed largely to the authorization by the Washington office of the use of cast iron pipe and to the co-operation of the Superintendent of the Anniston Foundry of the United States Cast Iron Pipe & Foundry Company. This company furnished from its Anniston, Chattanooga and Bessemer foundries all of the pipe in the line, except about 5,000 ft. of Universal pipe, and when completed the line contained, in addition to the Universal pipe, Standard Bell and Spigot pipe of Classes A, B, C and D; Standard gas pipe of two weights; and several thousand feet of 9.8-in. (25 centimeter) pipe of special quality which had been cast for the Argentine Republic. Not only did the foundry superintendent devote a large part of his time to securing these deliveries, but, in addition, he arranged for the use of the foundry pipe crane, much of the time under his personal supervision for distributing over 20,000 ft. of pipe along the trench from the railroad, with a maximum rapidity and a minimum of breakage.

The service of the Anniston Fountry was also of the greatest value in securing rapid delivery of special castings, and even of flanged castings. On one occasion, while additional pumps were being installed in the Coldwater pumping station of the water company, a crack was discovered on a Sunday afternoon in a 16x10-in. reducer. The superintendent of the foundry was reached on the telephone and on Monday morning the completed casting, faced and drilled and still hot from the molds, was delivered at the pumping station over 8 miles of country road. This service permitted the casting to be placed in position and pressure restored by 4 o'clock Monday afternoon.

Early Methods of Regulating Pressure

The early operations of the Camp McClellan water works system produced interesting examples of the difficulties due to the peculiar character of water consumption in military encampments. The pressure from the City distributing reservoir was sufficient to deliver the quantity necessary for night use and the requirements of the first troops which arrived on the 15th of August without booster pumping; but after the completion of the installation of the first booster pump on August 19th, it was necessary to operate the booster pumping station throughout the day, every day, from about 5 o'clock in the morning to 7 or 8 o'clock in the evening. This method of operation was sufficient to permit the continuous maintenance of satisfactory service after the completion of the camp distributing reservoir on October 13th; but until that time much difficulty was experienced in maintaining service, due to rapid fluctuations in pressure resulting from the large variations in hourly use.

Prior to the completion of the reservoir, it was found impossible to maintain pressure in the higher parts of the camps immediately after the noon mess hour daily when the mess kits were being cleaned, and for the greater part of Wednesday and Saturday afternoon when there was no drill, and when most of the showers in the camp could be found running either for bathing or washing purposes.

These difficulties were especially great during the period August 19th to September 11th, when the booster station was pumping into a closed system, not only without storage but without adequate pressure relief. During this period a direct telephone connection was maintained between the booster pumping station and the engineering office at the camp and during certain portions of the day, an observer was stationed at each point watching the pressure gages, the observer at the camp directing the operation of the suction valve on the pump so as to control the pressure at the camp. Even in spite of this precaution on several occasions sudden pressure jumps occurred, and breaks in the supply main resulted once or twice.

Standpipe Pressure Regulator

On September 11th a pressure regulating standpipe of 10 in. pipe supported by a wooden scaffolding was constructed and carried up to the elevation of the distributing reservoir, (then under construction). At the top of this standpipe an elbow and a 6-in. valve were leaded in, and this overflow at the highest point of the system proved a reasonably effective pressure regulator, although at times some attention to the pressure gage at the camp and control by regulation of the suction valves at the booster station were necessary.

In some respects there was much similarity between the cantonment water supply work and the work upon which the writer was subsequently engaged in the Water Supply Division of the Office of the Director of Construction and Forestry of the American Expeditionary Forces in France. In both cases the time element was of far greater importance than the ordinary considerations controlling engineering design. In one respect, however, the cantonment construction work was very much more satisfactory and enjoyable than that in France. Reference is made to the availability and orderly rapid delivery of material made possible by the efficient co-operation of the Washington office, as compared with the discouraging impossibility of securing materials which resulted from the tonnage shortage during the early days of the history of the American Expeditionary Forces.

The water supply work at Camp McClellan was carried on under the direction of the writer (who was succeeded, upon his departure for France by Mr. A. B. Hargis) first by Prof. G. J. Jacobs, of the University of Alabama and later by Mr. Ellwood Avery, as Division Engineer in charge of Water Supply; and under the supervision of Lieut. Col. (then Major) Dabney H. Maury, of the Engineering Division of the Department of Cantonment Construction at Washington; while on all construction work at the camp, the Supervising Engineer reported to Col. (then Major) Charles L. Dulin, Q. M. C., Constructing Quartermaster.

Experience with Metalium Joints in Water Pipe Lines in Davenport, Ia.

By Thomas Healy, Davenport Water Co., Davenport, Ia.

At the Council Bluffs meeting of the Iowa Section of the American Water Works Association a paper was read and there was discussion of a material used by the Omaha water works in the place of lead for making joints in the laying of water mains. It is called metalium. Afterwards we were taken to Omaha where we saw some joints poured with metalium and the water pressure was immediately thereafter turned into the mains having joints of this material.

Advantages of Metalium

The advantages in metalium joints seemed to be that the material was cheaper per joint than lead. Not so much fuel was needed to melt the material as needed to melt lead. The bell holes required were not so large and all caulking was dispensed with.

The disadvantage seemed to be, at that time, that greater care was necessary to melt the material because if too cold it would not pour and if too hot it became stiff and might burn. We saw no way by which a joint which leaked could be made tight and we did not have the nerve to act on the advice of the users who said let it alone and the leak will stop of itself. We had no previous acquaintance with that kind of a leak.

Metalium Successfully Employed

So when, as the war went on, and the cost of lead went up and the Government continued to request that metals should not be used, and everything was out of kilter anyway, we decided to try out metalium for joints in some mains we were laying for the U. S. Housing Corporation. This corporation was building several hundred houses to help relieve the situation caused by bringing several thousand additional families to Davenport, Rock Island and Moline, to help turn out material of war at the Government Arsenal situated at this point. These mains were required at once and we found we could lay them quicker when no caulking was required.

Procedure in Using Metalium

We usually join three or four lengths of pipe before lowering them in the trench. The pipe are laid on sticks across the ditch, lined up and leveled and after pouring are lowered by two pipe derricks using rope slings. No trouble seemed to result from handling the pipe after the joints were poured.

The metalium joint takes a little longer to cool than lead, especially the gate, which is made large to insure the filling of the joint.

We started out cautiously. We used the special furnace furnished by the metalium manufacturers and all the tools they have developed. We arranged with the manufacturers to send an expert to oversee the pouring of the first joints, but we started before he arrived and his only duty was to tell us that we had done the work well. Some of the pipe to lay was 12 in. and we used lead for this size. The first line using metalium was 6 in. pipe and this line was bottle tight when tested. The next 6 in. pipe laid developed two or three leaks and we decided that these leaks were due to carelessness, for the pouring seemed so easy the men neglected to clean the pipe in the joints or to make the gates high enough to insure a full joint. As soon, however, as we became as careful as we were when we began we had no further trouble.

We usually use 9 or 10 lbs. of lead in pouring a 6 in. joint and we found that 3 lbs. of metalium would make a joint of the same size. At that time lead was 8c and metalium 10c per pound so the material in the joint cost us about three eighths as much as lead would have cost. Lead, however, is much cheaper now than it was at that time.

When using lead we use a kerosene oil furnace which requires about 25 gals. of oil to keep it going all day. The number of joints poured in a day varies widely so the cost of oil varies, as it is not practical to let the lead furnace cool off, but the flame is kept going whether little or much lead is melted. With the furnace used for metalium we use only wood and we manage to "borrow" a piece here and there which furnishes the small quantity required.

It is evident that there being no work to do in the bell hole except to put on and take off the jointer very little space is required. We found at first that jointers were used up rather rapidly and probably there will be required more jointers than are required for lead. However, we now soak the jointer in water and smear it with clay and it lasts longer than formerly.

Metalium is easy to handle and we have had no trouble in getting our orders filled promptly. In one or two instances we have poured old joints that have caused trouble by lead blowing out and these joints hold well so far.

In 1918 we laid 9,155 ft. of pipe with metalium joints and we have so far laid nearly as much in 1919 and shall continue to use it until something better develops.

Leadite

In 1917 we laid 424 ft. of 6 in. pipe with "leadite" joints and this has given no trouble of any kind since laying. The method and cost of using leadite is not very different than in the case of metalium.

The foregoing paper was presented at the recent annual meeting of the Iowa section of the American Water Works Association.

EDITORIALS

An Interesting Cost Plus Contract

A contract awarded on the cost plus variable fee basis, for constructing an earth fill dam and reservoir, which proved very satisfactory in securing bids and selecting a contractor, and which gives great promise of proving equally satisfactory on construction, is described in an article published in the water works section of this issue. The works will cost about $200,000.

It is of prime importance to note that twenty-three bids were received and that there was an unusual amount of interest shown by contractors in this job. Under the terms of this contract the engineer assumes more responsibility than is usually the case. Greater justice to both the contractor and the owner is secured than is provided by the old-style, lump-sum, gambling form of contract which has so long been in vogue. The engineers are of the opinion that this contract, which distributes the responsibility and risk and gives the contractor a square deal, will also, at the same time, effect a saving of about $10,000 to the owner.

It is very interesting to note with what experience and in what spirit the engineers approached the preparation of this contract. Early last year they had designed and supervised the construction of a bridge and a dam on the cost plus a fixed percentage fee basis. Later they were engaged on government work, on which construction was carried out under various cost plus contracts. They had much previous experience, also, with the weaknesses of the old set unit-piece contract, so they decided to draw up, for this dam and reservoir job, a contract on the cost plus variable fee basis, but in such a way as to permit free competitive bidding, to protect the owner against irresponsible contractors, while the owner assumed all normal risk in place of the contractor.

It is distinctly encouraging to all who wish to see the construction industry placed on a just and equitable basis to learn that the form of contract drafted has received commendation from many engineers as well as contractors.

The contract provides for payment for the actual cost of the work, plus a fee, with bonus and penalty clauses covering keeping under or exceeding the estimated cost, respectively. The engineer and contractor jointly keep account of the actual cost, properly itemized, and the contractor is paid this cost. The cost includes every expense immediately connected with the work, but excludes home office expense, interest on funds used, and all overhead except that in the field. Monthly payments are made the contractor of the actual cost incurred and approved, plus 3 percent on account of fee.

The contractor's bid and contract give unit estimated costs and a total estimated cost for the work, a percentage of the total estimated cost as fee for the construction, a time within which he agrees to complete the work, with a penalty as liquidated damages of $40 per day for exceeding the time limit, a complete statement of experience and qualifications, and a list of equipment to be used on the job, with total rental prices at which the plant is to be furnished for the entire construction.

Finally, the contractor's total fee is determined as follows: With the actual quantities of work completed and the estimated unit prices bid, a corrected estimated cost is made up. If the actual cost is then less than this corrected estimated cost, the contractor receives his bid percentage fee of the corrected estimated cost, plus one-quarter of the saving up to $10,000 and one-half of all saving above $10,000. If the actual cost is greater than the corrected estimated cost, the fee is reduced by one-quarter of the excess up to $10,000 and by one-half of all excess over $10,000, but in no case can the fee be less than 3 percent of the corrected estimated cost after deductions have been made of penalties for overtime and for excess cost.

The contract has much to commend it, especially its recognition of the fact, so long ignored, that a contractor is entitled to at least nominal compensation on every job he brings to a successful physical end. Incentive to great individual effort remains because of the bonus and penalty clauses. In general, under this form of contract, the contractor profits in proportion to the character of his performance, but he is protected against the losses so common under the old lump sum contracts.

Introducing the Engineer to the Public

The public has not yet acquired the habit of employing the engineer to solve engineering problems and to perform engineering services with the same precision and regularity with which it employs lawyers and doctors to handle hygienic and legal matters. While an important section of the public appreciates the engineer, another section, perhaps larger than the first, does not instinctively turn to the engineer for help when in need of the help he alone can give. What shall be done to correct this condition, which is at once a misfortune to the public and to the engineer? Doubtless many things might be done; something specific should be done.

We suggest that an organized publicity campaign be undertaken by some existing engineering society for the express purpose of telling the public of the work of the engineer and of his ability to serve. For the purpose of encouraging thought and discussion we shall offer some specific suggestions which do not necessarily represent our final thought in the matter, but which may serve to assist others in formulating a better plan.

First of all, let it be said that here is a case where Mahomet must go to the mountain. Though Mahomet has been very patient, the mountain gives no evidence of intention to go to him, so it is clearly his move, if any move is to be made.

The idea of engineering service must be "sold" to the public. The public must be convinced that the engineer can render helpful service not otherwise obtainable. This calls for publicity work.

Assuming that some national engineering society should become interested in directing this publicity work, what character of matter shall be selected for this purpose and how shall it be disseminated?

The newspaper reporter's enthusiasm over the engineering "feat" is well known. What is an engineering feat? The engineer would give one answer to this question and the layman another. What is commonplace to the engineer is an engineering feat to the layman. This seems to indicate, broadly, the character of matter that should be selected. There are not many great works of dramatic interest like the Panama canal, the Los Angeles and Catskill aqueducts, etc., and for this purpose that fact does not matter. Engineering enterprises that come closer to the average citizen are more desirable and exist in great variety. Let these be described in non-technical articles sent out broadcast to the lay press. In our opinion, such press releases would be widely used by lay publishers and would be read with real interest by the public. The articles should be prepared or edited by a publicity committee, properly organized for this purpose.

The public would also be interested to learn of the folly of intrusting the work of the engineer to the quack. Plenty of good, readable copy could be written on this subject.

The feature writer should not be overlooked. There are a number of men in the country who are uncommonly handy with the quill who make a business of writing feature articles for popular magazines of great circulation. Supply these feature writers with anecdote and application diagrams in the rough, and they will round out polished, clever and extremely interesting articles which publishers will buy and which the public will read.

In these and in similar ways publicity methods can be employed to acquaint the public with the nature of the engineer's work and his ability to render great service. The advantages of such acquaintance are as great as they are obvious.

News of Equipment Performance

A contributor to this issue says: "Progress in road-building methods seems to advance in sudden jumps rather than by means of slow development, and this applies as well to mechanical devices as to designs and types of construction." The contributor describes how improved mechanical means have been very successfully employed recently in speeding up the construction of monolithic brick roads and in improving the character of this important class of paved roadways.

The same statement holds good in general. Equipment is quite as important as design and the selection of material. For this reason news of equipment performances is just as important as news of improvements in design, in construction methods or in the selection and use of the materials of construction.

The editor has long appreciated the interest of the reader in articles telling of the performance of construction equipment. Many such articles have been published; many more are wanted for publication. To no other class of articles do readers respond so readily as to articles of this class. All readers are invited to submit data on the performance of equipment in the municipal and county fields for publication in this journal. Needless to say, flamboyant "puffs" are not wanted; merely straightforward statements of experience gained in the use of equipment are desired.

Highway Maintenance Costs

The leading article in this issue is of great interest to all highway officials, engineers and contractors, and to the entire highway industry. It describes the maintenance cost-keeping system employed by the Washington State Highway Department in keeping the cost of maintaining the primary highways of that State. The cost data covering the first two years of record are given and interpreted.

The value of such a cost record is great and the data are of high value when fairly and intelligently applied. Unfair conclusions might be based on a garbled account of Washington experience, but the article in question deals with fairness with all interests concerned. The explanatory matter shows that many items of cost are charged against maintenance in a fair but arbitrary manner. It is, therefore, well to point out that the tabulated data must be considered in the light of the context.

The author's conclusion covering the money value of hard-surfaced roads in reducing highway operating costs are especially interesting and deserving of attention.

The American Association of Engineers Is Getting Results

Unmistakable signs of interest in the work of the American Association of Engineers are being shown by the readers of this magazine. Our readers will be pleased to learn that the association is accomplishing tangible results in its labors to improve the compensation of salaried engineers. Two specific examples of success are here cited:

R. H. Aishton, Regional Director of the United States Railway Administration, for the Northwestern Region, has authorized salary increases in his region for those employed below the grades of chief draftsman and assistant engineer. This new schedule was made effective as of July 1, 1919, for those roads that had put into effect Supplement 7 to General Order 27. Authority was granted roads to put this Supplement into effect if they had not previously done so. This means that the engineers who did not get the increase of $25 per month, authorized under Supplement 7, will be given it. That order went into effect Sept. 1, 1918, and therefore entitles engineers who did not receive the benefit of it at that time to receive back pay of $25 for each month after and including September, 1918. This accomplishment, of such great value to railway engineers, is directly due to the efforts of the American Association of Engineers.

The association is also making progress in establishing better salary schedules for engineers in the public service. The St. Louis chapter of the association has obtained the support of the St. Louis Board of Aldermen in the campaign for higher compensation for engineers employed by the city. (The campaign was described in our June issue.) A bill introduced before the Board of Aldermen on May 16, 1919, had been approved by the Efficiency Board and indorsed by the Associated Engineering Societies of St. Louis, but was pigeon-holed by the Board of Estimate and Apportionment. In order to get action on the bill the St. Louis chapter of the American Association of Engineers drafted and had introduced before the Board of Aldermen a resolution requesting the Board of Estimate and Apportionment to call up the bill for consideration. As this resolution was adopted unanimously by the Board of Aldermen, and as Mayor Kiel had announced his support of the bill, it is expected it will be passed very soon. The bill provides for an increase of about 15 percent in the salaries of engineers, draftsmen and other technical men in the city's service.

Maintenance Costs of Primary Highways in Washington for Two-Year Period

By George F. Cotterill, Chief Engineer, Washington State Highway Commission, Olympia, Wash.

On June 7, 1917, the State of Washington inaugurated the plan of state-controlled, county-administered maintenance of its primary highway system. State funds, derived from the motor vehicle license revenue, are apportioned to the counties "for the sole purpose of maintenance and repairing primary and permanent highways or highways of like character, and for equipment for the maintenance thereof." The primary highways are required to be maintained by the counties "under such rules, regulations and requirements as may be prescribed by the State Highway Board." In case any county administration is delinquent or deficient in maintaining any section of primary highway up to the prescribed standards, the law authorizes direct maintenance by the State Highway Department at the expense of the county apportionment of funds until the delinquency is overcome.

A Total of 1,796 Miles Now Under Joint Maintenance

At the outset, 1,245 miles of constructed primary highways came under the operation of this system of state control of county administered maintenance. By June of 1918, the mileage had increased by completion of new construction to 1,410 miles, and at this writing (July, 1919), by completed construction and additional routes designated by the recent legislature as primary highways, a total of 1,796 miles is under the joint maintenance plan. This will continue to increase at the rate of 200 to 300 miles annually for the next three or four years until the entire 2,700 miles of designated primary highway system is completed with permanent construction.

From 50 to 75 Per Cent. of All Traffic is Carried by Primary Routes

Although this primary mileage comprises only about 5 per cent. of the established road system throughout the state (excluding streets within corporate limits of cities and towns), it is certain that at least 50 and perhaps as much as 75 per cent. of the entire volume of highway traffic is carried by these primary routes, upon which the through and local travel is concentrated. The principle of making the upkeep of these primary highways a prior claim upon the motor vehicle license revenue—whether administered by state or counties—is economically sound and has proved its adequacy in practice. Prior to 1919, the license schedule, graded generally on the basis of weights and horse-power, averaged about $7 per vehicle, and all the revenue (over cost of license administration, about 10 per cent. of collections) was apportioned to the counties for maintenance. The 1919 legislature, desiring to increase the construction fund, practically doubled the license schedule to an average of about $16 per vehicle. This assures about $2,000,000 revenue in 1919, and probably $2,250,000 for 1920. The first $1,000,000 annually (after license administration expense), is required to be apportioned to the counties and municipalities for the maintenance and upkeep of the primary highways within their limits as a prior obligation. After meeting this adequately, any surplus in the county apportionments is available for maintenance of the county permanent highways other than on primary routes.

Main Features of Cost-Keeping System

In the exercise of state control over county administration of primary highway maintenance, the State Highway Board, in June, 1917, prescribed in detail the methods and standards to be applied and required, including a uniform system of cost-keeping and monthly reports, thus compiling a continuing cost record of the maintenance and repair expenditures upon each section of highway. This cost-keeping system includes the following main features:

(a) The primary highways in each county are divided into consecutive sections in accordance with their respective types of construction and surfacing.

(b) The county or maintenance engineer in charge prepares each December an "Annual Cost Estimate" for each section of highway on a prescribed form providing for a distributed estimate against the following segregated cost items, viz: Patrol, Drainage, Dragging and Dressing, Clearing, Removing Obstructions, Resurfacing and Repair, Sprinkling, Sanding, Structures, Safeguards and Signs, Industrial Insurance, Equipment and Supplies, Supervision and Contingencies the latter being 10 per cent. of the sum of all items preceding. These annual cost estimates are reviewed and modified as deemed necessary, by the County Board of Commissioners and finally are subject to approval of the State Highway Commissioners. The approved estimate for each section becomes its advisory budget for ensuing calendar year, and the total of all approved estimates in each county is set aside from the apportioned maintenance fund to meet the expenditures as they may be required.

(c) The engineer in charge prepares monthly reports of actual expenditures upon each section on a form segregated into cost items corresponding with the annual estimate, and extending in appropriate columns a simple system of budget bookkeeping for each item. The respective columns on each monthly report indicate "Expenditure, Month Reported"; "Previous Months, Calendar Year"; "Total to Date, Calendar Year"; "Budget Balance (or Deficit)." Each monthly report is prepared in duplicate, one for the county record, the other certified to the State Highway Commissioner. There is thus provided an expenditure report, cumulative each month, by which the responsible county and state authorities at all times have a permanent record of the physical and financial status of every section of primary state highway subject to their maintenance, administration and control.

(d) Special forms provide for detail explanation of annual estimates and monthly charges for "Equipment and Supplies" and for "Supervision," making a record of the apportionment of these general items as between the respective sections of highway upon which they are applied.

Explanation of Cost-Keeping Forms, Definition of Items. Etc.

The following matter, quoted from Bulletin No. 10 of the Washington State Highway Department, is here introduced to explain the cost-keeping forms, reproduced in the accompanying cuts, to define the items listed on the forms, etc.:

"A separate form shall be used for estimating and reporting the maintenance of 'each continuous, constructed section of primary state highway within the county.'

"For the purpose of estimates and reports the engineer shall divide each primary state highway into appropriate sections making the breaks between sections where the type of surfacing changes, so that each section reported shall be of the same general type of construction and surfacing. (Breaks need not be made by reason of planking, bridges or short sections of special surfacing interspersed in an otherwise continuous stretch of a prevailing type of construction.) For convenience in reporting the engineer may divide a continuous mileage of the same construction type into two or more sections, such divisions usually conforming to previous construction contracts.

"In designating highway sections, engineers will give consecutive numbers generally applying from the southerly county boundary northward, and from the westerly county boundary eastward. The mileage of each section shall be accurately checked and recorded to two decimal places (miles and hundredths).

"The dates and costs of construction are desired to be correctly entered in the heading of each section. It is realized, however, that engineers will have difficulty in some cases to give exact answers. Approximate estimates will serve until accurate information is supplied. In no event should any estimate be delayed for lack of this information.

Definition of Items

"The terms used in the forms for 'Annual Cost Estimates' and 'Monthly Report of Expenditures' are hereby listed and defined to include all labor, materials and other costs and expenditures applied in highway maintenance in accordance with the rules, regulations and requirements prescribed by the State Highway Board and segregated under the following headings for cost-keeping, estimates and reports, viz.:

"(A) Patrol: The prescribed maintenance patrol, including systematic inspection of the entire road section, immediate attention to drainage defects, removal of slight obstructions and such general 'first aid' repair service as can most effectively be rendered by a road patrol, as distinguished from definite, stationed work capable of more direct cost segregation under other item headings.

"(B) Drainage: The observation, care, upkeep, repair, renewal, replacement, enlargement, extension, diversion or other required modification of ditches, drains, inlets, culverts, channels, outlets and other drainage facilities which have been provided in constructing the highway or which may become necessary for the stability and permanence of the roadbed and the usefulness for traffic purposes of the surfacing thereof at all seasons (snow blockades excepted).

"(C) Dragging and Dressing: The dragging, grading, dressing, rolling and ordinary upkeep of the various types of improved earth, gravel or crushed rock roads so as to make and keep a smooth, compacted surface for the highway at proper crown and grade; also similar service to shoulders and slopes, in cuts and fills, as necessary to maintain the roadbed and roadway with widths at least equal to and gradients as easy as the original construction.

"This heading shall be applied to sections of highway with 'hard surface pavement,' only as to maintenance of shoulders and slopes, and keeping the pavement clean.

"(D) Clearing: The removal and disposal of weeds, brush, trees, stumps, fallen timber and debris within the right-of-way, or when threatening the road or obscuring safe traffic vision at curves, even though outside the right-of-way.

"(E) Removing Obstructions: The removal of rocks and sliding material, including any trees, stumps, logs or debris therewith, which have encroached upon or threaten the roadway, ditches or other portion of the constructed highway; the widening of any cuts or removal of spoil banks which become obstructive of traffic or vision. The cost of providing and maintaining detours for traffic around obstructions shall be included with this item. Snow removal shall be estimated and reported under this head but special note of the amount thereof shall be made in the 'Remarks' column when annually estimated and when reported for the month of expenditure.

"(F) Resurfacing and Repair: The resurfacing and re-

Form 1

State of Washington ________ County

MAINTENANCE OF PRIMARY STATE HIGHWAYS

Annual Cost Estimate For the Calendar Year 19__

(Prepared in accordance with Rules, Regulations and Requirements of State Highway Board prescribed under State Law.)

To the Board of County Commissioners of ________ County, Washington.

I do hereby certify the respective amounts set forth in the second column of the form below, and their total, as an itemized and complete estimate of the cost of adequate and proper maintenance of that certain continuous, constructed section of primary state highway described in the title of said form, throughout the annual period beginning January 1, 19__

Witness my hand this ____ day of ________, 19__

________ County (or Maintenance) Engineer

________ *Highway, Section No* ____; *Length* ____ *Miles*

Beginning at ________

Ending at ________

Graded, 19__; Roadbed width {*Cuts* __ *ft.*, *Fills* __ *ft.*}; *Cost* {*Grading and structures (except Bridges 20' or more span)* $____; ____ *Bridges 20' or more span, total length* ____ *ft.* $____}

Surfaced or Paved, 19__, Width ____ *ft.; Type* ____ *Base* ____ *Thickness* {*Crown* __, *Sides* __} *Cost* $____

ITEMIZED MAINTENANCE ESTIMATE FOR ANNUAL PERIOD.

SEGREGATED COST ITEMS (For definitions see Bulletin No. 10)	Expenditures Preceding Year	Estimate for Ensuing Year	As Modified by Co. Com'rs	As Modified by St. H'wy Com'r	REMARKS
*(A) Patrol	$	$	$	$	
(B) Drainage					
(C) Dragging and Dressing					
(D) Clearing					
(E) Removing Obstructions					
(F) Resurfacing and Repair					
(G) Sprinkling (or Sanding)					
(H) Structures					
(I) Safeguards, Signs, etc.					
(J)					
(K)					
(L) Industrial Insurance					
(M) Equipment and Supplies					
(N) Supervision					
(O) Contingencies					
Total of Estimate	$	$	$	$	

(*N. B. If no modification ordered, cancel bracketed words.)

To the State Highway Commissioner and Board

The Board of County Commissioners of ________ County, Washington, having duly considered the Engineer's Annual Estimate, providing for maintenance of the above described section of primary state highway for the ensuing annual period, all as set forth in the form above (*and having ordered certain modifications thereof and entered same in the third column), does hereby approve and adopt said Estimate (*with such modifications), as the Advisory Budget for the maintenance of said section of highway; and the Board does hereby declare the total of said (*modified) Estimate to be the amount necessary to provide adequate and proper maintenance in accordance with the methods and standards prescribed by the State Highway Board for the said section of highway, throughout the annual period included in the calendar year of 19__; and the Board does hereby set aside and make available for said maintenance as required, the total amount of said Estimate, together with the totals of similar approved annual estimates covering the maintenance of other sections of constructed primary state highway within the County, declaring same a prior claim upon the County Permanent Highway Maintenance Fund available during said annual period, and upon the permanent highway fund to the credit of said County if the maintenance fund be insufficient, and further agreeing in event both said funds are unavailable or insufficient, to provide any remainder from the general road and bridge fund, as provided by Section 5, Chapter 11[illegible], Laws of 1917.

Approved and adopted this ____ day of ________, 19__

Attested and certified to State Highway Board the day and date above named.

________ *County Auditor and Clerk of Board.*

Board of Commissioners of ________ County {________}

FORM 1 OF THE WASHINGTON HIGHWAY MAINTENANCE COST KEEPING SYSTEM FOR ANNUAL COST ESTIMATE.

Form 2

State of Washington ________ County

MAINTENANCE OF PRIMARY STATE HIGHWAYS

Monthly Report of Expenditures ________ (Insert month) 19__

(Prepared in accordance with Rules, Regulations and Requirements of State Highway Board prescribed under State Law.)

To the Board of County Commissioners of ________ County, Washington, and to the State Highway Commissioner.

I do hereby certify the respective amounts set forth in the first column of the form below, as being a true and correct segregated cost statement of expenditures made and properly apportioned upon that certain continuous, constructed section of primary state highway described in the title of said form, for the maintenance thereof, during the month of ________, 19__

Witness my hand this ____ day of ________, 19__

________ County (or Maintenance) Engineer

________ *Highway, Section No* ____; *Length* ____ *Miles*

Beginning at ________

Ending at ________

ITEMIZED MAINTENANCE EXPENDITURES, ________ (Insert month) 19__

SEGREGATED COST ITEMS (For definitions see Bulletin No. 10)	Expenditure Month Reported	Previous Months Calendar Year	Total to Date Calendar Year	Budget Balance (*Deficit)	REMARKS
(A) Patrol	$	$	$	$	
(B) Drainage					
(C) Dragging and Dressing					
(D) Clearing					
(E) Removing Obstructions					
(F) Resurfacing and Repair					
(G) Sprinkling (or Sanding)					
(H) Structures					
(I) Safeguards, Signs, etc.					
(J)					
(K)					
(L) Industrial Insurance					
(M) Equipment and Supplies					
(N) Supervision					
(O) Contingencies (see below)	Enter	Opposite	Appropriate	Items	
Total					

Distribute Expenditures for "Contingencies" to the appropriate items as per definitions. Describe in space below the location, character and cost of any work or expense classed as a "contingency."

Make general statement of maintenance conditions of this section of highway, noting any plans or suggestions for improvement.

Certified as a true copy of report filed with County Commissioners the ____ day of ________, 19__

________ *County Auditor and Clerk of Board.*

FORM 2 OF THE WASHINGTON HIGHWAY MAINTENANCE COST KEEPING SYSTEM FOR MONTHLY REPORT OF EXPENDITURES.

newal to thickness and width at least equal to construction plan, of the various forms of gravel, crushed rock and macadam roadway.

"Applied to 'hard surface pavements' this item shall include all care, upkeep, repair and resurfacing, including such partial renewals of pavement as may be made under the limitations of maintenance prescribed by the State Highway Board. Any pavement renewal to full width of roadway and exceeding 30 ft. in length shall be specially noted in 'Remarks' column, with location, length and cost thereof.

"(G) Sprinkling (or Sanding): The treatment of any section of highway by sprinkling same, for the convenience of traffic by dust prevention and for the preservation of the highway surface material.

"This heading shall be applied to 'hard surface pavements' when treated by 'sanding' or other topping treatment required for traffic needs or safety, especially in overcoming slippery conditions.

"(H) Structures: All work on any bridge, trestle, cribbing, retaining wall or other highway supporting structure (except drainage structures) or on any form of planked roadway, including safety inspection, care, upkeep, repair, strengthening, attention to walks, railings and safeguards, planking, paving, painting, renewals, reconstructions and replacements.

"Any estimate or report of expenditure proposed or made upon any structure for other than ordinary upkeep and repair, involving a substantial renewal, reconstruction or replacement shall be specially noted in the 'Remarks' column as to location, character of work and cost.

"(I) Safe-Guards, Signs, Etc.: The safety inspection, care, upkeep, repair, painting, strengthening, extension, addition and renewal of all railings and other safeguards (exclusive of those on structures); also similar maintenance and renewal of signs of warning, direction and mileage, and additional provision therefor as traffic safety, need and convenience may require.

Under this head shall be listed any expenditure in the proper care, upkeep and general maintenance of highway traffic conveniences such as watering places, drinking fountains, springs, rest or comfort stations, which are or may be provided for free public use in connection with the highway. Special note of such expenditures shall also be made in the 'Remarks' column, giving location, character and cost.

"(J) and (K). Blank lines are left on the forms opposite these letters, which the engineer may use, if necessary, to designate any item or class of maintenance work or expense, which in his judgment cannot fairly be listed under any of the defined item headings.

"While thus offering expansion opportunity for local needs, engineers are urged to make most careful review of the definitions of all items printed on the form, before adding thereto. It is believed they will be found inclusive of all classes of work and expense into which maintenance costs need be segregated. For uniform reporting and cost comparisons throughout the state, it is important that no change or addition be made unless absolutely compelled by local requirements and demonstrated to be necessary to the approval of the State Highway Commissioner.

"(L) Industrial Insurance: The payments required and made for industrial insurance, medical aid, compensation for injuries and disabilities, so far as such payments are made from state or county funds on account of workers actually employed on highway maintenance. Such payments to be apportioned to various highway sections on the basis of the men employed and expense actually incurred on each section.

"(M) Equipment and Supplies: General maintenance equipment, tools, etc., including any pits or quarries for maintenance materials with the facilities for utilizing same; also any materials or supplies for general maintenance use, which cannot be directly charged and segregated to the appropriate items is to be employed in all cases where feasible.

"In preparing the 'Annual Cost Estimate' there shall be listed on the separate form provided therefor, in general summarized items, all anticipated requirements of the county for General Maintenance Equipment and Supplies, which will be applicable for use on various sections of highways maintained under county authority, and whose cost must therefore be apportioned rather than directly charged to separate sections. Opposite each such item shall be noted its estimated total cost for the ensuing annual period, and in the columns following the apportionment thereof (a) to all primary highways, and (b) to all other highways, in the fair proportion of relative application of such item to the respective groups of highways. The total of amounts thus apportioned to all the primary highways in the county shall then be distributed as between the various sections into which they have been divided for estimates and reports, in fair proportion of relative application of such item to the respective sections. The amounts thus distributed shall be entered in the appropriate column at the bottom of the form before described, and the respective distributed amounts shall be inserted for 'Equipment and Supplies' on the 'Annual Cost Estimate' for the respective primary highway sections.

"In preparing each 'Monthly Report of Expenditures,' similar procedure shall be followed, using the separate form provided therefor, making statement of all county expenditures during the month reported for all General Maintenance Equipment and Supplies which cannot be directly segregated, the apportionment thereof as between the two groups of 'primary' and 'all other' highways, the distribution of the total apportionment as between the respective sections of primary highways, and the entering of such distributed amounts in the appropriate place on the monthly report forms.

"(N) Supervision: Special maintenance engineering, inspection and other supervision, also accounting and keeping office records of maintenance, with such supplies and other necessary expense incident thereto, so far as same are applied to general county highway maintenance and cannot fairly be included in payrolls and accounts directly segregated to the particular work to which applied—which direct segregation should be made whenever possible.

"In preparing the 'Annual Cost Estimate' and each 'Monthly Report of Expenditures' the separate forms consolidated with 'Equipment and Supplies' shall be used, appropriate spaces being provided for 'Supervision' entries. The same requirement of itemized statement covering all County Maintenance Supervision, its apportionment between the two groups of highways and distribution between the sections of primary highways, as provided above for 'Equipment and Supplies' shall also be applied in entering, apportioning and distributing 'Supervision' expenditures.

"(N. B. The salary or compensation of any regular county officer, road district supervisor or county employe, whose position or employment and compensation is not for the purpose of or dependent upon highway maintenance duties, but who may give attention to same in connection with other county duties, shall not be charged or apportioned against the maintenance of primary state highways.)

"(O) Contingencies: The regulation of the State Highway Board requires that the annual estimate 'shall include, in addition to all definite items listed, an item of not less than ten (10) per cent. of the total of all other items for contingencies.'

"In preparation of 'Monthly Reports of Expenditures,' any class of work or expense which can properly be classed as a 'contingency'—i. e., not contemplated in the making of the annual estimate—shall be entered opposite the appropriate item of segregation, even though it increases same and creates a deficit for that item in comparison with the approved estimate or advisory budget.

"A description of the location, character and cost, with statement of the cause of every such 'contingency' expenditure, shall also be entered in the space provided therefor on each monthly report form.

Special Instructions

"Referring to the column headings on the 'Annual Cost Estimate' form, it is intended that the first column shall be used to furnish the County Commissioners with figures available for convenient comparison when considering the ensuing year's estimate in the second column. At the time of preparing the annual estimate in December, the engineer manifestly cannot insert precise totals for the 'preceding year' until he knows actual December expenditures. He should therefore enter eleven months total from actual reports plus an estimate for December. (For the 1918 estimate the 'preceding year' expenditures will be derived from the monthly reports covering June to November, 1917, plus an estimate for December.) If actual December figures are available before the board approves the estimate, the totals in this column should be revised so as to include them, but there should be no delay in preparing, approving or certifying the Annual Cost Estimate on this account. The figures in this column are memoranda rather than records, and eleven months of accurate figures plus the December estimate will serve the purpose of comparisons.

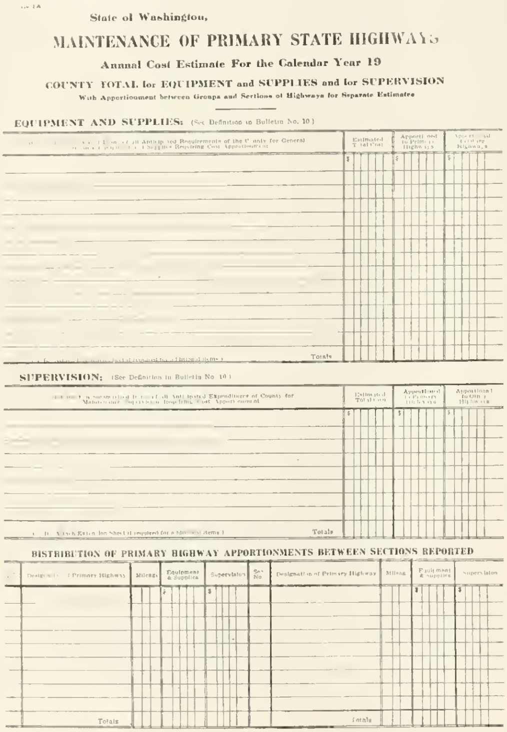
"Referring to the column headings on the 'Monthly Report of Expenditures,' it is intended that,

"(a) In the first column shall be entered the segregated expenditures for the month reported;

"(b) In the second column enter the sum of the similar segregated expenditures for all months in the calendar year preceding the month reported;

"(c) In the third column enter the totals of segregated expenditures for the calendar year to date, including the month reported, in all cases being the sum of the figures in the first and second column opposite each item;

"(d) In the fourth column enter the unexpended balance remaining from the advisory budget total for each item as approved in the 'annual cost estimate' at the beginning of the calendar year, deductions being made therefrom on successive monthly reports to the extent of the expenditures for each month as reported. When these deductions lead to a deficit in any item, note the amount of the deficit with an asterisk [*], and include in brackets. In compiling and entering the total of this column, 'budget deficits' as to certain items should be offset against 'budget balances' as to other items, and the total should indicate the net balance (or deficit) applicable to that section of highway.



State of Washington,

MAINTENANCE OF PRIMARY STATE HIGHWAYS

Annual Cost Estimate For the Calendar Year 19

COUNTY TOTAL for EQUIPMENT and SUPPLIES and for SUPERVISION

With Apportionment between Groups and Sections of Highways for Separate Estimates

EQUIPMENT AND SUPPLIES: (See Definition in Bulletin No. 10)

Statement in Summarized Items of all Anticipated Requirements of the County for General Maintenance Equipment and Supplies Requiring Cost Apportionment	Estimated Total Cost	Apportioned to Primary Highways	Apportioned to Other Highways
	$	$	$
Totals			

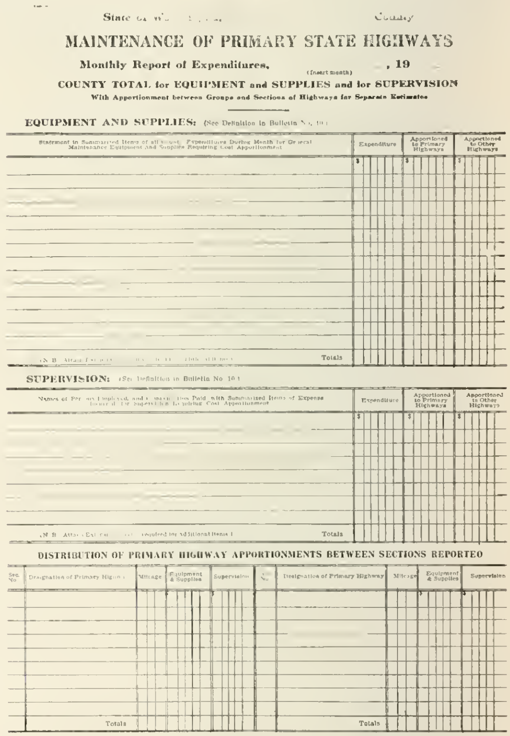
SUPERVISION: (See Definition in Bulletin No. 10)

Statement in Summarized Items of all Anticipated Expenditures of County for Maintenance Supervision Requiring Cost Apportionment	Estimated Total Cost	Apportioned to Primary Highways	Apportioned to Other Highways
	$	$	$
Totals			

DISTRIBUTION OF PRIMARY HIGHWAY APPORTIONMENTS BETWEEN SECTIONS REPORTED

Sec. No.	Designation of Primary Highway	Mileage	Equipment & Supplies	Supervision	Sec. No.	Designation of Primary Highway	Mileage	Equipment & Supplies	Supervision
			$	$				$	$
	Totals					Totals			

FORM 1A OF THE WASHINGTON HIGHWAY MAINTENANCE COST KEEPING SYSTEM FOR ANNUAL COST ESTIMATE FOR EQUIPMENT, SUPPLIES AND SUPERVISION.



State of Washington, County

MAINTENANCE OF PRIMARY STATE HIGHWAYS

Monthly Report of Expenditures, (Insert month), 19

COUNTY TOTAL for EQUIPMENT and SUPPLIES and for SUPERVISION

With Apportionment between Groups and Sections of Highways for Separate Estimates

EQUIPMENT AND SUPPLIES: (See Definition in Bulletin No. 10)

Statement in Summarized Items of all County Expenditures During Month for General Maintenance Equipment and Supplies Requiring Cost Apportionment	Expenditure	Apportioned to Primary Highways	Apportioned to Other Highways
	$	$	$
Totals			

SUPERVISION: (See Definition in Bulletin No. 10)

Names of Persons Employed, and Amounts Paid, with Summarized Items of Expense Incurred for Supervision Requiring Cost Apportionment	Expenditure	Apportioned to Primary Highways	Apportioned to Other Highways
	$	$	$
Totals			

DISTRIBUTION OF PRIMARY HIGHWAY APPORTIONMENTS BETWEEN SECTIONS REPORTED

Sec. No.	Designation of Primary Highway	Mileage	Equipment & Supplies	Supervision	Sec. No.	Designation of Primary Highway	Mileage	Equipment & Supplies	Supervision
			$	$				$	$
	Totals					Totals			

FORM 2A OF THE WASHINGTON HIGHWAY MAINTENANCE COST KEEPING SYSTEM FOR MONTHLY EXPENDITURE FOR EQUIPMENT, SUPPLIES AND SUPERVISION.

"Whenever in any month there shall have been no maintenance expenditures or apportionments chargeable to any section or sections of primary state highways, it shall not be necessary to use the regular monthly form, but the engineer shall in every such case certify on a sheet of similar size to said form, that there have been no such expenditures or apportionments chargeable to the given section (noting its number and designation), during the month stated. This certificate of no expenditures shall go to the County Commissioners and be transmitted to the State Highway Board the same as if it reported and segregated actual expenditures.

"The engineer shall prepare each 'Annual Cost Estimate' and 'Monthly Report of Expenditures' in duplicate—one copy shall be kept by the engineer as a county record, the other certified and transmitted to the State Highway Commissioner for the records of the State Highway Board.

"At the conclusion of each calendar year the engineer shall prepare a consolidated report of expenditures for the entire year, being the sum of the twelve monthly reports which have been rendered. Unless a special form shall be prepared and furnished therefor, the engineer shall use a monthly report form for this consolidated annual report, inserting the calendar year where the form provides for entering the month. This consolidated annual report of expenditures shall be certified to the County Commissioners and to the State Highway Board, at the same time as the monthly report for December. The engineer's file of reports for each section, including its initial annual cost estimate, the twelve monthly reports of expenditures and the consolidated annual report covering and closing the year, shall be deposited with the County Auditor, and remain available as a county record."

Records for Two Years Now Available

Two years of cumulative cost-keeping records of Washington primary highway maintenance are now available. They cover about 250 separate sections of highway, each averaging nearly 6 miles length; including 11 types of construction and surfacing. Their maintenance is under the direct administration of 30 Boards of County Commissioners and their county or maintenance engineers in charge. With an average of about 50 miles of primary state highway in each county, the maintenance organization covers these along with the larger group of main county and tributary highways, making the necessary apportionments for 'overhead' supervision, equipment, etc., as between the respective groups.

Argument for Joint System of State Control and County Administration

It may be opportune to emphasize the point just stated as the economic basis which supports the argument for county administration of maintenance of primary state highways under state regulation, as compared with direct state administration. Inasmuch as every county has and must continue in any event, its organization and equipment for the maintenance of several hundred miles of county highways over which it has sole jurisdiction, is not this existing county organization best equipped to cover most economically and efficiently the 50 to 100 miles of state highway within the same county territory? Is it wise or necessary to duplicate maintenance equipment and organizations by superimposing a separate state maintenance administration upon the relatively small proportion of primary highway mileage within each county? Will not a centralized State Highway Department control and direction of county maintenance administrations applied to primary state highways, with state authority to prescribe and enforce standards of maintenance, and with requirement of uniform cost-keeping and records of the expenditure of the state funds apportioned for the upkeep of these main roads, best serve the common public purpose? Moreover, will not the tendency be to expand the application of the state-prescribed standards and requirements for adequate maintenance of the primary highways, to the other main and tributary county highways and thus uplift and establish the entire highway maintenance plan and organization in all the counties? Thus runs the argument for the joint system of state control

(A) STATE OF WASHINGTON—PRIMARY HIGHWAYS

Expenditures for Maintenance, Repairs and Equipment, June, 1917-May, 1919.

Name of County	Year June, '17-May, '18 Mileage	Cost Per Mile	Year June, '18-May, '19 Mileage	Cost Per Mile	Annual Average Cost Per Mile-Year
Adams	25.28	$36.08	25.28	$112.58	$74.33
Asotin	2.27	283.10	2.27	50.00	166.55
Benton	38.81	359.38	44.67	390.40	374.86
Chelan	10.39	113.59	22.24	435.36	274.47
Clallam	76.45	267.31	76.74	522.80	395.05
Clarke	18.01	429.60	28.82	464.28	446.94
Columbia	19.63	557.11	23.46	447.35	502.23
Cowlitz	21.01	730.48	26.67	552.70	641.59
Douglas	23.17	108.68	31.69	432.51	270.60
Franklin	1.91	8.34	19.16	180.58	94.46
Garfield	5.78	982.49	5.78	288.80	635.65
Grant	20.68	143.89	38.31	246.67	195.28
Grays Harbor	69.93	596.88	76.17	864.53	730.70
Jefferson	31.84	237.67	34.81	334.25	285.96
King	119.68	928.16	119.68	954.65	941.41
Kittitas	75.88	219.68	98.28	159.71	189.70
Lewis	77.90	157.31	77.90	463.88	310.60
Lincoln	39.45	354.65	69.03	254.82	304.73
Mason	46.50	165.13	52.07	206.99	186.06
Pacific	37.56	139.70	55.65	375.61	257.65
Pierce	81.47	160.81	86.24	402.92	281.86
Skagit	27.00	536.20	27.25	417.14	476.67
Snohomish	42.41	234.48	44.12	157.36	195.92
Spokane	94.57	171.93	106.29	544.57	358.25
Stevens	8.91	164.62	8.91	339.08	251.85
Thurston	50.17	165.51	56.49	257.98	211.75
Walla Walla	40.55	320.58	45.69	297.81	309.20
Whatcom	13.48	163.03	21.06	227.85	195.44
Whitman	64.27	442.37	65.30	270.57	356.47
Yakima	118.85	173.77	122.76	291.63	232.70
30 Counties	1,303.87	$327.84	1,512.79	$419.86	$373.85

and county administration as in force in Washington. There is another side to this argument and there are some decided offsets in favor of the concentration of all trunk highway maintenance under direct state administration, irrespective of county organizations and boundaries. The figures of comparative maintenance costs of similar roads in adjacent counties are suggestive of decided differences of efficiency between county organizations, which concentrated state administration should overcome.

Cost Data

The tabulated statements which follow are a summary of the expenditures charged against the primary highways of Washington for their maintenance, repair and equipment therefor during the past two years (June, 1917, to May, 1919, inclusive), as reported by the county engineers in charge to the State Highway Commissioner. They are classified

A—By counties exercising direct administration;

B—By highways, as designated in the state primary system;

C—By types of construction and surfacing.

Interpretation of the Data

For correct understanding of the preceding tabular statements and making fair comparisons therefrom, it must be borne in mind,

(a) That the expenditures listed and averaged per mile include all charges upon the entire road, its drainage, roadbed, slopes, shoulders, etc., as well as the pavement or surfacing—everything that has been necessary for the adequate maintenance, repair and general upkeep of the highway.

(b) That equipment purchases make up about 15 per cent. of the total expenditures, varying from nominal up to 50 per cent. in the various counties, apportioned upon the respective highway sections to which applied. While this operates

(B) STATE OF WASHINGTON—PRIMARY HIGHWAYS

Expenditures for Maintenance, Repairs and Equipment, 1917-1918

Name of Highway	1917 (7 months June-Dec.) Mileage	Expenditure	Per Mile	1918 (Full Year) Mileage	Expenditure	Per Mile	1917-1918 Cost per Mile-Year
Pacific Highway	237.54	$45,875.29	$193.13	258.09	$107,171.13	$415.25	$384.24
Sunset Highway	227.99	43,578.31	191.14	281.16	93,218.02	331.54	330.11
Inland Empire Highway	310.14	51,746.94	166.88	336.93	136,132.45	404.04	360.58
National Park Highway	124.39	5,884.58	47.31	155.59	54,592.82	350.87	251.48
Olympic Highway	232.36	41,878.38	180.23	250.55	111,288.96	444.18	394.36
McClellan Pass Highway	71.27	20,295.53	284.77	79.27	50,731.67	639.98	584.05
Central Washington Highway	41.88	1,570.86	37.51	48.94	6,633.43	135.54	109.30
Primary Highway Total	1,245.57	$210,829.89	$169.26	1,410.53	$559,768.48	$396.85	$357.54

(C) EXPENDITURES 1917-1918, CLASSIFIED BY HIGHWAY CONSTRUCTION TYPES

Type of Surfacing	1917 (7 months June-Dec.) Mileage	Expenditure	Per Mile	1918 (Full Year) Mileage	Expenditure	Per Mile	1917-1918 Cost per Mile-Year
*Brick Pavement	8.81	$9,466.51	$1,073.38*	8.81	$6,652.29	$755.08*	$914.23*
Cement Concrete	90.59	6,110.60	56.41	102.38	11,427.54	111.61	106.12
Asphaltic Concrete	19.74	322.21	16.32	23.24	7,871.09	338.68	224.21
Bitulithic and Warrenite	14.41	3,040.50	211.00	17.77	5,143.54	289.45	316.07
Sheet Asphalt	6.97	326.05	54.61	5.97	207.07	34.68	56.39
½ Width Concrete) ½ Width Macdam and Concrete)	7.80	1,798.50	230.58	8.53	2,461.81	288.61	327.91
Bituminous Macadam	42.21	5,895.67	139.67	40.96	20,071.85	490.03	397.70
Water-bound Macadam	122.85	20,297.41	165.22	125.05	52,335.59	418.52	368.67
Crushed Rock Surfacing	54.03	8,396.81	155.41	66.30	32,063.53	483.61	403.59
Gravel Surfacing	756.33	138,199.34	182.72	825.81	353,845.15	428.48	386.02
Natural Earth Grade	121.28	10,511.82	86.67	182.13	30,185.56	165.73	159.42
Special, Bridges, Trestles, etc.	1.55†	7,474.47	......	3.58†	37,503.46	......	......
All Types—Total	1,245.67	$210,829.89	$169.26	1,410.53	$559,768.48	$396.85	$357.54

*Abnormal expenditures on brick pavements due to extensive repairs and replacements account faulty construction and road-bed settlements. The 1917-18 average per mile year obtained by adding annual averages and equal division of sum. In all cases of other types than brick the 1917-18 mile-year average is obtained by dividing sum of annual averages by 1.5833, on account 7 months of 1917 averaged with full year 1918.

†This item represents unusual expenditures on bridges, trestles, etc., such as replacements, redecking, etc., amounting practically to reconstruction, and therefore excluded from ordinary maintenance costs of the highway sections in which located.

fairly as a general state average, there are disproportionate equipment charges as between the several counties, which will not work out in fair comparison until at least four or five years of continuous records on this plan are made available.

(c) That the traffic on the various sections of highways included in these statistics varies from 100 to 200 vehicles per day (in such counties as Adams and Franklin) up to 2,000 to 4,000 vehicles per day (in such counties as King, Pierce and Spokane on the highways tributary to Seattle, Tacoma and Spokane). Any comparisons between the relative county averages of cost of maintenance per mile, must take this volume of traffic into consideration, especially in the case of macadam and gravel-surfaced highways.

(d) In general, and to a marked extent in certain counties, the cost statistics are made higher than ordinary maintenance should be, by the inclusion of incidental improvements to the highways, such as occasional widenings, additional drainage facilities, bank protection along streams, providing guard-rails and other safeguards of traffic, removing slides, etc. Most of the Washington primary highways are new construction of the past six years, and under a liberal application of the terms "maintenance and repairs" any defects or minor errors which are revealed by use and with the effects of the elements at recurring winter and flood seasons, are supplied and overcome from the maintenance funds. Thus, with the exception of pavements and structures, it can be demonstrated that the Washington primary highways have been decidedly improved by continuing maintenance more than they have been worn out by the traffic. Maintenance expenditures should tend to decrease its comparison with the record of the past two years, because of these incidental improvements and repairs of new construction which have been liberally classified and charged to maintenance.

(e) On certain sections of the McClellan Pass Highway in King county, and of the Olympic Highway in Clallam and Gray's Harbor counties, the Federal Government spruce operations of the war period imposed a most abnormal and destructive use upon more than 100 miles of gravel-surfaced highways. Extension trucks carried great logs, often to aggregate weights of 20 to 25 tons, over miles of roads unfitted for such abnormal use; but with no other transportation resource from the spruce forests, these roads were devoted to the national service. In order to keep up these roads under such traffic it required on the McClellan Pass Highway in King county an expenditure during 1918 of $1,861.37 per mile for the 19-mile section east of Enumclaw, which was the scene of the spruce hauling operations. Similarly on the Olympic Highway in Gray's Harbor county south from Lake Quinault, it cost almost $1,000 per mile to keep up the 37 miles of gravel-surfaced highway during 1918. These abnormal upkeep costs swell the figures for these counties and types of highway.

(f) The years covered by these tabular statements—beginning with June, 1917, have witnessed the highest scale of labor and material costs ever known. Common labor had reached the $3.75 mark before June, 1917, and rose to $4.50 and $5.00 during 1918, at which level it remains in June, 1919 (for day of eight hours). This represents a full 100 per cent. increase from the $2.25 to $2.75 rates for similar labor in the pre-war period. And the materials necessary for maintenance work have risen in almost similar doubled proportion. The Washington primary highway average of almost $400 per mile maintenance cost in 1918—and five months of 1919 shows a continuance at about this rate—is fairly comparable with $200 per mile during the period of 1910-16.

Economy of Paved Highways

At least one general conclusion is fairly deductible from the Washington figures of two years maintenance costs, viz: That there is a gap of $250 to $300 per mile per year between the group of hard-surface paved highways and the macadam-gravel group. Considering further that the paved highways carry a volume of traffic per mile, averaging two to ten times that of the macadam-gravel group, it is demonstrable from detail analysis of sectional reports that macadam-gravel sections under traffic comparable with paved sections are costing from $600 per mile per year and upwards for their upkeep. In other words the real gap between maintenance cost of paved and macadam-gravel highways under similar heavy traffic is at least $500 per mile per year. Assuming a traffic of 500 motor vehicles per day or 182,500 per year, it is certain that not less than one cent per mile—some would place it as high as two cents—will be saved to the motor-operating public, or $1,825 per year per mile in actual upkeep cost of motor vehicles employed, to say nothing of increased traction results, time saved and convenience served. Adding the $500 per mile of increased annual maintenance cost and $1,825 per mile of motor vehicle upkeep cost, makes a showing of $2,325 per year per mile which can be saved by substituting a hard-surface pavement for macadam or gravel-surfacing. Half this amount would pay the interest on an investment of $25,000 per mile in pavement.

Whenever the traffic on a macadam or gravel-surfaced highway approaches an average of 500 motor vehicles daily, the Washington experience demonstrates costs of $600 to $1,000 per mile for such ineffective degree of upkeep as is possible for these highway types under such traffic. In every such case a hard-surface pavement is economically overdue, and the Washington program is to get these roads up-to-date by hard-surface construction as fast as resources and credit will permit.

New Mechanical Methods Employed with Marked Success in Building Monolithic Brick Road from Ashtabula to Conneaut, Ohio

By F. A. Churchill, Conneaut, Ohio

(Editor's Note: By means of the two automatic templates which are being used for fashioning the concrete foundation of the Ashtabula-Conneaut monolithic brick road, the contractor is able to construct from 1,000 to 1,100 ft. of monolithic, 16 ft. pavement in a day, including foundation and final grouting. This piece of construction work is attracting much well deserved attention. The following article, prepared at our special request, does full justice to this truly noteworthy piece of modern highway construction.)

Progress in road-building methods seems to advance in sudden jumps rather than by means of slow development, and this applies as well to mechanical devices as to designs and types of construction.

It was only about four years ago that monolithic brick pavements began to attract notice, yet monolithic and semi-monolithic construction—two forms of the same thing—have practically eliminated the old sand-cushion type of construction.

Early Monolithic Brick Surfaces Sometimes Rough

Until very recently, however, the process of screeding and shaping the green concrete foundation for monolithic brick road was rather slow and required extreme care in order to get a smooooth, even surface. The usual method was to employ a wooden template, steel shod, moving on side forms, which was drawn over the concrete by means of the concrete mixer. Inequalities in the surface contour were equalized by filling and hand luting.

Very good results were obtained by this method, yet unless the contractor exercised care, and if the concrete happened to be dry and coarse aggregate appeared at the surface, there would be dragging of course aggregate by the blade of the template and the brick surfacing might not be as smooth as desired. In fact, one of the complaints against monolithic brick pavements was that it was likely to be rough. While the unevenness of surface could easily be avoided, measures to avoid it were not always adopted by the contractor who was in haste to complete his job.

All difficulties of the kind mentioned appear to have been obviated by mechanical means, and henceforth there need be no rough monolithic brick surfaces.

On a State—and Federal—aid road in Ashtabula County, Ohio, the main highway leading from Cleveland to Buffalo, some remarkable work is being done in preparing green concrete foundations by mechanical means, and the uniqueness and efficiency of the means employed are attracting engineers and officials from all parts of the country.

This road runs from Ashtabula east to Conneaut and it is 12 miles long. The brick roadway is 16 ft. wide, with an additional 2 ft. of concrete gutter on one side. A 4 in. wire-cut lug brick is being laid on a green concrete foundation 5 in. deep. About midway of the terminals a small lake fed by a running stream furnishes the water, the latter being pumped through iron pipes along the roadway by means of a power pump.

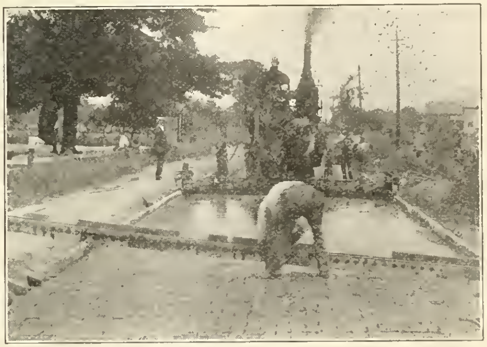
Parrish Automatic Cutting and Tamping Template Employed

As this road is the main thoroughfare for eastern and western travel in northern Ohio, and carries an enormous traffic, it was desirable to expedite its construction to the utmost possible extent without sacrificing good construction. The serious problem of time involved the factor of preparing the green concrete foundation to a true surface, and this problem has been solved by the use of a Parrish automatic cutting and tamping template which is self-propelling.

The template operates on wheels on the steel side forms used to hold the concrete to line. It operates and advances by its own power, always in a forward direction, just behind the Foote concrete mixer but is in no way connected with the latter.

The automatic template cuts the concrete base to a true contour a little higher than the required height of the finished surface, and then the rear section of the template tamps and vibrates the concrete to the true level and contour, leaving the surface as smooth and even as a billiard table.

The face of the tamping template is shaped to the true required contour of the pavement, as the mechanism is so adjusted that, always advancing, it delivers 65 successive taps on each section of the foundation covered by the face of the tamper. These blows are light, but they are delivered rapidly and the result is not only a perfect foundation contour and a uniform bedding course for the brick, but a thoroughly compacted foundation of uniform consistency throughout, without air pockets or other voids or inequalities of structure. The tamping also brings to the surface, if desired, a matrix in which the brick become imbedded.



PARRISH AUTOMATIC CUTTING AND TAMPING TEMPLATE and FOOTE CONCRETE MIXER AT WORK ON ASHTABULA-CONNEAUT HIGHWAY, OHIO, MAIN ROAD FROM BUFFALO TO CLEVELAND. MONOLITHIC WIRE-CUT LUG BRICK CONSTRUCTION, STATE AND FEDERAL AID ROAD 12 MILES LONG.

The absolute uniformity of the surface produced on the green concrete and the uniform density of the concrete assure an even and firm bearing for the brick and realize the principle of rigidity of beam to the fullest possible extent.

The Parrish template was used for the first time in regular contract work by its inventor in Illinois, and it is doing perfect work on this road. It operates below the rail as easily as on a level with the rail, and its possible rate of progress is declared by the contractor to be twice that which his big Foote power concrete mixer is able to provide for, or the brick layers to maintain.

Thomas P. Fitzgerald, the contractor, who is using two of the Parrish automatic tamping templates, says that he is building from 800 and 950 sq. yds. of monolithic brick pavement complete in an 8-hour day, with each machine, and he avers that there is a great saving per square yard in labor and material as compared with the cement-sand film construction.

In an interview, Mr. Fitzgerald said: "The tamping template is a great saving to contractors; also it makes better construction work."

The points of advantage possessed by the Parrish template are: It works below rails, or on a plane with them; it keeps going ahead without reverse action; it tamps rapidly; it moves ahead at any desired speed; it makes a dense foundation with a true, smooth surface, and it makes the concrete of uniform consistency without air holes or other voids.

Description of Parrish Template

Described in general terms, the template framework is of I-beams, with cross-bars to support the gasoline engine which operates it. The front I-beam acts as a cutting blade, set a trifle higher than the required height of the finished foundation. To the rear of that, and attached to the ends of rocker-arms, is a U-shaped channel iron beam set with the edges down, which spades the concrete. At the opposite ends of the rocker-arms, and rear of the spader, is a channel beam 3½ ins. wide on its face, which acts as a tamper, consolidating the concrete and finishing the surface to a true contour.

The ends of the transverse I-beams of the frame are attached to flanged wheels which run on the side forms placed to hold the concrete in place on the roadway. The motive power is a gasoline engine placed in the center of the framework and geared to the shafts. Clutches and levers regulate the speed, and stop and start the machine. Small steel cables, wound around drums on the template and carried ahead and anchored to driven stakes, draw the template forward evenly and steadily. The clutches on the drums operate independently so that the template can be adjusted to work on curves.

The cutting, spading, and tamping members can easily be set to operate at any required depth below the side forms, or on a level with them.

The template is mechanically simple, yet extremely efficient, easily learned and not complex, or delicate in mechanism.

Great interest has been excited by the methods used in constructing this important highway. Engineers, county officials and contractors from other states have visited the work for the purpose of inspecting the template and constructional work being done on the road, and even federal officials connected with road building have manifested an interest in what promises to be revolutionary methods of constructing not only monolithic brick but also concrete roads, since the template seems equally well adapted for finishing concrete slabs.

This new mechanical equipment for road building marks the beginning of a new era in highway construction, as distinctly progressive as the development of the new types of roads themselves, since more and better work can be done, and hazards of unsmooth surfaces are virtually eliminated, so far as foundation surfaces are concerned.

Design and Construction of the Telephone and Telegraph Tunnel Under the Chicago River at Harrison Street

By Wm. Artingstall, Consulting Engineer, 730 Old Colony Building, Chicago, Ill.

In laying conduit for cables, it has generally been understood that the nearer the conduits are kept to the surface of the ground, the less will be the cost of the installation. Sometimes, however, this does not hold true, even where there is no pavement to replace, and the Chicago Plant Division of the Western Union Telegraph Co. has just completed one of these exceptions.

Everybody knows that the Chicago River and its two main branches, roughly forming a big Y, with the stem connecting to Lake Michigan and the branches extending to the northwest and southwest, divides the city into the three divisions—North, West and South. The wholesale district, railway terminals, and main retail stores in the "Loop" are all within a mile of the junction of the two branches of the river. All the large office buildings lie within the loop, and it is in this section that the company is just completing their new building. Just west of the river are two large railway terminals, the Northwestern (lately completed) and the Chicago Union Station which accommodates several trunk lines and is now constructing a new terminal station at a cost of over $20,000,000.

Western Union Layout

The Western Union has a pneumatic tube system and cable run which forms a sort of belt between the main building, its branch offices and the various railway terminals. One side of this belt crosses the Chicago River at Harrison street and passes through the new Union Station. The enormous expense of maintaining marine cables in the river and the pneumatic tubes in the run compelled the use of a tunnel for the river crossing. The railway yard lying immediately west of the river could, under ordinary circumstances, be crossed by conduits, but the plans of the Union Station Company contemplated the lowering of their yard from 4 to 8 ft., without interruption to train serivce. A large concrete sewer had just been built and, on account of the numerous other conduits, water-mains, viaduct columns, subway reservations, etc., there was very little room available for our work and what was available had to be reached by first passing under the new sewer, several deep manholes, etc., and keeping sufficiently low to clear the railroad at its proposed grade. This meant expensive trenching under 18 tracks, 6 viaduct abutments, in various stages of collapse, and passing under a wide street intersection with more than the usual number of manholes, water mains, sewers, conduit runs and two lines of street railway tracks. Needless to state, the difficulty of laying conduit in a 10 to 14 ft. trench is sufficient without the additional burden of maintaining railway traffic of over 200 trains per day.

Chicago Telephone Co. Layout

The Chicago Telephone Company was in somewhat of the same fix as the Western Union, and had employed the writer as Consulting Engineer to develop a design for this crossing and maintain their cables during the construction of the new station. A complete study was made of the location and all the conditions entering into every feature of the work was thoroughly worked out. Four schemes were the result of these studies and estimates and, on the basis of the engineer's recommendations, the telephone company decided to construct a tunnel under the river approximately 500 ft. long and 90 ft. below the street surface. The Western Union decided to lease space in this tunnel, but later joined with the telephone company on an equal basis, so that now each owns half a tunnel. This took care of the river section, but the worst part of the run was still unsolved. Having participated in many conferences between the two wire companies, the writer was familiar with the Western Union problem and when engaged as consulting engineer by the latter company, he had no hesitancy in recommending that a small tunnel be designed so as to connect with the "joint" tunnel under the river, be projected west under the railroad yards, and come out in a manhole shaft on the west side of Canal street to connect there with the rest of the surface run. An estimate of cost was made to cover this scheme which ran less than the engineer's estimate of the cost of a conduit run. Considerable doubt was expressed as to accuracy of the estimate for the conduit run, so the engineer prepared complete designs and specifications covering

1st. A conduit run (with pneumatic tubes) located as close as practicable to the proposed track grade.

2nd. A small tunnel, shafts, manholes, etc., between the same points as proposed for the conduit run.

The Joint Tunnel

The intention was to submit both designs to contractors for competitive bids. Only one contractor was willing to take a chance on the first proposition, so after informing the "main office" that propositon number one would cost slightly over 50 per cent. more than the tunnel, providing the company took all the risks for damages, it was decided to withdraw the designs of the conduit run and submit only the tunnel designs for bids. Designs for the joint tunnel were submitted at the same time; James A. Green & Sons were low bidder in each case and were awarded the contracts for both jobs. The small tunnel was estimated to cost $20,010; the bidding price was $19,955, while the final certificate called for $19,572.22. The large tunnel was estimated to cost $34,450, and cost $33,-491.76. Certain work was later decided to be done and given to the contractor at a cost of $4,037.35, so the whole work cost in round numbers, $57,000.

The east shaft, called No. 1, is located about midway between the river and Franklin street; shaft No. 2 on the opposite side of the river is 500 ft. west; shaft No. 3 connects with the C. B. & Q. Ry., while shaft No. 4 is the western terminal of the tunnel at Canal street and about 1,200 ft. from shaft No. 1. The invert at shaft 4 is at—40 city datum, or about 60 ft. below street grade, and the slope is to the east, where at shaft No. 1, the invert is at —70, or 90 ft. below street grade. The various details that entered into and governed the design will not be dwelt upon because they vary with each design and location and while interesting in themselves, they would occupy more space than can be given in an article of this sort.

Shaft Sinking

The first work on construction was shaft 1, the sinking of which proceeded without difficulty until within a few feet of the bottom, when just as the men were ready to quit work on the day shift, a small amount of seepage was noticed coming through the excavation. The next morning there was 60 ft. of water in the shaft. This was then temporarily abandoned and work started on shaft 2. This shaft is partly in a basement, partly through an old retaining wall (28 ft.) and partly under a filled street, carrying two car tracks. This formed the basis for an ideal lot of trouble if the work wasn't handled just right, but fortunately our fears were groundless, the shoring was placed and the sheathing driven without trouble of any kind. After the first set of lagging was set, the shaft was sunk in the short time of 15 days. This shaft is offset from the tunnel in order to clear a proposed viaduct pier, so the tunnel makes a curve at this point, on a radius of 80 ft., for a distance of 35 ft. to meet the line drawn between shafts 1 and 4. As we had only 6 ins. to clear another caisson at the junction and were compelled to extend the tunnel 500 ft. one way and 700 ft. the other, with a back sight base line of only 6 ft., the engineers on the survey were somewhat relieved when the tunnel was "holed-through" and they connected up at the shafts less than half an inch off line.

After shaft 2 was finished, the "eye" or section of tunnel at the foot of the shaft was excavated and concreted. This is always a nasty part of the work, and the fact of its being 14 ft. high and only 6 ft. wide, added nothing to its charms. A short distance from the eye, the tunnel widened suddenly to 12 ft. (This was to permit the small tunnel to pass on to shaft 4.) From this section toward the east the tunnel is drawn down to the regular section of the joint tunnel 6 ft. 6 ins. high and 6 ft. wide. To the west the tunnel is 4 ft. 6 ins. high and 4 ft. wide.

Splicing chambers 6 ft. 6 ins. high, 6 ft. wide and about 15 ft. long are provided at two points, one for a future connecting shaft to the Alton-Pennsylvania cables and the other at the foot of a small shaft to the new C. B. & Q. Ry. freight house. This latter shaft is only 3 ft. in diameter, but was expensive on account of having to be built on an incline to clear the trunk sewer before mentioned. No difficulty was experienced in the small tunnel except by some of the visitors, who found trouble in accommodating 6 ft. of height to a 4 ft. head room. The joint tunnel, however, made up for all the lack of trouble elsewhere.

From start to finish, there was one thing after the other. Sand and gravel in the roof, water coming in at the top and sides, cave-ins from everywhere, but the bottom, and this at places was a swelling clay. Practically every foot had to be timbered. Time after time, a second or third cave-in would occur before the timber could be placed. And I have seen the "face" of the excavation move into the tunnel more than 2 ft. in four hours. However, it was all completed in good shape and the contractors are entitled to considerable credit for their part of the work.

Concrete was used both for the tunnel lining and for the shafts but the manholes were built of brick with an I-beam and concrete roof. The cables are placed on racks spaced 3 ft. centers and supported by clamps in the shafts. Two emergency ducts are laid under the floor of the tunnel and carried up the shafts, so that in case of trouble with one of the cables, one or two new cables can be pulled in without waiting to pump out the water. Arrangements have also been made to install an automatic pump in case of necessity.

The designs were developed in connection with Mr. W. W. Watts, now Division Plant Superintendent Western District, and the construction carried on under the supervision of Mr. C. C. Bowers, line supervisor. Mr. M. B. Wyrick is Division Plant Superintendent in whose district the work was located.

Why Some Engineers in the Service of the City of Chicago Joined the International Federation of Technical Engineers, Architects and Draftsmen

To the Editor:

There has come to my hand a copy of the June number of Municipal and County Engineering, in the very frank and enthusiastic garb of an "American Association of Engineers" issue.

Not being among your subscribers I would, in view of your evident attitude, hesitate to address you were it not for your equally frank statements that you "looked on from the side lines for a good while before deciding to cooperate with the Association," and that "since this magazine is devoted to the interests of the engineer in public service, it is our clear duty to co-operate with the Association in this work."

I assume, therefore that though your mind is evidently made up for the present as to the relation of engineers to society in general and to its governmental activities in particular, you are still open to a frank and reasonable presentation of opposing views. The three editorials, the address of Mr. Stinchcomb, the three letters pertaining thereto, and the letter and salary table from St. Louis, all present a formidable appeal, but to many of us they appear to ignore certain facts and reasonings, and it is these which I have in mind in writing to you.

I cannot attempt to separate the presentations in the various articles, but desire merely to discuss three aspects of the whole question, namely: 1. The proper attitude of engineers toward public affairs generally; 2. The much-discussed question of "professionalism" in engineering, *per se*; and, 3. The related question, the proper attitude of men in technical pursuits toward labor unions.

I wish to say that I speak, first, as a "professional engineer," in the sense of your articles, being a graduate of Armour Institute of Technology, a member of the Western Society of Engineers, and a licensed Structional Engineer; second, as an engineering employe for 13 years, of the City of Chicago, with some outside experience, and third, as a member of the Chicago Local No. 14 of the International Federation of Technical Engineers, Architects and Draftsmen.

First, then, as to the engineers, and public affairs. Neither I, in any of the capacities above mentioned nor any of my acquaintances in those groups, have any but the highest commendation for what is being proposed in many quarters looking to the recognition of the vital relation of the engineer to every public activity. As a citizen, but infinitely more as an engineer, he has a right to a voice in those matters, and as a citizen and an engineer he has a right to a material return commensurate with his ability and responsibility therein.

As to "professionalism," however, there seems to be a wide disagreement. If, as I judge, you hold that engineering from top to bottom is a "profession," then there is surely this disagreement. The great number of articles in the technical press in the last few years will certainly bear out this statement. The terms "profession" and "professional" themselves invite comparisons and yet, notwithstanding definitions, they are still so ambiguous as to make comparison almost impossible.

Although it is now true that in the so-called "learned professions," a school training and degree are required before permission to practice is granted, it was not always so. An apprenticeship to a member of the profession was formerly enough to admit a man to practice.

Engineering is perhaps the latest calling to emerge from this apprentice system, but it is emerging, as shown by proposals to license engineers in many sections of the country. When that becomes general there no longer need be any question as to the definition of "professional engineer." It will not be "one who does this or that"——but "one who has an engineer's license." Many inconsistencies may exist and many inequities, perhaps, but the title will be settled.

In the meantime, however, the hosts of young engineers and draftsmen are being urged and admonished by those older ones who have "arrived" not to forget the ideals of their "profession" nor the ultimate recognition which must come to consistent and persistent effort. The older man in his capacity of consulting engineer or manager or perhaps owner of large enterprises is interested greatly in low costs and so along with the admonition, the younger man has been receiving small pay and large promises for the future! But who has made it his business to remind the young man that he has only from one chance in fifteen to one in twenty to get even in sight of the top? And why, by the same token, is it necessary that the success of the *one* whose ambition and special fitness make him an executive, should so generally militate against the *nineteen* who are better fitted for and perhaps content with the jobs of turning out the work? *They* may be as good *engineers* as *he* or better, so far as mentality and technical training is concerned, and their work is as necessary to his success as his own.

The pith of the matter then should be in the answer to the question which you quote—"Shall Engineering be a profession or a trade?" I say it is and will be both, and especially if we accept the definition of a "professional man" proposed, I believe, by the present president of the American Association of Engineers, Prof. Newell; I quote from memory—"A professional man is one who tells a client what to do and receives for this service a fee."

If on the other hand we continue as other professions do not, to include in the profession, the wage earning, technical man, will it work out? Does the man class himself that way? Are there not thousands of draftsmen and engineers, field men, and office men who realize that *so long as they continue to do the work they are now doing in all sorts of industrial and municipal organizations, they* cannot *easily*, be distinguished from many of the groups of skilled labor? Endless attempts to make these distinctions appear invariably to fail either in reason or in actual comparisons. Great numbers of technical men realize this and realize, too, the truth of your statements that "affiliation with a national organization is highly desirable," that "They have tested to complete failure the old plan of individual effort," and that "the groups that remain unorganized can expect nothing better than the worst of it in the economic struggle."

Because they realized this, a group of Chicago draftsmen affiliated themselves, over twelve years ago, with The American Federation of Labor, knowing that they had nothing to hope for from the established engineering societies. Such groups multiplied, and while the old societies began slowly to take cognizance of the growing dissatisfaction among technical men, such groups continued to multiply, and why should they not? Because of the fear of strikes or other manifestations of organized effort? Even if it should come to this would there not be plenty of reason for it?

The editor of Engineering and Contracting, discussing this subject in the issue of Sept. 4, 1918, said "If engineers in high position are 'only human,' and therefore not always humane, engineers in low position can scarcely be blamed if they too prove 'only human,' even if in doing so they also prove shortsighted." He and many others, be it admitted, doubted the wisdom of unions for engineers, but could not deny the excuse. He says, "Tired of waiting for adequate salaries, a thousand draftsmen, many of them graduate engineers, have joined a labor union."

This is but one of four or five thousand scattered in 35 locals throughout the country but united in the International Federation of Technical Engineers, Architects and Draftsmen. Are these any less "National" in character than the American Association, which you give such great credit for that feature? You espouse the cause of the Association because "after looking on" you find it not a trade union and because being devoted to the interest of the engineer in public service, it is your clear duty to co-operate," etc.

Some of us who knew of the American Association of Engineers from its very inception, ascribe much of its success to date, to the leaven of unionism then present, and we think that to continue much longer in the esteem of the "ordinary" engineer and draftsman, it must return to those principles. Having watched at closest range, the drift of the Association toward that very "Chamber of Commerce" attitude which you so heartily approve, many of us have remained out of it. How else than with suspicion could the employed engineer view the election of a railroad president to the presidency of the Association? And how except with amusement or anger could they read the roster of the witnesses for the Association at a recent hearing before the Railway Wage Board? Their testimony has probably not been widely read but to the few who have had the privilege it is the best of evidence, not perhaps of the Association's ultimate destination, but at least of its direction of motion until very recently.

It is not, be it understood, without disappointment that we have seen this change in the American Association of Engineers, since many others than yourself "looked on from the side lines," but seeing ahead the shadow of the rock of "professionalism," stayed outside.

Quite naturally from the Association viewpoint, the action of the St. Louis engineers noted in your paper, is a notable event. When, however, 400 or 500 municipal engineers in New York, 300 in Chicago, and numerous government employes in Washington and elsewhere, besides private corporation employes throughout the country, turn to union affiliations, with a recognized international organization, is it not fully as notable in engineering annals, regardless of individual opinion as to its propriety?

Whether or not the St. Louis men have been successful in their matters, I have not heard as yet, but that Chicago Local No. 14 of the E. A. and D. U. has obtained recognition as a body and the payment of its scale, is now a fact.

I have even now trespassed on your good nature too far to permit further details of the scope and activities of these unions, but I hope you will be sufficiently "intrigued" to make other information acceptable.

Very truly yours,

Chicago, July 24, 1919. TENNEY S. FORD.

Correspondent Suggests Road Tax on Gasoline

To the Editor:

Several months ago, while sitting at lunch in the hotel at St. Catherine's, Ontario, I got to talking with a stranger about good roads and the means of raising money for them. He suggested that a tax on gasoline used in motor vehicles would be the most equitable means of raising funds. A little later, in looking through my files of literature on paving and road making, I ran across an article by Mr. Clifford Richardson, written many years ago, in which he discussed the same matter.

Some months past, I wrote an article suggesting the "Wheel Tax," which many of the magazines published. There is some analogy between the wheel tax and the gasoline or fuel tax, as both try to secure the money from the service they receive.

An annual tax on the "wheel" would not take into consideration how much the vehicle having the wheel was used during the year; while a tax on the "gas" would be in direct relationship to the actual use on the road. The more a vehicle is operated, naturally, the more gas it requires; also, the heavier the vehicle, the greater amount of gas it consumes per mile. Therefore, a tax on gas would most equitably compensate for the destructive use of the road by the owner of the vehicle.

The "gas" tax would, of course, present some difficulty. Means would have to be found for taxing vehicles not using gas; and there would surely be other flies in the ointment. One of these would be the necessity of the province or state carefully supervising the distribution of gasoline to users of road vehicles.

As the matter of raising money for road improvements seems to be the great stumbling block in the way of "good road" management and construction, it seems to me that this is a very vital issue today. I would like to see a much more exhaustive discussion on the subject of taxation for good roads than we have yet had.

Very truly yours,
C. A. Mullen,
Director of Paving Dept., Milton Hersey Co., Ltd.
Montreal, Quebec, July 17, 1919.

Civic and Engineering Features of Grade Crossing Elimination

By Allen L. Golinkin, Recently Assistant Civil Engineer, Division of Bridges and Grade Crossings, New Jersey Public Utility Commission, 1105 S. Richmond St., Chicago, Ill.

A grade crossing is generally understood to mean the crossing of a railroad by a highway at the same level. The term is also applied to the crossing of one railroad by another railroad at the same level.

During the period when railroads were first constructed in this country it was neither practicable nor economically possible for either the railroads or the communities through which they passed to pay great attention to the matter of grade crossings. Later on when these sparsely settled communities grew into villages and afterwards developed into cities the necessity for protecting and eliminating grade crossings became more and more acute until of late years no single question affecting the relation of cities and railroads has received more attention. Like many another important matter of this character interest in the subject has lagged during the war but the fact remains that the question of separation of grades in cities and towns is vital and there is every reason to believe that it will receive considerable attention as soon as our internal conditions again become normal.

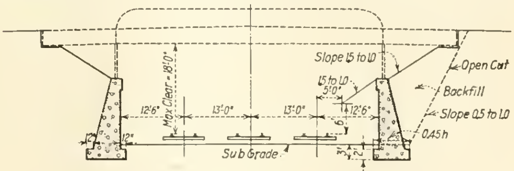
The history of the work of systematically eliminating grade crossings possibly dates back to the early eighties but it is only within the past 20 years that it has been the subject of much discussion and study. A striking amount of grade crossing elimination work occurs in Chicago where it is reported that over 800 grade crossings were eliminated up to 1912. Unquestionably this large number of crossings was necessitated by the low topography of the City but large numbers of eliminations are also reported for New York. Philadelphia also claims over one hundred to its credit and Buffalo over ninety. Despite this apparent activity dangerous grade crossings are still numerous, especially in the smaller cities, and much remains to be done in this matter.

Civic and Engineering Phases of the Problem

The problem of eliminating grade crossings can roughly be divided into two phases—the civic and the engineering. By the civic phase I refer to the agitation of the citizens of a community for the elimination of dangerous grade crossings within their community. Without going into a full discussion of this phase of the problem it appears that the final success of such agitation depends, in the last analysis, upon the attitude of the people towards human life. To the people of a town or city who are honestly convinced that the payment of a little additional tax or the disturbance of a few property values are minor items compared with the saving of human life there is practically nothing in the way of obtaining complete protection on all crossings and the elimination of the more dangerous ones. While this is purely a civic problem and has little direct bearing on the engineering phase, it does have some connection with it insofar as the agitation of the people must take a concrete form in partially financing the cost of the engineering work involved.

From the engineering standpoint I believe it is generally agreed that some method of grade crossing elimination can be worked out for any situation. This, however, does not mean that the engineering treatment of a grade separation is always a simple problem, but only that the difficulties encountered in topography, right of way trouble, and damage to property are rarely insurmountable. Given a competent engineer and sufficient funds it then follows that any grade crossing can be eliminated.

Unfortunately the elimination of grade crossings is not financially profitable either to the railroad or the city. Even



SUGGESTED SECTION FOR RAILWAY TRACK DEPRESSION SCHEME PERMITTING PASSENGERS AN UNOBSTRUCTED VIEW TO ORIGINAL GROUND LEVEL.

stressing the considerations of resulting convenience to the traveling public, the aid in the industrial development of the community, and the saving of time in both railroad and highway traffic, the fact remains that neither party can receive a financial return commensurate with the large amount of money expended.

Engineering Treatment of Grade Crossing Elimination

The following discussion includes some of the more general matters considered by the engineer in studying a grade crossing elimination project.

There are six methods by which a grade crossing can be eliminated:

(1) To leave the tracks at their original elevation and carry the street over them.

(2) To leave the street at the original elevation and carry the tracks over it.

(3) To leave the tracks at their original elevation and carry the street under them.

(4) To leave the street where it is and carry the tracks over it.

(5) To lower the street below the original elevation and raise the railroad.

(6) To raise the street above the original elevation and lower the tracks.

The last two methods noted are modifications of the first four and might be included in them.

In the choice of a final method for separation of grades there are many considerations but often one big element such as topography, geological conditions, or permissible railroad grade will definitely settle the scheme of treatment allowing for little choice in the other affecting matters. An instance occurs in Chicago where the ground is low and level, making depression absolutely out of the question on account of the interference with sewer and water systems, thus leaving the only alternative, elevation or partial elevation. However, there are many situations where grade separations are studied that allow for a wider choice, places located at the summit of ascending grades where depression might be used and again in level localities high above water where all elevation and depression methods can be considered.

In the preliminary study of a grade crossing project the following points should be given serious and constant attention.

(a) If practicable railroad grades should not be made excessive and due regard should be given the railroad to take advantage of the changes for promoting operating economies.

(b) Attempts should be made to benefit street traffic in addition to eliminating delay at crossings.

(c) Care should be exercised in creating a minimum of property damage and the usual currents of traffic should not be seriously diverted. In this connection it is well to keep in mind the fact that all property damage is chargeable directly to the cost of the grade crossing elimination.

(d) Since construction work on grade separation projects usually requires considerable time, attention should be paid to the inconvenience that will result to street traffic during the period. The frequent necessity for completely stopping both street and railroad traffic or building a detour around the entire project when depressing the tracks may often make this method inadvisable.

Other considerations of varying importance which invariably enter into elimination projects include the matter of resulting convenience to the traveling public in the arrangement of stations, elements affecting the industrial development of the community, and finally the aesthetic considerations which from the very nature of the project should receive full attention.

The number of crossings involved in the grade crossing elimination study is another element which has an important bearing on the method finally decided upon. In the case of a single crossing it is usually impracticable to change the railroad grade, for this would cause a hump in the grade line with long approaches and great expense, while the method of raising the street over the railroad track could be done much more effectively. In the case of a city or a thickly settled community where a number of crossings would probably be involved the plan of depressing or elevating the tracks and leaving the street grades alone would probably be the better scheme.

Excavation, Bridges, and Change in Street Grades

The subjects of excavation, bridges, and change in street grades are the specific problems involved in a grade separation study and are given special attention by the engineer.

The matter of excavation or fill is usually the ruling factor in estimating the cost of a grade crossing elimination project. To carry the tracks over the street requires a vertical separation of grade of from 16 to 18 ft., allowing for a depth of bridge floor of from 3 to 4 ft., and headroom of from 13 to 14 ft. To carry the street over the tracks requires a vertical separation of grades of from 22 to 26 ft., allowing from 18 to 22 ft. for clearance and 4 ft. for floor depth. In cases of depression the roadbed must also be wider because of the necessity for drainage. Considering the difference of from 5 to 10 ft., in vertical separation of grades for these two plans and the additionl item of increased roadbed makes the total quantity of material involved in the depression scheme considerably greater than that required for elevation. While additional cost of trestle in the elevation scheme and other items such as bridge costs, maintenance of traffic, and the nature of the material to be excavated may sometimes indicate in favor of the depression plan the larger item of reduced yardage will, in the majority of cases, overbalance them. The advantage of noninterference with sewers, water pipes and public service lines also counts materially in favor of the elevation plan.

Bridges for track elevation or depression are now made of steel or concrete, present practice being in favor of the latter, because it lends itself to better advantage of aesthetic treatment. The three general classes of structures used for track elevation are:

(1) Bridges spanning the entire width of the street with a single span.

(2) Bridges spanning the width of the street with two spans, a support being placed in the center of the street.

(3) Bridges spanning the street with three spans, one support at each curb line.

In all types the designer aims to obtain a structure which allows for a thin floor, the avoidance of any projection above the floor which might interfere with safety, and a form that allows for easy alteration in case additional track space is required. In the first type of bridge the arch can be used to good advantage. Bridges of the type having a support in the center of the street, have the objection of obstructing the roadway, which is most serious in the case of a boulevard, where it forms a barrier to the traffic and mars the appearance of the road and least objectionable on a street having a double car track where the space between the tracks itself tends to form a natural barrier between the traffic on both sides of the street.

In eliminating crossings the necessity often arises for changing street grades which in turn brings up the problem of allowable street grades, drainage, and interference with sewer, water and gas mains. Many cities have maximum grades fixed by ordinance ranging from as low a permissible grade as 3 per cent. (in Chicago), to 8 and 9 percent. in hilly cities like Washington, D. C., and Brockton, Mass. The general plan in most cities, however, is to keep the grades below 5 per cent.

In studying the effect of complete elevation or depression on a contemplated separation of grades the question often arises as to the advantage of partial elevation of the street or a partial elevation of the street with partial depression of the tracks. In practically all cases a slight change of 1 to 3 feet can readily be made in the street without causing serious property damage, expense or interference with view. This plan, however, is sometimes used to a real disadvantage where an attempt is made to obliterate the effect of a so-called "Chinese wall," by dropping the street elevation 4 or 5 feet. The dropping of 4 or 5 ft. on the street may often break up that desirable feature of continuity of view on the street without really changing the effect or appearance of the wall.

In carrying the street under the tracks it is sometimes possible to carry the roadway under at a lower elevation than the sidewalks. The difference in elevation between the sidewalks and the roadway may sometimes be made as much as 4 or 5 ft. at the deepest point, which allows for a maximum of clearance in the roadway where it is most desired.

Whenever streets are depressed suitable catch-basins should be placed with proper connections to sewers. Similar arrangements must be made when the tracks are depressed. Where streets are depressed so much as to interfere with the existing sewerage system the problem becomes serious and calls for either the designing of a new sewerage system or the use of a siphon, both of which add tremendously to the cost of the project.

Comparison of Elevation and Depression Methods

Since the application of complete elevation or complete depression schemes still remains an open question in many situations, it might be well briefly to examine into the outstanding advantages and faults of each.

The elevation of railroad tracks over the street allows for more efficient railroad operation in so far as it requires no structures that might interfere with the proper display of signals. Elevation also makes it easier to keep the track clear of snow and avoids the necessity of providing difficult and costly methods of drainage.

In matters affecting the damage and inconvenience to adjoining property some difference of opinion still exists as to the relative advantage of fill or cut. In cases of depression it is clear that the locomotive smoke is discharged at street elevation which certainly causes a more decided nuisance than would occur were the smoke discharged at a considerable distance up as would be true in elevation. Again, the puffing of the locomotive which is responsible for most of the objectionable noises of a railroad is less noticeable on an elevated track. However, the "Chinese wall" effect of an elevated structure is an eyesore and is considered more objectionable in some localities than the noise and smoke.

With reference to construction, experience has proven that it is easier to elevate railroad tracks than to depress them, and that the inconvenience that results at street crossings during the period of construction is much less serious when the former method is used.

As to the relative merits of the two schemes in so far as the traveling public is concerned, the elevation method offers a perfectly free and unobstructed view, while most depression plans result in poor light, air and view for the traveler. If sufficient space exists this objection to the depression plan can be overcome to a large extent by using the section indicated in the accompanying figure. It will be noticed in this sketch that from a point 6 ft. above the track and 5 ft. from its center line (about the location of the passenger's eye in a coach), a 1½ line of sight exists to the top of the wall from which a 1½ earth slope is then carried to the street elevation. This results in a full light from the street to the coach window and allows for an almost unobstructed view and good air circulation.

With the item of expense again on the side of the elevation scheme, as pointed out in the discussion under excavation, and the additional advantages present in the foregoing factors, the elevation method of grade crossing treatment seems to be the better plan.

Lack of Expert Engineering Advice in Paving Matters Costs the Public Vast Sums

By Hugh W. Skidmore, Chicago Paving Laboratory, Consulting and Inspecting Engineers, 160 N. Wells St., Chicago, Ill.

Observation of actual conditions reveals the fact that far too many pavements are either badly designed, or that the best paving materials have not been chosen, or both. The steady increase of frequency and weight of motor-driven traffic has rendered this fact more apparent in recent years. It is also true that evidence of these short-comings is more noticeable in the smaller cities, villages and counties; due no doubt to the fact that expert advice is more frequently lacking here than in the larger cities and highway departments. Thus, local officials become easy prey to the promoter who is able to paint the rosiest picture.

Notwithstanding the fact that matters relating to paving and other public improvements are usually in the hands of boards of commissioners, or similar bodies, the members of which rarely have had any experience in such works, it is quite common to find that these bodies are averse to the employment of experts, and will often even refuse to heed the counsel of the local engineer. In general, this attitude is due to ignorance of the actual economy of expert service. It is not at all uncommon to find these men of the opinion that outside assistance is entirely unnecessary. In communities where this spirit prevails, the worst failures are most frequently found, and the poorest engineering is evidenced. Another class is that which will admit the advisability of employing the services of an expert (the cost of whch is always ridicuously small when compared with the cost of the prcject), but fear an avalanche of public protest would follow such an innovation. The local boards which do not regard with suspicion a proposal purporting to supply the necessary means of safeguarding the public investment represent a decided minority; yet it is doubtful whether anyone of the members thereof maintain the same feeling toward the employment of a first-class attorney to advise him regarding a business transaction representing a few thousand dollars, nor would he hesitate to seek the counsel of a physician even for a slight or imaginary complaint. The difference seems to be that the average man has not yet learned that he can ill afford to do without the services of an experienced engineer. Or, perhaps, it may be partly due to the fact that public funds (everybody's and nobody's money) is involved, and the expenditure thereof is not entirely free from the taint of politics.

A dissertation on the short-comings of the local administration of public improvements is not intended, but it is thought that perhaps one very serious obstacle in the path of proper education of the public, regarding the need and wisdom of employing sound engineering experience where it is needed, is here represented. The problem seems rather difficult of hasty solution, yet it is a most serious one, because vast sums of the people's money is invested annually in pavements. This expenditure should, and must be, properly safeguarded. More money is spent each year for paving and road building than for any other one item of public improvement, and there seems to be slight doubt that some of it is unwisely and improperly spent.

Federal and State aid will undoubtedly have a material effect in relieving the situation. Under the expert supervision of the engineers on these projects, good construction will follow, thereby setting an example. But this will not necessarily prove a cure; unscrupulous material men and contractors will still have many fertile fields. It is rather surprising in this day of enlightened business methods to find even a few material salesmen and contractors who seems to have entirely lost sight of the well known fact that the game must be played pretty much on the square, if one expects to continue doing business. Promoting by educational methods is efficient, also beneficial. A good job well done, a good article at a fair price, advertise themselves; but unfair methods, misrepresentation, calumniation of the others fellow's goods, cheating the job, unreasonable prices, etc., all contain the seed of self-destruction, and will ultimately ruin the habitual user.

Engineers are not altogether blameless in many instances. Often they have been given too much to the seeking of a convenient door through which they might gracefully retire from a bad situation; too often have they lacked the courage to raise their voices above a weak protest; entirely too often for the public welfare and the good of the profession, have capable engineers, experts in their line, stood aside and let some inexperienced local engineer go through with, or attempt to put through, a job, when they could have had the job for the asking, thereby giving the community a good piece of work instead of a poor one, and at the same time, providing the local engineer the best possible opportunity of enhancing his own education.

The employment of a special engineer to render expert service will in no way interfere with the duties of the local engineer, since under such an arrangement, he usually serves as resident engineer. The duties of the engineer in the small town or average county cover a wide variety, such as drainage, sewerage, water supply, surveying, paving, lighting, parks. etc. Ordinarily such communities cannot afford the expense of employing a man with very extensive experience along so many lines. Therefore it is only logical that such communities continue to employ less experienced engineers at fair salaries to handle the general run of engineering work, and then employ special engineers on special work.

Before the situation can be entirely cleared, the laws in many localities will have to be revised, e. g., laws which provide that property owners shall select the materials and type of construction, regardless of the opinion of the engineer, simply create the greatest opportunity in the world for the promulgation of the propaganda of quacks. It is not advocated that the taxpayers be refused a proper hearing in such matters, but, for the general good, engineers generally must have more to say regarding matters their training and experience qualifies them to deal with.

It appears that the quickest and surest way out lies in the hands of the engineering profession. By increased activity in civic affairs and educational effort the general public must be converted. A start has been made by certain organizations —the work must continue—and it deserves the unqualified support of the entire profession.

Results of Two 24-Hour Tests of Two Riensch—Wurl Sewage Screens at Dyckman Street, Manhattan, New York

To the Editor:

You may be interested in the results of two 24-hour tests made in cooperation with the Department of Public Works of the Borough of Manhattan (represented by Mr. C. E. Gregory, Engineer of Drainage and Sewage Disposal) of the two Reinsch Wurl screens for sewage recently installed at Dyckman street. The test data follow:

	Screen No. 1	Screen No. 2
Width of Slot	3-64 in.	1-16 in.
Speed	0.5 R.P.M.	0.436 R.P.M.
Day of Week	Mon.-Tues.	Wed.-Thurs.
Flow	1,687,700 Gal.	1,554,500 Gal.
Raw Sewage—		
Suspended Matter	137 P.P.M.	122 P.P.M.
Settleable Solids	100 P.P.M.	78 P.P.M.
Screened Sewage—		
Suspended Matter	101 P.P.M.	102 P.P.M.
Settleable Solids	64 P.P.M.	58 P.P.M.
Removed by Screen—		
Suspended Matter	36 P.P.M.	20 P.P.M.
Settleable Solids	36 P.P.M.	20 P.P.M.
Screenings—		
Moisture	78.5%	81.7%
Dry Material	21.5%	18.3%
Ash (Dry Basis)	14.1%	9.1%
Volatile Matter	85.9%	91.9%
Volume	38.32 Cu. Ft.	25.88 Cu. Ft.
Volume per Mg.	22.7 Cu. Ft.	16.65 Cu. Ft.
Weight	2,132 Lbs.	1,443 Lbs.
Weight, per Mg.	1,264 Lbs.	928 Lbs.
Weight, per Cu. Ft.	55.6 Lbs.	55.8 Lbs.
Removal of Suspended Matter..	26.3%	16.4%
Removal of Settleable Solids...	36.0%	19.6%

There was a short sharp, shower between 12 and 12:30 P. M. on June 9th but this does not appear to have had a marked effect on the day's run.

Other shorter tests confirmed the superiority of the 3/64-in. slot over the 1/16-in. size for this sewage. Also, that the screenings generally contained about 80 per cent moisture and weighed about 55 lbs. per cu. ft. It will be noted that the quality of the screened sewage in the two tests was not very different.

The loss of head was about 0.25 ft. with the 3/64-in. screen and but a tenth of that with the 1/16-in. screen but this small loss was no doubt due in part to the fact that the flow was only one-third of the screen capacity.

KENNETH ALLEN,
Municipal Bldg., New York, July 29, 1919. Sanitary Engineer.

Procedure in Making Tests of Effect of Motor Truck Traffic on Road Surfaces

By A. T. Goldbeck, Acting Chief, Division of Tests Bureau of Public Roads, Washington, D. C.

In view of the present uncertainty regarding the manner of procedure in the design of high types of road surfaces to withstand heavy truck traffic, the Bureau of Public Roads and Rural Engineering has started several series of investigations to determine: (1) the amount of impact delivered to roads and, (2) the effect of this impact upon different types of road surfaces. Having determined the amount of the impact delivered by trucks of different sizes the same impact will be delivered to specially constructed road slabs with the idea of determining how much impact different types of road surfacing will withstand before failure takes place.

The manner of procedure in determining the amount of impact is to allow trucks of different sizes and weights, fitted whenever possible with both solid and pneumatic tires, to drop on a plunger fitted in a hydraulic jack. The blow of the impact is delivered to a specially prepared copper cylinder and this cylinder is deformed a definite amount depending upon the impact. Similar cylinders are tested under static loads in order to see how much static load deforms the cylinder the same amount that it is deformed by impact.

In order to determine the effect of this impact on high types of road surfacing a large number of slabs have been constructed: (a) on a soft subgrade and, (b) on a well drained subgrade. A machine has been built designed to approximate the conditions on the rear wheel of a truck. This machine consists of a weight approximating the unsprung weight of the truck and supporting on a large spring another weight designed to approximate the sprung portion of the weight of the truck. These weights are allowed to fall repeatedly on the center of the slab until failure ensues. The impact required to break the slab to an amount which would make it a practical failure will be determined.

It is the idea to fit motor trucks with a special device to determine the roughness of different road surfacings so that the amount of impact delivered to the surfacings may be determined. Using the above outlined series of tests as a basis it should then be possible to state how much impact or what volume of certain classes of traffic a road of a predetermined type of surfacing will be able to carry when the subgrade is of a definite character. In other words, the whole idea is to gain sufficient data to permit of the design of high types of road surfacings to withstand heavy truck traffic.

The Selection and Use of County Road Machinery

By J. R. Johnson, Division Engineer, Kentucky Department of Public Works, Pineville, Ky.

The development of road machinery has enabled us to meet the demands of the times, said Mr. Johnson in his address during Road Builders' Week at the University of Kentucky. Road machinery is a development, not a discovery. During the past four decades the advance from hand-tools to the modern road machinery has been rapid. The law establishing the labor system for maintaining public highways in Illinois, enacted in 1879 enumerates the various implements that overseers may require to be furnished as follows: spades, shovels, axes, hoes, plows and a yoke of oxen or a team of horses or mules. This indicates about the equipment which at that time was deemed necessary for highway work. Compare this primitive equipment with the elaborate machinery used today and you will find an explanation of the great superiority of present day roads.

Use Care in Selecting Equipment

One of the first steps to be taken by a county entering upon road construction should be to supply itself with an outfit of machinery adapted to its especial needs and conditions.

The selection of machinery of this kind is attended by many difficulties; pictures in catalogues can be made extremely alluring and traveling representatives of manufacturing houses are often equipped to outrival Demosthenes in tricks of persuasive oratory. Members of fiscal courts are often not versed in the subject and are in danger of falling easy prey to artful salesmen. We must, therefore, not accept without reservation the claims made for certain machinery and for some so-called modern improvements. When we are told, for instance, that a certain machine will send all the drag and wheeled scrapers to the junk pile, we should not exert undue haste in disposing of these useful articles.

However, it is hard to overestimate the value of the modern machines. Take away all the machinery made especially for road construction and our present enthusiasm would suffer a serious abatement. A proposed construction that looks almost impossible when contemplated from a pick and shovel viewpoint, becomes easy when the steam shovel begins to walk through earth, stumps, roots and rocks in its superhuman march over the road which it makes as it goes.

Since the value of machinery is universally recognized, and since its selection is so important, any county runs much risk in leaving purchase to inexperienced men; the necessity for the advice of trained experts in this, as in other lines of big business, is apparent.

I would, therefore, suggest that before any money is expended, each county contemplating road construction or improvement should provide itself with a duly qualified engineer, who shall be competent to advise the fiscal court in the expenditure of its money as well as to supervise and direct the location and construction of its roads. He, to my mind, is by far the most important and valuable of all road machines; he is the head of the system, the dynamo which will furnish power and direction to all subsidiary machinery. His wise advice will prevent disastrous mistakes and useless waste of the taxpayers' money.

Factors Influencing Selection of Equipment

The purchaser of equipment for a given county must be governed: First, by the kind and amount of road to be constructed or repaired; second, by the availability of contractors and, third, by the ability of the county to pay for it. While it is not likely that the fiscal court of any county and the fiscal court succeeding it in office would recommend or select anything like the same equipment for the county, I have confidence enough in the engineering profession to assure me that two competent engineers would select practically the same outfit.

Let us consider two counties, side by side, and as nearly identical as possible in the amount of road already built and in their requirements for the future. The first has a good working organization that has been handed down from one fiscal court to another, while in the other, the roads have always been constructed and maintained by the brothers and cousins of its squires and the grandchildren and nephews of the county judges. The first county will need a good machinery outfit, while the other needs absolutely nothing but a pen and ink with which to sign contracts till its citizens become capable of self-government.

In discussing county road machinery at this time, I take it that the most important phase of the subject is county owned machinery. How much and what kind of road building equipment should this county or that county own? And I feel that I am justified in omitting from consideration special equipment for concrete, brick, asphalt and wood block roads since these are not much in evidence in our state.

Contract Method Favored

The machinery outfit for any county should include apparatus for a moderate amount of construction as well as adequate equipment for maintenance; the latter being of far more importance than the former. As a rule, original construction should be done by contract. The less in force account work by counties is far in excess of a reasonable profit for a contractor. As evidence of the economy of contract work, we note that most railroad construction is done in this way. Since most of the machinery needed for construction is the same as that needed for maintenance, little in addition to good maintenance equipment will be needed for a moderate amount of construction.

Counties that have progressed properly in road building need little advice in the purchase of machinery, since they have learned to entrust such matters to the judgment of experts. In discussing this subject, I therefore have in mind constantly those counties in which road construction is in its infancy.

Influence of Local Conditions

The necessities vary widely in different sections and are controlled almost entirely by local conditions. It is therefore difficult, I might say, impossible, to prescribe machinery equipment that would be equally useful everywhere.

Graded Earth Roads

Counties having graded earth roads only should be liberally supplied with small tools—plows, dragscrapers and wheeled scrapers, one ditching plow, one heavy grader, one light grader, one 10-ton roller, one 3-way drag and a single drag for each 6 to 10 miles of road in the county. While the roller is not essential for earth roads it is very valuable in compacting new construction as well as on roads where considerable repair work has been done. If one of the two graders is to be dispensed with, it should be the light one. In the most progressive counties, where earth roads are oiled, an oil-sprinkling wagon would be necessary. The county engineer who fails to demonstrate in his county the best methods of maintaining earth roads is not worthy of the name, and to do this, he must have the proper outfit for maintenance.

Waterbound Macadam Roads

Since all counties will have some earth roads to construct and maintain, those having waterbound macadam roads chiefly will need the same equipment as those having earth roads only. For these counties we should add to the above list a sprinkling wagon of 300 to 500 gals. capacity, a scarifier or a scarifier attachment for either the grader or the roller. If the financial conditions permit, it is desirable to have two rollers instead of one, a few 2-ton dump wagons and one or two motor trucks of 2 to 3-ton capacity. Where available material for macadam surface is to be found a complete quarry and crusher plant should be provided. This may be portable or stationary, depending upon the distribution of the stone in the county. It is well to have the facilities for the transportation of stone from crusher to the road, divided between wagons and trucks, as it is sometimes advisable to use one and sometimes the other, and when necessary both can be used together.

Gravel Roads

Counties having gravel roads will need the same equipment as those having waterbound macadam, except that the quarry outfit would need to be replaced by a gravel screening plant. In the construction of gravel roads the practice all too general has been to take the gravel just as it was found in the pit, without any screening, and use it for surfacing the road. One objection to this procedure is that too much sand often occurs in the gravel, to give the road surface good wearing qualities. A second objection is that where gravel deposits carrying any considerable amount of large pebbles are put on the road without screening, the large pebbles are found showing through the surface of the road after a little wear; these are soon loosened by the traffic and the result is that the road soon begins to deteriorate.

Bituminous-Bound Roads

A county having bituminous-bound roads of any description will need all the tools and machinery heretofore suggested. In addition, I should recommend only the appliances necessary for maintenance, because it is even more desirable that roads of this type should be originally constructed by contract, than those of simpler construction. For the maintenance we would need a 500 gal. pressure road oiler, suitable for either hot or cold application, a rotary road-sweeper, suitable boiler for heating a tank car and a heating kettle on wheels.

In addition to the plants already outlined, many pieces of machinery may be needed in road construction which have not been mentioned and which under some circumstances should be owned by the county. A steam shovel is a great time and money saver where it can be used to advantage. A concrete mixer is very desirable where there is enough concrete work to warrant its use. Under ordinary circumstances, however, these machines can be leased or worked by contract rather than be owned by the county. Many appliances not designed particularly for road construction are used for special purposes, but need not be given a place in the discussion of road machinery.

The Care of Machinery

I would feel that I had neglected a very important phase of this subject if I did not say something about the care of the machinery after it has been selected, purchased and used. It is the duty of the county road engineer to care for the machinery and tools belonging to the county, as witnessed by Section 49, Chapter 80, Acts of 1914, part of which reads as follows: "All road machinery shall be under the care of the county road engineer, and shall be cared for by him, at the expense of the county to which they belong. He shall cause to be made annually a written inventory of all such machinery, tools and implements, indicating each article and the value thereof; also the necessary cost of repairs thereto and deliver the same to the County Clerk of the county on or before October 1st, in each year, and shall, at the same time, cause to be filed with the County Clerk his written recommendation as to what machinery and implements should be purchased for the use of the county, and the probable cost thereof; he shall provide a proper place or places for housing and storing all machinery and tools, and implements owned by the county and cause the same to be stored therein when not in use." In this connection, a very urgent duty of the custodian of the county's equipment is to keep it in repair. Nothing more strongly proclaims the worthlessness of a county engineer than the fact that his machinery is not kept in repair.

Instructions Governing the Sampling and Inspection of Road Making Materials in New Jersey

Instructions governing the sampling and inspection of road-making materials for the guidance of the inspectors of the New Jersey State Highway Department were recently prepared by Wm. G. Thompson, State Highway Engineer, and are given herewith:

Whenever an inspector is assigned to a job, he will notify the laboratory at once, giving his name, official title, present address, name, location and type of pavement or road, name of contractor, name of resident, county or division engineer under whose jurisdiction the work is to be performed. The inspector will secure as soon as possible from the contractor the source and location of the various materials that will be used. He will notify the laboratory at once, giving the source and location of such supplies. When the materials are purchased from a producer, give name and address of said producer, method of shipment, and source of supply; when produced by the contractor, give location of pit or quarry and method of shipment.

Inspector's Equipment—Each inspector will be furnished with report blanks, stationery, sample bags, shipping tags, and the apparatus needed to make the field tests required. The inspector shall secure this equipment before any pavement has been constructed. This equipment is charged to the inspector, who is responsible for its proper care and return to the laboratory when the work is completed. Equipment that is lost, injured or broken, will have to be replaced at the inspector's expense, unless the inspector is in no way responsible for said loss or damage.

Size of Samples Required—The size of the first samples sent of each material shall be as follows:

Portland cement—½ of a large sample bag full.
Sand—2/3 of a large sample bag full.
Stone or gravel—1 large sample bag full.
Brick or asphalt block—15 bricks or blocks.
Granite block—2 blocks.
Fillers for bituminous pavements—½ small sample bag full.
Bituminous cements—1 quart can full.
Liquefier—1 gal. can.

The size of all subsequent samples of these materials shall be as follows:

Portland cement—2/3 of small sample bag full.
Sand—2/3 of small sample bag full.
Stone or gravel—1 small sample bag full.
Brick or asphalt block—1 block of each.
Granite block—1 block of each grade.
Fillers for bituminous pavements—½ of small sample bag full.
Bituminous cement—1 pint can.
Bituminous pavement samples—8 to 10 in. square.

Note—No samples need be forwarded of materials used in macadam or gravel pavements unless the inspector is in doubt whether these materials meet the requirements of the specifications, in which case samples of same should be forwarded in the usual manner.

Samples of Raw Materials Required Before Construction Starts — Samples of such materials as the inspector has to sample shall be secured before shipment if possible, otherwise sampled at once when the material arrives at its shipping destination.

Whether a material has been previously sampled or not, a sample shall be taken from the first shipment of all Portland cement, sand, stone, gravel, bituminous cement, fillers and paving blocks and forwarded to the laboratory. Duplicate samples of sand, stone or gravel shall be taken at the same time and kept by the inspector for reference until the work is completed.

Samples Required During Construction

Portland Cement—A sample shall be taken and forwarded to the laboratory of each car received, and the cement represented by the sample not approved for use until a report is received from the laboratory permitting its use, unless the said material has been previously sampled at the point of shipment or manufacture by the laboratory force. When thus sampled by the laboratory, the inspector shall examine the car and see that the seal is intact, but no approval shall be given by him for the use of this material until a report has been received from the laboratory permitting its use. He will, however, report to the laboratory at once the arrival of all cars thus sealed. The seal used on all cars thus sampled will be marked with a lead seal, bearing the inscription, "N. J. S. R. Com." The entire sample should be taken from one bag usually near one end of the car. It is well, however, to occasionally take the sample near the car doors.

Sand, Stone and Gravel—The inspector shall compare each consignment of sand, stone and gravel with the first approved sample. In case any of these materials do not appear to be of as good character or quality as the first sample approved, and the results of the field test subsequently made indicate it is of inferior quality, a sample shall be taken and forwarded to the laboratory at once. A regular sample shall be taken from every 10 or 15 cars of sand received and forwarded to the laboratory regardless of its quality or character.

If the consignment to be sampled is of uniform appearance and grading throughout, one sample may be taken to represent the entire shipment. This sample shall be taken at various points and mixed by rolling on newspapers or canvas. After thorough mixing and so manipulating the paper as to bring the material to an evenly rounded pile, take one-fourth of the sample and with this proceed as before until the quarter last taken is of the proper size for tests. If the consignment to be sampled is not uniform in appearance, then a complete sample must be taken and tested from each grade contained in the shipment.

Paving Block—Samples of paving block shall be taken during construction only when the quality does not appear to be as good as that of the approved sample, in which case a single block will be mailed to the laboratory for examination.

Bituminous Cement—A sample shall be taken from each carload received and forwarded to the laboratory at once, and the material represented by the sample not approved for use until a report is received from the laboratory permitting its use, unless the material has been previously sampled at the point of shipment or manufacture by the laboratory force. When thus sampled by the laboratory the inspector shall examine the car and see that the seal is intact, but no approval shall be given by him for the use of this material until a report has been received from the laboratory permitting its use. He will, however, report to the laboratory at once the arrival of all cars thus sealed. The seal used on all cars thus sampled will be marked with a lead seal bearing the inscription, "N. J. S. R. Com."

When shipment is made in tank cars, the sample should not be taken until the material in the car has been heated and agitated sufficient to make it uniform in composition. If shipment is made in box cars, a sample must be taken from each lot or batch present as indicated by the batch or lot numbers on the head of the drums or barrels. Additional samples must be taken during the use of all bituminous material whenever the inspector has any reason to believe the cement is not of normal consistency or of an inferior quality as may be indicated by the general appearance of the paving mixture or pavement constructed therefrom.

Bituminous Pavement Samples—A pavement sample shall be taken of the pavement completed each day, such as warrenite, topeka, amiesite, sheet asphalt, etc. This sample shall be about 8 in. to 10 in. square and shall not be taken until the pavement has received its final rolling, but should be cut out before the pavement has chilled when it belongs to the hot-mixed type. In case a squeegee coat is required, a place shall be left unsqueegeed and the sample taken at this point.

The inspector at the mixing plant will sample, examine or test, in the matter herein designated, all materials used in preparing the pavement, keep a record of batches prepared each day, the number of loads delivered to the street or road, take the temperature of each load and note the general appearance and character of the paving mixture, also see that the asphalt cement or mineral aggregate is not heated above the limits permitted by the specifications. The maximum and minimum temperatures to which these materials were heated should be recorded and reported each day. Whenever a definite weight of paving material has to be used per square yard of surface pavement, the inspector at the plant will also keep a record of the weight of materials used therein. When materials come from a local sand or gravel pit, the quantity received per day of each shall be roughly estimated.

Paving mixtures that are improperly mixed, have been overheated, or do not have the minimum temperature required by the specifications, or are deficient in asphalt cement or filler, shall be condemned at the mixing plant and the inspector on the road notified to this effect.

The inspector on the road or street will keep a record of each load of paving material received, take its temperature, note its general appearance and report the total number of loads received each day, also observe whether the mixture is of proper consistency to be easily handled when dumped, observe how it consolidates during rolling and note the rapidity with which the rolling is executed after the material has been spread, also whether the rolling is continued until no further evidence of compression is evident. When mixtures are received that do not have the required temperature, are not fairly uniform in composition, or show evidence of careless preparation at the mixing plant, they shall be rejected as soon as the material is dumped and before it has been spread on the road. Special care must be taken to see that no depressions or waves are formed during rolling.

In additon, the foundation should be very carefully examined as the pavement is being spread, and any places that appear to not have the proper density or stability, or appear to be improperly drained, or have been recently rebuilt should be recorded on the daily report blanks. All such reports should be indicated by both the station number and land marks. The pavement samples shall also be taken and forwarded by the inspector on the road. The location of each sample shall be designated by the station number and also a land mark whenever possible.

When bituminous mixtures are purchased by the ton ready for use, the weight of each load shall be taken and recorded by the inspector on the road in addition to the other requirements specified above, and the total quantity received each day recorded.

Concrete Test Cubes—A 6-in. cube shall be made for each 1,000 sq. yds. of finished concrete surface or foundation, and for each 150 cu. yd. of concrete used in retaining walls, bridge abutments, etc. They shall be taken at proper intervals to space them at approximately equal distances apart. An additional cube shall be made whenever a mix appears to be unusual in any respect, such as exceedingly wet, improperly mixed, etc. In making the cubes, the inspector will proceed as follows:

See that the equipment is in proper order. The mold should be set on base and leveled carefully. See that it is securely fastened together and that inside surface is thoroughly coated with oil (either heavy lubricating or light cylinder is good).

Fill the mold full of concrete and puddle thoroughly with a steel rod ¼ in. to ½ in. in diameter. The greater part of puddling should be done around the outer edge near the sides of the mold, being careful not to scar the inside surface of mold when pushing rod down into concrete. When properly puddled the cube will be practically free of voids. After puddling fill mold to top again and trowel smooth and level with top of mold.

Place a piece of board or heavy canvas over top to keep off rain or hot sun.

About 24 hours after making, remove mold and mark plainly on side of cube sample number and date made. The inspector will then immediately clean and oil the mold for the next fill.

Place the cube in water and leave it there for six days, after which remove cube from water, wrap in wet newspapers, place inside container and ship to the laboratory.

The same inspector shall make the cubes in all cases to insure uniformity of tamping and other conditions.

It is essential that the above rules be closely followed to insure uniform conditions in making, storing and shipping; otherwise, the concrete cube is worthless for testing purposes.

Forwarding and Reporting Materials—Samples forwarded either before or during construction must be numbered and plainly marked with the name of the material, road, route or job, and the inspector who forwarded same. All samples forwarded of each material must be numbered consecutively, i. e., Portland cement would be marked 1, 2, 3, etc.; bituminous cement, 1, 2, 3, etc.; pavement samples, 1-P, 2-P, 3-P, etc., unless more than one pavement sample is taken of the pavement laid during any one day, in which case both samples will have the same general number but given different index numbers, thus, 7-P1 and 7-P2 would indicate that both samples were taken from the pavement laid during one day. Whenever paving-mixture samples are forwarded, they shall be marked 1-M, 2-M, etc., if the pavement is laid in one course only; if laid in two courses, they should be numbered 1-BM, 2-BM, for bottom-course samples, and 1-TM and 2-TM for top-course samples.

A separate report must be mailed at once to the laboratory of each consignment of samples sent. This report must be made out on the blank forms furnished therefor and must be filled out in the manner indicated thereon. The samples shall be designated in this report in the same manner as they are marked on the shipping tag, or, in other words, both reports must agree. The written reports must give the location of source of supply of the material, quantity represented by sample, and the purpose for which the material is intended to be used. Also state from where the sample was taken, and, if a special sample, state why it was taken; if taken from a car, the name, number and location of car shall also be given. The location of all pavement samples and date when laid and taken shall also be given. The location of all concrete represented by the cubes forwarded, date cube was made, and proportions of mixture used therein must be definitely stated in the written report.

A daily report must be sent to the laboratory during the actual construction of all bituminous, Portland cement or block pavements. In case work is suspended for any cause, the last report will designate why the work was stopped and when work will be resumed.

Field Tests

Field tests shall be made on the following materials in the manner designated herein below as soon as each shipment is received.

Concrete Sand—The sample taken shall be carefully compared with the first sample taken by the inspector and which has been previously approved by the laboratory. After thoroughly mixing, a portion shall be selected to test for organic matter by the colorimetric method described below. The balance of the samples shall be spread out in a thin layer on a paper or piece of canvas, so that it will dry quickly. After the sample has thoroughly dried, it shall then be compared with the inspector's sample. Colorimetric tests shall be made on concrete sands only.

Colorimetric Tests—Fill graduated bottle to 4½ oz. mark with sand; then fill to 7 oz. mark with sodium hydroxide solution (see directions for preparations in equipment case); shake thoroughly and fill again with solution to the 7 oz. mark; set bottle where it will not be disturbed and shake well several times after filling at intervals of two or three hours. From 20 to 24 hours after filling, compare the color of solution in test bottle with a standard furnished with equipment (see directions in case). In case the solution in the test bottle has developed a darker color than that in the sample bottle, no permit should be issued for the sand represented by this sample. The sample should then be taken and forwarded to the laboratory and a report made in the manner above designated.

Whenever a sieve analysis is required of a concrete sand, proceed in the same manner as specified therefore under "Bituminous Sands."

Bituminous Sands—Bituminous sands shall be sampled and compared with the inspector's sample in the same manner as specified for concrete sands. The dried sample shall be sieved as herein specified, and the results secured compared with the analyses made by the laboratory on the first sample. Samples taken from the hopper by an asphalt plant shall be quartered and sieved in the same manner as specified for a sand.

Sieve Analyses—A 200 or 300 gram sample of the dry sand shall be selected in such a manner that it represents the average composition of the sand dried. The bottom pan shall be then attached to the ¼-mesh sieve and the weighed sample poured into this sieve. The sieve shall then be shaken until practically no more material can be made to pass this size sieve. The material retained on the sieve shall then be weighed, the weight recorded and this material discarded.

The material which has collected in the bottom pan shall be transferred to one of the weighing pans or onto a clean paper, the bottom pan adjusted to the next size sieve (10-mesh), the unweighed portion of the sample transferred to this sieve and shaken until practically no more material passes this sieve. The material retained on this sieve is then weighed in the same manner as before and the operation repeated for each of the various size sieves, using next largest sieve in each case. The material that is finally secured in the bottom pan will be that passing a 200-mesh sieve. The weights secured for the material retained on each sieve should be divided by two if a 200-gram sample is used, or three if a 300-gram sample is used, which will give the per cent. of the various sizes of the sand grains contained in the sample.

It is not expected that the results thus secured should agree with the analyses made by the laboratory on the first sample approved, but should not show a variation of over 3 per cent. above or below that reported by the laboratory for the material retained on any one given sieve.

Stone, Gravel or Other Coarse Aggregate—In addition to general appearance examination to determine whether the quality compares with that of approved sample, the sizes of coarse aggregate must be checked from time to time with the larger sieves having circular openings. With these sieves, proceed as in sieve analyses of sand, except, of course, it will be necessary to use a larger sample.

Portland Cement—There is no field test for Portland cement, except that in cases where the original container has been wet, or, for any other reason, the material contained therein has become hard and lumpy, no permit will be issued for cement of this character.

Bituminous Cement—The only field test to be made on bituminous cement is to check up the consistency, or, in other words, determine the penetration the material has at 25°C. (77°F.). To make this test a 3-oz. can is filled nearly full of hot asphalt cement. When cooled to nearly normal temperature, it should be set in a pan containing sufficient water to completely cover the can. This water should be kept at 25°C. for about one hour. The specimen is then removed from the water and placed on the platform of the penetration machine. The needle is then adjusted so its point just touches the surface of the asphalt cement and the plunger released for a period of five seconds. The readings on the dial, which was previously set at zero, will show the distance in millimeters, the needle penetrated. This shows the consistency of the asphalt cement and should agree with the limits defined therefor in the specifications.

Bituminous Pavement Samples—All pavement samples cut should be carefully examined to see if they have the thickness and density required by the specifications. If the paving mixture was at normal temperature when spread (about 300°F.) the general appearance of a clevage face of the pavement will give a fair idea whether the bituminous content is correct or not. No other field tests are required on pavement samples.

Bituminous Mixtures—The temperature of these mixtures should be taken and general appearance when dumped into the wagon observed. If the mixture is at normal temperature (about 300°F.), it should have a bright and lively appearance if it contains the required quantity of asphalt cement. If it is deficient in asphalt cement, it will have a dull color, being more plastic and stiffer than a mixture containing the required quantity of asphalt cement. When a mixture is too rich in asphalt cement, it will be very soft and sloppy.

The paper-pat test is a more reliable method of determining the asphalt content of a paving mixture in the field than to judge the asphalt content of these mixtures by their general appearance. The test is made in the following manner:

Bituminous Paper-Pat Test—To make a pat-paper test, a small quantity of the bituminous mixture (about 200 grams), having a temperature of about 300°, is placed on one-half of the pat-paper and the other half turned over on the top of the mixtures and gently tapped down thereon three or four times with a small wooden block or paddle until the bituminous mixture has a thickness of about ½-in. The paper should also rest on a wooden board or block in order that the paving mixtures will not cool quickly. The top paper is then gently pulled away from the bituminous mixture. If the mixture is deficient in asphalt cement, very little stain will appear on the paper; if too rich in asphalt cement, a decisive coating will be left on the paper; if the per cent. of asphalt cement is about right in the paving mixture, a distinct impression will be left on the paper, but not enough to make a coating.

This test should never be made on a mixture that has a temperature less than 275° or over 325°F., otherwise the asphalt stain on the paper is of little value in determining whether the mixture contains the right amount of asphalt cement or not.

Recommended Method of Resurfacing an Old Macadam Road That Is Filled with Ruts and Holes

By William N. Bosler, Division Engineer, Department of Public Roads, Frankfort, Ky.

Perhaps the most general and perplexing problem met with today by highway engineers in Central Kentucky, is the resurfacing, economically, of an existing waterbound macadam road that is filled with ruts and holes.

No matter how well macadam roads were constructed in the past, they will not stand under our present day traffic conditions. It is true that maintenance is economy, and the patrol system will prolong the life of waterbound macadam roads, but generally speaking every third season resurfacing is required.

The condition most frequently met in practice is the road surface filled with ruts and pot holes, or the surface entirely worn off, which has been caused through internal wear, lack of sub-drainage, ditching or inferior grade of stone.

The Telford Road

In Central Kentucky two types of macadam roads are met with, namely, the old Telford road and the waterbound macadam road, and these will be treated in the order named.

Years ago, when materials and labor were cheap, slaves were used in laying this Telford type of construction. Today we find the cross section of this same Telford road distorted almost beyond recognition and with practically no metal covering remaining. The road in question may be dished in the middle, concave in sections, the edges of the Telford being as much as 6 or 8 ins. higher than at the center. Again we find the Telford wholly exposed with practically a flat or very little slope to the cross section remaining. This undoubtedly is due to inadequate sub-drainage or improper foundation and not to original design.

Being confronted with these conditions, and a limited road fund at hand, the road engineer is up against a tough proposition. In some rare instances it might pay for him to salvage the remaining Telford, crush it with his portable crushing outfit, and use the stone thus derived in constructing a new waterbound macadam road. However, it is generally conceded that such a road would not be the equal of a resurfaced macadam on this existing Telford foundation. Owing to the present cost of labor it would be prohibitive, in price, to attempt to re-lay the existing Telford to its original cross section and then resurface as waterbound macadam. As a solution to this problem, it is the writer's opinion, that the old Telford foundation should be left undisturbed except where it is above the new established grade and cross section, and a filling of creek gravel properly placed and spread on the old distorted Telford. The builder should add enough gravel to produce a true cross section to the sub-base course, then it should be properly spread and rolled with a 10-ton roller, allowance being made for sub-soil and blind drainage where necessary. Most localities have an abundance of good grade creek gravel, consisting of sand and gravel, which could be secured within reasonable hauling distance and thus reduce the cost of preparing the sub-base.

The next operation consists in spreading and rolling, on the sub-base just prepared, crushed stone not to exceed 5 ins., compacted measurement. After this screenings are spread and rolled, watered and re-rolled until the surface is properly bound as a waterbound macadam road surface.

The spreading and rolling and watering of crushed stone and screenings on this type of resurface work is just as important and should be done in the same way as in constructing an original waterbound macadam road. In some exceptional cases a small amount of surfacing metal is still remaining as a covering on the Telford foundation. However, it is too thin to bear consideration and if the Telford is true or nearly true to cross section our best plan is not to disturb the existing metal or Telford, but simply to add crushed stone not to exceed 5 ins., compacted measurement, spread properly, rolled thoroughly, apply screenings, water and bond as a waterbound macadam road.

So much for the Telford type of construction. We will now consider the ordinary waterbound macadam road that has begun to deteriorate.

The Waterbound Macadam Road

As in all branches of engineering pertaining to reconstruction work, our first duty is to ascertain what the existing structure, in this case the macadam road, consists of; how much metal remains and in what condition it is. This information cannot be obtained entirely by a mere surface inspection, but requires digging into the old road metal. It is true we can see at a glance where the grade has been disturbed, where the cross section has been destroyed, but to arrive at the amount of metal remaining in the road it is absolutely necessary to make test holes or test trenches. Either method will procure information. However the trench method, that is, digging a trench say, 12 ins. wide to the full depth of metal, across the entire road, at right angles with the center line of the road, gives the best results. These test trenches should be taken every hundred feet or so, depending upon the general condition of the road. This will enable one to see just where the road has worn and how much.

Having arrived at the conclusion of how much metal remains and in what condition it is, the next duty is to establish an economic grade line. Bearing in mind that most any practical road builder can construct a road with 12 ins. or more of stone, it is the road engineer's job to determine what will be a sufficient amount of metal to add, and no more, to insure thorough bonding with the existing metal and produce a good road surface. Most authorities agree that 7 ins. of compacted crushed stone is ample for any waterbound macadam road. In other words, there is a limit beyond which depth of stone in resurfacing work is too expensive for results obtained, and beyond that limit it is better and cheaper to surface or otherwise resurface the road in question.

Now having determined the amount and condition of existing road metal and having established an economic grade line, it is our duty to salvage or prepare existing road metal for the new stone. As an illustration, say the road in question has 3 ins. or less of compacted metal remaining and is filled with ruts and holes. In that event it is practically useless to scarify it, as scarifying would tend to destroy the bonded metal already in place and would not help our cause any. Oftentimes scarifying is misused, as a result you disturb what structure you had to start with, and in the end you are endeavoring to bond by rolling in one operation, a greater depth of metal than can be properly handled. The better plan would be carefully to fill all ruts and pot holes with clean stone well graded and thoroughly roll it. Add sufficient metal to insure 7 ins. of compacted stone, spread to true cross section, rolling it thoroughly with 10-ton roller. Add screenings, roll, dry, then wet and re-roll until the whole is thoroughly bonded and presents a smooth surface.

For next consideration, take a macadam road filled with ruts and holes that has 4 ins. or more of compacted metal, the road being distorted as to cross section. Our first operation is to fill the holes and ruts in question with new metal, then spike and scarify the road. After which harrow and grade the existing metal to the true cross section and roll thoroughly with 10-ton roller. Now add sufficient new stone to insure 7 ins. of compacted metal, considering the amount of stone already in the road. Spread and roll with 10-ton roller, add sufficient screenings, roll it dry, then wet and re-roll until the whole is completely bonded and presents a smooth surface.

In some cases one might find a macadam road of 7 ins., or more, compacted metal that is filled with holes and ruts, but has retained its cross section approximately and is true to line and grade. In that event it is the writer's opinion that it is useless and expensive to add an arbitrary amount of new stone. The proper course to pursue would be to fill the holes and ruts with well-graded crushed stone. Spike, scarify, and harrow them, adding just sufficient new metal to bring the road to its proper cross section after shaping. Roll thoroughly with 10-ton roller, applying sufficient screenings which when properly wet and rolled will bond thoroughly and produce a smooth surface.

In this day of inadequate road funds a road engineer that can work existing macadam road that is filled with ruts and holes, utilizing every ton of stone remaining in it, and adding just as little new stone as is absolutely necessary to produce a well-bonded road of smooth surface, has indeed accomplished something that is a credit to himself and his county.

Resurfacing or reconstruction of waterbound macadam roads, under present day traffic conditions, presents problems worthy of the attention of highway engineers. These problems are of vast importance, and should be given more earnest consideration than they have received in the past if we wish to make our road funds cover a greater mileage.

Acknowledgment

The foregoing paper was presented during the recent Road Builders' Week held at the University of Kentucky.

Seventeenth Annual Convention of the American Road Builders' Association

The seventeenth annual convention of the American Road Builders' Association will be held at Louisville, Ky., on Feb. 9, 10, 11, 12 and 13, 1920.

In connection with this meeting of the Association, which will be the Tenth American Good Roads Congress under the auspices of the A. R. B. A., there will also be held the Eleventh National Good Roads Show. At the 1918 and 1919 meetings the show feature of the congress was confined to small exhibits that could be accommodated in the hotels in which the meetings were held. The conditions which led to the adoption of this plan no longer existing, it is proposed to make the 1920 show similar to the complete exhibits that were held previous to 1918. Moreover, because of the re-awakened interest in road building and the enormous expenditures which are going to be made in the next few years, the officials of the association expect to get together an exhibition that will surpass even those of former years.

The decision to accept the invitation extended by the city of Louisville was reached at a meeting of the board of directors at which invitations from many other cities were considered. It was felt that Louisville, because its central location and its accessibility from all parts of the country would meet the requirements of the 1920 convention better than almost any other city. In addition, the 1919 convention was held in New York, and it was felt that the national character of the association compelled the holding of next year's meeting farther west.

Both the sessions of the convention and the exhibition will be accommodated in the First Regiment Armory. About 53,000 sq. ft. of floor space will be available and plans of the exhibition hall will be prepared and issued in the near future. As the armory is situated within two or three blocks of the leading hotels of the city, the officials of the association feel that the facilities of the meeting are very nearly ideal.

The program, as in years past, will cover every phase of highway construction and maintenance and various related subjects. The prepared papers and the discussions will deal with highway problems from the points of view of road and street officials, highway engineers, contractors, and all of the various classes actively engaged in highway work.

At no previous time in the country's history has road betterment been the subject of so great general interest as at present, nor have the expenditures for the improvement of the country's roads ever been so great as those which will be made within the next few years. During the next year there probably will be available almost a billion dollars for road and street work, and the prospects are bright for even greater expenditures in the near future. For these reasons it is believed that the Louisville convention will be the most important ever held, both in point of attendance and in the interest shown.

Results of the Test Run of the Direct Oxidation Experimental Sewage Treatment Plant at Easton, Pa.

By C. A. Emerson, Jr., Chief Engineer, Pennsylvania Department of Health, Harrisburg, Pa.

(Editor's Note: The present article is a report, slightly rearranged and condensed, made by Mr. Emerson to Edward Martin, Commissioner of Health for Pennsylvania, dated Jan. 28, 1919, covering a test of the "Direct Oxidation" experimental sewage treatment plant at Easton, Pa. The test was conducted under Mr. Emerson's direction by Assistant Engineers A. L. Reeder and R. B. Styer and Inspectors W. R. Crull and J. L. Sullivan. A test run of 8 hours' duration was made, starting at noon on Dec. 4, 1918, followed by a 24 hour test, starting at 8 a. m., on Dec. 6, 1918.)

General Conditions

The city of Easton, having a population of some 30,000, is located on the west bank of the Delaware River, just below the mouth of the Lehigh River. Most of the existing municipal sewers receive both storm water and sanitary sewage and provide sewerage facilities for approximately two-thirds of the total population. This city has been forbidden by the Department of Health to extend the sewer system until some adequate method of treatment is provided because of the extensive use of the Delaware River below Easton as a source of water supply for municipalities in Pennsylvania and also in New Jersey.

The city has made studies looking towards the adoption of some form of sewage treatment, but no definite plans have as yet been adopted. In the latter part of 1917 Mr. C. P. Landreth of Philadelphia, patentee of the "Direct Oxidation Process," proposed that an experimental plant be constructed in Easton without obligation on the part of the city. Permission was granted by the city on Nov. 10, 1917, and construction of a plant having a nominal capacity of 1,000,000 gals. a day was begun on a site near the Delaware River at Front and Spring Garden streets. The plant was completed and placed in operation shortly after May 1, 1918. The Department had intended to observe the operation of the plant throughout the summer, but shortage of engineers, due to war conditions, made this impossible.

The sewage received at the experimental plant appears to be a fresh, domestic, municipal sewage of ordinary concentration and composition and passes through a centrifugal pump before treatment.

The processes of treatment used consist of

1. Coarse bar screens
2. Flat plate fine screens—(¼-in. circular openings)
3. Grit chamber
4. Chemical treatment—(3,720 lbs. lime per 1,000,000 gals.)
5. Electrolysis—(Type C electrolytic apparatus, C. P. Landreth's "Direct Oxidation Process")
6. Settlement—(4½ hours average retention horizontal-flow basins)

Tributary Sewers

The area tributary to the plant is divided into two distinct districts. The first is sewered on the separate system, contributing sanitary sewage only, while the second district contains combined sewers, contributing both storm water and sanitary sewage.

A survey of the district indicated 585 properties connected to the sewer system as follows: 511 dwellings, 37 combined stores and dwellings, 10 stores, 2 office buildings, 3 hotels, 3 schools, 1 laboratory, 7 churches, 1 armory, 8 garages and 2 breweries. The order of the Federal Government closing breweries became effective four days previous to starting the test of the plant, hence the volume of manufacturing waste discharged from these breweries was much reduced.

The rainfall during the last part of November and the few days of December preceding the test was negligible.

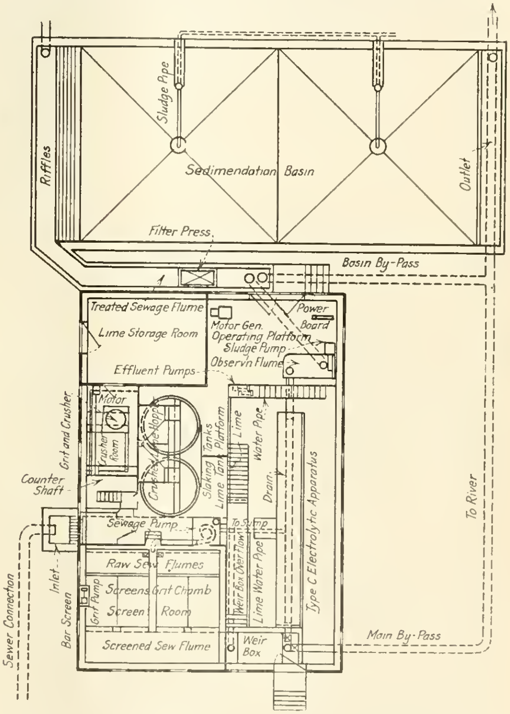
The time of passage of sewage from the most distant house in the district to the sewage treatment plant is comparatively short and probably does not exceed an hour and a quarter. The low quantity of total solids, suspended solids and oxygen consumed indicate a relatively dilute sewage; the presence in appreciable quantity of nitrates and nitrites and the ratio between the organic nitrogen and the free ammonia contents show that the sewage is quite fresh as treated at the plant.

Description of Plant

Sewage is diverted from the 3 ft. by 4 ft. 6 in. egg-shaped combined sewer in Front street through a 12-in. pipe, a concrete dam having been constructed in the main sewer immediately below the lateral. At the plant the 12-in. pipe discharges through a 10-in. valve into a covered flume 3 ft. 6 ins. wide, equipped at its inlet end with a coarse bar screen for the removal of sticks and other large objects. The flume leads to the suction well of a 6-in. centrifugal pump which lifts the sewage about 14 ft. 6 ins. to a raw sewage flume, placed at such an elevation that the sewage can flow thence by gravity through the treatment plant. From this flume the sewage flows on to a horizontal flat plate screen with closely spaced holes ¼ in. in diameter, through which it falls into a hopper-bottomed grit chamber. The raw sewage flumes, fine screens and grit chambers are in duplicate, only one-half being used at a time. The screened sewage overflows from the grit chamber into the screened sewage flume, passes over a 3 ft. weir, is treated with a suspension of lime and then passes through a 12 in. pipe to the electrolytic cell. From the cell the sewage flows through an open observation flume connected to the treated sewage flume and thence over concrete riffles into the sedimentation basins. The two basins are connected in series and have a combined capacity, to the elevation of the outlet weir, of 88,740 gals., giving when clean a detention period of about 2⅛ hours on a flow of 1,000,000 gals. per 24 hours. A 4-inch sludge pipe is provided from each basin to permit of drawing the sludge on to two small sludge-drying beds immediately east of the sedimentation basins.

The entire plant, with the exception of treated sewage flume, sedimentation basins and sludge beds, is neatly housed in a sheet iron building 48 ft. 3 ins. long and 35 ft. 6 ins. wide.

The difference in elevation between the fine screens and the overflow weir from the sedimentation basin is 5 ft.



PLAN OF EXPERIMENTAL DIRECT OXIDATION SEWAGE TREATMENT PLANT AT EASTON, PA.

By-pass arrangements permit of running screened or screened and lime-treated sewage from the weir box direct to the river, or of running treated sewage from the treated sewage flume to the river without passing through the sedimentation basins. An overflow pipe in the screened sewage flume diverts any excess over the capacity of the plant, returning it to the pump well. The low concrete dam in the main sewer permits the latter to take the entire flow when the pump is not operated or excess flow in time of storm.

Electrolytic Apparatus—The electrolytic apparatus is enclosed in a horizontal wooden tank 27 ft. 3 ins. long, 3 ft. wide and 2 ft. 9 ins. high (outside dimensions), reinforced with steel plates and mounted on supports 18 ins. high. Two 2-in. wrought iron vent pipes are carried up from the top of the tank for the removal of any excess gaseous products of electrolysis. A series of blow-out valves are provided along the bottom of the tank.

This tank contains 22 banks of plates, arranged in two layers of 11 banks each. Each bank of electrodes consists of 48 rectangular steel plates 16 ins. long, 10 ins. high and 3/16 in. thick, placed parallel to the sides of the tank and spaced ⅜ in. apart. The plates are so connected that alternate plates have the same polarity, giving 24 pairs of plates connected in multiple in bank, the 22 banks being connected in series. Spaces between the banks and the sides of the tank are closed, compelling the sewage to flow through the ⅜ in. spaces between the plates. In each space between the plates two straight paddles of Bakelite are revolved, being attached to shafts passing through holes punched in the plates to receive them. The paddles are driven at a speed of 20 revolutions per minute by a 3 H.P. motor, the power being transmitted to the paddle shafts through suitable reduction gearing. The total number of paddles in this plant is 2,068.

At the normal rating of the plant, i. e., 1,000,000 gals. daily the time of passage through the electrolytic cell is approximately 70 seconds, of which 17.4 seconds represent the time of contact with the electrodes, the remainder of the time being occupied in passing through dead space between successive electrodes. During contact the sewage travels in streams ⅜ in. thick for a distance of 14 ft. 8 ins. at a theoretical velocity of 0.84 ft. per sec.

Lime Apparatus—Provision is made for using either lump or hydrated lime. When the former is used the lumps are broken by hand on a 3-in. grid placed over a crusher which discharges into an elevator boot. When hydrated lime is used a spout delivers it directly into the elevator boot. The elevator discharges into an overhead hopper from which it is fed dry by adjustable feeding devices to the solution tanks.

The solution tanks are two in number, each 7 ft. in diameter and 3 ft. deep, each with an independent feeding device and agitator. Only one tank is used at a time.

The feeding device consists of a trough with a double worm feed actuated by a ratchet and pawls, which is turn are driven by a reciprocating link attached to an eccentric. The rate of feeding lime to the solution tank may be adjusted within certain limits by changing the throw of the eccentric and by varying the number of teeth engaged on the ratchet by changing the position of the pawl arm.

Either city water or plant effluent can be used in the solution tanks; when the effluent is used it is pumped by a motor-driven 1-in. centrifugal pump. In either case, the water enters the tank tangentially near the bottom to help the agitation and the lime suspension or milk of lime is drawn from the top of the tank. Agitation is by means of a two-bladed 10-in. fan placed at the bottom of the tank and operated at 900 revolutions per minute by the 1-h.p. motor, which also drives the feeding device. The circulation is downward at the center and upward at the sides.

Suitable piping delivers the lime suspension into either the spillway of the weir or the observation flume, as desired.

List of Electric Motors Installed:

For initial pumpage of raw sewage..	1	7½-h.p. motor
For lime treatment:		
Lime crusher	1	5-h.p. motor
Effluent pumps	2	1-h.p. motor
Feeding and agitation..........	2	1-h.p. motor
For electrolytic cell:		
Paddles	1	3-h.p. motor
Electrolysis	1	5-k.w. motor generator set
For handling grit and sludge:		
Grit pump	1	2-h.p. motor
Sludge pump	1	1-h.p. motor

Of the four 1-h.p. motors listed under lime treatment only two would be in service at a time.

Description of the Process

The process is essentially one of fine screening, followed by lime precipitation, agitation, electrolysis and sedimentation.

The screening through ¼-in. circular openings removes from the crude sewage solid particles of larger size than these openings.

The addition of the lime is claimed by the owner of the electrolytic process to be essential to that phase of the treatment of the sewage, but it should be borne in mind that chemical precipitation of sewage is one of the oldest processes known to the art and produces a very considerable removal of suspended solids.

The electrolytic action liberates nascent oxygen and hydrogen by the passage of the electric current through sewage rendered alkaline by the addition of lime. The agitation, in addition to its well-known effect in inducing precipitation, brings the sewage into intimate contact with the products of electrolysis. Chemical reaction is thereby stimulated while the gases are still in the nascent state and before they have an opportunity to escape. The paddles undoubtedly serve also mechanically to clear the plates and prevent polarization.

In normal operation the lime suspension is added to the sewage immediately before entering the electrolytic cell in order to insure positive alkalinity, a condition considered necessary for electrolysis without attack of the electrodes. There is a gradual deposit of calcium carbonate on the plates, which it is claimed can be remedied by temporarily shifting the point of application of the lime to the outlet flume leading from the electrolytic cell. The sewage, under such conditions, is said rapidly to remove the coating from the plates, permitting normal operation to be resumed in 15 or 20 minutes. A heavy deposit on the plates is indicated by a marked increase in the power required to drive the paddles. No considerable increase was noted during the period of the test.

Some polarization of the plates occurs from time to time, but this is overcome by a reversal of the polarity, which quickly decreases the necessary voltage and increases the current.

For satisfactory operation it is said that the cell effluent should contain not less than 30 parts per million of excess alkalinity. During the period of the test this content was always exceeded.

As the sewage reaches the observation flume after passage through the electrolytic cell it contains the lime and the suspended solids. The subsequent sedimentation is to permit the deposition of these materials so as to clarify the effluent and separate the sludge for treatment.

Condition of Test

The plant had been closed since about Oct. 15, 1918, and intermittent operation was again resumed on Dec. 2, only two days prior to starting the 8-hour test.

During the test the plant was operated by the company, in order that there might be no division of authority and to controvert possible criticism regarding inefficient operation. The department's representatives observed the operation of the plant, made tests on power consumption, quantity of lime used, flow of sewage, and took samples of the sewage, etc.

Prior to undertaking the test all bypass connections were closed and sealed, electric meters and water meters were read and various measurements were made of the dimensions of the units.

During the 8-hour test electric and weir readings were taken at intervals of 15 minutes and at intervals of 30 minutes during the 24-hour test. Samples of the sewage, proportional to the flow, were collected every 30 minutes during the 8-hour test and every hour during the 24-hour test. These were mixed to form composites for chemical analysis for each test run. Settleability and alkalinity samples were collected every four hours, and putrescibility, dissolved oxygen and bacteriological samples were collected every 8 hours. Lime samples were collected at irregular intervals, averaging probably 2 hours, and thoroughly mixed, forming a single sample for analysis.

The Standard Methods of Analysis of the American Public Health Association were followed at the laboratory.

The flow of sewage was determined by weir readings taken every 30 minutes during the tests, and varied from a minimum of 309,000 gals., which occurred at 2:30 a. m., to a maximum of 816,000 gals., which occurred at 11:30 a. m. The average flow during the 24-hour test was at the rate of 460,000 gals. per day, or slightly less than one-half the rated capacity of the plant.

During the 8-hour test the polarity of the electrolytic cell was changed at 3:23 p. m., in order to decrease the effects of polarization. Immediately after such change the voltage was found to be 40 and the amperage 55. During the 24-hour test a similar change was made on several occasions, but the exact hours were not noted.

At 4:20 p. m., on Dec. 6, a portable volt meter was applied to the various electrodes to determine whether the total voltage at that time was evenly distributed throughout the electrolytic cell. The results at the outlet end were as follows:

Upper Bank.....2.8 2.7 2.85 2.7 2.75 2.9 2.95 2.9 3.1 3.0 3.75
Lower Bank....3.0 2.7 2.55 2.65 3.0 2.9 2.8 2.75 3.4 2.8 3.45

Immediately after the completion of the test the switchboard ammeter was compared with a portable millivoltmeter with external shunt. The two were found to agree within two or three per cent.

SUMMARY OF RESULTS

Power Consumption	8-hr. test	24-hr. test
Lights and Electric Heaters	11 K.W. hrs.	47 K.W. hrs.
Pump Motor	30 K.W. hrs.	90 K.W. hrs.
All other power	50 K.W. hrs.	130 K.W. hrs.
Total	91	267
Total water consumption (This includes toilet, lavatory and the stuffing boxes of the centrifugal pump.)	66 cu. ft.	166 cu. ft.
Quantity of lime	......	1,712 lbs.
CaO content		61.52%
Average voltage for electrolysis	56.3	57.5
Average current for electrolysis, amperes	37.8	33.8
Average wattage for electrolysis	2,125	1,944
Average wattage for paddles	1,388	1,355
Sewage flow in gallons per 24 hours	482,700	460,000
Average sewage flow in gallons per hour	20,110	19,190
Electrolytic hydrogen liberated in grams per hour	31.04	27.82
Electrolytic oxygen liberated in grams per hour	247.73	222.03
Ratio of electrolytic hydrogen to sewage by weight	0.4 p.p.m.	0.4 p.p.m.
Ratio of electrolytic oxygen to sewage by weight	3.2 p.p.m.	3.0 p.p.m.

BACTERIOLOGICAL RESULTS

Figures Represent Bacteria per c.c.

—8-Hour Test—

	Time	Raw Sewage	Screened Sewage	Cell Effluent	Basin Effluent
Total Bacteria	2:30 P. M.	800,000	200,000	38,000	2,000
B. Coli	2:30 P. M.	36,000	24,000	0	0

—24-Hour Test—

	Time	Raw Sewage	Screened Sewage	Cell Effluent	Basin Effluent
December 6—					
Total Bacteria	8:00 A. M.	920,000	680,000	24,000	65
B. Coli	8:00 A. M.	100,000	120,000	0	0
Total Bacteria	4:00 P. M.	240,000	216,000	2,500	1,600
B. Coli	4:00 P. M.	12,000	50,000	0	0
Total Bacteria	12 midnight	48,000	16,000	190,000	18,000
B. Coli	12 midnight	15,000	18,000	0	0
December 7—					
Total Bacteria	8:00 A. M.	1,200,000	1,800,000	24,000	30,000
B. Coli	8:00 A. M.	45,000	30,000	0	0

PHYSICAL AND CHEMICAL RESULTS

—8-Hour Test—

	Time	Screened Sewage	Basin Effluent
Total Alkalinity	12:15 P. M.	106	193
Total Alkalinity	4:00 P. M.	103	326

—24-Hour Test—

	Time	Screened Sewage	Basin Effluent
December 6—			
Total Alkalinity	8:00 A. M.	98	380
Total Alkalinity	12:00 M.	89	276
Total Alkalinity	4:00 P. M.	88	252
Total Alkalinity	8:00 P. M.	98	282
December 7—			
Total Alkalinity	12:00 midnight	85	288
Total Alkalinity	4:00 A. M.	86	341

SCREENINGS REMOVED

—24-Hour Test—

Bar Screen	117 lbs.
Plate Screen	379 lbs.

RESULTS EXPRESSED IN PARTS PER MILLION

—24-Hour Test—

	Raw Sewage	Screened Sewage	Cell Effluent	Basin Effluent
Total Solids	217	248	608	640
Volatile Solids	114	140	196	94
Fixed Solids	103	108	412	546
Suspended Solids	71	69	215	26
Nitrogen as				
Organic	34.5	31.2	21.5	21.6
Free Ammonia	11.3	11.5	9.2	9.3
Nitrites	0.045	0.05	0.06	0.06
Nitrates	0.46	0.45	0.93	0.90
Oxygen Consumed	53	52	44	44

Raw sewage samples were collected from the discharge pipe of the pump after sewage had passed the bar screen. Screened sewage samples were collected after the sewage had passed the bar screen, the pump, the plate screen and the grit chamber. The samples of the cell effluent were taken from the observation flume. This sewage had passed the bar screen, the pump, the plate screen, the grit chamber and the electrolytic cell and had also received the lime treatment.

DISSOLVED OXYGEN

	Time	Temperature Degrees C	Content P. P. M.	Saturation Per cent.
Cell influent	10 A. M.	12.0	3.7	34
Cell effluent	10 A. M.	11.0	5.2	47
Cell influent	6 P. M.	12.0	6.8	63
Cell effluent	6 P. M.	11.0	7.0	63
Cell influent	2 A. M.	12.5	6.7	62
Cell effluent	2 A. M.	12.5	8.3	77

PUTRESCIBILITY

Using Methylene Blue at 20 degrees C

—8 Hour Test—

	Raw Sewage	Screened Sewage	Cell Effluent	Basin Effluent
1:45 P. M.	1 day	1½ days	4½ days	9½ days

—24 Hour Test—

	Raw Sewage	Screened Sewage	Cell Effluent	Basin Effluent
Dec. 6				
9:00 A. M.	1 day	1 day	14 days	14 days
3:00 P. M.	1½ days	1½ days	14 days	14 days
11:00 P. M.	1½ days	1½ days	14 days	14 days
Dec. 7				
7:00 A. M.	1½ days	1½ days	14 days	14 days

PUTRESCIBILITY OF SLUDGE FROM RESETTLING BASINS

	100% sludge	75% sludge 25% river water	50% sludge 50% river water	25% sludge 75% river water	100% riv. water
Standard Quantity Methylene Blue Solution	3 hrs.	3 hrs.	3 hrs.	3 hrs.	14 days
3 Times Standard Quantity Methylene Blue Solution	3 days	14 days	1 day	3 days	14 days

In the above table the entries signify the period during which the samples retained a blue color excepting in cases where the entry reads 14 days, which signifies that the color was still present when the samples were thrown away at the end of the 14-day period.

It was feared the bleaching properties of the lime would have a marked effect on the methylene blue solution added to samples of sludge mixed with varying proportions of the river water. Accordingly, the standard quantity of methylene blue solution was added to one set of samples and three times this standard quantity to the check set, including the control samples. It will be noted that the samples of 100 per cent river water were stable for two weeks in both cases, but in the other samples, containing varying proportions of sludge and river water, the lime apparently had a perceptible effect upon the methylene blue. The samples containing the greater proportion of methylene blue retained the color for longer periods although the period of retention of color was not proportional to the percentage of river water, tending to throw some doubt upon the accuracy of this determination.

The appearance of the raw sewage was typical of fresh dilute sanitary sewage from an American municipality except at times when brewery wastes are present.

The effluent from the electrolytic cell had a brownish cast, contained a floculent precipitate and evidenced tendency to form a floating froth in the observation flume and inlet end of the settling basin. The floculent precipitate settled rapidly, leaving a clear greenish tinged supernatent liquid excepting when large volumes of brewery wastes were passing through the plant when the effluent from the basin was clear amber color and contained some suspended matter.

There was no opportunity during the test to determine the feasibility of drying sludge from the settling basin upon the sand beds.

At the end of the 24-hour test the cover on the effluent end of the electrolytic cell was removed and the electrolyte drawn down a short distance below the top of the plates. After removal of the coating these plates as far as could be seen were bright and in good condition. The coating, which was removed easily by rubbing with the fingers, was found on analysis to contain 1.73 per cent. of iron.

There was no evidence during the test that under operating conditions there is a rapid deterioration of the plates to form a chemical coagulant which was purposely intended in the early processes for the electric treatment of sewage.

Life of Electrolytic Cell

The company states that the cell under test at Easton had not received any repairs during the summer and in fact the cell cover had not been removed prior to the conclusion of the 24-hour test when it was opened at request of the Department representatives in order to observe the condition of the plates.

Records of electric current consumed during the summer of 1918 (May to October, inclusive), were obtained from the monthly statements of the local electric company. It was found that the current consumed by the pump would have been sufficient for approximately 18 days' continuous operation and current recorded by the meter supplying circuits for the lime feeding and mixing devices, the solution pump, electrolytic cell and revolving paddles would have been sufficient for approximately 16 days' continuous operation. These periods are obtained by using the current consumption during the 24-hour test as a basis. The higher figure for the pump is probably due to the fact that the flow of sewage was greater on some days than during the 24-hour test while the current required for the lime feed and the cell did not vary uniformly with the flow of sewage.

The company states that the cell remained filled with sewage during periods when it was not operated.

Freedom from Nuisance

During the department's test the entire apparatus was free from objectionable odors. Inquiry was made at houses in the vicinity and it was found that the residents quite generally had no cause for complaint.

There is little reason to anticipate nuisance conditions from the screens, cell or settling basins when handling fresh sewage for there would normally be dissolved oxygen present throughout the process. Freedom from nuisance, however, cannot be predicted with any degree of certainty in a large municipal plant which must necessarily contain sludge beds or sludge presses for dewatering the sludge. In fact it is altogether probable that disposal of the sludge would at times be attended by offensive odors.

Cost of Operation

It is difficult to predict, with a satisfactory degree of accuracy, the cost of operating a large unit by comparison with data collected through operation of a single small unit. However, in the absence of complete information, reliance must be placed upon such data as are available and reasonable factors applied to meet expected conditions in the larger plant. The following figures regarding cost of operating the plant at Easton are therefore given as a rough indication of what might be expected, but apply more particularly to a plant of a similar size operating under the same conditions, namely, pumping of sewage and the addition of lime at a rate stated by the owner of the patent as being greatly in excess of that necessary to secure satisfactory results:

Without Pumpage—	
Hydrated lime—1,712 lbs. @ $6.75 per ton	$ 5.78
Water for mixing lime—20 cu. ft. @ $0.003 per cu. ft.	.06
Electric power—130.6 k.w.h. @ $0.0226	2.95
Electric lights—6¼ k.w.h. @ $0.0805	.50
Heating	1.25
Labor and superintendence	15.00
Electrode renewals—company's estimate	1.00
Maintenance and repair	1.50
Total	$28.04
Add for Pumpage—	
Electric power—88.3 k.w.h. @ $0.0226	2.00
Water—120 cu. ft. @ $0.003 per cu. ft.	.36
Total	$30.40
Equivalent cost per million gallons	$66.00

These figures are on the basis of pumping and treating 460,600 gals. excluding allowance for interest and sinking fund charges and cost of sludge pumping, treatment and disposal. The costs of hydrated lime, water and electric current are those which the department understands obtains at Easton. The figure for labor and superintendence is based upon employment of a superintendent at $1,650 a year who should be able to make necessary bacteriological and chemical tests, and who is familiar with the theory of operation of the process and upon employment of an operator on each 8-hour shift at a salary of $1,200 a year.

If we assume that the plant could be operated continuously at normal rating (1,000,000 gals. a day) the unit costs would be materially reduced and would probably be approximately as follows:

Without Pumpage—	
Hydrated lime—3,720 lbs. @ $6.75 a ton	$12.56
Water—20 cu. ft. @ $0.003 per cu. ft.	.06
Electric power—185.5 k.w.h. @ $0.0226	4.19
Electric lights—6¼ k.w.h. @ $0.0805	.50
Heating	1.25
Labor and superintendence	15.00
Electrode renewals	1.00
Maintenance and repairs	1.50
Total	$36.06
Add for Pumpage—	
Electric power—117.7 k.w.h. @ $0.0226	2.66
Water—120 cu. ft. @ $0.003	.36
Total	$39.08

These figures are exclusive of allowance for interest and sinking fund charges and cost of sludge disposal. It will be noted that the lime has been increased proportionately to the flow as this quantity was added during the test. Should it later appear that the quantity of lime can be reduced without deterioration of the effluent there would be a corresponding reduction in cost of treatment. It is probable that the cost of sludge pumping, treatment and disposal will be in the neighborhood of $7.50 a million gallons.

Conclusions

Consideration of the performance of the plant as operated by the owners and as observed by members of the Engineering Division of this department on Dec. 4 and 6, 1918, leads to the following conclusions:

1. The combined action upon the sewage of the fine screen, lime treatment and the electrolytic cell render the sewage in such a condition that after sedimentation in properly designed tanks the effluent can be discharged into a stream, affording a reasonable dilution of relatively clean water, without danger of creating nuisance. It is of course assumed that the effluent will be discharged through properly designed outlet so as to cause dispersion in the stream.

2. The fine screen, lime treatment and electrolytic cell have a destructive action on bacteria of the colon group. If, however, the use of the receiving body of water demands a high degree of bacterial removal in sewage effluents discharged therein, it would be on the side of safety to provide for disinfection of the cell effluent.

3. Assuming fresh domestic sewage, proper design, operation and maintenance of the various devices the treatment of sewage by the above described processes should be free from objectionable odors, with the possible exception of the removal and disposal of the screenings and the sludge from the final settling basins.

4. Similar screenings are being successfully disposed of elsewhere by incineration or burial and the sludge from the final settling basins should be susceptible of dewatering by presses such as are used in sewage treatment works, including the lime precipitation method.

5. The process should be extended by installation of some adequate method for treatment of sludge removed from the settling basins, as discharge of this sludge with the cell effluent is not permissible.

6. The cost of installation of a sewage treatment works including the above processes should not be excessive but the cost of operation would appear to be higher than for other methods of sewage treatment in general use to produce an equal quality of effluent.

Each proposed installation should be examined by comparison with other methods of sewage treatment to determine if savings in installation cost would be sufficient to counter-balance the increased maintenance and operation charges.

If it should be determined that the proportion of lime could be materially reduced without deterioration in the quality of effluent, there would be a proportionate reduction in operating costs.

7. To permit continuous operation of a works including these processes, electrolytic cells and other equipment must be in duplicate. It is undoubtedly necessary to replace plates in the electrolytic cell from time to time and accordingly a type of cell should be adopted which admits of such renewals in place and at a minimum cost for labor.

8. The short time observations of the combination of fine screening, lime treatment, electrolytic cells and final settlement appear to justify an extended test by this department should the opportunity be offered. Such test should include study of results secured with lime additions reduced to the proportion the owner of the patent claims as the actual needs of the process and should also include study of various methods of treatment and disposal of the sludge from the settling basins.

Special Features of the Gallery Water Collecting System of the Des Moines Water Co., Des Moines, Ia.

By A. F. Luce, C. E., Engineer and Superintendent, Des Moines Water Co., Des Moines, Iowa

The Des Moines Water Company is one of the pioneers, if not the first, thoroughly to develop its water supply by means of infiltration galleries. A number of cities have water supplies developed from the underlying sand and gravel strata by means of wells, but few, if any, have adopted the method used here.

In order to understand thoroughly the practical application of this method it will be necessary first to fix clearly in mind the fundamental features of the water bearing area before undertaking to follow through the various stages of its development.

Source of Supply

The water is obtained primarily from the Raccoon River. This stream lies in a southwesterly direction from Des Moines and discharges into the Des Moines river in the heart of the city. It has a drainage area of 3,677 square miles above the city and a minimum flow of sufficient quantity to more than meet the needs of the city for many years to come.

Geological Conditions

The most interesting feature of the river from a water supply standpoint is the geology of its valley in the vicinity of Des Moines. Here we find a broad valley nearly 100 ft. deep and a mile wide, which has been eroded in the clay, shale and rock of the natural topography and extending for many miles upstream with relatively steep sides terminating in rolling plains above. It is evident that this valley was eroded by a preglacial stream which eventually cut its way to a hard bottom and later covered this bottom with clean sand and fine gravel brought down from the glaciers and then, at a still later period, covered this gravel bed with from 5 to 10 ft. of alluvium. As might be expected, this stratum of sand and gravel terminates at the foothills on either side, but extends upstream for many miles. Borings have shown this to be true and many made by the water company affirm the fact that it is from 10 to 30 ft. in thickness, very clean and uniform in size. An analysis of the borings show no marked difference in the character of the material although in some places the sand predominates and in others the gravel. There is, however, little difference in the water-carrying capacity, the average effective size being about 0.42 millimeters with a coefficient of uniformity of 4.00.

Raw Water of Good Quality

Owing to the fact that the surface of the valley lies below the level of the flood plane of the river it is sparsely settled both within the city and for a long distance above it. Thus we find extending right into the city a large sand and gravel filled basin sealed off from practically all outside contamination by the topography and the natural clay soil, through which meanders a river of ample size to furnish the water requirements for many years to come. During the greater portion of the year this river is low in turbidity, but is subject to floods that periodically scour the silt deposits from its bed.

Early Infiltration Tanks

It was concluded early in the development of the water company that the sand of the river would act as a good filtering agent and there was accordingly constructed in 1871 a steel tank 12 ft. in diameter and 14 ft. high with perforated sides and closed top. This tank was sunk in the gravel on the south bank of the river until its top was 10 ft. below low water and it was surrounded with coarse gravel. It has been estimated that this tank furnished water at the rate of 1.5 million gallons per day for short periods. A direct river inlet was later connected for emergency use.

In 1876 two more tanks were installed on the north bank of the river. Those were very much similar to the original, being 12 ft. in diameter and 12 ft. high with perforated sides and open bottom, but having tops constructed of 12x12 in. timbers.

The Present Collecting System

The first unit of the present collecting system was built in 1882. This was the suction well located in the station yard and approximately 800 ft. from the river. It consists of a brick lined well 50 ft. in diameter and 35 ft. deep with walls 19 ins. thick, resting on an iron shoe. The well is roofed over below the ground and contains the suctions of the pumping engines. The top of the well is about 15 ft. above the normal river level. Upon completion the well was capable of delivering 500,000 gallons per day. With this well and the three boxes a supply of from 2 to 3 million gallons per day was obtained, although the draft upon the boxes was beginning to draw sand into the pumps and give more or less trouble.

No. 1 Gallery

In 1884 work was started on the first gallery. This gallery is known as the No. 1 Gallery, and extends from the suction well south under the tracks of the Rock Island railroad a distance of 260 ft., thence in a westerly direction along the railroad, between it and the river for a distance of 817 ft., terminating at a point 150 ft. from the river bank. It is 4 ft. high by 5 ft. wide, and surrounded with 1 in. screened stone. The bottom is open and the sides and top are made of 3x6 in. white elm timbers, laid with ⅜ in. spaces between. The gallery was built in open cut, the ditch varying from 17 ft. to 27 ft. in depth. It was completed in 1886.

The old iron tanks were abandoned in 1885, and the water drawn entirely from the No. 1 Gallery and the Suction Well. Thus we find that 34 years ago the entire water supply was developed by infiltration at a considerable distance from the river.

No. 2 Gallery

Owing to the steady growth of the city and the increasing demand for water, the No. 2 or River Gallery and river well were built in 1887. The well was located in the station yard and is 20 ft. in diameter by 30 ft. deep, built with 20 in. brick walls, resting on a wooden shoe. It is roofed over with brick arches supported by I-beams. In order to prevent wash from the gallery one-half of the bottom is floored with a baffle in the center. This gallery is 1,594 ft. in length, and lies along the foot of the bluff on the north side of the railroad, terminating in an emergency inlet to the river. Like the No. 1 Gallery, it is constructed of white elm timbers in open cut, varying in depth from 16 ft. to 30 ft. It is smaller, however, in size, being only 4 ft. wide by 4 ft. 2 ins. high, with open bottom and tightly sheeted sides and top made of 4x6 in., white elm timbers set on a bed of screened broken limestone. At the time of completion of this gallery, there was ample infiltration to supply the domestic and fire demand of the city without recourse to the emergency river intake, the average daily consumption being about 2,000,000 gals.

No. 3 Gallery

It was not necessary to augment this supply by additional galleries until 1894, when the consumption had increased to an average of nearly 3,000,000 gals. per day. During this year the No. 3 Gallery was constructed. This gallery is an extension of the No. 1 Gallery beginning at the end of the old gallery and extending across the river and upstream parallel to it for a total distance of 1,250 ft. It is 3 ft. 8 ins. high, by 5 ft. wide and was built with sides of 4x6 in. timbers in which ¼ in. spaces were left between timbers. The top was made solid, 8 ins. in thickness, and, like the other two galleries, the bottom was left open. Screened gravel was placed on the sides and bottom of the gallery. For 150 ft. under the river the gallery is protected by a 4 in. concrete slab. A low brush and rock fill dam was thrown across the river below the galleries in the fall of this year, which increased the head on the galleries about 2 ft.

VIEWS ON THE CONSTRUCTION OF A WATER INFILTRATION GALLERY AT DES MOINES, IOWA.
Top Row: Using Steam Hammer to Drive Solid Steel Sheeting. Bottom Row: Locomotive Cranes Employed on the Excavation—Reinforced Concrete Rings Laid on Timber Cradle and Surrounded by Crushed Sewer Tile Form the Conduit.

Five 8-in. drive wells were constructed about 800 ft. from the gallery in 1899. These wells were about 20 ft. in depth, extending nearly to the clay subsoil and were equipped with 8-ft. strainers. Pumping was done by means of an electric driven pump, which discharged into the end of the No. 3 Gallery through a 16-in. C. I. pipe line. In 1900 it was decided that the operation of this equipment was detrimental to the flow in the galleries and the wells were accordingly abandoned.

No. 4 Gallery

It was not until 1904 that additional galleries were built. The No. 4 Gallery was started in 1902, but floods and high water delayed the actual construction for 2 years. This gallery forms the first link in the present main gallery line and was built of similar construction to Gallery No. 3, although it is 4 ins. higher, being 4 ft. by 5 ft. in section. It was built in open cut at a depth varying from 10 to 30 ft. and extends from a point on the north bank of the river 600 ft. from the suction well across the stream for a total distance of 1,000 ft. The end of the gallery is connected to the suction well by means of a 36-in. C. I. siphon. A 20-in. cross connection was built between galleries No. 3 and 4, in order to equalize their flow. It is of interest to note that this gallery extended at right angle to the river and at its upper end is 400 ft. from the nearest bank.

During times of low water it became necessary to irrigate and rake the sand bars along the river adjacent to the galleries in order to increase the yield. This procedure was expensive and more or less unsatisfactory, and it was decided to extend the gallery system still further. After a careful investigation of the ground water contours and a further study of the water bearing strata it was determined that over two-thirds of the water collected by the galleries came from the river and that the rate of this infiltration approximated 220,000 gals. per acre of river bed per day. It was accordingly concluded that extensions made parallel to the river would develop the greatest delivery.

Gallery No. 5

Work was started on the No. 5 Gallery in 1908. This gallery extends in a southwesterly direction from the end of Gallery No. 4, a distance of 3,325 ft., and consists of a series of concrete rings 4 ft. in diameter, laid on a timber cradle surrounded by 6 ins. of crushed sewer tile. Each ring is 2 ft. long and 4½ ins. thick, made of reinforced concrete, and has small lugs cast on one end ¼ in. high, which serve as spacers between the adjacent rings. The excavation ranged from 20 to 27 ft. in depth and due to the intensely water-bearing character of the material solid sheeting had to be adopted. Three pumping plants were used during the work as it was necessary to handle water at rates varying from 4 to 12 million gals. per day. Manholes were built at points where the direction of the gallery changed. This gallery is divided into two sections connected by 36 ft. of 36 in. cast iron pipe and a gate valve. Cast iron pipe and valves were also placed at the beginning and end of the gallery. All three valves are located in valve chambers made of brick with concrete bottoms. The work on this section of gallery was completed in 1910.

Emergency Filter

In order to dispense with the irrigation and raking of the sand bars during periods of low water, an Emergency Filter was built simultaneously with the construction of the No. 5 Gallery. This filter consists of an earthen reservoir immediately above the gallery, divided into two sections by a street crossing. The filters are 30 ft. wide at the bottom, with side slopes 1:1 and a total length of 850 ft., and are connected by a 24-in. vitrified tile. Water was originally admitted to them by gravity from the river through a 20-in. cast iron pipe. The bottom is at elevation 100 and the tops of the banks are at elevation 120. Without the Emergency Filter this gallery produced about 2,000,000 gals. per day and it was thought that there would be no further extensions needed for some time as the average daily consumption of the city was about 5,250,000 gals. per day. The demand for water, however, became greater than was anticipated as the consumption increased over 50 per cent. between 1907 and 1913, at which time it became apparent that the galleries would have to be again extended and accordingly work was started on No. 6 Gallery in the fall of 1914.

Gallery No. 6

The No. 6 Gallery begins at the end of Gallery No. 5 and parallels the river for a distance of 3,500 ft. It is identical in construction with the latter gallery and is likewise divided into two sections by a short stretch of 36 In. cast iron pipe and a valve. The excavation ranged from 18 to 20 ft. in depth, and was done by two locomotive cranes, operating on standard-gauge track on either side of the excavation. Steel sheet piling was used for lining the trenches, and was driven by steam hammers supported by the cranes. Water was pumped from the ditch at rates varying from 2 to 8 million gallons per day. This gallery was completed and put into operation early in 1917, and completes the extensions up to the present time.

Low Lift Pumping

Owing to the lowering of the river level about 2 ft., by sand dredging operations and the inadvisability of raising the brush and rock fill dam previously mentioned to a sufficient height to overcome this loss in head, it became necessary in 1916 to install a motor driven low lift centrifugal pump of 5 M. G. D. capacity, to furnish water to the Emergency Filters during periods of drouth. This plant was replaced the first of this year by a permanent low lift pumping station, located at the extreme end of No. 6 Gallery. The station contains 2 motor-driven centrifugal pumps each of 5 M. G. D. capacity, which take their water from the river and discharge it into a series of ditches and pools extending along the land side of the gallery as far as the Emergency Filters. It has been demonstrated that this method of irrigation furnishes water of equal quality to that filtered from the river and that it filters at the rate of about 1 M. G. D. per acre flooded. At present only one pump is operated, and then during low water stages of the river although the average daily consumption has grown to over 8 M. G. D., and a maximum rate of 17 M. G. D. was reached last August for a short time.

In the normal operation of the galleries the pumping engines at the pumping station lower the water level of the suction well by their demand and this unstable condition of the ground water level thus created causes a draft on the gallery conduits which in turn is replenished by infiltration from the adjacent water-bearing area. The ground water then flows from either side towards the gallery; the greatest amount, however, coming from the river side. During periods of high pumpage the ground water level immediately adjacent to the river has been drawn down to a foot below the level of the water in the river. This heavy draft does not increase the yield from the river as much as might be expected, as it is limited by the permeability of the bed of the stream.

Efficiency of Natural Filter

In conclusion, it is of interest to note the bacterial results of the operation of this natural filter plant. A chemist and two assistants are regularly employed to observe the character and quality of the water, making daily analyses of water from the river, suction well, and tap. During last year the average daily bacterial count of the river, with samples incubated at 20 degrees centigrade was 19,047 per cubic centimeter, while that of the suction well, as filtered through the sands, was 1,061, showing a reduction of 94.5 per cent. The water is further treated with chlorine gas applied by an automatically operated machine which reduced the average daily count for last year to 47.5, or a total reduction of 97.5 per cent. It might be added that this average count at the tap is about double the normal actual count per day, the increase being due to a few high counts caused by abnormal fluctuations in the river.

Acknowledgment

The foregoing is a paper presented by Mr. Luce at the recent annual meeting of the Iowa Section of the American Water Works Association.

How to Provide a County with Good Roads

The improvement of county roads has become so urgently necessary to the proper development of the resources of the county, says the Highway Industries Association, that it is necessary for the county authorities and citizens to devise ways and means of bringing about such a development.

In undertaking this improvement, a number of important features have to be taken into consideration and given careful study. The entire road mileage of the county must be ascertained; the number of miles of roads that it will be advisable to improve; the character of the traffic, that passes over each road; an estimate of future traffic; the ability of the county to raise sufficient funds to improve the mileage selected; and the methods by which this money can be raised.

A close study should be made of the present taxable basis, and the financial obligations of the county, the tax rate, and the amount it would increase the tax rate to build the roads by a direct tax or by bonds. The financial ability of the county having been ascertained, the approximate amount of money the county can raise by bonds or otherwise determined, and the roads classified, a system can be laid out in keeping with the amount of money to be expended with adequate provisions for maintenance.

It is most important that a close study be made of the existing roads, a system laid out, and the cost of improving such a system determined. In estimating the cost, provision should be made for future maintenance so that the burden placed on the county would not be such as to raise the annual tax above that prescribed by law or become burdensome to the taxpayer.

Bonds should be of the serial variety, life not exceeding 25 years, preferably 20 years, and bearing a rate of interest that will make them attractive to investors.

The roads selected should be so co-ordinated as to form a complete system, connecting up the most important points and railroad stations in the county. If the county has no county engineer, the services of an experienced road engineer should be secured to lay out the system, and make an estimate of its cost of construction, and maintenance.

The system of roads having been selected and laid out, cost of construction ascertained, and the financial ability of the county being found capable of constructing such a system, it will then be necessary to plan a campaign of information and education, so that when the issue is put before the voters it will be clearly understood, and the great benefit to be derived may be fully known to every voter.

The best way to bring this about, is to form A Good Roads Organization such as a County Good Roads Association; elect a chairman, a vice-chairman, for each district of the county, and a secretary. Under a vice-chairman each district should form a committee, bringing together as many people as possible who will work for the passage of the bond issue or special law by calling the attention of the members of the legislature, and all the people to the great need for improved roads and the benefit that will be derived therefrom. The committee should extend their activities to such community in the district by holding meetings and sending out literature, setting forth clearly the object of the campaign and what it hopes to accomplish.

Movement to Construct National System of Trunk Line Highways Gains Momentum

The movement to construct a national system of trunk line highways intersecting each state, the cost of construction and maintenance to be borne by the Federal Government, is gaining throughout the country, according to reports coming into the Federal Highway Council.

Many letters are coming in from practically all sections endorsing the movement and calling for explicit information as to the main points in the national highway measure, now pending in the Senate. It is expected to come up for further consideration at an early day.

The national highway bill, introduced by Senator Townsend, chairman of the Senate committee on postoffices and post roads, is an entirely new piece of legislation. Its object is to build in each state, trunk line highways to the extent of not less than 2 per cent., nor more than 5 per cent. of the total mileage of the state, and to join them with the main trunk lines of other states, thus creating a national system connecting the entire country.

The decided trend in public opinion in favor of Federal construction of a national highway system is due, according to those having the measure in charge, to the fact that such mileage as each state will receive will put the state that much nearer to a complete and well connected state system, at the same time insuring logical connections with adjoining states. It is admitted that such connections are necessary to a properly co-ordinated system and that such co-ordination is logically a federal function.

The net result to each state, it now begins to appear, will be a strengthening of forces behind road development. The states on the one hand are to be aided by relieving them permanently of the construction and maintenance of the heaviest traveled interstate routes, thus permitting the concentration of state effort on routes having their terminal points within the state. In other words, more effective co-operation of federal and state power is to be gained by each having its specific work laid out, one applying its efforts to national connections and the other to the development of local or intra-state roads and their proper connections.

Supporters of the national highway movement are increasing their activities in the expressed belief that in the pending measure they are working for a plan whereby a comprehensive system of national highways may be constructed and put into permanent operation within the next few years, and at less cost to the public than under any other plan.

Analysis of Statically Indeterminate Structures by the Slope Deflection Method

In recent years rectangular steel frames with riveted joints have been used, and many types of monolithic reinforced concrete frames have been developed. The use of statically indeterminate stresses cannot, accordingly, always be avoided. Structures are frequently made of an indeterminate type to secure economy of material. It is felt that analyses of statically indeterminate structures are desirable since such information will do much to inspire confidence in the reliability and in the economy of such structures.

An investigation of statically indeterminate structures has been conducted by the Engineering Experiment Station of the University of Illinois to obtain a convenient method of analyzing the moments, stresses and deflections for a number of typical structures. The analyses were based upon the assumptions that the connections are perfectly rigid, that the length of a member of a rectangular frame is not changed by axial stress and that the shearing deformation is zero. The method used in the analyses and the equations derived are published in Bulletin 108, entitled, "Analysis of Statically Indeterminate Structures by the Slope Deflection Method," by W. M. Wilson, F. E. Richart and Camillo Weiss. The method has been explained in sufficient detail to enable the designing engineer to use it in the solution of his problems. It is believed that the fundamental principles presented may be readily co-ordinated with the ordinary principles of mechanics so that the more complex and even the simpler problems may be studied from a new viewpoint.

Copies of Bulletin 108 may be had without charge by addressing the Engineering Experiment Station, Urbana, Illinois.

Rideout Road, Toledo, Ohio. All during 1918 this road was traversed by Army trucks being driven to the Atlantic seaboard. Macadam road resurfaced with "Tarvia-X" in 1913 and treated with "Tarvia-B" in 1916 and 1918.

Total amount invested in this road for 18 years now saved every 10 months!

THIS is Wood County's heaviest travelled road. All automobiles and motor trucks in transit overland around the western end of Lake Erie from Detroit and Toledo to the East must drive over this highway. In fact, most of the overland motor traffic to the South also takes this route.

Mr. John F. Gallier, County Surveyor of Wood County, recently figured that this highway carries 2,000 tons per day for its entire length of 7.36 miles, or more than 5,330,000 ton-miles per year!

This road is a Tarviated highway, and in a very interesting article Mr. Gallier develops the fact that *every ten months* the saving in the cost of operating motor traffic over this highway, as compared with that on a well-drained clay road, *equals the total investment in the road for the past eighteen years.*

Space is too limited to give Mr. Gallier's figures in detail, but a copy of the article, which gives the history and maintenance figures of the road since 1900, will be sent to any interested road engineer or taxpayer upon request.

Briefly, the total investment in the road for 18 years, including three Tarvia treatments, is $99,367.63, or a trifle more than $13,500 per mile.

Figuring carefully and conservatively, Mr. Gallier has worked out the difference in cost of gasoline, tires and oil alone (not taking into account the saving in wear and tear on automobiles and trucks), for traffic over the Tarvia road as compared with the same traffic over a well-drained clay road. Reduced to totals, the figures are:

Total average daily cost of gasoline, tires and oil for motor traffic on clay road . . .	$714.62
Total average daily cost of gasoline, tires and oil for motor traffic on Tarvia road . .	381.73
Daily difference in favor of Tarvia road . .	$332.89
Difference for 365 days	$121,475.85

This means a saving of $10,122.98 per month, or $101,229.80 every 10 months, which is more than the improved road cost to build and maintain for 18 years, including interest, engineering and drainage costs!

Tarvia is ready to serve other communities as it is serving this one, helping them to build and maintain mudless, dustless, automobile-proof roads at low cost—*roads that pay for themselves—roads that are an asset instead of a liability.*

Interesting descriptive booklet telling all about this interesting proposition free on request.

Tarvia

Preserves Roads~Prevents Dust

Special Service Department

This company has a corps of trained engineers and chemists who have given years of study to modern road problems. The advice of these men may be had for the asking by any one interested. If you will write to the nearest office regarding road problems and conditions in your vicinity, the matter will have prompt attention.

The Barrett Company

New York, Chicago, Philadelphia, Boston, St. Louis, Cleveland, Cincinnati, Pittsburgh, Detroit, New Orleans, Birmingham, Kansas City, Minneapolis, Dallas, Nashville, Salt Lake City, Seattle, Peoria, Atlanta, Duluth, Milwaukee, Bangor, Washington, Johnstown, Baltimore, Youngstown, Toledo, Columbus, Richmond, Latrobe, Bethlehem, Elizabeth, Buffalo, Lebanon

THE BARRETT COMPANY, Limited: Montreal, Toronto, Winnipeg, Vancouver, St. John, N.B., Halifax, N.S., Sydney, N.S.

Much Interest in International Municipal Exposition

Since the recent announcement of the International Exposition of Municipal Equipment to be held as a permanent institution in Grand Central Palace, New York, considerable comment has been made in various interested circles throughout the country. Miss Jeanne Carpenter, who is to be the exposition director, has received many letters from manufacturers of municipal equipment, city officials, chambers of commerce, etc., praising the idea and speaking sanguinely for the success of the enterprise. Miss Carpenter is the author of the book, "Municipal Housecleaning." She has had years of experience in this field in various parts of the country and abroad. Her ideas for the exposition are decidedly practical and with the backing that the exposition enjoys, it is an assured success.

The International Exposition of Municipal Equipment is to be one of the eight or nine expositions which will make up the great industrial trade mart of the Merchants and Manufacturers Exchange, occupying the entire Grand Central Palace. The Municipal exposition will be staged on the whole floor with 50,000 sq. ft. floor space. The Merchants and Manufacturers Exchange of New York, which operates Grand Central Palace, is owned and controlled by the Nemours Trading Corporation, of which Alfred I. Du Pont is president. This corporation has representatives in all leading cities throughout the world, consisting of 19 branch offices and 3,000 foreign selling agencies.

The exposition is to include all that pertains to the construction and proper management of municipalities—for water, heat, light, power, fire protection, health, education, policing, amusement, and other departments. City officials, municipal engineers, members of Chamber of Commerce from many cities throughout the world will visit Grand Central Palace and the permanent Municipal Exposition will afford a most convenient means of putting the manufacturer of equipment in direct touch with the interested buyer.

A number of letters received by Miss Carpenter state that there has been an urgent need for just such an exposition as this. Detailed information can be obtained by writing or calling at Suite 421, 405 Lexington Avenue, New York City.

Removing a Concrete Engine Bed by Blasting

In removing an old engine bed or foundation, holes should be drilled vertically to a depth at least three-quarters the thickness of the piece. If there is machinery nearby or other property likely to be damaged, it is best to fire only one hole at a time. It is difficult to say definitely just how to space the holes, because the shape and dimension of the bed may be very irregular, but it can be taken as a safe rule to use about one-third of a 1¼ x 8 in. cartridge of ammonia 40 per cent. dynamite per cubic yard of material to be broken.

More can sometimes be used with safety, but as a general rule, if the charge is thus proportioned, no material will fly and yet it will be crumbled and cracked up so that it can be readily removed by hand labor.

An engine foundation 12 ft. long, 4 ft. deep, about 3½ ft. wide, was successfully broken by drilling three vertical holes, each 3 ft. deep, along the center line, using one-third cartridge of 40 per cent. ammonia dynamite 1¼ x 8 in. per hole. One hole was shot at a time.

Dynamite was successfully employed in breaking up a brick and cement foundation for heavy machinery. The base was a solid mass, 8 to 10 ft. deep. The method used was as follows: Eight holes, 5 ft. deep, were drilled vertically into the block. Small charges of dynamite were loaded in the holes and well tamped in. Electric blasting caps were inserted, in all eight charges, and by means of the wires connected up in series on the surface so as to get the cumulative effect of a combination shot.

As there was a large skylight less than 30 ft. from the base, besides other machinery nearby in the room, it was necessary to cover the bore holes first with burlap bags and afterwards with some heavy pieces of timber to prevent flying pieces of masonry from causing damage. When all was ready the charges were connected up to a blasting machine and fired. The result was that the block of masonry was shattered so that the various pieces could be handled and carried away by laborers. The entire job was done in two hours.

Pave Now!

"Next year we will win," was the Allied boast,
While it sparred and felt out the Teuton host.
And press and rostrum proclaimed the day
Of Victory—always a year away.

But Foch was a man of different mind,
Chafing at schedules a year behind;
He forced the arrogant foeman to bow,
By betting divisions on each golden NOW.

"Next year we will pave," is the laggard's plan,
Shirking decision as long as he can;
While capital stagnates and idle men reek
Of the fatuous cult of the Bolshevik!

Oh, vainest illusion to "pave next year"—
That mythical season that never gets here!
One season—one moment, does fortune allow
For the use of mankind, and that moment is NOW.

Present Status of State and Federal Aid Road Work in Alabama

The following is status of State and Federal Aid work at present time in Alabama:

50% of cost and estimates is paid by the Government

Completed, cost	78.78 miles,	$299,268.99
Under Construction, cost.....	97.73 miles,	532,089.76
Approved—work pend., cost..	111.45 miles,	599,130.91

From the above it will be seen that there is under way and pending 209.18 miles of road work to cost $1,131,220.67.

The State Highway Department has no authority over County work and has no way of knowing with any degree of accuracy how much work is contemplated by counties. No counties are issuing bonds.

Added Life for Galvanized Iron

Many firms and individuals who use galvanized iron seem to believe that since it is galvanized, it is automatically proof against all forms of deterioration, due to exposure to the elements. It is quite true that galvanized iron is one of the most durable materials of its weight and will stand quite a large amount of exposure before beginning to rust. However, continuous exposure to moisture will start the molecules of iron to rusting and when once through the outer galvanized coat, the damage is done.

This could be avoided by the use of a galvanized iron primer. After a primer has been applied, a good rust inhibitive paint should be used. This gives life to the galvanized iron and also prevents the formation of rust which would occur if the iron were not painted.

Many large users of galvanized iron about their factories are beginning to realize that in order to secure the best results from a standpoint of economy and service, it is necessary to paint the iron at intervals of two or three years. This policy adds many years of life to their sheds and buildings on which the galvanized iron is used.

WATER WORKS SECTION

How the Water Supply for 6,000,000 People Is Made Safe

By Wm. W. Brush, Deputy Chief Engineer, Bureau of Water Supply, Gas and Electricity, Municipal Building, City of New York

Imagine if you can six millions of people, or three times the number of soldiers we had in France, living in an area that is 32 miles in length by 15 miles in width, occupying some 360,000 buildings, each one daily requiring 35 kitchen-size pailsful of water, or enough pailsful each day to extend one and two-thirds times around the earth if placed in line, and you then have some idea of the magnitude of the task of supplying New York City with its water supply.

Under the law the duty of seeing to it that an ample supply is at all times available is placed on the Department of Water Supply, Gas and Electricity, to which is also given the responsibility of maintaining pure and wholesome the water so furnished. This is no small undertaking, and can only be successfully executed by constant effort of a small army of men, some of whom must be on duty at all times of the day and night, and for every day in the year. The detailed story of how sufficient water is gathered, stored, and then delivered through great aqueducts of a total length of several hundred miles, is a most interesting one, but we are not now to set this forth, but to tell how this vast quantity of water is guarded and made safe for all to drink freely of it, whether one lives in the most crowded tenement or dwells in a palace on Fifth Avenue.

Jurisdiction of the Commissioner of Water Supply, Gas and Electricity

The charter places on the Commissioner of Water Supply, Gas and Electricity the responsibility for "the preservation of all lakes and all waters from which a supply is drawn by the city * * * from injury or nuisance, and for the execution of such measures as may be necessary to * * * preserve and increase the quantity of water and keep it pure and wholesome and free from contamination and pollution." The health law of the state has granted to the commissioner the power to make such rules and regulations as may be necessary for the protection of the water supply, subject to the approval of the State Board of Health, said state board fixing the penalties that are to be imposed for violation of such rules and regulations.

The commissioner is also given the right summarily to abate any nuisance by seizing of property, but the city is made liable to the property owner for such action on the part of the commissioner. The law is interpreted that property owners are required to abate at their own expense nuisances where such nuisances can be abated within the limits of their own property, and the city must bear the expense of furnishing the means of abating nuisances where the property owner cannot abate the nuisances within the limits of his property. The law requires the issuing of permits for fishing, boating, and cutting of ice, to those who desire such permits, but these permits are to be issued under such rules and regulations as the commissioner may impose. There is apparently ample authority legally given to the commissioner to handle the pollution problems which may arise, but the extent to which the city is to meet the expenses requires legal determination, and in some cases, court action. So far very few cases have been brought to the courts, as settlements have been made without recourse to such tribunal.

Water Supply System

A brief summary of the water supply system of the city is a necessary preliminary to the discussion of its sanitation. New York now consumes and wastes daily about 650,000,000 gals., of which the municipal system furnishes some 610,000,000 gals., while seven private companies serve about 40,000,000 gals., to nearly one-half million people in various wards in Brooklyn and Queens. The department has supervisory jurisdiction over the private water companies as well as operating and maintaining the municipal system. Since the Catskill supply was generally introduced some two years ago it, together with the small Bronx and Byram supply, merged with it, has furnished two-thirds of the supply, the remaining third being drawn from the Croton system, leaving the former Brooklyn, Queens and Richmond supplies in reserve. We will, therefore, limit our story to the Catskill and Croton waters and to the private water companies.

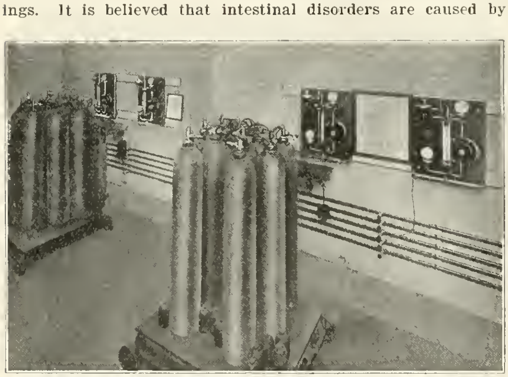
BIRDSEYE VIEW OF THE WATER SUPPLY OF NEW YORK CITY.

The Catskill supply is from Esopus creek, which has been damned at a point about 10 miles back from Kingston, where the Ashokan reservoir is formed, holding 130,400,000,000 gals., and forming a lake with a short line of 40 miles. About this dam there are 257 sq. miles of hills and valley, of which some two-thirds is woodland, with a resident population of 5,000 and 7,000 additional in the summer time. In the Croton water-shed there is an area of 375 sq. miles with 16 reservoirs and ponds holding 104,400,000,000 gals., and a population of 25,000, which does not vary greatly from winter to summer. The main reservoir, and from which the supply is directly drawn into the aqueduct, is Croton Lake, where over 30,000,000,000 gals. are normally stored.

The private companies all draw their supplies from the saturated sands and gravels which underlie Long Island and the waters in which come from the rainfall, percolating slowly through the soil on its way to the bay, sound, or ocean. Small stations, each usually furnishing less than 5,000,000 gals., daily, collect this water and deliver it into the distribution mains.

What Makes Water Unsafe or Objectionable for Human Consumption

In safeguarding a water supply, consideration must be given mainly to what may cause (a) disease, (b) tastes or odors, (c) discoloration or turbidity. The disease germs, which are well recognized to be water bourne, are typhoid, cholera, and anthrax, the latter being an animal disease which rarely occurs in human beings. The typhoid and cholera bacteria can only originate in the waste discharges of human beings. It is believed that intestinal disorders are caused by



THE KENSICO CHLORINATION PLANT OF THE NEW YORK CITY WATER WORKS.

Each cylinder holds about 100 lbs. of liquid chlorine at a pressure of 125 lbs. per sq. in. The flow of this chlorine is controlled by the Wallace & Tiernan machine attached to the wall panel. This machine uniformly delivers the desired quantity of chlorine with which to treat the water.

polluted waters which do not carry any of the disease bacteria noted above, but this has not been clearly proven. Typhoid bacteria will live in what is otherwise a reasonably pure water for from several days up to about three weeks, and the resultant long period of storage required to make safe a water so polluted is evident.

Tastes and odors are popularly considered to develop from organic matter, such as leaves and grass decaying in the water. It is seldom that such is the cause, as the true cause is shown by the microscope to be minute plant or animal growths, which may multiply to many thousand units per cubic centimer (equivalent to about seven drops of water) and the majority varieties of which give characteristic tastes or odors. The organisms most common in the New York City supply, with their characteristic odors, are as follows:

Diatoms—Asterionella Tabellaria—produce geranium to gassy and fishy odor.

Cyanophyceae — Anabaena Aphanizomenon — produce grassy to pig-pen odor.

Protozoa—Uroglena—produces oily and fishy taste; Synura produces cucumber and bitter taste; Dinobryon—produces fishy odor.

Schizomycetes (Crenothrix)—clogs well systems.

There is no harmful effect from these growths, other than rendering the supply unpleasant, and one's health will not suffer from using water in which these organisms are abundant. They may persist in a water for several months or may spring up and die out in a few days. During the past winter and spring the Kensico reservoir was shut out of direct service, due to Tabellaria being present in large numbers, and only recently has this reservoir been again regularly used.

Discoloration or turbidity of a supply is generally due either to color from a swamp area or to finely divided clay or silt, which is carried in suspension, due to heavy storms, or may come from clay springs where highly turbid water carrying a large percentage of clay is being constantly discharged. It is interesting to watch the clearly defined line between the turbid water and clear water in the Ashokan reservoir, when heavy stream flows are washing clay and silt into the head waters of the reservoirs, but usually this material is held in this portion of the reservoir and settles, without reducing noticeably the clearness of the water in the body of the reservoir.

Iron is a most frequent cause of complaint of so-called "dirty water." If present to a larger degree than one-half of a part per million by weight, it is likely to cause a yellowish red color, with a noticeable turbidity. Both the Croton and Catskill waters have a low iron content, and if iron is seen in the water as drawn it comes from corrosion of the pipes in the building, or possibly, but not likely, from the sediment in the cast iron street mains, having been stirred up by unusually heavy flow through them, such as is caused by a large fire.

Minor pollution is caused by sea gulls that in fall and winter persist in landing in large numbers in the distribution reservoirs, and which cannot be shot under the law. Dead fish, leaves and other organic matter are present to a varying amount, but do not ordinarily give trouble to the consumer.

How Polluting Substances and Objectionable Growths Are Excluded or Destroyed

In every water supply which is derived from surface waters there is always the possibility that pollution may occur at any time, and in most of such supplies it is a certainty that pollution is present at all times. This is true of the New York City supply, and the problem is how great an expense is warranted in excluding polluting matter when it is known that the supply cannot be kept free from contamination. Up to about 15 years ago it had been the city policy to purchase lands bordering the reservoirs in the Croton watershed, and in some locations a strip of land along the stream usually 100 ft. or more in width, and thus endeavor to keep polluting matter from reaching the reservoirs and streams. The legislature at that time passed a law preventing the acquirement of further lands for this purpose. It is estimated that if this former policy were followed throughout the Croton shed, many millions of dollars would be required for the purchase of such lands, and the city's taxes on lands, which are now about $450,000, would be greatly increased. During the past decade there has been an effort made to purchase land around the margin of all reservoirs, but to make no purchase along streams, and this policy was followed by the Board of Water Supply in connection with the Catskill supply. Such policy has been a very disappointing one to those who own lands which they desire to sell to the city at a much higher price than would be paid by private purchasers, and this desire to sell has caused some owners to increase the pollution in the hope that the city would be forced to buy such land. The city is required to furnish a property owner with the necessary facilities to dispose of sewage if the sewage cannot be disposed of on the land in question, but the property owner cannot impose an unnecessary expense on the city. The legislature has required the city to allow boating, fishing, and cutting of ice on its reservoirs under such reasonable rules and regulations as may be conisdered necessary.

City Policy on Protecting Its Water Supply

The present city policy on protecting its water supply is affected by the legislation mentioned, and is outlined as follows:

a—Own land around the shore line of all reservoirs.

b—Prohibit by suitable rules and regulations the discharge of polluting material in such a manner as to threaten the contamination of the supply.

c—Discourage the establishment of institutions in the watershed which would house those who do not normally reside within the watershed limits.

d—Collect, treat and dispose of sewage from villages and from individual private property when necessary.

e—Require property owners to submit for approval plans for proposed sewage disposal systems which must later also receive the approval of the State Department of Health.

f—Supervise the maintenance and operation of private, factory and institutional sewage plants, and furnish chloride of lime to treat continuously and sterilize the sewage from the institutions.

g—Treat with chlorine all city operated sewage plant effluents, and to so treat a portion of the water before it reaches the reservoirs and all the water while in the aqueducts on its way to the consumers.

h—Treat with copper sulphate, distribution reservoirs when microscopic growths become troublesome, and also so treat the shallow bays and coves of the storage reservoirs.

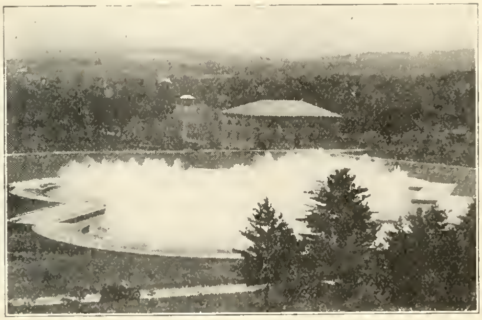
i—Frequently and regularly examine all parts of the watershed to see to it that any violations of the rules or regulations are promptly reported and speedily abated.

Organization to Safeguard Quality of Water Supply

The organization to watch over the purity and safety of the water supply and prevent the pollution thereof, is headed by an engineer who is an expert in sanitation as far as it relates to water. Under the engineer in charge in the Catskills there is a supervisory inspector, with seven inspectors, who cover the inhabited portions of the watershed by inspections which daily require some ten miles of walking by each man. Each inspector has a district within which routes are laid out, and the frequency with which each route is covered depends upon the sanitary importance of such route. Some important points are seen daily, but usually a week or more elapses between inspections. All cases of typhoid occurring on the watershed, of which there are usually about five yearly, are reported, blood tests made, and sterilization of discharges effected. A squad of sanitary laborers, with an auto truck, is assigned to correct all conditions reported by the inspectors, which cannot be remedied by them, and also to move toilets to new locations as remote as possible from the streams. In the Croton watershed, the organization is similar, except there are 2 supervisory inspectors over the 25 inspectors employed therein. All questions of sanitation that arise are handled as diplomatically as possible, and effort made to secure the co-operation of the property owners or tenants. This co-operation is usually obtained and there have been but few cases which have had to be referred to the corporation counsel for legal action.

Where sewage of human origin is present in sufficiently large volume to require other treatment than that afforded by a leaching cesspool, it is disposed of as far as possible by sub-surface tile drains, or open absorption trenches, and thus the sewage travels through many feet of soil before reaching the nearest stream. This cannot always be done, and there are two instances in the Croton system where sewage, after being purified and filtered, is treated with chlorine, and then discharged directly into the stream, which eventually discharges its waters into Croton Lake. The sewage so treated is practically sterile, and from a bacteriological viewpoint is better than the water supply which is furnished to many American cities and towns. The percentage of removal of B. coli, which is the typical intestinal bacteria used to determine the extent of pollution, averages over 99.9998 in these plants.

In the Catskill watershed the soil is generally unfavorable for rapid absorption of drainage water, and war has interfered with the department carrying out its plans to sewer certain communities and thus prevent sewage of human origin



THE ASHOKAN AERATOR FOUNTAIN, WHERE 375,000,000 GALS. PER DAY ARE SPRAYED INTO THE AIR TO RELEASE CONTAINED GASES AND DESTROY FRAGILE MICRO-ORGANISMS.

entering the Esopus creek and its tributaries above the Ashokan reservoir. There is, therefore, sewage now discharging into this creek and polluting the waters. At Phoenicia the department maintains a plant which introduces a solution of chlorine into the Esopus stream which destroys the bacteria. This plant is so located as to treat all water which is subject to such sewage pollution, and thus purifies the water before it enters the Ashokan reservoir. In the Croton valley there are several streams which pass through communities, so that incidental pollution cannot be avoided, and these are also treated with chlorine.

Chlorine Treatment of Water

The use of chlorine for treatment of water to destroy bacteria is a comparatively recent addition to the available safeguards for water supplies, as its use has developed almost wholly during the past decade, and is now the most important next to filtration. It can be obtained either in liquid form, or as hypochlorite of lime, which contains about 35 per cent. by weight of chlorine. It costs in the liquid form about 7 cts. per pound, and usually in the New York City supply only from one-tenth to two-tenths of a part per million by weight is used. This is equivalent to from 0.8 of a pound to 1.6 of a pound of chlorine for 1,000,000 gals. of water, or a cost for the chemical of about 10 cts per 1,000,000 gals. The amount of chlorine now used is so small that its presence cannot be detected by the most acute taste.

When chlorine was first used at Phoenicia several hundred trout and other small fish were killed, and immediately complaint was made to the State Conservation Commission. After a few days the dead fish ceased appearing, and subsequent experiments showed that the amount of chlorine applied could be reduced to an amount too small to affect even the most delicate fish. The trout are frequently seen swimming up to the treatment pipe and leaping over it, and indicating no diminished vigor from living in the chlorinated water.

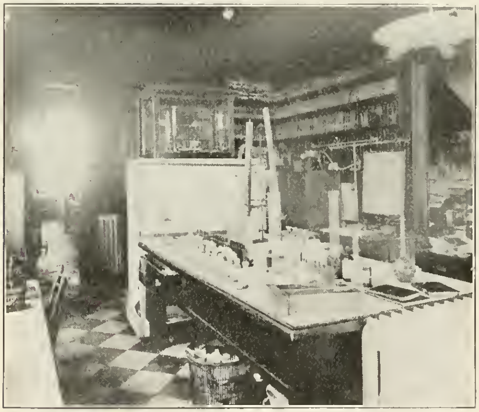
Treatment of Microscopic Plant Forms With Copper Sulphate

When water stands in reservoirs it may at any time and without previous warning, develop almost overnight microscopic growths, of which a number of forms are very objectionable, due to the disagreeable taste and odor produced thereby. The growths, which quite frequently multiply in the

New York supply, and the characteristic taste or odor, have been previously mentioned in this report. They are plant forms which have no effect on one's health, but it is hard to make the consumers believe this, and it must be admitted that their presence makes the water most objectionable. Fortunately, these plant forms are quickly killed by the addition of copper sulphate in as small a quantity as 1 lb. per 1,000,000 gals. of water. It is usually put in the water by placing the copper sulphate in a bag of porous material and dragging it through the water at the stern of a row-boat or small launch. The water treated should not be used for three or four days after the treatment, so as to permit the copper sulphate and the dead algae to settle and the taste and odor to disappear.

Storage

One of the very important safeguards that is available for New York's water supply is the long period of retention of the water in the immense reservoirs connected with the Catskill and Croton systems. In the Croton watershed there are 16 reservoirs and ponds having a total storage capacity of 104,400,000,000 gals., of which nearly one-third is stored in Croton lake. This vast volume of stored water is enough to provide New York with water for one year at the present rate of draft on the Croton system, even though not a single drop of water was added during the year. In the Catskills, the Ashokan reservoir has 130,000,000,000 gals., and at the present



THE BACTERIOLOGICAL ROOM OF THE MT. PROSPECT LABORATORY, BROOKLYN, WHERE THOUSANDS OF WATER SAMPLES ARE YEARLY EXAMINED.

rate of draft would last nearly one year. There is also the Kensico reservoir in the Catskill system, between the Ashokan reservoir and the city, holding about 30,000,000,000 gals. It is therefore reasonably certain that most of the water entering these reservoirs will remain therein for several months during which time disease bacteria will die from starvation, due to the general purity of the water. Also the dirt in the water will be almost wholly eliminated.

Aeration

The microscopic growths may develop in these reservoirs and also carbon dioxide gas may be present, which it is desirable to eliminate as far as possible. In the new Catskill system provision has been made for aerating the water by shooting it up in the air through nozzles, and thus forming enormous beautiful fountains. There is an aerator at both Ashokan and Kensico reservoirs, but, due to the greater head available, the fountain at Ashokan is the more impressive. The water does not need more oxygen, which it could obtain from this fountain action, but it is improved thereby through the liberation of contained gases and the breaking up of some of the more fragile of the micro-organisms.

The final act in making the water safe for the consumers is the treatment of all the water with chlorine while it is in the aqueducts, and flowing to the distribution reservoirs and pipes in the city. Liquid chlorine is used for both supplies, the Catskill water being treated at Kensico just after it leaves the reservoir and at a point about 12 miles from the city line, while Croton water is treated at Dunwoodie, about 4 miles from the city line. These plants are among the largest in the world, and daily treat some 600,000,000 gals. The water as it comes to these plants is usually in a condition that would be considered good for a domestic supply, but as no chance should be taken in safeguarding the lives of 6,000,000 people, this final treatment is given.

Typhoid Rates

The usual index of the purity of a water supply is the typhoid death rate of the community. In New York city the rate is now very low, as shown by the following comparison with the record of other cities having a population of over 500,000:

	Death rate per 100,000
Chicago	1.4
Boston	2.5
Philadelphia	3.0
New York	3.3
Cleveland	4.7
St. Louis	7.2
Pittsburgh	9.8
Detroit	10.0
Baltimore	12.2

It is considered certain that what typhoid does develop in New York is due to causes other than water supply. Charts are made of all cases reported, and some very interesting results have been found from studies of the local epidemics. Various causes have been found, such as typhoid carriers, milk contamination and ice cream contamination.

Very little need be said about the treatment of the supplies from the private water companies, as fortunately their source of supply is uniformly the water flowing through the saturated sands and gravels of Long Island, and the water is therefore naturally filtered and only need be guarded against contamination after it is drawn from the ground through the wells. This is the type of development of the supply used by all the private companies. A careful watch over the water furnished is maintained by the department force, and regular monthly examinations made of all supply works.

The Laboratories and Their Work

To determine the condition of the water and its contents, and also the effectiveness of protection from pollution and of the treatment applied to the various supplies, it is essential that there should be available well equipped laboratories, manned by experts who are constantly sampling and examining the various supplies. New York has three of these laboratories, the main one being at Mt. Prospect reservoir, Brooklyn, with branches at Mt. Kisco for the Croton system, and at Ashokan reservoir for the Catskill waters. Connected with these laboratories there are 16 men, and about 13,000 samples are examined yearly. At some nine points daily samples are taken, as these samples represent the supply furnished in the various sections of the city. The usual frequency of sampling varies from weekly to monthly. The results are sent to the operating and maintenance force who can call on the laboratory experts for aid in investigating any unusual problem which presents itself. The laboratory force undertakes a large amount of original research work as well as its regular routine work, and has to its credit many advances in the art of water examination and analysis.

Results Secured for New York City

Every hour of the day or night anyone in New York City can turn on the faucet and draw a glass of water which is certain to be safe from disease breeding germs and satisfactory for either domestic or manufacturing use. This is due to the effective daily work of the many men employed by the city to make its water supply safe and the $166,000, spent yearly for protecting and treating the water is certainly giving excellent returns. How soon the city will demand the higher standard of a perfectly clean, clear water, free at all times from tastes and odors cannot be now determined. Filtration is the only way to secure this improvement, and as the public seems well satisfied with the supply now furnished, the expenditure of millions for filtration appears to be one that will not be undertaken for some years to come.

The present head of the Department of Water Supply, Gas and Electricity is Commissioner Nicholas J. Hayes, and the Chief Engineer of the Bureau of Water Supply is Merritt H. Smith.

Design Features and Form of Contract for Constructing a Large Earthen Water Supply Dam on Cost Plus Fee Basis

By Jacob L. Crane, Jr., and J. G. Kimmel, with Gannett, Seelye & Fleming, Consulting Engineers, Harrisburg and Erie, Pa.

On May 8, 1919, the Girard Water Co. of Pottsville, Pa., awarded a contract on the cost plus variable fee basis, for an earth fill dam and reservoir to be constructed on Whiskey Mill creek in Schuylkill county, Pennsylvania. The dam and reservoir, which will cost about $200,000, are to provide additional storage to tide the Water Company over the dry periods in summer and fall.

Layout and General Features of Water Works

The interesting layout of the water company property is shown on the accompanying map, Fig. 1. The sources of supply are Dresher's Run, upon which Reservoir No. 5 is located, Whiskey Mill creek, upon which there is a small intake connected with Reservoir No. 5 by a 16-in. gravity main, and Little Catawissa creek, upon which there is another small intake. The water of this latter creek is only used in times of drouth, the water being then pumped directly from the intake.

The water collected from these sources is pumped through the station shown just below Reservoir No. 5, against about 600 ft. head, to the top of Locust mountain into Reservoir No. 3, from which it runs into Reservoirs Nos. 2 and 4. From all three of these reservoirs it is distributed by gravity to the collieries and villages in the Shenandoah and Mahanoy valleys immediately to the south. The collieries and their connecting railroads take 86 per cent. of the water supplied by The Girard Water Company, only 14 per cent. being used for domestic purposes.

These valleys form the most productive part of the Southern Anthracite coal field, and the mining operations have made it impossible to collect surface or ground water in this area. In fact, the mining operations have extended to the top of Locust mountain, where a great stripping operation, begun in 1913, has almost entirely destroyed the watersheds formerly tributary to Reservoirs Nos. 2, 3 and 4, and will soon force the abandonment altogether of Reservoir No. 4, which is underlaid with valuable beds of coal. There is one bed of coal under Reservoirs Nos. 2 and 3, but this is comparatively thin, and the reservoirs are worth more for storage and distributing purposes than the coal. These factors drove The Girard Water Company over into the Catawissa Valley, which is purely an agricultural region, for its sources of supply, and in 1913 and 1914 the No. 5 reservoir and pumping station were built on Dresher's Run.

This reservoir impounds 312,000,000 gals., at spillway level from a watershed of only one square mile, with an average annual rainfall of 54 ins., and a mean run-off of about 45 per cent. The area of the reservoir is 41 acres and its maximum depth 51 ft., 6 ins. Reservoir No. 5, for which Mr. J. W. Ledoux of Philadelphia made the plans, is an earth fill structure with a concrete pavement on the upstream face and a cut-off wall of concrete and clay puddle at the upstream toe. The reservoir and dam, the stone house of the pumpman and the pumping station make a fine appearance as viewed from Locust mountain in the setting of this beautiful valley.

Pumping

The pumping station is equipped with three 5-stage centrifugal pumps, operating against a head of 583 ft., or a pressure of 273 lbs. per sq. inch. The pumps are driven by three 250-H.P. electric motors. A fourth unit has been ordered. With this the capacity of the plant will be 6,000,000 gals. per day. The pumps have given splendid service and up to January 1, 1919, showed but little loss of efficiency after being in operation since Sept. 16, 1914, a total of 25,710 pump hours. Since Nov. 1, 1918, however, it has been necessary to pump directly from the Little Catawissa creek, in order to conserve the supply of stored water, and as this was not contemplated when the plant was designed, the water does not pass through the screen pot, as does the water from Reservoir No. 5, nor is there an opportunity for the sediment in the water to settle. This has caused more wear to the pump parts in six months than in the previous 4 years. The use as a suction main of the long supply line from the Little Catawissa intake causes a considerable drop in the capacity of the pumps, as compared with their duty when pumping from Reservoir No. 5, from

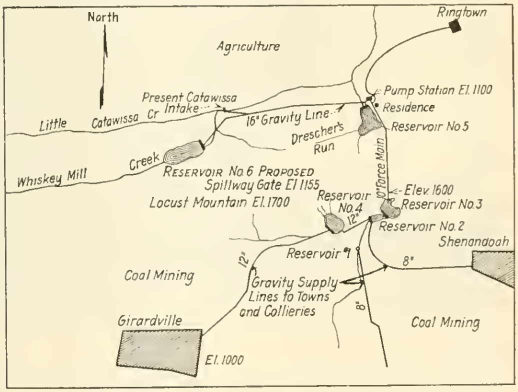


FIG. 1. MAP OF GIRARD WATER COMPANY'S RESERVOIRS AND PIPE LINES.

which water is supplied to the pumps above atmospheric pressure. The new reservoir, No. 6, will so increase the supply of stored water as to do away with the necessity of supplementing it from the Little Catawissa.

Consumption of Water

The demand for water from The Girard Water Company has increased very rapidly in recent years, as follows:

Year	Total Water Consumed
1912	444,729,136 gals.
1913	508,162,356 gals.
1914	471,287,900 gals.
1915	565,475,640 gals.
1916	830,404,236 gals.
1917	942,261,648 gals.
1918	1,057,487,984 gals.

In the studies for Dam No. 6, carefully drawn mass diagrams developed the fact that Reservoir No. 5, and the unstored waters of Whiskey Mill and Little Catawissa creeks would not provide sufficient water the year around to supply the demand in the immediate future. This is checked by the actual experience of the last four years, during which the stored water has steadily decreased in volume. It therefore became necessary to store the water of Whiskey Mill Creek as soon as possible, to collect the high winter and spring run-off and so hold a larger available supply for the dry periods.

Design of Dam

On account of the high cost of material, delivered on the site, for a concrete or a masonry dam, an earth fill type was selected. Embankment material can be obtained from the south side of the reservoir with an average haul of 1,000 ft.

The cross section of the dam is shown in Fig. 2. It will be 850 ft. long at the crest, 246 ft. wide at the base, and have a maximum height of 50 ft. The upstream slope will be 2½ to 1, protected by a 15 ins. layer of hand-placed stone paving. The downstream slope is 2 to 1, with a 5 ft. berm half way down the slope. A concrete spillway, 30 ft. wide will be built at the south end of the dam, the crest of the spillway to be 5 ft. below the top of the dam.

cost of the work, plus a fee, with a bonus and penalty for under-run and over-run of estimated cost, respectively, may be outlined as follows: An accurate account of the actual cost, segregated as to different items of the work, is to be kept jointly by the engineer and the contractor, and the latter is to be paid this actual cost, which includes everything immediately connected with the work, but excludes home office expense, interest on funds used, and all overhead, except that actually incurred in the field. Monthly payments are to be made to the contractor of the actual cost for which he has made approved bona fide disbursements, plus 3 per cent. on account of fee.

The contractor's proposal and contract give unit estimated costs and a total estimated cost for the work, a percentage of the total estimated cost as fee for the construction, a time within which he agrees to complete the work (with a penalty for liquidated damages of $40 per day for exceeding that

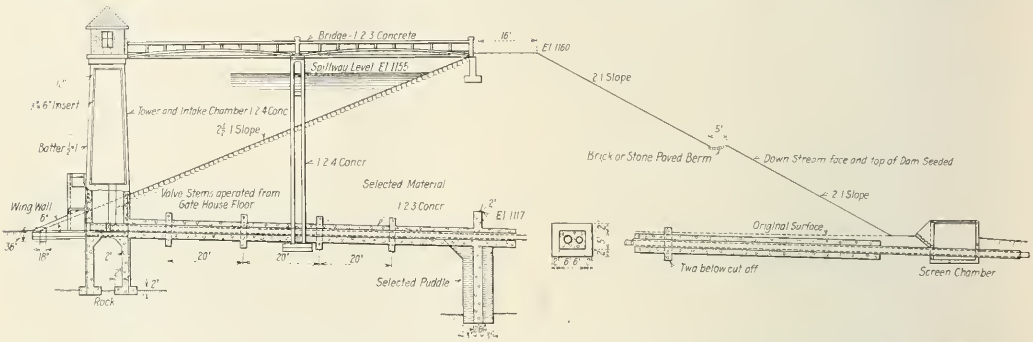


FIG. 2—CROSS SECTION OF THE EARTH FILL DAM OF THE GIRARD WATER CO. ON WHISKEY MILL CREEK. SCHUYLKILL COUNTY, PENNSYLVANIA.

A concrete cut-off wall with a 3 ft. puddle wall on each side, will extend from solid rock up into the dam about 3 ft. The bed rock in this vicinity is a broken, seamy, red shale. To reduce the loss of water through the foundation, this rock will be grouted under pressure to a depth of 25 ft. below the bottom of the cut-off wall.

The drainage area of the reservoir is about two square miles. The water area of the reservoir when full is 42 acres, and the capacity to spillway level is 270,000,000 gals.

Features of the dam are the concrete spillway and gate-tower bridge, which will add greatly to the appearance of the structure, at a minor increase in cost. The gate-tower will be of concrete, but the house surmounting it of gray mountain stone.

Form of Contract

In the spring and summer of 1918, Gannett, Seelye & Fleming designed and supervised construction of a bridge and a dam on the cost plus a fixed percentage fee basis. Subsequently they were engaged on government work on which construction was carried out under various cost plus contracts, and with much previous experience of the weaknesses of the old set unit-price contract, it was decided to draw a contract for this work on the cost plus variable fee basis, but in such a way as to allow the greatest scope for competitive bidding, to protect the owner from any loss by an irresponsible contractor, while the owner assumes all normal risk in the place of the contractor, and to secure precisely the desired job at the lowest possible construction cost. Much interest has been shown in the contract and it has received commendation from many engineers and contractors who have seen it.

The contract, under which payment is made for the actual

time), a complete statement of experience and qualifications, and a list of equipment to be used on the job, with total rental prices at which the plant is to be furnished for the entire construction.

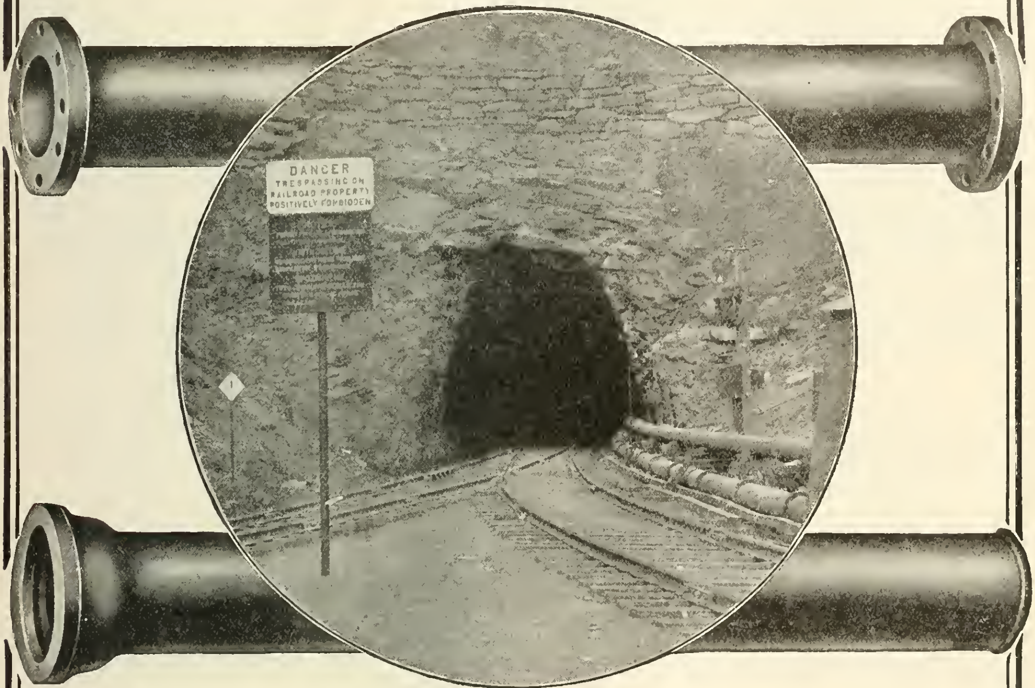
At the close of the work the contractor's total fee is determined as follows: With the actual quantities of work completed and the estimated unit prices bid, a corrected estimated cost is made up. If the actual cost is then less than this corrected estimated cost the contractor receives his bid percentage fee of the corrected estimated cost plus one-quarter of the saving up to $10,000 and one-half of all saving above $10,000. If the actual cost is greater than the corrected estimated cost, the fee is reduced by one-quarter of the excess up to $10,000 and by one-half of all excess over $10,000, but in no case can the fee be less than 3 per cent. of the corrected estimated cost after deductions have been made of penalties for overtime and for excess cost.

Twenty-Three Bids Received

The bids were opened on May 5, 1919, 23 proposals having been received. Ample opportunity to look over the work and to get complete information on the contract and specifications were given to all interested contractors, and there was an unusual amount of interest evinced in the work. A schedule for rating the proposals was drawn up before the opening of bids, and the best proposal selected on the basis of (1) Estimated Cost, (2) Qualifications, (3) Fee, (4) Time for Completion and (5) Equipment Rental.

The bids ranged in estimated cost from $160,000 to $450,000, with eight bids of $200,000 or less, and four between $160,000 and $185,000. The engineers' estimated cost was $175,000. On the basis above outlined the Central Construction Corporation of Harrisburg, Pa., was chosen to do the work, its estimated

"Danger"



This warning has no connection with the lines of cast iron bell and spigot and flanged pipe shown in the picture.

There IS danger, however, to the bank account and tax rate of industries or municipalities using OTHER THAN

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cost being $170,530; fee, 10 per cent.; time, 175 working days, and equipment rental, $20,875.

If this form of contract is as satisfactory on the construction as it has been in securing bids and selecting a contractor, it will demonstrate its great usefulness. In the meantime, it appears that much greater responsibility is rightly placed upon the engineer, that the owner has probably been saved not less than $10,000 on this job, and that a contract for the work more nearly just to both owner and contractor has been put into effect.

It is interesting to note that the Girard Estate, of which The Girard Water Company is a subsidiary corporation, was bequeathed to the City of Philadelphia by Stephen Girard, the income to be devoted entirely to the support of Girard College, a splendid philanthropic institution in Philadelphia maintained for the education of orphan boys between 10 and 18 years of age. The estate is administered by the Board of Directors of City Trusts, who are appointed by the judges of the Courts of Common Pleas of Philadelphia and who serve without compensation. Five of these constitute the Board of Directors of The Girard Water Company.

James Archibald is mining engineer of the Girard Estate and general manager of The Girard Water Company, with offices at Pottsville, Pa. Gannett, Seelye & Fleming of Harrisburg and Erie, Pa., are engineers on Dam No. 6, with the authors as principal assistant engineer and as designing and supervising engineer, respectively.

The Distribution of Water

By Edward E. Wall, Water Commissioner, Department of Public Utilities, 312 City Hall, St. Louis, Mo.

The distribution system of a water works gives more food for thought to the chief than any other division of the department, and less has been said or written about it than any other by technical men. This is not because it is of less importance, nor that it is uninteresting, nor that its problems are easier of solution than those pertaining to power or purification plants. The distribution force has to deal with the unthinking, and, therefore, unreasonable public on all questions of lack of pressure and quantity, deterioration in quality, disputed assessments of rates, incorrect meters, water waste and other major and minor troubles.

Both pressure and quantity cannot be maintained the same throughout the area supplied by any water works for the obvious reason of differences in elevation, or if the territory be approximately level, as in the lake cities, then distances from the pumping stations and the increasing losses by friction curtail both pressure and quantity to the residences of the outlying districts. Again, during the hours of greatest consumption those nearest the source of supply, using water wantonly and recklessly, deprive the far-away consumer of his just deserts. Despite these irremediable causes of and reasons for annoyance and inconvenience to the consumer, it is not always possible for the distribution office to convince him that he is the victim of circumstances over which neither he nor the office have control and that his condition is similar to those occurrences that are referred to as "visitations of Providence," and must be endured with as much patience as the victim can muster. If it is any consolation to him, he can justly blame the more fortunate consumer on lower ground or nearer the works, who is wasting the water that complainant needs so badly. This being a rather unsatisfactory procedure because it is so impersonal, the aggrieved citizen prefers to visit his wrath on the unfortunate employe of the water works, who represents to him the institution in person.

It is evident that it is humanly impossible to design a system of distributing pipe that will successfully meet all conditions of consumption and maintain an equality of pressure, when corrected for differences of elevation, unless all pipes were made many sizes too large for any possible demand, which is utterly impracticable.

In all probability, as long as water is distributed through pipes under pressure, the water works man will have to listen to complaining consumers and patiently expound to unbelieving ears the mathematical reasons why water will not flow at all times on the second or third floors of houses built on hilltops.

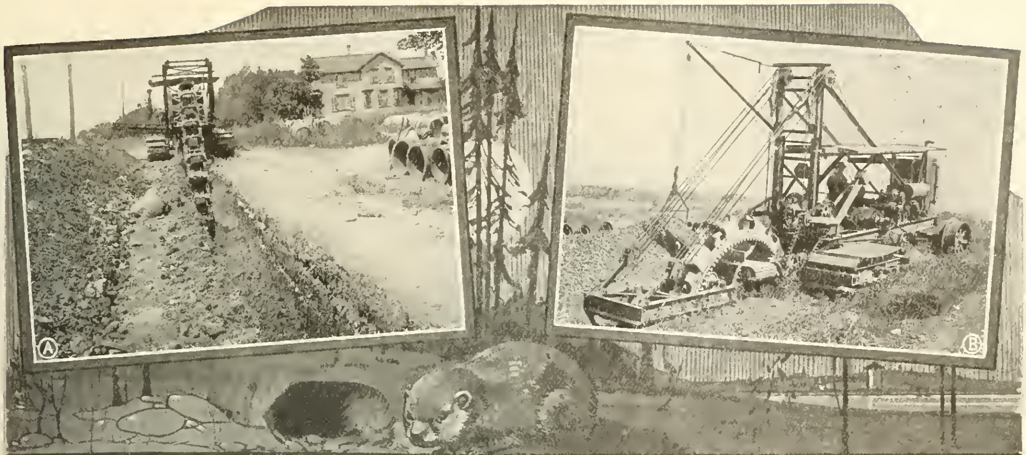
On account of the continually increasing consumption and waste of water as the northern portion of the city of St. Louis built up, in the southern part of the city pressure conditions gradually became worse until it became necessary in 1916 to lay a 36-in. main from the pumping station a distance of about 27,000 ft., to connect directly with the mains supplying the southern district. This 36-in. main had no connections with the distribution system throughout its entire length, and served solely as an outlet for one 20,000,000-gal. pump, which was operated at a pressure sufficiently high to increase the pressure in the southern district at least 10 lbs. during the hours of greatest consumption. It was found that pressures could be kept normal by operating this pump from six to eight hours per day during the seasons of greatest consumption.

Another fertile source of aggravation comes from the extreme delicacy of the sensory nerves of some people, who continuously discover strange odors and tastes in the water. Although tests of samples taken from their faucets fail to show any evidences of the presence of foreign matter, and although they can produce no sample of water taken from their own houses in which an unprejudiced person can find objectionable odor or taste, they remain unconvinced of their error and bob up serenely on some later date with the same complaint. We have had people swear they could taste alum in the water, when there was not a pound of alum in the whole works and when there had not been any on the premises anywhere for a year. Others have been positive that they could detect the presence of lime in the water and that it was ruining their stomachs, when it could be proven by chemical analysis not only that there was less lime in the treated water than in the river water, but that the lime that was left in the treated water was in such a form as to be absolutely harmless to the human system. And so on to the end of the chapter as to the smell and taste of the water.

If it were possible for the water works of any city to supply the people with water from the River of Life which flows through Paradise, still there would be consumers who would find fault with it.

When St. Louis was supplied with water of which Mark Twain said, "Every tumblerful of it holds an acre of land in solution," but little complaint was heard as to odor or taste, for they had been using it for 75 years, but as soon as it was clarified, purified, filtered, sterilized and delivered to them sparklingly clear, large numbers of the population immediately developed a fastidiousness bordering on the miraculous.

To attempt to enumerate the varieties of dissatisfaction which are brought to the office, where water bills are paid, would require more time and space than either the writer or editor could spare. It is one of the remarkable frailties of human nature that the mere possession of a bill for water in many instances produces a sort of temporary aberration and so obscures the memory that the number and class of fixtures in one's residence becomes but vague and hazy recollections, and the faculty of distinguishing truth from falsehood is suspended from action for the time being. Under the obsession produced by the presence of a bill for water, people have been known to do strange things. Garden hose have been stored in baby carriages or gas ovens; water-power washing machines hidden in the coal bin or stable; automobiles have changed owners over night; live stock has utterly vanished in a day, to reappear later; until an experienced inspector develops an uncanny fac-



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ulty of discovering these lapses from righteousness, as though he was gifted with second sight.

No better field for observing the littleness of human nature could be found than is afforded the water inspector in the daily round of his duties. Such a position should be very attractive to a man of keen observation with an eye for the unusual and a saving sense of humor, for the enjoyment to be derived out of the job would far outweigh the lack of proper remuneration for a person of his type.

It is distressing to discover the lack of faith many people have in the accuracy of an instrument so scientifically designed and as carefully constructed as a water meter. Hundreds of consumers are positive that their personal judgment as to the quantity of water used on their premises is more to be trusted than the registration of the meter. In general, a water meter is like a watch, bearing the truth on its face. Occasionally one goes wrong or fails to register; so do watches, but people as a rule do not distrust watches or look upon their faces with suspicion. One reason for the unpopularity of meters lies in the dislike which most people have of being reminded of their carelessness or extravagance by a conscienceless contrivance without brains and with which no argument is possible.

Consumers cannot be made to believe that a leaking faucet will waste 200 gals. of water per day or that a garden hose playing on the lawn will deliver more than that quantity per hour.

The same quirk in the human mind that leads people to buy goods at excessive prices on time payments, prevents the average man from comprehending that he indirectly pays far more for water waste in having to provide funds for new pumps and larger mains to meet growing consumption, than any number of plumbing bills he is likely to have to pay in repairing leaking pipe and fixtures. The gradual increase in his water bills as he and his fellows permit and ignore the reckless waste of water sold under flat rates, does not annoy him nearly so much as would the presence of a meter reminding him of the obligation to stop all leaks in his plumbing and keeping before him the knowledge that every gallon of water drawn on his premises was measured and recorded against him. By and by, when water meters are universally used in all cities and towns, he will accept the change almost unconsciously and forget that he ever aggravated a water works superintendent by advocating a flat rate.

As the character of localities changes in a growing city, the water mains which were ample for residences and small buildings become altogether inadequate for a congested district, dotted with office buildings and wholesale and retail establishments occupying buildings several stories in height.

In the meantime, below the surface of the street there is crowded tightly a tangle of conduits, tunnels, pipes, cables, etc., until it is hardly possible to tap or connect to the gas and water mains which were originally the sole occupants of the underground territory.

To replace the old main with a larger one, to supply the increasing demand for water for office use, for manufacturing and for private fire systems, is so difficult a task as to force the distribution engineer to lay feeders on cross-streets, enlarge mains on parallel streets, and to use alleys whenever possible, before considering the project of entering upon the crowded underground area to lay a new main.

Now, that it is possible easily to measure and record the flow through a pipe, a survey of the mains in any district sometimes brings out some startling facts, for example a main laid with the intention of serving as a feeder into a conjested district may be carrying less than one-fourth its capacity during the hours of heaviest consumption, while some smaller main not intended as a feeder will be carrying its full capacity all the time. Such a survey at once shows where a distribution system needs reinforcement and eliminates all guess-work and fixing sizes of pipe-lines from an inspection of the map.

The great mass of detail involved in the administration of the affairs of the distribution system of any water works, covers an extensive field outside of the difficulties arising from dealings with consumers. Some man with a penchant for writing books might consider the compilation of a decently sized volume on the subject, and he could doubtless find ample material through correspondence with superintendents and engineers experienced in water works operation.

Curtailing Water Waste and Fixing Equitable Rates at Sault Ste. Marie, Michigan

By W. M. Rich, City Manager, Sault Ste. Marie, Mich.

The Sault Ste. Marie water works are owned and operated by the City. The Pumping Station is located on the St. Mary's river about four miles west of the heart of the City.

Elements of the Plant

The plant consists of two-5,000,000 gal. Holly steam pumps and two-150 H. P. Morrison suspension boilers. The pumps have been in service 16 years, and are in very good condition except for the wear and tear that would naturally occur in that length of time.

The intake crib is located on the south channel bank of the St. Mary's River about 1,500 ft. from the shore, in approximately 32 ft. of water. The intake pipe is 36 ins. in diameter, and is laid deep enough to feed the pump well by gravity. The water may be pumped either from the well or from the intake pipe direct.

The pumps discharge into a 24 in. main leading to the City. This discharge pipe is equipped with a Venturi meter and a register-indicator-recorder instrument supplied by the Builders Iron Foundry.

Water is Chlorinated

From the above description it will be noted that there is no question about the abundance of the water supply. However, as to its purity, there is a potential danger of contamination owing to the great traffic that plies the river during eight months of the year. Then, too, during the spring when the ice is going out there is danger of pollution and again in September, when the surface waters from the large areas draining into Lake Superior begin to be felt. To overcome any possible danger from contamination of the water from any of the above mentioned sources, we have installed a solution feed, automatic control, chlorinator. We have equipped a laboratory where daily tests of the water are made, and in this manner every precaution is taken to protect the health of the people.

Since the chlorinator was installed, which was about 14 months ago, there has been only one case of typhoid fever contracted in the City, and in tracing the case, we learned positively that it could not be attributed to the water.

This, in a general way describes the pumping station of the Sault Ste. Marie water works. In the following discussion it will be necessary to touch upon the local situation at the Soo to bring out certain points in regard to maintenance, operation, rates, etc.

In dealing with a modern water works system, there is a great variety of features that enter into its make up, and in discussing briefly such a plant as operated municipally, it would be well to adopt a classification for this discussion. While water works plants may vary considerably in different parts of the country and suggestions applicable to one plant may not apply to another, the following classification will fit very nicely the plants with which I am most familiar.

Physical Features of a Water System

The physical features of a water works system may be broadly divided into supply to pumps, pumping station, water mains, service connections and meter services. In a plant such as the one at the Soo, the supply to pumps simply in-

cludes the intake, the pump well and the cblorinator. However, in some other plants, the supply to pumps department would have to be subdivided and embrace sedimentation tanks, sand fillers, softening apparatus, etc. The pumping station, service connections and meter services would not vary materially in any water works system, but in some cases the water mains would have to include stand pipes and reservoirs.

Municipal Ownership Not Always a Bar to Efficiency

In addition to the physical features of a water works system, we have the department for taking care of the revenue collections and the department to provide for interest and retirement of bonds. In my opinion these last two divisions in the classification are very important, and right here is where the danger lies when a water works system is opened and operated by a municipality. It is a very unfortunate state of affairs, but it is true, nevertheless, that when a plant is municipally operated there is a tendency to make a political football out of it and at each change of administration there is generally a change in all the important offices in the department. As a consequence there is no fixed responsibility or authority, the revenue collections are neglected, rates are not adjusted to meet conditions, and in many instances the funds for retiring bonds are lost sight of completely. In order to make a success of the system the business must be conducted in the same manner as if it were privately owned. There must be some one person to hold responsible and the authority must be undivided. Under the Commission-Manager Plan of City Government, this system of conducting a water works system is possible and there is absolutely no reason why the system should not be as profitable an enterprise as if it were conducted privately.

Budget System and Accounting

In order to operate a municipal water works system successfully, a budget system must be adopted and strictly adhered to. The costs of operation and maintenance must be very carefully kept and from these records the question of proper rates determined. As an example of the budget system as applied to the Soo Water Department, the classification as previously outlined takes care of each division very adequately.

These divisions are themselves divided into expense and capital outlay accounts according to the budget classification. Expense comprises all items of expenditures necessarily incurred for current administration, operation ond maintenance of the several departments; those which the funds are reimbursed; and those for materials and equipment in the nature of renewals or replacements, which do not add to the capital assets of the corporation. The Expense Classification is in turn divided into Personal Service Expense, which is direct labor of persons in the regular or temporary employment of the corporation not chargable to capital outlay; Contractual Services, which are activities performed under express or implied agreement, inviting personal service plus the use of equipment or furnishing of commodities; operating supplies expense, which are commodities of a nature which after use show a material change in, or an appreciable impairment of, their physical condition and rapid depreciation; materials for maintenance expense, which are commodities of a permanent nature in a new, unfinished or finished state, entering into the construction, renewal, replacement or repair of any land, building, structure or equipment; and capital expense and contribution, which consists of rent, taxes, insurance, interest, retirement of bonds, contributions and pensions.

Capital outlay includes all expenditures which increase the capital assests of the corporation. This includes land and land improvement, buildings and public improvements, teaming equipment motor vehicles, furniture and fixtures, and any other additions to equipment which may be necessary and useful in the operation of the corporation, and which may be used repeatedly without appreciable impairment of their physical condition and having a calculable period of serivce.

In arranging the budget for the year all of these accounts are taken into consideration and the total appropriation carefully prepared. The receipts are also carefully estimated and the estimated surplus is thrown into the departmental division for interest and retirement of bonds.

The need for accurately accounting for the expenditures of the funds of a water works system is obviously greater now than at any previous time; owing to the fact that the cost of everything entering into the operation and maintenance of the system has greatly increased in the last 2 or 3 years, while in most cases the water rates have remained the same, or if they have been raised at all, have not been raised sufficiently to offset the greatly increased cost.

Water Waste

Because of the increased cost of operation and maintenance it is more important than ever that the great wastage that occurs in practically all of the American cities be stopped. I think I will be borne out in the statement that in the majority of cities a large proportion of the water that leaves the pumping station never performs any useful work. Some of it is wasted through the ground owing to poor construction of the mains and service connections, some is wasted through faulty plumbing and carelessness af the consumer where there is no meter, and in some cases a considerable amount of water is wasted in the winter time where it is necessary to leave the faucets open to prevent freezing. All of this wastage means a great loss to a city financially, besides reducing the pressure and causing a diminution of the supply available for fighting fires.

In my opinion too much stress cannot be laid upon the wastage and leakage of water. It is a comparatively easy matter to detect and repair the larger proportion of the leaks in the distribution system by means of a systematic and comprehensive survey and the use of suitable equipment for the purpose of detecting leaks. The stopping of the waste of water by a thoughtless public is however a much more difficult matter. Where a great number of the domestic consumers are on a flat rate, it has been the custom in the past to make a house-to-house inspection and instruct the public in the correct use of water. This is not particularly successful, though, because wastage stopped today may begin again soon and probably continue until the next inspection.

I do not mean to say that the majority of the people deliberately waste water, but I do know that they don't realize what a small leak will amount to in 24 hours and consequently do not give the matter much thought. The only practical method of stopping excessive waste is to install meters on all services.

Universal Metering

The reasons for metering all services are two-fold: First, because it is the only fair and equitable way to sell water; and second, because it is the only practical way in which to prevent waste. Where cities have been completely metered, it has been found that the introduction of meters has been a great success in checking the waste.

Fair Meter Rates

Once a city has started out on a definite program of metering all services, it is confronted with the problem of determining a fair and equitable meter rate. As an example of what this problem amounts to, I will give a brief discussion on the conditions existing in Sault Ste. Marie at the time the Commission-Manager Plan of Government went into effect and we were confronted with the fact that owing to the increased costs, the revenue from the water works department ceased to be sufficient to meet operating and maintenance costs.

Practically all of the large consumers of water were metered at that time and a number of the residences, amounting in all to about 10 per cent. of the total number of services. No study had ever been made, however, of the probable legitimate use of water as compared with the total amount pumped. A careful study was made in order to determine as accurately as possible just what the distribution was and an effort made to secure information that would enable us to adopt rates that would be fair to all. The average daily pumpage was approximately 3,500,000 gals., or based on a population of 14,500, amounted to 240 gals. per capita daily. This average daily pumpage has been reduced to 3,000,000 gals., or 207 gals. per capita daily. This latter figure is too high, but it proves conclusively that the leaks and wastage are being stopped. After determining approximately the amount of water that should be used, I found that over 50 per cent. of this amount was consumed by manufacturing and industrial plants.

With the information obtained, a careful study was made to determine upon a schedule of fair rates chargeable for metered services. The meter rates finally decided upon were based upon the New England Water Works Association form of rate. The schedule recognizes the principal of the sliding scale and provides three rates for users up to 1,000,000 cu. ft. per quarter. For consumers using over 1,000,000 cu. ft. per quarter, a straight rate per 100 cu. ft. is provided.

In addition a service charge is provided which is for the privilege of having a service, but does not include the use of any water. The service charge is an alternative for the minimum rate and represents a more logical and just arrangement. Under the service charge a specific amount is collected for the service and meter, this amount being collected regardless of whether any water is drawn or not. If water is drawn it is charged for and the amount charged for water used is added to the amount of the service charge.

The Service Charge

The service charge is made up of the following items:

First, a sum per annum representing approximately the cost of reading the meters, keeping the records, making out the bills, etc. For meters read quarterly, it is estimated that $1 per annum is a sufficient allowance.

Second, an amount which will represent the approximate value of water which passes a meter without being registered. The amount lost per service will range from nothing to 13 cu. ft. per day for a ⅝-in. meter. On this basis a charge of $2 per annum is allowed for a ⅝-in. meter. The charges for the large meters are proportional to their relative capacities.

Third, an amount which will give a reasonable return on the money invested in the service and the meter. It is estimated that 10 per cent. is a fair allowance for the depreciation in the service pipe and meter, and for the interest on the money invested in them.

The Rates Adopted

The rates arrived at for the sale of water in the Soo, to meet the local conditions, are as follows:

Domestic rate, up to 10,000 cu. ft. per quarter—9c per 100 cu. ft.

Intermediate rate, 10,000 to 100,000 cu. ft. per quarter—7c per 100 cu. ft.

Manufacturing rate, 100,000 to 1,000,000 cu. ft. per quarter—5c per 100 cu. ft.

Over 1,000,000 cu. ft. per quarter, 5c per 100 cu. ft., straight.

The new schedule of rates is working out very nicely and there was very little criticism from the public, even though the meter rates were increased over the old rates, owing to the service charge.

In this paper I have purposely avoided the engineering features of a water works system, owing to the fact that I consider the problem of stopping wastage and the fixing of equitable rates of prime importance. Of course I do not mean to say that the engineering is not important, but I do feel that good engineering is much more easily obtained than the prevention of waste and the fixing of equitable rates.

The foregoing paper was presented at the recent annual convention of the League of Michigan Municipalities.

Relation Between Water Works Improvements and Fire Insurance Rates

By Kelsey L. Walling, Publisher, Iowa Insurance Service Bureau, Des Moines, Iowa.

The word "improvements" implies a condition in which perfection in the water works department has not been attained, and as each city has its own independent problems, we can only speak in generalities of desirable conditions.

Classifying a City for Insurance Rating.

The classification of a city for the purpose of insurance rating is dependent upon the efficiency not only of the water works but also the fire department, condition of the streets, the general character and construction of buildings, and the enforcement of proper ordinances. With a very few exceptions, the towns and cities of Iowa were classified under the rules of the Western Union Schedule which has been applied generally in the middle and western states. Recently we have adopted the Standard Grading Schedule of the National Board of Fire Underwriters, but as yet have applied it in only a few instances. This schedule, which brings practically the same results as the former treatment, although more technical in its application, is more susceptible to easy analysis in many of the details. Further reference will be made to this schedule later on.

Requirements for Water Works Protection in First Class City

The requirements for water works protection may be briefly outlined as follows:

Source—To be unfailing. If unreliable, a storage basin should be provided.

System—First, gravity system: supply from an unfailing source with impounding capacity of at least 30 days average domestic consumption. Second, combined system, the combined capacity of a reservoir or standpipe and pumps to be 100% greater than the total of the maximum daily consumption and the estimated fire flow. Third—direct pumping system: pumping capacity to be 100% greater than the total of the maximum daily domestic consumption and the estimated fire flow.

Boilers—To be equal in capacity to that of the pumps. Boiler feed pumps, injectors and steam pipes to pumps to be in duplicate.

Pump House—To be of fire-resistive construction and secure from inundation. Station to be equipped with a recording water pressure gauge.

Filtering Plant—If any, to have a capacity equal to the maximum daily domestic consumption and estimated fire flow unless pumps have direct connection to source of supply or unless the clear water basin has a capacity of at least one day's maximum domestic consumption.

Pressure—Pressure at pumping station or elevation of reservoir or height of standpipe should be sufficient to force the required fire flow over the highest buildings, unless fire department is provided with steamers.

Fire Flow—The estimated required fire flow ranges in accordance with the population. From 1,000 gals. per minute for a population of 1,000 inhabitants to about 9,000 gals. per minute for 70 or 75 thousands population. These figures are furnished by a table and are approximate only, the definite amounts to be determined upon inspection—considering the compactness and height of the buildings and values to be protected.

Mains—Main arteries should be ample in size to carry with moderate frictional loss, the domestic and fire consumption, and should be in duplicate. Mains in the business center and congested manufacturing district should be less than 10 ins. in diameter with 8 in. cross-connecting mains and in the residential section, not less than 8 ins. in diameter with 6 in. cross-connecting mains. Sufficient large feeders should be provided for all sections of the town, insuring suitable circulation, and all systems should be free from dead ends. No smaller mains than 6 ins. in diameter are recommended.

Gate Valves—Gate valves to be located at points so that it will not be necessary to shut off service more than the length of one block in the congested districts or more than two blocks in the residential districts. All branch connections to hydrants should be provided with gate valves.

Hydrants—To be "staggered" and should be located from 150 to 300 ft. apart in the mercantile and manufacturing district and from 300 to 600 ft. apart in the residential district. Hydrants should have no less than 2½ in. outlet and a steamer connection where steamer service is available. Street connections and riser for hydrant should not be less than 6 ins. in diameter. Hydrants and threads on outlets to conform with the National Standard.

High Pressure System—Water works system to be augmented by a separate system of high pressure pumps and mains to be utilized at times of fire and to carry sufficient pressure for direct fire fighting.

Records—Daily statement of consumption and pressure should be made and complete records of pipe, valves, hydrants, etc., to be kept in fireproof vault.

This, in brief, is an outline of the standard requirements for a first class city insofar as the water works department is concerned. The grading for second, third and fourth class cities are for the most part percentages of the requirements for the first class protection. Therefore, any improvements tending to increase the capacities of pumps, pipes, boilers, etc. so as to meet the domestic consumption plus the fire flow will result in better grading of the protection afforded by the water works department.

Of the cities of Iowa, Davenport leads with a second class grading. Several cities have been graded as third class, while the majority of the water works towns, as is also the case in most states, are fourth class.

Requirements for City of Third Class

In a city of the 3rd class, the source of water supply should be standard, or unfailing. The system at least 50% of standard; pump house, substantial brick construction, unexposed; boilers, standard, except that duplicate steam pipes to pump are not necessary; filtering plant, if any, 50% of standard; pressure and fire flow, standard; mains, in business and manufacturing district not less than 8 in. with 6 in. cross-connecting mains, and should have sufficiently large feeders to supply suitable circulation for domestic consumption and fire flow, but not necessary to have force mains in duplicate. From this it will be seen that any city having properly fulfilled the requirements for third class may secure a better grading by providing duplicate force mains and boilers and pumps for reserve purposes, which would increase the reliability of the system. The system in a third class town merely meets the conditions of domestic consumption and fire flow. Less than that would be three and one-half or fourth class, while better would be two and one-half or better according to the percentage of pumping capacity, boilers and mains in reserve.

The foregoing briefly outlines the standards to be desired for a first class city, and by variation of efficiency from that standard for second, third and fourth class cities, which comprise the whole list of water works towns.

Some Specific Information on Reduction of Fire Rates with Improvement to Water Works

We now come to the relation between water works improvements and fire insurance rates. As the water works is the only one department considered in the classification of towns or cities it must be treated in conjunction with the fire department; public fire alarms system; building and general ordinances and streets.

For the purpose of comparison, a one-story brick building in a 4th class town takes a basis rate of 30 cts. In a 3rd class town, 35 cts.; in a 2nd class town, 31 cts.

A one-story frame building in a 4th class town takes a basis rate of 77 cts. In a 3rd class town 71 cts. In a 2nd class town 67 cts.

The difference in the basis rates between the several classes will figure 13% on brick or fireproof buildings and 8% on frame buildings.

I have referred to the Standard Grading Schedule of the National Board of Fire Underwriters as one we have adopted for future use. This schedule is based upon the plan of an assumed number of points of variance from established standards.

The total points of deficiency is 5,000, allotted in accordance with their relative values as follows:

	Relative Values	*Points*
Water Supply	Engine Stream Basis	1,700
	Hose Stream Basis 2,000	
Fire Dept.	Engine Stream Basis	1,500
	Hose Stream Basis 1,200	
Fire Alarm		550
Police		50
Building Laws		200
Hazards		300
Structural Conditions		700
Total		5,000

The deficiencies chargeable to the water works may not exceed 1,700 points. These charges are made on the conditions of variance from standards which by experience and calculation are considered necessary for character and congestion of the buildings, areas of built up section and population.

Points of Water Works Deficiency

These points of deficiency are sub-divided under the following headings which will be referred to briefly and without analysis.

1. Appointment: Employees on municipal systems to be under civil service rules with tenure of office secure.

2. Chief Executive: To be competent and qualified by experience.

3. Records or plans: Records and plans of the physical structure and system to be complete, safely filed, in duplicate indexed and up-to-date.

4. Emergency Crews: To be on duty at all times or quickly available. An emergency wagon with necessary tools to be provided. At least one employee familiar with the system should respond to fire alarms in mercantile districts and second alarms elsewhere.

5. Alarms: To be installed in department quarters, in pumping stations, and where pressures are raised for hydrant streams, duplicate alarm circuits as to stations.

6. Adequacy: as regards capacity of source and supply works to deliver required supply. In calculating the deficiency under this item results obtained under fire flow tests in most favorable location are used. Ten hours fire flow in addition to the maximum domestic consumption is desirable in towns of over 2,500 population.

7. Reliability of source of supply: As may be affected by forest fires, floods, ice dams, shifting or channels, condition of intake.

8. Reliability of pumping capacity: On which supply is dependent.

9. Boiler capacity.

10. Condition and arrangement and reliability of plant equipment.

11. Fuel, and accessories for the transmission of power.

12. Pumping stations.

13. Reliability and installation of supply mains.

14. Arterial system and minor distributors and gridiron system.

15. Gate valves, as to location, inspection and condition.

16. Hydrant distribution, size, installation and condition.

It is not the purpose of this paper, nor is it feasible in so brief a time, to enter into all the details of water works engineering, but I have endeavored to show that improvements which will raise a city one full grade of protection will result in a reduction of 8 to 13% in the basis rates on frame and brick buildings respectively.

The foregoing paper was presented at the recent annual meeting of the Iowa Section of the American Water Works Association.

EDITORIALS

Expert Builder or Business Gambler?

Is the contractor primarily an expert builder or is he a business gambler? Presumably he is an expert builder, or should be, and usually he is, perforce, a business gambler, which he should not be. In these days of change in the construction field when engineers are being registered, their salaries increased, and when it seems the millennium is near at hand, perhaps the most gratifying thing of all is that so many engineers, as well as contractors, are rebelling against the archaic lump-sum contract which forces the contractor to gamble, to bet that it will not rain, and to guarantee an owner against all manner of unknown conditions influencing construction costs and clearly beyond human control.

The contractor is a construction specialist who has the ability to build safely and economically. That is enough to expect of one man. When, as is usually the case, the contractor is also expected to pledge his private means that the cost of a piece of work will not exceed the minimum possible under the most favorable conditions, he is simply making a bet that everything, including the forces of nature, will play directly into his hands.

The newer form of contract which protects the contractor against conditions which neither he nor any other mortal can anticipate or control is not only more equitable, but is a nearer approach to the standards of fair play and of the square deal which characterize American business life. We do not mean to speak extravagantly when we call the lump sum, guessing, gambling contract a disgrace to the construction industry and the darkest page in its history.

The old form of contract is not in the interest of good public policy or of good public morals. Surely it is contrary to the best interests of the public to have a new crop of contractors each year, yet that is the condition toward which the old contract forces the industry. Because some very wise or very lucky men make large "killings" in the contracting business there are always many who are willing to enter it, cheerfully assuming the risks of the game in the hope that they will win a large profit as a prize. As in any other enterprise depending largely on chance, many lose where few win. And those who win one year may lose the next. As a learned jurist once said of another risky enterprise, the old form of contract "is an appeal to cupidity which lures to improvidence." No argument is necessary to prove that it is a bad thing for the country to have three classes of contractors, namely, those who are just breaking in, those who are still in, and those who are down and out. The transition from the first to the third class is as painful as it is rapid; only the exceptional man succeeds in maintaining his precarious foothold in the intermediate position; even then there is but little joy in his life, for he has as many things to worry about as the proverbial night watchman in a powder mill.

The old form of contract is also contrary to public morals, for it engenders a battle of wits between the contractor and the owner or the owner's agent, the engineer. The tendency on one hand is to build up to a standard, and on the other down to a price. Contractors do not claim to be better than other men, but they insist they are just as good and we think they are right. In a game of gouge they try to protect themselves and that is only natural. Any one who expects the contractor to assume all the risks and then interpret all the clauses in the contract and specifications strictly in the interest of the owner is simply ignoring the elementary impulses of human nature.

The cost-plus contract is gradually being perfected so as to afford just protection to both parties. Contracts of this class are being worked out whereunder the contractor is not expected to cope single-handed with the forces of nature and all the "slings and arrows of outrageous fortune." At the same time his earnings are proportional to the skill of his performance so that the incentive to build economically remains, while the temptation to build poorly is removed.

The Graduate Engineer

It is undoubtedly true that in every engineering organization where the services of engineers of various grades of training and experience are required there is a certain point, as the scale ascends, where the services of a graduate engineer are required. By a graduate engineer we mean, of course, a man who has actually attended and graduated from an engineering school or college, as distinguished from the graduate of a technical high school or an engineering correspondence school. It is important to note that, generally speaking, there are certain positions which cannot be successfully filled by others than graduate engineers.

In any attempt to fix equitable salary scales for engineers, where the compensation bears direct relation to the duties performed and the responsibilities assumed, recognition must be given the graduate engineer at his point of entry; that is, there should be a very substantial difference between the compensation of the highest grade of non-graduates and the lowest grade of graduates. This difference should be proportional to the cost of a college engineering education. The graduate engineer has made an investment in an expensive education on which he is entitled to an immediate return, not only in justice to him, but also as a matter of public policy, for it surely is in the interest of the public that the engineering work of the country be done by well-trained engineers. The compensation of the young graduate engineer is of great importance, for on this depends his ability and inclination to remain in the engineering profession long enough to render maximum service to the public.

It will be understood that we speak here in general terms only. It is recognized that many self-trained engineers overcome all handicaps and reach the top. These men, because of native ability and the diligence with which they continue their studies, are able to fill successfully one position after another. This is a question of ability, solely.

The entire matter is merely a question of ability. As a rule the graduate engineer is more able than the non-graduate, and this fact should be recognized at the outset of his career. The point is stressed now because salary scales are being revised for engineers. Now is the time to give thought to this matter in fixing schedules that may be effective for years. In studying the duties pertaining to certain positions and in fixing salaries for those positions, the point of entry of the graduate engineer should be recognized. At that point there should be a sharp upward trend in the salary curve.

Remedies for an Engineering Ill

A very large number of engineers agree that the competition of engineering teachers with consulting engineers is one of the ills affecting the profession. The subject is one that has often been discussed and it must have more discussion, obviously, since it has not yet been settled right. It will be discussed here in all fairness, without prejudice or favor. The editor is friendly to all parties, not only because of his present cordial relations with engineering teachers as well as with engineers of all classes, but especially because he had some years of experience as a teacher in an engineering college and in city and consulting engineering work. This discussion is, therefore, based on personal experience and observation.

Why do teachers of engineering enter into competition with engineers in private practice? For two reasons: to gain experience and to earn money. Each reason merits further discussion.

Many engineering teachers seek outside consulting work as a side-line to their teaching so as to gain the practical experience that they must have for successful teaching. A teacher without such experience is regarded by students, as well as by others, as a mere theorist. That practical experience is an essential part of the teacher's equipment all will agree, but there is a right and wrong way and a right and wrong time to acquire such experience.

A teacher of engineering science who lacks practical experience is a misfit. He should have at least enough practical experience to command the respect of the first class he faces. He can gain additional experience during leaves of absence and during the long and numerous vacations that are such a delightful feature of academic life.

Experience should be gained by the teacher in collaboration with existing engineering organizations, not in competition with them. Such opportunities for professional work can be found by any teacher who seeks them.

When a man undertakes to run two jobs at the same time, each requiring his personal attention, either one or the other, or both, must suffer from insufficient attention at times. Where there is a conflict of interests the teaching is practically sure to be neglected. We dare say that the majority of engineering graduates can remember many occasions when their teachers, who were operating side-lines, were inaccessible to the students. This is unfair to the students, is keenly resented by them and lessens their interest in their studies. The time for outside work by teachers, then, is any time which does not belong to the educational institutions employing them.

One must sympathize with the teacher's desire to earn more money, for teachers' salaries are, in most cases, insufficient. If the teacher has great difficulty in making ends meet with his salary, it is only natural that he should seek secondary sources of income, and no amount of preaching or protesting will keep him from doing so if he is enterprising enough to get out and hustle. The remedy for this condition is to pay the teachers adequately for their teaching work and then require them to give proper attention to their collegiate duties. Practicing engineers who suffer from and deeply resent the unfair competition of teachers will do well to work for such salaries for teachers as will make them satisfied with one job at a time. State engineering societies should co-operate with the teachers of engineering in state colleges with this end in view. This can be done and should be done.

The competition of teachers with practicing engineers is, we have said, unfair competition. It is unfair to the students and to the engineers. Teachers do not have to pay office rent. They have one income, and so can cut under the prices of the engineer who depends only on his fees for a living. Some teachers who take outside work have much of the detail work done by their students at very cheap prices. The teacher has the prestige of his institution at his back, and this is a guarantee, in the eyes of prospective clients, of his integrity as well as of his ability. He has numerous unfair advantages in competing with the independent engineer. There are some teachers of engineering who go to extremes in their pursuit of practical experience and outside income. They apparently regard their teaching jobs as little more than meal tickets, depending on the outside earnings for their substantial compensation. In some localities this condition has reached scandalous proportions. In one state, at least, this unfair competition has almost ruined the practice of the consulting engineer.

The annual meetings of state engineering societies will be coming on in a few months. At those meetings this matter should be vigorously discussed and appropriate action taken. The present condition should not be allowed to continue, for it is bad for all parties.

Buried Treasure

The engineering editor's idea of buried treasure may provoke a smile, but, understand, the editor has a right to his opinion, and, fortunately, he has the opportunity to express it. Since the editor deals in engineering literature it is only natural that his idea of the treasures of earth should pertain to the great unworked deposits of raw material of this sort which are known to exist, but which remain deeply buried in the engineer's brain or in his files. It is a very tantalizing thing to know that these gems lie at the dark, unfathomed bottoms of filing cabinets in all parts of the country and that all the persuasive powers of the editor are not sufficient to draw them out for useful purposes. What a melancholy thing it is to realize that many flowers of engineering eloquence are but "born to blush unseen"!

Every month the editor goes prospecting around for these treasures. By keeping his sleeves well up at the elbow he manages to uncover a good deal of this material which assays sufficiently high to make its recovery well worth the effort involved. But always there remains regret that those who inter these treasures are so slow to exhume them.

Resurfacing Old Macadam and Gravel Roadways with Special Reference to Adaptability of Old Roadbeds as Foundation for Hot Mix Bituminous Surfaces

By Hugh W. Skidmore, Chicago Paving Laboratory, Consulting and Inspecting Engineers, 160 N. Wells St., Chicago, Ill.

While it is true that the value of old macadam, broken stone and gravel roadways as foundations for permanent pavements has been realized in some communities and is thoroughly appreciated by quite a few engineers in general, nevertheless, this valuable asset is often underestimated or entirely overlooked, with the result that an admirable foundation structure is either partially or entirely destroyed to make room for one which may not surpass the old roadbed as a foundation structure, all things considered.

General Requirements of Pavement Foundations

Before taking up the discussion of the adaptability and practicability of these old roadbeds as foundations for permanent types of surface, it is proper to point out briefly some of the requisites of a suitable foundation for pavement structures. The term is generally understood to mean a substructure upon which the wearing surface is laid, and by means of which the traffic forces are transmitted to the subgrade. When the foundation is called upon to act as an arch (or bridge) over weak sub-grade areas it ceases to function as a substructure and actually becomes a superstructure.

The character and thickness of the foundation to be employed is dependent upon three chief factors, viz., (1) the character and weight of the traffic to be carried, (2) the kind and condition of the subsoil, having in mind the natural drainage ability thereof, (3) and the type of wearing surface to be used. The first two items are of prime importance, the third permits of more latitude. The selection of surface type, is also made with reference to item number 1.

Local conditions often reveal a combination of circumstances rendering it necessary to consider a number of different factors in the selection of a suitable type of pavement surface and foundation. The relative values to be assigned to these various items will be founded upon ultimate economy; quality, sufficiency and adaptability of local materials; and the certainty of receiving bids from reputable contractors, experienced in, and properly equipped for constructing the pavement.

The pavement must first be well designed. This will require the services of a conscientious and thoroughly experienced engineer. It must then be built properly by experienced workmen in the employ of a reputable and well equipped contractor possessing a sound business organization. And last, but not least, intelligent and careful supervision must be maintained throughout the construction of the pavement. In short, the price of a good pavement may be said to be proper design, good workmanship and careful supervision intelligently and persistently applied.

While the foregoing digresses somewhat from the topic immediately under discussion, it is thought to be warranted by the fact that these points are of utmost importance and will bear much repeating.

The foundation must be able to bear up without crushing under the traffic loading. The portion of the weight which it is required to support will depend upon, (1) the type and method of construction of the wearing surface, (2) the supporting power of the sub-grade, and, (3) the ability of the foundation to maintain close contact with the sub-grade. For example, the foundation beneath a monolithic brick pavement will not be required to support the same proportion of a given load, as will a similar base under a 2 in. asphaltic concrete surface.

The foundation structure should rest upon a firm, unyielding sub-grade, reasonably well drained. The term "reasonably well drained" is used deliberately, since anything approaching absolute drainage of sub-grade in some kinds of soil will be prohibitive as to cost. Consequently, in the light of true economy it would not be considered good practice to incur the expense of an elaborate system of under-drains in some instances. Likewise, the construction of a rigid base of sufficient thickness and strength to enable it to support the heaviest loads, without the possibility of failure over a few small areas of weak sub-grade, would be false economy. In other words, it would be better engineering to specify a somewhat weaker foundation with the knowledge that the use thereof would very probably entail a small amount of repair due to foundation failures.

It has been advocated that the sub-grade be insured absolutely against the development of weak spots. Some have gone to the extreme of advocating that all sub-grade areas of doubtful stability be excavated and refilled with gravel, broken stone or lean concrete, and that a subsequent layer of gravel or broken stone be spread over the entire sub-grade area. While such elaborate procedure might have merit in extreme cases, the cost would undoubtedly be so great as to render it unjustifiable in most instances. A compromise by excavating and re-filling the insecure areas with gravel or broken stone and omitting the layer of gravel or stone, with some slight possibility of future settlement, seems a more reasonable plan. However, a soil condition which would warrant the expense of a layer of gravel or broken stone, primarily as an aid to drainage, may be readily appreciated.

The writer is inclined to feel that the ability of the foundation material to seek solid contact with the sub-grade is of more vital importance on the average paving job, than the securing of a rigid base of sufficient slab strength to carry the entire weight of traffic, and bridge over all soft spots in the sub-grade.

A foundation for bituminous surface should, in addition to supporting and load distributing power, possess certain qualities which will make for the minimizing, if not the elimination, of surface reproduction of cracks and other defects due to foundation failures, which experience has shown are practically unavoidable when concrete foundations are employed.

The foundation should by its nature and character preclude or at least minimize the amount of moisture coming in direct contact with the wearing course from beneath. This feature is not only of extreme importance with reference to bituminous surfaces, but it is also of considerable importance in considering foundation structures for other types of pavement.

Suitability of Broken Stone, Stone and Gravel Macadam Pavements as Foundations for Permanent Types of Surface

Almost innumerable examples may be cited of stone and gravel foundations which have given high-class service for many years. While no attempt is made here to enumerate any quantity of specific cases, the service records of this type of foundation furnish ample proof that they have usually surpassed the average cement concrete base, so far as general compliance with foundation requirements and moderate maintenance expense are concerned.

Salient Features of Design for Street and Highway Resurfacing—Drainage

Before taking up the discussion of practical methods of preparing the old pavement for use as a foundation, it is desirable to point out and briefly discuss some of the more important features of design peculiar to city streets and country highways. Since reasonably good drainage is of fundamental importance it should be one of the first items to be considered in designing any pavement structure. On country roads drainage is usually secured by means of side ditches. These ditches should be deep enough and wide enough that their effectiveness be not impaired by the growth of vegetation. They should also have sufficient fall and frequent outlets in order that the run-off during storms may be as rapid as practicable. The depth, width and gradient of these ditches will naturally depend to a large extent upon the porosity of the soil, the extent and shape of the drainage area and the frequency of available outlets. The recommended minimum depth below the crown of the pavement is 3 ft., the minimum width at the bottom can be safely established at about 24 ins.

HEAVY TRAFFIC HIGHWAY RESURFACED WITH ASPHALTIC CONCRETE. FAILURE TO PROVIDE EDGING OR CURB PERMITTED LATERAL DISPLACEMENT WITH RESULT SHOWN. SUCH FAILURES NOT DUE TO TYPE OF PAVEMENT BUT TO POOR ENGINEERING.

Side ditches should not be allowed to become choked, nor should they be built with low velocity gradients that will cause them to run full for any great length of time, since such a condition will be naturally conducive to excessive saturation of the sub-grade and foundation.

Special provision should be made for drainage of the roadbed across marshy land, through cuts which are inclined to be wet, across flat land which has a high water level during the wet season, and at the foot of rising grades. Sub-surface drainage may be accomplished in several different ways; lateral tile drains discharging into the side ditches will ordinarily be sufficient through cuts and in wet areas of limited extent. Across marshy land or areas on which water stands during the wet season, the pavement should be built up on broken stone, boulders, or some similar type of sub-base construction; the object being to raise the pavement well above the normal saturation level by means of some stable sub-foundation construction. In such cases a Telford or similar base will prove very effective.

Since all of the water which is liable to cause trouble comes from without the pavement, it is highly essential that this water be adequately intercepted and promptly removed. This is equally true of both highway and street pavement construction. A system of intercepting drains as indicated on an accompanying sketch with laterals topping portions of the sub-grade which are inclined to be unstable or poorly drained, will be found to be the most effective for city streets. The necessity of such drainage should be carefully gone into before the expense of construction is incurred, remembering that disaster usually follows when inadequate drainage facilities exist. It is very probably true that at least 75 per cent. of pavement ills may be traced directly or indirectly to lack of proper drainage.

Width of Roadway

In considering the problem of resurfacing of highways, the width of the old roadbed may have more or less weight in determining the width of the new pavement. When assigning a value to this item as affecting the pavement width, it should be remembered that the general tendency is to build pavements too narrow rather than too wide. Country roads should never be of less width than certain well established minimums, such as 10 ft. for a single line of traffic and 18 ft. for two lines. In fact, 12 ft., 20 ft., and 30 ft. are considered good practice for one, two and three lines of traffic, respectively.

When narrow pavement widths are used, substantial shoulders at least 4 or 5 ft. wide, with an earth berm of 3 or 4 ft. width between the shoulder and the ditch are advisable. When the wider pavements are specified, the width of shoulder and berm may be decreased somewhat; however, if the side ditches are likely to prove a source of danger on account of their depth, ample shoulder and berm space should be allowed between pavement edge and ditch.

Provision for ample width of pavement is especially important on country roads. When a bituminous wearing surface is specified without some sort of substantial edging, the pavement width should be increased 3 or 4 ft., as experience has shown that where 18 and 20 ft. roads are built without substantial curbs, vehicles are crowded over to the outer edge of the pavement, invariably causing a breaking down of the unprotected edge of the bituminous mixture. There are likewise many examples of broken curb and fractured concrete foundation resulting from the same source, on heavy traffic highways of insufficient width. The ultimate economy of any additional expense in providing ample pavement width will be readily apparent.

TWO-INCH ASPHALTIC CONCRETE LAID OVER OLD MACADAM 3½ YEARS AGO. OLD ROADBED CUT DOWN AT SIDES AND BUILT UP AT CROWN. PAVEMENT IN PERFECT CONDITION.

When hot mix bituminous resurfacing is selected, bituminous concrete naturally suggests itself as a most suitable material for widening the roadway. While other material may be used for this purpose, the use of bituminous concrete or bituminous macadam will save in time of coustruction, and will not only possess all the advantages of a bituminous base, but may also be so laid that curbing or edging may be dispensed with. When the width of the extension equals 4 ft.

or more cement concrete may be used; the use of concrete for narrower strips not being available owing to its susceptibility to lateral displacement under such conditions. Broken stone or macadam may also be used for extending the foundation, but is not recommended, except for very narrow strips, unless it is found practicable to open the road to traffic for several months. The accompanying half-sections are intended to convey some suggestions of practical methods of increasing the width of old highway pavements.

Thickness of Base

While it is true that an old macadam or gravel pavement may be of considerable worth as a foundation even though it be so badly worn that it is of practically no value as a pavement, it is also true that the resurfacing of an old road is often so long delayed that its potentialities in this direction are greatly reduced or practically destroyed—the moral to be drawn from this fact being obvious. Therefore, before advancing very far with plans for resurfacing a pavement which is in bad condition generally, or of which there may be doubt as to the depth of existing material, a sufficient number of test holes must be made to determine fairly the average depth of old metal. This knowledge may very properly be the determining factor in deciding upon the depth and character of new material to be added to the old pavement.

CRACK AND UPHEAVAL OF CEMENT CONCRETE FOUNDATION UNDER ASPHALTIC CONCRETE PAVEMENT, A COMMON RESULT OF THIS TYPE OF CONSTRUCTION.

Naturally, local soil and traffic conditions and the type of wearing course will determine the allowable thickness of base, so that no hard and fast rules may be laid down. But, in a general way, we may establish working minimum depths of old material which will preclude the necessity of adding fresh material, providing the surface is of fairly uniform contour. Depressions 2 ins. or more in depth should be brought to grade with fresh material before the top course is applied. For residence streets or country roads having moderate traffic the minimum foundation depth should be 6 ins.—preferably the material should show an average minimum depth of 6 ins. at the sides and 8 ins. at the crown; for fairly heavy or fairly dense traffic these minimum depths should be increased from 2 to 3 ins.; and for heavy or very dense traffic 10 ins. at sides and 12 ins. at the center will be none too much. These depths are intended to cover the final thickness of foundation, since old macadam or gravel of considerably less depth may be utilized by overlaying with bituminous concrete, bituminous macadam or broken stone.

Edging for Highway Pavements

Several types of edging or curbing are adaptable to resurfacing of this character, such as cement concrete, stone, metal, plank and a bituminous concrete header or heel, which may be satisfactorily used instead of curbing. Among these, cement concrete is perhaps the most satisfactory in some respects, while bituminous concrete used in the form of a heel, possesses the advantage of positive bond with the top course and is less subject to tilting or displacement due to lateral pressure. Stone curbing is very susceptible to displacement, unless set in a bed of concrete, which makes it ordinarily cost more than concrete. Plank, preferably 3 by 12 in. oak, supported by split cedar posts, spaced about 5 ft. apart, and extending into the sub-grade 18 to 24 ins., will perhaps prove the best when a saving in the first cost dictates the least expensive type of construction. Plank edging, naturally, will not last as long as the other types indicated, and should not be used if very heavy or dense traffic is expected.

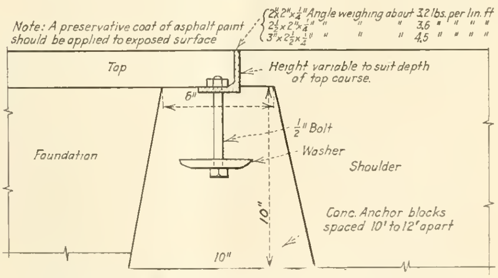
Very few metal edgings will be found satisfactory, nevertheless, it is possible to build one which should serve the purpose admirably and still not be prohibitive as to cost. As

FAILURE OF 6-IN. CEMENT CONCRETE FOUNDATION TO ARCH OVER WEAK SUBGRADE. PAVEMENT CARRIES AVERAGE TRAFFIC INCLUDING A FAIR PERCENTAGE OF TRUCKS.

shown in the accompanying sketch angle irons about ¼ in. thick, bolted to concrete anchor blocks set about 10 or 12 ft. apart should prove satisfactory, and at present prices would very probably cost less in place than concrete or stone curbing. Special forms and extreme care in securing blocks of exactly the shape indicated are not necessary; blocks deep enough and wide enough and properly spaced to securely anchor the irons is the main objective.

Practical Methods of Preparing the Old Roadbed for Use as a Foundation

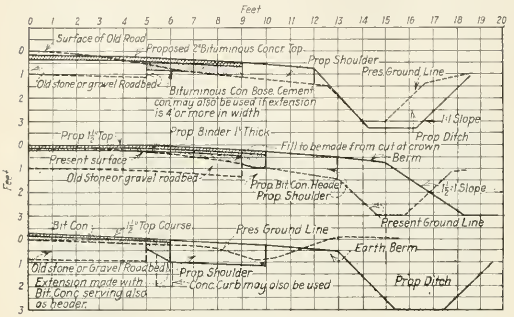
The first operation in preparing the old pavement for its intended use as a foundation is the thorough cleaning of the surface. If the pavement has been oiled or carpet-coated with bituminous material, the crust thus formed must be removed. This may be done to the best advantage by spike-rolling the surface, thereby breaking through and loosening the crust so that it may be easily removed with picks and shovels. After this top layer has been removed the surface should be thoroughly swept, preferably by means of a rotary street sweeper,



PROPOSED METAL EDGING FOR RETAINING BITUMINOUS WEARING COURSE ON HIGHWAY RESURFACING OVER OLD STONE AND GRAVEL ROADS.

or if such is not available, by means of stiff-bristled hand-brooms. After sweeping there should be no loose material remaining, and the uppermost stones composing the roadbed should be partially exposed.

Old street pavements are often inclined to be flat as a result of wearing down the central portion under concentrated traffic, while the average country road is likely to have more crown than is required for the new pavement. In either case the roadbed must be either built up or cut down, or both, to conform to the required elevation. Cutting is to be avoided



CROSS SECTIONS SHOWING SUGGESTED METHODS OF INCREASING WIDTH OF OLD ROADS.

as much as possible, however, conditions may be such that some cutting will be found necessary.

Extreme care must be exercised in removing metal from the old pavement; the bond should not be disturbed below the depth of material to be removed, nor should the cutting reduce the depth to less than the allowable minimum. Scarifying may be employed providing it is carefully done. All material removed in cutting down and subsequently used for filling in low areas, should be thoroughly rolled with a three-wheeled roller weighing 12 to 15 tons.

The fact that an old road has more crown than is suitable for a permanent pavement has been used as an argument against resurfacing, whereas, such a condition is of minor consideration, if not of real advantage, since an increase in the height of the pavement above the side ditches is ordinarily desirable.

The fill required to bring the outer edges of the pavement to the proper elevation for producing the desired crown effect in the new pavement may be considered excessive; if so, it may be compensated by removing some material from the center portion and using it in the side fills.

Materials for building up the old pavements may be classified on the basis of efficiency in the order named: Mechanically mixed bituminous concrete, bituminous macadam, and broken stone; the latter being applied and thoroughly rolled without adding screenings, or regular water-bound macadam construction being used. Broken stone is advisable rather than gravel, because the aggregate having greater angularity is more securely interlocked. Selection should be based upon the condition and depth of the old pavement and the character of the traffic anticipated. All of the above have been used and have proven highly satisfactory.

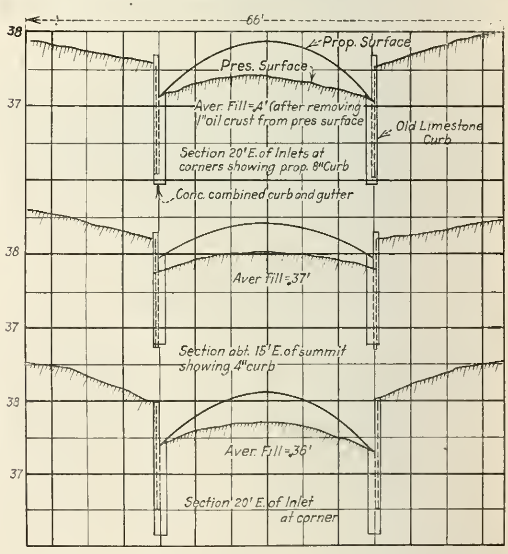
When broken stone is used, it is spread over the old pavement, after the same has been cleaned as previously described, and then raked to grade; rolled and re-rolled with a three-wheeled roller of 12 to 15 tons weight. As depressions develop during the rolling more stone is added and the rolling continued until the stone is well keyed, and a firm, even surface, true to grade and contour is produced.

If the true macadam type of surface is desired, the stone is laid and rolled dry as above described, after which screenings are added and rolled in, first dry, then adding water, and the rolling continued (low spots being "picked up" by adding more stone and screenings) until a first class macadamized surface has been produced. When this method is used, sufficient time must be allowed between finishing the foundation and laying the top course to permit the macadam to thoroughly dry out. By omitting the screenings and water, the wearing course may be laid immediately after the final rolling of the base.

Bituminous macadam should be laid according to the best construction, the binder being applied by means of a pressure distributor. If the surface of the original pavement is so irregular that the depth of the new material will vary considerably, the low spots should be filled up, rolled and poured so that the final layer will be of fairly uniform thickness. The quantity of binder applied must be in proportion to the depth of stone in order to avoid fat and lean spots. For this reason it is especially important that the base be built up in layers not to exceed, say, 3 ins. thick, when the old surface happens to be very irregular.

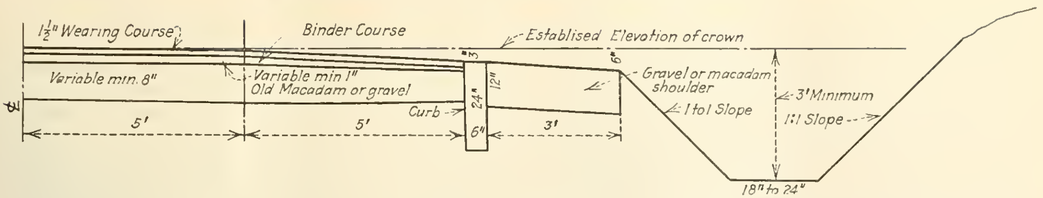
Irregularity of old surface will also dictate building up in layers, when machine mixed bituminous concrete is used. The use of either type of bituminous material as a means of building up the old pavement, will do away with the use of a binder course, providing the entire surface is covered. If only portions of the roadbed are covered, a binder course should be employed except for very light traffic which would warrant a wearing course of 2 ins. of bituminous concrete.

In determining the type of construction to be used in building up an old pavement, the uniformity of thickness of the old metal is a most important factor. For example, if the old pavement has a great many depressions of considerable depth, giving such extremes as, say, 3 ins. of old material in depres-



TYPICAL CROSS SECTIONS. PROPOSED STONE-FILLED SHEET ASPHALT RESURFACING (1½ INS.) ON ASPHALTIC CONCRETE INTERMEDIATE COURSE (AVG. 2½ INS. THICK) OVER OLD MACADAM PAVEMENT (6 TO 12 INS. THICK) BADLY WORN.

sions and 8 to 10 ins. in high spots; it would very probably be unwise to attempt to build such a surface up to grade with anything short of a high class bituminous mixture. In other words, extremes of thickness of old metal ranging from, say, 3 ins. to 9 ins., with the average at 6 ins., will not have as much inherent value as a foundation as will an old pavement



HALF SECTION OF ROADWAY SHOWING GOOD DESIGN FOR RESURFACING WITH HOT MIX BITUMINOUS PAVEMENT.

ranging in thickness from 5 to 7 ins., and averaging 6 ins.; consequently material possessing considerable stability should be used to build up an old pavement which consistently shows extremes in depth.

Protection Against Settlement of Trenches

Trenches incident to underground construction and repairs, which are excavated during the preparation of the foundation, as well as old trenches showing signs of weakness, must be carefully insured against future settlement. Old trenches and soft areas of the old roadbed which develop depressions during rolling or which may otherwise indicate lack of stability, should be excavated and refilled with broken stone, gravel, sand or some other material of equal merit. The fresh material should be tamped to excess in layers not to exceed 8 ins. in depth, and each layer should be puddled, but not flooded.

Extreme care must be taken in backfilling newly excavated trenches. If the original material is sand, or gravel, or if it contains a considerable per cent. of sand or gravel, it may be used for backfilling; but if the natural soil is clay or loam, or some other soil which naturally requires considerable time in which to reach final settlement, the trenches should be backfilled with such material as above designated for refilling old trenches. In either case tamping and puddling the layers must not be neglected.

The backfill should be carried about 2 ins. above the normal foundation elevation and then rolled and re-rolled with a heavy three-wheeled roller until the surface of the backfilled trench conforms to the proper foundation elevation.

In extreme cases, trenches may be partially filled as above described and a concrete slab, reinforced or plain, as necessity will require, may then be laid over the backfill, extending 12 ins., or so beyond the sides of the trench, and bearing upon solid earth. Concrete so placed should be suppressed and overlaid with 6 or 8 ins. of broken stone.

Thickness of Surface Mixture

Hot mixed bituminous surfaces are most readily adapted to resurfacing work. When used to resurface old roadways, as herein discussed, the usual and well known qualities and advantages of sheet pavements are increased by freedom from cracks, upheavals and other defects inherent in concrete foundations; speed of construction; and lower maintenance expense.

A binder course should be specified, providing the old surface is not entirely covered with bituminous macadam or concrete in the building up process. Although a 2 in. top of asphaltic concrete is used for very light traffic, such as will be found on strictly residence streets; a top course 1½ ins. thick laid on a 1 in. binder course is much to be preferred and should cost only 15 to 30 cts. per square yard more than the 2 in. single course construction.

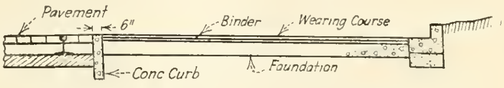
Two course pavements may be specified on the basis of traffic as follows:

Character of Traffic	Thickness Top course	Thickness Binder course
Light	1½ ins.	1 in.
Medium or moderate	1½ ins.	1½ ins.
Heavy and very dense	1½ to 2 ins.	1½ to 2½ ins.

Results of Resurfacing

It is thought that the accompanying table and charts relative to maintenance of old macadam street pavements and initial saving obtained are especially enlightening in so far as demonstrating the economical effect of resurfacing old roadways is concerned.

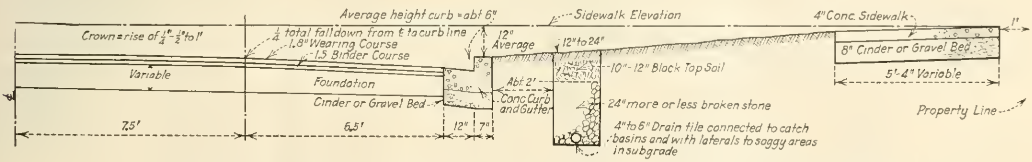
On Jan. 1, 1919, Oak Park, Ill., had 85.6 miles of pavement, including 2.45 miles of alley pavements, showing an increase of 80 per cent over the mileage in 1910. Of this



WHEN PAVEMENTS ON CAR TRACK STREETS ARE RESURFACED CONCRETE CURB SHOULD BE BUILT ALONG TRACKS AT END OF TIES.

85.6 miles, 50 per cent was sheet asphalt and asphaltic concrete, and 30 per cent. was old macadam which is treated yearly. No macadam has been laid since 1912.

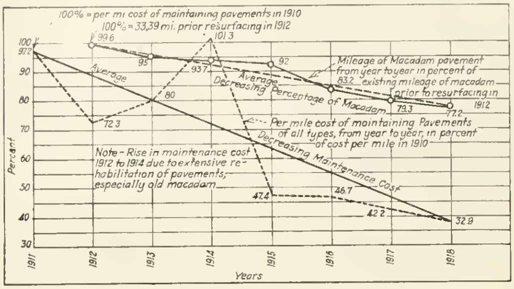
During the three years, 1916 to 1918, $32,253.95 was spent in maintaining old macadam pavements. As shown in the table the average expenditure per year was $10,751.32, or $404 per mile of macadam pavement. To bring this home, macadam maintenance cost the taxpayers at the rate of $129.67 per year per mile of street pavement within the municipality. Since maintenance expenditures come out of the general funds, every taxpayer is compelled to pay his proportionate share toward keeping up these old pavements, regardless of whether or not he may have already paid for a permanent pavement in front of his own property (under the special assessment plan) that requires a maintenance expense representing an insignificant portion of the unit rate for macadam. From this it will be seen that, unless the maintenance cost of all pavements is charged directly against the abutting property, injustice to some cannot be avoided when any considerable portion of the total pavement mileage is the source of such a large annual maintenance expense. It is significant that the average yearly maintenance cost of all other types combined amounted to only a few hundred dollars, as against the thousands spent yearly for maintaining old macadam roadways. The curves show conclusively what a remarkable effect the



HALF SECTION OF STREET SHOWING GOOD STANDARD PAVEMENT DESIGN, ALSO AN EFFECTIVE MEANS OF DRAINING SUBGRADE BY INTERCEPTING WATER FALLING OUTSIDE THE PAVEMENT.

resurfacing of these pavements had upon the maintenance costs, even in the face of rising prices of labor and material.

Notwithstanding the large amount of money spent in maintaining these old pavements, they are not to be compared with permanent pavements on the basis of smoothness of surface, pleasing appearance, cleanliness and low traction resistance. Moreover, in order to minimize the tendency of macadam pavements to become flat and develop ruts, they are



EFFECT OF RESURFACING OLD MACADAM PAVEMENTS WITH ASPHALTIC CONCRETE UPON COST OF MAINTAINING PAVEMENTS AT OAK PARK, ILL.

usually given a high crown, which renders them decidedly dangerous in wet weather after they have been oiled or carpet-coated.

The accompanying graphs showing the saving in initial cost are taken from actual costs on work laid in the vicinity of Chicago during the years indicated. An extensive yardage of work is represented in these figures, therefore the conclusions to be drawn are based upon representative facts and conditions. It is safe to say, that at present prices, the average old stone or gravel pavement may be utilized as a foundation for some permanent type of surface for approximately $1 per square yard less than the same pavement would cost if laid on a new concrete base.

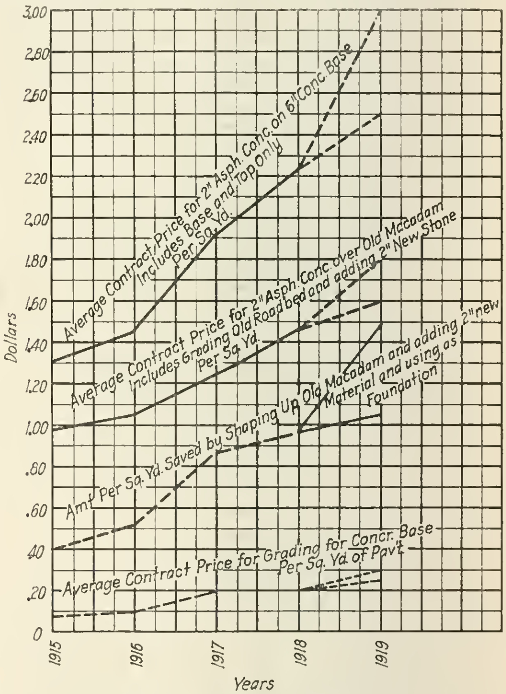
Conclusion

There are undoubtedly many miles of old roadways in every community which are either in a very bad state of repair, many of them being well nigh impassable, or, if any attempt is made to keep them even in a fair condition, are a source of continual expense. With very few exceptions these old pavements possess an intrinsic value not to be laughed at. When properly utilized, their practicability as foundations for first class pavements, has been proven beyond a shadow of doubt.

Some type of bituminous surface will ordinarily be found to be the best material for resurfacing these old roads; first, because bituminous mixtures are peculiarly adapted to this class of work; (2) they are the least expensive among the various types adapted to resurfacing work; (3) maintenance expense is very small; repairs being quickly and satisfactorily made at low cost; (4) sheet pavements are highly sanitary, of pleasing appearance, noiseless and watertight; and (5) the bituminous top may be laid immediately after preparing the base, and the roadway opened to traffic in a very few hours, thus avoiding the long period required for curing concrete.

In rigid foundations, vibration increases as the rigidity increases. Solidity rather than rigidity is the primary desideratum of foundations. The downward deflections of a concrete pavement or foundation slab under continually varying loads exerts pressure against the sub-grade. If the soil composing the sub-grade is sufficiently susceptible to compression, uniform contact between the bottom of the slab and the sub-grade is eventually destroyed. It is plain to see that when the sub-grade becomes sufficiently depressed, the slab is called upon to arch over the depressions, thus setting up high tensile and shearing stresses. Numerous practical demonstrations of the result of the inability of cement concrete to maintain uniform contact with the sub-grade are to be found.

Macadam and gravel foundations by virtue of their close contact with the sub-grade are not subject to high tensile stresses, therefore, when an old pavement, which has passed through the settling period, is used as a foundation, cracks



ACTUAL SAVING DUE TO UTILIZING OLD MACADAM PAVEMENTS AS FOUNDATIONS FOR ASPHALTIC CONCRETE.

and ruptures of pavement are much less likely to occur.

Grave danger lies in the failure of those responsible for the administration of public works and the release of public funds, to provide careful designing, wise selection of materials and intelligent supervision, and to make sure that contractors are selected who are not likely to perform their work

MAINTENANCE COST OF OLD MACADAM STREET PAVEMENTS IN OAK PARK, ILL.—1916 TO 1918.

	Light Oil Dust Layer Treatment			Repairs, Preservation, Carpet Coating, Etc.			Total Maintenance Cost			Mileage of Street Pav. in Town	
Year	Miles Treated	Cost Amt.	Cost Per Mi.	Sq. Yds. Treated	Cost Amt.	Per Yd.	Amt.	Per Mi. Macadam	Per Mi. Pavement (all kinds)	Macadam	All Pav.
1916	34.75	$5,744.24	$165.00	19,632	$5,207.12	$0.265	$10,951.36	$395.00	$131.00	27.78	80.46
1917	25.22	5,299.84	223.26	26,453	5,201.23	.197	10,501.07	397.00	128.00	26.48	82.37
1918	16.12	4,151.50	257.53	31,154	6,650.02	.214	10,801.25	420.00	130.00	25.79	83.15
Totals and averages	76.09	$15,195.58	$199.70	77,239	$17,058.37	$0.221	$10,751.32	$404.00	$129.67		

N. B.—Alley pavements not included.

in a haphazard and careless manner. The building of pavements is, and should be, a science. The old idea that most anybody could go out and make a road is fast vanishing—it should be dissipated wherever it still prevails. Road building is the largest item of public expenditure and it is on the increase. An investment of such magnitude must be wisely made and safeguarded. Better roads must be built, and maintenance must be systematically carried on. It is deplorable that in many localities those best equipped have the least to say of what and how the pavement should be constructed.

Some Practical Points to Observe in the Construction of Bituminous Pavements

By R. Keith Compton, C. E., Chairman and Consulting Engineer, Paving Commission, 21½ E. Lexington St., Baltimore, Md.

This discussion is intended to cover bituminous pavements of both fine and coarse aggregate, to outline the main features of inspection and construction, to describe the method of carrying out the specifications and to call attention to conditions confronting us with present day bituminous construction, which must be overcome in order to secure the desired results. Expert and detailed specifications and methods may be drawn up and provided for, but unless they are properly carried out, and what may be considered minor details strictly looked after, poor construction is likely to follow.

The Bituminous Pavement

The writer knows of no better way to describe the bituminous pavement than to quote from a similar paper delivered by Mr. Francis P. Smith at the Montreal Convention in 1916, as follows:

"Bituminous pavements, especially those with fine material aggregates, are smooth, non-productive of dust, almost noiseless, waterproof, non-absorbent and easy to clean. They are capable of sustaining very heavy traffic and also last well under light traffic. They are therefore well adapted for business and residence streets, and the facility with which they may be kept clean makes them especially desirable in tenement districts. They are easy to repair and offer but slight resistance to traffic. They are somewhat softer in summer than in winter, but when properly laid never become too soft for use even in the hottest weather. When dry and clean they are not at all slippery, but their slipperyness in moist weather is largely due to the presence of a thin film of mud caused by the collection of street detritus and this can be greatly reduced by washing or keeping them clean. For this reason they are less slippery in a heavy rain than in a drizzle. Horses accustomed to granite block pavements instinctively put their hoofs down and slide them until they obtain a foothold in the crevices of the pavement. As there are no such crevices in a bituminous pavement, it takes a little time for them to become accustomed to it, but they soon learn to adapt themselves to a smooth surface."

Some Characteristics of Bituminous Pavements

Bituminous pavements will withstand and sustain a very heavy amount of traffic, preferably quick moving, light or medium loaded vehicles, such traffic, for instance, as prevails on many of our business streets. It is not claimed to be particularly adapted to dense, slow-moving, heavily loaded traffic. Some block pavements will outlast it under such conditions. It must have some traffic. If a bituminous pavement is laid on a street and traffic completely blocked off for several months, exposure to weather conditions will cause volatilization or evaporation of the lighter oils leaving the pavement hard, brittle and almost worthless. Its life requires some traffic in order to cause the kneading action necessary for it to retain these articles which are the very life and durability of the pavement itself.

Choosing Type of Pavement

Before deciding on the type of pavement to install a well informed engineer will take into consideration the extent, volume and character of traffic, the grade of the street, the width of the paved driveway between curbs, whether or not street railway tracks exist, character of the section to be served, whether business or residential, whether noise is a factor, and it generally is, and whether or not the street is in close proximity to a water front, as bituminous pavements will not withstand moisture. They must have occasion in which they can fully dry out. This will not be the case on a water front street because the moisture will come up through the concrete and deteriorate the pavement from its under side, effecting first the binder and then the top.

Grades

It is not claimed that sheet asphalt, which is a bituminous pavement of fine aggregate, is suitable for excessive grades. A grade may be excessive under certain traffic, but not under other traffic. Generally speaking, 6 per cent. is the maximum grade for sheet asphalt on a heavy traffic street. On lighter traffic streets it has been laid with great success on grades up to and including 12 per cent. When excessive grades are encountered it is well to use a bituminous type of coarse aggregate such as bitulithic or asphaltic concrete. It is a well established fact that bituminous pavements are most slippery on light grades during bad weather when the pavement is covered with a thin film of slimy mud with insufficient rain water and grade to make it self-cleansing. This same condition does not exist on grades 3 per cent. and over.

Pavement Base

The pavement is no stronger than its base, therefore, great care must be exercised in deciding upon its character and thickness, depending mostly on the character and volume of traffic, but largely on the character of the sub-grade. Various kinds of base or foundation have been used; old macadam, cobble, brick and granite block have been resurfaced, using the old pavement as a foundation. Practical experience has proven that this is not first class construction although it has been followed with success in many instances. Its success depends entirely on conditions of the old pavement when the new top is installed and extreme care must be used in all phases of this construction.

Assuming that one decides to resurface an old cobble or block pavement, he proceeds to notify all public service corporations and city departments to install their construction before paving operations are started. After they are through it frequently happens that very little is left of the original pavement. In other words, that which you had intended to use as a foundation has been practically destroyed and it cannot be replaced in its original condition. In the meantime your contract has been awarded on that basis and there is nothing for you to do but to proceed. An ever increasing volume of traffic attracted to the new pavement soon breaks through the foundation and the topping starts to disintegrate.

Assuming that the old pavement remains in its original condition, its contour will probably not conform to the contour which is desired for the new pavement and the difference has to be made up, probably a half inch in one quarter, several inches in the center and more or less on the other quarter. As there is not sufficient room for concrete, it is concluded to make it up with the binder. This means an excessive amount of binder, probably lack of compression, resulting in a wavy, poor surface which may not develop at first, but undoubtedly will later under traffic. While this practice is not condemned, it is desirable to call attention to defects which may develop unless extreme care is used not only in inspecting the old pavement, but also great care must be used in looking after the details of construction when the new pavement is laid. When the traffic is light as on state roads where they may not be main arteries of traffic and on some residential streets, old macadam has proven to be a suitable foundation for bituminous pavements, but the same precautions must be taken as that outlined for cobble and block foundations. The most desirable foundation for a pavement is concrete from 4 to 8 ins. in thickness, depending on the factors named, generally 6 ins. and of a 1-3-6 mix. The sub-grade should be thoroughly drained and compacted before the foundation is laid.

Specifications

Specifications should be drawn without making either principal the goat, but should be broad and in detail, but not in such detail as to be burdensome and misunderstood. The specifications having been drawn, the contract duly advertised, awarded and executed, then comes up the question of construction and inspection.

Inspections

We must emphasize the importance in the construction of bituminous pavements of strict plant, laboratory and street inspection. Street inspectors should cover not only hot materials but the concrete base and all other items as well. The street inspector must see that the concrete, if mixed on the street, is of the proper proportions, that the proper size stone, character of sand, etc., is used.

Central Mixing Plants

Central mixing plants for extensive paving operations are now coming into vogue in large municipalities, thus avoiding congestion on the street in the storage of immense quantities of stone, gravel and sand, and hindrance to traffic, accidents, etc., and in case of storms or heavy rains much loss of lighter materials. The material is mixed at the central plant under the supervision of an inspector, transferred to the street in trucks and then handled very much the same way physically as the asphaltic material, but always under the supervision of an inspector on the street. Experience so far seems to indicate that this plan can be worked successfully provided the haul is not too long, say not exceeding 20 minutes. In this case sand and some loam is preferred to the absolutely clean sand because the latter is apt to cause a separation of materials in transit. This plan is at present working in a very systematic and practical way and as it is extended improvements will be made, so that in course of time streets can be improved in a congested section without so much interference, burden and inconvenience to traffic and the general public. Regarding inspection of hot material the following plan in vogue in many of the large municipalities is outlined, and it has been found to work in a most satisfactory manner.

Inspection of Hot Material

An adjunct of the municipal laboratory is established known as the asphalt division, in charge of a chief asphalt inspector with sufficient sub-inspectors to cover all asphalt plants. This division also looks after the inspection of other materials such as stone, sand and cement and finished concrete. Depending on whether the concrete is mixed at a central plant or on the street, the chief asphalt inspector visits the points of mixing and selects the sample of concrete as it comes out of the mixer. This is sent to the laboratory where under the following process the street inspector is checked up, and we can tell very closely whether or not he is following the mixture provided for in the specifications. A sample of concrete base is taken from the grade after it has been raked and tamped (about one 14-quart bucketful), but before it is set. This material is then washed and the aggregate separated by screens, the ¼ in. screen to remove the stone and the 10 mesh to remove the larger particles. The remaining sand and cement is then dried and screened over a 100 mesh sieve and what material passes the 200 mesh is, after making calculation for amount of very fine sand which passes the 200 mesh, taken as cement. It is not claimed that this process is absolutely correct, but it very closely approximates the actual proportions being used. Then again, the specifications may provide for a compressive strength test on a cube of finished concrete where cement concrete is used as a wearing surface. This is also handled by the chief inspector, who selects the sample, cures the concrete under field conditions, makes the test in accordance with standard practice and reports results to main office.

At each asphalt plant is stationed an inspector, who is equipped with screens, balances, a penetration machine and thermometer to be used in testing the stone, sand, asphalt cements and temperatures of the finished mixtures. All incoming raw materials are tested by the inspector at the plant, as received, except the asphalt and residiums, which are sampled and sent to the laboratory for analysis before they are used. Samples of the stone, sand and dust are also taken to the laboratory and tested. The inspector is given a mixture showing the percentage of stone, sand and asphaltic cement by which to turn out the binder mixture, also the penetration at which the binder cement is to be maintained, each kettle being tested before it is used.

The procedure for topping mixtures is as follows:

After the sand has been tested the inspector is given a formula, telling the mesh composition of the sand, the amount of sand, limestone dust and asphalt cement to be used, also the penetration of the asphalt cement. These instructions are received from the chief asphalt inspector. Each plant is visited at least once a day by the chief asphalt inspector, who makes an inspection of the plant and materials being used and collects samples of the asphalt cements, finished mixtures and the inspector's reports. These samples are taken to the laboratory, the asphalt cements being checked and the mixtures analyzed and any irregularities noted and the plant inspector immediately notified of same. The chief asphalt inspector during the day visits each street on which any material is being laid and takes samples, which are tested, and if found deviating from the mixture set, the inspector is at once notified of it and the trouble remedied.

When the mixtures arrive on the work they are tested for temperature by the street inspector, who oversees the laying of the binder and surface mixtures, seeing that the surface gets the proper amount of rolling and that the binder and wearing course are of the required thickness. The street inspector at the finish of each day's work sends a post-card to the laboratory showing the number of loads and batches of material received on the work, and also the yardage of material laid. These figures are checked against the reports of the plant inspector, the yardage per batch obtained and a report of same made to the principal assistant engineer and any irregularities noted and corrected. A record is on file at the main office and at the laboratory, of the cubical contents of the mixing box at each plant. A standard is set of how many square yards of a known thickness each batch should lay, after compression. In this manner we can tell whether or not the binder and topping laid on the previous day are of the required thickness as a check on the street inspector.

Brick Gutters

As a general rule brick gutters from 12 to 18 ins. in width should be used on bituminous streets. They are absolutely necessary where there is any amount of surface drainage. Where all surface drainage has been eliminated they are still necessary on grades up to 2 per cent., but they are desirable on all bituminous streets, for two reasons. Gutters are for the purpose of collecting the water, and consequently the space next to the curb is nearly always damp, owing to collection of drainage, debris, etc. Furthermore, it is not always feasible to roll bituminous material in close proximity to the curb and the very existence of the gutters permits a more accurate cross section and contour and also permits the accomplishment of better compression and more expert handling of the roller.

Handling on the Street

Even though the hot material has been handled with expert care at the plant and transported to the street, great quantities of such material have given poor results, owing to defective handling on the street, such as poor raking and poor rolling. Too much care cannot be exercised in expert raking and rolling. Each load should be spread in a space separate and distinct from where it is dumped. One great difficulty in handling this material on the street is the practice of the spreaders or rakers standing in the material. This can be avoided by shoveling channels, commonly known by the men as "alleys" through the material for workmen to stand in; spreading the material in a space separate and distinct from that where it was deposited eliminates danger to a very great extent of any foreign matter such as blocks of wood and tin sometimes used by the careless drivers in order to close up crevices in the body of the hauling vehicle. Rolling material when it is too hot causes it to buckle and overlap. The use of too much water when rolling, which is very prevalent and a great temptation, causes blisters. Both of these practices should be avoided. It is very difficult to obtain full compression in close proximity to hard surfaces whether by tamping or by rolling, so that it is desirable to keep the finish about ¼ in. high along gutters, liners, castings, etc., otherwise full compression, which is eventually obtained under traffic, will soon cause depressions.

Rate of Rolling

With further reference to the matter of rolling, so many yards should be allowed per hour, per roller, approximately 250 for binder and 150 for wearing surface. With expert roller men this can be slightly exceeded, but it is important to keep the rollers continuously in operation as far as possible. It is preferable to start rolling with the lighter roller, then after the material has somewhat cooled off, follow with the heavy roller, using as the occasion may require, both rollers for the final finish. Hot smoothing irons may be a necessary evil, but should be avoided as far as possible, as they are exceedingly dangerous and attractive weapons in the hands of men who may carelessly and unnecessarily use them. It is necessary to use for a final covering a material to close up the pores, usually Portland cement. It should be spread and swept almost clean by skilled labor. It is poor practice and very wasteful to use too much of this material. One such man will save enough cement in an eight hour day to more than pay his wages. Too freely used it causes an unsightly finish.

Sheet Asphalt Construction

Practically the same details of inspection enter into all classes of bituminous construction, although the construction of the bituminous portion of the pavement is not the same for all types. The standard sheet asphalt construction at the present time consists of 1½ in. binder and 1¼ in. top, laid on the foundation, while the standard bituminous pavement of coarse aggregate usually consists of 2 ins. of bituminous material of the same mixture throughout laid directly on the concrete. All dimensions given are those obtained after full compression. The coarse aggregate type, being an open mixture, it is covered with what is known as a squeegee coat of bituminous cement, after which stone chips are applied. Moderately close binder is recommended for all pavements of the sheet asphalt type. The binder should contain a sufficient amount of asphaltic cement and fine material otherwise it will break up under the vehicles transporting the top to its position on the street. Not more than one day's run of binder should be allowed and this should be swept clean before the topping is installed so as to secure a bond.

Coarse Mixtures

The asphaltic content of coarse mixtures should be given more attention and kept within closer limits than will be necessary with sheet asphalt mixtures. This is because there is a closer relationship between the mineral aggregate and asphaltic cement in the coarse pavements than in the finer ones, and no great variation one way or the other in the amount of bitumen used is likely to cause trouble. Too much bitumen will cause the pavement to become soft, which means that it will be wavy and it will cause it to roll. Not sufficient bitumen will cause the pavement to be open, dry and to disintegrate.

When a bitumen pavement joins a block pavement whether of brick or stone, a header must be used so as to keep both pavements in position, neither one being rigid in itself. The most common header used is of stone such as old curbing, fairly well dressed with its surface showing between the two pavements. This, however, is unsightly and in time a hindrance to traffic. A desirable header is one of some hard substantial material such as stone or concrete, but countersunk, say, 2 ins. below finished grade. This will hold the block pavement in position and at the same time allow the bituminous topping to be carried over flush with the surface of the block pavement, causing both pavements to maintain an even, smooth surface.

It is these points which, if closely followed by engineers and inspectors, will give a good workmanlike, satisfactory, bituminous job. If not followed, one may expect trouble in many of the several items covered.

Acknowledgment

The foregoing paper was presented by Mr. Compton before the convention of the League of Third Class Cities of Pennsylvania, at Allentown, Pa., Aug. 28, 1919.

The Trend in Municipal Refuse Collection and Disposal—Estimating Costs

By Rudolph Hering, D. Sc., Consulting Engineer, 170 Broadway, New York

In complying with the editor's request for a short article on the subject of Municipal Refuse Collection and Disposal, I can do no better, I believe, than endeavor simply to point out the directions in which this branch of municipal work is progressing, and thereby assisting those in charge, when they are studying ways and means of improving their local plant, to approach the most promising solution of their problem.

The community refuse, which in this small space is worth while considering, consists of garbage, or chiefly kitchen refuse, and of ashes, or chiefly the remains of coal fires, and of rubbish, or the miscellaneous trash or solid waste accumulating in or about buildings used as domiciles, stores or factories. Nothing will here be said about street sweepings or manure, not only because the latter is continually decreasing in quantity, but because they can both be either treated as rubbish, and sometimes as fertilizer, if justified by the analysis and the distance of haul through the suburbs; or, under certain precautions, they may both be dumped to make land. Nor will anything be said of the collection and disposal of night soil and dead animals, as the quantities are small and the treatment is comparatively simple.

Development of the Art

Garbage, ashes and rubbish form the materials which give the authorities the most trouble; and this trouble increases as the community grows larger. More than a century ago the practice was common to feed animals with garbage and to dump its surplus and the rest of the municipal refuse at any convenient places. In many old cities the ashes, then mostly wood ashes, and the rubbish were dumped and leveled on the roads used for travel, which raised them, gave them a harder surface, and improved their drainage. Roads built up in this fashion have been found in old cities both south and north of the Alps.

As cities grew and their inhabitants became more particular in their demands upon the local government, the promiscuous dumping in town was often considered objectionable, thereby necessitating the distance of haul to be increased. Where the expense of hauling grew large, and as most of the refuse is combustible, it was suggested to destroy it on open lots by burning, in order to remove the objectionable qualities and leave only ashes.

Nearly a hundred years ago, in England, where the cities were beginning to grow rapidly, it was first suggested to burn the refuse in specially built furnaces. Meantime the use of coal had become common and coal ashes were produced. The rainy climate turned some of them rather black, which indicated the presence of a large amount of unburnt coal and cinders (together 25 per cent.) in the ashes from the domestic fireplaces. At the same time there was more kitchen garbage produced than desired for feeding animals in and near the town, and the surplus was and had to be thrown upon the midden, which was the dung, rubbish and ash heap. This mixture of refuse, in the English midden, particularly as it contained a large proportion of unburnt coal, was found capable of being incinerated in furnaces. The first one for this purpose was constructed by Fryer of Nottingham. The refuse was burned so completely and satisfactorily that only ashes were left, but no organic matter.

Incineration

The result was that the incineration of refuse was adopted in other cities and became quite general in England and later also in many cities of the European continent.

The furnaces were gradually improved and became more efficient and more economical. In nearly all cases the resulting clinker was used for roadmaking and other purposes, and the resulting heat of combustion was utilized for the production of steam, which has been used in several ways, lately mostly to generate electricity.

The solution of the problem of refuse incineration therefore rested on finding a satisfactory furnace for destruction and getting the greatest money return from the clinker and heat.

American Practice

In American cities the development took a slightly different turn. Some of our garbage has always been fed to animals. Generally farmers collected it and took it to their farms. In the large cities hotels and restaurants, where the amount of garbage was large, soon supplied all the food which the neighboring farms required. To collect it also from private residences, as each one supplied but a small amount, proved more expensive than the profit justified. Such collection for feeding, therefore, not being financially attractive in large cities, was abandoned, and the garbage, ashes and rubbish were thrown upon a midden heap or into cans. This mixed refuse was then either removed by the parties creating it, or it awaited collection by the town, either through a contractor or by its own employes.

Garbage Reduction

A new aspect of the problem then appeared. Examination had shown that the American garbage contained an amount of grease greatly in excess of that of the European garbage. Analytically it was found to be so great that when recovered by known processes it would yield a revenue, which, according to the promoters, would not only yield a good profit, but in favorable cases even pay partly for the garbage collection. This method of reduction required that garbage be kept in a separate can at every house and not mixed with ashes or rubbish. It also required that the amount collected in a town be large enough to pay for the installation of a reduction plant which was costly, and could be made remunerative only if the bulk of the products was sufficiently great. The first city which introduced the reduction system of garbage was Buffalo, N. Y., in 1886. A company obtained a contract to manufacture grease and fertilizer from the city's garbage, after it was delivered to the works by the city. After a year's operation the company lost money, but continued the work profitably when the city paid $20,000 a year.

Since then many garbage reduction works have been built in our country, mostly by private companies. Many of them have failed in fulfilling their contracts, partly because the process was more expensive than originally supposed and partly because insufficient money was spent by the companies to prevent a nuisance and an objectionable condition of the works.

The Cobwell System

In three cities, Cleveland, Columbus and Chicago, reduction works were built and operated by the municipalities, with fairly satisfactory results. The most promising method of reduction seems to be the Cobwell System, as first installed and operated at Los Angeles, where grease and the remaining tankage are produced without a nuisance. So long as American garbage contains a sufficient amount of grease to pay for its extraction without producing also a nuisance, reduction works will no doubt be continued in use at least in the larger cities.

Another different aspect of the problem appears in America, where the amount of garbage per capita is much greater than in Europe. Our life conditions have permitted us to be more wasteful and we discard into the garbage pail much food matter from the kitchen which in Europe would not leave it. When in Italy, I once inquired what their people did with the garbage or wasted food, and the answer was that they had none beyond what was eaten up by goats and a few pigs in the town. When examining a garbage pail I was surprised to find that even goats would find enough on which to subsist.

Garbage Disposal by Feeding

American garbage when fresh is an excellent food for pigs. If it can be obtained at no cost and we pay merely for the collection and delivery to hog farms, we have in our country an excellent means of garbage disposal, limited only by two conditions: First, the collection must be frequent enough to be able to obtain the garbage in a fresh condition, and, secondly, the distance to the feeding grounds must be short enough to prevent the delivered garbage from becoming foul.

In many instances a daily collection is feasible during the hottest weather. In winter two or three times a week will answer.

Our own food is delivered to us thus frequently, and animals, eating only one or two days later what we have left, are thereby treated sufficiently well, so that they can eventually form a part of our own food, which we desire to be good and healthful.

We can shorten the distance and time required to remove garbage in two ways. We can establish a transfer station within a city where the garbage is dumped from carts into cars, protected from sun heat and delivered quickly to the hog farm. We can also, in my opinion, establish a number of feeding places within a city and thus obtain the required quick delivery. There is no reason why such places should be offensive. Hog pens can be kept as clean as stalls for horses and cows. The pens should be built of concrete, of material not absorbing water nor having a rough surface, and should be well drained. They should be cleaned and washed at least once a day and every practical provision should be made to keep the hogs clean and healthy. Such an establishment to which the garbage is delivered while fresh could readily be made even less offensive than many of our stables are, and certainly less offensive than many of our industrial works in our cities. The only necessary conditions to get these results are frequent and quick deliveries to a plant of proper design and arrangements for feeding, and all other provisions to maintain a healthy crop of hogs.

When the fundamental conditions have justified it in our country, we have developed a number of works that have never before existed on the same scale. Why should we not solve the important municipal problem of an inoffensive garbage disposal also in the direction of providing a good food when the financial conditions favor it? So long as American garbage contains so large a quantity of healthful food material, its disposal by hog feeding will continue.

We have, therefore, in our country, under the new conditions here existing, a somewhat more complex problem to solve than has been necessary in the older countries. Because our garbage has a more inherent financial value than theirs, we are able to add to the older methods of disposal, a reduction of garbage to grease and tankage-fertilizer, and a more extensive application for feeding. We have had sufficient experience to know that all of the methods mentioned above can be made satisfactory if the works are properly arranged, well designed, and built and are intelligently operated. The only question for us yet to decide is the expense required to erect and operate a plant, because the least expensive one, among the possible plants would be satisfactory, is the one that a city should adopt.

Estimating Cost of Projects

It is important then to know the cost of the projects. Formerly, bids were sought for a furnace and its construction, or for the construction and operation of a reduction plant, and the contract was given to the lowest bidder. Later, it was found that the cost of operating an incinerator, or of inoffensively operating a reduction plant were very prominent factors and, that the cheapest incineration or reduction plant often costs much more to operate satisfactorily than a more expensive plant. Thereupon, bids were requested for works, including the operating expenses on a basis of total annual cost. This proved to be a much better method.

When we have to decide the relative economy of disposal plants involving different systems, different distances for collection and different ways of final disposal, the financial comparison must begin at the origin, namely at the house. A shorter distance for collection, or a less frequent collection, will balance a greater cost for the disposal method, and vice versa. If the disposal plant can be located so that the collection distances are short, we are justified in spending more money to make it thoroughly proof against bad odors and otherwise attractive, than if the collection distances are long. We have such cases in Europe. If we must have more frequent collections for the selected disposal system, then we must either have proportionately less expensive plants, or they must yield a corresponding profit which pays for the greater cost of collection.

If the conditions of the city appear to be available for nearby hog feeding with fresh garbage, and the analysis of the garbage also justifies an inquiry into the economy of a reduction plant, the garbage must in both cases be collected separately from the ashes and the rubbish. We must then assume that the local conditions are favorable for ash dumping, and that the disposal of the rubbish will probably require incineration.

To get the lowest cost, we must first designate the best locations or points for the final disposal of the garbage, of the ashes, and of the rubbish, estimate the average distances for collection separately for each part of the total refuse, and determine the frequency of the collections. We are then able to estimate the annual cost of collecting the entire refuse at the origin and delivering it at the point of disposal, not forgetting to add the annual interest on the investment for the entire collecting outfit, stock and its housing, the depreciation, etc.

We must then, secondly, determine the cost of land, of designing and building the disposal works that may be applicable to the case, namely, feeding and reducing garbage, dumping ashes and incinerating rubbish. In each case, sufficient allowances should be made for contingencies, particularly in the line of providing all necessary means to prevent any nuisances. These estimates of the cost of construction should be reduced to the annual cost, and embody interest on the entire investment, taxes and the yearly depreciation of the works.

Thirdly, we must determine the annual operating costs of the various disposal works, as the cost of running a hog farm, of extracting grease and preparing tankage for fertilizer, of incinerating rubbish and disposing of ashes. This estimate should also include an allowance for contingencies depending on the variable cost of labor and materials.

Fourthly, we should estimate the income resulting from a sale of the products. There is an income from the sale of hogs, grease, tankage, heat from a rubbish incinerator, and there may be an income from made land.

From these four determinations, it is practicable to estimate the annual cost of the collection and disposal of the entire refuse according to whether a reduction or a hog feeding plant is used for the garbage disposal, ashes being dumped and rubbish incinerated in both cases.

Mixed Collection and Disposal by Incineration

The preliminary work, however, is not complete unless also another estimate is made, namely, one for the European method of a mixed collection and a disposal by incineration. In this case after selecting one or more suitable locations for one or more incinerators in the inhabited area, as in London, we must determine, first the cost of collecting the mixed refuse at the house, as frequently as has been decided, and delivering it to the nearest incinerator. We must also add the interest on the entire collecting outfit and the depreciation, but in this case the outfit must be for a combined collection.

Secondly, the cost of land and of the incinerator must be determined, including all facilities for producing the maximum amount of heat and of its conversion into steam power and electricity with all the necessary appliances for their respective utilization. As before, these estimates must be reduced to the annual cost, including interest, taxes and depreciation.

Thirdly, the annual cost of operating the incinerator must be estimated, including a fair sum for contingencies; and fourthly, we must estimate the annual return or income from the sale of the clinker and the return from the steam which can be profitably produced by the heat generated in the furnace. In many cities the heat has been converted into electricity, which was used for lighting and in a few cases also for loading storage batteries which supplied the power for the motor trucks collecting the refuse.

This annual cost and revenue estimate for producing heat and clinker from the refuse of a combined collection should be compared with the annual cost and revenue estimate for feeding, and for reducing the garbage, not forgetting to add to the latter two methods also the annual cost for disposing of the ashes and rubbish.

A study from such comparative cost estimates, if made on an equitable basis, should disclose the least expensive method by which a city could solve its refuse problem. If the estimates of cost include sufficient contingencies for preventing odor, first, by sufficient and frequent collection in clean wagons, and secondly, by the prevention of the generation and escape of offensive air at any part of the disposal works, the resulting least expensive project should give the desired satisfactory solution for the town.

The American Association of Engineers—Co-operation

By George C. Warren, President Warren Brothers Company, 142 Berkeley St., Boston, Mass.

Being much interested in recent articles to which Municipal and County Engineering has devoted much space, perhaps a contribution from the writer may be of use.

Beginning at the bottom as a lad, 35 years ago, continuously active during that period, closely associated with pavement and road construction work, and naturally co-operating with municipal engineers, it is my pleasure to state at the outset that, as a rule of my observation, engineers are faithful, conscientious and painstaking in the discharge of their duties. Of course, there are and always will be exceptions in this, as in every other, class of men. It will probably not be questioned that the three most glaring causes of the "exceptions," in the order of their pre-eminence, are the following:

1. Insufficiency of remuneration.
2. Uncertainty of reasonable tenure of office.
3. Requirement either by law or political custom that the engineer must be a voting resident of the municipality he serves, which brings appointment to a degree of political patronage.

These "causes" will be briefly discussed.

Remuneration

Every municipal official, as well as men in important commercial positions, should, to a reasonable degree, be care-free in the matter of support of himself and family. Too frequently in the past this rule has not applied to municipal officials in general, and engineers in particular, a condition which has more or less contributed to and reflected in:

(a) Inefficiency and inexperience;
(b) Lack of industry;
(c) Dishonesty.

To get the best from any man he must have an incentive, and one of the greatest incentives is appreciation, of which financial remuneration is a leading factor. Fortunately during recent years public opinion has rapidly improved in this respect, but much is yet to be accomplished.

Tenure of Office

Nothing could contribute more towards:

(a) Inefficiency of personnel;
(b) Falling into political patronage;
(c) Spending more time in trying to "hold his job" than in efficiency of service;
(d) Tendency toward dishonesty;
(e) Consequent inefficiency and lack of economy,

than for the incumbent to feel that his position is not likely to be held as long as he desires and shows competent, efficient, economical administration. This difficulty also seems to be on the wane, but much more can be accomplished. How much more efficient is an engineer if he is free from fear of political removal so long as he fills his office to the best of his professional ability and gives high degree of service, than if he is obliged daily to "trim his sails" to meet political requirements and approval.

Limitations of Civil Service

The writer is not one who believes that application of "civil service rules" and examination is by any means a "cure-all" for this evil. In fact he is strongly inclined to the belief that such "rule" tends toward:

(a) Selection of men of technical training rather than hard practical experience and "common sense" which is really the more important of the two considerations.

(b) Retention in important office of men who stand high in "book learning," but who really are inefficient, against whom no "charges can be preferred" or sustained.

Appointment and retention in office should be based on sound judgment rather than technical "civil service" examination. Given a man in the office of municipal engineer who attends to the business of his office and has competently for many years held office through serial administrations of varying political parties and we generally find a well organized efficient department with a man at its head who is acquainted with local engineering situations and problems such as is impossible for a new incumbent of otherwise equal ability.

In Canada, quite generally, and in European countries, more universally, competent engineers know to a reasonable certainty that their tenure of office is as long as they show efficiency and desire to retain the office, with the result that almost their sole thought is efficiency.

In Birmingham, England, for instance, the city engineer has held office to the writer's knowledge for a quarter century or more and the result is he "knows every stick and stone," as well as most of the people, in the city, and has one of the most highly efficient engineering departments in the world, and any political party which attempted to oust the incumbent, so long as that condition prevails, would be doomed to political disappointment. What an advantage for efficiency such an incumbent has!

Local Residence

In some places, largely as a result of the old "County Surveyor" principle, the laws of some cities still require that the engineer "shall be a voting citizen" of the municipality. More frequently political custom so requires. It is manifest that the result is a small list of personnel from which to make a selection, which naturally cripples efficiency.

In the year 1911 the writer had occasion in discussion of the subject, "Competition in Public Contracts" in the "American Society of Engineer Contractors" to discuss some of these matters in opposition to statements of one of its engineer members. The following extract from remarks then may be of value at this time:

> Is not the whole system of competitive bidding and award of contracts to the lowest bidder (regardless of responsibility, including previous experience in the line of work undertaken, evidence of honesty of purpose or otherwise and of the profit or loss on the work) based on the wrong principle of grinding the contractor down to a basis on which he cannot live and carry out his contract honestly; ruinously excessive competition in other words?
>
> Do not such conditions as to both officials and contractors breed and encourage, if not almost force dishonesty on the part of both?
>
> In any reform we undertake let us assume that officials (engineers or otherwise) as well as contractors are honest and place in the officials the responsibility and the confidence which that assumption would carry with it. Then pay the officials fair salaries and you will generally get good service, although at times in public as well as private life there will be an occasional wrong-doer.
>
> Let the contractors understand that their bids will be as readily rejected if too low as if too high and that experience, responsibility and general reliability in the past will weigh as heavily in determining the award as the amount of the bid in dollars and cents. Would any of us if we were to build an expensive house hire an architect who would work at the cheapest rate and then advertise for bids and say to the contractors—"The man who offers to do the work for the least money and gives a surety company bond will get the work?" What kind of house would we get on that plan? In such cases do we not consider price as only one of the many important factors for consideration in awarding the contract? Who has ever heard of satisfactory results through surety bond after the contractor has failed because the contract price is too low?

The specifications should be clear and distinct and as brief as practicable. They should avoid all trick clauses and at the end of every paragraph should state under what item of the contract and bid the work embraced in that paragraph is to be paid for. "Discretion of the engineer" should be eliminated and yet some things must be left to the "best judgment," which is another way of stating "discretion" of the engineer, but its exercise should always be fair. Too often the engineer considers his duty is to get all he can for his employer, however unfair to the contractor. In such cases it is only to be expected that the contractor will do his best to "recoup" and if the engineer is so narrow as to take unfair advantage of the contractor he is generally sufficiently dense so that the contractor can find a way to "put one over" on him. * * * *

Let contracts provide that if any item of a contract exceeds 20 per cent. of the estimated quantity the excess shall be done at cost of labor and materials plus 15 per cent., regardless of the contract price for such item, and let the engineer understand that when any item exceeds the estimated quantity by more than 20 per cent., the fact will be regarded as prima facie evidence of incompetence and be followed by rigid investigation and probable discharge, if the investigation proves the error to be due to either incompetence or dishonesty. Then, at least intentional unbalancing of bids and estimates will be promptly stopped and engineers will exercise more care than they often do at present.

In some cases the quantities cannot be accurately estimated in advance and in such cases the "cost plus 15 per cent." basis of payment for the excess will check dishonesty. Never put in a contract a clause that if certain unanticipated contingencies arise the work "will be done by the contractor without extra allowance." Nothing could be more unfair, for instance, than a clause in specifications for a pavement that if "soft or spongy places develop in the sub-grade they shall be dug out by the contractor and refilled with sound material (earth, stone, cinders or concrete *as the engineer may direct without extra charge*." Yet this is a common clause in pavement specifications, and equally unreasonable and similar clauses are found in specifications for other classes of work.

If the contractor, in the construction, is faced with such a condition, he is sure to know he has been "robbed," and if he doesn't retaliate by "stealing" some cement out of the concrete or otherwise it will be because he doesn't know how—not because he is dishonest, for he will be pretty certain to figure out in his own mind, that, under the circumstances, such retaliation is honest. In every construction unforeseen contingencies are liable to occur. It is absolutely dishonest to throw the extra expense on the contractor and specifications should always provide for such cases, that such unanticipated or unforeseen work shall be paid for at "cost of labor and material plus 15 per cent.," or, as is the custom of the city of Toronto and some other cities, include in the specifications and contracts a long list of unit prices generally accepted as fair and reasonable which will be the measure of pay in case such unanticipated work is required. The cost and percentage basis is the more fair for both parties because a schedule of unit prices cannot be made which will be fair to all cases regardless of quantity or other conditions of the unforeseen work. * * *

I have known cases where such a system was in vogue and on which, from my knowledge of costs, I believe the engineers systematically estimated about 5 per cent. below actual cost in order to entice the unwary contractor and get low bids. In such cases you may be sure the contractor will "work his wits" to get even, and I believe, generally speaking, will succeed in accomplishing the end at the expense of more or less poor work, and still consider himself honest. So long as contracts are based on such lack of confidence and fairness between the contractor and engineer, so long will there be dishonesty in carrying out of contracts. Employ only competent engineers; pay them fair salaries; treat the contractors fairly, yea, honestly, and I believe 90 per cent. of the rascality in public work will be removed.

It is often the practice to estimate a nominal quantity and receive unit prices for classes of work of which some may be required but the engineer cannot tell where, or definitely, if any nor how much will be required. For instance, the estimate may have an item, "10 cu. yds. concrete" and the bids for that item are sure to be high. Is it not far better to state that if any concrete is required it will be paid for at "the actual cost of labor and materials plus 15 per cent?" * * *

I believe that if our laws were such as to give officials the same sort of freedom and exercise of judgment as is generally given to officials of business enterprises we would find more high class business men willing and glad to accept "public office as a public trust."

In conclusion, I believe the province of this association ("Engineer-Contractors") is in an effort to mold popular opinion and official action rather than in enlisting in the passage of more or less complicated laws which should be a matter of local consideration and responsibility of local officials and taxpayers, and finally to treat the matter from the point of view that both contractors and officials are to be trusted and considered honest but watched, publicly exposed and promptly discharged or prosecuted if found "wanting" in the proper exercise of the trust committed to their keeping.

The Engineer in Municipal Contracts

Perhaps a brief discussion of the attitude of some engineers toward contractors may be of use. I refer to the facts:

(a) That some if not many engineers, as evidenced by their practical actions, take the view that the engineer's position is to get the *most possible* for the municipality and not, as many contracts state and as should always be the position of fair "arbiter between the parties," which position of arbiter would in the broadest sense give the "most to the municipality" in the line of both efficiency and economy. Let a contractor realize that he is being "mulcted" and under the laws of self-preservation he is pretty sure not only to try to retaliate, but to succeed in doing so even "by ways that are dark and tricks that are vain." Such maneuvers on the part of an engineer, are, in the writer's judgment, a prime cause of such inefficient results as follow in many cases.

(b) Whether by inefficiency or "smartness" on the part of the engineer in fixing standard of prices through cost estimates (which cannot be exceeded in bidding price) so low that the contractor "must steal what he makes," how frequently the engineer and the public glory in the letting of a contract at prices at which it is doubtful if the "contractor can come out whole," to say nothing of making the reasonable profit, which it is to the interest of all concerned that he should make?

Unfortunately many contractors in bidding rely largely on the judgment of the engineer or the prices of contractors on other similar work rather than on a careful, intelligent study of the project and plans and specifications. When the engineer's estimate, which cannot be exceeded, is too low, the tendency, if not sure condition is that competition will be limited to that class of contractors who take the "gambler's chance" even if they do not deliberately hope to make a profit by "taking it out of the work" and contractors of the most responsible, conservative and desirable class will not enter into the competition. Some engineers feel they have made a mistake and sometimes are criticised by their superiors and the public when bids are much below the "engineer's estimate."

It far too frequently happens that canvass of bids is considered in comparison with the engineer's estimate rather than on careful intelligent consideration of fair return for the work contracted for. It is submitted that with a liberal "engineer's estimate," broader competition, more intelligent bidding and a better class of contractors and results are obtained than if the engineer's estimate is too low to attract the best class of contractors.

The writer has in mind a situation, quite generally in vogue for 15 years by succeeding administrations aggregating expenditure of many millions of dollars, where it has been the general custom for the engineer to estimate so low that reasonable profit for high class work is impossible, and the inevitable result has been lack of competition by the highest type of contractors and a series of broken contractors, litigation with sureties and finally browen down roads, all due to, what is most important of all, lack of proper service to the public and an unnecessary waste of funds.

Given an engineer's estimate (this is not a moot case) of "Grubbing and Clearing, lump sum One Dollar" with nothing on the plans and specifications to indicate any "grubbing and clearing" to be done, and a rule in awarding contracts that any bid will be rejected as informal if any item exceeds ten (10) per cent. of the "engineer's estimate," bidders have a right to anticipate that there will be no "grubbing and clearing," and that that is the judgment of the engineer who is supposed to have more carefully surveyed and considered the work than is possible for the contractor in the, at best, few days between his noticing the advertisement for bids and the letting of the contract. The contractor naturally passes over that item as of no consequence and makes his bid formal by bidding the item one dollar or possibly one dollar and ten cents lump sum on two miles of work. When in prosecution of the work and the setting of grade and line stakes by the engineer it develops that rows of trees and large amounts of shrubbery must be removed at a cost of about $2,000, is it or is it not more than 'human nature" for the contractor to *know* that the other party to the contract has "stolen" $2,000 of his money and to "sit awake nights" to devise means to "steal" it back and will he not generally in some way "take it out of the work" to the ultimate public detriment?

When a road contract is let, the plan of which carefully locates an available stone quarry (this is another actual case) at a certain point, the *contractor has a right* to assume that the engineer has examined the stone and found it to be acceptable and when after the award and signing of the contract the engineer rejects the product of that quarry and he is sent a hundred miles away to get "suitable" stone, the contractor has a right to know he has been "robbed" and when the other party to the contract (the "sole arbiter" or engineer) gives him no redress he is pretty apt to try his best to "recover" in the best way known to him.

Some people in every walk of life are inherently dishonest, but the writer has enough confidence in the public to believe that most men, contractors included, prefer to be honest and will give fair value if they are getting fair return. He believes that any general dishonesty among contractors is due more than any other cause to their being led into unprofitable contracts and a consequent training of their minds into a line of thought for means of "recovery.' All of this will be most easily overcome by a system of fair pay for fair return, and the certain rejection of bids which are felt to be too low to yield both a fair profit and high class workmanship.

Now to the "American Association of Engineers": It is easy to conceive that a well and properly organized, active association can correct all of these and many other things which are against the best interests of the public.

Even if the association accomplished nothing more than a clearing house where the names and experience of engineers desiring engagement can be secured by organizations looking for high-class engineer service, the existence of the association would be justified.

Experience with Granite Block Pavements in New Orleans, La.

By John C. Bartley, Sewer and Water Board Building, New Orleans, La.

Intimately associated with the early development of the city of New Orleans has been the use of granite for street paving purposes, and under the unusual difficult conditions that surrounded New Orleans, it was the only material that successfully answered the demands of traffic, and at the same time withstood the vicissitudes of this semi-tropical locality.

Historical

The city when founded, in 1718, was located on the east bank of the Mississippi, about 100 miles up the river from the Gulf of Mexico, and as laid out on this higher ground was surrounded by large open canals that emptied into swamps and bayous, i. e., small outlets to the tidal waters of Lake Pontchartrain in the rear and to Lake Borgne, some distance below the city.

Street improvements followed European practice, first with cobble stones brought over from Europe as ballast, and then the use of the old square granite block from the quarries of Maine, Massachusetts and Vermont, and in the last 30 years from the quarries of Georgia. The streets when paved were highly crowned, with curbing and counter curbing, forming deep gutters, bridged at street intersections, and of such width as to take care of quickly overflowed surfaces at times of sudden and heavy downpours and expected slow removal due to flooded low lands in the rear. Because of this construction the "sidewalk" was known locally as a "banquette."

As the city grew it naturally expanded up and down the higher portion of ground paralleling the river, and gradually broadened to the low lands in the rear. This extended city necessitated a better system of drainage; commerce and business monopolized the higher lands along the river bank, and the smaller business and residence sections had to locate in the lower ground to the rear. Large canals were dug and a system of paddle wheel pumps built to lift the water to give it sufficient velocity, but this system was ineffective for the growing city, and during and after heavy rains the lower portions of the city reaching toward the rear were for days flooded. From time to time scattered street paving was done throughout the city, with more or less success, but always attendant with the lack of drainage, or the necessity to provide very unsatisfactory surface drainage.

Because of soil conditions and the difficulties attending prompt and proper drainage it was for a long time assumed by many of the citizens that modern sanitary improvements could not be built in New Orleans. About 1900, however, there was an awakening to the realization that many of these so-called impossibilities were only the want of a comprehensive plan that could take care of the present needs and be extended for the future growth of the city. With this awakening and engineering study a plan was adopted that has since been carried out, with the result that the city enjoys all of the benefits of modern sanitary systems.

Prospective Street Paving Work

In the improvement of streets no extensive plan could be adopted, because during the construction of the sewerage, water and drainage systems, streets had to be almost constantly cut into all over the city, but within the past few years such a plan has been mapped out, a law passed that provides methods of small yearly payments by the property owners, and work begun on bringing the street paving of New Orleans up to as high a standard as her other sanitary improvements. Previous to the war many streets were paved in the residence and business sections, but during the war all work had to be suspended. Efforts are now being made to continue with the street paving program, and bids for the work to be done in 1920 will be received about the middle of September.

How Pavements are Chosen and Paid for in New Orleans

Under the law the paving program for each year has to be prepared from six to eight months ahead of contracting; the property owners petition or the city on its own motion orders streets to be paved, and after usual formalities the city engineer prepares plans and specifications, advertises for various types of surfacing, and then the property owners, after bids have been received and tabulated and the price per foot figured out, select the type of surfacing. After this the city engineer estimates the amount of money required, and the city sells certificates. When these certificates have been sold contracts are signed and the contractor permitted to proceed with the work, and is paid cash in monthly estimates for the work done in the previous month, 20 per cent. being retained until the final completion and acceptance of the contract, with an additional 15 cts. per sq. yd. to guarantee maintenance for three and five years, respectively, for heavy and medium traffic streets, after completion and acceptance of pavement. These certificates, while a direct obligation of the city, act as a first mortgage lien against the property on streets where pavements are laid, and the property owners have the option of paying cash for the pavement or to extend the payments over a term of 10 years, at the rate of 4½ per cent. interest.

Should the property owners on any street select a type of pavement that would not in the opinion of the authorities be suitable to serve the traffic on that particular street, the city can designate the type to be used, and if costlier than the type selected by the property holders, paying the difference in cost out of the general tax fund. This permits the authorities to weigh thoroughly other considerations, such as ultimate cost figured by the probable life of the pavement; its durability by the occasion for minor but necessary and costly repairs and interruptions to traffic and business in congested sections, and many other factors of prime importance.

It is the duty of the city to maintain all pavements after the nominal maintenance required in the contract, at cost from the general tax fund, and at the same time bear the burden of complaining property owners, who are more likely to overlook their own shortcomings and call on the city to make good if after a few years' service the type of pavement they had selected has failed. Generally the city tax fund is a deficit for this purpose and, called upon for so many other needs, conditions grow from bad to worse until ultimately the street has to be resurfaced, with the attendant high cost, inconveniences, etc. Without this provision of the law the city would have to adopt the type of pavement most successfully promoted.

Old Granite Pavements Not Well Maintained

Of all paving materials granite has remained in service the longest in New Orleans, but unfortunately, streets laid with granite 60 or 75 years ago, after serving the purposes of those and subsequent periods, and repeatedly disturbed and replaced, often in the most careless manner, are sometimes judged as they are because they do not serve the requirements of the present day, all that which they have been called upon to answer and have answered in the development of the modern street pavements overlooked. That the granite pavements in New Orleans, both the old square block and the smaller Belgian block, are in an indifferent state of repair really emphasize the importance of granite as a paving material, because 95 per cent. of its value is there; in its life and usefulness many other types have completely failed and gone, still, because evidence of these failures is not present they are lost sight of and these same types of pavements by improved methods of production and laying are brought forward in competition with granite and granite is relegated to the primordial state of city street paving. In this enlightened age it would be fallacious were this prejudice permitted to persist; through the co-operation of the quarryman and the engineer improved methods of production and laying places granite on the same plane in these respects as other paving materials, and the same comparatives as well rule today that warranted our forefathers to select granite; conditions if anything being more intense and necessitating the most durable and wear-resistive material.

Old Belgian Block Pavements

Many years ago some streets were paved in New Orleans with the so-called Belgian block, principally from the Georgia quarries. The blocks were cut by unskilled laborers, and so long as they resembled a Belgian block, were acceptable. In laying no consideration was given as to size of blocks, joints, filler, etc.; they were rammed in place on a sand cushion, the joints filled with coarse gravel and sand; sometimes on a foundation, but more often on a sand cushion and natural foundation. As a consequence, these blocks have rounded at the joints, depressed, and so often disturbed on their base for the placing of various underground structures they more resemble cobble stone than granite block pavements.

Salvaging Old Granite Blocks

In the paving program for 1920 it is proposed to crush and use most of these and other old granite blocks for the mineral aggregate in the concrete for pavement sub-base. This value alone will approach $1.25 per sq. yd. salvage for the old pavements. Besides this value many of the old square stones heretofore have been used by the United States Government in jetty construction work, at a considerable saving in cost of material for that purpose. The greater amount of paving will be in the heavy traffic business section, and bids will be solicited on three representative types of pavements, one of which type is granite. The specifications of the city embrace all known improvements in modern street paving practice, and the specifications for granite block wearing surface is as follows:

Present New Orleans Specifications for Granite Pavements

Small Granite Block—Small granite block shall be of medium grained granite, showing an even distribution of constituent materials of uniform quality, structure and texture, without seams, scales and disintegration, free from an excess of mica or feldspar, and equal in every respect to the sample in the office of the City Engineer.

The granite shall have a toughness of not less than 7 and a "French Co-Efficient of Wear" of not less than 8. The said tests shall be made by methods prescribed by the U. S. Department of Agriculture, Office of Public Roads. The average of three tests shall be used for determining toughness and the average of 6 tests for determining the "French Co-Efficient of Wear."

Small granite blocks shall be made from 4 ins. to 4½ ins. in width and from 7 to 11 ins. in length, and from 4 to 4½ ins. in depth.

The blocks shall be so dressed that the faces will be approximately rectangular in shape, and the ends and sides sufficiently smooth to permit the blocks to be laid with joints not exceeding ½ in. in width and at the top. The top surface of the block shall be so cut that there will be no depression measuring more than ⅜ in. from a straight edge laid in any direction on the top and parallel to the general surface thereof. Care shall be exercised in handling the blocks so that the edges and corners shall not be chipped or broken, as blocks otherwise acceptable may be rejected on account of spawling.

Manner and Method of Laying

Small granite block roadway pavement shall be formed of a concrete foundation and a wearing surface of small granite blocks laid on the concrete foundation on a cushion course of sand and cement.

The cushion course shall consist of 1 part cement and 4 parts sand. The sand and cement shall be thoroughly mixed dry and then just sufficiently moistened to effect complete hydration. The cushion course thus prepared shall immediately be carefully and evenly spread by means of suitable templates, on the concrete foundation for an average of 1 in.; the thickness shall be permitted to vary slightly, depending on irregularity in the surface of the concrete foundation.

Blocks shall be sorted for laying in courses of uniform width.

If required by the special specifications an expansion joint of the width designated therein shall be provided along each curb.

As soon as the cushion course is in position, and before the cement forming part of the same has commenced to take its initial set, the blocks shall be laid thereon, at right angles to the curb line, except at intersecting streets, where they shall be laid at such angles and in such manner as the City Engineer may direct. All the longitudinal joints must be broken by a lap of not less than 3 ins., nor more than half the length of the block. The blocks shall be laid in the closest practicable contact with each other, the workmen standing on the blocks already laid, and in no case shall the cushion course in front of the pavers be disturbed or walked upon after being smoothed over and brought to exact crown and grade. After the blocks are laid, the end joints shall be made close and compact by the use of a steel bar applied at the ends next the curbs. At every fourth course, or as often as directed, the blocks are to be closed up and the courses straightened in a satisfactory manner. None but whole blocks shall be used, except in starting or finishing a course, except in such cases as may be specially directed or permitted by the City Engineer; and in no case shall less than one-half of a block be used. In the cutting and trimming of blocks, proper care shall be taken not to fracture the part to be used; the joints of all shall be at right angles to the top and sides.

Immediately after the blocks are laid they shall be thoroughly rammed by courses at least three times by a rammer weighing not less than 80 lbs., no iron being allowed on its lower face to come in contact with the paving blocks, and until brought to an unyielding bearing with a uniform surface, true to the established grade of the roadway pavement. The surface of the pavement thus completed must be even and smooth throughout and moulded to conform to street and alley intersections, drainage details and requirements and the grade and crown lines established by the City Engineer. During the final ramming the pavement shall be tested with a 4-ft. straight edge and any unevenness must be taken out and made true to the required grade, level and cross section. All unsatisfactory blocks shall be taken out with tongs and all low blocks shall be raised, and after additional cushion course material has been placed brought to an even and true surface by ramming. Pinch-bars shall not be used to remove blocks and no sand shall be placed in the joints except when mixed with cement as specified herein. All soft and chipped blocks which have been culled from the pavement and all other blocks which the City Engineer may deem unfit to be used shall be immediately removed from the street.

After the pavement has been brought to a true and even surface it shall be thoroughly wetted, without, however, using an excess of water, and then each and every joint shall be filled full to the surface of the pavement with a cement grout composed of equal parts of sand, or fine aggregate, and Portland cement, and mixed in a batch mixer approved by the City Engineer. The sand, or fine aggregate, used in the grout filler shall consist of clean, sharp grains or screenings from hard, durable rock, or gravel, preferably of silicious origin, free from vegetable or other deleterious matter and not containing clay in excess of 5 per cent. It shall be of such sizes that 100 per cent. will pass a No. 12 sieve, not more than 40 per cent. will pass a No. 50 sieve, and not more than 6 per cent. will pass a No. 100 sieve.

In proportioning the mixture the sand, or fine aggregate, shall be measured in a box having the same cubical contents as one sack of cement. The sand and cement shall first be mixed dry in the mixer, to a uniform color, then the proper amount of water added and mixing continued for not less than 12 revolutions of the drum. The grout first applied to the pavement shall be of a consistency to flow freely and to penetrate to the bottom of the blocks.

The grout as delivered from the mixer shall be immediately and rapidly applied in small quantities to the pavement and then swept into the joints with stiff brooms until the joints are filled to within 1 in. of the top of the pavement. After the grout has had time to settle into the joint, and within not less than 30 minutes after its application, the unfilled portion of the joint shall be filled with a grout of thicker consistency, and, if necessary, refilled until the joints remain full to the surface, or top, of the blocks. Extreme care shall be taken that the points are not cemented over, but that the grout extends down to the bottom of the blocks. After this last grout has had time to settle, and within 30 minutes after its application, the pavement shall be finished with a squeegee or wooden scraper having a rubber edge, which shall be worked over the entire surface of the grouted pavement at an angle with the courses of the blocks.

When completed and immediately after the cement has received its initial set, the pavement shall be covered for a period of one week with a ½-in. layer of sand, which shall be kept moist by being frequently sprinkled. No traffic shall be permitted on the pavement for a period of at least 14 days after grouting, or longer, if deemed necessary by the City Engineer on account of weather conditions.

Should the bond between the blocks become broken before the work is accepted the joints shall be cleaned out to the bottom, even if it is necessary to take up and relay the blocks. Such defective work shall be re-grouted or relaid and again barricaded as previously described.

In event rain stops the work before the joints are filled, the joints shall be protected by the use of tarpaulins, or by other equally effective means, to keep out water.

The period of maintenance for this character of pavement shall be three years; and the amount the Commissioner of Public Finance shall retain to guarantee faithful discharge of said obligation shall be 15 cts. per square yard for each square yard of pavement laid.

Concrete Base

The specification for foundation of granite block is the same as for other types of roadway pavements, to be of concrete 6 ins. or more in thickness, as directed by the City Engineer, formed of cement, fine aggregate and coarse aggregate in the proportion of 1:2½:5, the method for measuring the materials, including water, such as to insure separate and uniform proportions of each, and mixed in a batch mixer for not less than one minute before any part of the batch is discharged from the drum.

Specified Method of Placing Concrete

The method of placing concrete is specified to be as follows:

Immediately prior to laying the concrete foundation the sub-grade shall be carefully checked and any displacement of the materials composing the sub-grade that has been caused by teaming, or from any other cause, shall be corrected and the sub-grade shall be placed in its original condition. If deemed necessary or advisable in order to prevent drying of the concrete, the sub-grade shall be sprinkled (unless already damp) with water. While concrete is being placed particular care shall be exercised to prevent disturbance of the finished sub-grade. The laying of concrete on a muddy sub-grade is expressly forbidden.

Steel grade pins for the placing of the concrete will be set by the Assistant Engineer and the Contractor shall furnish the necessary pins and competent assistance to place them in position. The steel pins shall be placed across the street not more than 5 ft. apart. They shall be be set with their tops 2 ins. higher than the surface of the concrete so that they may be readily seen and pulled out when the concrete has been shaped around them.

The placing of concrete during freezing weather shall not be permitted.

After mixing, the concrete shall be deposited rapidly upon the sub-grade to the required depth and for the entire width of the pavement in successive batches and in a continuous operation. The concrete shall be deposited in a layer slightly thicker at the center than that finally required so as to procure a dense and uniform mixture. Whenever the placing of concrete as a continuous operation shall be interrupted by reason of stopping at the noon hour or at the end of a day's run or on account of adverse weather conditions, the concrete shall be laid up to and against a form or board placed in a vertical position, at right angles to the center line of the street and for the full width of the foundation, at the point of the sub-grade at which the concrete foundation is to be stopped. The vertical face so formed at the end of the concrete foundation shall be thoroughly wetted before fresh concrete is placed against it.

After depositing, the concrete shall be shaped or struck off by using such appliances or tools as may be approved by the City Engineer.

After the concrete has been struck off to the true grade and within 30 minutes of the time the concrete has been mixed, it shall be thoroughly floated or tamped in a manner to thoroughly compact it and to bring mortar to the surface and to produce a surface free from depressions or inequalities of any kind.

Grade pins shall be removed as soon as possible after the concrete foundation has been laid, and the holes filled with concrete.

The surface of the pavement shall be sprayed with water, as soon as the concrete is sufficiently hardened to prevent pitting, and kept thoroughly wet by means of a hose or approved sprinkling cans at all times during the five days immediately following the laying of the concrete. An adequate force must be provided by the Contractor, during the time required, to insure the concrete being kept wet. When the average temperature is below 50 degrees Fahrenheit, or during continuous wet weather, sprinkling of the concrete may, upon authorization from the City Engineer, be omitted.

No traffic shall be permitted to pass over the concrete foundation for a period of at least 14 days after the concrete has been deposited. The barriers protecting the work shall not be removed except upon authorization from the City Engineer. The Contractor will be held responsible for any damage resulting from traffic or other causes due to the removal of the barriers before the end of the 14 days' period, except when removed by special written order of the City Engineer.

All street paving construction in New Orleans is done under the supervision and direction of the City Engineer's Department, Mr. Thos. L. Willis, City Engineer. Prior to his appointment, Mr. Willis was for some years Assistant City Engineer, to Capt. Wm. J. Hardee, deceased, and then Engineer of the Municipal Repair Plant, in charge of the maintenance of all street pavement. During his administration of the Municipal Repair Plant this department did a considerable amount of repair, re-surfacing, construction, etc., of various kinds of street pavement.

Should granite block be selected to be laid on some of the streets to be paved in 1920, and constructed in all detail in accordance to the specifications above quoted, a pavement should be produced that will be uniform in appearance, wear smooth, and answer all the requirements of traffic.

Comparative Cost of Maintaining Roads with Tractor Outfit and Eight-Mule Outfit

By N. C. Hughes, Jr., Highway Engineer, Laurens, S. C.

Herewith are some definite data on the difference in the cost of maintaining roads with a tractor outfit and its nearest equivalent, an 8-mule outfit, as observed by the writer when engineer for the Cherokee County Highway Commission at Gaffney, S. C. The type of Lauson tractor employed is here illustrated.

Experience has taught me, however, that, given a system of highways to maintain, either an all-tractor outfit or an all-team outfit is an unbalanced proposition. Both, in my judgment, are needed to co-ordinate each other, for there are certain cases arising in the maintenance of roads which one or the other

LAUSON TRACTOR DRAWING GRADER FOR CHEROKEE COUNTY HIGHWAY COMMISSION, GAFFNEY, S. C.

will not prove suitable to handle. I could give some specific instances to substantiate this, but it is hardly necessary now.

Following are some cost data, taken from our daily cost and progress card:

Tractor Outfit

One 15-25 tractor, 2-7 ft. blade road machine. Progress: Machine, 9 miles 4 breadths of blade in 10-hr. day. Operation cost per diem, based on 24 work days in 30-day month:

Kerosene, 20 gals. at 15c	$ 3.00
Gasoline, 1 gal. at 26c	.26
Oil, 1 gal. at 75c	.75
Interest on equipment	1.00
Repairs	1.00
Engineman	3.50
Machine operators—1 at $4.50, 1 at $3.00	7.50
Total cost per diem	$17.01
Cost per mile at 9 miles per day	$1.89

Eight-Mule Outfit

Eight mules, 2 Standard road machines. Progress: Machines, 10 miles 4 breadths of blade in 10 hrs. Operation cost per diem, based on 24 work days in 30-day month:

8 mules at $1.25	$10.00	
2 drivers at $2.50	5.00	
Interest on equipment	1.00	
Repairs and shoeing	1.80	
Machine operators—1 at $4.50, 1 at $3.00	7.50	
Total cost per diem	$25.30	
Cost per mile at 10 miles per day		$2.53

When using a 3-way drag or leveler:

The tractor will cover 9 miles twice over in 10 hrs.

At a cost per diem of..............$12.01

At a cost per mile of............... 1.334

A 6-mule outfit will drag 10 miles twice over in 10 hrs.

At a cost per diem of...............$18.00

At a cost per mile of................ 1.80

When the occasion demands the use of a scarifier, one made to attach to an engine-drawn road machine, there is no comparison between tractor power and mule power then, the difference in the cost of operation being so much in the tractor's favor.

The above figures are based on facts and not on theory.

Recommended Procedure in the Construction of New Macadam Roads

By M. D. Ross, Division Engineer, Department of Public Roads, Newport, Ky.

The macadam road of today differs considerably from the one built by McAdam, although the fundamental principles demonstrated by McAdam that the foundation must be properly drained, and the water kept entirely away from the road, and that the aggregate of broken stone can be made to cement, or knit together and form a firm water-proof surface to support traffic. This still holds good today in new macadam construction, although with our modern machinery and scientific methods many changes have taken place.

When we consider the many different methods in constructing macadam roads (we will say water-bound macadam) for any macadam road at the present time must be water-bound if consolidated and bonded properly, there has been so much written, and it has been discussed so freely, it seems there would be little need to consider it at this time; nevertheless, it is not uncommon to see macadam roads under construction where little attempt is being made to observe the simple and well known principles of road construction, and that is perhaps sufficient reason for some discussion of those principles at this time.

Characteristics of Properly Constructed Road

The well known characteristics of a properly constructed water-bound macadam road are:—a well drained, carefully shaped and thoroughly compacted sub-grade; properly shaped shoulders and ditches to insure the removal of surface water, and a layer of thoroughly compacted, properly bonded crushed stone, the surface of which has been well keyed together by rolling so that it represents a compact mass of stone of sufficient size to bear the loads that will pass over it without crushing, and in which the stones are mechanically locked together by rolling and held in place by means of dust from the crushed stone which has been worked into the crevices between the stone by means of water and rolling.

Maximum Grade

As a properly constructed water-bound macadam road is a costly investment, careful consideration should be taken to make the important features permanent. The fixing of the maximum grade will be governed by at least two conditions: one the amount of the load that can be hauled over the grade, and the other the cost of maintenance. It has been conclusively demonstrated that grades should not exceed 5 per cent., on the other hand when possible, there should be enough grade to secure ample drainage.

Drainage

Great care should be taken to see that all drainage is such as will not cause failure of the road; if the sub-grade becomes water soaked it should be drained by means of tile sub-drain. The side ditches should be ample to carry the heaviest flow of water and a wide shallow ditch is preferable to a deep narrow one, they are much easier to construct, cheaper to maintain and are not dangerous to traffic. All ditches should drain to a natural drainage point, through a culvert and away from the road.

Width

A well constructed macadam road will have a width of at least 26 ft. from center to center of ditch in cuts, and at least 20 ft. from outside to outside of shoulders on fills, figuring 9 to 14 ft. of metal. At this point we will consider carefully the width of metal that should be used. This question is a much discussed one, some states have adopted 14 ft. as the least width of stone surface, some 12, and some 9; the width required depends altogether upon the amount of travel. For a good many of our roads in Kentucky 9 ft. of metal with a graded width of 20 to 26 ft. is ample; of course, a 9 ft. metal road will not, it is true, allow two vehicles to pass on the stone surface, but there are sections in some counties where it is comparatively seldom that two heavily loaded wagons have to pass, and where they do the shoulders offer a surface harder and firmer than the usual country road. This should be the minimum width and is only recommended where the heavy traffic is mostly in one direction. On the other hand, roads that are important and have considerable traffic in both directions, should never have less than 14 ft. of metal. This will allow two vehicles to pass each other safely, and if suitable earth shoulders are built on each side automobiles will have no trouble passing. If the stone is less than 14 ft. wide, there is a likelihood that the edges of the macadam will be sheared off by the wheels. The Department of Public Roads has figured that any width less than 14 ft. is waste of money and of little value, unless the surface is reduced to single track of 9 ft.

Equipment Used on Construction

In considering the construction of a water-bound macadam road the section used will be a 14 ft. metal surface. The equipment used in addition to picks, shovels and ordinary implements are a heavy construction plow for loosening the earth, wheel scraper for filling the low places and wagons for moving the earth any distance. Bottom dump or spreading wagons will save money, as they are used to advantage in spreading the stone, and often eliminating handling the stone twice. A scraping grader or road machine will be especially needed for shaping the sub-grade, ditches, etc. A steam roller of at least 10-ton size is indispensible in the construction of a modern road, both for preparing the sub-grade and rolling the broken stone. Water plays a large part in making the stone cement together so a watering cart or sprinkler of about 500-gal. capacity should be secured. The tires on it should be extremely wide; the sprinkling arrangement should be such that the water will be sprayed on to the crushed stone in a gentle, full and evenly distributed stream.

Unless it is cheaper to have the stone shipped from some regular quarry, or unless there is no suitable local stone available, a portable crushing outfit should be provided, consisting of a boiler, an engine, the crusher, and portable bins with a rotary screen and elevator to receive the stone from the crusher and to lift it into the screen from whence the different sizes are discharged into their respective bins. The crusher should be so arranged that the stone can be dumped on a platform built around the mouth of the crusher, so that the stone can be fed into the crusher without further lifting, and the bins should be so arranged that the crushed stone may be loaded into the wagons by gravity. The plant should be located as centrally as possible to the work, if possible the crushed stone should not be hauled over a mile, yet at the same time it must be convenient to water, as a great amount is needed for the boiler. The size of the crusher should be such that the output will be from 75 to 100 cu. yds. a day, as the roller can easily roll this much each day.

Preparing the Sub-grade

Considering all fills and cuts having been made, and the subgrade roughly prepared, then all spongy materials, vegetable matter, roots, stumps, etc., should be carefully removed from the roadway; nothing should be used but sound earth. The cross-section of the surface, slope, etc., is as follows:

In cuts the side slopes should be at least 1 to 1 and for a 14-ft. metal surface the width between center of ditches should be 26 ft., which includes 14 ft. of metal, 3 ft. for each shoulder and 3 ft. to the center of each ditch.

The slope of metal surface should be ½ to ¾ in. vertical to 1 ft. horizontal, the 3 ft. from the edge of shoulder to center of ditch should have a fall of 4 ins. to 1 ft., a total for 3 ft. will be 1 ft. depth of ditch. The only difference in section for fills is the 3 ft. slope from shoulder will run from 3 to 1 slope into 1½ to 1 slope, all fills will naturally slope 1½ to 1, making the total width from outside to outside edge of shoulder 20 ft.

In preparing the sub-grade for the broken stone if trench excavation is adopted most of the dirt to be moved in making this trench can be plowed and thrown out with an ordinary road grader at small expense, the width of the trench should be the same as that of the macadam, or 14 ft. and the depth the thickness of the bottom course of macadam.

Usually in constructing the sub-grade, with proper use of the road grader having the blade at such an angle as to cut half the required width of surface to be metaled, sufficient material is left on the side to form the shoulder for the macadam. this sub-grade can be properly crowned and brought to the proper cross section by adjusting the blade to the right angle.

After the sub-grade is shaped to the approximate cross section it should be rolled thoroughly until it is hard, firm and smooth. If soft places are found or depressions develop during the rolling, more good material should be put on. Remember that the sub-grade should be shaped and rolled properly, bumps and hollows left in the sub-grade will show up in each succeeding course. After the sub-grade is made it is very important to have drains cut through the shoulders (at intervals of 50 ft.) to the side ditches; this may save many days work and will keep the sub-grade dry when otherwise it would be flooded at every rain.

After the roadway shall have been graded with reasonable care, the surface upon which the broken stone is to be placed, must be hard, smooth, and carefully crowned to the same section as the finished roadway will assume.

First Course

After the sub-grade has been prepared for a few hundred feet, the spreading of the first course of stone should be commenced. This ordinarily consists of stone broken to sizes of from ¾ in. to 3½ ins., and should never be larger than 3½ ins. for our ordinary local limestone. In macadam construction where harder rock exists the maximum dimension is limited to 3 ins. This is so because the soft stone will often crush under thet roller to a greater extent than the harder. Any stone larger than 3½ ins. in any dimension should be broken with a napping hammer. Stone for the first course need not be of especial hardness or toughness. Ordinary limestone of any kind may be used. The thickness of the course (like every other feature of the road) varies with the local conditions. It has been carefully estimated by highway engineers, (for the average water-bound macadam road in Kentucky), and found that a thickness of six ins. loose will be the average, and should be mostly used; a course of 6 ins. can be thoroughly rolled with a 10 or 12-ton road roller. Any thickness over this is not advised as it cannot be consolidated properly.

This course should consist of a single layer of stone as specified, spread uniformly on the sub-grade; the metal should be dumped on dumping boards, unless spreading wagons or trucks of approved type are used. In spreading stone care should be taken to secure the required thickness and no more; the tendency seems always to use an excess amount. One way to prevent this excess is the use of wooden blocks about 6 ins. square with a height equal to the required thickness of the loose layer. These blocks should be used on each side and the center; the stone should then be leveled carefully to the top of these blocks. It is very important to have a good man in charge of the spreading as proper and economical spreading in many cases makes a saving of hundreds of yards of material per mile.

After one hundred feet or more of the first course of stone is spread and carefully shaped the rolling should commence. In rolling, there is one thing to remember: always roll the sides first, and when both sides are firm work gradually towards the center. This insures a uniform compacting of the stone, and finally roll until the whole surface has been rolled with the rear wheels, then there is no danger of spreading the stone. The roller should run as nearly parallel to the center line of the roadway as possible. If this rule is not followed the roller will mash the stone out flat and spoil the crown. There is no set rule as to how much the stone should be rolled. Experience will soon teach how much to roll any particular kind of stone; granite and other hard stone requires more rolling than do limestones, and in general the harder the stone the more rolling is required. In testing the stone to see if it has been thoroughly rolled one should be able to walk on it without causing much movement of the stone except just under the feet. All irregularities and depressions which may develop should be corrected with additional metal as the rolling progresses and the whole surface thoroughly compacted after such additions and corrections so that it is firm and true to the grades and cross-sections given. Screenings of sizes ranging from ¾ in. to dust should be spread with shovels from piles along the road side and in no case should the screenings be dumped on the surface. Screenings should be spread in thin layers and each layer rolled dry, this process being continued until the screenings are slightly below the surface of the rolled metal. Excess screenings should be scattered with brooms.

Second Course

In deciding upon the size of the pieces of stone to be used for the upper layer of a water-bound macadam road, the things to be taken into consideration are the quality of stone available for use, the amount of traffic, and the weight and character of the loads which will pass over the surface. With road surface carrying traffic made up of a great many heavily loaded horse-drawn vehicles, together with a large number of motor-driven vehicles, if the pieces of stone in the surface of the road are so small that the wheels passing over them crush them it is inevitable that rapid wear will result and that the road will destroy quickly. On the other hand if the surface of the road is made of large pieces of stone the traffic will not crush them nor even wear them with sufficient rapidity to supply fine material to fill the cracks between the stone and keep the voids filled, notwithstanding the action of the elements and traffic. In such a case the road will become rough and uneven, the surface being made up of rounded stones which project slightly and make it disagreeable to traffic. Considering this, it has been found with the limestone availabe, the size ranging from 1½ in. to 3½ ins. is most satisfactory. When stone of this size is used it is, of course, desirable to have the surface layer made up of fairly uniform pieces and should be screened as closely as possible to these sizes.

The second course should be spread with blocks to a depth of 4 ins. (the thickness of the course loose) as after careful consideration of the quality of our local stone and traffic conditions this thickness has been found most satisfactory. This course must be spread the same width, with same care as the first course and rolled in the same manner. In commencing to roll the second course the outside of the wheel of the roller should rest half on the shoulder and half on the stone so as to keep a uniform cross slope to both, and to pack the shoulder in order to keep the stone from spreading. Whenever possible the shoulder should be rolled for a distance of at least 2 ft. from the stone, at this period of the road's progress. Roll as before from the sides to the center until the stone is firmly in place so that a gentle kick will scarcely dislodge a stone and the surface is firm and even. Any depressions or bumps in the stone should be level or filled with additional stone (of same size as the rest of the course) and all wheel tracks smoothed out and the roller run over such places until the surface is hard and smooth.

Third Course

After the second course has been consolidated to the proper cross-section, the third or binder course should consist of stone screenings varying from ¾ in. in size to dust. Limestone screenings are generally used in this construction as the same material comprises the other courses, although sand and gravel has been used for binder for some rock with good results. The screenings should be spread from wagons or from piles alongside the road. They should never be dumped directly on a stone surface. In applying screenings a quick jerky motion is necessary, so that a shovelfull goes over a large area. They should be spread in thin layers, and each layer rolled dry, this process being continued until the screenings are flush with and not above the top of the rolled metal. If screenings are spread before the stone has been thoroughly rolled they only serve to separate the larger stone. The resulting surface is made up of individual stones set in pockets of screenings and is not as durable as one made of stone firmly locked together by rolling before any screenings are spread. All excess screenings should be scattered with brooms.

After spreading the screenings as described the road should be thoroughly sprinkled with water from the sprinkler to wash the screenings into the voids in the stone. Water thoroughly until it bubbles and flushes or rises to the surface as this shows that the voids in the stone have been properly filled. Follow the sprinkler with the roller and roll well, sprinkle and roll until the roller following close behind the sprinkler has a wave of water continually going before the wheels. This flushing may cause the dust to settle and bare spots to show up; cover these with more screenings, wet and roll until the surface is firm and hard and uniformly covered with a thin coat of dust. Don't make the mistake of using too much screenings; if more than just enough to fill the voids and cover surface is used, it will cause ruts under traffic and water standing in them will soften the surface and the result would be destruction of the road. After a section of road has been flushed and finished as above described, it should be left to set and dry out and then watered and rolled so as to make a thorough bonded surface. The surface when completed should present a granular surface with no excess of screenings and should be so hard that a piece of rock will crush beneath the roller, before penetrating the surface.

When a section of road is finished the road grader should be used to go over the shoulders and all surplus dirt removed until the road has as nearly as possible the cross section that the finished road should assume; by setting the blade to the proper slope, this can be readily done with little expense. Then the finished macadam road (with 6 ins. of loose metal for first course and 4 ins. for second course) should be, if properly rolled and bonded, a compact mass of metal approximately 7 ins. thick. It has been figured that 7 ins. compacted metal built on a proper sub-grade is sufficient to take care of the average traffic. The method of constructing a macadam road as outlined above, will be found in the General Specifications gotten out by the Kentucky Department of Public Roads, and if followed closely the best results will be obtained.

Acknowledgment

The foregoing paper by Mr. Ross was presented before the University of Kentucky Road School.

Some Things Learned in the Construction of Sand-Clay Roads

By W. S. Keller, State Highway Engineer, Montgomery, Ala.

Generally speaking the older an engineer gets the more thoroughly convinced he becomes that he does not know it all, as he used to think he did, and that in road construction in particular, something new and beneficial can be stored up in his bin of knowledge every day. The development of new ideas verified by experiments and tests are not confined solely to high class paved roads or to roads treated with oils, tars or other binders and dust preventives.

Even the humble earth road presents problems that are worthy of careful and painstaking thought, for after all for many, many years to come a vast part of our road system will remain unsurfaced. Next to the earth road and the one we desire to comment on particularly is the sand-clay road. This road has leaped into prominence within the past ten years and thousands of miles have been constructed. It would be idle talk to say that they are not of great value and will not be the popular road of vast areas of the South for years to come. Especially will this be true so long as freight rates make the importation into the sand-clay territory of better surfacing material, prohibitive.

Just what are the objections to sand-clay roads and what are the good features? Certainly there are both, else there would not be counties that have discontinued the construction of such and others that are perfectly satisfied with this homely highway.

Misuse of the Type

Unfortunately little consideration has been paid the character and volume of traffic before the type of road is decided on. What unquestionably is good for the rural districts is not necessarily suitable for populous sections, yet some road commissioners consider a road is a road and if it is good in one place it must be good in another. Acting on this false hypothesis sand-clay is used for surfacing roads through populous areas and even the streets of towns and cities with the inevitable result of dissatisfaction. Truly sand-clay is good in its place, but it must be kept there. That such roads should be condemned entirely is unreasonable and to, say the least, shows bad judgment. For a county road carrying a reasonable amount of traffic daily, reasonable in tonnage as well as number of vehicles, this road is quite satisfactory.

Steep Crown is Ruinous

The principle objections offered are that it becomes sloppy in wet weather and dusty in dry weather. That some such roads do become sloppy cannot be denied. The depth of ruts depends to a very great extent on the character of the sand-clay surfacing and the amount of maintenance such roads have had. Too much care cannot be exercised in the selection of this surfacing material and the mixing, where mixing is required. Often varying sections of good and bad surfacing can be seen in one continuous piece of road not exceeding two miles in length, showing clearly no judgment was exercised in the selection or test of material. One of the things experience has taught us is that one of the best ways to ruin what would be a good sand-clay road is to crown it to death, and literally this is true. The road is killed and its remains are washed into the side ditches leaving only its ribs for a driving surface.

The nature of the material, 65 to 80 per cent. being sand, should be a warning against such practice. Just sufficient crown to permit the water falling on the road to shed gently, is good practice. Alabama standard sections provide for a fall of ½ in. to the foot from center of road to edge of road bed, and 1 in. to 4 ins. from this point to center of ditch. The importance of having a good wide shallow ditch rather than a narrow, deep barrel-shaped ditch cannot be too strongly emphasized. Sand-clay roads are, of course, in sections where the soil has a large percentage of sand in it and naturally such soil washes easily. The broad ditch lessens the tendency of deep erosion and side washes, besides eliminating danger to the traveling public.

Good Width Means Long Life

Another lesson we have learned is that a good width means long life to this character of road. Our standard width of crown is 24 ft., and our width of ditches is 6 ft. We provide for a variation in the width of ditches according to soil condition, but generally the width is fully 6 ft. Grassing slopes is very important. Bermuda grass grows well in sandy soil and is the salvation of washing fills. It should not be planted on shoulders, especially in cuts as it grows rapidly and will soon choke up the ditches.

One of the good features of the sand-clay road is that it is less expensive than any other kind of surfaced road, the material for construction and maintenance being close at hand. Another good feature is that a well maintained road of this kind is most pleasing to all kinds of traffic.

Unquestionably the objectionable feature most often complained of, that it is "sloppy," can be reduced to a minimum by the frequent use of a drag during wet weather.

Some good roads crank will, one of these days, find a road
Some good roads crank will, one of the days, find a road oil or some other material that will preserve this popular road and he will be called "blessed" by the common people.

News Letter from the American Association of Engineers

Unexpected enthusiasm and wide-spread interest in the work and plans of the Association are found by President F. H. Newell, of the American Association of Engineers, in his visit to the centers of engineering activity, particularly in the middle and far West. The young engineers, notably those recently returned from army or navy service, are putting their surplus energy into the upbuilding of the local clubs and chapters. Retaining some of the enthusiasm of larger service they see home affairs from the broad viewpoint of the traveler and are not content with the narrow vision of their older associates. They want to join in state and nation-wide activities as well as in those of their own town. The A. A. E., with its wide spread organization, has an appeal to their imagination.

The principal cities recently visited by Pres. Newell are Boston, New York, Philadelphia, Baltimore, Washington, Pittsburgh, Buffalo, Cincinnati, Dayton, Omaha, Kansas City, Denver, Salt Lake City, Boise, Seattle and Portland. He is arranging other meetings with the engineers of Sacramento, Los Angeles, San Francisco, San Diego, Tucson and El Paso. At each point visited conferences have been held with the local officers of A. A. E. followed usually by open meetings to which the public is invited. And when the results and plans of A. A. E. are explained and discussed, especial interest is shown in the studies of conditions of engineers.

In general there is a good demand for engineers, and works as a whole are being undertaken at a steadily increasing rate. The greatest activity is in highway building. In this time there is a scarcity of experienced men. Some money is being wasted for this reason. The general enthusiasm for hard roads on the part of the public may have a severe setback when the fact is discovered that many of the politically-appointed boards or supervisors—not engineers—are wasting funds on experiments or schemes not approved by skilled engineers. Here is where the local chapters of A. A. E. have much difficult work "cut out for them," namely, in educating the public of the dangers of neglect of competent engineering advice, or of permitting the employment of cheap men in responsible places. The public will not discriminate, and when the roads or bridges fail, as many must, the blame will fall inevitably on the engineer. Even though today he protests, if he does not make this protest loudly and effectively, it will not do to say later, "I told you so."

A committee to investigate the compensation of municipal and county engineers, and another to make a similar investigation for engineers employed by public utilities is being organized by the American Association of Engineers. The committee personnel has not been determined entirely, but it is expected that this will have been done very soon.

The American Association of Engineers has grown so fast during the last six months that the national headquarters of the Association in Chicago has outgrown its quarters. These headquarters have been moved from 29 So. La Salle St., to the Nepeenauk Building at 63 East Adams St., where a lease has been taken on 6,000 square feet of office space. The Chicago Chapter, which has over 1,100 members and which is now the largest engineering society in Chicago, will take over the space vacated by the national headquarters of the Association.

As a result of the recent affiliation of independent engineering societies with the American Association of Engineers, of which the Oregon Society of Engineers is the most recent affiliate, inquiry has been made by a member of the Louisiana Engineering Society concerning the possibilities of a similar affiliation, and requesting to be advised of the advantages which accrue to a local organization through amalgamation with A. A. E. For the benefit of other societies who may be interested it is announced that through such affiliation a local society gains a broader field and becomes a part of a national organization without losing its own autonomy. It is through such arrangements that engineers will eventually be united in thought and in action, and it is not until engineering effort is correlated through a single organization that the hopes of the profession will be realized. Five hundred independent engineering societies accomplish only small results, but let their efforts be co-ordinated into one national effort and the effect will be that of a load of buckshot fired from a single barrel.

Further Comment on Why Some Chicago Municipal Engineers Joined a Union

To the Editor:

There appears to be a universal movement among engineers to better their position financially, socially and professionally. At present emphasis is upon the financial status. The important question agitating the rank and file of the profession is the best means to achieve a financial readjustment bearing some reasonable relation to the compensation of other *workers* and adequate to meet the high cost of necessities. It is, first of all, obvious that results can only be secured by organization and co-operation. It is apparent that the form of organization must be adapted to the members, nature of their work and the relation of their work to society and our present industrial condition.

Engineering is a composite work. Certain super-phases are truly professional in character, but the majority of workers engaged in engineering or allied work are really skilled workmen. Modern practice in specializing tends more and more to build up distinct groups doing routine work. This work may require high technical qualification and some original ability, but because of its prescribed limits it restricts the worker to his special field. He becomes then, in his relation to fellow-engineers and to society, a skilled workman. There are two classes of so-called engineers, the independent, consulting or employing engineer, and, secondly, the great mass of subordinates or employes. In a democracy the line of division between the two classes is not defined. Every one is free to rise to eminence, but of course, in the nature of things, few can or do. The great mass is destined to occupy permanently a minor but necessary position.

What form of organization can help the great mass? The typical engineering society is composed of members of both groups of engineers. Because of their superior merit or ability the government of these societies is controlled by the first group of so-called professional or "arrived" engineers. Their sympathies are with their own class and all they deign to offer is the elusive hope that you may one day be able to join their charmed circle. This situation makes it difficult for the great mass to receive recognition and support. The older engineers regard their early experience as an apprenticeship, but for the great mass it is the permanent state. It is but natural for the great mass of "engineering laborers" to want their own organization, controlled by them and in sympathy with their work and its necessary limitations. For self-protection and advancement they must organize. Where engineers are employed by large corporations or are in public service, organization is their only hope, not only because of securing adequate pay, proper working conditions, but of eliciting respect from those whom they direct or associate with. Unless present engineering societies can reorganize and recognize the needs of the *different classes* in engineering work, the trades union appears to offer the only asylum for the long-neglected engineer or "technical tradesman."

Many have taken the step of organizing a union of common workers and affiliating with the American Federation of Labor. Whether this affiliation is better than a reorganization within the engineering societies is a matter only time can tell. However, the union appears to be the only successful agency at hand. The engineering societies have virtually compelled the great mass of engineering employes to seek union help because of their own apathy born of the smug satisfaction of their leaders. Too long has the engineer been the football of industry.

The engineering employes of the city of Chicago have joined a union affiliated with the American Federation of Labor. They have been recognized, and are now being paid the union scale. The union appears to be the only refuge where employes are classed in groups and appropriated for at a uniform rate. Where individual efficiency is not recognized, as obtains generally in industrial and particularly in public service, and where the pay is fixed and uniform, the trades union organization alone, at this time, offers any hope to the so-called "struggling" engineer.

Very truly yours,

A Chicago Municipal Engineer.

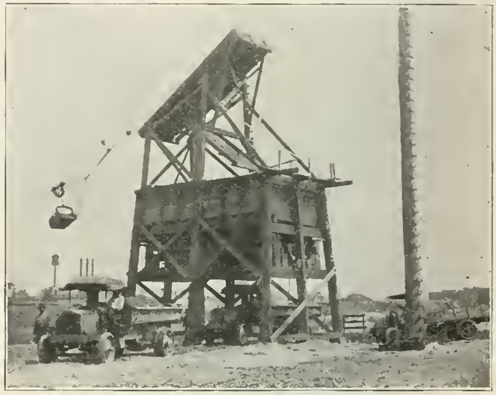
Chicago, Ill., Aug. 7, 1919.

City of Indianapolis Installs Own Gravel Plant

With 230 miles of gravel and unimproved streets to be smoothed and graveled, the city of Indianapolis has established its own gravel plant on the White river, near the heart of the city.

The plant consists of a ¾-cu. yd. Sauerman Dragline Cableway Excavator, operated by a Thomas 50-h.p. electric 2-speed hoist. The cableway spans the river, excavates material from the bed of the stream and conveys the material to the top of the gravity screening and storage plant shown in the illustration. The boulders are rejected and the material separated into sand and gravel by the gravity screens. The capacity is 180 yds. of gravel in 8 hours and a lesser quantity of sand, which is used by the city asphalt plant.

Street Commissioner A. I. Meloy this spring mapped out a 3-year program of improving the gravel streets and putting the unimproved streets in a passable condition. An appropriation of $17,814 was made to buy gravel for this season's portion of the 3-year program. It was then that Mr. Meloy set about to investigate whether the city could not save considerable money in the long run by operating its own gravel plant. The result of his investigation is the present plant, which has cost



SAUERMAN DRAGLINE CABLEWAY EXCAVATOR CONVEYING GRAVEL TO BINS AT INDIANAPOLIS MUNICIPAL GRAVEL PLANT.

the city about $5,000 and which produces enough gravel to carry out the improvement program at a cost of $9 per day for operator, laborer, electric power and oil. It is estimated that there is enough gravel in the river where the plant is situated to supply the city with gravel for the next 15 years.

A further saving has been effected by purchasing four motor trucks with dump bodies, doing away with the old-fashioned method of hauling by team. Mr. Meloy estimates that each of their gravel trucks will do an amount of work every day equal to eight teams. The eight teams would cost $44.80 per day, he says, while the truck costs only $6.20 per day, exclusive of depreciation and interest on investment.

Raising Funds to Pay for Roads

By James I. Blakslee, Fourth Assistant Postmaster General, Washington, D. C.

One of the greatest difficulties that confront the advocate of good roads in this country, is the cost of construction and payment therefor. I have participated in numerous movements for the betterment of the highways. I have heard splendid orations about how to build a road, but I have failed to note any concrete declaration of a satisfactory method of raising funds to pay for the construction of good roads, or to meet the expenses of the improvement and maintenance thereof, except through the use of Federal or local taxes. Forthwith dissension arises. For, whenever the general public is expected to pay for the construction of a particular highway, traveling through territory remote from the domicile of the taxpayer, the larger the taxpayer, the less enthusiasm is evidenced, for he feels that he is not receiving adequate direct returns from the investment that he has made in the highway.

Those Who Use Roads Should Pay For Them

I have, before this time, proposed that the greater portion of the cost of construction and improvement of permanent highways, should be borne by those who use them, and I have endeavored to illustrate how, through the increased use of the highways by the Federal government in a profitable enterprise, this cost of construction and expense of improvement and maintenance could be defrayed. I again present the proposition to you in a form that I trust will be easily understood.

Three Methods of Meeting Cost of Roads

I believe that there should be three different methods of meeting the cost of the construction and improvement of highways.

First: For a Highway Entirely Federal or National in Character: The Federal Government should defray the cost of construction, improvement and maintenance thereof as an interstate highway, available not only for the transportation of merchandise and food products, but, also useful for military purposes, and this *main line* or *through connecting National Highway*, should be utilized by the Federal government in the transportation of commodities upon which a revenue should be earned sufficient to meet the expenses of transportation, and to provide for the improvement and maintenance of the roadway over which the commodities are conveyed, and I submit a definite, specific method, one that we have tried and found profitable—the conveyance of mailable matter, including parcel post, at regular postage rates which are, at this time, sufficient to cover the cost of transportation, expense of administration, and the construction, improvement and maintenance of the highway used for such purpose.

There are transportation facilities in daily operation on *through* or *connecting highways* from Portland, Maine, to Richmond, Virginia; from New York City to Chicago; from Indianapolis, Indiana, to Montgomery, Alabama; and with an appropriation of $300,000, the postage revenues on these highways and adjacent roads leading to the same, now average over $2,000,000 per annum.

This concrete exhibition of the co-ordination of a governmental function such as the mail service with good roads, is more sufficient warrant for the encouragement of the greater extension of this program, than for any other that has yet been presented, and leads to the second method.

Second: For a Highway Supported by the Federal Government and the States and Local Subdivisions thereof: This method, one of co-operation in the improvement of highways, on a basis that is in effect at this time, is one whereby the Federal government participates with the states and local subdivisions thereof in the cost of construction and maintenance of highways, by paying one-half the cost thereof, and such expenditures should be made with due regard to the value of the highway in its relation to the *trunk line* or *National Highway*, heretofore mentioned. These highways should be known as *feeder highways* and located near *trunk lines* or *National Highways*, within producing territory, so that when mail facilities or other transportation functions may be established thereon, the revenues therefrom may be used to assist in defraying the expenses of construction, improvement or maintenance.

Third: For a Highway Supported by State, County or Township: This third definite suggestion includes the construction and maintenance of the dirt or gravel road, which should be borne by the local state, county or township, and would be utilized as supply roads to the *feeder* roads that finally connect with the *National trunk line roads*. These supply roads would, naturally, be used exactly as they are used today, mail facilities together with other means of transportation traveling over the same, collecting commodities from the outlying sparsely settled sections for transmission to *feeder* roads and thence to the *through National highway* to the larger urban centers that consume the products.

Now, in this proposition, I simply endeavor to illustrate, or to present to you, a definite, specific program of highway construction and maintenance, and a definite, specific method of defraying the cost of the same.

There may be other methods that are an improvement on this, or present a better or more desirable system, but until some such improved plans are forthcoming, it seems to me that the hearty co-operation and unanimous assistance of all those who are interested, directly or indirectly, in good roads, should be devoted to the promulgation of this program.

Profits

I shall concede to the conscientious objector that there are many points where this proposition may be attacked. I shall acknowledge that all the revenues derived as stated, are not to be credited exclusively to the particular service now in operation; that the matter transported could travel over other means of conveyance—perhaps not so efficiently, or safely, but none the less, travel. However, 50 per cent. is at least a fair proportion of such revenues that should be properly credited to the system of transportation now effective, and, even there, I know of few enterprises that upon an investment of $300,000 would be able to produce an annual income of $1,000,000, which is 50 per cent. of the whole income derived from this investment of $300,000.

Benefits

The benefits of the adoption of such a system of highway construction and improvement, are not confined to the enlarged revenues of the government, or the betterment of the roads alone; there is a still greater interest than either involved, and that is the convenience of the people. It is the value of the service performed. The benefits can be extended to include the cost of living, for, through the complete organization of a system of transportation facilities covering improved roads, commodity prices that have today reached exorbitant figures, can be influenced to a considerable extent; for, having established *through* or *connecting* roads as previously stated, it was our duty to ascertain in what manner such service could be utilized to a better advantage of the patron than simply the direct transportation of merchandise, and, in order to do so, we collected retail prices of provisions and produce of several different classes, at the 300 or more post offices located on or adjacent to the truck routes, and we found that on Oct. 22, 1918, fresh eggs were selling in the city of Newark, New Jersey—11 miles from New York City—at $1 per dozen, when a tremendous supply was available at New Holland, Pa., a distance of 100 miles from Newark, at 60 cts. per dozen. With a postal rate of about 3 cts. per dozen this indicated that if we had been able to provide adequate direct mail facilities from New Holland, Pa., to Newark, N. J., we could have possibly delivered this prime food product in that city at from 25 to 30 cts. per dozen less than the price the citizens were paying, and the price obtained at New Holland, Pa., was not the lowest price that prevailed at numerous other localities on the direct lines operating from Newark, N. J.

Consequently, when a complete system, properly equipped, is in operation, the revenues of the government will be increased and the cost of the construction and improvement of the highways will be defrayed.

But a far more desirable result will have been attained, and that is, we shall have supplied to the merchants in the city a means of conveyance for merchandise to the producer in the country, and shall have provided the residents in the city with a means of securing their produce, at greatly reduced prices, direct from the farmer.

Acknowledgment

The foregoing is from an address by Mr. Blakslee before the Highway Traffic Association of the State of New York.

Present Federal Aid Will be Strengthened by a National Highway System

Farmers are asking their state highway officials and representatives in Congress for definite information concerning the national highway bill now pending in the United States Senate, and with a clear understanding of the national road project they are, in general, expressing their approval.

An impression is held in some sections that the continuation of Federal Aid will be adversely affected should the pending measure become a law, since it provides for construction and maintenance under exclusive Federal control on such highways as may become state links in the national system. The fear has been expressed that such a step would result in a lessening of Federal co-operation on purely state and county roads.

Senator Townsend of Michigan, author of the bill and chairman of the Senate Committee on Post Offices and Post Roads, is keeping in close touch with highway problems, particularly during this period when auxiliaries to railways and quicker methods of food product distribution are so urgently needed to check living costs. Noting this tendency toward fear that the national highway project might in some way affect adversely the present system of Federal and State co-operation, he has expressed the opinion with emphasis that the Federal Aid plan will in no wise be weakened. On the contrary, the Senator asserts that Federal Aid will be strengthened since roads are what the people need, and a greater mileage of permanent highways will be constructed and put into use in much less time under the proposed national highway plan than is possible even at the rate roads are now being built.

"The object of the bill introduced by me," Senator Townsend states, "is to establish and maintain a national system of highways according to a national plan connecting the different states of the Union, and affording an example of proper highway construction, which will be beneficial to the states. The bill does not in any manner injuriously affect existing law, in fact it provides that the Commission created under it shall have charge of the Federal Aid Law, and shall make reports annually to the Congress as to what is being accomplished under existing law, and to make such recommendations for the future as the operation of the law and its results seem to be necessary. The two systems of road building are separate and distinct, except that they are under control of the same Federal Commission. The appropriations, however, cannot be mingled, and the results will be known and properly appraised by the people from time to time. If the present Federal Aid Law proves satisfactory, it will as a matter of course, be continued, and probably enlarged. If the proven results are not satisfactory, that law will be discontinued. And what I say of the Federal Aid Law will be true of the bill now pending before the Senate. The Commission appointed under the law, it may safely be presumed, will be high grade men, representing different sections of the country, and their life-work will be to serve the people by furnishing the best possible highway transportation facilities."

Immediate Needs of the Engineering Profession

By James C. Patterson, Principal Assistant Engineer of the Erie Railroad in Addressing New York Chapter of the American Association of Engineers

For many years the necessity for a business association of engineers has been apparent. The engineer, although a creator of wealth and a pioneer in advancement of civilization has never been adequately compensated for his service. This has been largely due to the lack of initiative among members of the profession in organizing for their own protection and the betterment of their economic condition as other professions have done. But the steadily mounting cost of living and the concessions granted to organized labor from time to time have at last brought the engineer to a realization of the fact that he is facing a struggle for existence and that he must either take steps for self-protection or abandon his profession for a more lucrative line of endeavor. The needs of the profession are as follows:

Minimum Compensation for Standardized Positions

First, adequate and uniform minimum compensation for standardized positions as far as it is practicable to apply standardized rates to the profession.

The principle of standardized rates has been objected to in certain quarters on the grounds that it will destroy initiative and eliminate the incentive for good work which exists under the principle of bargaining between employer and employee and reduce the organization to the status of a labor union. This is apparently due to a misunderstanding of the situation. What is needed is a uniform classification of all engineering positions according to duties and responsibility and fix a minimum rate for each position. This is a task of magnitude, but is no greater than problems the engineer is called on every day to solve. This will insure each member of the profession living salary and gradation according to individual ability can be made above the minimum rate maintaining the principle of bargaining between employer and employee. This will not be alone a benefit to the employee. It will be of even greater benefit to the employer who through a false idea of economy insists on paying a rate so low that competent men cannot be secured and eventually loses through poor engineering many times the small amount saved in salary.

Licensing of Engineers

Second, registration or licensing of the engineer to eliminate undesirable practitioners and protect the public as well as competent members of the profession.

Just why a doctor or lawyer should be licensed and not an engineer is not apparent. Certainly their responsibility to the public can be little if any more than an engineer. There is scarcely a day of our existence that we do not in some way entrust our safety to some structure or device designed by an engineer. What we need is a uniform law for every state in the union which will eliminate the incompetent and protect the competent members of the profession; in no other way can the abuse of the title of engineer in that technical sense be eliminated.

Standard Code of Ethics

Third, promulgation and enforcement of a standard code of ethics. There are at present no rules governing the conduct of an engineer toward the public and other members of the profession. Unscrupulous engineers have taken advantage of this fact to exploit the work of subordinates for their profit, to disparage the work of another engineer in hopes of gaining advantake thereby and to secure assignments by underbidding rates which are just and reasonable. This cut throat practice works strongly to the disadvantage of the profession and can only be eliminated by enforcing a standard code of ethics which will result in such men becoming outcasts in the profession.

Employment Bureau

Fourth, the establishment of a central clearing house or employment bureau and the elimination of exploitation of the profession by private agencies.

Undoubtedly much assistance has been given to engineers by private employment agencies which has been worth the fees paid but on the other hand thousands of dollars in registration fees have been collected without doing the registrant any good. These agencies are regarded by both employee and employer as a last resort; resulting in the majority of the positions listed and the applicants therefor being undesirable. The great difficulty in a man marketing his services is to find where the opening exists for which he is fitted. A central clearing house would be a great benefit in bringing the man and opening together.

As to the methods to be pursued in filling the needs of the profession is it believed that this can only be accomplished by a strongly centralized organization composed of engineers of all branches of the profession and devoted to the one object of bettering their social and economic welfare. To attempt to consolidate existing societies in the different branches of the profession is to bring together a number of unts each with somewhat different ideas according to the branch of the profession which they represent and who would probably become discordant elements making agreement on methods of procedure difficult. Again these societies are organized for technical discussion and have never really done anything effective toward bettering the economic condition of the engineer although the need has long been apparent. It is believed that they should continue to fulfill the function which they now perform and the separate organization should handle all matters of business.

With an organization of this character with a membership of practically the entire engineering profession it is believed that its moral effect will be so great that there will be no difficulty in securing the proper recognition for engineers. The American Association of Engineers has come forward and is filling the need of the profession and if each individual member will lend his support in increasing the membership there is every reason to believe that our problem will soon be solved.

Operating Experiences With Activated Sludge Process for Factory Wastes

By George W. Fuller, Consulting Engineer, 170 Broadway, New York, N. Y.

On the outskirts of Boonton, N. J., the E. A. Stevenson & Company, Inc., have a plant for refining crude cocoanut oil and the manufacture of cooking oil, soap bases and butter from cocoanut oil and milk products. The refined product is marketed for the most part as an edible oil of a melting point of 76° to 92° F. under the trade name of "COBEE" and as nut margarine under the trade name of "SPREDIT."

Character of Wastes

The average amount of combined wastes to be dealt with from the factory is about 150,000 gals. daily at rates ranging from about 30,000 to 300,000 gals. daily, and at an average temperature of 40°C. Some 100,000 gals. of clean hot condensing water was diverted to a nearby brook as part of the treatment program.

Refinery wastes, about 70,000 gals. daily, and discharged at rates varying from 20,000 gals. to 100,000 gals. daily consist for the most part of condensing water with which is discharged some 450 gals. of volatile oil. Some of this oil combines with caustic soda used in the process and forms a liquid soap. Probably 70 per cent. or some 315 gallons of this oil is recovered in the grease traps. These wastes are discharged every day of the year, 24 hours a day.

Charcoal is often and Fuller's Earth always present in these wastes.

The average temperature of the refinery wastes is about 50° C. but are often as high as 70° or more.

The dairy wastes discharged during 8 hours of 6 days in the week consist on an average of about 50,000 gals. of milk and churn wastes, containing some 1,000 gals. of buttermilk, 20,000 gals. of floor and apparatus washings and 1,400 gals. of acid wastes daily. Maximum rates are about double the average rates, although milk and churn flows are often three times the average. Dilute sulphuric acid from the digestors is discharged with these wastes intermittently in amounts varying from 700 to 2,000 gals. daily, the strength ranging from 100 to 3,000 parts per million. The actual rate of discharge is about 100 gals. per minute, the operator at the plant being notified in advance to allow him to by-pass them to the re-aerating tank for treatment.

Toilet and wash room discharges from the 200 employees at the factory amount to about 10,000 gals. daily.

Dairy wastes are conducted to the plant through a separate pipe and discharge into the inlet trough to the aerating tanks without preliminary treatment.

Former Disposal Experiences

Previous to the installation of the present treatment works, waste matters from the refinery and dairy and condensing water were discharged together into a grease trap of about 20 minutes' capacity at average rates. From this trap they were conducted to lagoons roughly formed with cinder banks, the discharge from which was over weirs protected by scum boards to hold back the grease and oils to a small brook leading to a mill pond and ultimately into the Passaic River. There was more or less sedimentation of the heavier matters, charcoal and Fuller's Earth, by this process and a large proportion of the floating oil was removed by skimming.

Toilet and wash room wastes were discharged to two cesspools which satisfactorily disposed of them.

Pollution of the brook resulted in complaints from property and mill owners and ultimately required improvements in the method of disposing of these wastes. The writer's firm was called upon late in the autumn of 1918 to advise as to remedial measures.

Recommended Process

The desirability of minimizing the investment for obtaining the necessary treatment of the wastes sufficient to avoid difficulty from a suit brought by riparian owners below as well as the restricted area of available land and the oily nature of the wastes brought about a decision against filtration as a fininshing process and a resort to the activated sludge process with such operating procedures as the local conditions demanded.

New Treatment Works

The plant as constructed consists of preliminary grease traps, aerating tanks, re-aerating tank, final settling tank and necessary operating appurtenances.

During the construction of the plant the jet condensers used in the refinery were replaced with surface condensers and this hot condensing water diverted through a new pipe line directly to the brook. This eliminated some 100,000 gals. of hot water which would have required cooling to prevent destruction of bacterial growths in the aerating tanks.

An attempt was also made to store and neutralize the acid discharge but this was later abandoned for the procedure described beyond.

The new grease traps supplementing the old one are in three units of a total capacity of about one hour's flow at normal rates or about 5,000 gals. They are each 10-ft. in length, 6½ ft. in width with a sloping bottom to flow-off drains allowing for an average depth of 3½ ft. wide.

The aerating tanks are in two units of a combined capacity of about 45,000 gals., each of them being 30 ft. long, 10 ft. deep and 10 ft. wide.

To insure thorough mixing of the activated sludge with the wastes treated, vertical baffles were placed across the aerating tank. The baffles are 3 ft. apart longitudinally, with a waterway 2 ft. deep, alternately above and below them.

The re-aerating tank is 30 ft. long, 5 ft. wide and 10 ft. deep and contains about 11,000 gals.

The final settling tank is of the Dortmond type to provide for a vertical upward flow. It is circular, 11.2 ft. in diameter, 10 ft. deep to the bottom of the cone and with capacity of about 6,000 gals. The sewage enters the tank through a 12-in. vertical trough enlarged at the lower end to about 2 ft. square;

the discharge is 6 ft. below the water level; the outlet is over weirs to troughs placed near the side of the tank.

Provision is made for the introduction of milk of lime at the inlet to the aerating chambers and also to the final settling tank. The former is to correct acidity and the latter to facilitate clarification.

Air is supplied from two motor driven No. ½ Root blowers, each of a normal capacity of 150 cu. ft. per minute at 5 lbs. pressure. Main air piping to the tanks is 4-in. wrought iron pipe with 2-in. drop pipes in duplicate to 1-in. air distribution grids. These distribution pipes are spaced 12 ins. apart, with 1/16-in. circular openings spaced 3 ins. apart and staggered on the lower quadrant of the pipe. Sludge is pumped by a 4-in. air lift discharging to a trough from which the sludge can be delivered either to the re-aerating or aerating tanks as desired. The blowers after operation for three months showed a serious reduction in capacity and arrangements are now being made for furnishing air from the main compressors at the factory and which with regulating valves will provide for an available pressure up to 100 lbs. if desired. This change will overcome irregularities in blower performance and assist in maintaining the air pipes free of clogging.

Clogging of the air pipes has been caused more by the settlement of heavy suspended matters around them during the early period of operation when experiments with humus, peat, etc., were being conducted, than by solid matters entering the openings in the pipe. Filtros plates and other similar devices were considered for air distribution but rejected because of the unusual quantity of grease and oil in the waste to be treated and which it was feared would clog the pores of the plates. While the comparatively large openings in the distributing piping compel the use of a greater amount of air than would have been the case with filtros plates, it also provides for ease in cleaning out these openings by the use of air under pressure. Experience has shown that it is always possible to remove any clogging matters by air pressures of 10 lbs. or over.

Preliminary Operating Experiments

On May 16, 1919, the plant was first started in a preliminary way with the intention of obtaining activated sludge from the contents of two cesspools which were emptied into one of the aerating tanks. The cesspool material amounted to about 11,000 gals. and represented the accumulation of some months, coming from the water-closets used by the 200 employees. There was some interruption in getting the mechanical equipment in smooth working order and very little was obtained as a result of the first month's operation. The cesspool wastes appeared to have been septicized to a point where it was difficult to activate the suspended matter.

Activation of Outside Material

Failure to obtain proper sludge from the cesspools resulted in a systematic effort being made to obtain activated sludge by using organic substances other than the factory wastes. Use was made of peat, humus, sawdust, horse manure and cow manure. Barrel experiments were made with these different substances alone and with the addition of washings from rich garden soil inoculated the organic material with nitrifying bacteria.

It was found that the use of peat presented difficulties caused by mineral matter which clogged the openings of the distributing pipes. In a measure the same was true of the straw mixed with the horse manure. Humus was tried but the expense was greater than for other materials and it was of such a texture that it was impossible to suspend in the liquid treated more than about 5 per cent., as measured by the volume of the sludge after 10 minutes' sedimentation.

Inoculation with washings from garden soil allowed a satisfactory sludge to be obtained in from 3 to 5 days with either peat or humus, and in not to exceed 12 days with cow manure or horse manure. Apparently these latter two materials require a longer period for activation on account of their anaerobic condition initially as compared with the aerobic condition of the peat and humus; without inoculation the sludge was ripened in 18 to 24 days, thus showing that inoculation with nitrifying bacteria materially hastened the activation process.

Combustion of Organic Matter

One of the interesting results obtained was the extent to which organic matter disappeared through wet combustion resulting from the oxidizing and nitrifying nature of the process. Studies were carefully made of available sources of organic matter which could be obtained cheaply and readily and which would be satisfactory as regards grit and fibrous products which would tend to clog the air distributing lines. It was finally decided that everything considered the best material to use is cow manure obtained from neighboring dairies. The volume required is about 8 cu. ft. per 24 hours for a flow of about 150,000 gals. of wastes. The water content of this material varies somewhat but probably averages about 70 per cent. This indicates a needed addition of dry organic matter of about 130 parts per million. The material is mixed with water in a wheel-barrow until in a liquid condition and then applied to the inlet section of the aerating tank. This is done about 4 times during 8 hours of the day or at the rate of about 1 cu. ft. of cow manure per hour during that period. No cow manure is added during the remaining 16 hours when no creamery wastes reach the plant.

Operating Program

Under normal conditions the flow is directed to one aerating tank to the amount of about 100,000 gals. daily. Quantities in excess of this flow to the second tank. Acid discharges occurring from one to five times per day are by-passed to the re-aerating tank and from there applied with the pumped discharge of limed sludge from the final tank.

The amount of air used is about 0.5 cu. ft. per square foot of tank surface per minute or about 1.5 cu. ft. per gallon of liquid treated. An aeration period of about 3 hours ordinarily seems to suffice and with peat a 2 hour period of aeration seems reasonably sufficient for short intervals. The amount of sludge is kept as nearly as possible to 20 per cent. as a smaller amount does not satisfactorily clarify the wastes and a greater amount requires additional expense for cow manure.

Final Sedimentation

After the wastes have been aerated and discharged to the final tank the supernated liquid is drawn off at the top and the sludge collecting in the hopper bottom is removed continuously by the air lift to the inlet distributing trough as previously explained.

It was found that plain sedimentation for the period available did not produce complete clarification and lime was added at the inlet to the final sedimentation tank at the rate of about 3 grains per gallon. This produces a clear effluent and the lime pumped with the sludge serves a double purpose in that it not only aids in precipitating suspended matters, but it also serves to correct the acidity which appears in the mixed wastes and which are by-passed to the re-aerating tank.

Quality of Effluent

The final effluent is not only well clarified and substantially free of fatty products, but is stable without dilution for a period of more than 14 days in stoppered bottles, subject to the methylene blue test at ordinary temperature.

General Considerations

The novelty of this process as applied under local conditions, will be appreciated when it is stated that the problem consists essentially of finding a material with which to build up sludge rather than that of encountering the expense of disposing of sludge as is usually the case; in fact the sludge beds on an adjoining cinder dump have not been used at all during the first 3 months of operation of this plant.

The average temperature of the mixed wastes, about 40°C., does not seem to be a handicap to this process, but on the contrary is probably a material factor in intensifying operations as indicated by the relatively short aerating period required as well as by the weight of organic matter which is actually burned out in the aerating tanks. An occasionally influent temperature of about 60°C., for a few minutes is of course not helpful, but the plant seems to recover during the interval between such occasions.

The process is also much less sensitive to acids than one might suppose, although it is a fact that it is somewhat interfered with at times, due apparently to acidity.

The process is greatly dependent on freedom from interruption of the air supply. This was demonstrated when on July 23, an extraordinarily heavy rain produced local floods which resulted in a suspension of the air supply on two occasions during the same day, one of them being for 8½ hours. This was sufficient for the sludge to lose its activation and become putrescible. It required aeration of about 7 days following this mishap to place the plant on a normal working basis again.

In spite of adverse local conditions this activated sludge plant shows that plants of this type will satisfactorily treat even so difficult a waste as this, and its operation shows that a satisfactory substitute for the suspended matters usually met with and utilized in municipal sewage treatment works of this type may be obtained from various materials outside of those contained in the sewage, the selection of the best material depending on local conditions as to availability and cost.

The plant has not been controlled with the aid of extensive laboratory tests, although at the factory there are reasonably satisfactory laboratory facilities. Working procedures have been developed on the basis of listing one after another the difficulties which arose with a description of remedial steps to be taken in each respective event. During the tuning up operations an experienced operator of sewage disposal plants has been sent to this factory several times each week in order to study its behavior and the effect on aeration of seeding with garden soil, the correction of acidity and use of lime, as well as the mechanical manipulation of the plant, and steps needed to control the wastes more effectively prior to their entrance into the aerating tank. This tuning up occupied a period of about 10 weeks.

Greater Attention to be Given to Highway Engineering Education

Commenting upon the report that Secretary Lane of the Department of Interior will shortly call a national conference on highway engineering construction in colleges and universities, Arthur H. Blanchard, Professor of Highway Engineering at the University of Michigan, says:

"Highway officials, progressive educators and many prominent business men realize that a serious condition will confront the United States and Canada if graduates of our technical schools are not properly trained in highway engineering. The phenomenal development of highway transport has created a demand for efficient highway improvement which can only be satisfied by placing highway work in the hands of competent engineers.

"Thoroughly trained and experienced highway engineers are needed to occupy the innumerable positions connected with the administration, financing, design, construction and maintenance of the 2,500,000 miles of rural highways and the thousands of miles of streets in the municipalities of the United States and Canada in order that highways may efficiently serve economic, social, transportation, agricultural, industrial, commercial, and military requirements. Highway appropriations will increase rapidly during the next five years as is indicated by the 1919 appropriations of $500,000,000 in the United States and a relatively large amount in Canada, for highway improvements and a widespread demand for the construction of a system of 50,000 miles of National Highways by the United States Government under the direction of a National Highway Commission.

"Estimates made this year by the United States Bureau of Public Roads disclosed a remarkable field of opportunity for highway engineers, as investigation showed that for federal and state highway work alone exclusive of cities, counties and towns, there are required 122 chief executives and administrators; 360 division engineers of the federal government, division chiefs of bureau, division chiefs of highway departments, district engineers of highway departments, etc.; 3,630 supervising engineers and chiefs of party, and 6,350 junior engineers, rodmen, chainmen, draftsmen and others of similar calibre.

"The consensus of opinion of eminent highway engineers and educators is to the effect that highway engineers should have the broad foundation which the four-year course in civil engineering gives. The Asphalt Association takes the definite stand that as much time should be given to the essentials of highway engineers as is given to sanitary, hydraulic or railroad engineering. The association will devote its educational campaign especially to institutions where either no courses or very short courses in highway engineering are given. The Asphalt Association has found that only 25 of the 93 colleges investigated give a satisfactory fundamental training in highway engineering as a part of the civil engineering course.

"The waste of millions of dollars annually in the United States will continue until the profession of highway engineering is placed on the same basis as structural, hydraulic, sanitary and other branches of civil engineering. England and France have seen the light. As a result, efficient highway engineers are retained in office, methods of construction and maintenance suitable for traffic requirements are employed and as a consequence the public funds are wisely and economically expended."

Professor Blanchard will co-operate with the engineers of the Asphalt Association in developing a plan with colleges and universities under which highway engineering courses of instruction will receive increased attention.

The end sought is that graduates of technical schools may be equipped properly to occupy the administrative, executive, business and engineering positions in national, state, county, town and municipal highway departments of the United States and in the Dominion, provincial and municipal departments of Canada.

Estimating for Asphalt Pavement Repairs

By J. O. Preston, C. E., Assistant Engineer Rochester Bureau of Municipal Research, Inc., Rochester, N. Y.

Highway engineering is approaching an exact science. As a general practice, maintenance of highways is less scientific than design and construction. The writer developed the following method of estimating the repairs for asphalt pavements in Rochester, N. Y. This system is another phase of the control of repairs outlined by J. W. Routh in the November, 1918, issue of MUNICIPAL AND COUNTY ENGINEERING, under the title of "The Maintenance of Asphalt Pavements by the Cut and Replace Method."

Purpose of Estimating Season's Repair Yardage

The purpose of preparing an estimate of the season's repair yardage of asphalt pavements is fourfold:

1—To obtain an indisputable basis for requesting funds;

2—To enable the person in charge properly to repair each street and portion thereof without fear of exceeding the total allowance for all streets.

3—To save the contractor from making repeated trips over the same street which, together with the definite, itemized quantities, should enable him to make a low bid.

4—To accumulate records to show when any portion of a street should be resurfaced.

The amount of material used in previous years is but one factor to be considered in preparing an estimate. In view of the general tendency to have a different standard for the maintenance of each street, it is evident that guesses made in the office of the amount of material needed for the next year over that used the past year cannot be relied upon. Such procedure is based on the assumption that most of the work done the previous year will have to be torn out and replaced. It does not consider the causes of disintegration or admit that some of them may have been removed by past repairs. If an empirical quantity is added to the total material used the one year, as a factor of safety in asking for material for the next year, it is an admission of ignorance of conditions.

Estimate Made in the Field

To be of any real value the estimate must be made in the field. Two men are necessary, one to drive an automobile and to count and estimate the size of the patches and condition of the street, the other man to pass judgment on the condition of the street and to keep notes. The estimators should have no difficulty in covering 20 miles or 250,000 sq. yds. of pavement per 8-hour day.

What Notes Should Include

The notes should include the size of the existing holes and the size of repair patches required to fill cracks, depressions and disintegrated spots. To the total for each block should be added a percentage between zero and 15 per cent., based upon the following factors:

1—General condition of the surface,

2—Previous rate of disintegration,

3—Age of the surface,

4—Cleanliness as affecting visibility.

To the total yardage computed from the street estimate, as indicated, should be added an allowance for repairs to additional pavement yardage released from guarantee. For the five-year guarantee in Rochester this has been found to average one-tenth of 1 per cent. of the total.

It is expected that considerable estimating must be done before judgment can be relied upon to give proper allowance for the above factors. For this reason and because winter changes must be taken into consideration, a spring inspection is necessary to check up and adjust the estimate made in the fall. The estimator should actually re-estimate enough streets in the spring revision to enable him to fill in the column on the card marked "Revision, pounds, plus or minus," for typical streets as a check on his fall estimate. This assists him in forming better judgment in future estimating. Of course, the budget request must be based on the fall estimate and this cannot be altered by the spring inspection. For this reason a factor of safety of from 5 per cent. to 10 per cent. should be added to the fall estimate. As the estimator becomes more proficient, this factor of safety (or factor of ignorance) need not be added.

It is the general practice for the person in charge of asphalt repairs to keep an extensive diary in the effort to keep the repair yardage within the budget allowance. In addition, it is probable that considerable time of the person in charge, as well as that of clerks, is spent in preparing extensive tables of useless statistics of the work. With the outlined system of estimating, both the diary and the tables are replaced with a set of cards containing the yearly estimating data and a column showing the percentage of the area actually repaired to the total.

It is the Rochester practice to purchase asphalt by the ton, so that it is necessary to multiply the yardage per block by 234, the average number of pounds used to replace an average square yard, in order that useful comparison can be made with the actual quantity used. This requires an additional column on the cards.

The following data are recorded on the card mentioned: The name of the street, and the portion of it under consideration; the total pavement area in square yards; the date when laid, date resurfaced; year of the estimate; then, under fall estimate, the estimated yards, per cent., number of square yards, and number of pounds. There is a column for spring revision in pounds, plus or minus; a column for the number of pounds actually used, and one for the per cent. of the total area. The final column is headed: "Remarks, reasons for variation, condition, etc. The cards measure 5 x 8 ins.

The person in charge of asphalt repairs should route the work so as to be convenient for the contractor. The cards for each day's route should be taken from the office and on them noted the actual repair yardage, together with a note of the reason for discrepancy. These cards then, are in shape for estimate-making the following fall. It will be convenient if these cards are filed according to work routes instead of being in alphabetical order.

The possible objection that the actual repair yardage is likely to be limited to the estimated yardage, regardless of the condition of the street, is not likely if the person in charge considers the problem from the street maintenance viewpoint. Moreover, a record of excesses is available which can be balanced against other streets not requiring the estimated yardage, thereby allowing the person in charge to keep the work in hand or, if conditions warrant it, to give definite reasons for asking an emergency allowance.

Sometimes it is necessary to make a hasty repair trip in the spring to fix the dangerous holes in the main traffic streets. This trip should be confined to repairing dangerous holes in main traffic streets and no time should be wasted with conditions not requiring immediate attention. If this is not done, there will be unnecessary delay in covering all the main traffic streets, and the repair gang will get the habit of making superficial repairs to all streets. Falling into this general practice works havoc with the estimate and necessitates repeated trips to all streets. These are conditions to be avoided.

Combination Lead Melting Furnace and Portable Oil Burner

A practical and economical piece of apparatus for the water works man is the combination lead melting furnace and portable oil burner of Hauck make. Its use is free from smoke and ashes. This device is actually two outfits in one. When used as a melting furnace, 200 lbs. of lead can be melted in 15 minutes and kept in molten condition at cost of few cents per hour. An additional supply of fresh lead melts instantly. When not used for melting lead in the pot, the burner may be detached from the furnace and used for melting lead out of pipe and fitting joints, bending pipes, straightening, preheating in connection with welding, brazing, heating tar and asphalt kettles, etc. The device consists of a furnace on three legs, supplied with a 200 lb. capacity pot. The 12-gal. oil tank is of heavy steel, equipped with pressure gauge, hand pump and fittings. The burner is of the Hauck hand pump type, burning kerosene as fuel. The burner does not consume any air from the tank. The pressure secured by the use of the pump is simply to force the oil to the burner where it is vaporized. A single pumping will operate the apparatus for three hours. The device is made by the Hauck Manufacturing Co.

Personal Items

Capt. Lucius A. Fritze, Sanitary Corps, U. S. Army, has become associated with the technical staff of Wallace & Tiernan Co., Inc., New York City, manufacturers of chlorine control apparatus. Capt. Fritze, who was sanitary officer of the Rainbow Division, after the armistice was signed was assigned to the office of the surgeon general in Washington. While there he prepared a history of the sanitary corps of the A. E. F. Capt. Fritze will be the manager of a new office which Wallace & Tiernan Company are opening at Kansas City, Mo., serving territory comprised in the states of Montana, Wyoming, Colorado, North Dakota, South Dakota, Nebraska, Kansas and Missouri.

Beginning August 1, the promotion and inspection bureaus of the Universal Portland Cement Co. were combined under the name of "Service Bureau." J. H. Libberton, formerly "Engineer, Promotion Bureau," and "Inspecting Engineer," located in the general offices of the company at Chicago, became manager of the service bureau; G. E. Warren, assistant manager; J. W. Lowell, eastern manager, Pittsburgh; J. H. Chubb, Northwestern Manager, Minneapolis, and O. L. Moore, chief cement inspector, Chicago. The two bureaus which were combined formerly had separate and distinct duties, the Promotion Bureau handling special service and furnishing of information to cement users and the Inspection Bureau having charge of the physical testing at the mills. In combining the two bureaus, service rendered to cement users by the department will in no way be changed, either in policy or scope of the work.

Arthur H. Blanchard has been appointed Professor of Highway Engineering at the University of Michigan to occupy the chair recently established by the board of regents. He will retain his consulting office at Broadway and 117th street, New York City, until September 15, after which he will be located in Ann Arbor, Michigan.

Captain Bruce Aldrich, who will take charge of the Toronto office of the Asphalt Association as district engineer of the Canadian district, with headquarters at the office of the H. K. McCann Company, Limited, Toronto, Ont., is a native of London, England. He came to Canada at an early age and began his education in the public schools of Ottawa, returning later to England to complete his studies. From England he came to the United States and after serving as a volunteer in the United States Army in the Spanish-American and Philippine wars, he was appointed in 1901 to a position in the office of Inspector of Asphalts and Cements, engineer department, District of Columbia, where he served in various capacities, testing paving materials under Prof. A. W. Dow of New York until February, 1912. In March, 1912, he went to Baltimore, Md., which city was then beginning operations on the biggest paving program it had ever undertaken, with expenditures aggregating nearly $15,000,000. Capt. Aldrich organized and equipped the Municipal Laboratory in which were tested all the materials entering into the new paving. As inspector of asphalts, he supervised the laying of more than 3,000,000 sq. yds. of sheet asphalt and bituminous concrete, having on occasions as many as seven asphalt plants working at the same time. He assisted also in the inspection of the laying of all vitrified brick and granite block paving laid by the city. At the outbreak of hostilities between the United States and Germany, Mr. Aldrich responded to the call of the President and served in France as a captain of infantry for one year, returning to the United States and resuming his former duties in Baltimore June 5, 1919. He resigned this office to become connected with the Asphalt Association of 15 Maiden Lane, New York. Captain Aldrich will devote his attention to co-operation with officials and engineers in the several provinces with a view to bringing about the most constructive results possible in asphaltic highway work.

Proposed Water Filtration and Pumping Plant for Sacramento, Cal.

Charles Gilman Hyde, professor of sanitary engineering at the University of California, has been employed by the City of Sacramento as consulting engineer in the construction of a water filtration and pumping plant for which bonds to the amount of $1,800,000 were voted by the people in June, 1919.

Professor Hyde until recently was in the United States army service, having been commissioned major in the office of the surgeon general at Washington, D. C., and serving in that capacity for more than a year. He has had extensive experience as a water supply engineer. Fifteen years ago he designed the filtration plant at Harrisburg, Pa., and acted as consulting engineer during the period of construction.

The filtration plant at Sacramento is to be of the mechanical or rapid sand type, filtering the water of Sacramento river. Its nominal capacity will be 30,000,000 gals. a day, and sulphate of alumina will be used as the coagulant. This will be the first modern municipal filtration plant in California, and is expected to be in operation early in 1921. Major Hyde is preparing the plans under which contracts will be let.

For more than 50 years Sacramento's water supply has been unfiltered and at times it has been turbid and muddy so it could hardly be used. The decision of the people to build a filtration plant was the result of recommendations made by Prof. Hyde, George H. Wilhelm and Frank C. Miller in 1916, after they had made a diligent and exhaustive investigation of all possible sources of water supply for Sacramento.

Obituary

It is with keen regret that Pawling & Harnischfeger Co announces the passing of Otto A. Ruemelin, works manager and 2nd vice president, on September 1, 1919. As a youth Mr. Ruemelin began his apprenticeship with the Pawling & Harnischfeger Co. After several years as journeyman he was promoted successively to the foremanship of various departments. His energy, ability, and kindly nature made his rise rapid from assistant superintendent to superintendent and finally works manager, which position he has held since 1912. In this capacity he enjoyed a marked respect and comrade-like relation with the men of the shop. His death concludes a period of thirty years association with the Pawling & Harnischfeger Co.

Trade Note

Pressed steel members for beams and studs have now become a well established method of fire-resisting construction. The light weight and simplicity make it particularly desirable in many buildings where the heavier and more involved fireproofing methods would not be practical, particularly in light occupancy buildings such as apartments, stores, schools, hospitals, institutions, hotels, residences, etc. Truscon pressed steel, combined with the hy-rib metal lath, provides a fire resisting construction which is economical in cost. It also assures the additional advantages of light weight, vermin-proofness, and sound-proofness. Truscon pressed steel has been used in very many important buildings with great satisfaction to architects, contractors, and owners. The new catalog on Truscon structural pressed steel, just issued, gives complete information on the use of this construction in building work. In the catalog are details, tables, specifications and numerous illustrations. A copy of this book will be furnished free to interested persons by asking for Structural Pressed Steel Catalog, addressing Truscon Steel Company, Youngstown, Ohio.

WATER WORKS SECTION

Methods Used and Results Obtained in Metering the Water Supply of Terre Haute, Ind.

By Dow R. Gwinn, President and Manager, The Terre Haute Water Works Co., 63½ Cherry St., Terre Haute, Ind.

The old notion that water should be as free as the air is not as prevalent as it used to be. Water in the Wabash River is free to all who care to go to the river, dip it up and carry it home. However, we take water from the river through an expensive intake, coagulate it, settle it, filter it, sterilize it and pump it (most of it twice) and deliver it to the consumer in small or large quantities, day or night at a nominal cost—about 6 cts per ton at the highest rate. To be able to do this requires expensive equipment for pumping, purifying, distributing and measuring. An aged colored gentleman was converted at a camp meeting and joined the church. He complained, when he was asked to contribute towards the support of the church, saying that he thought salvation was free. The parson replied promptly, "Salvation is free but some one has got to pay for the pipes."

Historical

The Terre Haute Water Works Company was organized in 1871, and the construction of the plant was started late in 1872. The direct pumping system was adopted.

A wooden enclosure was built underground on the bank of the river, and the water was filtered by passing through the sand and gravel placed on top the timbers. This was abandoned and in 1890 a contract was made with the National Water Purifying Co. for mechanical pressure filters; this was the first public filter plant in the state of Indiana.

The ordinary domestic pressure is 70 lbs.; fire pressure 130 lbs.

Policy of the Company in Metering Services

At first only large consumers such as railroads and industrial plants were metered. Then livery stables, photograph galleries, saloons, hotels and public buildings. Next stores and restaurants. Not much opposition was met until boarding and rooming houses were included. Public indignation meetings were held and oratory flowed freely in denouncing meters and the manager of the company. Space in the newspapers was bought and a series of statements or "Water Talks," as they were headed, were published. Incidentally, when a public utility is attacked, without reason, we believe it pays to buy advertising space and present the facts—a few at a time. The sentence, "It is a good thing to pay for what you get," was used frequently and it was interesting to hear some of our customers using the expression, apparently unconscious that they were using our argument.

In the year 1914, with 44 per cent. of all service pipes metered, including practically every factory and business premises, the average daily consumption was 4,939,617 gals. (82 gals. per capita), but *with a peak load of over 16,000,000 gals.*, during sprinkling hours on hot days. If a serious fire should have occurred it would have been impossible to maintain fire pressure while the peak load was on. Therefore, arrangements were made early in 1916 to set meters on every flat rate service where there was a hose connection.

Explanatory information was prepared and mailed in advance, and the result was only two real protests against the installation of the meters, although there were 3,700 meters set during that year. In 1917 the peak load was less than 10,000,000 gals., a reduction of over 6,000,000 gals.—the average daily consumption being 4,813,765 gals. (74 gals. per capita). During the same time the number of consumers increased from 6,804 in 1914 to 7,492 in 1917.

Incidentally, it pays to inform your customers and take them into your confidence.

The company furnishes the meters and installs them free of charge. The consumer is liable for injury to a meter on his premises, occasioned by the want or lack of ordinary care on his part. In practice the company maintains the meter except when damaged by hot water.

Meters are read monthly, beginning about the 21st of the month. The nearest 100 to the actual reading is used.

Every meter bill bears the following statement: "The company will test meters in the presence of consumers, free of charge." Very few take advantage of the offer; however, it is a good talking point and it shows that the company has confidence in the accuracy of its meters.

There is no allowance for leaks and the readings are conclusive except when the meter is defective or fails to register. In the latter case, the quantity is determined on the basis of consumption when meter was registering.

The company reserves the right to meter any service and any consumer may demand a meter, but cannot change again to flat rate service.

While indignation meetings were held when meters were put on boarding and rooming houses, it is safe to say, that citizens of Terre Haute now approve of the meter system and that there would be serious objections to a suggestion that the old flat rate basis be restored.

Pumpage Results Obtained by Metering

The reduction of the peak load from over 16,000,000 to less than 10,000,000 gals., has been referred to. This was the result of metering every service where there was a hose connection. The average daily consumption was not materially affected at that time for the reason that practically all premises except private residences had been metered previously and owing to heavy demand for water by industrial consumers.

In 1900 with 8 per cent. of all services metered the pumpage was 1,564 gals. per consumer, while in 1918 with 95 per cent. metered, the pumpage was 646 gals. per consumer. During this period the per capita consumption was reduced from 90 to 74 gals., and the consumers per thousand population was increased from 58 to 114—or 17 persons per live service in 1900 and 8.7 in 1918. The comparatively small number of consumers is due to the ease with which water may be secured from the ground; it might be said that this means a strong competitive condition.

Quantities Used by Consumers

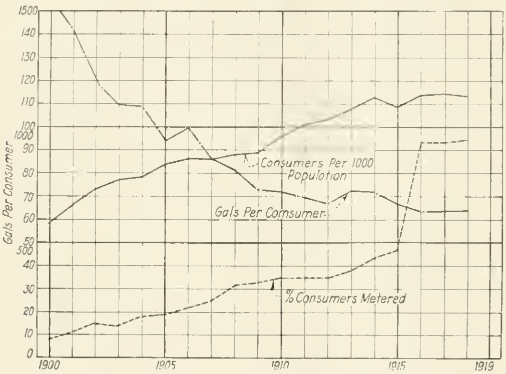
In respect to gallons per consumer, there is one that used approximately 900,000 gals. per day throughout the year 1918 and three others used a total of 600,000 gals. per day, making a total of 1,500,000 gals. by four consumers.

Under the system of accounting required by the Public Service Commission, practically all consumers except railroads, factories, public parks and street sprinkling wagons are classified as, "Commercial." The latter class in Terre Haute—7102 in number—comprise over 99 per cent. of the total number of metered consumers. The approximate average monthly consumption by the metered commercial class in the year 1918 and the number of consumers using certain quantities per month was as follows:

Using less than 750 gals. per month	553	of all	7.8
Using 750 gals. per month	898	of all	12.6
Using 1,500 gals. per month	933	of all	13.1
Using 2,250 gals. per month	1,060	of all	14.9
Using 3,000 gals. per month	1,061	of all	14.9
Using 3,750 gals. per month	702	of all	9.9
Using 4,500 gals. per month	477	of all	6.8
Using 5,250 gals. per month	320	of all	4.5
Using 6,000 gals. per month	226	of all	3.2
Using from 6,750 to 9,750 gals. per month	492	of all	6.9
Using from 10,500 to 19,500 gals. per month	239	of all	3.4
Using 20,250 gals. and over per month	141	of all	2.0

As 3,000 gals. are allowed for the minimum rate, there was an average of 4,505 consumers per month or 63.3 per cent. of all that did not pay over 75c per month.

The average amount of each bill for the year 1918 for the commercial class of consumers based on rates of 25c per thousand for the first 20,000 gals. used in a month and 20c per thousand for the next 80,000 gals. in the same month was $1.25. The schedule provides lower rates for larger quantities, the lowest rate was 5c per 1,000 gals., which has since been



DIAGRAMS SHOWING THE NUMBER OF CONSUMERS PER 1,000 POPULATION, THE PER CAPITA CONSUMPTION, AND THE PERCENTAGE OF CONSUMERS METERED, TERRE HAUTE, IND., WATER WORKS 1900 TO 1918

increased to 5¾c. For all metered consumers, including industrial, etc., the average monthly bill was $1.74. Of all metered consumers, including industrial, etc., only 2.3 per cent. used on an average more than 20,000 gals. per month.

Comparison of Revenue on Meter Basis with Flat Rates

In 1913 the annual flat rates were $5 for domestic use, 6 rooms or less; $1 for each additional room. Additional, for bath $3, closet $3; $5 for 30 ft. sprinkling and 5c per foot for additional frontage—corner lots measured the long way.

The minimum meter rate was then $12 per year and the rate for the first 20,000 gals. per month was 30c per thousand. In that year we were supplying 819 residences, boarding, rooming and apartment houses through meters.

On flat rates the average monthly payments would have been $1.86. The average monthly on the meter basis was $1.34—a reduction of 52c per month, or $6.24 per year, or 23 per cent. For a period of five years the reduction of revenue from this class of consumers on account of changing to the meter basis, was approximately 25 per cent. In view of the many leaks and abuses that were stopped there were not regrets on the part of the water company.

The average daily consumption for the 819 consumers in 1913 was 150 gals.

There are two large educational institutions in Terre Haute; hence there are a number of rooming and boarding houses.

In the first three months of 1918 the minimum monthly rate for small meters was 60c, and the last nine months it was 75c. Our records show that a certain lot of 98 residence consumers with bath rooms and host connections paid an average of 97c per month in 1918; this was 65c or 40 per cent. less than the service would have cost on the flat rate basis. If the minimum rate had been 75c per month for the entire year (rate 25c per 1,000 gals.) the average per month would have been $1.01—a reduction of 38 per cent from what would have been paid on the flat rate basis.

Meters and Installations

About 98 per cent. of all meters are of the Empire type. The writer began using these meters in 1886, and is still buying them because they give good service for a long period and are easy to repair. For private fire protection services, we use the Hersey Detector and the Trident Protectus.

Basement Installation

Where meters are set in basements or cellars, they are located below the floor level at the point where the service enters the cellar. Our rules provide that service pipes shall be laid at a depth of not less than 4½ ft. underground and must be laid under foundations and a depth of at least 1 ft. maintained below floors of cellars. An excavation 20 x 26 ins.,

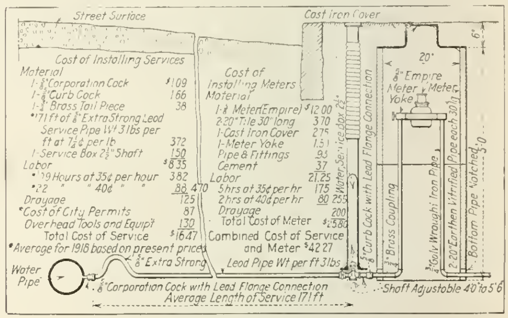


DIAGRAM OF SERVICE AND METER INSTALLATIONS, THE TERRE HAUTE WATER WORKS CO., SHOWING WHAT THE COMPANY MUST DO FOR A NEW CUSTOMER WHERE THERE ARE NO CONNECTIONS.

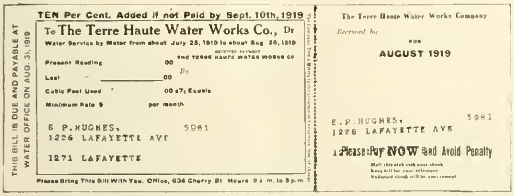
lined with brick or concrete, is made for meters set in cellars. Either an iron cover or one made of 2 in. boards are used. After the meter is set, saw dust or old newspapers may be used, if thought necessary, to prevent freezing. About 2,000 meters are installed in basements.

Outdoor Installation

At first, brick pits, 2 ft. 8 ins. inside diameter at bottom, by 4 ft. 6 ins. deep, were built for outdoor installations. These were provided with iron frames and covers, made locally, with an opening of 19 ins. There are 317 installations of this character and the records do not show that a meter was ever frozen in one of them, even with a temperature of 18 degrees below zero.

Later, in order to reduce cost of construction and labor in reading, brick pits were made 3 ft. 3 ins. deep by 2 ft. 8 ins. in diameter at bottom, with same kind of covers used on the 4 ft. 6 ins. pits. Risers were used to raise the bottom of the meter to a level of 3 ft. 3 ins. below surface and the excavation filled to that point. There are about 750 installations of this design.

The next plan of installation was a concrete tile, 15 ins. in diameter by 3 ft. 6 ins. long, with a Wabash cover, 9 ins. in height, an 8 in. throat opening and an extra lid. This made a total depth of 4 ft. 3 ins. Ford yokes were used on risers so that the top of meters would be approximately 13 ins. below the surface of the ground or top of cover. There are nearly 4,000 of these installations, some having clay instead of concrete tile. The writer confesses to an error in judgment in selecting a tile 15 ins. in diameter. Experience has shown that with sandy soil, such as largely prevails in Terre Haute, that the tile should have been 20 ins. in diameter and about



FORM OF WATER BILL USED BY THE TERRE HAUTE WATER WORKS CO.

5 ft. in depth; that vitrified tile or clay sewer pipe would probably have been a better non-conductor of cold.

At present we are installing meters out doors in 20 in. vitrified sewer pipe, using two pipes, each 2 ft. 6 ins. in length, the lower one being slotted to accommodate old service pipes that may not be as deep as we now are laying them. We use the Clark Meter Box Cover and Coupling Yoke; as these covers are 6 ins. high, the total depth of the installation is 5 ft. 6 ins.

Frozen Meters

Frost has been known to penetrate to a depth of 4 ft. 7 ins. in the sandy soil of Terre Haute. In a nearby city, with the same temperature but with clay soil, the frost does not penetrate to a depth of 3 ft.

In the winter of 1917-1918 there were 17 days when the U. S. weather office in Terre Haute reported zero and below zero weather, with a minimum of 18 degrees below zero. Out of 7,064 meters there were 616 frozen or 8.7 per cent. of all; these were divided as follows:

In brick pits, 3 ft. 3 ins. deep,	16.2%	of installations.
In 15 in. concrete and clay tile,	11.2%	of installations.
In 18 in. concrete tile,	4.5%	of installations.
In basements or cellars	2.6%	of installations.
In brick pits, 4 ft. 6 ins. deep,	0%	of installations.

These meters were repaired without cost to the consumer. In most cases the frozen basement meters were the result of leaving windows open.

Outdoor Meter Boxes Without Locks

About one thousand brick pits were provided with an iron frame and cover having a 19 in. opening. Originally these were not provided with locks. However, complaints were received from four persons, claiming that they had been injured by stepping on loose lids which turned. Two suits were filed for a total of $12,000, which were settled at a cost of $1,000. After this, all meter box covers of the design without locks were provided with them. Complaint has been made by a few consumers that they cannot get to the meters to read them. In reply, we offered to open the meter box, but have only found a few who actually wanted to read the meter.

Meter Readings

Meters are read monthly, beginning about the 20th or 21st of each month, so that bills may be ready for delivery by the last day of the month when they are due. Ordinarily there are ten to twelve readers, most of them being men who are regularly employed in various capacities. We usually have three or four high school boys reading on Saturdays and pay them 35c per hour.

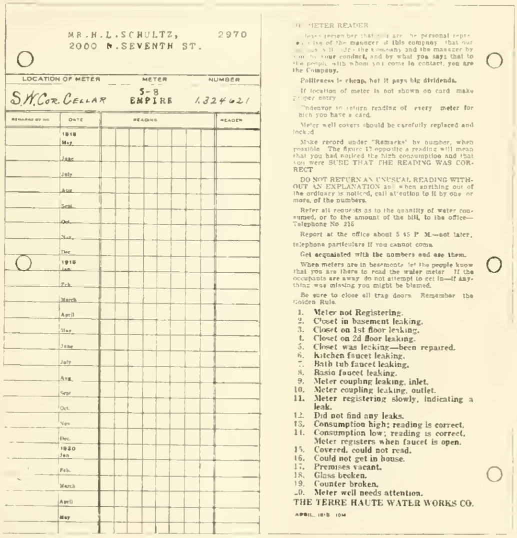
The readings are recorded on heavy linen paper instead of cards so that about 200 can be placed in a loose leaf binder. In preparing a new lot at the expiration of the old ones, the records are run through on the Addressograph for the name, street number and ledger number. We find that readings are expedited by giving the general location of meters.

There are 37 routes, two being taken by men on bicycles. Portable blackboards, 31 x 42 ins., are provided on which are painted headings and lines with numbers corresponding to the numbers of the meter books. The headings are, "Reader, Time out, Time in." The reader writes his name and time out opposite the number of the book he takes, which must be the one next above the last one recorded. The readers are not allowed to select particular books or routes. The average number of readings per hour ranges from 30 in April to 22 in June. The best individual record made was an average of 49 per hour in the month of April, the lowest in the same month was 22.

The cost of reading meters is materially increased on account of going back over the routes to read meters that could not be read on the first trip due to inability to get into basements. Extra readings are also taken where there is reason to believe that errors have been made. The average monthly cost of reading meters, including extra readings for the year ending June 30, 1919, was $184.60, which divided by 7,462, the number of meters, gives an average cost of $2\frac{1}{2}$ cts. per meter.

We have a stamped postal card with printed request that the occupant read the meter and mail; these are left where the house is locked and there are indications that someone is home in the evenings.

Where it is necessary to send back for a reading or to



FRONT AND REAR VIEWS OF LOOSE-LEAF IN METER READER'S BOOK, TERRE HAUTE WATER WORKS CO., TERRE HAUTE IND.

verify the reading on the regular route, the permanent reading card is not taken, but a small card is furnished the reader. This is done to avoid danger of loss of the record.

Entering Readings in Ledger and Billing

Loose leaf ledgers are used and are arranged in order on the different streets, beginning with the river or lowest numbered streets, then the diagonal and then those that are at right angles with the numbered streets.

The meter reading routes follow as closely as possible the arrangement of accounts in the ledgers. In the front of each reading book a monthly record is kept of the clerk who enters the readings. Each clerk is provided with a table showing each 100 cu. ft., equivalent in gallons and amount or charge at schedule rates. These tables are typewritten, every tenth line is in red ink; the size of the table is 10 x 15 ins., and gives each 100 cu. ft. up to 32,000 or 240,000 gals.

After the readings and charges are entered in the ledger, a second clerk copies the readings, and the cubic feet consumed on the bills which are addressed previously on the Addressograph. A third clerk stamps the gallons and amount due. Rubber stamps are provided for each 100 cu. ft., and are so marked on top; on the face or printed portion is shown the gallons that are equivalent, and the amount due. They are arranged in a special case so that the work proceeds rapidly. Later the bills are compared with the ledger to detect errors and omissions.

number are only paying one-half as much as on the flat rate basis.

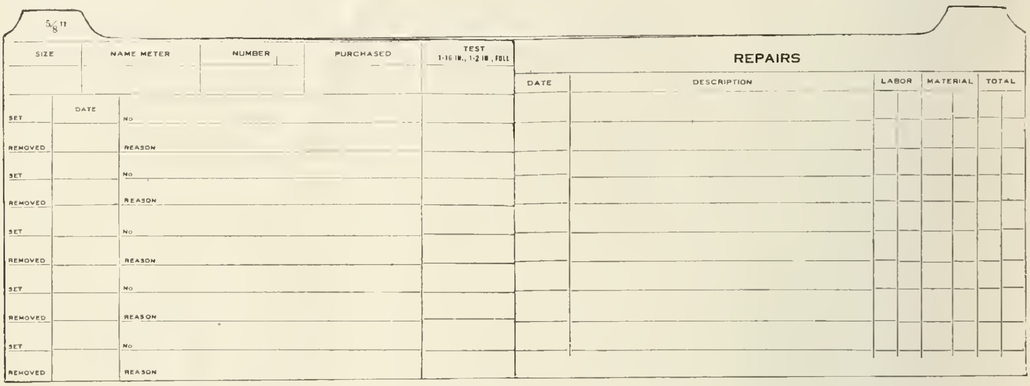
The consumption of water has been reduced by reason of more care being taken of plumbing fixtures and by the elimination of gross sprinkling abuses.

The peak load has been reduced 40 per cent.

We expect to be able, ere long, to report that the percentage of metered services has been increased from 95 per cent. to at least 99 per cent.

Miscellaneous Data

The following miscellaneous data are appended, as they may be of interest to some water works men.



FRONT AND REAR VIEWS OF METER HISTORY CARD USED BY THE TERRE HAUTE WATER WORKS CO., TERRE HAUTE, IND.

With the exception of about 200, all bills are delivered direct to the consumer.

Delivering Bills

Bills are delivered on the last day of the month. In addition to some of our regular employes, about 15 to 18 extra helpers are used; these are mostly women and girls and are paid $3 for about 8 hours' work. They are required to furnish references and are also expected to read our instructions each morning before starting work, although they may have read them a half dozen times previously. The routes are ready, so there is little time lost before beginning work. Three dollars in change is furnished, a large pocketbook for currency and detached coupons; also two street car tickets. They are responsible for the money they collect. Very few balance short beyond a few cents. As soon as they reach the office the coupons are delivered to a clerk who lists them on the adding machine while the money is being counted. We have yet to find a dishonest person among those who deliver and collect our bills. It is a great convenience to our customers to be able to pay without making a trip to the office. About 40 per cent. of the bills are paid on delivery.

The average number of coupons brought in on a certain day was 87—the total number being 2,270. Of the 35 routes, about 25 are delivered on the last day of the month, the balance on the following day. The average monthly cost of delivering bills by hand for six months ending June 30, 1919, was $126.91. The average cost per bill was 1.76 cts.; this includes the cost of collecting the 40 per cent. of bills that were taken out. The cost of mailing is 2 cts. for postage alone.

There is a delayed payment charge of 10 per cent. when bills are not paid within 10 days after they are due. About 93 to 94 per cent. of all consumers pay their bills by the 10th of the month. The additional 10 per cent. is collected in all cases.

Conclusion

The metering of residences and stores in Terre Haute has resulted in a reduction in cost of water to the consumer. A

The following table shows the quantity and cost of coal and alum bought in recent years by the Terre Haute Water Works Company:

COAL

Year	Tons	Average Cost per Ton	Total Cost
1915	4,048.75	$1.00	$4,048.75
1916	3,905.85	1.18	4,639.69
1917	3,812.16	1.92	7,337.74
1918	4,620.40	2.64	12,215.61

Present cost of coal f. o. b. cars Terre Haute, Ind., $2.77 per ton.

ALUM

Year	Wt. in Lbs.	Average Cost per 100 Lbs.	Total Cost
1915	497,000	$0.85	$4,162.59
1916	545,400	1.21	6,593.51
1917	631,343	1.18	7,467.99
1918	635,780	1.587	10,094.37

Cost of alum December, 1918, $2.01—Cost in February, 1919, $1.894.

The following table, compiled in December, 1918, shows the prices of coal, alum and other supplies used in the operation and maintenance of the Terre Haute water works. The prices are taken from the records of the company under dates as shown:

Item	Unit	1914-1917 Mo.	Yr.	Price	1918 Mo.	Price	% Increase
Coal	Ton		1914	$1.00	Dec.	$2.77	177
Sulphate of Alumina	100 lbs.		1914	.84	Dec.	2.014	140
Hypochlorite of Lime	100 lbs.		1914	1.30	Oct.	4.00	207
Neutrient, Gelatine and Agar	Liter		1914	3.40	Dec.	4.50	32
Coal Oil	Gal.	Apr.,	1916	.08	Dec.	.125	56
Gasoline	Gal.	Aug.,	1915	.10	Dec.	.23	130
Havoline Oil	Gal.	Oct.,	1916	.30	July	.43	43
Cylinder Oil	Gal.	May,	1914	.57	Nov.	.695	22
Engine Oil	Gal.	Aug.,	1915	.143	Dec.	.286	100
White Cotton Waste	lb.	Jan.,	1915	.085	Oct.	.188	121
Square Flax Packing	lb.	May,	1916	.26	July	.37	42
Paint and White Lead	lb.	May,	1914	.07	Oct.	.13	85
Brooms	Doz.	July,	1916	5.50	July	12.00	118
Transmission Rope	lb.	Apr.,	1913	.18	Aug.	.37	105
Stirling 3¼ in. Boiler Tubes	Each	Apr.,	1916	4.35	Apr.	7.25	66
⅝ in. Meter Repairs (average)	Each		1915	.557	Dec.	.743	33
Auto Casing, K. S. 30x3½ in.	Each	May,	1916	17.01	Oct.	28.18	65
Applications	M	Feb.,	1916	22.75	Sept.	47.08	106
Meter Bills	M	Mar.,	1915	1.43	June	2.05	43
Envelopes 6¾ in. Outlook	M	Feb.,	1914	1.53	Dec.	2.71	77

Paved Street Repairs Permits ....Yard		1914	2.50	Dec.	5.00	100
Ledger Sheets ....M	Aug.,	1916	15.00	Dec.	19.00	26
Paper Towels ....Case (25)	Mar.,	1915	4.50	Apr.	8.00	77
Machinist Labor ....Hour		1914	.60	Dec.	1.25	108
Boilermakers' Labor .....Hour	May,	1914	.60	Sept.	1.00	66
Compensation Insurance Rate per $100 of Pay Roll—						
Pumping Station Employes...	Sept.,	1915	.72	Oct.	1.56	116
Laborers, Trench Diggers, etc.	Sept.,	1915	2.50	Oct.	4.69	87
Foremen, Inspectors, Meter Readers	Sept.,	1915	1.00	Oct.	2.00	100
Clerks and Officials	Sept.,	1915	.06	Oct.	.10	66
Average Increase 86.7						86.7

The Ipswich River Water Supply for the City of Lynn, Mass.

By H. K. Barrows, Consulting Engineer, 6 Beacon St., Boston, Mass.

General Statement

The development of the water supply of the City of Lynn, Mass., is typical of that of many Massachusetts cities where rapid growth of population and industries has required frequent additions to the supply system. In the earlier years cities have in many cases failed to appreciate the need to look well ahead, with the result that water supply additions have been more or less makeshifts, soon outgrown.

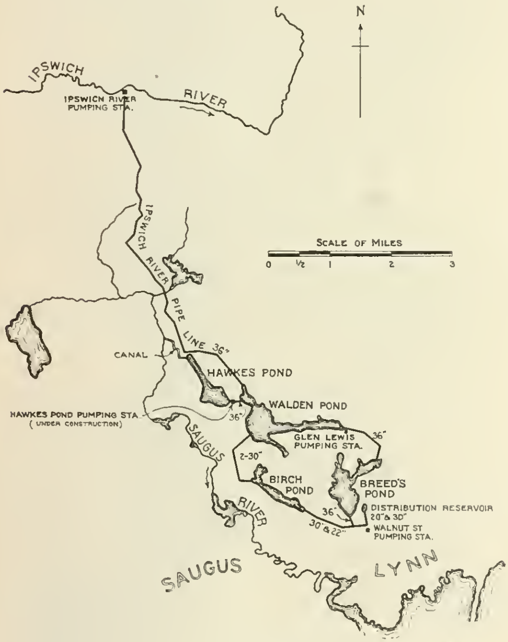


FIG. 1. MAP OF THE WATER SUPPLY SYSTEM OF LYNN, MASS.

In later years, however, often under the direction of the State Board of Health, broader plans have been more generally adopted, with the idea of settling the water supply problem for a substantial period of time.

The additional water supply of the City of Lynn from the Ipswich River, granted under legislative right in 1901, but with the necessary works only recently completed, will for many years provide for the city's needs.

It is the purpose of this article to describe briefly the essential features of these new supply works and some of the steps taken in planning them.

Old Supply System

The original water supply (1870) was from Breeds Pond, (see Fig. 1), of small capacity and yield and within the city limits and serving but for a few years. Water was pumped to a distribution reservoir of 20 mill. gals. capacity which is still in use.

Extensions of the supply system to include Birch Pond, a canal to the Saugus River, Walden and Hawkes Pond (all not far from the city), as well as construction to increase storage capacity in Breeds and Walden Ponds, were made at various times up to 1904.

Between 1912 and 1915 a new dam at Breeds Pond was built, affording a large increase in storage capacity, as by that time the general method of obtaining the future water supply of the city had been determined. This consists of utilizing as far as possible the natural yield of the various ponds previously noted, supplementing this as required by water from the Ipswich River. Large storage capacity (principally in Walden and Breeds Ponds) is provided to improve the quality of the water.

For some time water can also be obtained from the Saugus River (by canal to Hawkes Pond), but this cannot be premanently included in the supply owing to the steadily increasing degree of pollution of this stream.

The capacity and safe yield, etc., of these various ponds are given in the following table:

CITY OF LYNN—CAPACITY AND YIELD OF RESERVOIR SYSTEM

Pond	Area of Pond at H. W. Level Acres	Max. Draft Feet	Storage Capacity Mill. Gals.	Total Drainage Area Sq. Miles	Estimated Safe Yield Mill. Gals. Per Day
Breeds	210	55	1,600	1.07	0.70
Walden	240	40	2,000	1.75	1.75
Hawkes	75	26	330	1.86	1.30
Birch	82	20	400	0.68	0.68
Total	607		4,330	5.36	5.3

The safe yield of this reservoir system by itself is thus about 5 mill. gals. per day (based on Sudbury River yield but with correction for relative water areas).

Water Required from the Ipswich River

The estimated future water consumption of the city (which also includes the adjacent Town of Saugus) used in these studies and the corresponding deficit in yield of the reservoir system, or amount to be provided from the Ipswich River in a very dry year, was as follows:

Year	Estimated Daily Consumption Mill. Gals.	Water from Ipswich River Mill. Gals. P. D.
1915..........................	7.5	2.5
1925..........................	11	6
1935..........................	15	10
1945..........................	20	15

Yield of Ipswich River

The Ipswich River at South Middleton (the diversion point according to the Act of 1901) has a drainage area of about 44 sq. miles, is of slight fall, with a small percentage of water area, but considerable swamp and meadow areas which overflow at times. Mean annual rainfall is about 41 ins.

Measurements of flow at two points on the river had been made by the State Board of Health for short periods prior to 1913, but of sufficient extent in time to conclude after comparison that the Sudbury River records (available since 1874) could properly be used as a yield basis, making due allowance for relative water areas on the two basins.

Water to be Pumped from Ipswich River

The legislative act limited the time of pumping during each year to the months of December to May, inclusive, and also required a minimum of 10 mill. gals. per day to be let down the river. Keeping this in mind, the amount of water to be pumped from the Ipswich River and the time of pumping in any year would depend: (1) on the yield of the reservoir system as previously noted, and, (2) the distribution of the yield of the Ipswich River during the six months when pumping could be carried on, considering also desirable limits in maximum capacity of pump equipment.

Three parallel sets of computations were then made by the hydrograph method covering the period 1875-1912, inclusive, on the basis of an average daily consumption of 10, 15 and 20 mill. gals. respectively, further assuming the maximum pump capacity at 20, 40 and 60 mill. gals. per day respectively. The results of these computations gave, for the various different assumed rates of consumption: (1) the amount of pumping required during any month of this period of 38 years, (2) the

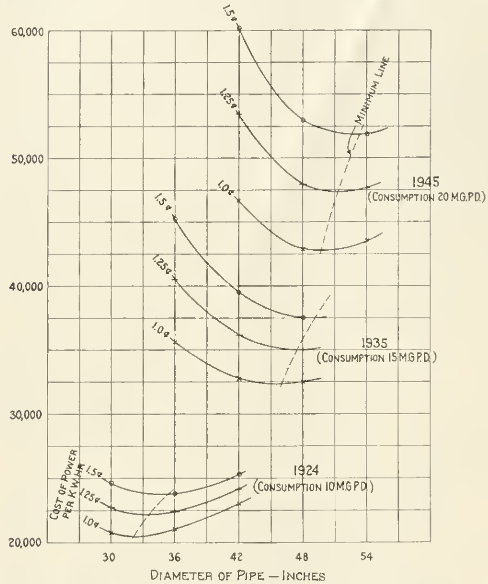


FIG. 2. DIAGRAM FOR DETERMINING THE ECONOMICAL SIZE OF THE IPSWICH RIVER PIPE LINE.

reservoir capacity necessary for each year, and ,(3) the amount drawn from storage each month. Following is a tabular summuary of results:

PUMPING REQUIRED FROM IPSWICH RIVER AND NECESSARY STORAGE CAPACITY AT VARIOUS FUTURE DATES

Item	Rate of Consumption—Million Gallons per Day (and approximate date of this consumption) 10 (1924)	15 (1935)	20 (1945)
Rate of pumping			
mill. gals. per day—			
Average	11.4	22.5	32.4
Maximum	20.0	40.0	60.0
Minimum	4.1	5.0	5.0
Number of months of pumping—			
Average	5.1	5.4	5.6
Maximum	6.0	6.0	6.0
Minimum	3.8	4.4	4.8
Reservoir Capacity required, mill. gals.—			
Average	1,660	2,650	3,690
Maximum	2,160	3,760	6,060
Minimum	906	1,800	2,710

Obviously storage capacity in the two principal reservoirs (Breeds and Walden Ponds), which totals nearly 4,000 mil. gals., is adequate for a considerable period of years even with a liberal allowance of time of holding stored water to insure good quality.

Size of Pipe Line to Ipswich River

Studies were next made to ascertain the most economical size of pipe in 1924, 1935 and 1945, when the consumption is estimated at 10, 15 and 20 mill. gals. per day respectively. Curves of total annual cost of pipe line and pumping were plotted from the results of the computations as shown on Fig. 2, omitting certain items of cost, such as right-of-way, pumping station, engineering, etc., common, or substantially so, in all cases.

Cast iron pipe at $25 per net ton was assumed because at the time of these studies (1913) it was without question the most economical material for use. The pipe as actually purchased later in the year cost in the vicinity of $21 per ton.

To allow for possible variation in cost of power for pumping, curves for 1.0c, 1.25c and 1.5c per k.w.hr. were plotted in each case.

From Fig. 2 it will be seen that the best size of pipe was about as follows:

Year	Size of Pipe
1924	36 ins. or less
1935	48 ins.
1945	54 ins. or less

In acordance with these results the capitalized cost of two schemes was computed:

(1) A 36-in. pipe to be laid at first, followed by another about 1930. (Two 36-in. pipes would substantially afford a capacity equal to one 48-in. pipe.)

(2) A 48-in. pipe to be laid at first and adequate until about 1940.

These costs were $248,000 and $335,000 respectively (assuming a life of 50 years for the pipe), indicating the advisability of the 36-in. pipe as the first installation. This size was adopted and the line constructed (see Fig. 1) during 1914 and 1915.

Cost of Pipe Line

This work was all done directly by the employees of the Water Department. Approximate costs were as follows: (length about 30,000 ft.).

COST OF IPSWICH RIVER PIPE LINE (36 in. c. i.)

Item	Total Cost	Cost per Lin. Ft.	Remarks
Labor	$65,660	$2.19	Laborers at $2.50 per day.
Pipe and Valves	105,000	3.50	5,782 tons pipe 38 tons specials 4 24-in. gates 11 8-in. gates
Lead	9,140	0.30	About 4.5c per lb.
Yarn	490	0.01	7.25c per lb.
Hauling Pipe	10,630	0.35	Hauled with motor truck. Does not include labor, but full cost of truck.
Miscellaneous	9,640	0.32	
Total	$200,560	$6.67	

Ipswich River Pumping Station

Equipment. Considerable study was given as to the type of pumping equipment to install, with the result that motor-operated units were found to be most economical and desirable—all things considered. In accordance with bids received Nov. 16, 1915, a 15-mill. gal. per day 18-in. De Laval pump, direct connected with a 250-h.p. G. E. motor @ 875 R. P. M. (3 phase, 60 cycle, 4,000 volts) was installed, at a cost of about $12,780, including station equipment and piping, revolving screen, etc.

Pumping Station. This was built by contract during 1915-16. The substructure and intake to the river, of reinforced concrete, cost about $13,300. The superstructure was of brick (yellow salt glazed inside and rough tapestry outside), with wooden roof beams and metal ceiling, about 48x25 ft., with space for a second pumping unit. Cost about $5,200.

The appearance and general arrangement of the station and equipment are shown in Figs. 3 and 4.

Transmission Line

Power for operating this station is furnished by the Lynn Gas & Electric Co., who also built the transmission line (during 1916-17) paid for by the City as follows:

Poles (including crossarms, guys, etc.) in place	$ 7,000
Wire and insulators, in place	6,600
Total	$13,600

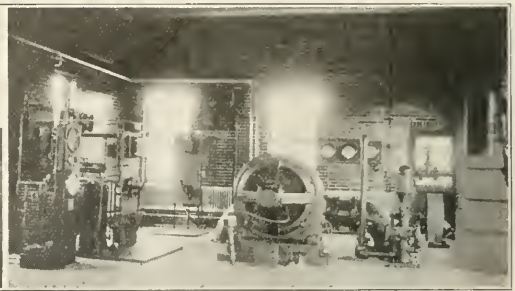


FIG. 3. GENERAL VIEW OF IPSWICH RIVER PUMPING STATION. FIG. 4. INTERIOR VIEW OF IPSWICH RIVER PUMPING STATION SHOWING PUMPING UNIT INSTALLED.

The line has chestnut butt-treated poles, 200 ft. span and a capacity of about 220 K. W. at 4,000 volts. It is about 6.5 miles long and thus cost about $2,100 per mile.

Concluding

The total cost of the Ipswich River supply to date (which includes some items not described above) is about $250,000. The city was very fortunate in completing practically all of this work. Acknowledgment is made for information and the war. To duplicate this work at present would mean an expenditure of upwards of a half million dollars.

The writer has acted as consulting engineer for the city on this work. Acknowledgement is made for information and courtesies extended in the preparation of this article by Mr. Reeves J. Newsom, Commissioner of Water Supply of the City of Lynn.

Some Economies That May Be Effected in the Operation and Maintenance of the Water Works System

By Homer V. Knouse, Assistant Superintendent and Purchasing Agent, Metropolitan Water District, Omaha, Neb.

While manufactured products of every nature have been advanced in price to the consumer, with reasons therefor that have been accepted, albeit with some grumbling, and while the cost of labor of every class has followed in order to meet the increased cost of those very necessities, it is a matter of considerable significance that the cost of service of publicly owned properties has not advanced in even a small fraction of the amount of other service, and in fact, in most cases there has been no advance at all, there being a few cases where it has been possible to continue the decrease of a rate at only a slightly lesser rate than in pre-war periods. And in the water works field has this condition been especially notable. The cases of increase of rates have been mighty few in number, and men responsible for these utilities may well feel that they have truly "done their bit" when they remained at home and combatted the enemy of high prices, generally in the face of an unsympathetic public, and always with the knowledge that there would be no "crosses for distinguished service." While we cheer the returning men in arms, we can feel that even though we have risked much less in many ways, we have at least made it a little easier for the industrial army behind the lines to meet the inevitable burdens imposed by war.

At the outset there is one thing that is emphasized by the writer, namely, that none of the plans carried out have been wholly new in the instance cited, but it is believed that in most cases they are adaptations of the plans of others, or have been suggested at times by very dissimilar proposals, and possibly may be even the carrying out in its entirety of the work of some other man. A great deal of credit must be given to the meetings of men interested in this line of activity, to the time that they have given to the preparation of papers, describing those things that they have attempted, as well as to those things which were crowned with success.

Organization of Metropolitan Water District

The Metropolitan Water District of the City of Omaha is a comparatively new property, if measured in the years that it has been under municipal control, although as a water system it had been in successful operation since 1880. Originally built by the American Water Works Company and successively under the control of subsidiary companies, to suit the various needs of corporate financing, it finally came under the control of the City of Omaha in July, 1912, and has since been operated under the title mentioned above. Just a brief word in regard to this form of government, for it seems to be a fact that cannot be disputed, that the form of control has been a large factor in the successful operation of the plant. The management is under the control of a Board of Directors which it was desired should be as nearly non-partisan as possible, and to secure such condition it was decided that the nearest approximation would be secured in a bi-partisan board. Each two years two members are elected, one from each of two political parties, and these men serve six years. The salary is merely nominal, and with a majority of the board holding over, a continuing policy is assured. This board appoints a general manager who is in responsible charge of the entire property, and appoints his subordinates with no other motive than to obtain those who will serve in such a manner as to get the results that the general manager must obtain to retain his position. Under this plan as applied, every department head is in actual charge of his department, selects his subordinates, is responsible for their efficiency, is brought to task for their failures, and reaps benefits of the successes of his department without the possibility of "passing the buck" either in his own mind or in actuality. Under this plan every employe is continually on tip-toe to make a record that will be to his credit, and in the last analysis it will remain an undisputed fact that the greatest economies in the operation of any enterprise will be from the whole-hearted co-operation and interest of the men making up its personnel.

Records of Operation

The logical step from individual efficiency is to mechanical excellence, and the factor which will control both are the records of the operation. This is a matter that every superintendent realizes, but in many cases is compelled to defer until a time when he has a few minutes free to get out the necessary forms and issue the requisite instructions to place in effect the ideas that have formulated in his mind. To often the many demands upon the time of the superintendent do not allow him to get further than this, and it is a regretable fact that this feature of the work is many times not in the form which would allow him quickly to locate the leaks that mean so much in economical operation. Just one instance to illus-

GROUND HOGS

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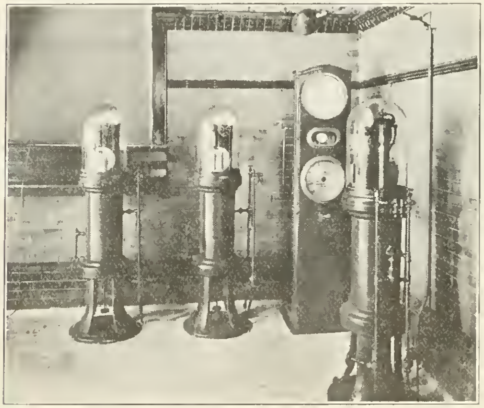
trate wherein a most decided economy has been effected at an expense that is insignificant compared with the results achieved.

Every Element Weighed or Measured

The main pumping station of the water district has been so arranged that every element entering into the operation of the plant is measured. Coal in and cinders out are weighed.



VENTURI METER REGISTERS ON LINES TO SEDIMENTATION BASINS TO CITY SYSTEM AND ON BOILER FEED LINES, OMAHA WATER WORKS.

Water pumped and water to each boiler and to each engine is passed through a steam flow meter. The water delivered to the settling basins and to the distribution system is passed through Venturi meters.

On the basis of this information there comes to the desk of the superintendent each morning a report showing in its final analysis a statement as to the number of foot pounds of energy developed per pound of steam in each engine, the number of pounds of water evaporated per pound of fuel in each boiler, the number of gallons of raw water pumped as well as the number of gallons of treated water put into the distribution system. Each engine and each boiler is watched, and the individual performance known each day that adjustments may be promptly made, and it is finally developed as to what the overall station duty is, and the number of pounds of water evaporated per pound of fuel burned.

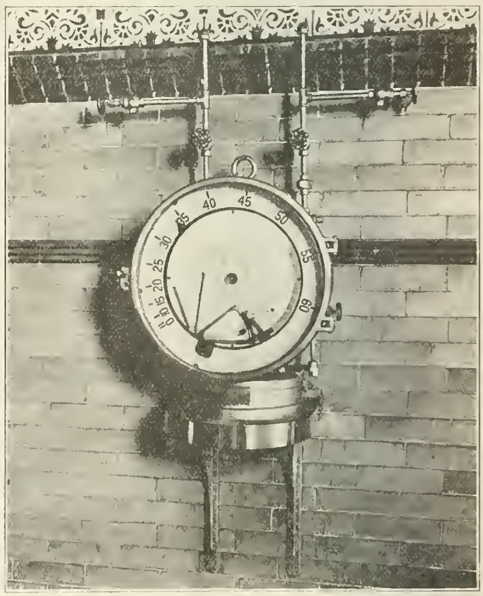
Testing Worth of Coal

Coal is the large factor in the operating cost and, therefore, this is the item in which the most interest develops. Knowing the kind of coal that was under the boilers, and of course its cost, it is a simple matter to determine the cost per pound of water evaporated, and it is at this point that the large factor of economy may develop. Probably every operator has had a salesman from one or the other coal district approach him with an argument as to why he should buy that salesman's coal in preference to all others, because it contained so many thousand B. T. U.'s, and the worst part of it is that the salesman has all the best of it, for one cannot dispute a fact that is usually attested by such authorities as we all know to be above reproach. We have a feeling that there are lots of things that we could tell him about our plant, and that there are some things that he does not know about burning coal under our boilers, but in view of the array of figures that he gives we are very loath to enter into an argument when we cannot quote data on the same basis of reliability as those that he quotes. The answer is simple, in the case under consideration, and the writer has found great satisfaction in being able to reach over the desk and pick up a report showing the performance of a certain coal and ask the salesman if he can guarantee his product to perform on an equivalent basis.

A concrete example will probably explain the method more clearly than would any further discussion in the abstract. The station duty for a certain date showed that when burning coal from a specified district an evaporation of 6.0 lbs. of water per pound of fuel from and at 212 degrees was obtained in all the boilers, and from a knowledge of previous days' reports it was known that this was a fair average for this coal. The coal cost on cars at the plant was $3.50 per ton. The coal offered was quoted at $4.85 and it was a very simple problem in proportion to determine that in order to be as cheap as the coal being burned, the coal offered would have to develop an evaporation of 8.3 lbs. of water per pound of coal. Previous experience with coal from this district had told us that such evaporation was very improbable, and consequently we were not deceived by any claims that were not available under our particular operating conditions. A similar process of reasoning shows the price that may be paid for any other coal, for past tests are on record showing what may be reasonably expected from many different fields. It is difficult to estimate what the net saving has been to the water district from this method, but the writer is confident that it is very large.

Economy of Alum Cake Plant Demonstrated

Probably the next largest item that enters into the operation of this particular plant is the matter of coagulant for the settling of the water, and those who are familiar with the natural state of the waters of the Missouri, or perhaps better known as the "Big Muddy," can realize that it has been no inconsiderable item. Prior to the year 1916 commercial sulphate of alumina was used as a coagulant, but in that year a plant was placed in operation to manufacture a material which served the purpose in as efficient a manner and had the advantage of considerable economy. This is an alum cake plant, as developed by Mr. Charles Hoover at Columbus, Ohio, and the operation over a period of three years has demonstrated



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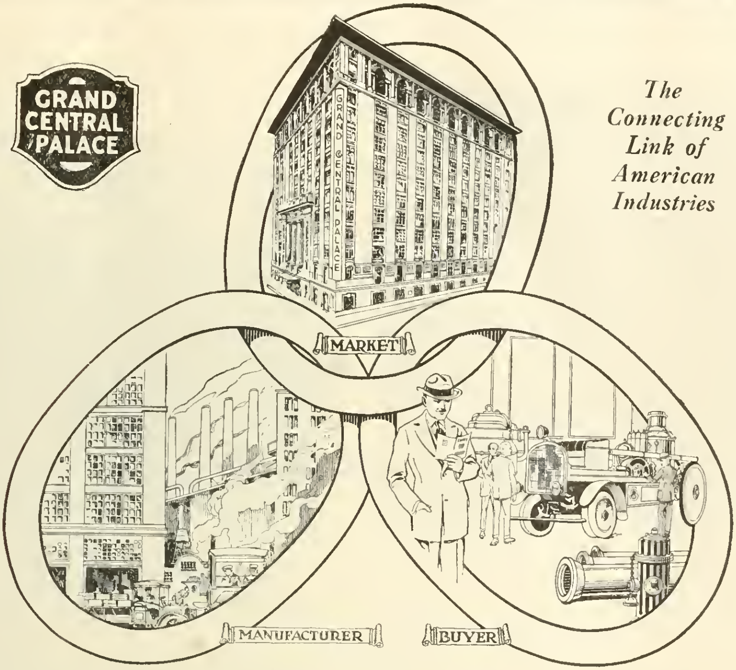

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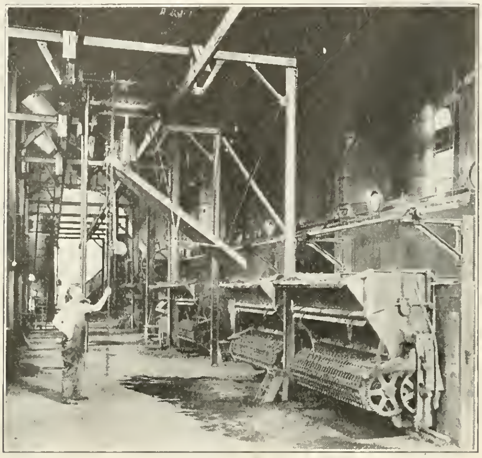
Suite 421

405 Lexington Avenue, New York

its economy in a manner that is almost too good to be true. The raw materials are bauxite, obtained in Arkansas, and sulphuric acid. The manufacturing process is very simple, and even the machinery in use could well be replaced in many instances by a few simple tools, and a cheap installation that would reduce the investment to a negligible figure. A product is obtained that is fully as efficient as a coagulant as the commercial product, is no more expensive to handle, and the cost of $0.60 per hundred represents a substantial saving over what would have been the cost had a contract offered in 1916 been accepted. In fact, figured on this basis, the net saving for 1918 was $15,000 on a plant equipment cost of $6,500.



SECTION OF BOILER ROOM OF OMAHA WATER WORKS SHOWING EQUIPMENT WITH WEIGHING HOPPER FOR WEIGHING COAL TO EACH BOILER.

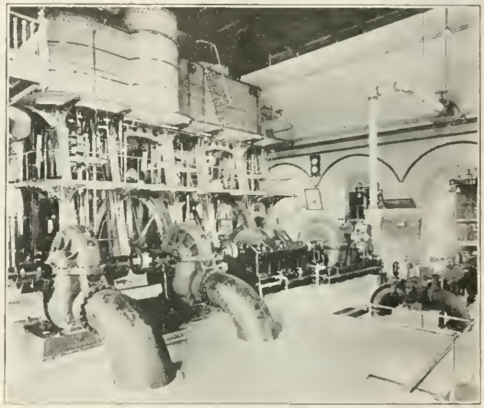
Many special rigs, a number of plans for the handling of work, and not a few just plain "fool ideas" have been advanced, and to tell the truth almost that many have been discarded as being more bother than they were worth. But from the fact that even a few were worth the time spent on the whole lot, and that these few will lead to the development of others, that work along this line is very much worth while. A few will be mentioned:

Folding Ditch Barricade

A folding ditch barricade, so arranged that for transportation from yard to job a minimum of space would be required, with provision for suspending a red lantern in a secure manner, and being so painted that it was conspicuous under an automobile headlight, was a cheap device that has proven of considerable value. With the lantern supported from the top of the frame and the bail removed, it has been noted that the lanterns were not nearly so popular with the early morning milkman as were those whereon the bail was left in place.

Modified Uses of Motor Trucks

A tee placed in the exhaust line from the motor of a 2-ton truck, to which was connected a flexible metal hose, proved to be a most useful piece of equipment, for it often saved the expense of sending a steamer for the thawing of a hydrant. Another modification applied to the truck was the attachment of a coupling device to the body, and the fitting of suitable attachments to the tongues of all tool wagons, concrete mixers, trailers for the transporting of large pipe, trench pumps and other wheeled tools. Much time was saved, and an added security obtained that is difficult to measure in dollars, but which the operating official will recognize as being a real advancement.



MAIN HIGH SERVICE PUMP ROOM OF OMAHA WATER WORKS, SHOWING DE LEVAL 30 MILLION HIGH SERVICE PUMP IN FOREGROUND, 20 MILLION ALLIS IN BACKGROUND AND 18 MILLION ALLIS IN DISTANCE.

Foreman's Map of Distribution System

Another tool, if it may be given such a name, that is present in some plants, and also absent from a considerable number, is a map of the distribution system that has been compiled with the idea of usefulness to the foreman on construc-

VIEWS ILLUSTRATING SUCCESSFUL APPLICATION OF METALLIUM JOINTS IN PIPE LINES OF OMAHA WATER WORKS.

Left: Pipe Work Using Metallium Joints. Right: Test Section of Pipe Showing Deflection after Pouring of Joints.

tion and repairs. The "Big Boss" usually has a big map of the system in his office, and the chief engineer has a lot of tracings that tell him just the things that he wants to know, but too often the man on the job is left with an out-of-date blue print with innumerable scratches thereon in pencil, or in many cases he is compelled to rely on a memory already overtaxed with things that the super has told him to do as soon as he has the time. To help out this worthy individual a skeleton map was drawn on a scale of 600 ft. to the inch, and cut up into sections covering a district one mile by two miles. These maps, printed on cloth, were bound in a roll or cover having a snap clasp and which, when not in use, occupied a space of about 3 ins. by 3 ins. by 11 ins. Shown thereon are mains, valves and hydrants only, with a numeral alongside the main to indicate its size. Its usefulness has been well proven, for even the memory of the oldest foreman will at times prove to be faulty, and especially so under the stress of a shut-out around a break where the flowing water is causing considerable damage.

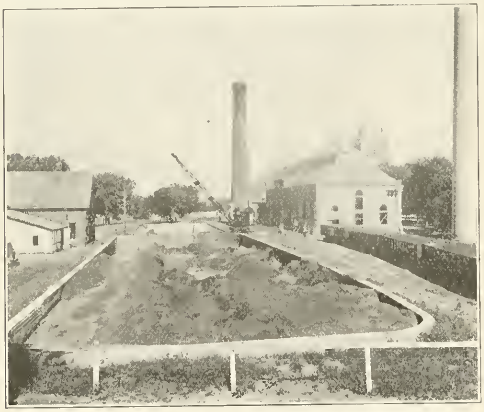
Fifty Miles of Main Successfully Laid with Metalium Joints

Much stress has often been laid upon one characteristic of water works men, and the writer feels whenever he hears it mentioned in terms of criticism that it is instead a most flattering compliment. It has been given two or three names, depending upon the size and position of the man addressed; sometimes it is politely mentioned as conservatism, and again someone had the temerity to call it by the name of bullheadedness. But in the light of the results that have been achieved during the war period it must be apparent to everyone that there is some unnamed quality in these men that has made for safe and economical operation of the properties entrusted to their care. It is this quality that has undoubtedly safeguarded the owner, whether public or private, of the water works of the country against many proposals that had not had a sufficient time for trial, and which might have proven of great disadvantage to the plant in many ways.

It was probably this natural conservatism that made the management of the water district hesitate to try a substitute for lead as a jointing material in the laying of bell and spigot water pipe. However, upon close analysis it appeared that lead was not an entirely satisfactory material for this purpose, and an investigation was made with a view to determine its failings, and to investigate the claims of those who offered substitutes that their assertions as to superiority over lead might be substantiated. In was in 1914 that the Metropolitan Water District began this investigation, primarily with a view to decrease the cost of construction of a large force main, but also with the idea of eliminating some of the difficulties that were inherent with lead, and to which years of use had made them somewhat callous. Chief among the difficulties was the increasing difficulty of paying the increasing scale of wages demanded by expert caulkers, and even of obtaining the services of competent men for this class of work at any price; the time necessary for the caulking of the joint before the ditch could be refilled or the pipe placed in service, and the necessity for testing the line before the refilling of the ditch due to the inability of the caulking material to take up any initial leakage. All of these factors proved to be items of considerable expense due to delays to the pipe gangs.

It was during the first day that the greatest number of objections to the new material presented themselves, for after the foremen and the workmen had become familiar with the slightly different methods of handling necessary with the improved joint a decided speeding up of the work was apparent, and when it was considered that even with the pre-war prices of lead effective that there was a saving on material alone of about $1.10 per joint, the troubles of the first day were forgotten. The workmen's attitude changed from one of skepticism to one of enthusiasm, until at the present time there would be decided objections to going back to lead.

The year following all lines, of every size, were laid with this material, and the practice has continued to the present. Many joints have been uncovered to see what their condition was after several years of installation and it has been with a great deal of pleasure that the management has noted that there has not been the slightest change during the period of use. Lines under pressure have been lowered as much as 3 ft. with only a slight leakage immediately after deflection, and which has in every case taken up as rapidly as would any slight leakage that might occur when pressure was applied after the initial installation. There has been greatly decreased trouble in joints under railroad tracks, where the tendency has been for lead to "walk out" of the joint, and it is now



COAL PITS HAVING A SUBMERGED STORAGE CAPACITY OF 8,000 TONS, OMAHA WATER WORKS.

general practice in this department to peel the lead at the first sign of trouble and replace with metalium.

A number of instances might be cited where metalium has been useful for special jobs where no other product would be suitable, but when once its use is begun these adaptations will be apparent to the superintendent and foreman. With more than 50 miles of main laid with this material, and the joint troubles practically nil, it is felt that the management was more than justified in giving the city the benefit of greatly reduced costs with an increased efficiency.

Acknowledgment

The foregoing paper was presented at the recent annual convention of the Southwestern Water Works Association.

Most Recent Developments in the Methods of Measuring Irrigation Water to Farms and Irrigators

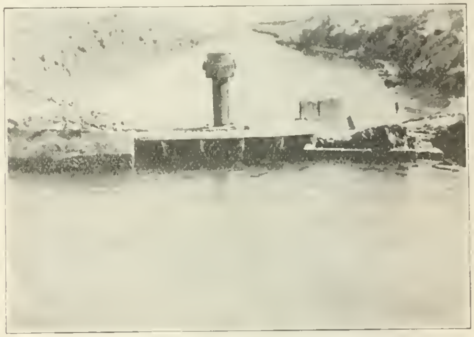
By F. E. Trask, C. E., Consulting Civil and Hydraulic Engineer, 616 Union Oil Bldg., Los Angeles, Calif.

For a period of 32 years the writer has been intimately connected with all phases of the engineering problems involved in the development and operation of irrigation projects in the southwestern portion of the United States.

Of the multitudinous problems confronted in all these years, none have been more difficult of satisfactory solution than that presented in the effort to obtain accurate measurement and correct knowledge of the volume of water delivered to the irrigator.

Old Methods and Their Limitations

The writer has read and heard much discussion of this subject, and to those who may desire more detailed informa-

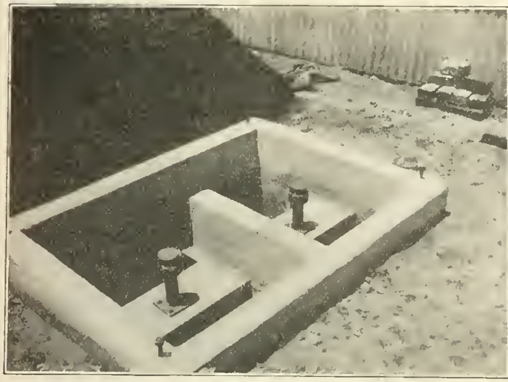


TWO SECOND FOOT RELIANCE IRRIGATION METER OPERATING IN AN EARTHEN CANAL.

tion thereon, he would refer to issues of Engineering and Contracting of dates November 13, 1918, and February 12, 1919, wherein engineers of the United States Reclamation Service emphasize the great importance, to all parties in interest, of an accurate knowledge of the exact volume of water delivered to each farm; and the further fact, that, within reasonable costs, there are none of the old enumerated methods that are satisfactory in practical service.

The writer is in hearty accord with most of the argument and conclusions presented in the mentioned article; and further is firmly convinced that the "weir," and "Venturi tube" will always be used to some extent, where special conditions operate to make such use commercially practicable. However, for most headworks and lateral canal intake measurements and all measurements for deliveries to individual irrigators much use will be made of a new device or meter, now on the market. The conservative business methods of the owners of this meter are wholly responsible for its being so little known today, and when engineers are acquainted with its merits, it will be as important in irrigation works designs and specifications as are pressure meters in domestic water works equipment.

The writer has been watching this meter for more than two years and is now convinced of its merit to the extent that he is specifying it in all new work and adding it to the weir boxes in many of the older irrigation systems.



VIEWS ILLUSTRATING USES OF RELIANCE IRRIGATING METER IN CALIFORNIA.
Left: Setting and Measurements of Water in and From an Old Weir-Type Measuring Box. Right: Example of Method Used by the Lindsay-Strathmore Irrigation District.

The New Method of Measuring Irrigation Water

The Hydrometric Company of this city has placed this irrigation meter on the market under the name "Reliance Irrigation Meter," and it has been tried out under all possible conditions with general satisfaction.

In a nutshell, this meter may be described as a "calibrated throat," in which is suspended a "propeller wheel," connecting directly by rod to a "gear train" having a dial, from which may be read directly the volume of water, either in "acre feet" or "cubic feet" as may be required.

This is not an integrating meter as the whole body of water, in ditch or pipe line, passes through the meter.

Likewise, it is not a 'pressure meter" but can be readily adapted to non-pressure irrigation conduits, sewerage and drainage conduits, and domestic water reservoir intakes. The three photographs represent the regular uses to which the meter is being applied in this state. The first shows a "two second foot" meter, operating in an earthen canal: the second illustrates the setting and measurements of water in and from an old weir-type measuring box; and the third is an example of the method used by the Lindsay-Strathmore Irrigation District, which has three meters installed throughout its irrigation pipe system.

Sizes of Meters

These meters are built with capacities varying from 1/5 to 16 second feet, and the writer finds it very easy to design a canal section in such a manner that any volume of flow can be measured by installing duplicate meters in battery form.

Degree of Accuracy

The makers' tests show the meters to register within 2 per cent. when operating from one-half to full rating. It has been found that under normal conditions and careful placement of the meter that the error is usually within one-half of one per cent., when checked against a well conditioned standard weir. Volumetric tests, made by discharging into calibrated reservoirs have given substantially the same results.

Merits of Metering.

The writer has been active in urging that all classes of water services should be metered; and within the past year has been able to apply, to all water services, the same methods heretofore commercially possible only for domestic services, and do so with great satisfaction to all parties concerned.

Metering irrigation water is the sole method of eliminating friction between a company and its consumers. The scientific farmer may now measure accurately the right quantity of water for his crops, and do so without waste or unnecessary expense.

Meters eliminate disputes, litigation, and trouble and worry for engineers and superintendents. The cost of installation is moderate and within the reach of every irrigator.

Building Up a Worn Pump with the Oxy-Acetylene Process

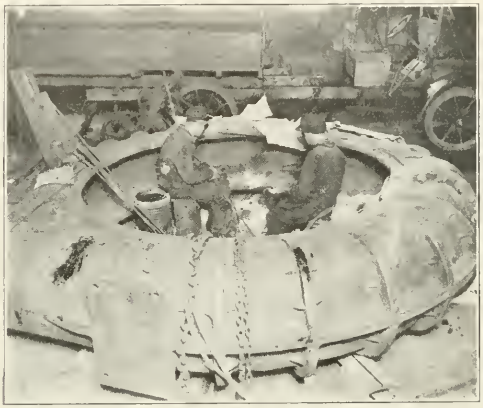
By Charles C. Phelps, Engineering Department, Oxweld Acetylene Co., 30 East 42d St., New York, N. Y.

The type of centrifugal pump used by dredging contractors and mining operators for such purposes as dredging silt, sand, mud and gravel from the bottoms of channels and for mining soft ore by the hydraulic mining system, is subject to excessive wear, due to the constant abrasion of the sand and gravel against the inner walls of the pump chamber. When the wear becomes so great as to interfere with the operation of the pump, or "sand sucker," as it is commonly called, it becomes necessary not only to put the pump itself out of commission for repair but also to hold an expensive dredging barge and its crew in idleness.

Such a sand sucker chamber that had become badly scored through use was recently restored to practically its original condition by the Chicago Job Welding Department of the Oxweld Acetylene Co., by means of the oxy-acetylene process. When it is considered that new castings would have cost about $3,500 and that the actual cost of repairing by welding methods amounted to only one-third as much, it is not surprising that the contractor decided to repair instead of to replace, especially in view of the still more important fact that repairing enabled him to get the dredge back into service with only a few days' delay, whereas replacement meant a delay of from 10 to 12 weeks.

Delay Meant Great Loss

In order to gain some idea of the cost of delay of a hydraulic dredging outfit an estimate of the earnings of a dredge will be given. In the year 1912 the United States Government estimated the cost of hydraulic dredging to be 7.18 cts. per cubic yard. This figure represented the average total unit cost of operating a fleet of hydraulic dredging vessels. The record for



BUILDING UP WORN SURFACE OF "SAND SUCKER" DEPOSITING 1,264 LBS. OF HIGH CARBON STEEL WITH AID OF OXWELD OXY-ACETYLENE BLOWPIPES.

one month for one dredging pump having a 20-in. outlet pipe was 456,000 cu. yds. of material. At the average unit cost given above, the monthly cost of dredging this amount of material represents over $30,000. The sand sucker shown in the illustration is much larger than the one referred to above. Furthermore, the cost of materials and labor is much greater today than in 1912. When such factors as loss of profits, overhead expenses, non-productive labor and contract penalties are taken into consideration, obviously every week of idleness meant a loss of thousands of dollars.

Over Half Ton of Metal Deposited

The pump chamber of the sand sucker illustrated is 14 feet in outside diameter, and consists of two massive steel castings having a total weight of 7 tons. The abrasion had been so severe it was necessary to rebuild both side walls of the pump chamber for a distance of 8 ins. from the inner circumference. The thickness of the added metal varied from 1½ to 2½ ins. In addition, a new section approximately 14x18 ins. in area had to be welded into the throat of the casting. The latter was approximately 3½ ins. in thickness.

In order to insure holding the two halves of the chamber in alignment during preheating and welding they were bolted together and the heavy outer reinforced sections of the castings were not heated, as this would have produced internal strains, either breaking the castings or shearing the bolts that held them together. Preheating by means of charcoal was applied locally for a distince of about 14 ins. in from the edges of the flanges, each preheat extending for a distance of 3 ft. around the inner circumference.

The total weight of steel added to the castings by welding amounted to 1,264 lbs. The operators, each using an Oxweld blowpipe fitted with No. 15 welding head, worked in pairs. As the heat in the small enclosure where the men worked was intense, it was necessary to hold several welders in reserve and to work on the relay plan, each welding shift extending for a period of 20 minutes. Six days were required to complete the building-up work.

Construction Improved by Use of High Carbon Steel

As the built-up surface will be subjected to the same abrasive action of sand and gravel, high carbon steel welding rods were used for the purpose of building up, thereby giving an extremely hard surface, in fact, one that it was impossible to cut with a file, after cooling.

The oxy-acetylene welding work was completed in six days, saving the contractor the expense of several weeks of idleness, nearly $2,500 in cash on the cost of the casting alone, and giving him a pump actually improved in construction, because lined with abrasion-resisting steel.

EDITORIALS

Is It Wise to Confess Error?

A learned contributor to this issue observes: "It has not seemed to the writer that the importance of a knowledge of failure is sufficiently appreciated. Every one wants to know of a brilliant success, but it is just as important to learn of a failure, so that it may not be repeated."

These are most interesting statements. We can scarcely agree that there is any lack of appreciation of the importance of a knowledge of failures. Every one will admit that it is wise to learn from the mistakes of others, but how are we to do it? Engineering journals get themselves very cordially disliked when they attempt to advance knowledge by describing the failures of men and materials. The purest of motives is likely to be misunderstood when one attempts this journalistic enterprise. Any editor who would make it a part of his business to search out failures would soon incur the displeasure of so many people that his usefulness would be destroyed. The fear of doing injustice often stays the editor's hand.

Confessions of error must come from the one who made the error, if they are to be given out at all. This leads to the query: Is it wise to confess error? Can an engineer afford to make public the lessons he has learned from his failures?

Men naturally hesitate to admit that they have made mistakes. They fear that public confession of error entails loss of prestige. We believe that a man who is generally successful can safely tell of his occasional mistakes, especially if he goes back far enough to speak of himself as a "young" engineer.

But among engineers we find such a degree of caution that many fear even to describe their successes, lest under the cold scrutiny of their professional brethren these successes turn out to be failures at some point or in some particular. Are engineers really so critical? We doubt it.

But where engineers are so reluctant to break out in print, even to describe their successes, the difficulty of getting them to describe their failures can be appreciated.

Some years ago one bold spirit decided to describe some of the failures he had made as a water works engineer. His article was most instructive. No article published that year called out more letters of appreciation than his. A few other articles were contributed by readers of the first article—and that was all, although the editor grew very enthusiastic about articles of this class and wrote several editorials urging engineers to describe the lessons learned from their failures, for the good of the profession. He argued that an engineer who had finally succeeded in spite of the failures that all men make could safely tell of his earlier failures without loss of prestige. We still remember how much fun a contemporary journal had in holding those editorials up to ridicule.

What happened to the eminent water works engineer who described some of the failures he made when a young engineer? Did he lose the confidence of the public or of his profession? We don't think so. We noticed that when his country went to war and a first-class water works engineer was wanted to design quickly and safely the urgently needed water supply works for the various military cantonments, he was selected as the man best qualified to do the work.

For a Continuing Highway Policy and Personnel.

The wise expenditure of public funds for highway construction can best be insured by the formulation and adoption of well-considered policies which shall remain in effect from year to year, and by the retention in office of highway engineers of demonstrated ability, who shall be left free to carry out these policies. There can be no real continuity of policy or progress where changes are frequently made in entire state highway commissions and in state highway engineers. These changes make for a policy of inaction and vacillation, generally speaking. These "quick turnovers" are most expensive to the public, and arrest where they do not endanger the normal development of the good roads movement.

Just how many of the 48 state highway engineers who were in office on the first of this year are still in office we do not at this moment know. Several changes have been made. The percentage of removals has been disquietingly large. If all these changes have been made in the interest of efficiency, well and good, but in some cases partisan politics has probably dictated the change. This statement is made with all due respect to the gentlemen who have ascended to this high office this year. We are as friendly to the present incumbents in all cases as to their predecessors in office. It is not a matter of individual fortunes with which the public is so much concerned as it is with the smooth running of state highway departments, which clearly requires greater security of tenure of office. There have been too many changes this year. We trust that the engineers now in these offices who enjoy public and professional confidence will remain undisturbed for years to come. They have a right to be set free from the worries of practical politics so they can devote all their time and talents to the difficult and exacting duties of their offices.

The states which have made the greatest successes in state aid highway work are those in which the fewest changes have been made in the state highway engineering organizations. All engineering positions in state highway departments, both for selection and tenure of office, should be based solely on merit. This plan has already been adopted in a number of states and it should be adopted elsewhere. The main reason why it is not in operation in more states is that highway commissions frequently change with the political changes in the state. Many of these commissions, however, are being made continuous by having the term of one of the commissioners expire each year or every second year, thus leaving on the board two or more commissioners who have had previous service. Where this plan has been adopted the highway commissions are more likely to continue the engineering force from year to year without change.

Engineers who now see that it is a part of their duty to advise the general public on all matters of an engineering nature will find this subject one offering most attractive educational opportunities.

Progressing Under the Scourge of Epidemics.

Some cities, like some individuals, can progress only under necessity. This is not strange, as the policies of cities are determined by individuals. City officials who are accustomed to look and plan ahead in their private business affairs usually adopt the same attitude toward their public duties. To those who like to be forehanded the suggestion is offered that in matters of an engineering nature affecting the public health it is well to take thought of the future.

This point is brought out with striking force and clarity in the recent report on the filtration of the water supply of the city of Detroit, by R. Winthrop Pratt, the consulting engineer. After recommending filtration, he said: "It is true Detroit is not confronted with any severe sanitary crisis, but to progress only under the scourge of epidemics is not a desirable policy. This has been proved in many cases where cities have undertaken filtration projects without sufficient preliminary investigation and consequently at heavy cost. The logical process of improvement, therefore, and the one pursued in this instance, is to anticipate every possible source of disaster, and to demand the best rather than to be content with that which is passably good. For a moderate cost Detroit can add to its industrial distinction and world-wide repute for civic enterprise, the further priceless boon of an irreproachable water supply. It is in the light of such an opportunity that the project outlined is presented."

It is a pleasure to add that the Detroit officials have chosen to safeguard the health of the people by taking steps to filter the water supply as soon as practicable. They are to be commended for this. A "wait and see" policy would continue present conditions there, exposing the people to the possibility of a water-borne epidemic at any time.

The quotation constitutes a complete argument for health insurance of the kind underwritten by engineers. As a piece of effective engineering writing it merits close study from several viewpoints.

Pavement Experiments, Good and Bad.

Experiments in street pavement work must be made if we are to progress in this important branch of municipal engineering work, but not all the experiments are good. Experiments should be made first on a small scale, advancing slowly from the laboratory to the short service-test roadway. There are many desirable experiments to be made in the combination of paving materials as well as in features of design and construction. All these are good experiments, entirely in the public interest.

A bad pavement experiment is the laying of a large yardage of an untried paving material at public expense. Such experiments begin at the wrong end of experimentation. What should be made the last step is made the first. If such an experiment has an unfortunate ending the cause of street paving receives some undesirable publicity. Such cases have occurred more than once.

Recently a county in a western state constructed 100,000 sq. yds. of a new process pavement without first determining whether it would stand up under traffic. The pavement is said to be rapidly going to pieces. In this case the public officials are being severely criticised for adopting a paving material admitted by its promoters to be still in the early experimental stage of its development.

Watch the Assumptions

Perhaps the greatest folly of which men of science are guilty is to work out to a precision of one-tenth of one percent the answer to a problem in which there is a probable error of, say, fifty percent in one or more of the assumptions made preparatory to the application of the symbols of mathematics. Engineers pride themselves in their skill with mathematics, but they should keep steadily in mind the fact that figures can and do lie in many cases. Whether or not the results of the application of mathematics have any real value depends primarily on the soundness of the preliminary assumptions and to the statement of the problem.

Mathematics is an exact science, it is said, and of pure mathematics this is true. But applied mathematics? That is a different story. The mischief comes in the use of the same symbols in applied as in pure mathematics. This tempts the computer to place too much reliance on the results of a problem involving the use of mathematics, but also involving opinion, the forces of nature, prejudice, and goodness only knows what else.

First and last, a vast amount of bosh has been perpetrated in the language of the mathematician. Examples? Assuredly; here are three of them:

A very eminent scientist, at last accounts still among us, once proved to his entire satisfaction—and in fairness to him, let it be said, to the satisfaction also of other eminent scientists—that an attempt to navigate the air in a heavier-than-air machine was but flying in the face of Providence, attempting the physically impossible, flirting with the hearse. Yet we have seen such machines darken the sky and so have you. One or more of his preliminary assumptions were fallacious, that's all.

At one time every professor of physics in this country could prove by mathematics that it is physically impossible to "curve" a baseball. They could all prove it in just the same way, right on the blackboard in front of the class. But along came a long-fingered gentleman who set three stakes in line and curved the ball around the middle one. This he did for three professors, who then reconsidered their assumptions, and, at length, found a fallacy.

Our final illustration is drawn from the late war, as we desire nothing so much as to be up-to-date. According to the rules of exterior ballistics the maximum angle of fire is 45 degrees for the greatest range. Every student of mechanics has proved it. Yet the 42-cm. guns were tilted to 60 degrees. The projectile thus reached a stratum of rarified air which offered less resistance than that encountered when firing at 45 degrees, so the range with 60-degree firing was much longer than the theoretical range.

Give your attention to the assumptions. Let your assistant do the figuring.

More Engineering on Sewer Inlets

By W. W. Horner, Chief Engineer, Sewers and Paving, Room 300, City Hall, St. Louis, Mo.

Of the accessories to our municipal sewerage systems the most obvious is the ordinary corner inlet, and it is the one which has received the least consideration.

It has long been the custom throughout the country to place a storm water inlet at the low corner of every street block, or in some cities where the grades are flat, to place them in the middle of the block and drain from both corners. In the earlier days these inlets were subject to many modifications,

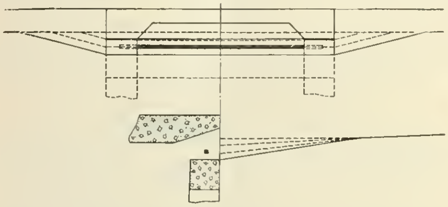


FIG. 1—ELEVATION AND SECTION OF THE ST. LOUIS "OLD STYLE" STORM WATER INLET.
Note: With Each Change of Depth of Sump from Water Line There Is a Corresponding Change in the Stone and Sill.

and as their insufficiencies became apparent to sewerage engineers there gradually evolved a few types of structures, one or all of which may be found in any of our large cities. The commoner type consists of a basin in the sidewalk area to which the water flows through an opening in the face of the curb. The dimensions of this opening vary in different city standards, the height of the opening and the details of the pavement in front vary to some extent, and in some cases the opening is provided with bars to hold out large sized rubbish.

St. Louis Types of Inlets

The St. Louis style is typical of this inlet, known in St. Louis as the "old style" as shown in Fig. 1. It has a clear opening of 4 ft. in length and a face opening of 8 ins. in height, partially obstructed by a horizontal bar, and a net opening of about 5 ins. The outstanding feature of it is the broad sill extending back under the stone cap. About six years ago the deterrent effect of the bar and broad sill on the water seeking to enter the inlet caused the adoption of the "new style standard inlet" in which the face opening is 4½ ft. long, a clear height of 6 ins., the bar is omitted, and the top of the sill is sloped abruptly back from the curb line. In addition to these types, St. Louis has used, somewhat, a cast iron inlet, in some instances having a barred grate flush with the gutter, and in others having also a small curb face opening in addition. This inlet, when clean and carrying clean water, compares favorably with the other types, but in the fall of the year, or for streets in which a considerable amount of rubbish is thrown, becomes quickly stopped and is almost useless.

Theoretical Analysis of Intakes

Our sewer engineers have from time to time commented on the failure of all of these types of inlets to catch heavy gutter flows on steep grades, and there has been developed in the last few years a type called the double inlet, with an opening 9 ft. long, and in other respects similar to the new style inlet. This double inlet has arbitrarily been placed on steep grades, and sometimes at other points where large capacities were known to be required. Aside from the arbitrary placing of the double inlet, the inlet work of the St. Louis system involved no real engineering. About four years ago, however, a theoretical analysis of the intakes was made, and the determination was reached that the new style single inlet would not in the future be placed under conditions where it was known that more than 1 cu. ft. per second intake capacity was required.

Tests of Intake Performance

A large amount of research work done by the St. Louis engineers in the past five years, largely in connection with the recomputation of old sewer systems for the purpose of determining necessary reliefs, brough about *a growing consciousness of the extraordinary importance of storm water intakes*, which finally developed to the point that the writer has felt that it is no longer permissible to design a new sewer system, or to design relief sewers for other systems, without careful determination of the ability of the intakes to place water in the storm water sewers at the points where the sewers were designed to receive it. It was, therefore, essential that more actual information on this subject should be obtained, and the tests described below were outlined by the writer, and have been carried out during the past summer by Henry Miller, Junior Engineer of the Division, under the general supervision and co-operation of Guy Brown, in charge of the Section of Sewer Design, and Arthur Keller, First Assistant in that Section.

Objects of Tests

The objects of the tests were to determine the intake capacity of both the old and new style inlets under the various conditions in which they were installed, and to determine the intake capacity of the double inlet under similar conditions.

A general survey indicated that all types of inlets had been

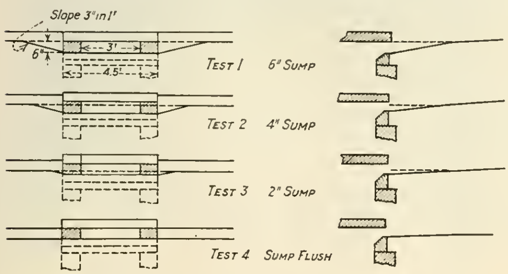


FIG. 2—ST. LOUIS INLET TESTS, SHOWING HOW PAVEMENT WAS RELAID IN FRONT OF INLETS PREPARATORY TO MAKING TESTS.

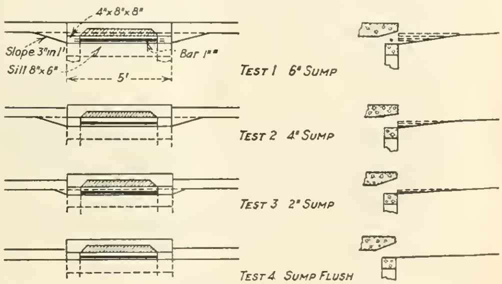


FIG. 3—ST. LOUIS "OLD STYLE" INLET TESTS, SHOWING HOW PAVEMENT WAS RELAID IN FRONT OF INLETS PREPARATORY TO MAKING TESTS.

installed on street grades of from one-fourth per cent. to ten per cent., and that the paving in front of the inlets has been treated with generous disregard of scientific consideration, the extreme variations being from uniform paving with no depressions of sump at the inlet, to a sump as much as 10 ins. deep and of 10 ft. in extent. After some study it became evident that this excessive sump was not permissible under modern traffic conditions, and it was decided that the limit of the tests would be for 6 in. depth.

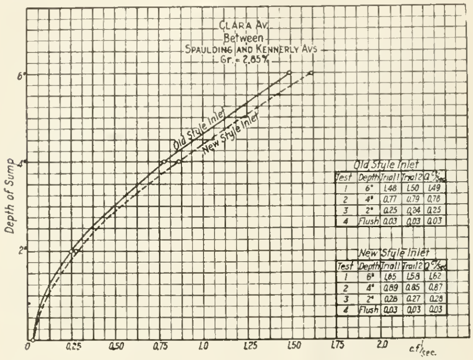


FIG. 4—DIAGRAM AND TABLES SHOWING CAPACITIES OF OLD AND NEW STYLE ST. LOUIS INLETS.

Four locations were chosen to cover the general range of grades, and at a later date another location on a steep grade was added as a check.

In many of the tests the pavement in front of the inlet was carefully relaid, as shown on the sketches in Figs. 2 and 3, in all cases being made parallel to the water line in the gutter, and either flush with it, or a fixed number of inches below it. In the direction of the gutter the slope from the normal water line to the depressed water line was made a constant equal to 3 ins. to the foot. Toward the center of the street the slope was carried out a distance of 3 ft. from the curb.

How Tests Were Made

The water for the tests was supplied from fire plugs through 3 and 4 in. meters in lines of fire hose, four lines of hose being required under the extreme conditions. The water was placed in the gutters a considerable distance above the inlet, and the flow was gradually increased until the inlet was taking its maximum capacity with the water just beginning to lap by. This was recorded as the inlet capacity. The character of the flow in the gutter shows clearly in the accompanying photographs. View B-7 shows a 4 in. sump on a 0.42 per cent. grade, with the capacity of 1.27 cu. ft. per second. B-8 shows the same situation with 3.42 second-feet in the gutter, of which 2.09 is entering the inlet. This contrast indicates that a considerable overcapacity can be obtained after the inlet's real capacity has been passed, which would somewhat alleviate the conditions caused by improperly placed inlets during extreme floods. Photographs C-3 and C-4 show similar conditions for a 2 in. sump, and A-9 and A-10 for the 6 in. sump.

The difference between the capacities of the old and new inlets is brought out clearly on Fig. 4, and was somewhat of a disappointment to the designers of the new style type.

Effect of Depth of Sump on Capacity

On Fig. 5 is shown the effect of the depth of sump on capacity, indicating clearly that with a sump of only 2 ins., less than half of the old value of 1 cu. ft. per second is obtained. This seems to indicate that a sump of 4 to 6 ins. is highly desirable, and should be used unless traffic conditions make it entirely impossible.

Effect of Grade on Capacity

The effect of grade on the capacity is shown in Figure 6, and is probably the most startling result of the test. The converging lines seem to indicate that with the new style single inlet it would be impossible to take in water on grades of over 7 per cent., and that this condition is certainly true for any of the sump depths within the range of this test, and within the range of probability. Tris indicates, therefore, that *for all steep grades a different type of inlet is required*, and an inlet with a long opening like the double inlet described above seems desirable. Tests of the typical double inlet are now being made, and the results, in so far as the 9 ft. length is concerned, will soon be available.

Tests on Detailed Shape and Position of Sump

Other variations on which further tests are being made deal with the detailed shape and position of the sump. Preliminary tests have been made in which the shape of the pavement sump was varied by making one end higher than the other, instead of having it parallel to the water line, as in the test recorded. The most interesting result, however, is in the case where the sump of the lower side of the sump base was moved upstream. This was tried in several positions; the most effective was found when the movement was 2 ft., in which instance the increased capacity varied from 20 to 50 per cent. The reason for this is quite evident in the photographs G-6 and G-11, as compared to conditions on photograph B-7. In the latter case, that is in the symmetrical sump, it is noticed that a hydraulic jump occurs near the low side of the inlet opening, but that the head created by this jump is not effective in forcing the water into the inlet face. With the sump moved

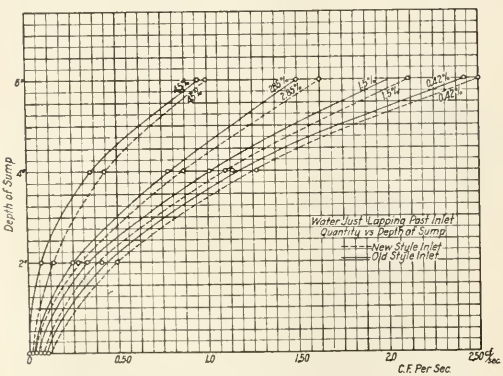


FIG. 5—ST. LOUIS INLET TESTS-DIAGRAM, SHOWING EFFECT OF DEPTH OF SUMP ON INLET CAPACITY.

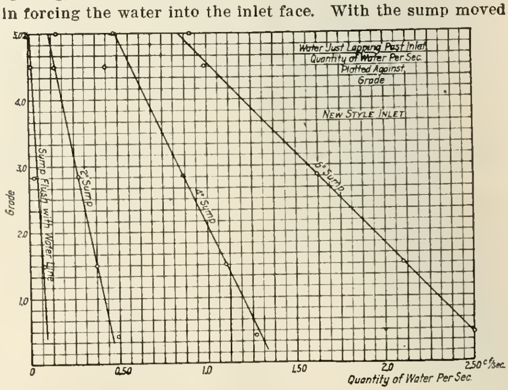
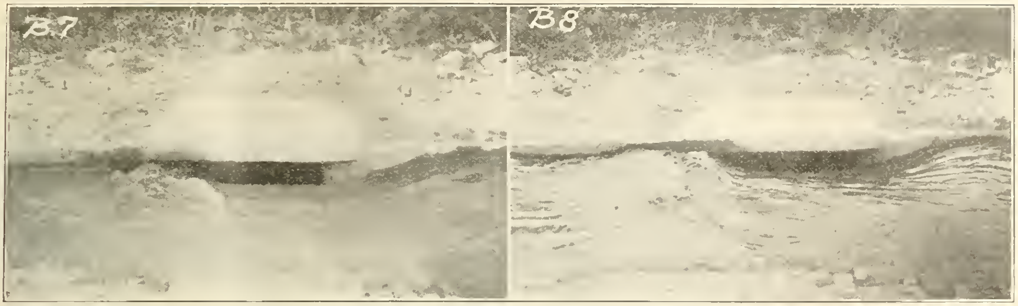


FIG. 6—DIAGRAM SHOWING EFFECT OF GRADE ON CAPACITY OF STORM WATER INLET.



ST. LOUIS STUDIES OF STORM WATER INLET PERFORMANCE.

View B-7 Shows a 4-in. Sump on 0.42% Grade, with Capacity of 1.27 cu. ft. per second. B-8 Shows Same Situation with 3.42 sec.-ft. in Gutter of which 2.09 is entering the Inlet.

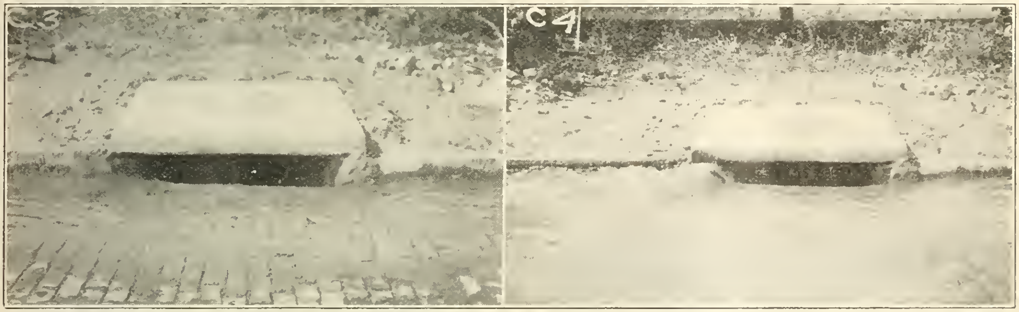
upstream the jump occurs near the center of the inlet, and this head is effective over a considerable area of opening.

Conclusions from Tests

As a result of these tests, the writer has become convinced of the necessity for a scientific determination of the character and spacing of storm water intakes. It is clear that the capacity is dependent on three different factors, the length of the opening, the grade of the street, and the depth of the sump, and also to a considerable degree on the exact shape and position of the sump paving.

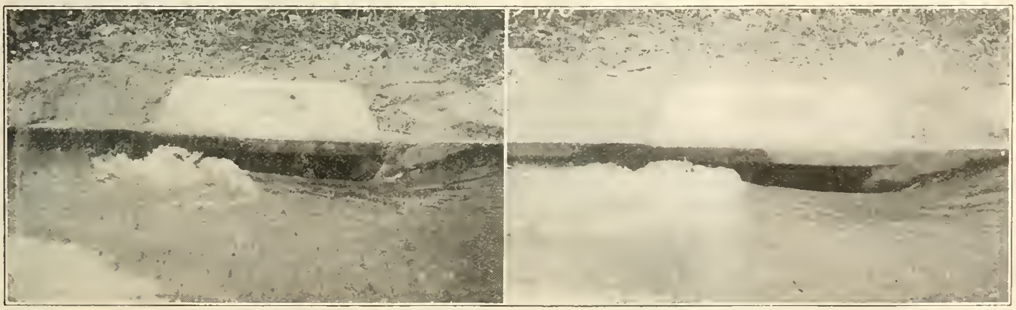
It is intended to work out an ideal shape of paving which will produce the greatest capacity for a given length of inlet, and to work this out for at least two depths of sump, one of which will be permissible under extremely heavy traffic, and a deeper one which will be used under more remote conditions. After determining the type of sump paving possible, the test results taken in connection with the street grades will indicate the maximum spacing of single inlets, and when this spacing becomes uneconomical, double inlets may be assigned at larger intervals.

Scientific inlet detailing and placing by this method will undoubtedly produce some increase in the first cost of the storm water sewer system, but it will make impossible a repetition of conditions which have been observed to be common in our older systems where serious flood congestion and damage has occurred at low pockets in the street grades, at times when even inadequate sewers are not running full. Furthermore, it should be at once evident that careful and rational sewer de-



ST. LOUIS STUDIES OF STORM WATER INLET PERFORMANCE.

C-3 Shows a 2-in. Sump on 0.42% Grade with Flow of 0.49 cu. ft. per sec., Water Just Lapping Past. C-4 Shows Same Situation with 3.92 sec.-ft. in Gutter and 1.03 sec.-ft. Entering Inlet (Estimated).



ST. LOUIS STUDIES OF STORM WATER INLET PERFORMANCE.

A-9 Shows a 6-in. Sump on 0.42% Grade With Flow of 2.50 sec.-ft. This Quantity Represents the Amount Inlet Takes Without Appreciable Amount Passing. 10-A Shows Same Situation with 3.62 sec.-ft. in Gutter and 2.90 sec.-ft. Entering (Estimated).

ST. LOUIS STUDIES OF STORM WATER INLET PERFORMANCE.

G-6 Shows a4-in. Sump on a 0.42 Grade With Flow of 1.57 sec.-ft. Downstream Slope Begins at Center of Inlet. G-11 Shows 4-in. Sump on 0.42% Grade With Flow of 1.55 sec.-ft. Dowrstream Slope Begins at 13½ ins. From Lower End of Inlet.

sign will be accompanied by a large unused value if the water or a large portion of it is to enter the sewer system a block or more further down grade than was expected in the original design. To be more explicit, an under-designed inlet system will result in an apparently over-designed sewer system, with a serious congestion and inadequacy along the lower streets of the district.

The writer is glad to present the accompanying results, because of their immediate value to sewerage engineers. It is expected that the entire series of tests will be completed during the present year, and that they will be the subject for a more exhaustive paper by one of the engineers now actively engaged in the testing.

Some Suggestions for Highway Design

By George W. Tillson, 313 S. Catherine Ave., La Grange, Ill.

Some ten or twelve years ago the writer said in an article on pavements, that the highway and pavement engineers of this country, did their work less scientifically and with less investigation than did engineers of any other class. The statement was disputed, but the writer still believes it was correct at that time. He feels the more free to say this because he was probably one of the worst offenders. Conditions at the present time are different however. For many years a pavement was simply a pavement, constructed of asphalt, brick or stone as the case might be, but generally in the same manner for each particular kind. Very little attempt was made to study the special needs of the different streets but only enough to determine the kind of wearing surface. This hit or miss method was more successful than might have been expected on account of the many changes in the conditions of the streets of our rapidly growing cities.

When the different states started on their regular highway programs and when it was seen how the water-bound macadam failed under motor driven traffic, the necessity of complete investigation became apparent and the highway engineers rose to the occasion.

Connecting State Systems

The fact that each state is proposing a big system of improved roads emphasizes the idea that each state system should be laid out not only to conform to the needs of each individual state but also so that it would form a part of a great national system covering the whole country. The organization of state highway officials bringing together state commissioners and engineers makes it very easy to effect the necessary combination of the systems. These officials, meeting as they do, discuss their own and their neighbors' problems and so add much to the general knowledge, each taking advantage of the others' failures as well as successes. It has not seemed to the writer that the importance of a knowledge of failures was sufficiently appreciated. Everyone wants to know of a brilliant success but it is just as important to learn of a failure so that it may not be repeated. The exchange of ideas at the different conventions permits this to be done.

Grades

After the alignment of the different highways has been established the question of grades must be settled. This is more important on a combined than on an individual system, as on a through inter-state route the ruling grades should be the same when possible. These, too, should be governed by character of the traffic to be provided for. In these days when motor trucks are run regularly from Canton, O., to Boston, Mass., the factor of grades is particularly important.

Foundations

It has always been understood by engineers that a good foundation is required for any construction. It is especially true of highways. To have a good foundation for a road thorough draining is necessary. How these two facts have been appreciated by French highway engineers can be seen from the fact that when the American Commission of Engineers conferred with the French engineers in Paris last December, upon the matter of reconstructing the roads of France the Americans were told that foundation and drainage need not be considered as they had both been sufficiently provided for in the original construction. This, too, was long before the time of motor vehicles. But as the highway systems of this country are generally made up of new roads these two matters require very careful attention.

The writer had an opportunity some two or three years ago of examining the brick roads in the vicinity of Cleveland. Quite a number of cracks in the brick surface was observed, but in almost every instance they were where the roadway was not properly drained.

Width

The width too of the paved roadway is an important question to be settled and only after a careful investigation. In fact, the ruling grade, the width of roadway and character of the pavement must not be determined till after a full and complete census of the traffic has been taken. It may be said that the above are fundamental and well known facts. While this may be so they are so important that they cannot be too strongly dealt with.

Character of Traffic

A traffic investigation is not as simple as it may seem. It is easy enough to count the number of vehicles passing over a road in a given time and approximating their weight, find the traffic tonnage. But that is not sufficient. It will be readily recognized that a roadway might fail under one 10-ton load where it would be perfectly satisfactory under ten 1-ton trucks. But the traffic tonnage would be the same. Then, too, the rate of speed is a factor to be given consideration. When all the traffic information has been obtained an estimate must be made as to what it will be in the future and provision made for that amount. Then the most important question of all comes up, how to provide for that traffic.

At the present time highway officials have pretty accurate knowledge of all materials that enter into highway construction, such for instance as asphalt, brick, stone, cement, etc. But when it comes to a combination of these different materials they are somewhat at a loss.

Combining Materials

When the character of the traffic is known and the kind of pavement to be used is under consideration much advice is given by the different material men. While not, perhaps, disinterested it is generally honest. Generally speaking the road surfaces now in use are either bituminous, brick or cement concrete. As has been said while we know the different properties of the articles in these roadways it is not known just how to combine them. For instance brick and bituminous pavements are generally laid with a concrete base. To sustain a certain heavy traffic, who knows what should be the different foundations under these materials, or should there be any? Then, too, what should be the character and thickness of a cement concrete surface to equal these other two?

Very few experiments have been made to determine facts that would answer these questions. The English Road Board previous to the war had a machine for this purpose and at the Road Congress held in Detroit in 1913 a somewhat similar machine was shown, but, of course, during the past five years other things have demanded the attention of the world.

Mr. Francis Wood, Borough Engineer of Fulham, London, by observing the wear on wood pavements under known traffic has deduced a method of determining the life of other similar wood pavements when their traffic is known. This determination is made as the result of observation and not by the application of a principle. What is needed is exact knowledge of the conditions that enter into the destruction of a pavement under traffic conditions. That the necessary investigation to determine these conditions should be made by the Bureau of Public Roads at Washington, probably no one will deny. The apparatus which will be required to make all the tests will be expensive but when it is remembered how many millions the government is to contribute during the next few years, the logic of this conclusion will be seen, to say nothing of the weight reports issued from the Bureau of Public Roads will have in the different states.

Specific Tests Recommended

What then are the specific tests to be made? The following are suggested:

Assume a certain traffic (tons per foot of roadway, to be known as heavy) made up principally of 10-ton or heavier trucks and ascertain the kind of construction of the materials heretofore mentioned necessary to sustain it. Ascertain the same facts with the same total tonnage but with lighter traffic units. Make the same experiments with rubber and steel tires at different rates of speed. Also with motor driven and horse drawn vehicles. It would be well to find the difference in results if any when the pavements also are laid on gravel, sand, well drained clay or a natural undrained sub-base.

It must be remembered that in previous tests attrition has been of great importance. With the use of rubber tires on the heaviest trucks a great difference arises and the constant hammer of heavy units upon the road must be given careful consideration; also the effect of the rub or push of the driving wheels of a truck upon the surface of the pavement.

To obtain the above information it must be known if a concrete pavement will fail under the constant hammer of heavy loads or by attrition; whether a brick pavement on a concrete foundation will wear better with a sand cushion or with monolithic construction, also with cement or bituminous joints; how much the wearing surface of asphalt or asphaltic concrete adds to the shock resisting power of a pavement; what the relative values of asphaltic concrete on a concrete base and bituminous macadam are;—whether a concrete base to obtain mass strength should be made thick with a comparatively lean mix or with less thickness but with a better mixture.

The Bureau of Public Roads is at the present time conducting a series of tests somewhat upon the lines herein suggested and some of the results have already been published. These cannot but be of great value to highway engineers. But if detailed results of the action of different forms of construction of the different kinds of pavements in use at the present under the conditions that are bound to arise are known the cost of each kind could be learned and then a scientific determination of the proper one to be used could be made.

Contract for Garbage Disposal by Feeding Awarded by Newark, N. J.

By James W. Costello, Engineering Supervisor, City Hall, Newark, N. J.

A contract for the purchase and final disposition of garbage by feeding as awarded by the City of Newark, N. J., on July 3rd, 1919, for a period of five years commencing September 1st, 1919 to the National Utilization Company, Arthur N. Pierson, president, Woolworth Building, New York City. The price to be paid to the city for each ton of garbage delivered is 8 times the price per pound of live killing hogs on the Chicago market, as determined by averaging the top price for each month.

The site of the piggery is located along the shore of the Passaic River and the City wagons are to deliver all garbage to the feeding site, where it will be weighed. The City agrees to the enforcement of existing ordinances, by orders or otherwise, to effect a good primary separation, and also agrees to endeavor to pass ordinances whereby the contractor will receive all hotel and restaurant garbage.

NEW SANITARY METAL ASH WAGON COVER WITH FOUR SEPARATE SLIDING COVERS, USED BY CITY OF NEWARK, NEW JERSEY.

The collection of all city refuse was done by contract until 1916, when the contractor terminated the contract on the grounds that the separation ordinance was not enforced. It was then taken over and carried on by municipal forces. There has been some attempt for several years past to separate garbage from other refuse, but it was rather unsuccessful. In March, 1919, a new ordinance was introduced requiring the separation of ashes, rubbish and garbage. At the present time separation is effective in about 50% of the City. A Police Officer and Inspector is assigned to each district to enforce this ordinance, and the results have been very gratifying. Separation in the remainder of the city will be completed about Sept. 15, 1919.

The erection of a reduction plant of 150-ton capacity was contemplated, but in view of the present cost of building material it was considered prohibitive, an estimate received from one company being $750,000 exclusive of the site. The city has some 6 square miles of meadow land and all classes of refuse have formerly been dumped on this land. There is a contract for the salvaging of the material for which the city receives $3,000 annually for the privilege, in addition to which the contractor supplies all labor necessary to keep the dumps and the roads leading thereto in good working condition. When separation is completed in the entire city, it is planned to erect a utilization plant for rubbish and when this is realized only ashes will be deposited on the meadow land. The area of the city is 23 square miles and the population is 450,000. It is estimated that 5,000 hogs will be required to consume the maximum amount of garbage during the peak months of summer.

On account of the limited area available at the site of the piggery, intensive methods will be employed. The hogs will be housed in unit buildings 100x100 ft. which will accommodate from 800 to 1,000 hogs. A double concrete driveway and feeding floor 24 ft. wide extends through the center of each building with a gutter on each outer edge next the pens. The gutters discharge into large grease traps to prevent solids reaching the sewer. The pens are arranged on either side of the driveway, having a slight pitch toward the gutters. There are five pens on each side, equipped with an automatic drinking fountain. Each pen opens into a yard 50 ft. deep. The houses are of the saw-tooth type with windows the entire length below the eaves and in the peak.

New Sanitary Metal Ash Wagon Cover

Herewith is a view of our new sanitary metal ash wagon cover. This cover or top has four separate sliding covers, one over each other, and but one-quarter of the top is open while being loaded. The wagon has a capacity of 5 cu. yds. and we now have 50 of these tops on our wagons. The chief advantage of this top is that the load is always covered, dirt and dust does not fly in the face of pedestrians while being loaded, as there is no draft through, and regardless of weather conditions wagons always go to the dump well covered, while with the old canvas cover, under abnormal weather conditions it becomes badly frozen and is very hard to handle and fasten securely and in consequence of this much material rattles off the wagon.

Recommended Procedure in the Design, Construction and Maintenance of Asphalt Macadam Pavements

By Prevost Hubbard, Chemical Engineer, The Asphalt Association, 15 Maiden Lane, New York, N. Y.

Definition

The term asphalt macadam is used to designate a highway having a wearing course of macadam coated and filled with asphalt applied by the penetration method after the broken stone or similar material has been placed on the road. The asphalt macadam pavement is ordinarily laid upon a broken stone foundation but both Telford and concrete foundations may often be used to advantage. Frequently an old existing pavement can be made to serve both as a satisfactory and economical foundation.

Advantages of the Asphalt Macadam

The maximum value of the asphalt macadam for relatively heavy traffic has seldom been developed because of the fact that its foundation has not been properly designed for such traffic. This coupled with careless or unscientific methods of construction have in general placed the pavement upon a lower plane of efficiency than it deserves. Provided careful attention is paid to the details of construction the asphalt macadam will prove not only satisfactory but more economical than many pavements which are classed as higher types.

The first point is well illustrated by sections of asphalt macadam pavement laid some years ago upon a concrete base in Alexandria, Va. During the year 1918 these sections were subjected to excessively heavy motor traffic in connection with the construction and operation of Camp Humphreys. As no railroad was available for transporting the materials of construction everything was carried over these sections, and for many weeks these trucks formed a continuous procession both day and night. Adjacent highways ordinarily classed as higher types were either partly disintegrated or absolutely ruined. The asphalt macadam, however, owing to its very careful construction successfully withstood this traffic except in one or two spots where the foundation was inadequate and the entire structure failed through lack of support.

Throughout the country there exists an enormous mileage of old macadam roads which under present traffic conditions cannot be successfully maintained as such. Bituminous surface treatments are usually depended upon to preserve these roads as long as possible but a time finally arrives when reconstruction or resurfacing becomes necessary. In such case the old broken stone represents a very considerable investment which if practicable should be conserved. The asphalt macadam makes this possible and its selection and use in this connection is often the best solution of the economic problem confronting the engineer. A surprisingly large percentage of existing city pavements are of the macadam type so that the matter is not only of moment to state and county highway engineers but to the municipal engineer as well.

Attention to Details Essential

The purpose of this article is not to present complete specifications for asphalt macadam pavements but to call attention to the important details of construction by suggesting sound methods and to point out faulty practice which should be avoided and which has been responsible for much unsatisfactory work in the past. It has been frequently noted that the best asphalt macadam laid by an engineer or contractor is his first. When this is so it is due to the fact that owing to his lack of familiarity with such work he at first pays careful attention to the details of construction. The work apparently proves to be so simple and the finished pavement so satisfactory that in subsequent jobs he is likely to slight or lose sight of details which he may consider to be of minor importance but which have a great deal to do with the ultimate satisfactory life of the pavement. Neglect of certain of these details may not appear in the newly completed pavement and resulting defects may not develop for a year or more, at which time the true causes will not likely be understood. In order to obtain a pavement which is uniform and will wear uniformly it is necessary that each square yard be constructed as nearly like every other square yard as possible. Owing to the rapidity of asphalt macadam construction the opportunity for variation is so great that too much emphasis cannot be placed upon this fact. The first rule to observe, therefore, is: Construct the asphalt macadam by the square yard and not by the mile.

Foundations

An existing Macadam or Telford makes an excellent foundation for asphalt macadam pavements provided it is sufficiently thick and well drained to afford adequate support. Too often the thickness of the old road is overestimated. In many cases pavements have been laid on old broken stone roads presumably 6 ins. or more in thickness which in reality averaged but little over 2 ins. of true broken stone. Under such conditions failure of the new pavement is almost sure to follow if subjected to heavy loads when the subgrade is wet. Broken stone foundations for ordinary traffic should seldom be less than 6 ins. thick and for heavy traffic should run from 8 to 12 ins. in thickness. If therefore an old broken stone road is to be utilized as a foundation, test holes should first be dug at frequent intervals to ascertain its true thickness taking into account the fact that some of the broken stone has been forced into the subgrade. Deficiency in thickness should be remedied by the addition of fresh broken stone which should be thoroughly rolled and filled with screenings to make a finished macadam. The old road should preferably be disturbed as little as possible, but when badly worn into ruts or pot holes or when it is to be materially widened, scarifying, reshaping and bonding with water may be necessary in order to prevent irregularities from showing up in the finished pavement. When the road is not badly out of shape and is of sufficient width and thickness to serve as a foundation existing depressions are best remedied by patching in the usual manner.

Old gravel roads may sometimes be utilized as foundations but gravel carrying a high percentage of clay cannot be depended upon to support heavy loads during the early spring. North of the frost line, or in localities where the subgrade is likely to be wet for considerable periods. Old brick, block and concrete pavements make satisfactory foundations provided all bad depressions are first patched with either hot or cold mix asphaltic concrete.

In the construction of new broken stone foundations it is preferable that the voids should be filled with screenings so as to produce maximum stability. In fact the closer such a foundation approaches the condition of a finished well bonded macadam the more satisfactory will it be. In order to secure this condition it is desirable when conditions permit to complete the foundation considerably in advance of laying the asphalt macadam and to allow it to take traffic until thoroughly seasoned. During such period it should be carefully maintained so that it will have a smooth well bonded surface upon which the pavement proper may be laid.

Under severe subgrade or traffic conditions where the advisability of a slab foundation for other types of pavement is apparent no exception should be made in connection with the asphalt macadam. As the serviceability and economic value of this type become more fully recognized it is quite probable that the use of concrete foundations for asphalt macadam will be more widely adopted for highways subjected to heavy truck traffic.

General Features of Asphalt Macadam Construction

The asphalt macadam is laid upon the prepared foundation in a single course of large size broken stone of about the same dimensions and grade as in ordinary macadam construction. A wider range in types of rock may however be allowed owing to the fact that the natural cementing value of the rock may be ignored. After rolling the layer of coarse stone, hot asphalt cement is applied in such quantity as not merely to cover the surface but to flow into the voids between the stone fragments and thus penetrate the entire wearing course. Application of the asphalt cement may be made either with hand pouring pots or mechanical distributors as later described. After such application the surface voids are filled by spreading and rolling in a thin layer of stone chips. All surplus of stone chips and dust is then broomed off of the surface and a second application or seal coat of asphalt cement is made, covered with stone chips and the pavement completed by rolling.

Spreading and Compacting the Coarse Broken Stone

Before laying the pavement all excess dirt and fine material should be swept from the surface of the foundation. This will not only promote a closer bond between pavement and foundation but will tend to prevent the broken stone from becoming coated with dust and thus interfere with the adhesion of the asphalt cement to the surface of individual fragments. As the completed thickness of the pavement is usually made from 2 to 3 ins. the broken stone should all pass a 2 in. ring. It should consist of sound, durable and angular fragments of uniform quality and should contain no dirt or other objectionable matter occurring either free or as a coating on the stone. If stored in piles along the sides of the road prior to use special precautions should be taken to prevent its becoming mixed with dirt. The fragments should be of as nearly uniform size as possible so as to produce a course of uniform texture, in which, after compaction, the voids are evenly distributed. Wide variations in sizes, particularly running to small sizes, result in the formation of spots which are so dense that uniform penetration of the asphalt will be hindered or entirely prevented. Such spots although not discernable in the newly finished pavement will ravel and disintegrate under traffic long before the pavement has attained its normal life. For this reason the size of broken stone should be carefully inspected as to suitability. For this class of work specifications of the U. S. Bureau of Public Roads require a broken stone product at least 95 per cent. of which will pass a 2 in. laboratory screen and at least 85 per cent. of which will be retained upon a 1 in. screen. In addition the specifications require that from 25 to 75 per cent. of the product shall pass a 1½ in. screen. Except in special cases which require a different method of treatment than here considered the rock should be sufficiently hard to prevent the excessive formation of dust during initial compaction before the first application of asphalt is made. To insure this quality specifications frequently require the rock to show a French coefficient of wear of not less than 7 when subjected to the abrasion test.

The broken stone should be shoveled and not dumped in place upon the foundation. The practice of dumping loads where the stone is required and spreading or flattening out the piles not only results in segregation of fine material thus hindering proper penetration of the asphalt at spots, but also makes it impossible uniformly to compact the wearing course. This is due to the fact that the center of the space originally occupied by each load receives upon dumping an initial compaction much greater than the surrounding area, and ultimate compaction of the entire course leaves such spots slightly higher than the adjacent surface. An uneven bumpy road will therefore be the result. Best practice calls for dumping the stone upon dumping boards from which it is spread by shoveling.

After being spread uniformly over the foundation to the desired thickness, usually about 3 ins. loose, the broken stone should be dry rolled until the fragments have firmly interlocked. A 10 to 12 ton 3-wheel roller is usually satisfactory for this purpose and should be operated exactly as in Macadam Construction. The extent of rolling is a most important consideration and should be carefully watched. If the stone is not thoroughly keyed together before the asphalt cement is applied it is practically impossible properly to consolidate the pavement for heavy traffic; after the asphalt has chilled or set. The result will be a wearing course which will develop waves and ruts in the course of time. On the other hand, if the broken stone is over rolled, dust begins to accumulate on the surface of the fragments and tends to prevent proper adhesion of the asphalt. There is also danger of filling the voids with fine material produced by crushing the larger fragments under the roller and thus preventing uniform penetration of the asphalt. Extreme over-rolling will moreover round the fragments and prevent interlocking. On the whole, however, there exists a general tendency to under roll and much unsatisfactory work in the past is directly responsible to this tendency. If during rolling any surface irregularities appear they should be remedied by loosening the surface and removing or adding coarse stone as may be required. Such places should of course be again compacted to insure uniformity.

Manipulation of The Asphalt Cement

The first application of hot asphalt cement should be made as soon as possible after the coarse broken stone has been compacted. Whether application is made by hand pouring, or by a mechanical distributor there are certain important details which should be closely observed. In the first place no asphalt should be applied unless the entire depth of coarse stone is thoroughly dry and after a rain sufficient time should be allowed for drying out. The broken stone surface should be clean and uniform in texture and should be free from all ruts, bumps or depressions. For this reason traffic should never be allowed upon the compacted course before the asphalt is applied and any existing irregularities should be remedied before application. This is extremely important in spite of the fact that many surface irregularities may apparently be rolled out after application of the asphalt. Such elimination is more than apt to be but temporary. The initial bond produced by the asphalt is so great that while the stone may be squeezed into depressions it does not become thoroughly compacted at such places, and months later, under concentrated wheel loads, the position of the original ruts and depressions will appear at the surface of the pavement.

Before application the asphalt cement should be heated to a temperature between 275 and 350 degrees F. which will render it sufficiently fluid to penetrate the wearing course before congealing provided the weather is not cold. It is important that heating tanks or kettles be equipped with large stationary thermometers so that the temperature of the asphalt is at all times clearly indicated. If heated above 350 degrees F. for an appreciable length of time the asphalt will harden and may be otherwise injured by coking or burning. If heated lower than 275 degrees F. proper penetration will be hindered or prevented and an excess will remain near the surface and cause bleeding in hot weather. Application of the asphalt should not be made in cold weather and the air temperature at the time of application should preferably be not less than 65 degrees F.

The proper normal consistency of asphalt cement will vary somewhat with climatic and traffic conditions also with the kind of rock which is used. Because of relative ease of application in cool weather a strong tendency exists to use a softer asphalt than is altogether desirable. Such practice is apt to produce a wavy road under concentrated motor traffic. In the asphalt macadam, resistance to downward displacement of the fragments of broken stone is mainly dependent upon their interlocking while the bond produced by the asphalt cement creates sufficient resistance to prevent upward displacement and consequent ravelling.

Horizontal displacement or shoving is prevented mainly by frictional resistance and the use of a very soft asphalt cement materially reduces such resistance. The same effect is produced by the use of an excessive amount of asphalt. The accompanying table will serve as a general guide in selecting suitable ranges of penetration for asphalt cements to be used under various climatic and traffic conditions. These limits are for use when the pavement is constructed of relatively hard, tough rock, such as trap, granite, gneiss and hard limestone. When it is necessary to employ the softer grades of limestone it is not only safe but advisable to use asphalt cement of relatively high penetration although the maximum limit of 150 penetration need seldom be exceeded. An exception to this rule occurs in the case of very soft rock such as the coraline rock of Florida. With such a product very heavy asphaltic oil may safely be used in place of asphalt cement. The reason why softer asphalt cements may be used with the softer grades of limestone lies in the fact that the edges and corners of the fragments grind away under traffic and form dust which amalgamates with the asphalt films to form a tough mastic of higher frictional resistance than the asphalt itself.

Penetration Limits of Asphalt Cement

TRAFFIC	TEMPERATURES		
	Low	Moderate	High
Light	120-150	90-120	80-90
Moderate	90-120	90-120	80-90
Heavy	80-90	80-90	80-90

Uniformity in rate of application of the asphalt cement and its depth of penetration into the pavement are equally important, and should receive just as close attention as the proper porportioning and through combination of concrete. A surplus of asphalt at any point will produce a soft fat spot which will develop into a bump while a deficiency will tend to promote disintegration and ravelling once the seal coat is broken. The proper quantity of asphalt to use for first application on a compacted course 2½ ins. thick is from 1.5 to 1.75 gals. per square yard. Less than 1.5 gals. will not penetrate uniformly for the entire depth and the pavement will not be thoroughly bonded. On the other hand, much in excess of 1.75 gals. will create a surplus which is apt to work to the surface in warm weather and cause bleeding or produce general waviness of the pavement under the shove of heavy traffic. Proper and uniform distribution can only be secured by the use of suitable methods.

Hand Pouring

In spite of the general impression to the contrary excellent results may be obtained by applying the asphalt with hand pouring pots. It is necessary, however, that the pots be properly designed and that at all times the spouts be kept open for their full width. Two types of pots should be used, one with a slotted spout no less than 8 ins. wide and the other with a one-half nozzle. In the former, the slot should be horizontal so that the operator walking directly across the road may carry it in one hand and apply the asphalt for a full width of 8 ins. When pouring, the spout should be kept close to the broken stone surface and never more than 2 or 3 ins. above it. The pot with small nozzle should be used only to touch up spots or narrow strips that may be occasionally missed with the wider spout. Great care should be taken that there is no overlapping but that each strip poured makes a neat joint with the preceding strip.

It is not ordinarily advisable to pour the strips at right angles to the center line of the road as such practice repeated with the seal coat is more than apt to develop a washboardy appearance in the finished road after it has been subjected to traffic. A better method is to pour the asphalt diagonally across the road, and, when seal-coating, to cross the pouring lines of the first application. As an aid to uniform distribution alternating the direction of pouring on each succeeding trip is desirable. Before pouring, the pot should be gaged so that during application it will be emptied on one or two trips across the road. Thus a 3-gal. charge will cover a width 8-ins. wide and 25 ft. long, if applied at the rate of a little over 1.6 gals. per square yard. If the road is, say, 20 ft. wide, the angle of application for a 3-gal. charge is ascertained by measuring off 25 ft. diagonally across the road, from side to side. A constant check should be kept on distances, and until the pourer becomes experienced a string should be stretched to guide each trip. With a little practice the pourer will soon learn to keep the rate of distribution uniform by walking somewhat faster when the pot is full than when it is nearly emptied.

It is advisable to have at least two heating kettles and two pourers on the job. When the layout of the work necessitates emptying the pots across the road from the filling station it is most efficient to locate a kettle on each side of the road slightly in advance of the pouring operation. Especial attention should be paid to having the pots filled each time to the gage marks which have been set.

Mechanical Distribution

Excellent results may be obtained with mechanical distributors, provided they are properly designed and operated. Most of the modern distributors are of heavy construction and large capacity, and apply the heated asphalt under pressure through a set of nozzles set in a frame close to the road surface. As the distributor passes over the course of compacted broken stone before the asphalt reaches the road, it is very important that the load be so distributed that rutting will not occur. Many otherwise well-constructed roads have been seriously injured by rutting, due to the use of a distributor with too narrow tires. This and other general features of importance have been well covered in specifications adopted in 1917 by the American Society for Municipal Improvements, as follows:

> The pressure distributor employed shall be so designed and operated as to distribute the bituminous materials specified uniformly under a pressure of not less than 20 lbs. nor more than 75 lbs. per sq. in. in the amount and between the limits of temperature specified. It shall be supplied with an accurate stationary thermometer in the tank containing the bituminous material and with an accurate pressure gage so located as to be easily observed by the engineer while walking beside the distributor. It shall be so operated that, at the termination of each run, the bituminous material will be at once shut off. It shall be so designed that the normal width of application shall be not less than 6 ft. and so that it will be possible on either side of the machine to apply widths of not more than 2 ft. The distributor shall be provided with wheels having tires, each of which shall not be less than 18 ins. in width, the allowed maximum pressure per sq. in. of tire being dependent upon the following relationship between the aforesaid pressure and the diameter of the wheel: For a 2-ft. diameter wheel, 250 lbs. shall be the maximum pressure per linear inch of width of tire per wheel, an additional pressure of 20 lbs. per inch being allowed for each additional 3 ins. in diameter.

In operating a mechanical distributor it is very important that applications should not overlap at either the sides or ends and that at the completion of an application the pipes and nozzles should not be allowed to drain onto the road and thus produce fat spots. In some cases it may be helpful to place strips of building paper along the ends and inner edge of a proposed application to prevent overlapping of the asphalt during passage of the distributor. All nozzles should be kept clean and free so as to avoid unnecessary touching up. For covering narrow strips that may have been missed by the distributor a narrow spout pouring pot may be used. Rate of application is controlled by measuring off the distance that the contents of the distributor should cover in a single trip, the width of application being known. The rate of speed of the distributor should then be adjusted so as to just cover this distance during the emptying of the tank when the feed of asphalt to the nozzles is set. Slight adjustments in feed should be made by an experienced operator when variations in rate of speed occur during distribution.

It should be remembered that the covering capacity of a large mechanical distributor is greater than the rolling capacity of a single roller, and the natural desire to use a distributor to its maximum capacity should not be allowed to handicap the construction of the road through under-rolling.

Filling Surface Voids

Immediately after the first application of asphalt has been made, and progressing with it, a thin, uniform layer of small-size broken stone should be spread over the surface in such quantity as to fill the surface voids. The road should then be rolled with the addition of more broken stone if necessary, until the surface is tight and thoroughly bonded.

The size of broken stone used for this purpose is commonly known as ¾-in. Specifications of the U. S. Bureau of Public Roads require at least 95 percent to pass a 1-in. laboratory screen and at least 85 percent to be retained upon a ¼-in. screen. It should be as clean and free from dust as possible and thoroughly dry when applied, or otherwise its bond with the road will be interfered with and this will prevent proper adherence of the seal coat, which is next applied. The same effect will be produced if dust or dirt are allowed to collect upon the surface of the asphalt treatment before the small stone is spread. For this reason the stone should be spread as soon after application of the asphalt as possible.

It should be broadcasted with a wide side swing of the shovel in order to distribute it uniformly in a very thin layer. The use of an excessive amount is not only wasteful, but will result in caking on the surface and in the formation of an excessive amount of stone dust under the roller. After the road has been thoroughly rolled it should be carefully broomed to clean the surface and remove all fine material which is not firmly held in place by the asphalt. The road is then ready for the application of the seal coat.

Application of Seal Coat and Cover

The second application or seal coat of asphalt is made in exactly the same manner as described for the first application except that the quantity is less. From 0.5 to 0.75 gal. per square yard will ordinarily be required, the exact rate being dependent upon the texture of the surface treated. The surface should be uniformly coated but an excess is to be avoided in order to prevent the formation of an unnecessarily thick mat or carpet. The same grade of asphalt should be used as in the first application.

Immediately after the asphalt is applied it should be covered with a uniform layer of small size broken stone such as used after the first application. The road should then be rolled until the surface is smooth and uniform. An excess of cover should be avoided as it will grind up under traffic and overload the seal coat with mineral matter. Such overloading will reduce the life of the seal coat and promote disintegration. In general the amount of cover should be kept to the minimum required to blot up the excess asphalt and prevent it from sticking to the wheels of vehicles. The mat so produced should not exceed a thickness of ½ in. and should preferably be about ⅜ in. The broken stone should be broadcasted over the road so as to make the cover as thin as possible and as rolling progresses additional stone should be spread where its need is indicated.

Maintenance

Ordinary maintenance of a properly designed and properly constructed asphalt macadam pavement will consist only in the rejuvenation of the seal coat or mat or its renewal as it is worn away. Unless traffic is exceedingly heavy or a large amount of dirt has been brought onto the road and ground into the surface no treatment should be necessary for a period of about 5 years. A very light cold surface treatment with road oil at the rate of from 0.2 to 0.25 gal. per square yard, followed by a light cover of stone chips will serve to rejuvenate an old seal coat which has not worn badly or become broken. The use of an excess of such oil should be carefully avoided first because it may soften the underlying asphalt to too great Cover should then be applied in sufficient quantity to blot up will create too thick a mat which is likely to shove under traffic. In no case should the total thickness of the old seal coat and new material exceed ½ in.

As the seal coat protects the underlying road from most of the wear of traffic and at the same time serves as a waterproof blanket it should never be allowed to completely wear out. If perfect adherence to the road surface has been secured and traffic has been uniformly distributed it should wear away very slowly and uniformly until a slightly mosaic surface has developed due to exposure of the upper faces of the coarse stone. As soon as this occurs the seal coat should be renewed. Such renewal may be made by surface treatment with a cutback asphalt or a very heavy grade of road oil after the road has been carefully swept to remove dust and all loose material. The same general method should be used and the same precautions observed as in the application of the original seal coat. If facilities are at hand it is sometimes advantageous to flush the surface with water after it has been swept in order to cleanse it thoroughly. It should then be allowed to dry out before the new seal coat is applied. Rapid wearing of the seal coat is sometimes due to the use of a soft friable stone for cover. If no better product is available a light dressing of clean sharp sand may prove advisable.

If for any reason breaks or scaling should occur in the seal coat it should be promptly repaired by thoroughly brooming and cleaning all such weak spots. Cut-back asphalt or a very heavy grade of road oil may then be hand-poured over the exposed surface at a rate not to exceed 0.5 gal. per square yard. Cover should then be applied in sufficient quantity to blot up all excess and bring the patches flush with the surrounding area after rolling or tamping. An excellent method is also to spread and compact a mixture of stone chips and emulsified asphalt over the broken areas. Whatever method is employed of patching the seal coat such work should be done considerably in advance of any general surface treatment in order to allow the patches to season. Otherwise fat spots are apt to develop where the patches have been made.

By properly maintaining the seal coat, breaks or disintegration of the pavement proper will be prevented and the life of the pavement continued indefinitely. If, however, through faulty design or construction breaks occur they should be promptly repaired. When possible the cause of such breaks should first be ascertained in order to apply the proper remedy. Frequently a break in the surface is due to lack of support from below. This may be caused by foundation weakness, poor subgrade or to faulty drainage. Under such conditions it is of course a waste of time and money to repair the pavement without first eliminating the cause of failure. Breaks may, however, also be due to lack of uniformity in distribution of the asphalt throughout the pavement, the presence of unsound stone or to the use of asphalt which has been overheated or burned, during application. Ruts and depressions are either due to lack of support from below, lack of rolling at the proper time during construction, disturbance of the compacted broken stone before the first application of asphalt or to the use of too much or too soft an asphalt. The same is true of bumps and waves. Lack of reasonable uniformity in distribution of the asphalt usually produces both breaks and bumps due in the first instance to lack of binder and in the second to a surplus of binder.

Bumps may sometimes be remedied by cutting them off with a hot shovel but in general patches should be made for both bumps and depressions in the pavement proper. This may be done by cutting out the defective areas so as to produce excavations with approximately vertical sides for the entire thickness of top course. The excavations should then be thoroughly cleaned after which they are filled either with broken stone of the same size and quality as used in original construction with an asphaltic concrete. If the first method is used the stone should be firmly interlocked by tamping after which melted asphalt is hand-poured and the patch finished as described for the original construction of the pavement, seal coat also being applied. In the second case unless facilities are readily available for the use of a hot mix it will be found convenient to patch with a mixture of broken stone and emulsified asphalt.

Emulsified asphalt patching mixtures are usually prepared on a mixing board or platform but sometimes an ordinary concrete batch mixer is used. The mix is proportioned by volume, the proper amount of asphalt being dependent upon the character and grading of the mineral aggregate. Each particle of aggregate should be thoroughly and uniformly coated so as to produce a homogeneous mixture, but an excess of asphalt should be avoided or otherwise the mixture will shove under traffic. The mixing process should be carried only to the point of securing a uniformly coated aggregate as over-mixing may cause the emulsion to separate and deposit a film of water on each mineral particle, thus destroying the bond between asphalt and aggregate. If, however, the separation of water is allowed to occur gradually by evaporation after the mixture has been placed the asphalt will adhere firmly to a clean uncoated aggregate.

After the mix has been prepared it should be laid in the clean hole and tamped or rolled flush with the surrounding area. The patch should then be sanded or covered with a light dressing of stone chips, after which it should be allowed to set up for a short while before being subjected to traffic.

For patching shallow ruts and depression a mixture of emulsified asphalt and small-size broken stone is sometimes used without first cutting out a hole. Care should be exercised, if this method is followed, that the old surface is first very thoroughly cleaned. While somewhat more costly, it is safer to cut out the old surface, as concentrated traffic is apt to squeeze the patching mixture out of a depression with cup-shaped or rounded sides.

If the maintenance of an old asphalt macadam pavement has been neglected to the extent that it is so badly broken up or out of shape as to need resurfacing, it should either be removed or scarified and reshaped to form a foundation for a new pavement.

Characteristics of Bitoslag Pavement

By J. R. Draney, Bitoslag Paving Co., 90 West St., New York City

The highway and pavement engineer of the present has problems different from those which confronted engineers of only a few years ago. Then, building a pavement to fulfill heavy traffic conditions meant one which would withstand the abrasion of heavily-shod horses and the weight of so-called heavy loads on narrow steel tires. In those days the steel tire with 2 or 3 or 4 tons in the load was considered quite a menace to a pavement unless the steel band was of a certain minimum width considered necessary to distribute the weight of the load. Now, the problems of the steel tires and heavily shod horses are to a large extent eliminated, and the new problem is the heavy motor vehicles, with weights running four and five times greater than the average heavy load of the past.

It is true that the shock to the pavement with the heavy loads of today is somewhat ameliorated by the use of rubber tires. Nevertheless, this offset is not sufficiently great to equalize conditions.

A pavement designed to meet modern traffic conditions is Bitoslag. The writer, being especially interested and active in the development of this form of pavement, would naturally be considered biased and prejudiced in its favor, and he therefore desires to make it clear that this article is merely intended to convey a description of Bitoslag pavement and the claims that are made for what it accomplishes in practice.

Representative Installations

This pavement, laid to a large extent in many important places, such as Jefferson county, Alabama, adjacent to Birmingham; Fulton county, Georgia, adjacent to Atlanta; Allegheny county, Pennsylvania, adjacent to Pittsburgh; New Castle county, Delaware, adjacent to Wilmington; State Highway of Pennsylvania, adjacent to West Nanticoke, in Luzerne county, and in the cities of Philadelphia, Detroit, South Bend, Mahanoy City and Coatesville, has attracted considerable attention, and it is the writer's purpose to acquaint his readers with intimate detail of its construction and observation under heavy traffic.

As a matter of information it might be stated that in addition to the above-named places, contracts for about 100,000 sq. yds. have been let for Bitoslag in Hamilton county, near Cincinnati. Most of this work is under State Highway Department jurisdiction with Federal aid. The State Highway Department of Rhode Island is also laying some miles of this pavement, and three or four municipalities in northern New Jersey have contracted for it.

Bitoslag is a pavement composed of especially prepared asphalt and finely crushed slag combined with a filler and mixed in regular asphalt paving plants. It is generally laid to a depth of not less than 2 ins. in thickness after compression. Bitoslag paving cement is an oxidized bitumen compounded with an impalpable powder prepared specifically for the purpose.

It is relatively unaffected by temperature changes because it is low in susceptibility. It is, therefore, considerably harder in warm weather and softer in cold weather than the asphalt cements commonly used in sheet asphalt and asphaltic concrete types of pavements.

When in contact with the broken, crystalline particles of slag this bituminous cement remains as an unchanged cement, binding the particles of broken or crushed slag strongly together. It seems particularly adapted for use with slag.

When the particles of slag are coated with Bitoslag paving cement in the process of heating and mixing together and combined with a filler, the Bitoslag paving cement then penetrates the openings and relatively larger pores of the slag and takes its final and stable position when the pavement is firmly compressed in place on a street or road. The Bitoslag paving cement also remains as a matrix, or coating, between the pieces of broken slag, firmly binding them together.

Where the slag is slightly deficient in certain fine asphalts, sand is used in conjunction with the limestone dust filler or Portland cement filler.

In the process of mixing it is necessary to keep the temperature at a minimum of 325, as Bitoslag should arrive on the work at a temperature of not less than 300 degrees. The mixture is spread and raked on the roadway in the same manner as sheet asphalt or asphaltic concrete. However, it should be promptly rolled, as the mixture "sets up" or cools very quickly.

A strong individual characteristic of and recommendation for Bitoslag is the fact that traffic can be sent over it immediately after rolling. Bitoslag presents a slightly roughened and gritty surface, thereby affording a good foothold for horses and machines. So far, under the very heaviest kind of traffic it has shown no tendency to creep, roll, push or shove, nor has there been any evidence of ruts. Likewise, there is no tendency toward cracking.

A sightly, smooth-riding, durable pavement, capable of taking care of the most extreme traffic conditions, is the aim of the Bitoslag proposition, with the cost within reason. Whether these aspirations have been realized is left to the good judgment of those who have had the opportunity of observing the pavement in use under all conditions of traffic and weather.

Correction to "Some Broader Aspects of Rain Intensity in Relation to Storm Sewer Design"

The following paragraphs were accidentally omitted in the publication of the article bearing the above title in the June issue of Municipal and County Engineering. They should be inserted on page 220, following table No. 1:

Excessive rain intensities of such short duration are nearly always the result of thunderstorms.

Thunderstorms also commonly occur in conjunction with such general cyclonic storms as produce the highest rain intensities for longer durations, so that there is a close correlation between thunderstorm frequency and the frequency of high rain intensities of all durations.

Table No. 1, compiled by Mr. W. H. Alexander of the U. S. Weather Bureau, shows for a number of selected stations the large proportion of rains of excessive intensity which occurred with thunderstorms. In this table the rains counted as of excessive intensity are those classified in accordance with the U. S. Weather Bureau Scale and the number of thunderstorms per year represents the number of storms in which thunder was distinctly audible at the observation station. In a general way the proportion of excessive rains which occur in conjunction with thunderstorms increases with the altitude, and with the frequency of thunderstorms at a given station.

Meyer has compiled data for 100 rain storms of notable intensity, which have occurred at 43 stations east of the Rockies in the period 1896-1914. Grouping together stations for which the intensities of a given frequency are about equal, he obtains final groups of average intensities for various durations and recurrence intervals.

The characteristics of Meyer's groups are as follows:

Group	No. Cities	Locality	5 minute intensity of 1 year frequency
1	3	Gulf Coast	5.28
2	15	Southeast States	4.32
3	19	Northeast States	3.84
4	4	Great Lakes	3.12
5	2	Northwest	3.00

Considerations Affecting the Choice of Highway Culvert Materials in Oklahoma

By Max L. Cunningham, State Engineer, Capitol Bldg., Oklahoma City, Okla.

Construction conditions in Oklahoma have, in common with other States, been extremely difficult during the past two years, and, in fact, ever since the organization of the present State Highway Department in May, 1916. Prices and conditions have never been normal and the enforcement of new, and generally unpopular, laws has been a difficult matter.

The special session of the Legislature in 1916 gave the department wide advisory powers, but it has not been possible to enforce all things as we would wish, owing to lack of teeth in the law, which planned good things, but provided few ways to see that they were carried out.

The power is given the department to approve different types of material for the construction of openings with area less than 36 sq. ft., but owing to the defect above mentioned this matter has been handled with gloves, and only such work as comes within the special provisions of the laws (concrete or stone) is approved unless it is certain that the work will be built in the manner approved by the department.

Where it has been deemed advisable, small openings have been built of the material most satisfactory under existing field and transportation conditions. In the mountainous country in the southeast part of the State, where the streams flow so rapidly that there is no sand deposited for use in concrete and where distances and grades are both great, extensive use has been made of corrugated metal pipe in diameters up to 4 ft. It has been an almost universal rule under these conditions to build culvert heads of rubble concrete or range masonry.

Where transportation is expensive, as in the oil fields, and where there are no local materials available, small openings have been built of vitrified pipe in sizes up to 24 ins. and of segmental vitrified tile for openings as great as 6 ft. inside diameter. Both materials have been entirely satisfactory and distinct economies have been obtained by their use. Headwalls are invariably built and local materials used wherever possible, but we have been successful in the use of hollow tile blocks with square or slanted ends, used to build culvert ends where the segmental blocks are used in the body of the opening.

Concrete and stone are used where the material can be secured locally or at reasonable cost, but the transportation situation has been such for the past two years that it has been absolutely impossible to make any definite figures on cars and work has been badly handicapped.

Very little use has been made of the patented cast iron pipe offered by some manufacturers, because of the cost and because of the great difficulty in getting average road officials to install it properly. No cast iron water pipe has been used because of the fact that other materials could invariably be installed for much less money than this under prevailing prices for pig iron.

It is impossible to give an accurate idea of the comparative cost of culverts of different materials, because nearly every piece of work we handle is done by contract (and where this is not the case, it ought to be), and local conditions govern the prices in nearly every case, so that there can be no reasonable basis for comparison. Prices of teams have varied from $4 to $16 per 8-hour day, labor has run from 30 cts. to 90 cts. per hour, and both teams and labor have been unsatisfactory, as is usually the case when high wages prevail. Cement has advanced by several arbitrary jumps, and the less said about freight rates and conditions, the better. Estimates have been made and checked carefully, and it is safe to say that contractors have averaged 15 per cent. paper profit on their work, but in many cases the overhead charges have caused these small jobs to show losses. Holding men while you wait for material has been expensive.

Concrete pipe has been used very little, not because we do not approve it, but nobody manufactures it, and the only place where any considerable use was made of it the contractor did not do well because of bad road conditions and expense of transportation from his central yard.

We feel that we have been very fortunate in keeping on the move at all, and our prospects for the future are apparently much brighter, as we have developed a resourceful organization, have discovered and made use of many sources of supply that we did not dream of using before we were pinched, and are much better able to meet difficult conditions than ever before.

Arguments Favoring National System of Improved Highways, Constructed, Maintained and Financed with Federal Funds

By M. O. Eldridge, Director of Roads, American Automobile Association, Riggs Bldg., Washington, D. C.

Many thousands of thoughtful citizens now believe that a national system of roads, constructed, maintained, and paid for by the federal government, is an urgent need of our country today and second to no other thing. Such a system has been advocated by far-visioned statesmen from the early days of the republic up to the present time.

Our present commercial, social and military needs call for roads which cross and recross state lines, for traffic does not begin nor end at state boundaries. The character and condition of highways in a neighboring state are often of as much importance to a road user as the arteries of communication in his own state, county or community. A comprehensive system of highways selected by federal and state authorities and a program of construction and maintenance such as could be carried out under federal control would insure a higher standard of road building and repair than is possible under the present federal aid plan, said Mr. Eldridge in addressing the North Carolina Roads Association recently.

Shortcomings Inherent in Present Federal Aid Plan

Under the present plan, by reason of the fact that the initiative rests with the states in selection not only of the individual project, but the type of construction also, there can be no uniformly high standard of durable types of highways. The varying degree of financial ability on the part of the several states, the conceptions of legislators, officials, and the people as to the extent to which the federal funds should be distributed, and the difference in judgment among the 48 state engineers and the thousands of local engineers, make impossible any real consistency in construction. Thus on the same highway carrying heavy traffic, one may find concrete, brick, bituminous macadam, or other high type, extending to a state line and then suddenly dropping off to light gravel construction or even earth, because the next commonwealth was either unable or unwilling to meet this standard.

Of the 10,445 miles of federal aid projects approved up to a recent date, the distribution by types was as follows:

Types	Miles	Per cent. of Total.
Earth	3,223	30.9
Sand-clay	1,533	14.7
Gravel	3,167	30,3
Water-bound Macadam	462	4.4
All other types	2,060	19.7
	10,445	100

Forty-five per cent. of the roads approved at the time this statement was prepared were of light construction, more or less temporary in character. Seventy-five per cent. were of a type lighter than water-bound macadam, while only 20 per cent. of the roads were of a type which should be used on a State federal system, where present day and prospective traffic requires in most cases something better than earth, sand-clay, gravel, or even water-bound macadam. These figures tell the discouraging story.

It should be stated, however, in justice to our state and federal highway authorities that the legislatures and the people in many states insist that federal and state funds shall be spread out yearly so that each county will obtain a "small slice of the pie," thus perpetuating the practice of patching and make-shift construction for purely local purposes. In those states in which a short-sighted policy prevails, it will be impossible for state and federal authorities to accomplish anything other than the building of roads that meet merely local needs.

Modern traffic requires that main routes be wide, that dangerous curves and railroad crossings be eliminated, that substantial bridges be built, that road surfaces be durable, and that they be systematically maintained. In building detached individual projects, as often is the case under the present federal aid act, the accomplishment of those purposes is difficult, and in many cases impossible. For example, if a federal aid project is two miles in length and is located on an important ten miles of highway, it betters the situation very little to widen the road, cover it with hard surface and keep it in good repair for the two miles and leave it untouched for the other eight miles. In many of the states the law provides supervision of the highways of the state, while the bridges are under care of the counties, and in some states, complete jurisdiction over both roads and bridges is vested in county authorities. This, of course, renders unified control in such state out of the question.

The day of the individual road, except as feeders to trunk lines and market roads, has passed. Highway improvements must be continuous and coordinated, and the federal government should not encourage the continual individualizing of the highway improvements through confining its efforts to the granting of aid to the individual highway, which does not constitute a part of a well conceived system that justifies National consideration.

The Townsend Bill

The Townsend bill now before Congress calls for a national system of highways which will meet our present and future needs. The bill provides that the government shall take over, with the consent of the states, not less than 2 per cent. nor more than 4 per cent. of the most important highways of the country, selected by state and federal authorities with this system constructed and maintained by the government at government expense. That such a system can be kept within 3 per cent. of the total road mileage in the United States and still serve our greatest needs, has been definitely established by careful research.

To make the point clear, it may safely be stated that a zone 10 miles in width and 25,000 miles in length will reach more than 86 per cent. of the population of the United States, more than 85 per cent. of the taxable real estate, and more than 55 per cent. of the tonnage of farm products. Such a system would include possible military roads having an aggregate of about 10,800 miles; serve our Atlantic, Gulf, and Pacific Coast lines, and also cover our Mexican and Canadian borders; would give access to our national forests and national parks and open up much of the public domain not now easily accessible, besides affording trunk line routes for parcels post in the territories where this form of transportion is needed. It would also include adequate links in the national system in every state.

If, as a condition to the building of the national highways in each state, a construction of an equivalent mileage of state highways should be required, this would add 75,000 miles of state highways, which with the national system, would aggregate 150,000 miles of main trunk lines. With this double system, practically all of the 1,400 cities and towns of 5,000 population and over would be on the main system, as well as every Atlantic, Pacific, Gulf, and lake port. It would be possible to achieve at the same time a superb military system connecting every important fort and concentration point, arsenal and munitions center throughout the U. S. while meeting industrial needs so completely that less than 5 per cent. of the population and the taxable values, and less than 15 per cent. of the tonnage of farm products would be more than five miles away from this joint national and state system.

It needs no profound statistical manipulations to demonstrate these points, for it can easily be understood that 150,000 miles of highways, with a zone extending for 5 miles on each side, would serve 1,500,000 square miles of area or approximately half of the total area of the United States.

The task of building the national system is well within the means of the nation, and it is the duty of all good Americans to rally to the support of Senator Townsend's bill.

An Engineer Comments on the Labor Question

By H. W. Skidmore, Chicago Paving Laboratory, 160 North Wells St., Chicago, Ill.

Notwithstanding the fact that organized labor is being extensively lauded by high officials of the American Federation of Labor, strikes, walkouts and lockouts still seem to be quite prevalent.

We are being constantly reminded of the fact that the ideals and principles of organized labor are of sterling American quality. Labor officials are making much talk concerning the exalted patriotism displayed by the worker during the war period, and the public is assured, by the words of these same officials, that organized labor is prepared to meet every emergency created by the transition from war to peace. Labor is pictured as the savior of democracy from the blight of radicalism. In the light of careful analysis of the situation, it does not seem reasonable that any one group, even though it be highly organized, is entirely justified in acclaiming it is the chief protector of American democracy.

Organized labor is one result of true democratic government. Under our Constitution, men and groups of men are permitted to think and act as they see fit, to protect and promote their interests individually and collectively, just as long as their acts do not jeopardize the rights of others.

The labor unions of this country should be American institutions, founded on true American principles; to be otherwise would certainly be to their discredit. If they be in true accord with these principles, surely that fact will speak for itself, without any special advertising campaign. While a reasonable amount of praise of one's own goods is oftentimes necessary and ordinarily commendable, there is great danger in overdoing a good thing. If the song seems unnecessarily loud, and the singing a bit too frequent, the public mind is apt to become apprehensive, and may begin to search for the reason back of such a sudden outburst of self-advertisement. Moreover, in order to avoid being classed among the idle boasters, the singer sometimes finds himself in the uncomfortable position of being required to "deliver the goods."

General strikes, street car strikes, milk wagon drivers' strikes, telegraphers' strikes, and the like, with refusal to arbitrate, violence and threats, lack a considerable amount of measuring up to the American idea of patriotism, justice, charity and consideration for the rights of others. When the public is no longer confronted with such frequent examples as these, then, and only then, will it be in position to accept at their face value these declarations of high-up labor leaders regarding the thoroughness with which organized labor is grounded in the fundamental principles of American democracy.

Enterprising Farmers and Township Road Commissioners Co-operate in Economical Road Oiling

Two farmers, Lewis Dixon and W. D. Shelton, of Dalton City, Ill., recently co-operated with the road commissioners of Milan Township, Macon County, in distributing oil on the public roads. These farmers each own and operate a Reo "Speed Wagon" on their farms for general farm hauling. For this purpose the trucks are equipped with farm dump bodies.

The farmers contracted to distribute oil on the roads for 1 cent per gallon. They removed the farm dump bodies and used instead gravity feed oil tanks of 350 gals. capacity, equipped with oil spray pipes that cover 8 ft. 6 ins. This oiling equipment is manufactured by the Leader Iron Works of Decatur and retails at $121 f. o. b. Decatur. The cost of the Reo chassis is $1,285.

VIEWS OF REO "SPEED WAGON" EQUIPPED WITH ROAD OILING BODY AS OPERATED IN MILAN TOWNSHIP, MACON COUNTY, ILL.

With these two Reo "Speed Wagons," equipped as described the farmers twice oiled 9½ miles of road in 2½ days. Twelve 350 gal. loads were distributed per mile. The average haul was 3 miles. A total of 4,260 gals. were distributed on each mile of the 9½ miles of road. For this the farmers received 1 cent per gallon, or a total of $404.70 in 2½ days.

These figures clearly indicate that money is quickly made in the operation of these oiling units. The oiling equipment is easily and quickly removed when the truck chassis is wanted for other than oiling purposes. This light truck readily lends itself to a variety of uses in county and township road work.

Road Contracts Being Completed in Kansas Refute False Statements About Highway Costs

The following illuminating article is reprinted in full from the August number of *Kansas Highways*, the official organ of the Kansas State Highway Commission:

When Kansas people began to get up petitions for the improvement of roads under the benefits district plan the dove of peace was hovering over us and building material and labor costs were in a normal condition.

Since then everything has become abnormal, but despite this fact, road costs have not been as great as the enemies of road building would have you believe. This talk of "taking a man's farm," of "placing a mortgage of $2,500 on every quarter section of land," and other like expressions, are not borne out by the facts as proven by projects now under construction.

A Concrete Road

Shawnee county is constructing a concrete road 18 ft. wide from Topeka east to the Douglas county line. This is approximately 10 miles in length. A citizen of Shawnee county living outside the benefit district and townships interested, will pay 12 cts. a thousand for 20 years as his portion of the county's share of the road improvement. On the township's share each $1,000 worth of property in the townships benefited will pay 38½ cts. a year for 20 years, and the average cost an acre to the land in the benefit district, interest included is $4.17. Hence a man in Shawnee county who owns 160 acres of land in the benefit district and pays his apportionment in 20 annual installments, all his taxable property being $10,000, will pay toward the construction of this concrete road the following amounts: county tax, $1.20; township tax, $3.85; benefit district tax, $33.36; thus making a total of $38.41 a year.

A Brick Road

Reno county has a contract for a brick road 18 ft. wide and 7.09 miles in length. A thousand dollars' worth of taxable property will pay approximately 18½ cts. a year for 20 years as its share of the county tax. The same $1,000 also pays 85 cts. a year, including interest for 20 years if it is in one of the townships in the benefit district.

The land in the benefit district will pay $4.71 an acre a year, interest included, for 20 years as the benefit district tax. In other words, if a man in Reno county owns 160 acres of land in a benefit district and pays his apportionment in 20 annual installments, all his taxable property being $10,000, he will pay toward the construction of this brick road: county tax, $1.85; township tax, $8.50; benefit district tax, $35.15; making a total of $45.50 a year.

A Gravel Road

Labette county is constructing a gravel road 16 ft. wide which has a total length of 9.14 miles. A thousand dollars' worth of taxable property will pay 60 cts. a year for 10 years as its share of the county tax. The same thousand dollars also pays 25.4 cents a year for 10 years as its share of the township tax. The land in the benefit district will pay $1.16 an acre a year, interest inclnded, for 10 years as the benefit district tax. A tax payer in Labette county who owns 160 acres of land in the benefit district, and pays his apportionment in 10 annual installments, and all his taxable property is assessed for $10,000, will pay toward the construction of this gravel road: county tax, $0.60; township tax, $2.54; benefit district tax, $18.56; making a total of $21.70 a year.

It must be borne in mind that, in each one of these examples we have given, the figures are arrived at from contracts actually let and from reports of roads under construction. In each case government aid on a basis of 50 percent, not exceeding $15,000 a mile, has been included.

These figures are a matter of record in each county referred to. It is therefore, as we mentioned before, certainly difficult to understand the motive of those who are loudly proclaiming that the cost of road improvements will equal $2,300 to $3,500 a quarter section and in some instances it would be equivalent to a confiscation of property.

It is true that in some counties petitions were signed before the war by those eligible in the benefit districts, believing that the cost would not exceed $18,000 to $20,000 a mile. Those were the average costs in other states at the time those petitions were circulated, but costs of every kind have advanced greatly since then, and no one in his right mind can justly accuse those who circulated petitions of practicing deception.

However, it also must be remembered that those petitions were signed with the understanding that Federal aid would be 15 per cent., and now it has been advanced to 50 per cent.

Likewise, the man who pays the largest tax for road improvement; that is, the man who lives next to the road, is marketing his products, whether grain, hay, cattle or hogs, for a much greater per cent. of increase than the per cent. of increase in the cost of road construction, in view of the greatly increased Federal aid.

Building Construction a Gamble Except Under the Cost-Plus-Fixed-Fee Contract

By A. E. Wells, President Wells Brothers Construction Co., 914 Monadnock Block, Chicago, Ill.

If a half dozen street urchins are caught by a burly representative of the law while engaged in the pastime of shooting craps, the law against gambling acts. Law makers have recognized that gambling is an unnecessary evil and have, so far as possible, put a stop to it.

Yet an owner and a contractor can gamble with a million times the stake of the street urchins without fear of the law and it is done constantly under the guise of the lump-sum contract.

For under its terms the contractor agrees that for a certain sum of money he will guarantee the owner against all the unknown conditions involved in putting up a structure. Whether he makes his figured profit or whether he loses so heavily as to be put out of business rests partly on his ability to figure costs but largely on his luck in failing to meet those conditions which would increase costs.

Both parties to this contract stand to gain or lose. If the job costs 20% more than estimated the owner gains to the other's loss. If conditions make considerable saving possible, then the contractor gains to the owner's loss.

Many contractors who in times past have built extensively in your field are no longer operating. Others have taken their place. Perhaps the majority of the missing firms are those who were expected not only to build according to specifications and within the time limit but to gamble that their costs would fall within a fixed contract price. Gambling against variables such as the forces of nature and the conditions of labor—they lost. In many cases their failure involved an added investment on the part of the owner or possibly the surety company. It is certain that no one gained thru the failure.

The contractor is an expert retained to assemble certain materials into a finished structure. The question being asked today is "should the contractor insure the owner that his structure will not exceed a definite contract price?" In competitive bidding the cost of this insurance is paid generally by the low bidder out of profits or, as frequently happens, out of his capital, for the reason that he is more likely to get the contract as he scales down his allowance for contingencies. In fact the man whose bid includes a safe allowance for insurance against higher costs cannot expect to obtain work under the competitive bidding system. The inevitable result is the bankruptcy of many contractors and an additional cost to the owner or the surety company to complete the unfinished contract. This situation has come to such a point that surety companies are refusing to write surety bonds on fixed price contracts except under specially favorable conditions and frequently recommend to owners the cost-plus-a-fixed-fee contract.

But from the owner's standpoint is it not preferable to know in advance what a certain project will cost? It is true that a careful estimate is due him. It should be made by a reliable contractor and checked by owner's architect and engineer. Such a figure should be more satisfactory than a competitive bid which does not necessarily show the cost of the building but only what some contractor is willing to gamble 's the cost of the job.

An issue of bonds for an office building or other structure can as well be based upon a careful preliminary estimate in either case. It can only run below the estimate under the cost-plus-fixed-fee plan. Is not the owner entitled to the possible saving?

Additional financing may be an unfortunate necessity but is there reason why the contractor should be asked to underwrite the accident of greater cost?

We have been operating under this plan almost exclusively for several years. We know that it is possible to convince most business men of the perfect fairness of the cost-plus contract and among our clients are several who would be the last to tie themselves up with us on any basis of contract likely to be unfair or dangerous. We have built on this basis for Montgomery Ward & Co., four successive times; for the Robert Simpson Co., Ltd., Toronto, five separate buildings and for the William Davies Company, Ltd., Toronto, six buildings. For these firms we have been able to start actual construction much earlier than otherwise would have been possible, which means early occupancy. The reason for this is that we can start the foundations just as quickly as the foundation plans are complete and further design and construction may go on co-incidently.

Money tied up during construction earns nothing until the building is ready for occupancy and the interest often amounts to a considerable sum. When we have opportunity to work with the owner, architect and engineer from the very inception of plans and when we begin foundations as soon as the general contour of the building and equipment are determined upon, we are able materially to cut down the period during which the owner's capital is unproductive. Under the lump-sum contract it is necessary that the plans be complete before bids are taken which may delay occupancy for months and without occupancy a building investment is poor as a dividend producer.

But while speed is of first importance in most building contracts, yet fairness to both parties is an equally good reason for its general adoption and on that basis our company is now operating almost exclusively. We feel that the owner should reap any benefit we are able to bring about. To give us incentive to make such savings we ask a moderate percentage of that saving under the estimated cost. Our standard contract calls for a return to the owner of 90% of such savings all of which would have accrued wholly to the contractor under the lump-sum plan. We believe 10% of the savings to be an adequate incentive for the contractor. We have almost invariably made savings for the owner below the estimated cost on our cost-plus contracts and such savings have not been through the padding of preliminary estimates but through changes or economics in construction made with the consent of owner, architect and engineer, which produced either a structure more adaptable to its purpose or of lower cost with equal value. Such changes could be made only with difficulty under the lump-sum contract as the average owner is averse to changing original specifications because of the generally high cost of "extras" or divergence from the original basis of bidding.

Unquestionably the contractor is called in because he is an expert in building and not to absorb the risk entailed in the lump-sum contract. If it is not the purpose of the owner to buy price insurance along with his building then cost-plus-fixed-fee is a better basis.

The Planning of Residential Suburbs with Special Reference to Engineering Features

By F. L. Olmsted, Landscape Architect, Brookline, Mass.

In the technical field of planning residential subdivisions in a comprehensive way there is involved the co-ordinated work of men of diverse expert training relating especially to the following groups:

(a) The design and construction of engineering utilities with due regard to operators' problems, contractual relations and the business and financial aspects of each utility:

- Water supply;
- Gas and electric services and street lighting;
- Sewerage and storm drainage;
- Street construction and maintenance;
- Passenger transportation, etc.

(b) The design and construction of surface improvements considered primarily from the point of view of general convenience and attractiveness of appearance, and the influence on real estate values, also with due regard to maintenance problems, the bearing of the burden of costs.

General design of streets, blocks and lots.

Visible details of surface constructions and of above-ground utilities. Parks, playgrounds and kindred recreation facilities.

Lot improvements external to buildings.

(c) The design and construction of buildings with all the technical subdivisions of that field of design and construction, again with due regard to cost and value.

(d) The general business of watching values as reflected in price and rentals of real estate variously improved and of operating problems.

No man can cover all parts of that field well and thoroughly. There must be collaboration of somewhat specialized experts, but for the most effective collaborations each one must be enough of a city planner to understand and respect the special points of view and problems of the others and to recognize his own limitations. The one who has the best general grip on all aspects of the complex subject and the best executive head will be the natural and the best leader in the co-operation, irrespective of what his own specialty may be.

Primary Considerations

A city planning agency whose field covers a whole city ought to concern itself, in respect to streets, sewerage, drainage, water supply and transportation, with the location and proper capacity of the trunk lines of these several services in relation to each other and to the permanent interests of the whole community, and with questions of source and destination, especially in water supply and sewage disposal, leaving the details of local streets, service mains and branches for some one else to worry out, so that there shall be the least possible hampering of individual initiative on the part of neighborhood units, of real estate developers and of special departments of the city administration or private utility companies in developing their individual plans so far as is consistent with providing for the few big things that can only be done by united central action. It is not that the ways in which these other local or special services are supplied do not affect the interests of the entire city. They do. Bad local streets all over the city make the whole city in so far bad. Badly planned local service mains all over the city mean a general fire risk or a needless burden of cost or other drawbacks which affect the city as a whole.

But if, because the city as a whole is affected by the way in which all of these details and a million more are decided, the responsibility for planning all of them is thrown back upon any single centralized planning agency, its human limitations will surely cause it to fail except in so far as it delegates and decentralizes most of the work and manages to make it stay decentralized.

The way in which comprehensive city planning can best make progress is hy not biting off more than it can chew, especially by concentrating on the things about which the advantages of centralized and interrelated control of planning are indisputably greater than the disadvantages.

These things differ enormously in respect to the size and character of the territorial unit under consideration. In the case of a residential neighborhood small enough to be fairly homogeneous, a planning agency comprehensive in its scope as to that particular neighborhood and not burdened with similar responsibility for each of the other neighborhoods in the city or for the larger problems which are insoluble except by joint action on behalf of many neighborhoods, can properly and effectively carry its centralized planning much further into detail than is at all wise or practicable for a planning agency whose field is the whole city. The residential neighborhoods planned under the direction of the United States Housing Corporation have generally been of this small homogeneous sort, like many other industrial housing developments and innumerable less completely planned residential subdivisions of land companies and realtors.

The purveyor of water, gas or electricity, the specialist in one of those utilities, can make probably a better job, and certainly a quicker and more efficient job, of planning the supply and distribution of his own utility, considered in itself, if he is given a free hand, than can be done by any humanly possible comprehensive and centralized city planning agency, with which that particular utility is but a fraction of its responsibilities. The same is true of the specialized professional or commercial purveyors of houses, of parks, of almost any urban commodity; and it is emphatically true that individual citizens and owners of real estate are on the average and in the long run safer judges of the interests of their own localities than any central authority can be. The justification for comprehensive city planning is simply that there are some aspects of almost all specialized or localized planning where control of the specialist or localist planner, by application of the comprehensive city planning point of view, is apt to save so much more through avoidance of physical interference and duplication of waste of effort in actual construction and maintenance, than it loses through extra administrative machinery and loss of time and duplication and waste of effort in planning, as to be well worth its cost.

Recognizing, then, that the first problem of city planning, in the limited practical sense, is to mind its own business, to concentrate on the problems where its value is most certain, to avoid those where its advantages are apt to be purchased at too high a cost, in circumlocution and wasted effort, let us consider the more important city planning functions in connection with a residential neighborhood unit, first of the city planning agency of the municipal corporation whose field is the entire city, and second of a proper local planning agency exclusively for the neighborhood. The latter most often represents the land owner, such as a development company, the United States Housing Corporation offering a good example, but sometimes represents a syndicate or co-operative group of land owners, and might represent a subordinate municipal unit with certain powers delegated by the state.

Thoroughfares

First as to thoroughfares: So far as I can recall, in all the operations of the United States Housing Corporation it was only in Philadelphia that the municipal authorities had a plan of streets not yet dedicated or otherwise acquired, in which there was a clear and conspicuous distinction between those which the city regarded as necessary for traffic between points lying outside of our development and those which were strictly local. The Corporation was required to adhere to the former on pain of receiving no co-operation from the city in respect to sewerage and water supply, but was permitted to rearrange the latter very much to suit itself. Without here stopping to discuss the advantages and disadvantages of the particular plan of through streets on which the Philadelphia authorities insisted, or of the intermediate local street plan which the Corporation substituted for the conventional Philadelphia plan, I want to emphasize the soundness of the principle which they followed and the deplorable absence of that principle in most cities. Generally the Corporation found no streets planned except those actually dedicated to public use, and among streets dedicated or even open and more or less completely improved, no clear recognition of which were needed as thoroughfares for more than local use. Through the power of requisition intrusted to the Secretary of Labor the Corporation was enabled where necessary to acquire the fee of dedicated streets, to close them and to lay out new street plans, and it availed itself of this power in a good many cases. In doing so it took special pains to provide what it believed to be suitable through lines of traffic important for the city as a whole, but in so doing it was performing a function which no city ought to leave so completely in the hands of local proprietary interests, as most cities do. On the other hand, in many cases the platted streets which had been dedicated long in advance of actual improvement and installation of utilities, mainly or entirely as a device to facilitate speculative transactions in lots, were found to be laid out so totally without regard to any distinction between thoroughfares and supplementary local streets, that the Corporation was fain to accept an uninteresting, unattractive and often a somewhat extravagant plan of local subdivision because any street changes within the limited area which it controlled would interrupt lines that might become important as thoroughfares.

Sewerage

Again, as to sewerage and storm drainage, the usual experience of the Housing Corporation was that in undeveloped or partially developed areas the cities had no plans for the new trunk lines required to serve the lands of the corporation in common with other lands, although generally willing to co-operate in the construction of them when plans were prepared by the Corporation, which the city ought to have had ready in advance, at least in tentative form, for its own protection. A somewhat extreme case was in Portsmouth, Va., where a tract near the edge of the city's growth previously platted, partially sold off in lots, and in part provided with sidewalks and water, was acquired by the Housing Corporation. This tract could be sewered only by constructing a wholly new outfall to tidewater at the expense of this one small development, the intermediate territory having sewers of capacity sufficient only for the population now being served, the city having no plans whatever for taking care of sewerage from its outlying portions, and no machinery being in existence for securing relief by joint action within any reasonable time. The cost would have been far too great and the only feasible solution was the use of leading cesspools under very unfavorable conditions as to soil and ground water.

On the other hand, there were some instances where a city was up on its toes and had its sewer system planned well ahead of the actual physical extension of urban development, and where there were extreme and arbitrary requirements as to the design and capacity of the lateral branches of sewers, and especially of storm drains in strictly local streets, which placed upon the housing project a needless burden of initial development cost which could only be met by curtailing something else which would be worth more to the occupants than the more permanently ample and satisfactory sewerage and storm drainage.

Case after case arose where the city authorities did not plan ahead as to the things which concern areas so large that only the city authorities can reasonably be expected to plan them. There were occasional cases of city authorities tying the hands of local initiative by elaborate and arbitrary regulation of details which are primarily of local and not of individual concern.

I know much of this is an old story, but my experience in supervising the planning of government housing projects in nearly a hundred places scattered over the country has deeply impressed upon me the necessity in our cities for hammering away on a few plain, well-established elementary principles and on their simplest and most obvious applications, until that much at least is as firmly established in the practice of American municipalities as the habit of having a fire department and a police department.

Routine City Planning

I am strongly impressed with the feeling that we could accomplish much more valuable results in the line of propaganda by concentrating first on such undebatable rudiments as the systematic advance planning of thoroughfares and main drainage systems, both storm and sanitary, with the selection of school and playground and park sites, and with districting, in the near background, and by hammering away on the economic need for every city to maintain in its service an engineering staff suitable in size and organization to keep well ahead of the game in at least these elementary rudiments of comprehensive planning. May I here parenthetically suggest that "suitable in organization" means, among other things, that part of the organization, if that part be only one man, shall be assigned exclusively to planning future undertakings, not yet authorized or decided on, and may under no circumstances be devoted to current or routine work, even if the appropriation for routine work is exhausted. Otherwise, planning for the more distant future goes to the wall.

I am not saying that the available sort of assistant in the average city engineer's office is likely to do a very inspired quality of all-round city planning, but he can make a very useful beginning of city planning where it is perhaps most urgently needed and where it can get a chance to win its way by results. Such work can be the means of educating those directly engaged in it, and gradually the other city officials, with whom they come in contact, in a broader and larger conception of city planning. If consultants of wider experience are plainly needed they will be called in from time to time, and when they are called in they will work with and through a permanent organization that has the basic city planning viewpoint instead of making a report in vacuo and listening in vain for an echo.

Co-operation with Real Estate Men

But to return to the subject of residential subdivisions and the city's special functions in regard to their planning. School sites, playgrounds and local parks and the subject of districting occupy a curious position on both sides of the border between the planning functions of the city at large and those of the local planning interest. Where a residential neighborhood is constructively planned by a land company or other local agency on a sufficient scale, it is clearly a matter of enlightened self-interest to plan for a suitable school and playground site, for a school is a necessity of a successful residential neighborhood, and the territory tributary to a single school is the normal neighborhood unit under ideal conditions. Even where the unit of subdivision is considerably less than a school unit, the importance of having a school and playground well located in respect to the subdivision is a matter of keen interest to a clear-thinking planner of a subdivision, and will lead him to take the initiative in negotiations with the school authorities looking towards its establishment. It has been fully established that a well located school and playground or even a site for the same definitely fixed and known to be embraced in the program of the school authorities, adds to the value of all the remaining land in the territory to be served by the school more than the value of the land withdrawn for the purpose, just as a local park of suitable size, location and character and of which the proper public maintenance is reasonably assured adds more to the value of the remaining land in the residential area which it serves, than the value of the land withdrawn to create it. Enlightened realtors who are engaged in the legitimate business of producing and selling what the ultimate consumer wants, for the best price that a satisfactory article will bring, know these things and act accordingly when circumstances are favorable. The speculative subdivider who seeks his profit in selling to suckers, themselves largely speculators on a small scale, like Wall Street lambs, or who relies for his profit more on abstract skill in salesmanship than on the inherent value of what he offers, generally does not.

But even the thoroughly legitimate and thoroughly enlightened realtor whose subdivision is considerably less than will support a school and playground, or a local park, cannot afford to contribute land for the whole thing largely for the benefit of other subdivisions. He can perhaps afford to do somewhat more than his share but not much more.

He is always tempted to take a chance on the optimism of the buyer of lots, who expects that the necessities of a residential neighborhood will be supplied somehow by somebody, and let the school authorities come along and do the best they can by purchase, when the time comes that they must meet the demand for a school.

Such a subdivider will meet the school authorities at least half way in providing school and playground lands well located and suitable in size, shape and character if they will go their half of the way at the time the subdivision is planned instead of standing off until the favorable opportunity is gone. I may say incidentally, that this was precisely the usual attitude of the United States Housing Corporation in its subdivisions.

We sought out the public school authorities and earnestly tried to arrive at an agreement with them as to the best school sites, except those cases where existing schools would serve, and having agreed on the sites we avoided any development which would prejudice their use for school purposes and tried to reach an equitable agreement with the school authorities for taking them and developing them, stretching a point if necessary to get the best practical results.

For these reasons and because the initiative in such matters cannot be expected to come from the smaller subdividers or from all the larger ones, and still more because the economical relation of one school site to another turns on matters which interlock over districts much larger than any single residential neighborhood, it is a matter of serious consequence that the school authorities and the park authorities of a city in co-operation with the other central planning agencies should also plan well ahead in the matter of distributing schools and playgrounds and local park sites at least in a tentative and flexible way, and instead of waiting for enlightened subdividers to hunt them up and offer them a chance, should be on the spot as soon as a subdivider shows the preliminary symptoms of an outbreak, and work out a mutually satisfactory solution, using the assessment principle if necessary for distributing any part of the burden of site cost which cannot be equitably covered between the subdivider and their general funds.

Planning of Local Streets and Lots

And now we come to the planning of purely local streets and the lots which front on them. I have said again and again, and certainly everything I have seen in the operations of the United States Housing Corporation confirms it, that much is to be gained and little lost by the city's leaving the greatest latitude of choice to the individual subdivider in the matter of local streets and lotting, by postponing the detailed planning of such streets until the use of the land for dwellings is so close at hand that the desires of the actual user can be estimated with some precision and by acting as a guide and helper to the subdivider who is in the business of producing commercially something that he expects his customers to buy because it suits them, instead cf dictating to him in a high-handed way because they have some fixed theory of what a proper subdivision ought to be like. Mind you I always except an occasional local street which ought to be fixed in a particular place or at a particular grade in order to provide an economical location for a sewer or storm drain or other public utility trunk line which does not influence the individual subdivider, and I expect some compulsion in regard to keeping unbroken a site specially desirable for a school or playground or other feature of importance to the neighborhood or the city, provided the city planning authorities are fore-handed enough to know the real needs. Moreover, there are certain things to be avoided unless there are the strongest special and local reasons for them such as dead end streets, unbroken blocks very much more than six hundred feet in length, needlessly excessive grades and arrangements likely to result in houses having inadequate light, air or means of access. But when all such exceptions are made the principle stands, of giving the individual subdivider the maximum liberty of discretion and acting as live advisor and helper rather than as on obstructionist or a keeper who would put him in a straight jacket. This applies completely to strictly local streets not at all required for any purpose except access to lots which front on them and it applies with qualifications to secondary connecting streets which may be feeders of important thoroughfares.

There is no one way to lay out lots and blocks, there are no half dozen ways, so much better than others that a city planner can afford to canonize them, or say with certainty that no other arrangement is in the same class. Liberty of choice and individual initiative and ingenuity with the penalty of losing money if a relatively unsaleable result is produced will in the long run give better average results and certainly a more varied and interesting city than plans imposed in detail from above.

For the individual subdivider of residential neighborhoods, himself and for the planning agency of the city as his guide and helper, experience suggests a number of points, as suggestions but not as rules. Few of these can here be cited. Besides the few "don'ts" already cited, I would say of local streets on the esthetic side, out of my experience with the housing corporation work, that such streets to secure a quality of domestic charm, ought not to run in a straight unbroken vista for more than a few hundred feet at a stretch where it can be avoided without material loss, that where the street vistas are thus made reasonably short by curves or obtuse angles in the street it is usually desirable that the houses seen in connection with each other on both sides of the bend should seem to be in continuation of each other and to relate to the continuous line of the street as it makes the bend rather than that there should be a discontinuity in the houses where the street bends by facing some of them on a cross street or greatly verging the set back, that the relation between changes in the gradient of a street and the points where curves or angles occur and also the relation between the grades of the street and any grouping of houses is of far greater importance to the appearance of the result than is generally realized, that slight variations in the set back of the building line of a street are valuable as adding to its appearance but that there is the greatest danger of overdoing the variation. On the practical side, if you will not misunderstand me as implying any conflict between the esthetic and the practical, I might mention, besides the controlling motive of spacing the streets so as to give marketable lot depths and so avoid wastefully acute or tapering corners as far as practicable, the importance of fixing the locations and grades of the streets not only to minimize the cut and fill on the streets and avoid lots needlessly depressed below the streets or even excessively elevated above them, but also to minimize the total cut and fill on both streets and lots when the latter are developed, so as to give satisfactory and economical sewer profiles, and (especially on flat grades and where combined sewers or storm sewers in front of every lot are not inevitable) so as to carry the storm water in such a way and to such points that the amount of storm sewer construction can be reduced to a minimum without anywhere overloading the gutters. To keep these desiderata all in mind at once, and skillfully to strike a balance of these practical advantages and disadvantages dependent on location and grade while shaping the whole to a result pleasing to the eye is no joke, but the success with which it is done easily makes a difference of thousands of dollars per mile of street both in cost and in resulting values.

Acknowledgment

The foregoing is from a paper read by Mr. Olmsted at the latest National Conference on City Planning.

Some Common Errors in Municipal Financing

By A. R. Hebenstreit, City Manager, Albuquerque, New Mexico

Errors in municipal financing usually occur in one or more of the four following particulars: Crude financial legislation; lack of modern accounting methods, including a real budget system; improper handling of bond issues and certificates of indebtedness; and failure properly to regulate public utilities and public utility franchises.

Crude Financial Legislation

This is often brought about by an effort on the part of a well meaning legislature to arrest or curb the actions of public officials who have previously, unknowingly or wilfully abused good business practice. Oftentimes financial legislation is affected by the influence of large corporations, who oppose certain classes of legislation for selfish reasons and launch other legislation of less merit for the same reasons. Oftentimes legislators will legislate to affect a particular locality which has come to its attention, neglecting to ascertain the full import of that legislation to other localities. I believe it is the duty of municipalities to keep their legislature informed of local conditions so as to have their legislators represent them intelligently. This can be accomplished best by an organization of a state league of municipalities in each state in the Union and these states in turn organize a national league of municipalities for the purpose of representing municipalities in national legislation.

Lack of Modern Accounting Methods

Lack of proper accounting methods in a municipality or in any business is the cause of bankruptcy or wastefulness in a large percentage of cases. Detailed knowledge of every financial transaction, no matter how trivial, will oftentimes avoid unnecessary expenditures and with the proper utilization of the budget system will cause the city officials to anticipate the needs of the city and make necessary provisions for same.

The budget system must be utilized properly, otherwise it is more of a hindrance than an advantage. For instance, in the state of New Mexico, the law requires that the expenditures for the ensuing year shall be budgeted for approval. However, when it comes to budgeting the income of a municipality, the budget system is entirely discarded by an arbitrary rule which says that no municipality will levy beyond a certain limit. In other words, we have a budget for expenditures but no budget for revenue. The budget system in the state of New Mexico is, therefore, useless. It is hoped through the efforts of the New Mexico League of Municipalities to submit to the next legislature a workable budget system for municipalities.

Improper Handling of Bond Issues

Bond issues are opposed by the conservative element, although recommended by the more progressive element. It is a well known fact that bond issues are legitimate and equitable when made to pay the cost of a permanent improvement; and when the sinking funds necessary to retire the bond issue are distributed over a period of time so that all of the future generations deriving benefits from the permanent improvement will assist equally in paying for that improvement. The usual method adopted by municipalities, and which in my opinion is one of the greatest mistakes that can be made, is neglecting to establish sinking funds for the retirement of the bonds immediately after the public improvement is available for use to the people; also failure to extend the payments over a period of time approximately three-fourths of the recognized life of the permanent improvement. Common practice is to postpone the first sinking fund requirements for a period of 10 to 15 years so as to relieve the present generation even though that generation will have the use of the permanent improvement. Mistakes are also made in extending the period of the bond issue, far beyond the life of the improvement. To illustrate this last point, I have knowledge of one bond issue which provided for payments over a period of 20 to 30 years, although the life of the structure, when originally built was not more than 15 years and should not have been bonded for a period of more than 10 years. Another mistake often made in state laws relative to bond issues, is that they require a bond election to be held at a general election. This is absolutely wrong, for the reason that other political issues oftentimes cloud the real issues relative to the bond election and many times a meritorious bond issue is defeated because of the ability of one political faction to defeat another.

Certificates of indebtedness are only of value where it is impossible to have a bond issue at times other than at the general election or where the improvement contemplated is a district matter rather than that of the entire city. The issuance of certificates of indebtedness for a community improvement in my opinion is poor practice unless made necessary by the inability of the governing body to call a bond issue election. The governing body must have the power to issue certificates of indebtedness in the operation of public utilities because if a major improvement is contemplated there are very few businesses capable of financing such an improvement out of one year's earnings. It is then necessary that such improvements be spread over a period of years by issuance of certificates or until such time as a bond issue can be floated.

Failure Properly to Regulate Franchises

Public utilities and public utility franchises should be at all times under full supervision of the governing body of the municipality in order that their operation and construction may be regulated and the granting of franchises should be made a matter of income to the city in return for the benefits derived by the public utility from the city. By this I do not mean that public utilities should be militated against by any governing body of any municipality but that the governing body should have the power to regulate that public utility so as to guarantee a fair earning power and to protect the citizens against excessive rates.

The foregoing paragraphs are from an article contributed to a recent issue of Pacific Municipalities by Mr. Hebenstreit.

Stone and Gravel Road Construction in Ontario

By J. G. Wilson, County Road Superintendent, Halton, Ont.

The county road, which is intended to link up the different centers in the county and to be a feeder to the Provincial County Road, doubtless will have to be constructed of stone or gravel, and it is very important that they should be built in the best possible manner, said Mr. Wilson in addressing the annual meeting of the Ontario Good Roads Association.

Method of Construction

1. The roadway should be staked out straight in the center of the road allowance from 24 to 28 ft. wide, depending on the locality and the amount of traffic it will have to take care of.

2. The hills should be cut down to a grade of not more than 6 per cent., if possible, for after the road is constructed it is not likely to be done again, and if it is, it will be at a considerable extra cost, and a little extra cost at the time the road is built will give satisfaction for the cost is soon forgotten, but a bad job is an eye-sore and an inconvenience for all time to come.

3. It should be underdrained where necessary and culverts placed at the natural water courses to carry the water across the road; never carry it along the road to save putting in a culvert.

4. The road should then be well graded and the crown for a single track road should be 1 in. to the foot to allow for settling, with good open ditches with sufficient outlets. Water should never be allowed to stand in the ditches as it will soak under and injure the road.

The preparation of the road as stated above should be done one year before the metal is put on to give it time to consolidate; if not, it should be thoroughly rolled. The harder you get the foundation the bettter, for it is much easier to consolidate the stone on a firm foundation. One never gets good results when building on a soft or yielding sub-grade. Very wet weather is a bad time to build a road, as it is important that the foundation of a road should always be dry; it is also important to be dry and hard when it is being constructed, for when the road is wet the stone is pressed down into the mud and the mud is forced up through the stone and in a very short time the road becomes rutted and soon goes to pieces.

Stone Roads

After the road has been thoroughly prepared the next thing to consider is the quality of the stone, which should be hard and tough. Of course conditions and the convenience of the stone to the work will have to be considered in deciding what to use, but don't use a poor quality for the sake of saving a few cents a yard.

The next question is width and depth of metal for a single track road. Ten feet should be a suitable width but it should not be less than that; wider would be preferable. The depth of the metal should be determined by the amount of traffic it will have to take care of and the kind of soil on which it is built; for instance, where the foundation is of a gravelly nature, making a good natural drainage, a depth of 8 ins., when consolidated might be sufficient, but where you have to build on a sub-grade of heavy clay, it might be necessary to make it 12 ins. In that case the road should be excavated to a depth of 6 ins. and filled with coarse stones and thoroughly rolled when dry. For the second course stone from 1½ to 2 ins. would be a suitable size and this course must also be thoroughly rolled, beginning at the edge of the stone and working to the center. The screenings are then put on and plenty of water to make a slush, the roller should still be kept going and at the same time the road should be well brushed with stable brooms to fill this void.

The water wagon should have wide tires, not less than 4 ins., to prevent rutting the road; in fact, all wagons used on the job should have wide tires.

It is very important that the foreman in charge of the work and the man who operates the roller should be competent men, and work together with the end in view that when the road is completed it will be the best road in the county.

Gravel Roads

Gravel roads, while not as durable as broken stone, have some advantages on account of being easier to construct, easier to maintain and cheaper. Of course, the length of haul is a big factor in the cost of any kind of road, and where the length of haul brings the cost up to anywhere near the cost of stone, gravel should never be considered.

Gravel varies greatly in quality but is, as a rule, suitable for roads where the traffic is not too heavy.

When you can get the right proportion of stone from pebbles up to 2 ins. with just enough sand to fill the voids, you have an excellent material with which to build a road, if the road is well drained and you put on a sufficient depth of gravel, say from 10 to 12 ins., and have the road well crowned it will stand up under quite heavy traffic, but it is very rare one will get a pit where the whole body of gravel is as I have described, but in most pits there is some good gravel, and great care should be taken to see that only gravel of good quality is used.

Dirty gravel should be avoided. While gravel with an excess amount of clay will pack quickly and make a good road in dry weather, when the rains come in the spring or fall it turns to mud and ruts badly and soon wears out.

A few stones are not objectionable if the gravel is otherwise good as these can be raked forward and placed under the next load. Never leave them in a heap at the end of the load. They prevent the gravel from settling evenly.

See that an even grade of gravel is taken from the pit. One part of the pit may be very fine, another quite coarse and still another may contain too much clay, and the teamsters all crowd in at the same time and load wherever it is most convenient with the result that every load is of a different grade and where the roads are consolidated it will be very uneven and one will be able to tell where every load was dumped from the depressions that will be found. A road of this kind is very objectionable.

Where the gravel has a large amount of stones or boulders it should be run through the crusher. Gravel should be spread on the road at least 7 ft. wide and from 10 to 12 ins. in depth. While the traffic will in time consolidate the gravel and in a year's time there may not be much difference between it and a road that is rolled, the satisfaction of having the road in a finished state from the beginning is well worth the cost of rolling.

Registration of Professional Engineers in Oregon

The Oregon State Board of Engineering Examiners is now fully organized and prepared to receive applications for registration of the professional engineers in Oregon, and others who expect to practice engineering in Oregon.

The Board has held several meetings to date and has worked out and adopted complete by-laws, rules and regulations for the government of the action of the members of the Board and methods for holding examinations.

The following officers have been elected to serve for the next biennium ending July 1, 1921: O. Laurgaard, City Engineer of Portland, President; F. D. Weber, Electrical Engineer for the Oregon Insurance and Rating Bureau, Vice President; A. B. Carter, Civil and Mining Engineer, Secretary.

Headquarters for the Board have been established at 520 Corbett Building, Portland, Ore., where the necessary application blanks for registration without examination, and copies of the law and all other information may be received at request.

The business of the board will be transacted to a large extent by committees which have been appointed.

Under the provisions of this law, it will be necessary for all civil, mechanical, electrical, mining, chemical and all branches of professional engineering, to register.

Applications may now also be made for examination by those engineers who have not the required six years of actual practical experience.

It is very important that all engineers who expect to register without examination file their application blanks as soon as possible in order that the board may have sufficient time to pass intelligently on their qualifications.

The professional engineers who expect to practice after January 1, 1920, according to the law must be registered, so it is very important that the applications of not only those who expect to be registered without examination, but also those who expect to take the examination should be in before January 1, 1920.

The Street Lighting Problem of the City of St. Louis

By Ralf T. Toensfeldt, Electrical Engineer, Department of Public Utilities, City Hall, St. Louis, Mo.

The contracts for street lighting between the City of St, Louis and the Union Electric Light & Power Co. and the Welsbach Street Lighting Co. of America expire next year. The situation involves many serious problems and resolves itself into a question of high finance as well as engineering.

If the present procedure is continued, the city will be involved in large increases in cost, fully justifiable in view of present economic conditions. The situation is further complicated by the condition of the city treasury, which faces a greater deficit than usual on account of the passage of the prohibition laws. It, therefore, behooved us at the City Hall to analyze costs and find some more economical way to accomplish the end desired.

Present Contracts

There are two contracts in existence at present, one for electric lighting in the downtown or arc district, and the other for gas or naphtha by which the rest of the city is lighted.

The Union Electric Light & Power Company is contractor for the arc district, furnishing and maintaining all equipment and supplying current, for the sum of $12.25 per arc lamp per 1,000 lamp hours, or $49.66 for the average year. They also furnish incandescent alley lights for $4.49 per 1,000 lamp hours or $12.20 per average lamp year. There are 2,291 arc and 767 incandescent lamps, so the total yearly cost for electric lighting amounts to $124,138 for an average year.

Similarly, the Welsbach Street Lighting Company of America is the contractor for the gas and naphtha district, furnishing all equipment and maintenance, supplying gas, and lighting, and extinguishing the lamps, for $5.62 per 1,000 lamp hours, or $22.78 per lamp year. There are 26,019 such lamps in service, making a total cost of $592,829 per year for gas and naphtha lighting.

The city's total annual bill for all street and park lighting is $734,967.

An investigation of the conditions in other cities reveals the fact that the probable cost of arc lamps under a contract let at the present time under the same conditions as the old contract, would be between $90 and $100 per lamp per year, doubling our present cost for the arc lamp district.

Current cost for the installation is a minor consideration amounting to about $20 per year. The remainder consists of labor, electrode and glassware renewals, repairs, and amortization of a very expensive installation in a comparatively short time.

The Type "C" Series Tungsten 1,000 Watt Lamp

It is obvious that if a type of light can be found which will give just as effective lighting with a reduction of the total of these items, it will be possible to reduce the cost of lighting to the city. The type "C" series tungsten 1,000-watt lamp is at present the magnetite arc lamp's only competitor as to lighting efficiency. It gives slightly less candle power per watt than the arc, and a different quality of light, being more yellow in color; however, it has a distinct advantage in that it is an absolutely steady light, while the arc flickers more or less. Furthermore, less cleaning is required with the tungsten than with the arc, since there is no actual combustion taking place and, hence, no deposits of ash on the enclosing glassware.

As to the cost, the type "C" lamp requires a somewhat less expensive installation than does the arc. The cost of type "C" fixture and lamp is approximately one-half that of an arc, and series transformers are less costly than rectifiers. Excepting for this, the installation cost is approximately the same.

In regard to maintenance, type "C" lamps are slightly cheaper; they do not require so frequent cleaning, and renewals are necessary only once to every seventeen times for arc electrodes. Substation attendants are entirely eliminated because transformers require no attention, while rectifiers, necessary for an arc system, require at least one operator per substation.

A change to type "C" tungsten, therefore, would effect some saving in operating cost, but the feature of amortizing an expensive installation in a short time still remains. To overcome this feature, it would be necessary to let a very long-term contract, which would be very disadvantageous, or eliminate this feature from the contract entirely, by municipal ownership of the entire equipment. This would mean an effective saving, since the rate of interest paid by the city is considerably lower than that paid by private corporations, and, above all, because the city can amortize the investment over its actual life instead of over a short period of years.

Municipal Ownership Suggested

In computing the cost of such an installation, the cost of a conduit system has been disregarded, since the city now owns one duct in each conduit in the city streets and alleys, and all such ducts located in high tension conduits which would be used for this purpose are vacant. Unfortunately, Ordinance No. 18,680 (the "Keyes Ordinance"), which provides for these ducts for the city, specifies their use as for fire and police telephone and telegraph cables. Inasmuch as it would be exceedingly bad and dangerous practice to install such cables in high tension conduits, these ducts would be useless for all time under the terms of this ordinance. It is believed that an agreement could be made by which these restrictions would be waived, giving the city the right to install in these ducts, cables for street lighting purposes.

An estimate of the cost of such an installation shows that it could be made for approximately $400,000. If it became necessary to install conduits, $1,500,000 additional would be necessary.

Annual Cost of Lighting "Arc" District

Assuming that duct rights can be obtained, the annual cost of lighting the arc district would be as follows:

With current at 2c............................$164,190
With current at 1½c.......................... 140,160
With current at 1c 116,130
With current at 0.887c (water power rate).... 110,667

as against a present cost of $124,138, and a probable future cost of $206,190 or more.

If it becomes necessary to construct separate conduits for this purpose, the annual cost would be as follows:

With current at 2c.........................$271,640
With current at 1½c........................ 246,430
With current at 1c.......................... 222,400
With current at 0.887c (water power rate).... 216,930

It follows from these figures that a very marked saving can be effected, provided the city's duct space, now unused, can be employed for this purpose. If, however, new conduits must be built, no saving would result, but the annual cost would be approximately the same as the probable new bid price under the existing plan.

The present contractor has been approached on the matter of duct space, as well as the sale of such parts of the present equipment as would be useful to the city under the new plan and seems favorably inclined to the proposition. Should the purchase of the old cables, poles and laterals, in place, be negotiated, the cost to the city would be even less than that estimated, since this contemplated an entirely new installation.

It would be entirely unnecessary to remove these cables from their present location, since the city ducts, now vacant, could be exchanged for ducts used for this purpose.

This scheme has a further advantage in that it offers free competition without again reopening a dispute over the "Keyes Ordinance," the intent of which was to eliminate the opening of downtown streets for the purpose of installing underground equipment. A letting under the old plan would necessitate either a permit to the successful bidder to again tear up all streets in the underground territory to lay the needed conduits, or a restriction of competitors to those who now have the necessary facilities installed. Such a restriction would practically eliminate all competition, since only the present contractor is equipped to handle this system without circumventing the "Keyes Ordinance."

Alley lighting, now being done by incandescent lamps, can be practically eliminated by the proper placing of street lights. done, but with a city-owned system, it would be an easy matter to take care of such locations from the street circuits.
There may be a few isolated cases where this could not be

Gas and Naphtha Sections

The gas and naptha lighting contract, because of the entire distinct character of the two problems, is divided into gas and naphtha sections. The gas light problem may be solved in several ways. A renewal of the present contract under which the contractor would furnish everything, could be made at probably only a small increase in the price per lamp. Here, again, the elements of cost are renewal of mantles and glassware, labor of maintenance, and amortization of the equipment; renewals, gas, and labor of maintenance, are fixed, but amortization of the equipment varies inversely as the length of the contract. In this case especially, a long-term contract is inadvisable, because of the advancement of the art of lighting along different lines and the necessity that the city adopt the best as it is developed. Then the problem once more becomes one of amortization. The gas mains, of course, cannot be taken over by the city, and, since the charge occasioned by them is properly taken up in the gas rate, they have not been considered in these computations.

There remain the service connection, the post, the top and the burner equipment. It would not be desirable to purchase the tops and burners equipment since these would not be useful should the city ever desire to convert the system to some other type. The estimates are, therefore, based on the purchase of the posts and services, buying gas from one contractor, and service, including the furnishing of tops and burners, from another.

No accurate cost of posts and services is available, but the present owner has given us a rough figure, which is believed to be high. However, computing the average annual cost on a basis of this figure, charging gas at 50 cts. per 1,000 cu. ft., and estimating the cost of service at a somewhat higher value than it now costs, the resulting cost is $480,702 per year as against $526,950 per year now paid for an equal number of gas lamps. The annual saving is, therefore, approximately $46,000 per year by municipal ownership of posts. The investment necessary, which has been charged off in the annual cost, will be approximately $560,000.

The gasoline lamp situation offers an entirely different aspect. Gasoline has more than trebled in price since 1900; as a result, the gasoline lamps now under contract have been operated at a loss to the contractor. Prices in other cities for similar service are more than double the present cost to us, and in view of the computation on gas lamps, it seemed hopeless to reduce this cost sufficiently with any combination of municipal ownership. Consequently, a system of electric lighting has been laid out covering all the parks and those gasoline lamps installed on the streets, which could neither be abolished nor converted to gas at a reasonable cost. The entire installation cost would be approximately $190,000 for the parks and $110,000.00 for other gasoline lamps, there being 1,818 park lamps and 1,079 street gasoline lamps.

The annual cost of such an electric installation, including interest, depreciation and maintenance, would be as follows:

With current at 2c	$ 58,670
With current at 1½c	54,700
With current at 1c	50,750
With current at 0.887c (water power rate)	48,250
as against a present cost of	65,922
and a probable cost of	132,000

In this case the city would own the entire equipment, simply purchasing power.

In view of the figures on gasoline or naphtha lamps as compared with electric, it would seem that the entire gas district might be electrified to good advantage. However, park lighting and street lighting differ greatly in construction details. In parks, steel armored cable can be used to advantage and conduit work is confined to a minimum, becoming necessary only where road crossings cannot be avoided. On streets, intersections, sidewalks, driveways, and alley crossings, all necessitate the laying of conduits, greatly increasing the cost of the installation.

A rough estimate of the cost of electrification made it clear that an expenditure in the neighborhood of $5,000,000 would be necessary; it was promptly dropped as a financial impossibility.

For such an installation as that contemplated, the approximate funds necessary would be as follows:

Electric (arc) district	$400,000
Gas	560,400
Gasoline	300,000
Total	$1,260,400

The probable annual cost of these installations, based on 2c electricity and on 50c gas, is as follows:

Electric (arc) district	$164,190
Gas	480,702
Parks (gasoline)	54,700
Total	$ 699,592
as against a present cost of	734,986
and a probable cost, under new similar contract, of	893,380

This plan then effects a saving of $35,376 over the present costs and $193,788 over the probable cost, besides entirely avoiding any possibility of trouble over the "Keyes Ordinance" and giving full competition. It would further permit the city to extend the electric district into gas territory or vice versa, if it so desired, to a limited degree without excessive expense or litigation of any kind due to restricted areas.

The figures given above are based upon liberal estimates and should be considerably lowered when actual bids are taken, cheapening the cost of installation as well as the annual cost, and effecting an even greater saving than that estimated.

These are the schemes we have worked out to hold down the cost of street lighting as much as possible, at the same time making the system more flexible. We would be able to adopt any new type of light we chose without an endless amount of discussion and disputation with contractors.

The problem now is to persuade the powers that be to make a very profitable investment for the city and talk the owning companies into falling in with our ideas. The utility companies are inclined to admit that the schemes have merit, but the question of price is a difficult matter on which to reach an agreement.

It is hoped that a satisfactory solution will be reached before the city is confronted with the imminent necessity for making new contracts.

Acknowledgment

The foregoing paper by Mr. Toensfeldt was presented before the Engineers' Club of St. Louis and published in the Journal of the club for May-June, 1919.

Herbert Hoover: A Modern Engineer

(Having performed a series of labors beside which those of Hercules pale into insignificance, Mr. Hoover has returned to his own country. He has been politely received by the public and the press, but all the salvos of applause were for the military heroes. We are, as yet, unable fully to appreciate Mr. Hoover's services to our nation and the world. It is not improbable that future and wiser generations will hail him as the hero of the world war of 1914-1918. Meanwhile, in returning, he was well received by his own kind, the engineers. The following paragraphs are from a speech by William L. Saunders at the Welcome Home Dinner given Mr. Hoover by the Society of Mining and Metallurgical Engineers on September 16, in New York.—Editor.):

Here at last we have the example of an engineer who typifies the modern definition of engineering, which is thus written in large letters on the wall of the engineer's library in New York: "Engineering, the art of organizing and directing men, and controlling forces and materials of Nature for the benefit of the human race." How well this modest mining engineer has shown that he has the art of "organizing and directing men!" Of the many thousands working for him, here and abroad, it is said that not only have they given him loyal support, not only are they glad to work for him, but every man of them would take off his coat and fight for him. How well he has shown his capacity for "controlling forces and materials of Nature for the benefit of the human race!"

This definition of engineering would have been amazing 40 years ago. The civil engineer was then a surveyor, a mathematician and a bridge designer; the mechanical engineer an educated mechanic, a designer and draughtsman; the electrical engineer was unknown outside of the school and the laboratory, while the mining engineer was a combination of the geologist and that kind of a chemist who could tell how much phosphorus there was in a steel rail. I make this statement with apologies to Alexander Holley, who in his day was the one and only mining engineer known beyond the fence of the workshop or mine.

But the engineer is at last coming into his own. We see the dawn of a new day; truly there is a new order of things. The great centers of the world are now industrial centers. The prosperity and strength of nations in peace and war rest now upon the factory system, the shops, the railways and steamships, the mines, the smelters and the public works. And who is responsible for this? Who plans and executes these things? It is the engineer, civil, mining, electrical, mechanical, chemical and automotive. Such captains of industry are by education and experience best fitted to steer the ship of state.

The place for the engineer is not in the dark confines of the hold below, but on the upper deck, yes, on the bridge. We are told that practically all the executive heads of the organization for the relief of Belgium were engineers. Who like an engineer is as well trained by education and experience to meet emergencies? He must be prepared for extraordinary conditions. He must foresee these conditions and be ready to act quickly. A mine manager, usually a mining engineer, when told that a pump has broken down in the mine, cannot wait for the common remedies, but must provide in advance for experts and appliances to be on the spot at once and cure the trouble promptly. Is not this the one thing above all others which enabled America to play so important a part in the war? Was it not the spirit of the engineer, his capacity to do things and do them quickly? Surely the war was not won by money, for the enemy was never financially embarrassed.

I think we shall all agree that the basic strength of the Allies throughout the war was in the never-dying morale of all the people, including the armies, arraigned against Germany. But what would this strength have availed us but for the resources behind the lines. Modern war resources are mainly coal and iron and the capacity to put these things to practical use on a large scale. The mines would avail little but for the works, and the works might avail little but for the men, the engineers who direct them on modern, scientific lines of high efficiency.

And so America, through its engineering and industrial strength, helped to save the world from calamity. Now what individual best exemplifies this? Food played an important part in the war. We have heard the cry that food will win the war. Surely, without food no war could be won. It was Mr. Hoover who took care that there should be no food shortage. He did more—he taught thrift to millions of people in all walks of life and in all parts of the world. He preached the gospel of the clean plate. But it is not only in food that our guest stands as an example of achievement; he typifies the engineer, the executive, the man behind the gun. It is easy to see things that lie directly before us, but the best executive is one who builds his fences around the future, who anticipates trouble before it comes.

The Construction of Portland Cement Concrete Pavement Foundations

By James W. Routh Director, Rochester Bureau of Municipal Research, Inc., Rochester, N. Y.

The foundation of any structure is the most important part of that structure. This holds true as well for a pavement as for a bridge, yet in the majority of cases all attention is paid to the wearing surface and scant attention to the foundation. Even the national engineering societies in their specifications pay little heed to the method of designing and constructing the foundation courses of pavements. As a result many pavements which otherwise would give 18 or 20 years of excellent service last less than half that time. It is the expressed opinion of leading pavement engineers who have been consulted on this point that more than 50 per cent. of pavement failures are due to failure of the base in the first instance.

Base failure may result from three causes, all of which are more or less controllable: First, the subgrade may be at fault; second, the concrete base itself may be carelessly and improperly constructed; third, pavement cuts made after the completion of the pavement may be improperly replaced. Each of these causes for pavement failure will be discussed in the present article.

The Subgrade

The subgrade actually carries the traffic load. Failure of the subgrade means failure of the pavement. Hence, it must be carefully prepared and thoroughly compacted throughout, and reinforced where necessary. The purpose of the concrete foundation is to reinforce and distribute the load over the subgrade.

Underdrainage

Much has been said and written about the importance of properly underdraining state roads and highways in general. It is necessary in discussing the problem of city pavement construction to repeat some of the things said so frequently in connection with highway construction.

Underdrainage is essential, and underdrains must be so installed as to function properly. In many cases where farm tile are laid back of the curb it is found that careless work methods are responsible for clogging the drains before the pavement is completed, and, in other cases, no effort is made to connect the drains with sewer inlets. A further source of difficulty with this type of underdrainage comes from the practice of public utility companies in opening pavements after they have been built, removing sections of the under drainage system in order to make service connections to houses, and then failing to replace the tile.

Many of the difficulties encountered in controlling the use of farm tile may be practically eliminated by substituting the use of bell jointed vitrified pipe of small dimension. Pipe is available in sizes as small as 3-in., and where it has been used has proved very satisfactory. This type of underdrainage is more easily laid than farm tile, the pipe being laid with open joints, and it has been found that when excavations are made for service connections the pipe usually will support itself in place. This relieves, to some extent, the uncertainty of the utility company making proper replacement.

Whatever type of underdrainage is used, the pipe or tile must be laid carefully to line and grade and in coarse gravel or

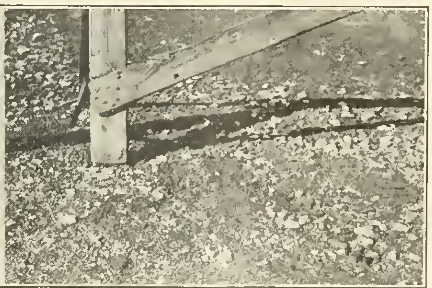


FIG. 1. LAYING CONCRETE ON A BADLY RUTTED SUBGRADE MAKES FOR UNEVEN BASE THICKNESS. FIG. 2. AN UNEVEN SUBGRADE FREQUENTLY MEANS AN UNEVEN, POORLY DRAINED CONCRETE BASE.

crushed stone. To fill in around it with bank run gravel or sand simply means that the drains will be clogged at the first rain and will not function thereafter. Of course the drains should be connected with all sewer inlets, and, where necessary, directly connected with the main sewers.

Other Precautions

The subgrade itself must be carefully worked over in order to prove satisfactory as a bearing area for the pavement. All vegetable matter and soft spots which cannot be compacted by rolling must be removed and replaced with suitable material. Then the entire subgrade must be thoroughly tamped or rolled. If settlement occurs, the depressions should be scarified, filled and rerolled until the surface is solid, uniform and parallel with the grade of the finished pavement.

When the subgrade is composed of material that cannot be made stable by ordinary means, sometimes draining excess moisture from it by the use of transverse trenches is effective. Such trenches generally are made about a foot in width and depth, and extend entirely across the subgrade. In the bottom of the trenches vitrified drain tile are laid with open bell joints so as to slope from the center of the street to each curb and to connect with the curb drains. The trenches then are filled with coarse gravel or crushed stone and compacted by light tamping. It is important that the trenches be kept free from dirt until concrete can be laid immediately on top of the crushed stone.

The Concrete Base

The proper base thickness for any street will depend upon sub-soil conditions, character and density of traffic, and kind of wearing surface. When unstable sub-soil conditions are encountered, extra base thickness is necessary. Given a substantial subgrade, however, it is believed the following base thicknesses for plain concrete are economical and sufficiently substantial:

I—For main, heavy traffic thoroughfares:

(a) Bituminous wearing surface, 10 ins.

(b) Monolithic or semi-monolithic brick or stone block surface, 8 ins.

II—For intermediate thoroughfares, subject to a moderate amount of heavy traffic:

(a) Bituminous wearing surface, 8 ins.

(b) Monolithic or semi-monolithic brick or stone block surface, 6 ins.

III—For major residential streets, carrying light weight thorough-traffic and few loads over 10 tons:

(a) Bituminous wearing surface, 6 ins.

(b) Monolithic or semi-monolithic break wearing surface, 5 ins.

Strictly minor residential streets, not likely to develop into other than local traffic streets, of course, will not require even as heavy construction as Class III. For such streets, base thicknesses as little as 4 ins. may be used with safety.

In considering the foregoing, it should be held in mind that a classification of streets can be accepted with safety only when based upon knowledge of present and probable future traffic conditions and protected by a proper city plan, including "use" districts or zones.

In addition, of course, soil conditions must be known. Under such conditions, it is believed that more experimental data relative to the influence of soil bearing values and load weights and frequency on pavement thickness, may indicate the possibility of using even thinner concrete bases. More complete data of this kind are much needed.

Careful Construction Important

The mixing and placing of concrete in pavement foundations is a matter all too generally given little attention. It is believed that if a concrete base is properly made it should last through one or more resurfacings, and thus make for better economy in street construction. To accomplish this it is necessary that the foundation course be considered almost as a pavement in itself. The concrete for such a base should be somewhat richer than the ordinary 1:3:6 mix. A 1:2½:5 mix has proved to give better results and to be little, if any, more expensive.

FIG. 3. THE BASE SHOWN IN FIG. 2 RESULTED IN AN UNEVEN FINISHED ASPHALT PAVEMENT. FIGS. 1, 2 AND 3 INDICATE HOW AN IMPROPERLY PREPARED SUBGRADE MAY PRODUCE IRREGULARITIES THROUGHOUT THE PAVEMENT STRUCTURE. Fig. 4. THE ROUGH IRREGULAR SURFACE OF AN IMPROPERLY FLOATED CONCRETE BASE.

It is not thought necessary to discuss the constituent parts of the concrete. The cement, sand and coarse aggregate should all be of the same high quality demanded in other foundation work. Laboratory control over proportioning is essential, and of course all materials should be subject to test before acceptance.

Consistency and Thorough Mixing

The consistency of concrete for pavement foundations is an important matter. It requires constant attention from the inspector, especially when spot mixers are used. Excessive water is as detrimental to concrete in a pavement base as it is to that in a building. The use of boom and bucket mixers, properly graded coarse aggregate of fairly small maximum size, and thorough mixing, aid greatly in obtaining good concrete. Spot mixers generally have so little slope to their spouts that it is difficult to get concrete of a proper consistency to flow out. The use of fairly small stone and the insistence upon thorough mixing (at least one minute in the drum), result in concrete of a mushy consistency being easily workable and reasonably easy flowing.

In many cases the inspector or engineer can aid the contractor in speeding up his work without shortening the mixing interval. Time studies of concrete gangs on city street work indicate that much lost time results from lack of proper control over separate operations. The placing of materials conveniently, the routing of wheelers, and the proper direction of loaders require careful attention. It is poor economy to shorten the mixing interval to a few seconds and then hold the drum empty for two or three minutes because of delays in filling the hopper. That thorough mixing actually makes for more workable, as well as better, concrete can readily be demonstrated.

Placing and Shaping

The placing of concrete is facilitated by the use of boom and bucket mixers. With this type of machine each batch can be placed directly where it is needed, with the result that the minimum of pulling over is required. Whatever type of mixer is used, however, it is important that proper means be provided for shaping the base section. In streets of 28 ft. width or less, it is possible to use a template or strike board extending across the street and resting upon each curb. Such a strike board should be shaped to the crown of the street and when manipulated across the freshly placed concrete should leave it at the proper elevation and in the proper shape for the finished pavement. The use of reasonably small stone has been found to facilitate the use of a template in the wider streets.

In streets of 30 ft. or more in width, pins can be used to guide the shaping of the base. Iron pine provided with 2 in. rings at the top are desirable. The ring serves as a guide for elevation and provides means for pulling the pin out after the concrete has been placed. When the pin method is used, however, it is more difficult to get a uniform crown than when the template is used. This means that the inspector must watch the shaping of the concrete much more closely than is necessary when the other method of shaping is in use. A lop-sided crown on the base means a lop-sided crown on the finished pavement, with all of the consequent ills.

Use of the Roller for Finishing

After the concrete has been placed and roughly shaped, the pavement base must be floated in order to obtain a uniform surface and density. The use of a roller for this purpose gives excellent results. The roller has been developed for use in the construction of concrete roads, but as applied to concrete bases in city streets, it is equally effective, ensuring uniform density with a minimum of physical effort. Contractors who have been persuaded to try this method of finishing concrete, find considerable economy in man-power to result. They also find that the resulting concrete surface has sufficient uniform roughness to serve as a base for bituminous wearing surfaces. (A smooth surface for block pavements may be obtained by following the roller with a belt).

When the roller is used in city streets having curbs, it is necessary to float, with the back of a shovel or a wooden tamp, the concrete immediately adjacent to the curb and extending out some 18 ins.

Curing

After placing and floating, ordinary practice has been to allow the concrete base to take care of itself. Proper curing, however, is as important for a pavement base as for concrete in any other structure. A concrete base should be considered as a concrete pavement in all essentials except richness of mix. Proper curing requires that concrete be kept damp for a period of five days after placing. This can be accomplished by ponding in level streets or by spraying with the hose at regular intervals each day. Of course when a block pavement with a sand cushion is to be laid, the sand can at once be spread on the green concrete and kept damp.

Pavement Cuts

Proper care in the preparation of the subgrade and construction of the concrete base will go far toward preventing foundation failures, but if public utility companies are allowed to make pavement cuts without regulation, no pavement can be expected to last. Every cut weakens the pavement structure, no matter how carefully the replacement may be made. It is believed important that utility companies be prohibited from opening pavements for a period of five years after construction. To accomplish this a permit with the payment of a relatively high fee should be required before cuts are permitted. The most effective way of preventing pavement cuts, however, is to place all substructures on the sides of the streets in the sidewalk or planting strip area. It is believed that when the economics of the problem are fully understood, this will become a general practice in all new streets.

FIG. 5. THE SURFACE OF A ROLLER FINISHED CONCRETE BASE. FIG. 6. OPERATING A ROLLER ON A CONCRETE FOUNDATION TO BE COVERED WITH AN ASPHALT PAVEMENT.

Whenever pavement cuts are allowed, the cutting and replacement work should be done under the supervision of the city's engineering organization. The backfilling of trenches in particular should be carefully watched. Mechanical tamping is effective in such cases. As a general rule flooding should be avoided, because of the danger of saturating the filling material so it will not dry out.

The recommended practice of requiring the concrete in the original base to be cut back a foot or more from each side of the trench to provide a proper bearing area for the replaced slab, is believed excellent. Double thickness of concrete or reinforced concrete over trenches also should be required. Every precaution should be taken to ensure satisfactory replacement and reinforcement of the pavement that is bound to be weakened by the cut.

Systematize Motor Truck Express Lines to Reduce High Cost of Living

By E. A. Williams, Jr., President Garford Motor Truck Co., Lima, Ohio

Systematic organization of motor truck express lines already in operation and intelligent inauguration of new routes will afford at least a partial solution to the present high cost of living problem according to men prominent in industry and commerce.

Lack of adequate transportation is one of the chief reasons offered for the present crisis. In many cities, government and state officials are investigating food waste which, according to the commission men, may be traced directly to transportation delays.

There are numerous instances of commission firms having been indicted for the wholesale disposal of food-stuffs, which, the commission-men claim, were delivered by railroads in unsalable condition.

Efficient organization of the motor truck lines in various communities with the idea of eliminating the possibility of idle trucks and light return loads will go far toward solving this transportation problem and reducing transportation costs, in the opinion of many who have given this phase of the matter careful consideration.

To obtain maximum returns from motor truck transportation, the numerous lines now operating should be systematically organized. Without a unity of purpose there is a capacity waste in every community. This naturally results in a loss of tonnage and increased costs. It has been said that 70 per cent. of the motor trucks operating in the United States during 1918 traveled empty one way. From these figures it was estimated there was a capacity waste of 283,500,000 tons during the year.

With the establishment of highway transportation commissions in the various states and the organization of transportation bureaus in many of our cities this tonnage waste is being eliminated. In several cities the haulage concerns have formed associations and have established central offices from which the motor truck transportation activities of that particular community are directed. These associations are affiliating with associations in nearby cities in order further to decrease the possibility of idle trucks and light return loads and to increase the general efficiency of the service.

The motor truck actually has become a public utility in many localities. Entire communities are depending upon it as a means of supply. It has become equally as essential as the railroad and waterway.

To obtain maximum efficiency, the transportation units of the country—the railway, waterway and highway—should be linked up systematically. More highways should be built, the present highways improved and a greater number of motor express lines touching those sections not reached by either rail or water, should be created.

That such a system would have important bearing upon reducing the cost of living essentials is apparent. Available government figures show that in 1919 the cost of shipping by truck throughout the country was from 10 to 30 cts. per ton-mile lower than the cost of horse-drawn vehicles. One can at least imagine what this will amount to in a year.

Speakers before a recent convention of retail and wholesale grocers in Toledo voiced the opinion that their hope of reducing prices lay in the motor truck. Practically an entire session of the convention was devoted to this phase of the transportation problem which they deemed highly responsible for the present high costs.

One speaker, an officer of the grocers' organization, declared that the motor truck held the actual solution to the problem. This recognition of the motor truck as a transportation factor, coming from men who analyze and understand conditions governing the markets is noteworthy and should be taken as convincing proof of its worth.

Some Problems Confronting Municipal Engineers in England

By Charles Brownridge, Borough Engineer, Birkenhead England.

(The strain of the war on England was so much greater than on the United States that it is of interest to American municipal engineers to read what a British municipal engineer has to say on the above topic. What follows is from the presidential address delivered before a conference of engineers and surveyors held in connection with the Royal Sanitary Institute Congress at Newcastle-on-Tyne—Editor.)

With the conclusion of the war there is much leeway to be made up, and arrears to be made good, and it is very desirable that—having regard to the altered conditions which now exist—we should closely consider how we can in future best plan and carry out our work, and what improvements in our methods we can with advantage adopt.

In work connected with the war all branches of science were organized for one common aim, and I would express a hope that this principle should not be altogether abandoned, but that the system should, at least in part, be retained and continued, with its energies directed now to investigation and research for the improvement of the health and welfare of the community, and that the State should, either by direct action or generous subsidy to the laboratories of the various universities, foster and encourage experiment and research in order to ascertain the best methods and appliances to adopt to prevent and stamp out disease, and to discover new, and improve existing, materials and methods used in construction work.

The Supply of Materials

With reference to materials, we have in the past, while endeavoring to do our best with those to hand, been too content to accept the materials available. I feel sure that if the energy and ability of our chemists were directed in the right channels, they would be able to give us many improved and alternative materials suitable for our work, and devise methods to increase production and cheapen the cost of manufacturing or producing existing materials.

As engineers we would welcome the discovery of a cement having the combined merits of Portland cement and bitumen, and satisfactory substitutes for wood, stone and bricks. I feel sure that, although the bricks at present manufactured are excellent, cheaper methods of manufacturing and burning could be devised.

Any and all efforts to insure good buildings being erected and new work carried out at a reasonable cost will be to the material advantage of the state, and enable us to carry out more quickly the many and various works that are so urgently required, and so necessary in connection with our municipal work, to make our people healthy, and to keep them healthy and happy in the future.

The past has taught us many lessons from which we should now profit, and we should now, by taking a wide and generous view, so shape and design our work as to look well ahead and not only provide for the present, but have due regard to the changing conditions now existing and the consequent probable requirements of the future.

Labor Difficulties.

The wave of industrial unrest now passing over the country is seriously affecting the work of our municipalities, and it will be necessary that we should carefully consider and review the position with a view to best overcoming the serious labor shortage existing, and adapting our conditions to meet the higher wages now ruling.

It is to be regretted that workmen, while justly and properly taking all means to assert their rights, do not in very many instances appreciate that they have in addition also their duties to themselves, their families, their work and to the State.

Good wages can always be justified if supported by good labor, but the present irregular time-keeping of many of our workmen is causing serious unnecessary difficulties and waste to arise. In my own case, I regret to say that since armistice day there has been among the men employed under my direction an average daily absenteeism exceeding 10 per cent., often causing necessary sanitary duties to be seriously prejudiced and affected. Unfortunately, this irregularity not only affects the work which should be done by those absenting themselves, but in many instances disorganizes and interferes with the arrangements necessary to be made in connection with all work, and causes serious loss and waste of time. If any steps can be taken to stabilize labor and make its service dependable—subject, of course, to justifiable absence owing to sickness—it would, I am sure, be welcomed by all having the charge and direction of work.

Use of Machinery Necessary.

It will be necessary on financial grounds for the engineer carefully to consider what machinery and appliances can be installed to cheapen and expedite work, and to foster and further the employment of mechanical appliances for all work in which it is possible for it to be suitably and beneficially used, especially that which will tend to reduce the employment of unskilled labor, as, with the universal advance in education and learning, this branch of labor should be reduced to a minimum and its present members transferred to and trained in some branch of the arts and crafts.

The extent and character of the use of machinery in our work in future will no doubt be considerable, and its form and design offer a wide field to the ingenuity of the inventor, and, as progressive engineers, we should do all we possibly can to further its application and foster its invention. Most municipalities have already found it both economical and advisable to adopt mechanical haulage, and are considering the introduction of machines for the combined sweeping and collecting of refuse from the streets, and for excavating, filling and ramming trenches; a more extended use of mechanical mixers for concrete and tar-macadam; a more general adoption of mechanical means for lighting and extinguishing lamps and other numerous mechanical devices will be found necessary and desirable.

Institution Sparing no Efforts.

The work of the municipal engineer is most wide in its scope, of a most varied character, and its duties onerous, calling for unremitting attention, care and thought, and it is therefore fitting that the Institution of Municipal and County Engineers are sparing no efforts to ensure that its younger members shall be properly educated and trained for their work, and have every facility for this purpose, and further to ensure that local authorities should only appoint properly trained engineers and surveyors at a proper and adequate salary; and, having regard to the great effect the work of the engineer and his assistants has on the prevention of disease and the comfort and health of the community, this excellent work will no doubt bear good and valuable fruit and enable the members of our profession to direct their endeavors in the most effective and productive way to carry on their duties.

Macadam Construction on Primary and Secondary Feeder Highways

By W. C. Buetow, Division Engineer, Wisconsin Highway Commission, La Crosse, Wis.

As we think about our highway problems we picture in our minds a system of highways. The outline of the counties stands out plainly and within the borders we see wide bands crawling in different directions, like the main branches of a tree. These are the main arteries of travel and the surfaces are of the higher types, concrete and brick. From these main arteries we see other roads, with their feeders, crawling away, carrying lighter travel and bringing traffic from the remotest part of the county to the business centers. Each county has its own picture to draw, depending on the amount of travel passing over the roads. We are now considering only the more lightly traveled roads, starting with the primary feeders emptying their travel onto the main highways surfaced with either concrete or brick.

Primary Feeders.

Primary feeders may be constructed of bituminous macadam either by the mixing method or by the penetration method, said Mr. Buetow in addressing the annual road school. The foundation for the wearing surface is the same for either road. The thickness depends on the nature of the subgrade. The size of stone usually used is the same as the No. 1 stone of a waterbound macadam, stone passing a 3½-inch ring and retained on a 2½-inch screen. Spreading and rolling are the same as for the ordinary macadam work. However, the base course is filled with sand or screenings and, if deemed necessary, flushed with water to make it firmer. The reason for filling the base course is to make the base firmer and to prevent the bitumen from running down into the voids, thereby wasting the bitumen and drawing it away from the wearing surface where its presence is very essential.

It is not essential that a detailed description be given of the various steps of the mixing method, because of the plant involved. Briefly the method is this: The stone and bitumen are mixed hot in a specially prepared mixer at either a stationary or portable plant. Even with a portable plant it may be advisable to set up at the stone pile and haul the mixed product to the road. The mixed material must be delivered on the road hot so that it can be spread evenly and properly rolled. Even spreading and proper rolling are extremely important. Great care must be exercised that the bitumen is not burned because that particular batch will fail in the pavement.

Penetration Method

The penetration method requires less expensive equipment and for that reason a more detailed description will be given. Having the base prepared, the surface stone is carefully spread so as to get a uniform thickness. Here, as in waterbound macadam work, the stone should not be dumped in a pile and then shoveled over the required area. Dumping stone in piles compacts the bottom and allows the coarse stone to roll to the sides. This gives the surface an uneven density.

Size of stone depends somewhat on the thickness of the wearing surface and the hardness of the rock. The size usually ranges from 1¼ to 2½ inches, but may run slightly larger for soft stone and finer for the harder rocks like trap and granite. Uniformity is an essential requirement and great care must be exercised to see that the material is clean and free from dust and dirt.

Rolling The Rock.

Rolling the rock is done with an ordinary road roller of ten tons weight and in the same manner as in waterbound construction. Too much rolling can be done on the softer rock. All that is required for soft stone is to shape the road and lock the stone. The surface should be open to admit the bitumen, yet not so open as to allow the binder to pass through the base course. The bitumen is a binder and must get between the stones and thoroughly coat them. If the roller crushes the rock too much, closing up the voids, such spots must be removed, otherwise the bitumen lies on top as a mat only to peel off, leaving a bare and weak spot in the surface. Hard, rock-like granite cannot always be locked without the addition of ¾-inch keystone. In addition to locking the stone, the ¾-inch chips reduce the voids and prevent the binder from passing through to the base course.

Applying the Bitumen.

Having the stone properly rolled, the surface is ready for the bitumen. It is not necessary to go into details about how hot the asphalt is applied, because different products require different spreading temperatures. Nevertheless the binder must be properly heated and the stone must be dry.

About 1.5 gal. per square yard is required for the first application and it must be evenly applied so that each square yard gets the specified amount. As the work progresses, whether the binder is applied by pressure wagon or by hand, the application should be checked to see that the bitumen used has covered the required area.

When the first application has been put on, the surface should have a uniform black appearance and the spaces between the stones should be open. Stone chips, ¾ inches in size, or whatever size is necessary for the size of the voids, are now spread evenly over the surface in just sufficient quantity to keep the roller from sticking. The road is again rolled, forcing the chips into the voids. All excess material is now swept off and the road is ready for the second application. If considerable excess material is allowed to remain on the surface, the second application of binder may not adhere properly to the road and will peel off. The second or seal coat of about 0.5 gal. per square yard is now applied and must be spread evenly. As soon as the bitumen is on, the surface is covered with stone chips or pea gravel and a final rolling prepares the road for travel.

In either of the methods, uniformity is the keynote. It is highly important that the size of stone be kept uniform, that the temperature be uniform, that the materials be placed uniformly and that each course gets uniform rolling.

Secondary Feeders.

So much for the primary feeders. The secondary feeders, or the feeders to the primary roads, are the still less traveled roads in the highway system. For these the modified penetration is applicable. The so-called modified penetration calls for lighter asphalts and tars than those ordinarily used for surface treatments. These light products do not have to be heated.

The base course of the so-called modified penetration macadam road is no different from that of the plain waterbound macadam construction. In the case of the soft limestone, there is enough locking due to the crushing action of the roller, and the small pieces broken from the corners of the stone during the rolling fill the voids to some extent. This is not true of the harder stones like trap and granites; the base course must be filled with clay, sand or screenings. Clay is a good filler and if not used to excess it can be drawn up to help bind the second course. It should not be drawn up more than half way into the second course because asphalts and tars will not stick to dirt. Whether the base course is filled with clay, sand or screenings, or whether it is left open, the stone must be thoroughly rolled, because the screenings are not flushed in from the second course as is the case in the waterbound road.

The Second Course Stone.

When the base course is in shape, the second course stone is spread and rolled. Success or failure of the work lies in locking the second course, and this must be mainly brought about in the rolling, because the light oils do not have the cementing properties of the heavier binders used in the mixing or penetration methods. Locking the stone by rolling applies particularly to the softer stone and is not true of harder rock like granite. Too much rolling of the soft rock is worse than not enough, because the crushing and grinding action under the roller wheels will make the surface too dense. Excessive rolling of hard rock tends to smooth it up, making it that much harder to bind. During the rolling it is essential to see that voidless spots do not develop. If any occur, due to crushing the stone or from material improperly screened, they should be raked out and the holes filled with clean stones. A uniform surface is necessary and any spots filled up tight before the oil is applied break up the uniformity and leave weak spots in the pavement.

At this stage the surface is very porous and if the bitumen were applied it would run through to the sub grade. An enormous amount of oil would be required to fill up the surface, besides making it soft and spongy. To keep the stones from shifting under travel, the voids must be partially filled before oil is applied. The screenings must be applied evenly and when dry. The roller is operated over the road during this process and shakes the dry screenings into the voids. There should be several steel push brooms on the job so that the uneven patches of screenings may be spread properly. Screenings should be applied until the voids are about filled, giving the surface a mottled appearance. The first application of 0.5 gal. of road oil is put on by a pressure distributor. The force of the spray cleans the fine dust off the exposed stone, besides forcing the screenings further into the voids. Spots that are impervious will show up very plainly after the oil is applied, presenting smooth, glossy, unbroken surfaces. These places, if not removed, are getting but a surface treatment rather than being impregnated. Consequently these spots do not have the same wearing qualities as the balance of the pavement and in a short time bald spots appear. Should such appear after the road is opened to travel, immediate attention should be given them because such a spot grows rapidly in size and depth.

Screenings.

After the first oil is applied, a light coat of screenings should be spread and followed up with the roller. If the surface was properly filled before the oil was applied, there will not be enough oil in the road to cause roller wheels to pull up patches of the surface. If there should be too much oil, the only thing to do is to let the road stand as it is for a day or two, giving the oil a chance to soak in. If allowed to stand too long, a light application of oil may be necessary before additional screenings are put on. The roller brings the oil back to the surface and bonds or mixes the screenings in. A second application of 0.5 gal. of oil is given the surface and followed up with a heavier course of screenings. The second coat of screenings can be heavier than the first because the oil will not soak in so much. The roller will again bring the oil to the surface and mix it with the screenings. The surface should now be well filled up, if not, a third application of 0.125 gal. per square yard is applied. Clean stone chips or torpedo sand are better for the finish coat.

When granite or trap rock is used, and its screenings are used for filler, it is quite necessary to use ¾-inch keystone to help lock the second course. The hard rock does not absorb the oil as the soft stone does and consequently the oil is drawn to the surface more readily. If screenings are added in sufficient quantity to keep the rollers from pulling up patches, there is danger of getting too much material on the road, causing the surface to flake under the action of the roller. Should this happen, a light sprinkling of ¾-inch stone must be applied and rolled in, otherwise the horse traffic will chop the flaky spots to pieces, causing holes to form.

No matter what material is used, soft or hard rock, care must be taken that a thick mat of oil and screenings is not formed on the surface. After the road is finished, it should be allowed to stand for several days before traffic is allowed to use it. Automobile traffic is a benefit to this type of road because the pneumatic tires iron out the surface. If there are places which look as if there were not enough oil, the chances are that after the road has been open to travel for a few days, the oil will be drawn to the surface, giving it the appearance of a sheet asphalt pavement.

It is very doubtful to my mind if we should build any more waterbound macadam roads. If they are built they must be surface treated immediately. Then you will have paid for watering and oiling the road, while, if the modified penetration method is used, the watering cost has been eliminated. In addition to this, the oil is incorporated in the surface and not merely lying on the surface as is the case in surface treated work. The results obtained by the modified penetration method have placed the waterbound macadam in the class of the "has beens."

Tarvia

Preserves Roads
Prevents Dust—

Upper—Hubbards Woods, Green Bay Road, Winnetka, Ill. Original treatment, "Tarvia-A" over macadam in 1907. Kept in prime condition up-to-date with the same material.

Lower—Elm Street, Winnetka, Ill. Scarified and treated with "Tarvia-A" and granite chips in 1917.

What Winnetka thinks of Tarvia

THE VILLAGE OF WINNETKA
WINNETKA, ILLINOIS.

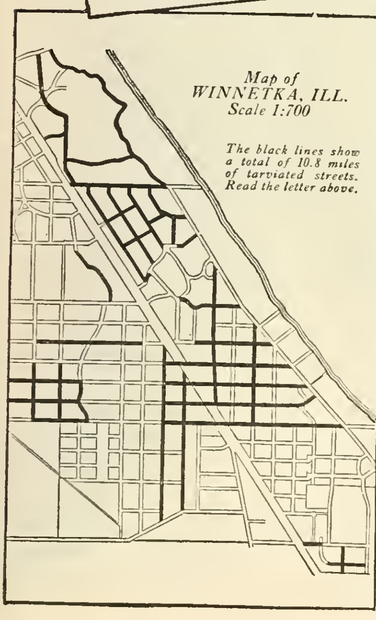
November 18, 1918

The Barrett Company
Chicago, Ill.

Dear Sirs:

Two years ago this municipality adopted the policy of resurfacing all macadam streets within the village limits with "Tarvia-A" and granite chips. Inasmuch as the close of the present season finds the program practically completed, we wish to take this opportunity of thanking you for your very excellent service in meeting our requirements, and to express to you our judgment that this method of maintaining macadam streets in high-grade condition is most satisfactory from the standpoint of economy, good appearance and durability.

Yours very truly,
THE VILLAGE OF WINNETKA
(Signed) H. L. Woolhiser
Business Manager



Map of
WINNETKA, ILL.
Scale 1:700

The black lines show a total of 10.8 miles of tarviated streets. Read the letter above.

How Winnetka, Ill., obtained beautiful streets at low cost

A FEW years ago Winnetka streets were much like those of hundreds of other villages to be found all over the country—beautiful homes on both sides, separated by muddy roads in wet weather and clouds of dust in dry weather.

Then the Village Council got busy. The property owners were canvassed and asked to contribute part of the cost of a good roads program.

The result was 5.8 miles of Tarvia streets laid during the first year, a third of the cost, amounting to 15 cents per front foot of the abutting property, being paid by the property owners and the rest by the village.

Last year all the rest of the macadam streets were tarviated, so that today Winnetka ranks among the best-paved villages in America.

Up-to-date municipalities and road authorities use Tarvia—

—because it gives durable, all-the-year-'round roads at the lowest possible cost; because Tarvia roads are dustless, mudless and frost-proof; because they stand up under severe motor traffic; because they quickly pay for themselves in reduced maintenance costs.

That is why Tarvia is the standard road-making material in most American communities.

Write for illustrated booklet and further information.

The *Barrett* Company

New York Chicago Philadelphia Boston St. Louis Cleveland Cincinnati
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Columbus Richmond Latrobe Bethlehem Elizabeth Buffalo Baltimore
THE BARRETT COMPANY, Limited: Montreal Toronto Winnipeg
Vancouver St. John, N. B. Halifax, N. S. Sydney, N. S.

A Small, Portable Heater for Use of Highway Maintenance Patrolmen

A small, portable heater, for heating tar and other bituminous materials used in highway maintenance work, has recently been designed and placed on the market by Littleford Bros., 460 E. Pearl St., Cincinnati, Ohio. It is called the Littleford Patrol Heater No. 68 and is here illustrated. This heater was designed especially for use in connection with the patrolling system which is being rapidly installed by state and county road departments. With this outfit the patrolman or operator, covering a limited mileage, is in position to make patches immediately after the road shows signs of wear. It is durably constructed of sheet steel, not too heavy, and

NEW PORTABLE HEATER FOR USE OF HIGHWAY PATROLMEN.

the design is such as to make it easily handled by one man. The fire box is fitted with cast iron grate and hinged fire door. The welded kettle rests entirely within the fire box and is removable; it has a capacity of 8 gals. As soon as a concrete brick or asphalt road cracks or shows signs of wear or disintegration, the patrolman takes this kettle and with a supply of crushed stone or gravel makes repairs that arrest the deterioration of the roadway. This is the proverbial "stitch in time."

Personal Items

The Kelvin Engineering Co., Inc., Mr. Gustavo Lobo, President, Engineers and Contractors, 32 Broadway, New York, have organized a new department to do general engineering and contracting work in this country and in Latin America. This department will be in charge of Mr. Carlos Lobo, M. A. S. C. E., formerly Borough Engineer, Department of Water Supply, Gas and Electricity, Borough of Brooklyn, New York. The Company will continue its existing business of designing and manufacturing sugar machinery and machinery for various industrial purposes and its business of export of machinery of all kinds, sugar, electrical, industrial, etc., to Cuba, Mexico and other Latin American Countries. In addition, the Company is now prepared to execute contracts for furnishing and erecting sugar, electrical and industrial machinery and equipment and for the design and construction of water works. The Company also, in conjunction with the Nazareth Foundry and Machine Company, are equipped to manufacture all types of castings and to do all kinds of steel plate and machine work.

Mr. Walter E. Rosengarten has resigned his position as Highway Engineer in the United States Bureau of Public Roads to accept the position of Traffic Engineer with the Asphalt Association and will make his headquarters at 15 Maiden Lane, New York. At his new post Mr. Rosengarten will deal with the very difficult and pressing problems of coordinating the design of the various highway types with the requirements of modern traffic. In specializing along these lines the Asphalt Association has shown its appreciation of the fact that the traffic of America's 7,000,000 motor vehicles including some hundreds of thousands of heavy trucks calls for a keen and appreciative study of the forces which on the one hand tend toward the deterioration of the highway and on the other hand toward increasing operating costs and the deterioration of the motor vehicle itself. Mr Rosengarten is particularly fitted for his new post by reason of the fact that since his graduation from the Engineering Department of the University of Pennsylvania he has had a combination of practicable highway construction experience and research study with both the University of Pennsylvania and the U. S. Bureau of Public Roads. He was with the Federal Bureau about eight years during which he spent about four years in practical highway construction, and about two and a half years in the research and testing division in connection with laboratory and field work.

Captain Robert B. Murdock, who has recently returned from military service in France, has been appointed executive engineer with the Asphalt Association at 15 Maiden Lane, New York. He will directly assist the secretary of the association in developing the organization and operating policy. Captain Murdock has had an extensive experience in practical highway work during the course of which, as resident engineer, he had charge of the construction of one of the most difficult portions of the Columbia River highway including the famous figure "8" section at Crown Point, near Portland, Oregon. Later he was made Assistant State Highway Engineer of Oregon and held that office until he entered the military service.

The City Engineer of Barcelona, Spain, Professor Jose Me de Lasarte, Dr. Sc., has lately been in the United States as the Representative of the Section of Education of the Congress of Engineers, which is to take place in Madrid, Spain, during the month of October. Dr. Lasarte is well known as a Municipal Engineer in Barcelona, and is also a writer of some note and a Professor of the University of Barcelona. Just previous to his departure for Barcelona on September fifth, he received a cablegram from the President of the City Council of Barcelona, asking that arrangements be made for the technical reports of American municipalities to be sent to the Ayunteamiento de Barcelona; Consejo de Cultura, Barcelona, Spain, (The City Council Development Committee) in order that they might become more familiar with American practice in municipal work. Municipal engineers in this country should note the desire of Barcelona to receive the official publications of American municipalities on an exchange basis. Foreign cities are very appreciative of such courtesies.

Trade Notes

The Philadelphia Vitrified Brick Company, Philadelphia, Pa., has engaged in the manufacture of wire-cut lug paving brick under license contract with The Dunn Wire-Cut Lug Brick Company of Conneaut, O. The eastern works of the company are at Saxton, Pa. Charles D. Ames is president of the company and J. T. Hawthorne is secretary and treasurer. The addition of the plant of the Philadelphia Vitrified Brick Company makes 75 plants licensed to make wire-cut lug brick in 12 states.

WATER WORKS SECTION

Proposed Water Filtration at Detroit, Mich.

As a result of a recent report on an investigation of the Detroit water supply with reference to filtration and other improvements, definite progress toward construction is now being made. The report was made by R. Winthrop Pratt, Consulting Engineer, Cleveland, Ohio. The present article is based on the report and on developments subsequent to its delivery.

The investigation was made for the purpose of obtaining accurate data relative to the quality of the Detroit water supply and determining the maximum rate at which the water could be filtered, consistent with safe and satisfactory results. An experimental plant was therefore constructed and operated for one year begining Oct. 1, 1917.

Experimental Filter Plant

The experimental plant is, in addition to being of strictly technical value, serving also to create interest in filtration on the part of a large number of residents of the city who made a practice during the warmer months of carrying away the filtered water in bottles. Special facilities were provided for filling these bottles without interfering with operation of the plant.

At the same time there were prepared a set of general drawings of a 300-million gallon filtration plant, these drawings being in sufficient detail to permit a fairly accurate estimate of cost to be made and at the same time to serve as a basis for construction or contract drawings.

The filtration of Detroit River water is of course considerably easier than filtration of most of the existing supplies; and the results show that it is possible to filter the water through relatively coarse sand at the rate of approximately two hundred million gallons per acre per day, using less than one-tenth of one percent wash water. The bacteria in the raw water, during the year of operation which averaged 37 per C.C. (37° AGAR) were reduced to 6 per C.C. without using any sterilizing agent. All turbidity and practically all B. Coli were eliminated.

The results of the investigations, together with some general data relative to filtration, were printed in a report which was distributed by the Detroit Board of Water Commissioners to a large number of interested citizens. This report also contains reproductions of the general plans. The following are the Summary and Conclusions of the report:

Summary and Conclusions

Analysis of Detroit's municipal water supply, a survey of parallel experience in other cities and the experimental purification of Detroit's water on a small scale for one year have been instituted to determine what type of purification plant and what methods of operation are best calculated to improve the quality of Detroit water.

The report comprises chiefly the results of operating an experimental plant and their application to the design of a filtration plant of the type best suited to treat the entire supply.

The report also covers the design of an auxiliary pumping station needed to increase the capacity of the intake tunnel and so arranged as to be readily convertible into a low lift pumping station for a filtration plant, if such should be built.

Lessons from Experimental Operation—A miniature filter plant, with a capacity of 200,000 gals. per day, ws operated for one year from Oct. 1, 1917, to demonstrate the advantages of filtration and determine the best operating condition for Detroit's particular supply. Public sentiment was also developed and tested on the subject of filtration by piping the filtered water to the main entrance to Water Works Park and dispensing it freely from a booth, where hundred drank the water daily and many families secured water in bottles for domestic use.

Operations checked by an elaborate system of tests proved that the water of the Detroit river is capable of relatively rapid and inexpensive filtration and that the removal of bacteria under those conditions is adequate. The filtered water was of such clearness that a newspaper could be read easily through a volume of water several feet thick.

Recommended Plant—The filtration plant recommended in the report is of the rapid sand type and while, from the standpoint of capacity, it will be the largest similar plant in existence, there is plenty of room for its installation at Water Works Park without buying additional land and in this location it can be supplied with water from the present tunnel. It has a daily capacity of about 300,000,000 gals., suitable for 1930 or 1935 conditions; and is so arranged that it can be readily enlarged, if desired, to about 450,000,000 gals. daily capacity.

There is no better place for the water works intake than its present location. The proposed construction of an intake and aqueduct connecting with Lake Huron would cost several times as much as the filtration of the present supply, and the results would not be so good. The present water supply, when treated with chlorine, is relatively safe, but the taste resulting from the use of chlorine is objectionable and there are extended periods of turbidity when the appearance of the water renders it unattractive. Contamination of the Detroit River will increase with the increase of population on tributary water sheds. Filtration will put an end to the use of chlorine in unpleasant quantities, will safeguard the city against the certainty of increased pollution in the future. It will provide every consumer with water superlatively safe, clear as crystal and gratifying to the taste.

Estimated Cost of Filtration—The filtration plant described and recommended in the report is estimated to cost $5,800,000. The cost of filter operation, including low lift pumping, is estimated at $3.69 per 1,000,000 gals, while the interest and sinking fund charges would be $4.22, making a total of $7.91 per 1,000,000 gals., which, in spite of the present high prices, compares favorably with the costs in other cities. On the basis of the present rate policy, filtration would cost domestic consumers 6 cents per 1,000 cu. ft., or less than a cent a day per family.

Auxiliary Pumping Station Recommended—The large amount of water consumed on certain days during recent years has resulted in some difficulty, at such times, with the older high service pumps which are at too high an elevation to operate satisfactorily under low river conditions. It becomes necessary, therefore, either to undertake extensive improvements to the old pumping station or to construct an auxiliary low lift pumping station to raise water from the tunnel, at certain periods, to supply the high service pumps above referred to. As such auxiliary station, with very little change, can be made to serve as a low lift station for a future filtration plant, it seems logical to adopt this method of correcting present pumping difficulties.

Success of Filtration Demonstrated—The time is now long past when the basic principles of the filtration of municipal water supplies can be considered an experiment, although experimental plants so called, are useful in order to study the application of these principles to local problems. More than 750 municipal filtration plants are now in operation. In Detroit, particularly, has every speculative element been discounted. To a large volume of data from other localities has been added the fruit of a year's operation under conditions locally prevailing.

It is true, Detroit is not confronted with any severe sanitary crisis, but to progress only under the scourge of epidemics is not a desirable policy. This has been proved in many cases where cities have undertaken filtration projects without sufficient preliminary investigation and consequently at heavy cost. The logical process of improvement therefore and the one pursued in this instance, is to anticipate every possible source of disaster and to demand the best, rather than to be content with that which is passably good. For a moderate cost, Detroit can add to its industrial distinction and world-wide repute for civic enterprise the further priceless boon of an irreproachable water supply.

Progress Toward Construction—Since the submission of the report, the City Council has appropriated funds for constructing the low lift pumping station. This will probably be completed before the filtration plant can be built and will therefore be temporarily used as an auxiliary or Booster station to increase the capacity of the present tunnel. The low lift pumping machinery has already been purchased and bids are to be taken soon for the construction of the station proper.

Preparation of detail contract plans and specifications for the completed filtration plant have been started; and it is expected that contracts for at least a portion of the plant will be awarded wihin the next year if funds are available. The preparation of these detail plans is under the immediate direction of Major T. A. Leisen, Civil Engineer of the Detroit Board of Water Commissioners; and F. H. Stephenson, who was associated with B. Winthrop Pratt on the preliminary plans and investigations, is now acting as principal assistant to Major Leisen. Mr. Pratt has been retained by the Board to act in an advisory capacity.

Considerations Affecting the Choice of Pumps for Small Water Works

By Henry A. Symonds, Boston, Mass.

In designing a plant for pumping water for a small community, it is usually the case that the per capita cost of operating and maintenance is greater than in the large city plants, and it is important that a careful study be made of the relative merits of the different forms of power available, their adaptability, first cost, and efficiency when operating to do the particular work desired.

It is usually the case that strict economy must be practiced in the introduction of these works, and studies relative to first cost have usually been made to bring the cost of the work within the ability of the communities to pay. Not so much attention, however, has been paid to the question of relative efficiency and daily cost of operation, and it frequently occurs that plants are in operation which citizens of the town, and even the water works officials themselves, believe to be highly economical, and that are the reverse. The difference in cost of operation may be so great as to make it good business to pay a much higher price for an economical unit.

Water Power—The early use of power for pumping water in the small-town installations was largely by water power or steam, and it is possible that water power is coming back into use for pumping purposes, but probably through the medium of the hydro-electric plants, as it is not common to find good water privileges so located as to be directly available for pumping from the approved sources of water supply.

Steam Pumps—Steam has been used for many years very efficiently in many small plants.

Steam Turbines—The development of the centrifugal pump, which has now found so wide a field, was closely identified with the bringing out of the steam turbine.

The Ideal Small Pumping Plant

The centrifugal pump has been known for a great many years, but for a long time after it was invented the difficulty of getting suitable drive with sufficiently high speed retarded the development of successful operation of this type of pump. The real growth of this pump has occurred in the past ten years, during which time the use of the steam turbine and the electric motor with direct connection to the centrifugal pump has brought up the efficiency of the pump to a relatively high stage. At the present time the use of the steam turbine as applied to pumping water is mainly in the large units, and the motor is generally adopted for driving the smaller plants.

The result of the use of steam is, on the whole, satisfactory, but for the small water plants it is subject to the objections that the economical pumping machines with boilers are expensive and occupy much space, and provision for large storage of coal and adequate pumping-station buildings are required, all of which conditions add to the first cost of the plant and are aggravated by the fact that licensed engineers are required to operate such a station.

To-day we consider the ideal small pumping engine that which is economical in first cost and is self-contained, i. e., operates from a source of power which is part of the engine, or at least located in the same station. It is desirable to have it occupy as small space as is practicable, be simple in operation and not require the services of licensed men, easily repaired, quickly started, using fuel which is readily available at all times, and be capable of producing power at a relatively low unit cost.

Electric Motor

Many of the conditions of an ideal plant are met by the electric motor, and the electrical installation has become more and more common. The advantages are:. Low first cost; it requires little space; low cost of maintenance; no expert supervision; it is especially well adapted to drive centrifugal pumps with direct connection, which saves friction loss of gears, and prevents noise; it may have automatic control; it may operate during periods of low load at central station, thereby getting lower rates; instant starting; as it has no reciprocating parts, it can be left to operate without attendance better than any other form of drive. The use of electricity has two serious defects in the average municipal plant, namely, it is not self-contained, but depends upon a line of wires and a power plant, usually at a distance, for its operation. For this reason neither one nor two units in a pumping station operated from the same plant are satisfactory to the insurance authorities, as they rightly claim that an accident to the wire line or the power plant will put both units out of use as quickly as one and leave the town or city in an unprotected condition in case of fire.

The advocates of the use of motors base their claims of low cost of operation upon the fact that attendance may be a minimum and that this is really the large item in operating small water plants. The writer believes that this argument has considerable merit, and that the improvement in efficiency brought about recently in the centrifugal pumps, and the low cost of the pump and motor, with the advantages above referred to, make this form of pumping plant a very close competitor of, and in some cases it will be found actually to be a better business proposition than the other types of pumps and engines, in spite of the difference in efficiency.

Gasoline Engine

Another form of drive which has been used in some of the small pumping plants is the gasoline engine. This form of power has practically all the advantages above mentioned except cost of operation, and in this it falls down badly, as it is operated upon a fuel of such high cost as to make the operation per horse-power-hour too high for practical purposes in the ordinary municipal water works. However, in plants where an emergency unit is wanted and electricity is not available or desirable for any reason, the gasoline engine may meet the requirements in a satisfactory manner.

Producer Gas

The gas producer as a source of power corresponds to the boiler in a steam plant. It has a great many advantages, and when combined with a proper engine for utilizing the gas to the best advantage may be considered as having most of the requirements of the ideal plant. This form of power has been used for some time, and, so far as the writer has record, with good satisfaction in all cases. Gas produced in this way may be used in various types of internal-combustion engines with slight modification. A plant of this kind can be installed at reasonable first cost, is self-contained in so far as the power is generated directly next to the engine itself, and operates at a remarkably low cost upon a relatively inexpensive form of coal. The plant takes up more room than some of the other types, and calls for a larger pumping-station space.

Fuel-Oil Engines

In the writer's experience, in nine cases out of ten, fuel-oil engines have proved an ideal installation for plants from 25 to 150 h. p., and for this reason it may be proper to give some extra details regarding this engine. The term "fuel-oil" is here used to mean any oil, from the heavier crude petroleum up to kerosene. Fuel-oil engines are today known under two general heads as Diesel and semi-Diesel, or surface ignition.

Semi-Diesel Engines

The idea conceived by Diesel is the bringing into compression a mixture of air and oil vapor to a point where heat is generated sufficient to ignite the combination. The compression reached varies from 500 to 1,100 lbs. per sq. in., but when the proper temperature occurs the gases burn rather than explode, and it is the claim of the producers of the Diesel type that this slower burning conserves the power of the gases, and the energy realized is utilized almost entirely in pushing the piston through the length of its stroke. In order to permit of the great pressure produced by this process, the machine must be exceedingly heavy, and the great amount of work which is required to perfect the Diesel engine makes it too expensive for the ordinary requirements of small water-supply plants.

The Semi-Diesel, or surface-ignition engine, on the other hand, gets its power by the explosion of a mixture of air and oil gas in the cylinder under compression around 200 to 300 lbs. per sq. in. While part of the energy is undoubtedly used in the shock against the metal of the plunger and cylinder, the resulting thrust produces motion of the piston, which is connected through the crosshead, or directly to a crank shaft which gives the motion to the driving pully or gear.

The Semi-Diesel seems to meet all the ordinary requirements of the ideal engine described above, and while the first cost of this engine is considerably greater than that of the gasoline engine or the electric motor, the operating costs are so low that this outweighs in most cases the advantages of the low first cost of the other machines.

Poor Fuel Oils Satisfactory

In the types which are considered as small pumping outfits, designed to pump water for communities of from 1,000 to 10,000 inhabitants, the engines required ranged from 25 to 150 h. p., but in the writer's opinion there is a large field for a still larger oil engine, and there are some machines now being produced that show wonderful efficiency in operation. They are of the Semi-Diesel type, but are able to operate on the poorest grade of fuel oil, and even tar products which have to be heated before it is possible to get them into the cylinders. The oil used runs as low as 18 degs. Beaume, while in the smaller machines—that is, below 60 h. p.—the writer knows of good results with oil heavier than 26 degs. Beaume, and with 25 to 35 h. p. engines kerosene or light oils of that grade have seemed to give the most satisfactory results. Pre-war prices ranged from 2 cts. to 7 cts. for the various grades.

The ordinary time of starting with fuel oil is from 12 to 18 minutes, but engines of this type may be equipped with apparatus which permits of instant starting by electric ignition and gasoline, the fuel oil being turned on after a few minutes, without interruption of the operation of the engine. This latter contrivance is of especial value where but little storage of water is possible and pumps have to be operated in case of fire, as the delay in heating the cylinder head may be serious if the supply of water is not available.

It is claimed by the advocates of the electric motor, in comparison, that the motor requires little attendance, while the oil engine calls for constant supervision. This claim is not entirely substantiated in practice, for many of the oil plants are operating for long periods of time without attendance. This of course assumes that there are duplicate units which will take care of any fire hazard if repairs are necessary. It should also be considered that constant attendance does not eliminate many of the breakdowns.

Perhaps the most satisfactory combination that can be installed for a small pumping plant for general municipal needs is made up of two duplicate units, of which it is probable that the fuel-oil engine meets the need fully as well as any other drive which has been developed up to this time.

One advantage, of considerable importance in some cases, that steam machines have over most of the other types is in the varying speed in operation. The speed in the electric motor and of the internal-combustion engines is variable only

TABLE 1—COMPARATIVE FUEL AND FIRST COSTS OF VARIOUS TYPES OF PUMPING PLANTS FOR SMALL WATER WORKS

1,500 g.p.m., 250-ft. total head; operating 300 days per year, nine hours per day; theoretical h.p., 94.7.

Pump.	Drive.	Pump Efficiency per cent.	H.p. required.	Cost of fuel per h.p. hour.	Total fuel cost per hour.	Total fuel cost per 300 days.	Estimated cost of plant.	Remarks.
Vert. triplex	Fuel-oil engine	85	112	$0.004	$0.498	$1,209.60	$17,189	
Centrifugal	Fuel-oil engine	71	134	0.004	0.536	1,547.20	16,343	Guarantee—1 h.p. for 0.55 lb. fuel oil per hour. Price fuel oil, 4c per gal.
Vert. triplex	Steam turbine	85	112	0.0075	0.840	2,268.00	13,657	
Centrifugal	Steam turbine	71	134	0.0075	1.005	2,713.50	9,957	
Vert. triplex	Electric motor	76	125	0.0124	1.55	4,185.00	11,116	Coal at $6 per ton (2,000 lbs.)
Centrifugal	Electric motor	64	148	0.0124	1.84	4,968.00	6,248	Efficiency is combined pump and motor. Electricity cost, 0.9c per h.p.-hr. plus "service charge" of 77c per h.p., based upon max. h.p. in use, per month.
Cross-compound, fly-wheel, steam pumping engine						1,350.00	17,000	
Compound-dup.-Deane steam pump (original plant). Rate about 700 g.p.m.						2,725.61		Actual figures of present cost. Rate of pumping about 700 g.p.m.

to a small extent, except by change of gears or belt pulleys, and it is sometimes necessary to pump to waste or through a bypass back into the suction, an uneconomical process, in order to keep the rate of delivery as desired.

Comparison of Costs

The writer had occasion, a short time ago, to make a comparison of different types of pumping plants, to determine which plant would best meet the needs of a community. In connection with this, the results of investigation of different units were tabulated and are given in Table I. The figures are not to be considered as exact, either of operation or first cost, but are obtained by using quotations and guaranteed efficiencies by the manufacturers of the different lines of machinery. These figures were also taken before the extreme rise of prices which occurred since the United States entered the war, and, while they are far above the averages of five years ago, it is probable that they are nearer what we may expect in the next few years than pre-war prices.

Acknowledgment

The foregoing article by Mr. Symonds is here reprinted from the Journal of the New England Water Works Association.

How to Reconstruct Small Water Power Plants

By Ray K. Holland, Consulting Engineer, Ann Arbor, Mich.

Developments that may be classed as small water power plants, with heads ranging from 8 to 20 ft., and with a contributary stream drainage area of 100 to 500 square miles, are principally for flour and feed mills, but there are a large number of small hydro-electric developments, both private and municipal, and water works pumping plants driven by hydraulic turbines.

The owner, in looking over a water power development that had been constructed prior to eight or ten years ago, generally feels, and correctly so, that the plant can be improved, but he is usually at a loss as to just how to go at it. He knows whether or not his present plant is sufficient in power to carry the usual load he imposes upon it, and he knows for what seasons of the year he is very short of water, and what seasons he has plenty of water, and approximately the range of head that prevails. He knows that the turbines are old and is aware that if he should purchase new wheels similar to those installed, he would undoubtedly receive more power; but when he makes an examination of the turbines, he finds that the replacement of perhaps a broken gate and a little lining up of the shafts will give him, in appearance, a turbine which looks as serviceable as a new one. The consequence of all this is that while he has a feeling that the plant ought to be reconstructed, he has not been satisfied that the reconstruction will show him a particular gain for his investment.

Engineer Must Study Conditions

If we, as engineers, could be called in to examine such a plant, with the idea of putting before the owner concretely what his needs are and what the costs will be, we find that we must start deeper in the problem if we will obtain for the owner any particular advantage in reconstruction. We must go back first to study his plant and check up as to whether the original installation was suited to the stream and the purposes to which he proposes using it.

The question of whether the machinery installed is suitable or not for the speed at which he desires to operate and for the prevailing head, we can pass up for the present, until study of the other considerations influencing the development is completed.

The stream flow is naturally of the most importance to the development, and its determination is usually our first consideration. The stream flow at a particular site may be determined by steam gagings or observations of flow over a dam of uniform crest and the like, but to be of any value the observation must extend over a considerable period of time. It is generally the case that there are no records of the particular stream at the particular site being considered. The engineer must then draw upon his accumulation of stream flow data of other streams, in the neighborhood if possible, having similar drainage basin characteristics, in order to estimate the probable flow of this particular stream at the site considered.

Application of Known Data

The judgment used in the selection of the records of known streams and their applicability to this drainage area is an all-important factor in this approximation of stream flow. It is to be particularly noted that three or four stream observations at this site, unless they be selected at extreme conditions and at average conditions, are of very little value in arriving at what might be the average flow of the stream in the course of a number of years.

Assuming that we have arrived now at the average flow of the stream, the next point to consider is the head under which the turbines will operate. The head, as we use it, is the distance from the average water surface level in the wheel pits to the average surface level of the water in the draft pit, or, in case a curved draft tube is used discharging the water down stream, to the water surface at the exit of this draft tube.

Factors Influencing Head

The two particular factors, therefore, influencing the head are the level of the water surface of the pond and of the tail race. The pond level is subject to variation due to the stream flow being less, or in excess of that used by the turbines. The excess is taken care of usually by flood gates or spillway, and the pond is generally at its highest level during such periods. When the river flow is less than the water used by the turbine, there is a draft on the pond and the water is pulled down.

The highest stage that the pond may be carried is generally controlled by the flowage rights and in each case requires investigation as to whether there are physical limitations to a higher pond stage—that is to say, whether the raising of the pond level will cause very large flat areas to be flowed, or is prevented by the physical conditions at the dam or plant. If no such limitations are present, it is usually advantageous to the owner to acquire flowage for a higher pond level, and it can be usually shown that this flowage is worth much more to the owner than he has assumed it to be, when he has considered it worth only the value of the adjacent property for farming purposes.

The tail water level is generally the level of the natural river before the development, and if there are no obstructions immediately below the plant, usually no particular advantage to the head may be gained by improvement to the tail race, such as deepening and the like.

Effect of Raising Pond

There is one factor usually present in the question of raising the pond that is little understood, and that is the question of backwater, meaning by backwater, the increase of the water stage due to the construction of the dam, over the water stage of the natural stream. With any dam constructed across a stream and with a normal stream flow and the pond level carried at the crest of the spillway, the maximum backwater effect will occur at a point located approximately at the intersection of planes tangent to the water surface of the pond and to the water surface of the stream above the pond. If the pond surface is now maintained at the crest of the dam, with increasing stream flow, the backwater effect will usually become less, and with decreasing flow becomes greater at this point, but if the spillway is of ample discharge capacity, so that the head on the spillway for the overflow increases at a lesser rate than the normal river stage for the same increased flow of water, the backwater effect at the point first considered becomes no greater with this increasing flow, when such increase of flow is wasted over the spillway.

While it may be found that the amount of the backwater effect is less with the increased flow being wasted over the spillway, at the same time it may be also found that the backwater effect reaches farther upstream. Usually this is of little importance because of the small amount of the increase of river stage, but should this back against another water power development, this small amount of backwater effect frequently causes a large amount of trouble.

The engineer should make a careful study and endeavor in such cases to present the problem clearly, so that it may be understood by the interested parties, and if possible form the basis of an agreement whereby the lower development may back water against the upper under the extreme conditions, thereby obtaining between the two plants the maximum power obtainable from the river.

Uses for Power

The use to which the power is to be put is our next consideration. If for milling or manufacturing, it is generally for 9 or 10 hours each working day, sometimes for the 24 hours. If for hydro-electric developments with a single plant, power may be required for 24 hours, but sometimes is required for only 10 or 12 hours, this usually where commercial lighting only is served, or for lighting and pumping where a reservoir or elevated tank is available.

In reconstruction, this matter is more or less definitely settled by the past performance at the plant, and the gain in power output from the higher efficiency usually provides a margin that insures the turbine being of sufficient capacity to care for peak periods.

Where a change in the length of period of operation or additional load is contemplated, particular attention must be given to the probable power obtainable at the site in order to advise whether the development will permit the change.

The capacity of the pond (in acre feet) is the factor which determines the ratio of the maximum power of the daily period to the average 24-hour power available from the river flow.

An acre foot being the quantity in an acre of water 1 ft. deep, the capacity of the pond is then dependent upon the product of the average area and depth of draft to which the pond may be drawn. The area being fixed by physical conditions, the capacity is directly dependent on the draft. But the draft on the pond reduces the head on the turbine and results in a power loss that increases at better than three halves power of the ratio of the change of head, consequently a minimum draft is desirable. From practical considerations 5 to 8 per cent of the head may be permitted as the draft on the pond.

Pulling Down the Pond

This question of pulling down the pond is one that the engineer should cover thoroughly with the owners of the development, as the usual rule is to find that the operators of the plant pull the head excessively at the beginning of the summer season and it is not given an opportunity to recover again until the fall rains, resulting in shortage of power during the whole summer. We find this condition usual with municipally operated plants and only little less frequent with privately owned plants. One plant, a year or so ago, whose average head is 15 ft., pulled the pond in the first three summer weeks to between 9 and 10 ft., and operated at these low heads all summer by generating some auxiliary power by steam and cutting short the street lighting period. The plant capacity at these lower heads for the same amount of water was less than one-half the capacity at the full head, and had the auxiliary power been supplied when the head started lowering, auxiliary power would probably only have been required the first week of the summer period. The best rule is perhaps to have the pond brought to normal stage at least once in 24 hours.

The ratio of the turbine capacity to the normal stream flow is determined as is shown above from the considerations of the load to be carried and the size of the pond, and the permissible draft on the pond.

Deciding Capacity of Turbine

We have now gotten the elements together that permit our decision as to the capacity of the turbines to be installed. By reference to our determination of the river flow we can select the point from the expected average annual stream flow that will give us the most economy in the relation of the cost to the power obtained. Naturally, if the installation is made equal to the minimum continuous flow, we would obtain the most power for the least money invested in machinery only, but because of the investment in the power house, dam, flowage rights, etc., we usually find that the economical development in most cases will occur at a point in the stream flow that may be said to be just above the average normal flow of the stream. Applying to the quantity of water flowing, we can obtain the theoretical 24-hour power of the development, to which must be then applied the factor previously determined by the use to which the power is to be put, resulting in the theoretical capacity to be installed.

If this be taken roughly at 70 to 75 per cent efficiency, the approximate plant capacity is obtained, which may be checked against the power required for the operations, and adjusted, if necessary, to meet the actual conditions that prevail. This adjustment, however, is usually at a sacrifice of the power that the stream produces. This is true from the fact that if a much larger installation is made, the efficiency of operation is less because of the necessity of running at small gate openings for longer periods, and if a much smaller turbine is installed, the possibility of not being able to carry the peak load becomes pertinent.

Selection of Turbine

As is generally known, a turbine of a given runner characteristic will have a practically fixed speed for a given head for each of the manufacturer's size of turbines, and it is necessary here to make adjustments and concessions between the capacity of the wheel or wheels and speed at which these wheels are to operate. The higher the speed, of course, the smaller the individual turbine. With hydro-electric developments this problem is usually complicated further by the fixed speed requirements of an alternating current generator, and with any development it is usually necessary that the speed selected be maintained constant, notwithstanding the variations of head that will occur.

It is therefore necessary that the engineer, in making the selection of the turbine, be conversant with the type characteristics and the standard capacities of the manufacturers' developed turbines and co-ordinate the number of turbines and the speed to the total capacity which is now practically fixed, to obtain the maximum power under the variations of head and load usually prevailing.

Aside from the runner characteristic of the turbine to be selected, some consideration must be given to the mechanical construction of the turbine, so far as relates to the shop work, strength and rigidity, these being more important where the turbine is to be operated on an extremely variable load, with the gates controlled by oil pressure governors.

Having selected the turbine, a computation of the probable annual output may be made, which, combined with the fixed and operating cost, forms a criterion from which the owner may arrive at a decision as to the necessity of reconstruction.

Details Affecting Operation

There are numerous minor details now to be considered relating principally to those affecting the operating of the plant.

If the power is to be used for milling and for general manufacturing purposes, the so-called friction governors are generally satisfactory, but if for hydro-electric work, it is usually necessary to have the more sensitive oil pressure governors. The question of bearings and the supporting of the runner and shaft is more important than the consideration usually given, because these points are the ones continually under the observation of the operator, and where no trouble is experienced he has faith in his machinery and does all in his power to keep it in first-class condition, while, if he is continually having trouble with alignment of shafts and with bearings, he is very apt to become convinced that the entire equipment is no good, with the result that he does not give it the attention that it should have to deliver the power of which it is capable. This is a point that is frequently lost sight of, and is particularly important from the owner's point of view.

The structure to house the equipment is controlled primarily by space required for the machinery on the operating floor and by the requirement of ample water passages to and from the turbine, and secondarily, by the relation of the structure to existing structures, bridges, the channel, and the like.

The power-house construction itself does not differ materially from other first-class constructions except the requirement of water tightness, rigidity of construction and the necessity of providing that no settlement takes place. Special caution must be observed, however, that foundations are protected against undermining, as a small spurt of water at a critical point will very quickly wreck the best hydraulic structure.

The shape of the flume and location of the turbine in the flume requires special study, if for any reason that water area to the turbine is to be restricted. Trash racks and easily operated wheel pit gates are necessities to a well-designed plant, particularly the desirability of easy and quick operation of the head gates by the operator, as they serve as an inducement to him to the making of periodical inspections of the turbines and under-water mechanisms.

Unless the head is very low, the turbine is invariably placed above the tail water level, making the question of the draft tube a particularly important one, and not of easy solution, even when the engineer has wide latitude in his design. When space is restricted, the design of the draft tube must be governed largely by the designer's experience and the results obtained from other constructions where conditions analogous to those under consideration are present.

Examples of Plant Reconstruction

As a result of the practical application of the principle of making a study of the small plant reconstruction along lines very similar to those followed with a larger installation, I would cite the following reconstructions of this type made by our firm in the last couple of years:

In a hydro-electric plant in the northern part of Michigan, drainage area about 100 square miles, normal head about 14 ft., the old installation was a single turbine some 20 years old, rated at 170-h.p., apparently in good shape, except that the runner had the edges of the buckets bent by debris going through the gates. The turbine was gear-connected to a line-shaft some 15 ft. long, running at about twice the speed of the turbine, from which a 150-k.w. generator was belt-driven. The plant operated only on night load. This equipment was replaced by a single directly connected turbine and generator unit of 100-k.w. capacity, the rating of the turbine being slghtly smaller than the orginal turbine and running at about 60 per cent greater speed. The plant is carrying from two to four times the load previously carried, and at no time within the last two years has the plant been short of water, as had been the case each midsummer and midwinter season previous.

A hydro-electric plant in the central part of Michigan, drainage area 500 square miles, 14 ft. head, formerly consisted of two turbines, each one gear-connected to two short horizontal lineshafts from each of which was driven a generator. There were two outgoing feeders from the plant and the load of both feeders was sometimes carried on the larger of the two generators, and at other times the units ran separately, one to each feeder. The reconstruction here was caused by the undermining of the foundation, resulting in a collapse of the power house. The equipment of the new power house was in two units, each consisting of a directly connected turbine and generator, the one unit being approximately one-half the capacity of the other, permitting power to be produced at high efficiency from about one-sixth to full capacity of the plant. The load on the plant has been approximately tripled since the old plant went out of service and no shortage of water has been experienced within the last two years of operation.

Increases in Power Output

A hydro-electric plant consisting of two turbines, gear-connected to a horizontal shaft about 20 ft. long, to the end of which was directly connected a horizontal shaft, slow-speed generator of 350-k.w. capacity, and to which was also belted a steam engine. One turbine, the gears and part of the horizontal shaft were removed, and a vertical shaft, directly connected generator unit installed, with a turbine capacity slightly larger than one of the original turbine. Upon completion of the work the load was thrown from the remaining gear-driven unit, to the new unit and 100 per cent additional load thrown on, and after shutting down the old unit the surface of the water in the tail race dropped about 4 ins., due to the decreased discharge through the new turbine, even when carrying double load of the old one.

In an industrial plant requiring power 9 hours, three old turbines were removed and replaced by one vertical shaft turbine, gear-connected to a mill, with the turbine selected for proper speed for connection to a future alternating current, vertical shaft generator. The new unit, although slightly larger than larger turbine of the old installation, is carrying, at about two-thirds capacity, the entire mill equipment, which has been materially increased over the installation which the old turbines could just carry.

Acknowledgment

The foregoing paper by Mr. Holland was presented before the Michigan Engineering Society.

Water Purification at Buffalo, N. Y.—Present and Prospective

By H. F. Wagner, Chemist, Bureau of Water, Department of Public Works, Buffalo, N. Y.

As to the purity of the Buffalo water supply, I think I am quite safe in saying that without any treatment at all it is as good as any that is available to cities having Lake Erie as their source of supply.

Sources

The greatest contamination occurs during the summer months and a large percentage is due to freight and passenger vessels which generally use the north channel entrance to Buffalo harbor, which course takes them within less than 1,000 ft. of the inlet crib and on the upper side. Upon the opening of the summer resorts a short distance above on the Canadian shores several excursion boats ply back and forth from Buffalo hourly. These boats carry thousands of people daily and with no restrictions or discrimination for the disposal of their sewage. This constitutes a great menace as excreta from this source may easily pass into the water supply and in a fresh and virulent state.

The shore drainage adding to the pollution, while considerable, is not necessarily excessive, as there are no cities of any size above us whose sewage might find its way into our water supply. There are several streams flowing into the lake within easy radius of Buffalo, but they are small and the tendency is for them to follow inshore, as the extensive use of floats has proven. In the winter, after navigation closes, and especially after the ice has formed, the water is of a most excellent quality. The bacteria count obtained on 37 degree agar is very low. There is one aspect, however, which has to be given weight and that is with reference to the condition arising as a result of the hundreds of fishermen who go out on the ice to fish. The excreta which these people leave upon the ice is a constant menace to the water supply, more so at thaw periods and acutely so when upon the coming of spring the ice breaks

up and all is carried in the direction of the crib. It can be seen, therefore, how most of the contamination occurs at uncertain periods. This condition makes it necessary that chlorine be added to the water in sufficient quantities to take care of the high wave at all times even though the dose may be in excess of that actually essential 75 percent of the time.

Chlorination

Our chlorination apparatus is located at the Intake Pier, where the chlorine solution is injected into the mouth of the 12-ft. arched tunnel. This, therefore, affords a run of over a mile in a leak-proof tunnel and gives ideal conditions for sterilization. We are using a chlorinating apparatus, formerly manufactured by the Electro Bleaching Gas Co., and it is the float meter type. The float in this apparatus is about 3 ins. long and has never caused us any trouble from sticking as has been the case where the small indicator was used. Our chief trouble with this apparatus has been caused by the clogging up of the pressure reducers, which requires taking apart every once in a while for cleaning. Generally, it is necessary to replace the old diaphragms with new ones when this is done.

The amount of chlorine used ranges from an average of 0.16 parts per million to an average of 0.28 parts per million. These figures are equivalent to about 1 lb. and 2½ lbs. per 1,000,000 gals.

Standard of Purity

I do not believe in any set and fixed standard for a safe water. In other words, the same standard is not applicable to any two waters and when such is aimed at there is certain to be a variation of one from the other in actual practice. A set standard will be hard to abide by because of the great difference in the kind and character of the pollution, or, while the standard may be too severe in some cases it is not severe enough in others, and therefore misleading. A standard is no sooner proposed for certain conditions than it is at once grasped and applied to a great variety of conditions. Our standard and procedure is that the bacteria count made on 20° agar is a gage of the efficiency of the sterilization plant and means nothing as to whether the water is safe or not. The real knowledge is obtained from the test for organisms of the bacillus group. Of the different kinds of media in use, I do not believe we are far enough advanced to say standard media. I prefer Lactose Peptone Bile. Our own standards are that we aim to eliminate gas formers to the extent that negative tests are obtained on 4 out of 5 in 5 c.c. samples of the treated water.

Prospective Filtration

Physically, the condition of the water is open to severe criticism from 10 to 15 percent of the time. This brings us to the subject of filtration. Lake Erie lies to the west by southwest from Buffalo. It is from this direction that come the winds which render our water supply turbid and when we are told that we need a filter plant. These winds prevail principally during the fall months when our highest turbidity occurs. Compared to some waters, this is not at all bad, as 250 parts in a million is about the maximum. It consists principally of very finely divided clay, the percentage of organic matter being very small. Generally, the sediment is offensive for from 3 to 6 days at a time, for the sediment is quite heavy and settles rapidly as soon as the disturbing element is removed and the second day after a blow the water has improved 50 percent. In all the water is noticeably turbid from 30 to 60 days of the year.

In planning for a filtration plant in Buffalo, consideration must be given to the following points: First, do the prevailing conditions of the water as herewith set forth warrant such an expenditure? Second, the water consumption must be reduced to a reasonable figure and waste reduced to a minimum before such a project is feasible. And lastly, and perhaps the most difficult problem, is a suitable location for a filter plant. When the water works were originally laid out, it seems, the idea that Buffalo might some day have such a plant was not thought of, or at least no provision was made for its possible location. As to the proposition that the water be pumped to an elevation outside of the city and returned by gravity I would explain this by saying we are here handicapped by the flat nature of the country around us. To secure an elevation anywhere near sufficient for the purpose it would be necessary to go out at least 15 miles into the country. The enormous expense that would be incurred in securing the right of way and in constructing a dual pipe line of the size which would be sufficient for the purpose would place too heavy a burden upon the resources of the city of Buffalo.

I believe, however, that a solution to this problem will eventually be found as I have here very briefly outlined. Directly to the south of the Porter Avenue Pumping Station, the grounds being separated by Jersey Street only, is a large tract of water front land which is at present used for a dumping grounds. Part of these lands are covered by the harbor waters but can be easily reclaimed by a retaining wall and subsequent filling in. I believe that this would make the best location and in fact all that could be desired for a rapid sand filtration plant. The water could be diverted to the filters by short extensions to the existing canals and raised to the required height by low duty pumps. After passing through the filters the water would be permitted to return to the original suction wells by gravity and distributed through the present system.

Acknowledgment

The foregoing matter is from a paper by Mr. Wagner presented before the recent annual convention of the American Water Works Association.

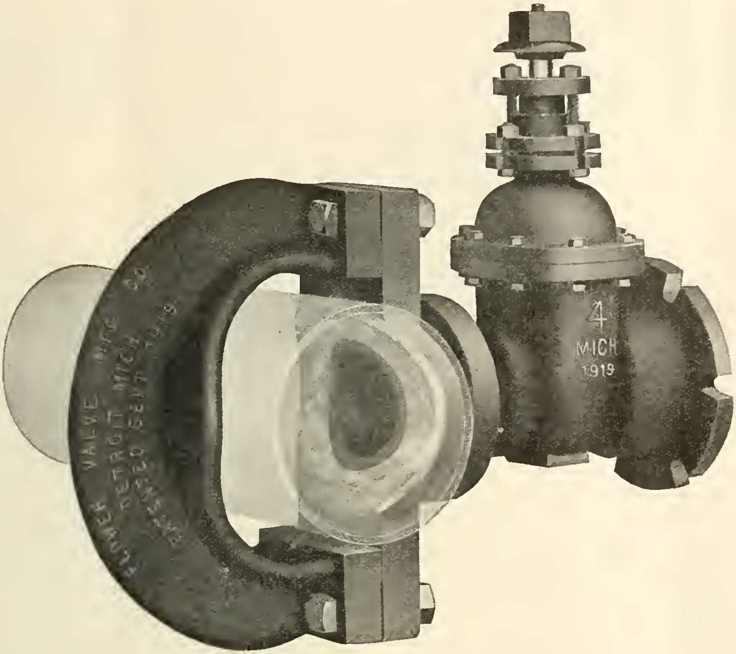
Cost Data on Small Water Works Systems

By William Artingstall, Consulting Engineer, Old Colony Bldg., Chicago, Ill.

The expenditure incurred for water supply for small cities is dependent on the locality and varies in the per capita cost due to the local conditions peculiar to each city. This variation is due not so much to the cost of the water mains and feeders as it is to the cost of the pumping plant and the difficulty (or ease) with which the necessary amount and kind of water is obtained. For this reason it is customary to let separate contracts covering these two phases of the work and in the majority of cases the cost of the supply is not reported for public information. In Table I, the cost of the distribution system is all that is given unless otherwise noted. To this cost must be added an amount per capita of from $15 as a minimum to $40 or $50 as a maximum. In cities where there are no deep wells nor expensive pumps to install, the cost would run in the neighborhood of $15 or $20. Table I, will

TABLE I—EXPENDITURES FOR WATER SUPPLY SYSTEMS IN SMALL CITIES AND VILLAGES IN 1919

Town State	Population	Expenditure Total	Per Capita	Remarks
Oneida, S. D.	150	$30,000	$200.00	Incl. Plant etc.
Dumont, Minn.	188	Contract not yet awarded		
St. Clair Beach, Mich.	200 approx.	10,000	50.00	Approximately
Ladora, Iowa	260	17,790	58.50	
Waconda, S. D.	326	30,000	92.50	Complete
Garber, Okla.	382	22,500	59.00	
Pretty Prairie, Kans.	327	32,000	97.50	Complete
Menno, S. D.	621	35,000	56.30	
Foley, Minn.	710	40,000	56.30	
Hettinger, N. D.	766	27,000	35.00	
Dexter, Ia.	767	36,000	47.00	
Townsend, Mont.	759	30,000	39.60	
Wendell, N. C.	759	36,000	47.30	
Orem, Utah	800	100,000	125.00	Complete
Markesan, Wis.	892	55,000	61.50	
Walker, Minn.	917	25,558	27.80	
Fairmount, Neb.	921	35,000	37.00	
Grand Junc. Ia.	1,012	40,000	40.00	
Ferndale, Mich.	1,070	85,595	79.00	Complete
Spearfish, S. D.	1,130	49,800	44.00	
Spirit Lk., Ia.	1,162	52,763	45.50	
Roundup, Mont.	1,513	38,000	25.70	Approximately
Aiken, Neb.	1,638	40,000	24.00	
What Cheer, Ia.	1,720	50,000	29.00	



A Revolutionary Improvement in Sleeve Construction

THE new Flower sleeve (patented September, 1918) is unquestionably the greatest time and labor-saving improvement made since the first sleeves were built.

It comes to you ready for installation with the lead in place. The lead is firmly imbedded in dovetail joints in the sleeve and shaped to the contour of the pipe, which eliminates the difficulties of pouring in the trench. This permits making a smaller trench and setting the sleeve without the necessity of pouring lead for the joints.

The Flower sleeve simply needs to be bolted firmly in place, the tapping machine placed on the hub of the tapping valve, and the tap made in the usual way, with any standard tapping machine on the market. Little or no caulking is required in making the joint between the pipe and the sleeve proper.

The sleeves are all cored for class "B" pipe. The bolts used are "Sherardized," preventing rust, and are of ample size and length to permit the use of class "C" pipe or even larger. If caulking is necessary, the area is so small and the caulking joint so easily accessible and in full view, that it is easily done without special tools.

We want you to have full information regarding this improved sleeve, as it will facilitate your work and save you time and money. The old style sleeve requires so much lead in the larger sizes that the cost is materially increased.

Write us for price list and full description

The Flower Valve Manufacturing Company

117 Parkinson Street **DETROIT, MICHIGAN**

(19)

TABLE 11—APPROXIMATE COST OF HOUSEHOLD PLUMBING FIXTURES

	*Class 'A'	*Class 'B'
Laundry Tubs	$12.00	$ 6.00
Kitchen Sinks	12.00	6.50
Bath Tubs	32.00	18.00
Toilets	22.00	12.00
Wash Bowls	7.00	4.00
Hot-water Tanks for Kitchen & Bath Supply	9.00	7.00

* Class 'A' is a moderate priced article.
Class 'B' is a cheap article.

show approximately what has been expended in some of the smaller cities during the past year.

Note that as the size of the city increases, the cost per capita becomes less due to a greater density of population.

Table 11 gives the present, approximate, cost of plumbing fixtures. These data are given as local authorities usually anticipate that sewerage systems will quickly follow water systems, and in deciding on the installation of a water system the individual householder can see what the prospective cost for the house end of a sewerage system will be.

Recent Water Works Improvements at Lansing, Mich.

To the Editor:

In 1918 we completed the building of two 3½ million gallon reinforced concrete, circular, underground reservoirs. We also completed the construction of a new pumping station containing the following equipment: One 10-million gallon, high duty Snow pumping engine, one 5-million gallon Holly pumping engine, steam driven, one 4-million gallon, two stage centrifugal, motor driven Alberger pump and one 750-h.p. Stirling boiler equipped with Taylor Stokers.

We have added to our water supply which is from deep wells, three 20-in.x400-ft. wells in Marshall sandstone, equipped with 4-stage American Well Works turbine type of pump, located 130 ft. in the well and operated by 50-h.p., 2,300 volt A. C. motors which deliver their water to the reservoirs.

At the present time we have four sub pumping stations with the pumps located at the surface, pumping gangs of wells. These sub stations furnish us approximately 6,000,000 gals. of water per day. Our new 20-in. wells produce approximately 1,000,000 gals. of water per day per well.

We have something over 10,000 services which are all metered.

Very truly yours,

Guy G. Crane, Manager.

Lansing, Mich., Sept. 19, 1919, Board of Water and Electric Light Commissioners.

Ozone as a Disinfectant in Water Purification

By Joseph W. Ellms, Consulting Sanitary Engineer, Engineer Of Water Purification, Division Ave. and W. 32nd St., Cleveland, Ohio

Ozone was first observed by the Dutch chemist Van Marum in 1785, while operating a static electrical machine. In 1840 Schoenbein, while investigating the properties of the gases produced in electrolizing water and electrifying air, noted the odor and oxidizing properties of the gas and gave it the name of "ozone", because of its peculiar odor. It was not until the results of Soret's work in 1865 were known that scientists agreed that ozone was tri-atomic oxygen, although it had been generally held that it was some form of oxygen.

Ozone is an unstable gas requiring a large amount of energy for its formation (34,000 calories). It is but slightly soluble in water, and undergoes decomposition when heated. When strongly ozonized oxygen is liquefied and the product subjected to fractional distillation, a mixture of ozone and oxygen results, of which about 85% is ozone. The factors governing the "ozone-oxygen system", are none too well understood. The state of equilibrium which exists in a mixture of the two gases is dependent upon several factors, such as temperature, pressure, and electrical conditions that are extremely complex.

Ozone is an extremely energetic oxidizing agent. It attacks many inorganic oxidizable substances readily, and is particularly destructive of organic matter even at low temperatures. Its value as a bactericidal agent is probably due to this property, and is the reason for its use in the disinfection of drinking water.

For practical purposes, the production of ozone can best be effected by certain forms of electrical discharges through oxygen gas, or through air, which, of course, consists in part of oxygen. It may be well to describe the nature of these discharges so that the technical difficulties of the practical production of ozone will be better appreciated.

Production of Ozone

The phenomena of an electrical discharge through a gas is complicated. Ordinarily gases are non-conductors, but may become conductors under certain physical and electrical conditions brought about by the flow of the current through them. When two electrodes are separated by a gas, and connected to some source of high tension electricity, and between which the potential difference is being gradually increased, there is first produced an invisible electrical discharge which gradually becomes visible by a glow upon one of the electrodes. As the potential difference increases the corona effect is produced, which changes to the true brush discharge. It is this latter form of discharge that is regarded as the most effective in the production of ozone. By still further increasing the potential difference between the electrodes there is formed in succession the spark discharge, the flame discharge and finally the well known electric arc is established.

The brush discharge is of a dark blue violet color and is accompanied by a peculiar hissing sound and the "electric wind," which latter, according to J. J. Thompson, is due to a current of electrified ions that set the air in the vicinity of the discharge in motion. Brush discharges are readily formed on electrodes having sharp points or roughened edges. Alternating or direct current may be used, but usually the alternating current is preferable since it may be obtained more readily under high tension. A better production of ozone appears to be obtained with alternating currents of high frequency. A 500 cycle alternating current is more commonly used in ozone installations than one with lower frequencies.

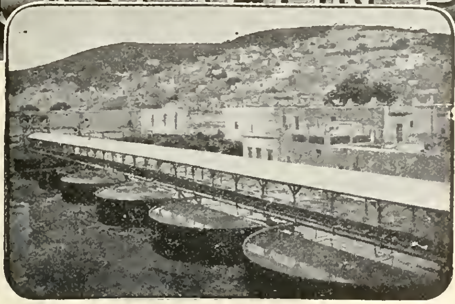
It has been found, as a result of much experimentation, that the use of a dielectric between the electrodes increases the yield of ozone, in other words, imposing even greater resistance than that offered by the air itself, effects a larger production of ozone by the discharge. Dielectrics are made from various substances, such as glass, mica, fused quartz and "Bakelite". While many other substances will act as dielectrics, the above named include the practical materials available in ozone work.

It will probably be appreciated from the little that has been cited of the complex character of the phenomena of ozone production, that the pressure, temperature and humidity of the air being electrified, the form, size, spacing and material of the electrodes, the kind of current employed, the frequency in the case of an alternating current, the voltage, amperage and other secondary influences of an electrical nature in general, and the kind and arrangement of the dielectrics employed, are factors that must all be given careful consideration in an efficient ozone apparatus. A brief description of one or two of the ozonizers that have been developed and have been used may be of interest.

Two Types of Ozone Apparatus

There are two general types of ozone apparatus. The Siemens-Halske ozonizers are of the vacuum tube type, in which air is drawn through an annular space across which high tension electrical discharges occur. An inside metallic

A "Daring Experiment"



in "Mexico's Treasure-House"

GUANAJUATO REDUCTION AND MINES COMPANY
Sand leaching tanks, with slime tanks in background, showing sands under treatment

"The position of the Bustos mill site, in a narrow valley with little flow of water to carry off the residues, made necessary a somewhat daring experiment, that of separating the crushing and concentrating portion of the plant by a distance of nearly a mile from the cyanide plant, which could be located on the main stream of the district where there is always sufficient water to carry away residue or tailings discharged. Against practically the unanimous opinion of all visiting engineers who were consulted, it was decided to carry the ores, after they had been crushed and concentrated, through a small cast-iron pipe, laid with uniform grade, from the Bustos mill to the cyanide plant situated in the heart of the city, utilizing simply the flow of the water in which the ore was crushed, due to the gravitation of the pipe. As the grade available was only 2¼% it was believed by almost every one that the sand could not be carried, and that the pipe would inevitably be choked and stopped up. Certain experiments were made upon this matter which caused the company to proceed with their construction on the original lines indicated.

SERVICE — CAST IRON PIPE — MEASURED BY — CAST IRON PIPE — CENTURIES
THE FIRST CAST IRON PIPE EVER MADE IN THE WORLDS HISTORY IS STILL IN SERVICE — MORE THAN 250 YEARS OLD

"The plants were started March 1, 1906, and have been in constant operation, 24 hours a day since that time. The pipe line, which was looked upon with so much fear by visitors, demonstrated at once that not only was there no danger of stoppage but that it would actually carry several times the volume of pulp treated with perfect ease, and with much less water than is normally used in the mere crushing and concentrating of ores. In fact, before the normal stamp-mill pulp, coming from the concentrators, is introduced into such pipe line, the company, by means of large settling cones, are removing something like 50% of the water and returning it immediately for mill use, the pulp flowing through a mile of 8-inch cast-iron pipe without experiencing the slightest difficulty, thus effecting the transportation of 250 tons of ore per day, for the distance of a mile through the heart of a crowded city, and this without a cent of expense. The pipe being, in general, buried throughout a considerable distance of its length, requires no expensive maintenance or inspection, and the right of way for such a line was, naturally, but a small fraction of what would have been necessary for any other means of transportation possible." (From "Mexico's Treasure-House", by Percy F. Martin, F. R. G. S., pages 93-94.)

The Cast Iron Pipe Publicity Bureau

1 Broadway — New York

cylinder acts as one electrode. It is covered by a slightly larger tube of glass covered with tin foil. The electrodes are water cooled. The General Electric and the Gerard apparatus are of the tube type also. The Small-Linder, Abraham-Marmier and Vosmaer apparatus use plate forms of electrodes and dielectrics. In some cases their electrodes are hollow and water cooled, but in others this cooling is not attempted. Voltages varying from 2,000 or 3,000 to 55,000 or 60,000 have been used in various ozonizers, but from 10,000 to 20,000 volts are more commonly employed. The yield of ozone increases with an increase in wattage for any given area of electrodes, that is with the density of the current per unit of area.

Application to Water

The application of the ozonized air to water, where the ozone is to act as a disinfecting agent, has been given considerable attention by investigators, but much more study of the problem is needed. In some cases the flowing water is used to suck the ozonized air through the ozone generator and into the water to be treated. This method is not susceptible of very close control. Another method consists in pumping the ozonized air into the bottom of towers down through which the water descends. A modification of this latter method consists in placing the air compressor back of the ozonizer, thereby avoiding handling the corrosive gas in the compressor. In this case the ozonizer must be in a container that will withstand the air pressure required to overcome the hydrostatic head of the water columns and the friction head resulting from the flow of the air through pipes and towers. A third but expensive method has been used in which the water has been sprayed into the atmosphere of ozonized air. Baffled towers where the counter-current system is used have not proven very successful.

A great deal is yet to be learned regarding the proper method of distributing the ozonized air at the bottom of the column of water, so that a maximum absorption of ozone may be effected.

Since the expenditure of so much electrical energy in ozonizing the air creates more or less heat, and in consequence subsequent decomposition of the ozone formed, cooling and drying the air by refrigeration have been usually resorted to. In small plants, passing the air over chemicals that would absorb the moisture, has also been successfully utilized. The yield of ozone apparatus naturally varies greatly, depending upon the manner in which the air is handled both before, during and after the passage of the gas through the ozonizer. Mr. Russell Spaulding in a report to the New York State Department of Health in 1913, very concisely states the desirable features of a good ozonizing apparatus. He estimates the theoretical yield of ozone for an expenditure of one kilowatt of electrical energy to be 1,386 grams. Since the actual yields of apparatus will vary all the way from 10 to 60 grams per kilowatt, it is evident that their efficiencies are very low. Mr. Spaulding summarizes his conclusions as follows:

"To summarize them, the main desiderata in generating ozone are:

1. A supply of alternating electric current at low cost.
2. An efficient transformer to obtain high tension.
3. Ozone electrodes that do not generate heat to
   a. Disrupt the dielectrics.
   b. Cause reversion of ozone to oxygen.
   c. Require external means of cooling.
4. Ozone electrodes that will approach the theoretical efficiency much more closely than the various systems now in use."

To this the writer would add, that unless the ozonized air is effectively applied to the water to be disinfected, that is, unless practically one hundred per cent absorption of the ozone by the water is effected the over-all efficiency of the entire apparatus may still be far from satisfactory. This phase of the subject still warrants considerable investigation.

The ability of ozone to reduce the bacterial content of a water has been too frequently demonstrated to doubt its inherent disinfecting properties. Nevertheless, it has its limitations in this direction like other disinfectants. In waters containing too large an amount of organic matter some of the bacteria may escape being killed. Pathogenic organisms probably are more readily killed than the ordinary water forms, because of the unfavorable conditions imposed upon them in the water, as well as from the destructive effect of the disinfectant. Spore forming bacteria may also escape destruction. Ozone, because of its strong oxidizing powers, has the merit of being able to oxidize and remove tastes and odors due to organic matter in suspension or solution, and to reduce the color due to vegetable stain. If ferrous iron exists in a water, it is able to oxidize the iron to the ferric condition, in which form it is practically insoluble, and hence may be removed by sedimentation and filtration.

In conclusion, it may be well to point out that ozone used as a disinfecting agent is no more a cure-all for a polluted water supply than are other disinfecting agents that are at present more widely employed. As a supplement to filtration processes ozone can be used with good effect, and thereby render the water safer for drinking purposes. That the process needs investigation and scientific development in order to make it economical and efficient, cannot be denied by its most ardent advocates. When such a development is brought about, its use in the purification of water will become more general and its points of real merit better appreciated.

Acknowledgment

The foregoing paper by Mr. Ellms was presented at the recent annual convention of the Central States Section of the American Water Works Association at Erie, Pa.

How to Finance Public Improvements in Illinois Villages

By William Artingstall, Consulting Engineer, Old Colony Bldg., Chicago, Illinois

[When it is suggested to a Village Board that they install a public water supply, or other public improvement, they invariably ask two questions: "What will it cost?" and, "Where will we get the money?" The first question can be answered only after making the necessary preliminary plans, cost estimates, etc. The present article is an answer to the second question for Illinois conditions. The Local Improvement Act in this state is such a formidable statute that it frightens progressive tendencies out of many honest heads. Originally drawn to safeguard the public, it is so precise as to detail and is so technically interpreted by courts that it makes it impossible for well-meaning people to progress without competent advice at every step. The present article clears up the points that are usually most bothersome to city officials and others, including engineers.—Editor.]

Four Methods of Raising Money

The four methods of raising money with the least hardship to the public are:

(a) Bonds may be issued to cover the cost of the work and the ordinary procedure followed to provide for a sinking fund for the retirement of the bonds as they come due. Bonds may be issued for periods of from one to twenty years and bear interest at not to exceed five per cent. per annum. The form is established by the statutes.

(b) Payment may be made out of the corporate funds raised by general taxation or out of an income, if the city is fortunate enough to have such source of revenue. In this case the five per cent. limitation applies.

(c) Payment may be made by levying a "Special Tax." This may be spread so as to cover the whole city or it may be limited to a certain district in which the proposed improvement is to be constructed. The tax must be an equal one and is spread regardless of whether one piece of property is benefited to a greater or to a less degree than some other piece. This method is not very satisfactory except in connection with some general improvement or in connection with a special assessment where the whole town is benefited, but not to the same extent as the district in which the improvement is located, and for which a special assessment is also levied. For instance, a park might be created, the cost of which would be met by a special tax; but the cost of the pavement on a particular street leading to this park would be met by a special assessment to cover the particular benefits which the property would enjoy over and above that enjoyed by the creation of the park.

This is a very common method of raising money to pay for much needed improvements and is equitable in that whatever tends to improve a neighborhood, or section of a city, also tends to improve the city as a whole.

(d) Payment may be made by what is known as "Local Assessments" the details of which will be taken up somewhat extensively in the following pages.

Special Assessment for Local Improvements

Where there are objections to constructing certain improvements either under a bond issue or by taxation, an opportunity is presented to take advantage of a different method of financing and prosecute the work under what is known as "The Local Improvement Act." Operating under this act, the cost of the improvement is assessed not against the whole municipality, but against only the property benefited, and the amount assessed against any particular piece of property must be only in proportion to the benefit the tract derives from the improvement. Furthermore, the determination of the benefits and assessments are in each case subject to review by the courts, which, if need be, revises the assessment.

In view of the many desirable features of this law, particularly the assessing of cost against only those benefited and in the proportion benefited, the municipality can consummate many improvements that would otherwise be postponed or abandoned entirely.

The Local Improvement Law is easily understood by the average citizen, but it is strictly interpreted by the courts, which insist on absolute compliance with the same and the uniformity of precedents which have been established.

Statutory Authority

The Constitution of the State of Illinois provides that—

"The General Assembly may vest the corporate authorities of cities, villages, and incorporated towns with the power to make local improvements by special assessments, * * * etc." and the statutes of the state provide that—

"The corporate authorities of cities, villages and incorporated towns are hereby vested with the power to make such local improvements as are authorized by law by special assessment or by special taxation of contiguous property or otherwise as they shall by ordinance prescribe."

The Supreme Court has held that the city or incorporated town or village may by ordinance adopt the provisions of the "Local Improvement Act" and where so adopted, they shall have the right to take all proceedings therein provided for and enjoy the benefits of all the provisions thereof.

The corporate authorities are clothed with the power to determine whether or not a local improvement is required and also its nature, character and location, when it shall be made, and the manner in which it shall be constructed and the courts have no power to interfere to prevent the construction on the grounds that its construction is not necessary or that the cost is an unreasonable burden on the property sought to be assessed.

(Sect. 8 L. I. Act Hurd's Rev. Stat. 1905).

(C. & A. RR. vs. City of Pontiac 169 Ill. 155).

(Clark vs. City of Chicago 214 Ill. 318).

The method of making the improvement, i. e., by special assessment, special taxation, by general taxation, or by a combination of one of the first two with the latter, rests with the discretion of the local authorities and their exercise of such discretion is not subject to judicial control. (Washburn vs. City of Chicago 198 Ill. 506. Walker vs. City of Chicago 202 Ill. 531. City of Chicago vs. Haywood 176 Ill. 130).

It is necessary however that "No ordinance for a local improvement to be paid for wholly, or in part, by special assessment or by special taxation shall be considered or passed by the City Council or Board of Trustees of any city, village or incorporated town, unless the same has been first recommended by the Board of Local Improvements, provided for in this Act." (L. I. Act Hurd's Rev. Stat. 1905.) Under this section it is evident that the ordinance must be first recommended by the Board of Local Improvements created for the purpose of determining the preliminary questions relating to the proposed improvement (or improvements) which when determined act as a restriction on the power over the property of the citizens, which power the corporate authorities possess. If the Board has competently performed its duties, it is fully informed as to the necessity for the work, the cost, and the views of the citizens or owners of the property to be assessed to pay for it, before a report and recommendation is made to the Corporate Authorities of the municipality. (Givens vs. City of Chicago 188 Ill. 348.

The Board of Local Improvements is assumed to have at heart the welfare of the community and to this end has full power to originate an improvement whether it is in harmony with the majority of property owners or not and even if it be in opposition to the sentiment of the public. (L. I. Act Sec. 6). However, a majority of the abutting property owners have the right to petition the Board to make an improvement and in that case the Board must take the necessary steps forthwith. The nature and cost of the work are matters that still lie in the discretion of the Board at the close of the public hearing. (L. I. Act Sec. 24).

The power conferred upon municipalities to levy local assessments is restricted to the real estate benefited, in the municipality. When the assessment is in the form of special taxes, the levy is confined to the contiguous property, and where it is by special assessment the levy is limited to only the property benefited by the proposed improvement. (Guild vs. City of Chicago 82 Ill. 472).

A special assessment is a charge against the property and not against the owner (Demster vs. People 158 Ill. 36) and in case of a sale of the land, the amount of assessment rests against the property and not against the previous owner. Payment of the assessment, of course, discharges the indebtedness.

Board of Local Improvements

The Local Improvement Act provides that "in cities of less than 50,000 inhabitants, the Board of Local Improvements shall consist of the mayor, or president of the village board, who shall be president of such Board of Local Improvements, the public engineer and superintendent of streets, where such officers are provided for by ordinance; but if no such officers shall be provided for, then the city council or board of trustees, as the case may be, shall by ordinance designate two or more members of such body, who with the mayor or president of such village or town, until otherwise provided for by ordinance, constitute the members of the Board of Local Improvements." (L. I. Act 406 Hurd's Stat. 1905).

Preliminary Proceedings to Making a Local Improvement

Section five of the act forbids the corporate authorities not only from passing but also prohibts them from considering an ordinance for a local improvement payable by special assessment, or by special assessment and special taxation of contiguous property, unless the same is first recommended by the Board of Local Improvements; and further, the ordinance must originate with the board. The reason for this is that without having obtained the necessary information, which as will be seen later, it is the duty of the board to obtain, before any recommendation is made in an ordinance to be adopted by the village board, no intelligent action could be taken by the latter in regard to an ordinance for such improvement.

A majority of the property affected (i. e., the owners of a majority of the frontage) may petition the board for a local improvement. This petition should be addressed to the Board of Local Improvements, which is vested not only with the power of carrying out the will of the property owners but also vested with the power of originating a scheme for an improvement on its own initiative to be paid for by special assessment or by special taxation. The board is required to adopt a resolution describing the proposed improvement and transcribe the same in its records at once, whether the act was presented by a petition of the property owners or originated with the board. Said resolution shall describe the proposed improvement, describe the property to be taken, if any (or any that may be damaged) and shall fix an hour and day not less than ten days from the adoption of the resolution, for the public consideration of said resolution and shall make a part of the resolution an itemized estimate of the cost of such improvement as made by the engineer for said board. (Bickerdike vs. City of Chicago 203 Ill. 636. L. I. Act Sec. 7 406), but such resolution need not state how the improvement is to be paid for nor need it include the signature of the engineer nor any general remarks. (Zeigler vs. City of Chicago 213 Ill. 61). "Notice of the time and place of such public consideration or hearing shall be sent by mail directed to the person who last paid the taxes for the preceding year on each lot, block, tract or parcel of land fronting on the proposed improvement, not less than five days prior to the time set for such public hearing. Said notice shall contain the substance of the resolution adopted and a notification that the extent, nature, kind, character and estimated cost, may be changed by said Board at the public consideration thereof and that if upon such hearing, the Board shall deem such improvement desirable, it shall adopt a resolution therefor and prepare and submit an ordinance as hereinafter provided." (Sec. 7 L. I. Act). At the time and place fixed for the public hearing, the Board shall meet and hear the representations of any person or persons desiring to be heard on any and all of the three subjects: the necessity, the nature and the estimated cost and only such objections as pertain to these shall be heard or considered at the preliminary hearing. (L. I. Act 406 Zeigler vs. City of Chicago 213 Ill. 61.) If necessary the Board may adjourn the meeting from time to time and no further notice need be sent to the property owners.

In case any person shall appear to object to the proposed improvement, or to any part thereof, the Board need not abandon the resolution, but they have the power to and "Shall adopt a new resolution abandoning the proposed scheme or adhering thereto, or changing, altering or modifying the extent, nature, kind character, or estimated cost of the improvement without further hearing thereon, as it shall consider most desirable and where said alteration does not increase the cost in excess of twenty per cent. of the amount estimated, no new hearing is required nor need a new estimate be submitted to the property owners.

If the proposed improvement is not abandoned, or is not stayed by a remonstrance petition, the Board of Local Improvements shall prepare an ordinance covering the proposed work and submit the same to the corporation authorities for passage. The ordinance shall prescribe the nature, character, locality, and description of the improvement, state whether it is to be paid for by special assessment, special taxation of contiguous property, or part by special assessment and part by special taxation, and it must describe within a reasonable degree all property, if any, that is to be taken or damaged.

The ordinance should also provide for payment by installments, usually five (but not to exceed ten) and that "the first and subsequent installments be equal in amount, except that all fractional amounts shall be added to the first installment so as to leave the remainder equal in amount and each a multiple of one hundred dollars." Also "Installments shall bear interest as herein provided until paid, at the rate of five per centum per annum. Interest on assessments shall begin to run from the date of the first voucher issued on account of the work done as aforesaid. The interest on installments on each installment shall be payable as follows: On the second day of January, next succeeding the date of the first voucher, aforesaid, so certified as aforesaid, the interest accrued up to that time on all unpaid installments shall be due and payable and be collected with the installment, and thereafter the interest on all unpaid installments then payable shall be payable annually and be due and payable at the time as the installments maturing in such year and shall be collected therewith." Any property owner may, if he so desires, pay the whole assessment against any lot or parcel of land, or any installment at any time with interest up to the date of payment, but no installment can draw interest unless the assessment is payable in more than one installment.

An ordinance shall also be presented to provide that a sum of not more than six per cent. of the total assessment shall be applied toward the payment of the costs and expenses of levying the assessment of letting the contract, etc. These costs shall be paid out of the first assessment. (L. I. Act Sec. 94 427 Hurd's Rev. Stat.). The ordinances must be passed before the assessment roll is confirmed by the proper court.

The corporate authorities may refuse to pass any ordinance presented by the Board of Local Improvements except where the proposed improvement is the result of a petition of not less than half of the property owners abutting on said improvement. But there is nothing in the Local Improvement Act to prevent the presentation of a new ordinance covering substantially the same improvement, in case the corporate authorities refuse or neglect to pass, after a reasonable time, the ordinance first presented. It is seldom, however that mature deliberations and investigations of the board as expressed in an ordinance and submitted to the council or village board, are rejected by the latter.

The ordinance when presented to the village board shall be accompanied by a recommendation, signed by a majority of the Board of Local Improvements. This recommendation shall be prima facie evidence in court that all the preliminary requirements of the law have been complied with and if a variance be shown in court, it shall not affect the validity of the proceedings unless the court determine the preliminary requirements which may have been omitted or neglected were with fraudulent intent. (Sec. 8 L. I. Act. McChesney vs. City of Chicago 205 Ill. 611). This recommendation need not be signed by the president nor the secretary so long as a majority of the members affix their signatures. (Sec. 6 L. I. Act. Dodge vs. City of Chicago 201 Ill. 68. Gage vs. City of Chicago 194 Ill. 490).

The Board of Local Improvements has no power to accept a contract which is vitally different from the proposed improvement as first presented and on which a public hearing was held but, acting in good faith, the board may accept an improvement of the same general character as that specified in the ordinance and the contract although constructed with trifling defects and differences from that contracted for and the action of the board will be binding on the property owners. (Gage vs. People 200 Ill. 432. Gage vs. Springer 211 Ill. 200). This wise decision permits the exercise of the ordinary changes in a contract for a local improvement such as is always necessary on any work due to conditions which cannot be foreseen or provided for without an unwarranted expenditure of money for preliminary investigations, etc.

The Local Improvement Act and the various amendments to the Act cover several other questions that are pertinent to the construction of an improvement under the Act. These and various forms of ordinances, resolutions, recommendations etc. should be taken up with or referred to an attorney specializing, or at least thoroughly familiar with the necessary procedure specified in the Act as has been interpreted by the courts.

Local Improvement—How Determined

As will be noted from the above, the whole question of making an improvement under the Local Improvement Act depends on what is a local improvement as provided for under the Act.

In a general sense, all improvements are local in that they do not extend to all parts of the state. This, however, is not what is meant by the constitution nor expressed in the terms "Local Improvement" when spoken of in the statutes, and particularly in the "Local Improvement Act." An improvement that may be local in its nature but does not specially benefit the property assessed and is not enjoyed by the property of the municipality in general lacks the essential of a "Local Improvement." For instance a High School built and paid for by a certain section of a city (school district) is not embraced in the act. But, the laying of water mains along a particular street for the use of the inhabitants thereof is held to be strictly a local improvement. (McChesney vs. City of Chicago 152 Ill. 543. Morgan Park vs. Wiswall 155 Ill. 262). So too, service pipes of individual owners are held to be a local improvement. (Palmer vs. City of Danville, 154 Ill. 156.)

In view of the legal question involved in constructing a water works system under the Local Improvement Act, I have referred this phase of the question to Mr. Dan'l M. Healy (Healy, Litzinger, & Reid, Attorneys) of Chicago. The substance of his report to me is as follows:

"The erecting of a reservoir or elevated tank for fire protection of certain parts of the city or of certain property is a local improvement and the cost of the same can and properly should be assessed against the property benefited.

"If a proposed water works system will be of benefit to a certain section of a city, or to certain property therein, as distinguished from the village as a whole, then and in that case the improvement can and should be installed as a Local Improvement and the cost of the improvement should be assessed in accordance with the provisions of this act.

"If the water works system be installed to embrace the whole of the property in the municipality, then and in that case, the improvement could not be considered as being embraced in the provisions of the Local Improvement Act, and the improvement should be made under an ordinance which provided for the payment to be made either under, or by, a general tax or by a bond issue. In this case, it would come under the constitutional five per cent. prohibition.

"Whether or not the improvement is "Local" is a question of fact; and the decision rests with the Board of Local Improvement, and their decision is final as to whether it shall be made by 'Special Assessment,' Special Taxation of the contiguous property, General Taxation, or a combination of the latter with either of the others."

Use of Explosives in Breaking up Concrete Piers Inside of Buildings

By Frank A. Huntington, New York, N. Y.

In the cellar of a factory building at Batavia, N. Y., there was a concrete pier 12 ft. high and 6 ft. square that the owner desired taken out. There was machinery nearby on one side and windows directly above on the other.

In building the pier, the concrete had been poured into forms in courses or tiers in the usual way, the junction between the courses being plainly marked. These courses were from 2½ to 3 ft. thick.

Selecting these junctions as the weakest point of attack, I drilled holes into the column 18 to 20 ins. deep and 1½ ins. in diameter. From three to five holes, usually one on all four sides of the column, were drilled.

For the upper courses. I loaded ¼ lb. of 20 percent dynamite in each hole, well tamped in with moist clay. For the sake of safety, only one or two holes were fired at a time. Had it not been for the danger of breaking the machinery, windows, or the floor above the pier, better results could have been obtained by firing all of the holes together.

Where more than one hole was set off at the same time, it was necessary to use electric blasting caps connected up with a blasting machine circuit, because in no other way is it possible to make charges go off at exactly the same instant and unless they do go off that way, the result is not satisfactory.

After loading the holes, blasting mats were made of burlap bags bound together to a thickness of about 4 ins. and thoroughly saturated with water. These mats were hung over the bore holes to prevent any flying chunks of concrete damaging surrounding objects.

In all, about 10 lbs. of dynamite were required to break up the pier. The dynamite cost $2.50 and the blasting caps about $1.25. Labor cost amounted to considerably less than a day's time.

Trade Note

The Van Wie Pump Co. of Syracuse, N. Y., successors to the Baldwinsville Centrifugal Pump Co., established in 1860, sold their business on September 8, 1919, to the East Iron & Machine Co. of Lima, Ohio. With this change the oldest centrifugal pump manufacturing concern in North America retires from the field. The business was established at Baldwinsville, N. Y., in 1860 and was first conducted by White, Clark & Company. Later, the name was changed to The Baldwinsville Centrifugal Pump Company. In 1880. the factory was removed to Syracuse, N. Y., and in 1905 it was incorporated as the Van Wie Pump Company. The line manufactured includes vertical and horizontal centrifugal pumps, double suction pumps, sand pumps, hydraulic dredge pumps, single action triplex pumps and vertical steam engines. It includes pumps suitable for. and adapted to, every industry where pumps are used—contractors, irrigation, mills, factories, dry docks, water works, dredges, etc. Thousands of these pumps of various types are in use throughout North America and are now operating in many of the largest plants and industries. The East Iron & Machine Company at their plant in Lima will at once begin to manufacture the entire line, as well as make parts and repairs for all Van Wie products. It is also their intention to make improvements on several of the pumps, which will greatly increase their efficiency. Their engineers are now working on this, and the Van Wie line of pumps will be developed to the limit of modern engineering skill. Established in 1903, the East Iron & Machine Co. occupies an enviable position in manufacturing circles. They build Merriman Steam Melting Asphalt Plants, and complete lines of machinery for the Chemical, Food and Allied Industries.

EDITORIALS

HE GETS RESULTS

So many public improvements of the first magnitude are being made in Chicago that it would be quite possible to write enough good articles about them to fill several issues of this magazine. Perhaps we have been neglectful of news opportunities close at hand. There are two reasons for this, now that we think of it. The first is that we assume that our readers, living in cities of all sizes in all parts of the country, are not greatly concerned about projects of exceptional importance in this great city, but much prefer articles dealing with problems of ordinary size and frequent occurrence. Then, too, we long ago resolved to be as different as possible from journals that fed their readers regularly with stories of the Catskill Aqueduct, the Hudson River Tubes, the Woolworth Building, etc., all of which are as remote from the problems of the average engineer as the design and construction of a planetary system of canals. The second reason for our neglect of these great local improvements is that we were reluctantly forced to conclude, some years ago, that these jobs would never get out of the prospective work department. The names of some projects became household words, but the works themselves seemed as far removed from the present generation as Fort Dearborn itself.

Now all this is changed. Chicago is doing things on a big scale again in the public improvement department. Many of these improvements undoubtedly possess dramatic interest of an exceptional order and quite possibly our readers would tolerate, if they did not entirely approve, descriptions of them. But the most dramatic features connected with these improvements are those of Michael J. Faherty, President of the Board of Local Improvements, known locally as "Mike."

When he entered his present office he found a quantity of plans and projects that dated back to more or less remote times. There was the Twelfth Street Widening project, the Boulevard Link project, etc. These projects had long been talked of but their arrival was always indefinitely delayed. Today the Twelfth Street widening is an accomplished fact and the Boulevard Link construction is well on its way and only yesterday, November 4, funds were voted to complete it. To Mr. Faherty must go the major portion of the credit for accomplishing these results.

How does he do it? We can not give a detailed answer to this question, but we suspect that his effectiveness as a public servant rests largely on his leonine courage and his ability to cut through or brush aside all manner of legal and other obstructions deliberately placed in his path. He is especially happy in the possession and in the exercise of a faculty for quickly acquiring private property for public uses at a fair price to all parties. He has the Homeric trait of taking what he requires. We do not want to give the impression that illegal methods are employed. The methods are not only legal but sometimes, it is said, extra-legal.

On November 4 the citizens of Chicago voted $28,600,000 in bonds to pay for the construction of six great public improvements in the city. It is reported as characteristic of Mr. Faherty that much of the preliminary office and survey work for the improvements on which the people voted "yes" this month, has been finished for months. On one great street extension project, involving the condemnation of property, he is now ready to go into court.

As soon as the result of the voting on these projects was known, Mr. Faherty issued the following statement:

> Now that we've got action, let's have it quick action. My advice to the property owners whose holdings will be affected by the improvements which the voters ordered is to lay off the lawyers and their promises to go shares with the owners on the loot they can get from damage suits. That stuff don't get you anything except a big supplemental assessment slapped on your property long after you think you've got something for nothing. In the long run we in the city hall will do better for you than those fifty-fifty lawyers can. The city expects us of the various equalizing boards to be fair and reasonable and decent with its citizens. We know the values and we don't want to gouge, and we won't be gouged. Not even a soap boiler is slick enough to put it over.

This statement is more eloquent than anything we could say. The saponaceous allusion in the concluding sentence is undoubtedly intended to apply to a laundry soap factory which for some time physically and otherwise obstructed the carrying out of the Boulevard Link plan.

Mr. Faherty is a most successful public works official. He understands the will of a majority of the people and, by successfully handling the obstructing minority, gets done what nearly everybody wants done. We believe he is appreciated by practically every class of people in this city. His methods are worthy of study by public works officials in other cities, especially in cities where a small minority of property holders obstruct progress year after year.

If we have bordered on the facetious at any point in this expression of appreciation it must be charged to our exuberant enthusiasm over the work of this man. In all seriousness we regard Mr. Faherty as the most useful citizen Chicago has had since the passing of the giants of thirty years ago.

MARKING HIGHWAYS WITH NAME OF BUILDER

It has long been the custom in cities to require the builder of a concrete sidewalk to mark his name upon it in some permanent fashion. The reason for this requirement is undoubtedly sound. The writer of a letter is inclined to weigh his words carefully if he expects to sign his name to it. Works marked with the name of the builder will represent his best efforts.

There is considerable discussion now in California of a suggestion to mark highways with the names of the builders. It is argued in support of the suggestion that the public has a right to know the names of good as well as poor builders. It is proposed that a large sign be placed at the beginning of each contract section of the road marked so that the public will know who built the road, when it was built, and of what material it is made. At least two other names should appear on these signs: those of the engineer who designed the road and the one who supervised its construction.

Beyond a question of doubt this simple expedient would furnish the public not only a basis for intelligent criticism but would inevitably lead to the greatest degree of care in the selection and use of the materials of construction. If it should become necessary for individuals to defend themselves against criticism the engineering profession, as well as the public, might learn something worth knowing.

AN ADMIRABLE ANNUAL REPORT

To print and distribute an annual report within 30 days after the end of the year is an accomplishment much out of the ordinary in the public works field. The first thing to command our admiration of the thirteenth annual report of the Board of County Road Commissioners of Wayne County, Michigan, therefore, was the fact that we had our copy within a month from the end of the year covered by it. The earlier annual reports have been issued promptly, but this is such an exceptional happening as annual reports go that attention should be called to it.

The report is admirable, also, for what it contains and for what it omits. Undoubtedly many of our readers have seen the report, but for the sake of emphasis let us point out its strong features. It contains a large number of interesting and instructive half-tone illustrations. The text briefly describes the outstanding features of the year's work in maintenance as well as construction. The successful use of construction equipment is illustrated and described. Naturally the report contains some general and specific information about this world-famed system of concrete roads; just the information, doubtless, that is most frequently requested.

The report also possesses the charm of brevity as it consists of but 100 pages. If the best work done in a year by these commissioners can be described in a 100 page report there is little excuse for the bulky reports one frequently sees.

FOR A HORIZONTAL INCREASE

Having left off the actual practice of engineering while still a comparatively young man it is perhaps only natural that the editor should be something of a worker for the younger men in the profession. We have always felt that the earnings of the profession should be increased from the bottom up. Certainly we have never thought that increases should both begin and end with men in the lower grades, yet something of that kind is occasionally proposed. In some cases where salary increases have been recommended, it has been proposed that men in the lower grades be granted increases as high as seventy per cent. while those in the highest grades of the same organization are slated for increases of only ten per cent. or for no increase at all. We are unable to defend any such adjustment.

Granting that all salaries have been too low, what justification can there be for raising those at the bottom without correspondingly raising those at the top? We must have a starting point for any readjustment and the starting point in this case should be the level of salaries existing at the outbreak of the war. Unsatisfactory as those salaries may have been they were the only ones we had and we fear there would be much difficulty in agreeing upon a better starting point. Those salaries had been fixed by the practical application of the law of supply and demand for several decades, by individual salesmanship, by the salary expectations of engineers, by their willingness to work for the salaries offered, and by all other factors of whatever nature. We believe, therefore, that the old level of salaries is not only the best but the only base from which to operate in working for increases.

Now what we have said applies to all grades alike. The same factors, generally speaking, had fixed the compensation of engineers in all grades. These salaries may have been absolutely wrong but they were relatively right. It is not likely anyone would argue that the chief engineer was paid more than he was worth in comparison with the salaries paid draftsmen and instrument men. If the salaries were relatively right then they must be proportionately increased to remain relatively right. A straight horizontal percentage increase seems the logical readjustment to work for. What that percentage increase should be is another story, but if it is 50 per cent., then the chief engineer should get it as well as his minor assistants. This is not only justice but it is the very essence of expediency as well, for a movement calculated to benefit but a few cannot hope to gain the support of all.

LARGER TYPE

A reader of this magazine recently suggested that the use of larger type in the editorial section would undoubtedly be appreciated by all our readers. In line with this suggestion the articles in this issue are set in 10 point type instead of in 8 point as formerly. Numerous readers have suggested from time to time that the headings of articles be made more prominent to facilitate the location of matter of greatest interest to the individual. The article heads in this issue have been set in capital letters instead of in capital and lower case as heretofore. These changes are made, therefore, in line with the suggestions of users of the magazine and we trust this will add to its usefulness.

RESURFACING OF OLD MACADAM STREETS IN MILWAUKEE

By C. J. Van Etta, Superintendent of Street Construction and Repair, Department of Public Works, City Hall, Milwaukee, Wis.

When the present Milwaukee city administration came into office in 1912 there was a total of 200 miles of water-bound macadam streets, and traffic conditions at that time rendered these streets impossible. The problem of maintaining this water-bound macadam was one which proved a puzzle to the Street Construction Department. For two or three years we attempted to resurface them with water-bound, but found that they would not hold up under traffic. We were compelled to go over the same streets year after year in order to keep them in any kind of a passable condition, which at the best, was not very good. We soon found that some other method would have to be resorted to in order to maintain these streets until such time as a permanent pavement, that is to say, a pavement with a concrete foundation could be constructed. After some experimenting we finally hit upon the plan of resurfacing with the penetration method, which we have found to be the only method that will hold our streets until such time as we could get to them to improve them permanently.

Cost of Resurfacing

Since 1915 we have averaged 200,000 sq. yds. per season with this penetration work, at a cost as low as 55c per square yard and ranging to the present season at 70c per square yard. This includes the entire cost of the work, both the labor and material for the base and also the tar application and the labor and the material in connection with the surface. This method of resurfacing has worked out so successful that up to date we have had absolutely no maintenance cost—up to this time have not found it necessary to tear up any of these streets for the purpose of constructing a permanent pavement. This, I think, is an excellent recommendation for this method, for I can say that it certainly has been a "life-saver" to this city where such a great amount of water-bound macadam existed.

The Method Employed

The method that we use for this resurface work is as follows:

The surface of the old road, after being cleaned of all loose dirt and foreign material, is spiked up or scarified. The road surface is re-shaped, made smooth conforming with the grade, but 2½ ins. below the finished grade, and rolled until firm and hard.

The roller used is a power roller of a type suitable for macadam road construction and weighs 10 to 15 tons.

The stone is of best quality crushed rock (or other approved road material metal) free from dust, loam and clay.

If, after re-shaping, the surface of the road is more than 2½ ins. below the finished grade, it is brought up to the required grade with crushed stone of a suitable size. The added stone is filled thoroughly with sharp sand, gravel, stone screenings or similar filler approved by the engineer, and rolled until smooth and firm. No filler shall be left on the surface.

The wearing course is placed over the base thus prepared and consists of a layer of stone which passes a 2¼ in. ring and is retained on a 1¼ in. ring, spread to a finished depth of not less than 2½ ins. This course is not filled but is keyed thoroughly together by rolling. The surface is left smooth and of even, firm texture, clean and free from dirt, clay, stone dust or other material which will prevent the easy penetration of the Tarvia X.

WALNUT STREET LOOKING EAST FROM 31ST STREET, MILWAUKEE, WIS., BEFORE AND AFTER RESURFACING OLD MACADAM WITH TARVIA X.

Tarvia X Employed

Tarvia X, heated to a temperature of not less than 200 degrees F. and not more than 275 degrees F. is spread uniformly over the surface when dry to the amount of not less than 1 7-10 gals., nor more than 1 8-10 gals. to a square yard.

Three-quarter inch crushed stone without dust, i. e., stone which passes a 1¼ in. ring and is retained on a ½ in. ring, is spread over the surface, filling the voids, but leaving none on the surface. This course is then rolled until firm.

The road is swept free from any particles of stone not held by the Tariva X. Not less than ½ nor more than ¾ of a gallon of Tarvia X to the square yard, heated to a temperature of not less than 200 degrees F. nor more than 275 degrees F. is spread over the surface and covered with stone screenings or sharp sand. The road is then rolled until compacted. A sufficient amount of screenings or sand is left on the surface to protect the road while setting up.

How the Work is Handled

When we first took up this work we handled the tar mixture with our own forces but this did not work out very successfully, owing to the fact that we handled it from tank cars which had to be heated and loaded into tank wagons and hauled to the street and applied under pressure, by hand. For the last two or three seasons we have been buying tar applied—the company furnishing it having their own equipment and their own forces to handle it. I find that this can be done cheaper and more effectively than the old method, as we have absolutely no concern about the applying of the hot tar as heretofore.

I would recommend, where this work is carried on, that a limestone be used if possible although a good heavy crushed gravel will answer. I am probably more partial to limestone owing to the excellent grade we are able to procure within a very short distance from the city, since we have three or four quarries within a radius of from 2 to 12 miles. I believe that limestone is superior to the crushed gravel owing to its absorption qualities, which you do not get in a hard crushed gravel.

I have received a great number of inquiries regarding our method of handling this work from various parts of the United States and Canada, and do not hesitate to recommend this method for residential sections for the larger cities and also streets of the smaller towns, where this type of surface would hold for years owing to the light traffic conditions.

Tarvia "K. P." Successfully Employed

In connection with this work I have found that where plumber's cuts and other cuts were made in streets, that had been resurfaced with this method that the new "K. P." mixture is an excellent material for replacing the surface. This can be mixed cold and if necessary, stocked and used anywhere from one to six weeks after it has been mixed or can be mixed by hand on the job, to be used to replace the penetration surface.

This mixture is certainly a wonderful thing in my opinion because of the simple manner in which it can be mixed and applied. It should be well rolled or thoroughly tamped in order to close up the surface as much as possible and to consolidate the mix.

LOCUST STREET LOOKING WEST FROM EIGHTH STREET, MILWAUKEE, WIS., BEFORE AND AFTER RESURFACING OLD MACADAM WITH TARVIA X.

We have been able to use this mixture, not only where there has been a penetration resurface, but have also used it for filling in on old brick streets, stone pavements, etc., where it holds up wonderfully well.

ROAD IMPACT TESTS

Test of impact delivered by various types of motor trucks on the road have been continued by the Bureau of Public Roads during the past few months with a 1½ ton truck, Class B Army truck, 5½ ton truck, equipped with solid tires.

The maximum impact pressure obtained with the 5½ ton truck was about 29,000 lbs. at 13 miles per hour, the wheel falling from a height of 2 ins. The truck carried 7.78 tons load. With a load of 5.65 tons, however, and under corresponding conditions of speed and drop, the pressure exerted was about 22,000 lbs.

With a Class B Army truck, carrying a total load of 7,750 lbs. on one rear wheel and having an unsprung weight of 1,837 lbs. on one rear wheel, speed 13 miles per hour, height of drop 2 ins., the impact was about 34,000 lbs.

Using another type of truck with a rear wheel load of 8,060 lbs., and with an unsprung weight of only 1,000 lbs. on the rear wheel, using the same conditions of impact as above, the impact pressure produced was only about 22,000 lbs., which is approximately 65 percent of the impact produced by the Class B truck.

It will be noted that the unsprung weight of the last truck is only about 56 percent of that of the Army truck. The indications are that the unsprung weight plays an important part in the impact delivered to the road.

Under corresponding conditions of impact as stated above a $1\frac{1}{2}$ ton truck with a total weight on one rear wheel of 3,470 lbs. and unsprung weight of 1,065 lbs., delivered an impact pressure of about 13,000 lbs.

The fact that the $1\frac{1}{2}$ ton truck having an unsprung weight approximately equal to that of the $5\frac{1}{2}$ ton truck exerted less impact than a $5\frac{1}{2}$ ton truck, but it seemed to show that the unsprung weight is not the only factor to be considered in connection with impacts delivered to roads. The total weight on the rear wheel must likewise be taken into consideration.

Tests to determine effect of impacts on road surfaces are just about to begin. A trial has been made with an impact testing device and certain imperfections corrected. It is expected that very soon a number of tests will be made.

UTILIZATION OF OLD CONCRETE PAVEMENTS AS FOUNDATIONS

By Arthur H. Blanchard, M. Am. Soc. C. E., Professor of Highway Engineering, University of Michigan, and Consulting Highway Engineer, Ann Arbor, Mich.

No material created by natural or artificial processes, when subjected to the forces of nature and vehicular traffic, will last indefinitely. This axiom, as applied to paving materials, is accepted by progressive highway engineers. The belief, in some quarters, that certain types of pavements, constructed today, will be in perfect condition in the days of our grandchildren's grandchildren is being relegated to the proverbial closet containing the family skeleton (see Fig. 1).

Cement-concrete pavements have been used in the United States for 25 years. Today the cement-concrete pavement is being employed by many state and county highway departments, in conjunction with brick, bituminous concrete and stone block pavements, for the improvement of trunk highways. Municipal highway officials are likewise using the above types of paving in addition to others suitable for municipal work.

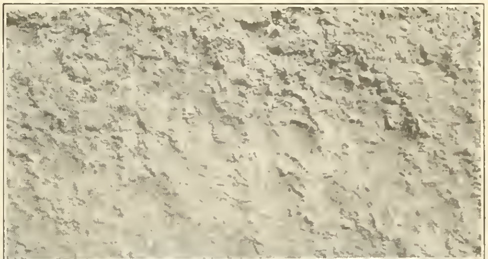
Utilization of Cement Concrete Pavements

It is apparent that the time has arrived when there should be a general recognition of the fundamental economic principles underlying the utilization of the cement-concrete pavement. This discussion will be devoted to the consideration of the cement-concrete pavement in its dual capacity of serving, first, as a wearing course directly subjected to traffic, and, second, as a foundation for a new wearing course such as a brick, bituminous, wood block or stone block pavement. Cement-concrete, as a resurfacing material, has purposely been omitted from the above general classification, as its utilization in this manner is, as yet, in an experimental stage, considered from the standpoint of economics.

In discussing the dual capacity of cement-concrete pavements, Lt.-Col. W. W. Crosby, formerly Chief Engineer, Maryland Roads Commission, states on page 1155, American Highway Engineers' Handbook: "When the ordinary concrete roadway surface begins to need repair it is practically only a question of a short time when the concrete surfacing will have to be abandoned as such, and turned into a concrete foundation because of the difficulties of repairing the concrete so as to leave it satisfactory as a road surface. The difficulties of proper repair are so well recognized that many engineers are now recommending such work to be done with bituminous concrete instead of cement-concrete, but of course this is only a step toward the ultimate transformation of the concrete roadway into a concrete foundation."

Need for Good Construction

The durability of properly constructed cement-concrete pavements, under different amounts and kinds of traffic, is a matter of conjecture within certain limits. The writer has seen cement-concrete pavements in an unsatisfactory condition, from the standpoint of serviceability, within two years after they were built. For example, the average cement-concrete pavement built by the State Highway Department of New York prior to 1914 had a short life due primarily to poor specifications, inexperienced



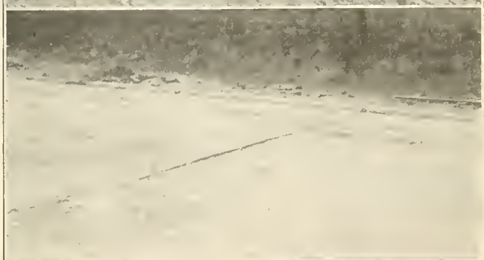


FIG. 1. TYPICAL SURFACE VIEW OF DISINTEGRATED CEMENT CONCRETE PAVEMENT.

FIG. 2. WORN OUT CEMENT CONCRETE PAVEMENT ON KILBOURN ROAD, MILWAUKEE COUNTY, WIS.

FIG. 3. OLD CEMENT CONCRETE PAVEMENT WIDENED FOR USE AS FOUNDATION FOR ASPHALTIC CONCRETE ON KILBOURN ROAD, MILWAUKEE COUNTY, WIS.

contractors, and low paid, inefficient inspectors. On the other hand, cement-concrete pavements, built in accordance with methods recommended by the National Conference on Concrete Road Building, the American Concrete Institute, the Portland Cement Association, Wayne County or Sioux City, have a life much longer in duration than the sad case heretofore mentioned. Recognizing the fact that inexperienced highway officials, contractors and inspectors are responsible for the construction of many poor pavements of types inherently good, the writer,

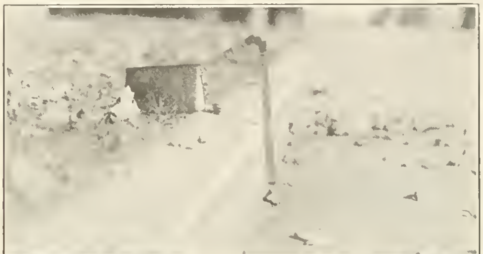


FIG. 4. FIVE INCH CURB ON STREET PAVED WITH CEMENT CONCRETE.
FIG. 5. SINGLE CAR TRACK ON STREET PAVED WITH CEMENT CONCRETE.
FIG. 6. DOUBLE CAR TRACKS ON STREET PAVED WITH CEMENT CONCRETE.

while consulting engineer in 1916 to a county just starting out on a reconstruction problem, recommended the use of cement-concrete, as one type for trunk highways, provided that the engineering staff of the Portland Cement Association would instruct the contractors in the proper methods of building cement-concrete pavements.

Engineers who have used cement-concrete pavements for years place their life, under trunk highway traffic, at between 8 and 15 years. Two examples will be cited. The cement-concrete pavement on Kilbourn Road, built by the Milwaukee County Highway Commission in 1913, had a life of six years and was utilized in 1919 as a foundation for a wearing course of asphaltic concrete (see Figs. 2 and 3). In 1910 a cement-concrete pavement was constructed on Grand River Road by the Wayne County Road Commissioners. In 1916 this road was resurfaced, as an experiment, with 3 ins. of cement-concrete. The Commissioners state that "Grand River Road was selected for this experiment because we felt that it would receive the severest kind of test, on account of the heavy mixed traffic which uses this highway, and because the section selected was rough and uneven."

The highway official or engineer who is responsible for the economic expenditure of public funds on highway improvements should look ahead and build for the future. As it is self-evident and generally admitted by broad-gauge engineers that the cement-concrete pavement will wear out within the first or second decade after it is constructed, the question naturally arises as to what will be done with the pavement when it reaches such a condition that its economic usefulness as a wearing course is at an end. Engineers, who have a proper appreciation of the public interests with which they have been entrusted, expect to use the worn-out concrete pavement as a foundation for a new wearing course.

Dual Capacity of Cement-Concrete Roads

The consideration of the dual capacity of the cement-concrete pavements will be dwelt with from three viewpoints: First, a road without the pavement adjoining a car rail; second, a curbed street without car tracks; and third, a road or street with the pavement built flush with the car track rails.

On Highways Without Car Tracks

On highways without car tracks and outside of urban districts, it is generally practicable, from a construction standpoint, to use a worn out concrete pavement as a foundation. Of course, cement-concrete or other suitable headers should be constructed and the shoulders must be raised and, in some cases, widened. The Maryland State Roads Commission has resurfaced in 1919 two worn out cement-concrete pavements, one built in 1913 and the other in 1914, with asphaltic wearing courses. Mr. J. N. Mackall, Chief Engineer, states that "both of the cement-concrete roads described have reached the end of their life, as such. They show a number of cracks, and are disintegrating. We have tried patching cement-concrete without success, and are now covering them with a 1½-in. binder course and 1½-in. topping course of asphalt."

On Streets With Curbs at Established Grades

On streets with curbs at established grades the problem may be unnecessarily complicated. Many municipal officials unfortunately have not looked ahead and considered the conditions with which they will be confronted when their cement-concrete pavements wear out. For example, an investigation of practice in many municipalities reveals the fact that cement-concrete pavements have been constructed between curbs where the clear curb depth is 5 ins. (see Fig. 4), the depth which local conditions require as a minimum. The construction of a wearing course on the worn out concrete pavement will reduce the desirable minimum depth to from 3 ins. to 1 in., dependent upon the type of new wearing course. It is self-evident that the use of any type of bituminous pavement will allow the curb depth to be cut down the least amount, and hence this type is being considered by many engineers as the most desirable form of resurfacing. In order to provide for a new surface, when 5 or 6 in. curb depths are encountered, it will be apparent that the curbs must be reset, which not only entails unnecessary expense, but this procedure may also be impracticable from the standpoint of abutting property. The obvious solution is to construct the cement-concrete pavement at an elevation or grade which will provide a curb depth of at least 7 ins. under conditions where the curb depth should be not less than 5 ins.

For example, the wise policy of the City Engineer of Springfield, Mass., will be mentioned: "The city recognized as its problem the construction of a pavement which would not only carry successfully all present traffic, but which, at some time in the future, could be utilized in connection with the development of the road into a city street, as the city was building up rapidly in this direction. The roadway was laid with concrete pavement, the top surface of which was made parallel to and 2 ins. below the middle 22 ft. of the surface elevation proposed for the street pavement in the final development. When the growth of the city out this road may make it desirable to reconstruct it as a street the present concrete roadway will be widened by 12 ft. on each side, and the whole will then be used as a concrete base and covered with a 2-in. layer of stone-filled asphalt. The present pavement is 6½ ins. thick, which will be ample for a foundation for such a wearing surface, even though it may have lost ½ in. or so of material by wear in the meantime."

Where Pavement is Flush with Car Track Rails

The acme of unfortunate and uneconomical practice is reached when the construction of a cement-concrete pavement flush with the rails of car tracks is encountered (see Figs. 5 and 6). From the standpoint of conservation, a railway company should not be required to pay for the construction of its tracks to a new grade after it has once built its tracks to a grade established by the state, county, town or municipality. Many municipal franchises require that only the cost of construction to one established grade shall be paid by the railway company. In case a cement-concrete pavement, flush with the rails, is worn out and it is desired to use it as a foundation for a new wearing course, it will be necessary to raise the tracks and, in many cases, the expense incurred must be met by the municipality. The cost of this reconstruction is prohibitive from an economic standpoint. If, however, the old concrete pavement is not used as a foundation, usually the only satisfactory solution will be to tear up the worn out pavement. Milwaukee County, Wisconsin, has recently had this experience and, after an unsuccessful attempt to make the railway company raise its tracks from the established grade to a new grade, has broken up its worn out concrete pavement and thus thrown away the original investment. Future practice should conform to the rule that a cement-concrete pavement should never be constructed on roadways where the pavement must be built flush with the rails and the track areas form an integral part of the roadway surface subjected to vehicular traffic.

THE CONSTRUCTION OF PORTLAND CEMENT CONCRETE PAVEMENT FOUNDATIONS (CORRECTION)

Readers are requested to note a correction to the article of the above title as published on pages 169 to 171 of the October issue. As first set up the captions for the three cuts were in the wrong size of type. They were reset in the proper size and were then transposed before being inserted. Thus the captions as printed should have been inserted as follows: Figs. 3 and 4 under the first cut in the article; Figs. 5 and 6 under the second cut; and Figs. 1 and 2 under the third cut. The error was purely mechanical and was in no way the fault of the author of the article. Newspaper readers, familiar with the transposed line, probably had no difficulty in mentally transposing these captions to their obviously proper positions.

MORE ENGINEERING ON SEWER INLETS

The article entitled "More Engineering on Sewer Inlets," contributed to the October number of Municipal and County Engineering by Mr. W. W. Horner, Chief Engineer, Sewers and Paving, St. Louis, Mo., was much appreciated by engineers in various cities, as letters to the editor have demonstrated. Extracts from some of the letters received follow:

To the Editor:

I was interested in the article in the October number of your journal, entitled "More Engineering on Sewer Inlets." Mr. W. W. Horner, Chief Engineer of Sewers and Paving, of St. Louis, makes a valuable contribution to the profession in his tests and the conclusions he draws from them. This is particularly true in cities where streets have steep gradients and water is apt to collect in the lower stretches of the street because of inadequate inlets to the sewers.

This condition does not obtain in Chicago, as the streets are practically level and the sewer inlets are frequent. The inlets are usually horizontal grates and unless obstructed by leaves or other refuse will take the water and discharge it into the sewers more rapidly than the sewers themselves can carry it away.

Very truly yours,
C. D. Hill,
Engineer, Board of Local Improvements,
Chicago, Ill.

To the Editor:

I feel that this study on storm water inlets will be very beneficial to engineers and will give them some idea of the amount of water which can enter the inlet. The standard inlet which we use in this city is 2 ft. wide and 6 ins. high, and we endeavor to place them close enough so that no inlet will receive more than 1 cu. ft. per second.

Very truly yours,
W. J. Weaver,
Engineer in Charge Sewer Construction,
Columbus, Ohio.

To the Editor:

It is a pleasure to receive Municipal and County Engineering. I found the article by Mr. Horner in the October number very enlightening. By coincidence, when this number was received, it so happened that I was reading three or four articles written by Mr. Horner in 1914 pertaining to the Mill Creek sewer in St. Louis. Contributions from Mr. Horner are of real benefit to anybody concerned in the design of sewerage systems.

Very truly yours,
W. H. Ohmen, Asst. Engineer,
Department of Public Works,
San Francisco, Calif.

Walter G. Turley, City Engineer of Sante Fe, New Mexico, writes: "Mr. Horner's investigation fills a want in the literature of the profession, and I appreciate his efforts and results."

A CONCRETE ROAD

The accompanying picture tells its own story. We publish it not so much for its news value as for its beauty. We present this view of a North Carolina highway as an eye tonic.

The view does serve to illustrate the quality of the highways in Guilford County, N. C. It shows a part of the road that won first prize in the Glidden Tour from New York to Atlanta. This road connects Greensboro and High Point. It is 16 miles long and the people of Guilford County hold to the opinion that there is not a better road in the United States. Disinterested observers have called it one of the finest pieces of county highway in the nation. For this handsome picture we are indebted to C. M. Vanstory, President of the North Carolina Automobile Association, to Mr. G. Daniels, Secretary of the Greensboro Chamber of Commerce and to the Roberts Film Co. of Greensboro.


VIEW ON 16 MILE CONCRETE HIGHWAY CONNECTING GREENSBORO AND HIGH POINT, NORTH CAROLINA.

PROPOSED SCHEDULE OF SALARIES FOR ENGINEERS IN STATE HIGHWAY SERVICE

The Committee of the American Association of Engineers on Salaries of Engineers in Public Service invites discussion of the accompanying proposed schedule for engineers in state highway service before presenting it to the Association for final adoption.

In appointing the committee last June the Board of Directors gave it authority to add to its personnel, with the approval of the President, representatives of the several branches of public service engineers in order that the schedules as finally adopted should not only harmonize with reference to each other, but that they should be generally accepted as stating the value of engineering service to the public, hence what it should pay for such service. In discussing the schedules sent out from time to time engineers should therefore bear in mind that the endeavor of the committee is not to standardize and classify engineering service, but to price this service.

The Committee on Salaries of Engineers in Public Service consists of S. C. Hadden, Editor of "Municipal and County Engineering"; H. G. Shirley, Secretary Highways Industries Association, Washington, D. C.; J. H. Prior, Consulting Engineer on Public Utilities, Chicago; A. R. Hirst, State Highway Engineer, Wisconsin; F. H. Newell, President of the Association, and A. N. Johnson, Chairman, Consulting Highway Engineer of the Portland Cement Association.

Preliminary to drafting the schedule for highway engineers, the following were invited to serve as corresponding members of the committee: Thos. H. McDonald, Chief of U. S. Bureau of Public Roads; W. L. Basset, Bureau of Municipal Research, New York; Col. W. D. Uhler, Chief Engineer, Pennsylvania State Department; A. B. Fletcher, State Highway Engineer of California; A. W. Dean, Chief Engineer, Massachusetts Highway Comission, and Clifford Older, Chief Engineer Illinois State Highway Department.

It is to be realized that the accompanying schedule is not an outline of organization. But in order that each state organization may readily place each person within it, it has been thought best to enumerate in considerable detail the description of the various positions even at the expense of some apparent repetition. The grouping of various positions is clear from the captions.

The proposed schedule follows:

ADMINISTRATIVE AND EXECUTIVE POSITIONS

Chief Engineer—

In charge of all construction and maintenance work of the department, acting as chief executive officer	$8,000	$15,000

Engineer of Construction—In immediate charge of all construction work from time contracts are let. Assigned to state headquarters	6,000	10,000
Engineer of Maintenance—In charge of all maintenance work. Assigned to state headquarters	6,000	10,000
Engineer of Bridges—In charge of preparation of specifications and designs for bridges, and in charge of construction of special bridges. Assigned to state headquarters	5,000	8,000
Office Engineer—In general charge of preparation of plans and specifications for all construction work up to point of letting contracts. Assigned to state headquarters	5,000	8,000
Engineer of Tests—In general charge of laboratory routine tests, investigations, material surveys and field inspection of materials	4,000	7,000
District Engineer—In charge of all construction and maintenance work in a division or district of the state, generally including a number of counties. Assigned to division headquarters	5,000	8,000

ENGINEERING POSITIONS INVOLVING SOME ADMINISTRATIVE DUTIES IN THE HIGHER GRADES

Advisory and Consulting Engineer—To the Chief Engineer	$5,000	$10,000
First Assistant Engineer—Assigned to Construction Engineer at state headquarters. In general charge of office work in connection with execution of contracts	3,600	5,000
First Assistant Engineer—Assigned to Maintenance Engineer at state headquarters. In general charge of office work in connection with maintenance	3,600	5,000
First Assistant Bridge Engineer—Assigned to Engineer of Bridges at state headquarters. In charge of bridge drafting room and responsible for bridge specifications and bridge designs	3,600	5,000
First Assistant Engineer—Assigned to Division Headquarters. In general charge of division headquarters office	3,600	5,000
Assistant Engineers—Assigned to Construction Engineer at state headquarters. Duties as assigned	2,400	4,000
Assistant Engineers—Assigned to Maintenance Engineer at state headquarters. Duties as assigned	2,400	4,000
Assistant Engineers—Assigned to Bridge Engineer at state headquarters. Acting as especially skilled draftsmen, designers and computers	2,400	4,000
Assistant Engineers—Assigned to Office Engineer at state headquarters. Preparing and checking specifications and plans as received from division offices. Work as assigned	2,400	4,000
Chief Chemist—Assigned to Engineer of Tests at state headquarters. In charge of the chemical work of the laboratory	3,500	5,000
Assistant Engineers—Assigned to division headquarters. Some in charge of construction, others in charge of maintenance, both field and office work as assigned	2,400	4,000
Assistant Engineers—Assigned to laboratory work. Tests and investigations in laboratory, field examinations and reports on sources of materials as assigned	2,400	4,000
Assistant Chemists—Assigned to laboratory	2,000	4,000
Chief Draftsmen—Assigned to division headquarters. In charge of division headquarters drafting room and the preparation of plans	2,400	4,000
Chiefs of Survey Parties—In charge of surveys and relocations; during time spent in office, work on plans and computations as assigned	2,400	4,000

INSPECTION SERVICE

Confidential Inspectors—Assigned to Chief Engineer. Report only to Chief Engineer on work of all character wherever it may be. Positions of peculiar responsibilities, represent the chief engineer	4,000	5,000
General Inspectors of Maintenance—Assigned to state headquarters	2,400	4,000
Inspectors of Bridge Construction—Assigned to Bridge Engineer at state headquarters. Inspecting construction of the larger bridges only. Work inside on bridge plans and design as assigned	2,400	4,000
Field Inspector of Materials—Assigned to Engineer of Tests at state headquarters. Inspection of materials in the field and at point of manufacture	2,400	4,000
Inspectors of Construction—Assigned to Division Engineers at division headquarters. Inspect construction reporting to division engineers or a number of inspectors may be under immediate charge of some assistant engineer to whom they make immediate reports	2,400	3,000
If inspectors are employed during working season only to receive per month	250	300
Inspectors working the year around are at division offices during winter on plans, estimates and computations, as assigned.		

JUNIOR ENGINEERING POSITIONS CONCERNED WITH ROUTINE WORK ONLY

Engineering, Draftsmen, Computers, Checkers, Estimators—Assigned to state headquarters	1,800	2,400
Tracers, Computers, Checkers—Assigned to bridge engineer	1,800	2,400
Engineer Draftsmen—Assigned to division headquarters. Preparation of plans, computations, estimates, checking	1,800	2,400
Instrument Men—Transitmen and levelers. Those employed the year around work inside division offices part of time on plans, computations and estimates	1,800	2,400
If employed by month during construction season only, they should receive, per month	200	250
Rodmen and Chainmen	1,200	1,500
Laboratory Assistants—Routine testing, laboratory records	1,800	2,400

All engineers working away from state or division headquarters to which they may be assigned are to receive traveling and subsistence expenses.

This schedule not to operate to reduce any salaries now existing.

Any comments or suggestions on the foregoing schedule should be addressed to the American Association of Engineers, 63 E. Adams St., Chicago.

The readers of Municipal and County Engineering will be interested to know that the association has organized committees at work drafting similar schedules for county highway engineers and for engineers in municipal service.

ASPHALTIC FILLER FOR BRICK PAVEMENTS

By Allen D. Dimmick, Middle Western Division, Asphalt Sales Department, The Texas Company

A number of articles recently appearing in the engineering journals, dealing with the subject of brick paving, have stated it as the experience of the writers that splendid results are obtained by the asphalt filler type of construction. It might be interesting in this connection to review a little of the history of this phase of brick pavement construction.

VIEW ILLUSTRATING SMOOTHNESS OF BRICK PAVEMENT WITH ASPHALTIC FILLER, MAIN STREET, GALESBURG, ILL.

Constructed by J. B. McAuley, Galesburg, Ill. Texaco No. 32 Asphaltic Filler Used.

When brick pavements were first laid and it was necessary to find some material to fill the joints, merely to keep the brick from rattling around on the base, sand was the first and most obvious material to suggest itself, and for a time was universally used both as a cushion under the brick and to fill the joints.

Why Sand Filler Failed

It was soon realized, however, that brick pavements laid in this manner were open to a number of objections. Far from being waterproof, the sand filler actually blotted up the water, which collected between the foundation and the wearing surface resulting in ultimate disintegration of the latter. The brick, as the sand ran or was blown out of the joints, showed a tendency to chip and spall at the unprotected edges under the impact of traffic and horses' hoofs. Worst of all, no way could be found to keep the sand in the joints, which were soon emptied and the brick left loose on the sand cushion beneath, which consequently became more and more uneven as the brick moved in their bed, resulting in inequalities in the surface. Furthermore, the joints became unsanitary as they were filled with street liquids and refuse. The extreme noisiness as compared with the various forms of bituminous construction furnished another objection on the part of property owners.

APPLICATION OF ASPHALTIC FILLER ON BRICK PAVEMENT BY THE SQUEEGEE METHOD, NEWPORT AVE., TAMPA, FLORIDA.

Constructed by Georgia Engineering Co., Augusta, Ga. Texaco No. 39 Paving Filler Used.

Introduction of Bituminous Filler

To meet these difficulties it was believed that a bituminous filler would give good results. It was immediately plain that a bituminous filler eliminated expansion troubles and the consequent heaving, as well as furnishing a perfect waterproof bond. The filler could also be poured flush with the surface of the brick and, to a great extent, protected the edges from spalling.

In the first decade of the twentieth century, when the pure asphalts began to come upon the market in quantity, they were promptly recognized as a superior filler, principally because the asphaltic filler retained its life as long as the pavement lasted, and was but slightly susceptible to temperature changes. In addition, asphalt was found to have great adhesiveness and binding power under climatic temperature changes.

Constant Improvement in Asphaltic Filler

As a result of these qualities asphalt was quickly adopted very generally as a filler, and each year showed less and less of the older expedients in use. Of course a wide difference has always existed and always will between the better and cheaper grades of asphaltic filler on the market. There has been a constant improvement in the quality of asphaltic filler produced, and this has been reflected in the increasing use of it throughout the country. Mr. Geo. W. Tillson, a recognized authority, writing five years ago, stated that sand filler had been almost entirely abandoned at that time.

Expansion and contraction are the natural enemies of a brick or block pavement. Expansion naturally occurs as a result of extreme heat, and contraction takes place during the cold weather. It is clear that a successful joint between the bricks or blocks should allow for this contraction and expansion and at the same time prevent the bricks or blocks from shifting in their positions on the base, and at the same time preventing excessive internal stresses in the pavement surface.

From these natural tendencies through which the success or failure of a brick pavement is largely affected, it must appear that a filler must be placed between the bricks which is of such consistency that it will adapt itself to climatic changes. At the same time, it must adhere firmly to the blocks at various temperatures, and above all not bleed or flow in hot weather, nor become brittle and pulverize in cold weather.

Rolling is Necessary

In order to obtain a true and even contour on the surface of the pavement, the blocks should be thoroughly rolled, but not too heavily, as an excessive weight will push the blocks into the sand cushion on which they are laid, as a result of which the sand pushes up through the interstices between the blocks thereby occupying the space which the filler should occupy.

Applying Asphaltic Filler

Two methods of applying asphaltic filler have been used more extensively than any others. One method is by pouring the asphaltic filler into the interstices between the bricks from pouring cans, the spouts of which are designed so as to be trough-shaped. The other is called the squeegee method in which the hot asphalt is spread directly over the surface of the blocks and forced into the joints by either rubber or hot iron squeegees. Two applications of the asphaltic cement are usually desirable to procure the best results, because after the filler has been poured it penetrates the cushion and shrinks in the process of cooling.

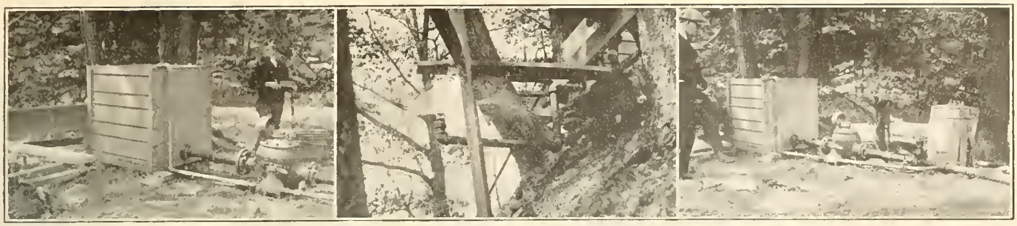
Maximum results are procured when the filler is heated to a temperature of from 350 to 400 degrees Fahrenheit.

Sand Should Be Hot

When the joints between the brick have been thoroughly filled with asphaltic filler, a uniform spreading of clean, sharp sand should be made over the surface of the pavement. The sand should be heated to a temperature of approximately the same as that at which the asphalt was poured. The hot sand sinks into the asphalt and settles into the joints, producing a material which is somewhat in the nature of a mastic.

Rolling is usually proper after the sand has been evenly spread and before the asphalt is thoroughly cool. Rolling imbeds the sand into the asphalt and causes an even contour of the surface of the blocks.

As a summary, it might be stated that an asphaltic



VIEWS OF APPARATUS USED AT BINGHAMTON, NEW YORK, IN TESTS TO DETERMINE DISCHARGE OF VARIOUS SPRINKLING FILTER NOZZLES UNDER VARIOUS HEADS.
Fig. 1 (Left). Stilling Box and Supply Lines. Fig. 2. Discharge End of Apparatus. Fig. 3. Close View of Supply Pipes.

filler produces a pavement which is not affected by temperature changes, and that cannot be permeated by water and street liquids. The asphaltic filler protects and prolongs the life of the blocks and reduces the noise common to brick pavements laid with rigid fillers. Furthermore, it provides a surface which is smooth and comfortable, less expensive in upkeep and highly attractive in appearance.

TESTING DISCHARGE OF SPRINKLING FILTER NOZZLES

By W. Earl Weller, City Engineer, Binghamton, N. Y.

The Bureau of Engineering of the city of Binghamton, N. Y., has recently completed a rather extensive series of tests to determine the discharge of various sprinkling filter nozzles under various heads. The results of these tests are shown in the accompanying diagram. (No. III.)

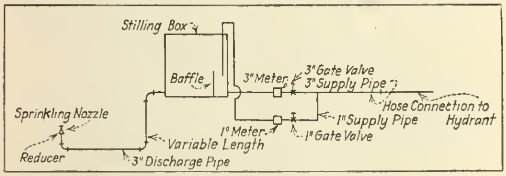


DIAGRAM 1. DIAGRAMATIC SKETCH SHOWING ARRANGEMENT OF APPARATUS FOR SPRINKLING FILTER NOZZLE TESTS.

The apparatus consisted of a metered connection to the city's water supply, a stilling box 3 ft. x 3 ft. x 3 ft. inside, and a discharge line. The apparatus was set up in such a manner as to make possible the variation of the static head from 1 ft. to 12 ft. by merely changing the vertical length of pipe in the discharge line. The arrangement of the apparatus is most clearly shown in the diagram and illustrations accompanying this description. It will be noted from diagram No. 1 that a 3 in. and a 1 in. supply line are provided. These were necessitated by the variation in flow, the 3 in. line being used for high heads and free discharges and the 1 in. line being used for low heads and small discharges.

In conducting the tests the sprinkling filter nozzle was first omitted and a determination made of the discharge through the remainder of the system. Water was admitted to the stilling box through the 3 in. line until the surface stood at a predetermined level above the outlet. By adjusting the gate valve on the supply line the surface was maintained at this elevation while 80 to 100 cu. ft. of water passed through the apparatus. The time consumed was measured by stop watch. Prior to the starting of the test the area of the discharge end of the reducer had been carefully determined. These observations gave the factors "Q" (discharge in cubic feet per second) and "a" (area of discharge) from which "v" (velocity of discharge) could be computed. This velocity was changed into terms of head available at the nozzle by the usual formula. The computed head was checked by an actual observation. The purpose in observing the free flow through the apparatus was to obviate the necessity of computing the friction head in the system. After the available head had been determined for one eleva-

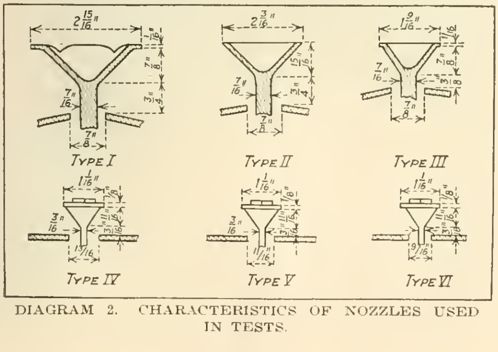


DIAGRAM 2. CHARACTERISTICS OF NOZZLES USED IN TESTS.

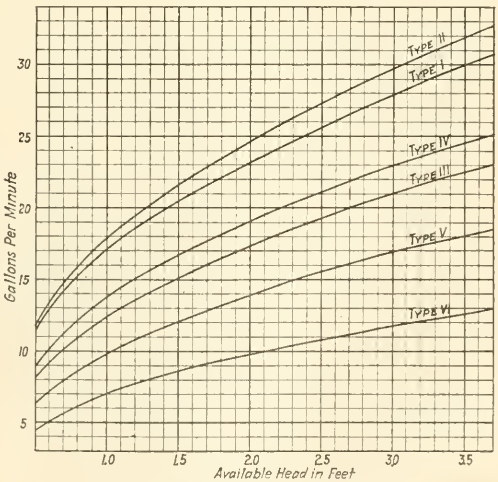


DIAGRAM 3. DISCHARGE CURVES FOR SIX TYPES OF SPRINKLING FILTER NOZZLES.

tion the water surface was raised or lowered 6 ins. and a new series of observations taken.

When the complete range of heads possible without a change in the discharge piping had been observed, as explained above, the various nozzles were similarly tested, "Q" being computed directly from the meter readings and the observed times. In the plot of results "Q" is given in gallons per minute and "h" in feet of head acutally available at the nozzle. The characteristics of the six types of nozzles tested are shown in diagram No. II. Types 1, 2 and 3 are Taylor nozzles, type 1 being a so-called "square" spray type. Types 4, 5 and 6 are Worcester nozzles differing from each other only in the size of the openings.

RECENT DEVELOPMENTS IN CONCRETE HIGHWAY CONSTRUCTION

By A. N. Johnson, Consulting Highway Engineer, Portland Cement Association, 111 West Washington Street, Chicago, Ill.

There are many features connected with the general design of concrete streets and roads which are of importance but of which the limited space allotted to this article will not permit more than a brief mention.

The subgrades should receive more attention. It is desirable to have the bottom of the concrete slab as nearly a true surface as the top. Where heavy clay soils are encountered it is better not to roll the subgrade to any extent but shave down the final inch or two by hand or with a subgrading machine. Evidence exists to prove that heavy rolling of many soils results in subsequent disturbance of the pavement; for these soils, as soon as any moisture reaches them, swell and actually heave the pavement.

Street corners should be rounded to a radius of not less than 20 ft.

The construction of concrete streets makes possible the use of integral curbs, which are not only more economical, but are readily constructed, present an excellent appearance and avoid any chance of displacement which so often occurs with separate curbs. The face of the curbs should not be perpendicular but should have a slight batter so that the upper corner will not come in contact with the rims of motor vehicles.

Grading of Aggregate

Much progress has been made in our knowledge of the use of variously sized aggregates and their proportioning for concrete mixtures. This has been made the subject of most exhaustive study and investigation by Professor D. A. Abrams of the Lewis Institute, Chicago. The results that he has obtained have shown that the arbitrary divisions of fine and coarse aggregate by sizes to be found in many specifications do not necessarily give a grading that will produce the best concrete or, in fact, be even a measure to indicate the relative value of various aggregates. If many of the gradings specified for fine aggregates were strictly enforced, it would result in the rejection of much material from which as good concrete could be made as with material that would be accepted under a particular specification.

Consistency

One point on the subject of mixing concrete should be mentioned, which is, the great importance that the amount of water exercises on the strength of the resulting concrete. The less water that is used, compatible with securing a mixture that is workable, the stronger the concrete will be. This fact, but recently understood, is a further result of the investigation of Professor Abrams.

In order to measure the consistency and make a definite specification therefor, there has been developed what is known as the slump test. This is most satisfactorily performed by the method devised by Mr. F. L. Roman, testing engineer of the Illinois State Highway Department. He uses for the purpose a light metal mold in the form of a truncated cone 12 ins. high, having an 8 in. base and a 4 in. top, into which the concrete is placed. The conical shell is removed by means of handles attached to the mold and resulting slump in the concrete is noted. This method, Mr. Roman has demonstrated, gives very consistent results and is a better measure of the consistency than if a cylinder is used to make the slump test. The amount of slump for concrete to be placed with a finishing machine should be about ½ in. to 1 in., a trifle greater allowance being made for concrete with rounded pebble aggregate than with crushed stone aggregate.

Improved Methods of Finishing

Aside from improved methods of handling materials the developments in concrete road construction have been chiefly improvements in methods of finishing. Of these, the first place must be assigned to the roller. The roller that is used in finishing a concrete pavement consists of a light metal cylinder 10 or 12 ins. in diameter, about 6 ft. long, weighing not to exceed 100 lbs. On roadways 18 ft. or over in width the roller is most conveniently and effectively operated by means of ropes attached to a double bail. Two men, one on either side of the pavement, pull the roller back and forth over the freshly laid concrete. This operation is repeated at intervals of 10 to 20 minutes, as often as there rises to the surface a film of water which the roller squeezes off to the edges. This water, if it remained in the concrete, would greatly lessen its strength and if not removed from the surface there would be a thin layer of laitance, which is very apt to scale and present an undesirable appearance.

After the pavement has been rolled not less than four and possibly five times it is finished with a broad canvas belt or thin board. The belt or board is drawn over the surface with a see-saw motion and leaves a uniform even finish to the concrete. Excellent results have been obtained by attaching a belt to a thin board which serves as a bow by which the belt is stretched.

Previous to using the roller a heavy tamping template should be employed or, in the case of street work which may be too wide to use such a template, the surface should be hand-tamped.

An interesting point in connection with the development of the use of the roller is the fact that while the roller and its effect upon newly laid concrete are described by Mr. E. L. Ransome in the 1910 edition of Gillette's Hand-Book of Cost Data, its general adoption as an adjunct to concrete road construction was not until 1917.

Mechanical Finishers

Mechanical finishers have now been developed that are used very successfully upon roadways up to 20 and 24 ft. in width; and are being constructed to operate upon even wider roadways. These machines shape the concrete, at the same time tamping it, and are also provided with an automatic belting arrangement. Concrete of a comparatively dry consistency is required if the best results are to be obtained. In the event somewhat too large a quantity of water is used the effect of the tamping is to bring considerable water to the surface. These machines should then be followed with a roller to be sure that the excess water on the surface is removed and not allowed to stand upon the fresh concrete. Such a machine to be successful must be easily reversible so as to be operated a number of times over the same area.

An important object to be gained by using the roller or finishing machine over a given portion of the concrete surface for a number of times extending over a period of 30 or 40 minutes is to keep the concrete plastic during a long enough period to overcome the formation of minute shrinkage cracks that may occur with the initial set and which may develop where the concrete is given but one application, either of the roller or the finishing machine. If it is noticed that shrinkage cracks still occur, then the operation of the machine or roller should be continued for a longer period.

Use of Machinery in Concrete Road and Street Construction

The time is approaching, in fact has approached, when to employ unnecessarily a number of men upon a given job is little short of an economic crime. More than ever attention must be given to the application of machinery and labor-saving devices in all forms of construction; and this applies with special force to paving work, where there is opportunity for much improvement.

The construction of concrete pavements lends itself very readily to labor-saving devices, many of which have now been perfected so that today it is practicable to lay concrete pavements with a minimum of hand work, that is, nearly every man upon the job will be operating machinery. On the average for concrete highway work there need be required but four or five men doing only hand work.

A central material plant where materials are unloaded by power, transported thence to the work on a narrow-gage industrial track, thence to be lifted by derrick to the mixer, constitutes an economical set up. This method of hauling the materials enables the work to proceed through bad weather when team hauling would be impracticable; the number of men necessary is greatly reduced from the old method of placing materials upon the subgrade and shoveling them into the mixer; the materials themselves are kept cleaner, are not wasted to the same extent, and the subgrade remains in better shape. In general, to place materials directly on the subgrade is a clumsy, costly and defective way of doing the work.

A recent development is to handle the concrete from a central mixing plant, and under many conditions this promises to be one of the most economical and expeditious methods of laying concrete pavements. It should have particular application to the laying of concrete streets when the concrete may be mixed at the railroad yards or near by where materials are received, and hauled to the work in trucks. In this way the particular street to be paved need not be encumbered by any materials, may remain open to traffic up to the last minute, and kept closed for a minimum period.

To insure rapid prosecution of work the contractor should be required to assemble a sufficient amount of materials to insure that no delays arise on this account.

Recent experience in handling cement in bulk demonstrates that this is not only thoroughly practical but is economical. A good method is to deliver the cement in open-top cars protected by tarpaulins. To use cement delivered in this manner economically it is necessary that the job be of such size as to warrant building cement-storage bins capable of molding from 25 to 50 cars of cement. The cement is readily unloaded by means of a clam-shell bucket.

The storage bins required for the sand and gravel need be no larger than is necessary to hold a sufficient amount to fill one or two trains of the small cars. The principal storage should be in storage piles. An excellent arrangement for these is to depress the track so that there will be a tunnel made beneath the storage pile and no storage bins are then necessary.

Alley Construction

An economical method for handling alley work is to have the materials delivered at the head of the alley on an adjoining street, where this is practicable. The mixer is stationed nearby and the mixed concrete delivered by small gasoline-driven buggies.

It is a good practice in laying an alley that abuts upon buildings or high fences first to lay a form about 18 ins. from either edge of the alley and fill the concrete behind this form adjacent to the buildings or fences. This strip on either side finished, the forms are removed, and the center of the alley is placed, the side strips offering a place for the workmen to finish with facility the center portion of the alley.

Where it may be necessary occasionally to gain access to pipes or conduits the procedure would then be to lay a narrow strip of concrete directly over the line of the conduit separate from the remainder of the pavement. It is assumed that this strip will be at the center of the alley. First one side will be laid, then the other and last the 18 in. or 2 ft. space at the center. There should be no joint material put in but the edge of the concrete before placing the center portion may be painted or oiled, in this way assuring ready removal of the center section whenever it may be necessary. When finished the joints should be practically unnoticeable.

The Use of Reinforcement

The function of reinforcement in concrete roads seems to be a matter of some confusion. The amount of reinforcement which is generally used and beyond which amount it is not practicable to go, does not to any great extent reinforce the concrete slab in the sense that a concrete beam or girder is reinforced by steel rods. That is, no great increase of structural strength is produced. The chief effect secured is not so much the prevention of cracks as to prevent cracks that do form from opening and becoming of any appreciable width; so that the chief function of reinforcement in concrete roads is to hold the concrete slab together after it may have cracked.

Some have contended that if reinforcement were used a thinner slab might be employed than if no reinforcement were put in the pavement. If the amount of reinforcement were 10 to 20 times as much as is used there would be some ground for such contention, but where the amount of steel does not exceed 40 to 50 lbs. per sq. ft., and usually it is considerably less, the increased strength given the slab is so slight that it is practically negligible in so far as being able to reduce by any appreciable amount the thickness of the slab. The best reinforcement to increase the strength of the slab is added thickness. This not only gives a much stronger slab but also one of greater weight and therefore of greater inertia, which is of importance when the nature of the loads and shocks produced thereby are considered.

General practice today regarding reinforcement is to use it on those portions of the road where the greatest disturbance is expected in the subgrade as, for example, on clay hills. It is also the general practice to reinforce streets where it is desirable to hold to a minimum in size such cracks as may form. There is also an increasing tendency to use large metal units of reinforcement, that is, larger bars spaced further apart, rather than smaller ones spaced closer.

Reducing Prices for Pavements

In closing may I disgress to say a word as to paving prices? If there are certain causes which make for higher prices and it is possible to remove the causes, then to that extent will lower prices be secured. Let us discuss for a moment some of these causes.

Whenever a contractor is in doubt, when he is confronted with uncertanties, when he must assume certain hazards, he endeavors to secure himself against possible loss and makes his bid price accordingly. At the present in most paving contracts the contractor must assume all the hazards and in proportion to the degree of risk to be incurred does the bid price increase.

The hazards to be encountered may roughly be divided into two classifications. First, those which, although perhaps inevitable, it is nearly impossible, even after the work is completed, to assign just to what extent the cost of the contractor has been affected. Under this heading would fall the hazards due to weather conditions.

Of the second class are those hazards which, when they occur, their financial effect upon the contractor can be definitely calculated. In this class would come a change in freight rates during the term of the contract. Under such conditions the contractor can readily show definitely how much more or less the work cost, due to the difference in freight rates on the materials involved. These two examples are perhaps sufficient to indicate the difference in the nature of the hazards which every contractor making a bid must consider.

The added price he must charge is in the nature of insurance. If the risk were removed then there would be no need for an insurance charge, and the bid price should be that much less. It is submitted that, certainly as to those risks which come under the second classification, the public can insure itself to much better advantage and assume itself some of the risks for which contractors now make a very considerable charge.

Contracts should be so drawn as to relieve the contractor of every uncertainty and hazard that it is possible to foresee. Surely every contract should provide for an adjustment to be made in case freight rates are changed subsequent to the execution of a contract, if increased then additional compensation for the contractor; if reduced like advantage to the public.. If, in order to hasten completion of work and avoid delays costly to both contractor and the public, it is desirable to store quantities of materials ahead, allow the contractor a fair advance upon such materials. If a contractor is required to store materials but paid only for completed work he must charge for this service and the risk incurred. And this charge will be more than the cost to the public to advance to the contractor the money necessary to pay for the materials stored.

But it is not so important here to give specific examples as to call attention to the general principle that lower bid prices will be secured upon street and highway work to the extent that the contractor is relieved of risks. The engineers in the public employ could well consider carefully every chance and hazard that may arise during the prosecution of a given paving project and so draw the specifications and contract as to relieve the contractor of every uncertainty possible. The method that imposes upon the contractor all the risks and requires him to do all the guessing is both costly and unbusinesslike.

Acknowledgment

The foregoing is the major portion of a paper presented by Mr. Johnson before the American Society for Municipal Improvements at the New Orleans convention, November, 1919.

ACTIVITIES OF AMERICAN ASSOCIATION OF ENGINEERS

To the Editor:

Unity in the engineering profession is a necessity. It will be achieved only by building up one strong, universal society; a democratic unified organization. To date, we have more than eight thousand members in good standing and they represent our activities in every part of the United States. The A. A. E. plan gives 3 or more members in your community a club charter and 20 or more a chapter charter. Under each chapter as many sections may be organized as are needed to represent the membership. At present, A. A. E. has 50 chapters and 33 clubs in operation.

Ethics for the engineering profession have been promoted by this association and in an earnest attempt to better them we have submitted the "Engineer's Creed," which includes a code of ethics accepted by many as the greatest contribution to the subject. In the very near future the association will print the "Engineer's Creed" in a high class booklet, complimentary copies of which will be distributed to all members.

Professional Engineer is the new name selected for our official publication. This will be an improved magazine of large size devoted to the engineering profession. It will be non-technical; a business service magazine for engineers. The magazine will be an important step towards "Promulgating the association ideas through publicity."

Compensation problems have taken much of the association's time and money since its origin in 1915. During this time many individual benefits have been secured and many engineers have received relief that was greatly needed. General increases have been received in four regions of the U. S. Railroad Administration and have been promised in two of the three remaining. The increased salary schedule for technical men in the Navy was authorized; a new schedule for highway engineers has been proposed. A special committee on Schedule of Salaries for Engineers in Public Service is working on other new schedules. Several local committees are developing a new schedule for telephone engineers. In all these matters A. A. E. has taken the leading part and our activities have not been opposed, because we are recommending fair compensation.

Civic Activity—Nearly all of our chapters are taking their part in their communities in a civic and political way. Let us cite two recent national activities to show what 8,000 engineers can do. On receipt of news from Washington that an attorney was about to be appointed to the vacancy in the Interstate Commerce Commission, a flood of wires and letters from the chapters and individual members protesting the appointment of a lawyer and urging the appointment of an engineer resulted in deferring the appointment for the present. A. A. E. is credited by the chairman of the National Service Committee of Engineering Council with doing more than any other society to further the Jones-Reavus Bill providing for a Department of Public Works in the U. S. Government.

Employment for technical men is a great activity in the Service Department and Employment Committees of our association. The volume of this work is indicated by the average business for three months period ending September 30.

Positions received	1,084
Applicants introduced	2,985
Members placed	264

Thirty-three and thirty-five members were placed in positions for the weeks ending October 11 and 18, respectively.

Fourteen members were placed in new positions on October 20. With a greater organization our Service Department will be able to sell more engineering service at a greater price.

Opportunities for new members in A. A. E. today are greater than ever and the new member will share these with the other members of the profession after he joins. We write this letter to point out the advantages of joining immediately. There is still limited time to complete a membership this year and to be enrolled at the present entrance fee of six dollars. This will be a saving of four dollars because the entrance fee next year will be ten dollars. A. A. E. offers nation-wide opportunities to the engineering profession. The entrance fee should accompany the application.

Yours for co-operation,
A. H. Krom, Assistant Secretary,
American Association of Engineers.
63 E. Adams St., Chicago, Ill., October 30, 1919.

LARGEST SWIMMING AND SKATING POOL IN THE UNITED STATES

The Clifton Park swimming pool at the southern end of Clifton Park, in the city of Baltimore, Md., is the largest artificial swimming pool in the United States, if not in the world. This article, giving a description of the pool with data on its cost, is from the official journal of the municipality of Baltimore.

General Design Features

The pool is elliptical in shape, with a maximum diameter of 595 ft. and a minimum diameter of 340 ft.

The deep water section of the pool is also elliptical in shape, with a minimum diameter of 170 ft. and a maximum diameter of 356 ft. This deep water ellipse is at one side of the pool area, and from the line of this ellipse the depth increases at a 10 per cent. grade. From the shallow edge of the pool to the deep water ellipse, the grade ½ of the way is 1 per cent. and for the balance of the way 1½ per cent.

The maximum depth is 9 ft. and the minimum 3 ins. The pool has a capacity of 4,500,000 gals., with a water area, when filled, of 3.7 acres.

Site of Pool

The area selected for the pool construction was triangular in shape, bounded on two sides by city streets intersecting at right angles, with a high railroad embankment along the other side, containing about 9 acres. The construction of the high-ways was upon filled ground similar to the railway embankment, but of much less elevation, so that the area without drainage would have formed a natural pond or pool.

Preparation for Pool Construction

A 48-in. combination storm water sewer line from a residential section north of Clifton Park had been carried to and under the railroad embankment into the triangular area where the line was partly exposed. There was also a considerable wash from the railroad embankment, and by way of preparation for the pool construction considerable grading and filling was necessary. The cost of this work was as follows:—

4,230 labor hours @ 25c	$1,057.50
356 team hire hours @ 62½c	222.50
330 ft. 6-in. terra cotta pipe with fittings	69.60
11,727 cu. yds. of earth @ 10c	1,172.70
Total	$2,522.30

Specifications and Contract

Plans and specifications were prepared by the Park Engineer and contract awarded by the Municipal Board of Awards at an expense of—

$40.00	for design
62.45	for printing
25.65	for advertising
Total....$128.10	

The contract work was commenced about the middle of April, 1915, and completed in 94 working days. The time allowance in the contract was 120 working days, with a bonus of $10 per day for completion in less time, so that the bonus earned was $260.

Cost of Work Done by Contract

The items of work, done under contract, cost as follows:

Excavation—4,651 cu. yds. @ 35c	$1,627.85
Filling and replacing—5,888 cu. yds. @ 25c	1,472.00
Trench excavation and backfill—1,041 lin. ft. @ 45c	456.30
Ten-inch vitrified pipe—1,041 lin. ft. @ 33c	334.62
Lumber placed under drains, 410 B. M. ft. @ 3c	12.30
Concrete drain inlets—7 @ $35 each	245.00
Under-drains in place—483 lin. ft. @ 75c	362.25
Concrete pit and drainage outlet	20.00
Changes to sewer line (including man-hole)	210.00
Man-hole for drainage valve	90.00
Excavation and back-fill, water supply—510 lin. ft. @ 56c	285.60
Eight-inch cast iron water pipe with connections—510 lin. ft. @ $1.50	765.00
Eight-inch supply valve	25.00
Excavation and back-fill for pool drain—100 lin ft. @ 75c	75.00
Fourteen-inch iron drain pipe with connections—100 lin. ft. @ $2.40	240.00
Fourteen-inch drainage valve in place	55.00
Lighting conduit (1½-in.) in place 2,402 lin. ft. @ 24c	576.48
Lighting conduit (2-in.) in place 300 lin. ft. @ 27c	81.00
Light post foundations—7 @ $24 each	158.00
Light post foundations—11 @ $8.50 each	93.50
Concrete life buoy bases—23 @ $5.40 each	124.20
Excavation and back-fill for concrete wall along side of pool at deepest point—539 cu. yds. @ 50c	269.50
Concrete in wall, furnished and placed—332 cu. yds. @ $8	2,656.00
Steel reinforcement rods for wall and pool bottom—68,249 lbs. @ .026 per lb. in place	1,774.37
Wire mesh reinforcement—15,670 sq. yds. @ 8c	1,253.60
Concrete for pool bottom in place—1,838 cu. yds. @ $5.86	10,770.68
Concrete walk around pool—15,473 sq. ft. @ .096c	1,485.41
Overflow drains and boxes—6 boxes, 200 lin. ft. of pipe	310.00
Spring boards in place—2 @ $10	20.00
Concrete structure for sliding boards, with two concrete slides	1,425.00
Miscellaneous extra work	280.54
	$27,564.20

Cost of Work by City Forces

Electric lighting was installed by park electricians on force account, at a cost for material and labor, as follows:

18 cast iron posts in place, $27 each	$486.00
3,942 lin. ft. of cable in place @ 10c per ft.	394.20
18 lamps @ $4.14 each	74.52
18 globes in place @ $4 each	72.00
18 transformers @ $.2777 each	95.00
18 switches @ $4.50 each	81.00
	$1,202.72

The cost of water supply, connection made by the Municipal Water Department, was as follows:

Labor	$109.73
Material	159.20
Total	$268.93

Total Cost of Construction

The total cost of the pool, including lighting equipment, but not including showers, diving rafts, dressing rooms or other equipment was $31,946.25.

Operation of the Pool

The water supply is through the city reservoir and filtration plant from the Gunpowder River. The water is supplied through one 8-in. inlet pipe and through one needle shower with 1½-in. supply pipe. There is one outlet or drain pipe 14 ins. in diameter. By regulation of inlet and drain valves there is a constant circulation of water, and the pool is emptied and cleaned annually. The city filtration is depended on for the purity of the water and chemicals are not used. Bacteriological tests of the water have never been made.

All bathers are required to pass under shower before entering the pool, and the use of soap is strictly forbidden. The average daily attendance during 100 days of operation in 1918 was 900 persons, and the average during the first 50 days of operation in 1919, 1,400 persons. The maximum daily use of the pool in 1918 was 4,254 persons on August 6th, and in 1919 4,674 persons on July 5th. The pool is opened during the first week in June, and is continuously operated for a period of approximately 100 days.

During the winter months the pool is available for skating when ice freezes a sufficient thickness, which is very seldom.

There is a concrete pool building constructed at a cost of $45,000, in which there are four showers and 949 steel lockers of the best grade, with toilet facilities, and with ample accommodations for handling bathing-suits, etc. The building contains a steam laundering and drying plant, with the most up-to-date equipment. There are two frame wing additions to the concrete building, in which there are dressing compartments and racks, in which boxes are used for checking clothing as a substitute for steel lockers. These two wings cost $10,000, and will accommodate at one time 2,400 persons or a maximum of 24,000 persons on any one day. The operating organization is under the Superintendent of Clifton Park, and the employees are classified and paid as follows:

1 Manager	$20 per week.
1 Engineer (laundry machinery)	20 per week.
1 Head life guard	18 per week.
8 Life guards	16 per week.
8 Lockermen	16 per week.
1 Head woman attendant	14 per week.
1 Ticket cashier	12 per week.
7 Women helpers	10 per week.

Cost of Operating the Pool

The annual cost of operating the pool is something in excess of $12,000. The exact cost is not known, owing to the fact that the pool has not been in operation under park management long enough to show the depreciation cost of towels and bathing-suits. The receipts from the Clifton pool in 1918 (the first year of park operation) were $4,576.96, and the total patrons, not counting free entries from Charitable Institutions, 83,865 persons.

Income From Baltimore Swimming Pools

The Park Department has two other outdoor pools, and the number of bathers and the amounts collected at each for the season of 1919 were as follows:

1919.	Total Patrons.	Total Collected.
Patterson	115,428	$4,972.33
Clifton	118,694	7,189.13
Gwynn's Falls	34,616	1,582.23
Total for 99 days of operation	268,738	$13,743.69

The corresponding figures for the outdoor pool operations in 1917 and 1918 are as follows:

	Total Patrons.		Total Collected.	
	1917.	1918.	1917.	1918
Patterson	138,341	113,711	$3,525.42	$3,574.37
Clifton	92,565	83,865	2,733.74	4,576.96
Gwynn's Falls	76,554	45,374	1,494.34	1,570.08
Total for 100 days of operation	307,460	242,950	$7,753.50	$9,721.41

CHARACTERISTICS OF PAVEMENT TYPES AND CONSIDERATIONS AFFECTING A CHOICE IN KANSAS CITIES

By A. P. Learned, of Black & Veatch, Consulting Engineers, Interstate Building, Kansas City, Mo.

The subject of paving is indeed a broad one and to discuss it with its various ramifications is impossible at this time, but it is my intention to mention briefly a number of the items which are of general interest to all of us. We pave our streets to better transportation facilities, to better sanitary conditions and to improve the appearance of our city; namely, we pave for commercial, sanitary and aesthetic reasons.

Factors Influencing Choice of Pavement

The choice of pavement should be based on its cost, which includes first cost and maintenance, its value for transportation as influenced by tractive resistance, slipperiness or climatic conditions that may affect its usefulness, its sanitary qualifications and its general appearance. Affecting the item of maintenance is durability which is a very vital factor in one's selection because of the objection to continued maintenance, or the objection to a road being in such a condition that it needs to be repaired.

Width of Pavement

Before the selection of the pavement, or at least before it is built, it is quite necessary to determine the width of pavment to build and then is town pride put to test and it becomes necessary to advise the well meaning citizen, who would pave the business district 80-ft. wide if there is room, and the resident district 40 to 50-ft. wide, that the traffic, which passes down New York's famous Fifth Avenue, passes down a street 75-ft. between curbs and then he should realize that when the width is not too narrow that yardage in length rather than in width will be of the most benefit to the City as a whole and will not result in excessive cost to the property owner.

There are a great number of items that enter into the selection of the width for instance, whether it is the intention to park on the side or the middle of the street, whether the street is one of heavy or light traffic and whether it will fit up with the general scheme of the street. There is quite a general practice in this section of the United States to build the pavement just as wide as it will permit, allowing 12 to 16-ft. for sidewalks in the business district and to build in the strictly residence districts pavements 25 to 30-ft. wide. A width less than 25-ft. proves too narrow and one wider than 30-ft. unnecessarily wide.

In this connection we have found that with motor traffic it has been found necessary to figure travel widths of a vehicle from 8 to 11-ft. instead of 6 to 8-ft. as heretofore, and that the width of the street should be figured in multiples of this width; for instance if we figure the street for three vehicles at 9-ft. clearance, the width will be 27-ft. The returns at street intersection need to be large to furnish the space for turning around in the narrow streets, and to facilitate the turning of corners by the rapidly moving vehicle without its running out into the street.

Four Types Considered in Kansas

The next problem that confronts is to determine what kind of paving we should select for our city. There are, if we have determined upon what is regarded as a truly hard surfaced pavement and one that does not necessitate a regular annual maintenance, four kinds to be considered; namely: concrete, asphaltic concrete, sheet asphalt and brick. I have not included wood block and pavements of that class because our conditions, both traffic and financial, do not warrant its consideration.

Two Types of Concrete Pavement

When we consider and discuss concrete pavement there are two types of concrete pavement; namely: The one course, and the two course pavement. In this section of the country there is not a large amount of concrete pavement and there is a reticence shown towards building it. However, we find in the states of Michigan and Wisconsin a considerable amount of this character of pavement and it seems logical, for in that section of the country the aggregate available is satisfactory for wearing surface. To be perfectly frank, one of the serious drawbacks of concrete pavement in this section of the United States is the securing of the proper aggregate for the wearing surface.

In the single course concrete the aggregate of necessity is the same throughout while in the two-course concrete the aggregate in the wearing course may be entirely different from that in the base course and it is the better practice to use as near as possible the local material for the first course and to ship in a proper aggregate for the wearing course; that is, such as crushed Joplin flint or material equally as good, such-as Wisconsin granite. The shipment of this material for the total thickness of the pavement would make it excessively expensive. There is no reason why the two-course pavement will not afford, if properly built with reinforcement between the courses and adequate expansion, a first-class pavement.

One of the arguments against concrete pavement in the past has been its noisiness, its slipperiness and its hardness, but with the increased use of motor driven vehicles with pneumatic tires, these objections, especially of hardness and noisiness, are set aside.

Development of Concrete Pavements

Concrete pavements, or at least the present type of cement concrete pavements, are of recent construction. We find that in 1879 there was constructed in Scotland a concrete pavement that proved to be very satisfactory for a short time but when it started to wear, it wore out very rapidly. The conditions under which these pavements were constructed we are not acquainted with and there may have been some local reasons for its rapid deterioration.

The first concrete pavements in this country were built in 1894 but did not attain any particular popularity or general consideration until 1909 when the construction of a considerable amount of this pavement was undertaken by Wayne County Michigan, where their uniformly satisfactory results lead to a considerable discussion and, if we might say, popularized this pavement so that up to the first of 1917 there were 150 times as much concrete pavement as there had been previous to 1909.

Asphalt Pavements

Asphaltic concrete and sheet asphalt furnish the smoothest surface and probably embody, when first constructed, more of the requirements of an ideal pavement in so far as resistance to traffic and sanitation are concerned than any other kind. Sheet asphalt which is a pavement built up of a base, a binder course and a wearing course, was first built in a somewhat modified form in 1877, in Washington, D. C., on Pennsylvania Avenue. This is at least the first well known installation. This type of pavement had for a number of years a very extensive and high popularity but a little later, when cities of smaller size saw fit to pave, there was developed a pavement that could be built for considerable less money than the sheet asphalt and which provided in many respects the characteristics of sheet asphalt; namely, asphaltic concrete.

Asphaltic concrete is a bituminous concrete pavement having a predetermined mechanical graded aggregate composed of broken stone, gravel, sand, finely ground inert materials and is the outgrowth of a pavement known as the Excelsior pavement which was advertised as early as 1871 but of its installation we have no record. Asphaltic concrete as we know it in this section of the United States has been built largely under or with modifications of the Topeka Specifications. This pavement as ordinarily built consists of a 2-in. course of this bituminous concrete aggregate on a concrete base. The sheet asphalt ordinarily consists of a 1½-in. binder course and a 1½-in. wearing course rolled to 2½-in. in thickness. Certain requirements are very essential to the securing of a satisfactory piece of work in case of both sheet asphalt and asphaltic concrete. The proper rolling of the surface to thoroughly compact it and to get it smooth so water will not stay on the surface, resulting in the rotting of the asphalt due to chemical changes, is essential in both cases. It is necessary that an excess of asphalt be guarded against for an excess tends to soften it so that the street becomes wavy or it works down into the gutter. If too small a quantity is used the pavement will look dry and lack the proper elasticity. Within the last few years a condition that has as yet not been satisfactorily solved and is a problem of concern, has come up; namely; what will be the influence of the oils that drip from automobiles and that are sprayed out of the exhaust of automobile engines, and will it not be necessary, if this has an effect, which it seems it has, to determine the effect on different streets due to the likelihood of difference in intensity of traffic on this type of pavement?

Brick Pavements

Brick pavement as now built in Kansas is generally a fibre brick, so called, laid on a sand cushion upon a concrete base with an asphalt filler. There are also a number of stretches of so-called monolithic brick in which the filler is of cement grout and the brick has been laid directly upon the base when it is still green so that the contemplated effect is to make the pavement monolithic. Fibre brick have been used five years in this territory. However, the experience in brick materials is much older and the durability can be determined by the rattler tests. There has been an argument against brick pavements that they were hard and noisy. However, the use of an asphalt filler and the change from horses to motor drawn traffic has removed the cause for a large part of these arguments.

Life of Pavements

As was stated in our general consideration of this problem, we contemplate the consideration of these four types and it is only fair to say that the life of these pavements is somewhat a matter of conjecture. As one studies the general experience over the country he will notice that in certain cities one type of pavement gives absolute satisfaction while in other cities, pavement of the same type is entirely unsatisfactory. And again we find that the conditions which recommend a pavement to one individual condemn it to another. For instance, a number of people feel that asphalt pavements should not be used where the traffic is quite heavy because it softens in warm weather and will be cut up while others realize that the life of the pavement of that character is materially influenced and lengthened by the kneading and working that traffic gives it.

During the last five years there has developed in connection with the various types of pavements discussed quite extensive promotional organizations and these promotional organizations have, as a general thing, been striving to secure in their respective lines the highest grade of work possible in addition to the largest yardage possible and this feature of securing a high grade product has resulted in a different character of pavement being built throughout the territory than has heretofore been constructed. This fact means that we really, in this section of the United States, have no actual but only a comparative basis to compare our different kinds of pavement.

Influence of Construction on Pavement Life

There is of necessity a very much different life to a pavement built of high grade material than there can be to one of slip-shod construction. For instance take the brick industry. Several years ago it was quite the custom to have brick plants in a number of cities furnishing brick for these respective cities and the local plant so arranged the situation that only their brick was considered in the cities where they were located and a large number of these plants were producing a brick that was not of the character that should be used for this purpose. This has resulted in considerable criticism of this type of pavement that is truly unfair as compared to the present products. Such might be said of the other types of pavement up to the time of their general standardization, although we must confess that there were previous to the present time at different places very high types of pavement built.

Costs

The general cost and particularly first cost of pavement have, by our accepted method of choice, a very vital bearing upon the selection of pavement and it is quite important that we consider it in the true light. In an analysis of the cost of the construction of brick paving previous to the present increase of prices, after the material was on the ground the labor cost for the paving was approximately 20 per cent. of the total amount but I find that although labor is being paid approximately 100 per cent. more than it was previous to the war time conditions, the labor item has increased 250 per cent. This is due to the decreased efficiency of common labor occasioned by the tremendous demand, and a general attitude of getting the pay and not necessarily delivering the required work. This results in a case of brick pavements that the labor item becomes 25 per cent. of the present cost. This as compared with the brick itself which has increased approximately 65 per cent. and cement which is close to 100 per cent., necessarily makes the present price of our pavement almost double what we paid previous to the war. The larger increase in the case of concrete and asphaltic concrete is largely because the proportionate part which labor plays in the cost of the work is somewhat higher and these products cost more nearly twice what they formerly did. For instance, in the case of asphaltic concrete the labor item, which formerly amounted to 22 per cent. of the total now amounts close to 33 per cent. The present price over the State in case of brick pavements ranges from $3.40 to $4.00 depending on local conditions. The cost of asphaltic concrete pavement is approximately 90 cts. per yard less and the cost of two-course concrete pavement is approximately 40 cts. less than the brick pavement under similar circumstances. The price of brick pavement previous to the increase was close to $2 a yard and you will note that compared with the average increase of prices from 1914 to December 1918 on all commodities was 194 per cent., the price of paving is not out of line. In other words, products received for your dollar in paving is as much proportionately and slightly more, than it is in the general average of all commodities.

In a comparison of these various types of pavement one should consider that in the case of sheet asphalt the material on top of the base is 2½-ins., material in brick pavement is 3-ins., and that in concrete and asphaltic concrete 2-ins.; therefore, the difference in price has logic.

To purchase a pavement at this time is not to purchase a luxury at a luxurious price, but is to purchase a utility at a price not out of line with the present purchasing power of the dollar in other industries. The popularity of street improvements is more noticeable at the present time than it has been for a number of years. For instance in the case of brick pavement there is over 50 per cent. more yardage this year than any year previous amounting to close to 1,500,000 sq. yds. The demand for improved streets and roads is the result of the change of our general transportation system from animal drawn to motor driven power; to the increasing population of our country; and the recognition that the motor is providing a means of transportation on short distances that is reasonably economical, and facilitates the movement of supplies and unifies the country. It is also the result of an unusual prosperity in this section of the country and the recognition of the fact that a small city can have, so far as utilities are concerned, as good as a larger city.

Maintenance costs will not be discussed for we do not have in the territory any valuable data on the subject.

Recognizing the fact that cities are having these improvements and that the prices are not prohibitive, and that the community can afford them, we are confronted with the question: How shall we proceed legally to procure such improvements?

Legal Steps in Kansas

In discussing this problem I have confined myself largely to cities of the 2d and 3d class and we find that the law permits the construction of improvements of this character by petition by 50 percent of the resident property owners on the street, or by resolution of the council, if they deem it necessary for the general well being of the community, provided said resolution is not protested against by as many as 50 percent of the resident property owners on the streets affected.

After this petition has been accepted, or the resolution has been properly advertised and not successfully remonstrated against, the city can let contracts for the work. To pay for paving, the law provides that general improvement bonds may be issued chargeable against the city as a whole to pay for all intersections of streets and alleys and for the bringing of streets to grade and that special improvement bonds may be issued to pay for that which is taxed directly to the property owners affected. The law also provides that these bonds may be issued for either 10 or 20 years, provision being that the 20-year bond shall not exceed 5½ percent and the 10 year bonds 6 percent and that these bonds may be paid off in equal annual installments. It is of course good practice, if the pavement is of such a character that it will not last to exceed 10 years, that these bonds be made of such a term that they will have been paid off before the pavement begins to deteriorate seriously. The law provides that a city may be indebted up to 15 percent of its valuation and this necessarily gives to our State means of providing for itself if properly handled a very considerable amount of street improvements, provided the sewer and water works which they may have, have not been excessively costly in construction due to peculiar difficulties.

It has not been my intention to recommend any particular kind of material to use for I feel that this is primarily a problem which is local in all of its aspects on account of materials available, financial resources, and requirements of the pavement, but it is my advice that whatsoever type is selected that an effort be made to secure the best of construction in that particular type for the best is none too good and in the end is the cheaper.

SUCCESS OF ASPHALT JOINT-FILLER IN VERTICAL-FIBER BRICK PAVEMENTS

By Clark R. Mandigo, Consulting Engineer, Western Paving Brick Manufacutrers' Association, Kansas City, Mo.

(Editor's Note—The following discussion on the success of asphalt filler in brick pavements by Mr. Mandigo is from his paper on vertical-fiber vitrified brick paving, presented before the convention of the American Society for Municipal Improvements at the New Orleans convention this month. The entire paper is most interesting. The portion not here given was omitted for the reason that it pertains largely to the matters of manufacturing covered by Mr. Mandigo in his contribution to Municipal and County Engineering for July, 1919.)

The asphalt joint-filler almost universally used at present in vertical-fiber brick pavements has been so interwoven with the success of such brick pavements that mention must be made of the filler in discussing this type of pavement.

Four items affecting the pavement have contributed to the success of asphalt filler in brick pavements: (1) the method of application, (2) the shape and texture of the brick, (3) the quality of the filler, and (4) the changed character of traffic.

Taking these items up in order, first, the bituminous filler is heated to a temperature below its flash point, is flushed over the surface of the brick pavement and squeegeed back and forth until the joints are full, leaving, necessarily, a slight surplus on the surface. It is impossible to get the joints properly filled by the old method of pouring cans. No matter how carefully the work was done there was settlement of joints in hot weather. By flushing the hot asphalt over the brick a saving in labor is effected which more than offsets the slight additional amount of filler used. A coating of sand on the surface of the filled brick absorbs the surplus and, working into the asphalt, makes a good mastic.

In the second place, the wire-cut surface of the vertical-fiber brick which is uppermost in the pavement aids in retaining the thin asphalt mastic on the surface so that it doesn't scale off causing a dirty street. Without lugs the brick set up close and the square edges give a minimum width, even joint at the surface. The asphalt retained on the surface is only an incident to the proper filling of the joints and is not designed to be maintained. It remains, however, from three to five years and during that times acts as a reservoir for filling joints that settle, so that by the time it has worn off, all joints are packed tight with a solid asphaltic mastic. Dark spots on the joints of such a pavement are caused by the asphalt coming to the surface in hot weather so that the mastic filler is enlivened and renewed from the bottom of the joint.

In the third place, only the best quality of asphaltic cement is recommended as a filler, as this has proven to be the least susceptible to changes in temperature, possesses a long life, great adhesiveness, elasticity and malleability, and resists wear and rubber-tire suction. A grade of asphalt cement of about the consistency and requirements that would be specified in the best sheet asphalt pavements for an asphaltic base manufactured asphaltic cement has proven very satisfactory. Refined tar has been used in some instances, but does not at present seem to fill all the requirements.

In the fourth place, the preponderance of rubber-tired traffic on the modern pavement has practically eliminated maintenance of joints where soft filler has been used. When asphalt filler began to be used some eight or ten years ago, it was expected that the joints would require refilling on dense traffic streets every five to seven years, but the changed traffic conditions, which have practically eliminated the horse-drawn, steel-tired vehicle and substituted the rubber-tired automobile and truck, have not made this necessary. In fact, the droppings of oil and kneading action of the tires seem to keep the filler alive and prevent any signs of disintegration, or working out of the top of the joints.

The advantages of this type of street or road surfacing may be briefly summarized as follows: (1) The street or road may be opened for traffic as soon as the filler has been applied. (2) Service cuts and openings are easily and simply repaired. (3) It carries the minimum risk in construction, since serious defects do not result through careless workmanship, lax inspection, or ignorance—a real advantage in these days of inefficient labor. (4) The steps in construction are simple, all materials being tested before being incorporated in the pavement and an opportunity given to correct any mistakes by the following step. (5)The filler is easily manipulated, and not subject to damage by frost, rain or premature traffic. (6) Noise is eliminated. (7) It provides an ideal, non-skid, smooth riding surface for automobiles and gives a good grip for auto tires and horses on all grades. (8) Expansion and contraction are properly and effectively cared for. (9) The elastic filler cushions the brick and the foundation from shock and impact, reducing the thickness of base required and allowing slight readjustments between individual brick under traffic so that each brick remains solidly bedded in the sand cushion—there is no necessity for a cement-mortar cushion. (10) The wearing surface, being semi-flexible, adjusts itself to slight changes in foundation conditions without damage, and to deflections in less rigid types of bases than concrete.

SNOW REMOVAL PLANS AND PROCEDURE

Considerable attention has been paid snow removal from highways since motor haulage of freight between cities has been employed to supplement transportation by rail. As the season is at hand when work of this kind must be done it is of timely interest to note the snow removal plans and procedure of the northern states as reported to Municipal and County Engineering by engineers of several of the state highway departments.

New York

Charles Van Amburgh, Third Deputy, New York State Commission of Highways, Albany, writes:

Our laws do not provide for any systematic treatment of this problem by the State Highway Commission. The law under which we are working at present was enacted before the construction of improved highways by the state had begun, and before present traffic conditions were dreamed of. As it now stands, this matter is left entirely to each town; the town boards are vested with authority to raise such sums as they may deem advisable for this purpose. The sums so raised are expected to cover the entire mileage of all the towns. The matter of determining the amount of work which shall be done on any highway improved, or unimproved, being left entirely to the discretion of the town superintendent of highways under advice of the town board.

In the western, central and northern portions of the state, very little attempt has been made to keep improved highways open for motor vehicle traffic, as the expense thereof when borne by the town alone would be prohibitive.

In the southeastern portion where are located many wealthy towns, with a large percentage of improved mileage, and with a light snow fall and frequent thaws, the main improved highways have been kept open at the town expense which, under the physical conditions mentioned, is comparatively light.

In very many of the northern towns where the winters are long and severe and the snowfall heavy, frequently reaching a depth of 5 ft., snow rollers have been largely employed and make a very satisfactory road for sleighs drawn by horses, but these roads would be unsatisfactory for a large amount of automobiles, and practically impassable for the heavy motor trucks.

The total amount expended by the towns of the state for this purpose in the winter of 1918-19, was $537,707.67, but that winter in this state was very mild, and the snowfall light, and this expenditure much smaller than the average.

The legslature of this state in the spring of 1918 made an appropriation for snow removal on the so-called "Army Truck Routes" during the winter of 1918-19. Some of this appropriation was used successfully for this purpose, but the necessity for moving army trucks having passed, the balance of this appropriation reverted to the general funds of the state. It is now up to each town to keep their own highways open; the cost of doing this work to be paid from town funds raised by town tax for that purpose.

In doing the above mentioned work, some towns, or localities joined forces and used snow plows, sometimes in connection with a motor truck for power, others used horse-drawn road scrapers, while some relied on shovelers.

In the main cross state routes, some 19 miles of snow fence were built and erected during the fall of 1918. This proved very satisfactory and it will again be placed to protect badly drifting spots during the coming winter. We believe that many towns will construct more snow fence now that they have been made to see that it is a money saving method for eliminating this trouble.

When the time comes, if it is not already here, that the traffic demands upon our highways warrant a revision of our methods, a complete revision of legislation for this purpose will be necessary. The cost of maintaining the principal improved highways in a condition to permit automobile and auto truck traffic during the winter months by the towns unaided, is absolutely prohibitive. It would manifestly be as unjust to ask the towns to bear this burden individually as it would have been to ask them to have borne the entire cost of the original improvement of these highways. It would seem that the cost might be distributed very much as the cost of improvement was in the first instance; that is, by the state, county and towns, but so far as we know, no tentative plan of this kind has as yet been brought forward and it remains for the wisdom of future legislatures to work out the details and enact legislation which shall put in force some feasible plan.

Connecticut

W. Leroy Ulrich, Superintendent of Repairs, Connecticut Highway Commission, Hartford, writes:

The Trunk Line Roads in the state of Connecticut have been kept open for traffic since the winter of 1917. The work is handled by the same men and equipment used during the balance of the year to perform the various work necessary to keep the road surfaces in condition. The bulk of the work is accomplished by the use of snow plows attached to the front of automobile trucks owned by the department. At the present time we have about 50 of these snow plows and expect to have about 75 working this winter. In some of the sections horse-drawn road machines are used and in the others the road machines are attached to the back of trucks or hauled by tractors. The department is informed by the local weather bureaus upon the approach of storms and our men in the various sections are notified. The work is commenced when the snowfall reaches a depth of from 3 to 4 ins. and work is continued as long as snow falls and until the roads are open for ordinary traffic. On the main roads the snow is removed practically to the surface of the road; in some of the outlying districts where this would cause inconvenience to traffic, all but 3 ins. is removed and this is allowed to pack down so that sleds may be used. Under ordinary conditions traffic is delayed very little; under the most severe conditions the roads are usually open for traffic the day following the cessation of the storm.

Vermont

R. S. Currier, Asst. to Commissioner, Vermont State Highway Department, Montpelier, writes:

Under the law of the State of Vermont, this department has nothing to do with the question of snow removal, that being left entirely to the towns, cities and villages. There are no state funds available for this purpose.

Outside of the city and village streets, where a certain amount of snow is removed, the general method employed in Vermont is to roll the snow down with a snow roller and keep the traffic on top of it.

In places, where the snow has a tendency to drift, it is either controlled by snow fences or by shoveling out the drifts.

Rhode Island

I. W. Patterson, Chief Engineer, Rhode Island State Board of Public Roads, Providence, writes:

Our state highway law places the responsibility for the keeping of state roads open during the winter months with local authorities. This department, therefore, is unable to go into the matter of snow removal. We have attempted for several years to have our state highway law amended so that we might assume the responsibility for snow removal, but to date our efforts along these lines have been unavailing.

New Jersey

E. M. Vail, Maintenance Engineer, New Jersey State Highway Commission, Trenton, writes:

So far as the state highway department is concerned only a small mileage is now controlled by them, the larger mileage of roads being cared for directly by the counties.

The highway department is planning to purchase snow plows to be attached to the front of trucks which will be operated by state employes on state routes.

Delaware

Charles M. Upham, Chief Engineer, Delaware State Highway Department, Dover, writes:

Last year we prepared to remove snow from one of our main roads of travel, but at no time during the winter was there snow enough to bother with.

We are attaching snow plows to some of the auto trucks that have been turned over from the war department, and expect to keep our main routes of travel in the northern part of the state, opened up by these means. If we remove snow in the southern section of the state, it will undoubtedly be by horse power, using snow plows or road scrapers.

Pennsylvania

George H. Biles, Assistant Commissioner, Pennsylvania State Highway Department, Harrisburg, writes:

It is our intention to keep all of the main connected, hard surfaced highways open for Winter traffic, particularly those sections where motor trucks can be used for the transportation of farm products to the centers of population.

From our past experience, gained during the severe winter of 1917 and 1918, we made somewhat extensive plans to take care of the snow removal operations during the season of 1918 and 1919. Our intention was to use snow plows attached to department trucks, as well as road machines and wooden drags. We have purchased for this winter's operations 10 snow plow truck attachments in addition to the 16 already on hand. There are 225 road machines, property of this department, which will be transferred to the main lines of travel. The district organizations will handle this phase of the work the same as all of our general maintenance operations.

Of those particular highways where it is essential that they be opened up at the earliest possible moment we are transferring our truck equipment; the road machines to be used on roads of secondary importance and supplementing the truck equipment.

We have a caretaker on each section of from five to six miles in length, and he is given authority to hire additional labor if circumstances warrant.

The District Engineers and Superintendents will keep in touch with the prognostications of the Weather Department, in order that they may anticipate the snow storms and have their organizations in condition to take up the snow removal work as soon as the storm starts. We have arranged with the United States Weather Bureau to forward daily reports of the snow and road conditions, which will be published daily.

Ohio

A. H. Hinkle, Deputy Highway Commissioner of Ohio, Bureau of Maintenance and Repair, Columbus, writes:

Owing to the fact that our state law makes it the duty of the Township Trustees to remove snow from highways, our plans for doing this work cannot consist of much more than a campaign of education for encouraging the local officials to take up the work of snow removal on the principal thoroughfares of the state.

We have prepared a circular describing various methods of doing this work and illustrating various kinds of snow plows and equipment used for such purpose.

During the war we departed from the law to the extent of using state funds in keeping open the government truck routes across our state. We did this as a war emergency and owing to the fact that no large amount of funds were used for this purpose, we feel that no just criticism could be brought against the department. Whether or not we will venture to do some of this work this season is yet to be seen.

It is perhaps possible that some revisions may be made in the mentioned circular this year. The circular states that the causes of snow drifts frequently can be removed and a campaign of education throughout the country in regard to this fact would be a wonderful help in keeping open our roads for winter traffic.

Illinois

H. B. Bushnell, Maintenance Engineer, Illinois Division of Highways, Springfield, writes:

Snow removal on roads under state maintenance will be handled by maintenance foremen that are assigned to each district.

Our state is divided into 9 districts with a district engineer in charge of both maintenance and construction of all work within the district. Each district engineer has one or more maintenance crews and in addition to this, in a number of cases we have local men acting in the capacity of patrolmen.

We have a few snow plows rigged up to attach to trucks and we estimate that it will be possible to take care of the greater part of our snow removal with this equipment.

Iowa

W. H. Root, Engineer of Road Maintenance, Iowa State Highway Commission, Ames, writes:

The maintenance of the most traveled roads in this state is now handled directly by the county. This means that there will be as many plans for snow removal this winter as we have counties in the state. Commencing July 1, 1920, the maintenance of the Primary Road System will be directly supervised by the State Highway Commission. Very little attention has been paid to snow removal in this state in the past. The only machine which has been used to my knowledge has been the blade grader. The blade grader gave very good satisfaction where the snow was not too heavy.

Kansas

M. W. Watson, State Highway Eingineer, Topeka, writes:

We have made no definite plans for this work during the coming winter. I do not believe that Kansas is troubled as much with the removal of snow from the highways as many of the more northern and eastern states. Most of the counties have handled this work by the use of drags and the ordinary blade grader and when the cuts are deeper than these tools will handle effectively, snow has been removed by shoveling.

We have discussed the question at the meetings of our county engineers in a number of instances, but no conclusions have been reached whereby we could derive a better method than has been employed.

Nebraska

George E. Johnson, State Engineer, Lincoln, writes:

The 1919 legislature empowered this department to adequately maintain the roads included in the highway system, some 89 separate routes. This means that the coming season the State Highway Department will plan for the removal of the snow on all main highways of the state. Until that time, January 1, 1920, all that can be done, will be to urge and advise the county commissioners and supervisors to remove the snow from the blocked roads throughout the state. After that time, maintenance systems will take care of the snow removal problem. Letters and bulletins of advice, together with co-operation, will probably clear the main highway systems.

Idaho

F. L. Drew, Maintenance Engineer, State Department of Public Works, Boise, writes:

The problem of snow removal has not been gone into very thoroughly as yet, and in all probability it will not be considered a serious factor until such time as traffic will have increased to a considerable extent.

At this writing a good portion of our highways will not be affected because of the fact that we have a very light snowfall in the southern portion of our state. In parts where snow is apt to drift it will be our policy to erect snow fences and thereby keep the cuts clear of snow.

In certain parts of the state where the snowfall is heavy, it will not be possible to make any provision for keeping the highways clear, as traffic will be carried on by means of sleighs more or less.

As for any organization to carry on this work, would say that we have not gone into it deeply enough to warrant any such procedure.

Colorado

J. E. Maloney, Chief Engineer, Denver, writes:

We have handled snow removal with the regular county maintenance outfits. There will be no changes this season. This applies, of course, to sections of the state except the roads over the Continental Divide, which it has not been found practical as yet to keep open during the heavy snows in winter.

RECLAMATION BY DRAINAGE OF LAND IN THE MISSISSIPPI VALLEY

By Edmund T. Perkins, President National Drainage Congress, Consulting and Supervising Engineer, 1211 First National Bank Bldg., Chicago, Ill.

The greatest opportunity in the United States today for the development and utilization of our natural resources lies in the Mississippi Valley. Nature has provided the opportunity and only the stupidity and slothfulness of mankind hinders the development of this valley to its utmost capacity.

The Opportunity

The greatest known system of navigable streams, flowing through the greatest valley in the world, a valley most productive in all things essential for the need and comforts of the world, centers here; and unified effort on the part of the states, the cities and the people of this valley, is the one thing needed to make it the great center of the world in production, wealth and population, and to bring the utmost prosperity to all the cities and people of the Mississippi Valley.

The Valley

The area of the valley is 1,240,050 square miles, a little less than 50 per cent. of the entire area of the United States, which is 3,026,789 square miles. In round figures the total area of all the countries of the European Belligerents excepting Russia, is 1,200,000 square miles, a little less than the area of the Mississippi Valley, and had our natural resources been fully developed, the wealth of this territory would have far exceeded the combined wealth of all the European belligerents.

The River Sytem

The Mississippi river starting at the Southwest Pass with its depth of 35 ft. comprises the following streams with approximate navigable depth:

The Mississippi river, New Orleans to Cairo, 1,000 miles with 9 ft. of water; Cairo to St. Louis, 250 miles, 8 ft of water; St. Louis to St. Paul, 700 miles, with 6 ft. of water. The Illinois river from Alton to Chicago, 230 miles, with 6 ft; the Ohio from Cairo to Pittsburgh, 945 miles, 6 ft. of water—but here there are being constructed

EDMUND T. PERKINS, CONSULTING ENGINEER.

37 locks costing $63,000,000 which will give between Cairo and Pittsburgh, a minimum depth of 9 ft. Cumberland river, 600 miles, 4 ft. of water; Tennessee, 800 miles, 4 ft. of water. Missouri river from St. Louis to Kansas City, 460 miles, 5 ft; Kansas City to Fort Benton, 1,700 miles further with an average depth of 4 ft. The Arkansas to Forsythe, Mo., 380 miles, with 4 ft.; to Muskogee, Okla., 480 miles, with 4 ft. The Red river to Denison, Texas, 800 miles, 4 ft. of water.

Water and Rail Transportation

In brief, of the 27,800 miles of navigable waterways in the United States, 15,000 miles comprise the Mississippi Valley system, and your knowledge of geography will tell you that this waterway system carries you from the trough of the Mississippi river on the west into Texas, Oklahoma, Kansas, Wyoming and Montana; on the east, through Alabama, Tennessee, Ohio, West Virginia into Pennsylvania, Ohio, Indiana and Illinois, so that there is no part of this valley that cannot be reached by water. As for other means of transportation, 50,000 miles of trunk line railroads are tributary to this valley with the best grades of any roads in the country. Moreover, the north and south railroad systems connect Chicago, St. Louis, Indianapolis and Pittsburgh with one another, with New Orleans and other ports, and intersect all transcontinental systems giving all parts of the valley access by rail to every point of the interior of the United States, and when the river and rail have brought their load to the Gulf, there they find ocean harbors fitted to handle any amount of export business.

With the natural advantage of transportation all "down hill" to the Gulf and ports ready to handle any export business brought them, why should we not develop to our utmost the natural resources of this tributary region that our internal, our export and import business, and our profits may reach the ultimate degree?

Even now we find approximately 50 per cent. of population and of every product in the United States coming from the Mississippi Valley and with the wonderful natural resources of the valley fully developed, this percentage would amount to 85 or 90 per cent.

In no other region of which I know, is there the opportunity for the reclamation and improvement of agricultural lands intimately tied up with the necessity; for navigable reasons, of controlling the streams which devastate these lands.

There are unreclaimed swamp and overflowed lands in these states classified as follows by the United States Department of Agriculture:

Classification of Unreclaimed Swamp and Overflowed Land

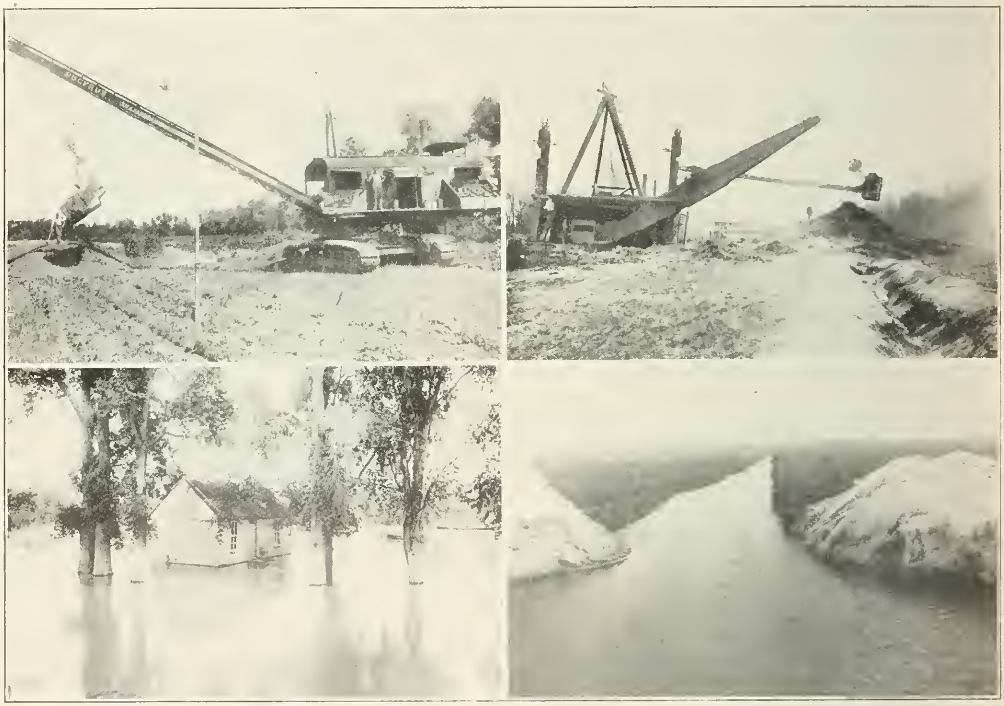
With reference to their productive value as affected by their natural wet condition, they may be classified as follows:

First, lands which are permanently wet and are never fit for cultivation, even during the most favorable years, nor afford profitable grazing for live stock.

Second, lands which afford pasturage for live stock, though the forage they produce may be of indifferent quality.

Third, lands which in their natural condition are subject to periodical overflow by streams, but which at other times produce valuable crops.

Fourth, lands which during seasons of light or medium rainfall will yield profitable crops, but which are wholly unproductive during the seasons characterized by a greater than the normal rainfall.



VIEWS SHOWING LAND RECLAMATION BY DRAINAGE IN THE MISSISSIPPI VALLEY.
Top Row: Dragline Levee Builder at Work, Green Bay Levee and Drainage District, Lee County, Iowa—Floating Dredge Levee Builder on same Project. Bottom Row: "Rainfall" Pumping Station Inadequate, Lima Lake Drainage District, Adams County, Ill.—Drainage Ditch on Wisner Estate, Inc., Raceland, La Fourche Parish, La.

The following classification of the swamp and overflowed lands, with reference to these differences, represents approximately their relative agricultural value as affected by water conditions. All of these classes of land require draining to fit them for profitable cultivation, though a revenue of greater or less amount is periodically derived from all except the first class.

State	Permanent swamp Acres	Wet grazing land Acres	Periodically overflowed Acres	Periodically swampy Acres	Total Acres
Alabama	900,000	59,200	520,000	....	1,479,200
Arkansas	5,200,000	50,000	531,000	131,300	5,912,300
California	1,000,000	1,000,000	1,420,000	....	3,420,000
Connecticut	....	10,000	20,000	....	30,000
Delaware	50,000	50,000	27,000	200	127,200
Florida	18,000,000	....	1,000,000	800,000	19,800,000
Georgia	1,000,000	....	1,000,000	700,000	27,000,000
Illinois	25,000	500,000	400,000	....	925,000
Indiana	15,000	100,000	500,000	10,000	625,000
Iowa	300,000	200,000	350,000	80,500	930,500

Kansas		59,380	300,000	....	359,380
Kentucky	....	100,000	300,000	44,600	444,600
Louisiana	9,000,000	....	1,196,605	....	10,196,605
Maryland	100,000	....	92,000	....	192,000
Maine	156,520	....	....	....	156,520
Massachusetts..	20,000	....	39,500	....	59,500
Michigan	2,000,900	947,439	....	....	2,947,439
Minnesota	3,048,000	2,000,000	....	784,308	5,832,308
Mississippi	3,000,000	....	2,760,200	....	5,760,200
Missouri	1,000,000	....	1,439,600	....	2,439,600
Nebraska	....	100,000	412,100	....	512,100
N. Hampshire..	5,000	....	7,700	....	12,700
New Jersey ...	326,400	....	....	....	326,400
New York	100,000	100,000	329,100	....	529,100
No. Carolina ..	1,000,000	500,000	500,000	748,160	2,748,160
North Dakota..	50,000	50,000	50,000	50,000	200,000
Ohio	....	....	100,000	55,047	155,047
Oklahoma	....	....	31,500	....	31,500
Oregon	254,000	....	....	....	254,000
Pennsylvania ..	....	....	50,000	....	50,000
Rhode Island..	....	....	6,000	2,064	8,064
So. Carolina ..	1,500,000	....	622,120	1,000,000	3,122,120
South Dakota..	100,000	....	511,480	....	611,480
Tennessee	639,600	....	....	....	639,600
Texas	1,240,000	1,000,000	....	....	2,240,000
Vermont	15,000	....	8,000	....	23,000
Virginia	600,000	....	200,000	....	800,000
Washington ...	20,500	....	....	....	20,500
W. Virginia ..	....	....	23,900	....	23,900
Wisconsin	2,000,000	....	....	360,000	2,360,000
Total	52,665,020	6,826,019	14,747,805	4,766,179	79,005,023

In addition to the above total area of 79,005,023 acres of wet land, it is estimated that there are 150,000,000 acres of what is now known and occupied as farm land, which is too wet for the most profitable cultivation, and whose production would be increased 20 per cent. by proper drainage.

Present Value of Unreclaimed Lands—Malaria

Today these lands in general have only nominal values from $5 to $30 an acre, depending upon the frequency of their overflow, and on account of the swamp diseases which they generate they are a perpetual menace to the health of the nation, and a tremendous financial loss each year on account of the lessening of the man power of the nation. This loss Dr. W. A. Evans, former health commissioner of the city of Chicago and writer of health articles for many papers, has estimated as follows:

Loss through Malaria death per annum....	$ 10,200,000
Cost of disability and illness from Malaria..	192,000,000
Depreciation of real estate and loss in earning power of labor due to Malaria..........	60,000,000
Total annual economic loss due to Malaria.	$162,200,000

In arriving at these estimates, Dr. Evans frequently cut in half the general accepted estimate. The terrible suffering that must be endured by humanity so long as Malaria is permitted to exist is a matter of the deepest concern to the whole nation.

River Regulation

To develop the natural resources of the Mississippi Valley, so that we may profit from Chicago, St. Louis and Minneapolis on the north, Pittsburgh on the east, Kansas City and Omaha on the west, St. Louis, Cairo, Memphis in the center of the valley to New Orleans and other gulf ports, it is necessary that our rivers be regulated and made navigable with proper terminal facilities, and facilities for exchanging freight to and from the railroads, that levees of proper height and section be built and maintained from Cape Girardeau to the south, and that the upper reaches of the river be regulated by every means possible, as for example by the proposed flood reservoirs on the Monongahela and Alleghany rivers, as sponsored by the Pittsburgh Flood Commission.

Levees and Reservoirs

For let me definitely state that as levees are absolutely essential and the only way for the controlling of the rivers through the south, reservoirs on the upper reaches of the river are equally essential. These problems of river regulation and flood protection are so great and so intricate that there is no one way of solving it. Every device known to the engineer must be used according to the demands and needs of each locality. To develop the streams, the lands, the electric powers and other natural resources of this Mississippi Valley would easily take all the engineering talent of the nation, and all the money that the nation could advance, for what though it cost a billion of dollars, for every dollar rightly spent, there should be an annual return of an equal amount.

These are figures which a few years ago would not only have been beyond the comprehension but beyond the thought of any one, but at least the war has done one thing, it has taught us to think in billions.

Results to be Accomplished

Were this development carried out we would accomplish the following results:

1. The construction under government supervision of navigation facilities vastly improving waterways, now used for transportation, and opening up for navigation thousands of miles of waterways not now navigable.

2. The creation in connection with such navigation of an enormous total of hydro-electric power for the making of nitrate fertilizer for the farmers of the Mississippi Valley, for railroad operation, for manufacturers, for dewatering of wet lands or irrigating of arid lands, and for making "electric steel" and other similar products.

3. The construction of great public works, to give immediate employment to labor and to capital.

4. The development of waste lands, arid, wet and cut-over, providing homes for thousands and making the population and wealth of the Mississippi Valley many times what it is at present.

5. The prevention of destructive floods by river regulation.

6. An improvement in the public health worth millions yearly to the valley.

For a National Department of Public Works

To accomplish this work and to accomplish similar work, throughout the United States, there should be a National Department of Public Works, and daily we see in the papers, some organization demanding such a department, and until there is such a department, the development of the United States and of the Mississippi Valley will be continually hampered and will be done by piece-meal as it is done now, so let me urge upon the readers of Municipal and County Engineering in all parts of this great region, that we demand of our representatives in Washington and of the National Government, the creation of this department and the allotment to it of funds sufficient to develop for health, wealth and prosperity, for internal use and for export, the natural resources of the Mississippi Valley.

SEWAGE TREATMENT PLANT AT MONTEZUMA, IOWA

By J. H. Dunlap, Assoc. Prof. Hydraulic and Sanitary Engineering, State University of Iowa, Iowa City, Ia.

The town of Montezuma has had under construction since July 27, 1918, a sewage treatment plant consisting of a sedimentation tank of the Imhoff type, a siphon chamber, two intermittent sand filters and a sludge bed. The plant is now nearly completed, and when put into operation, will mark the end of a long-continued nuisance. For many years the town has discharged its sewage into a small creek which was practically dry in summer. During the hot, dry period of the year, this creek became an open septic tank full of black, foul, ill-smelling, septic sewage. The milk cows in the adjoining pastures found it a favorite pastime to splash in this open septic tank in order to cool themselves and drive away the flies.

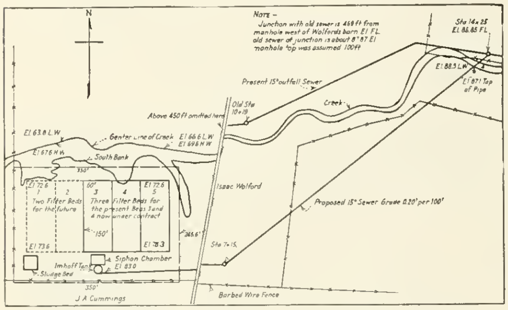


FIG. 1. GENERAL PLAN OF SEWAGE TREATMENT PLANT AT MONTEZUMA, IOWA.

The description of the work thus far accomplished in Montezuma falls naturally into three divisions; one, the relation of the design of the plant to the funds available; two, the features of the plant as finally designed; three, the unit costs of the work to date.

Relation of the Design of the Plant to the Funds Available

The county auditor of Poweshiek County reported that the actual value in 1917, without moneys and credits, of the taxable property of Montezuma was $1,075,584. This represented a taxable value of $268,896. Each mill of tax levy would therefore amount to $268.896. Since Montezuma is an incorporated town, it has the power under section 840-g, supplemental to the code of Iowa, 1915, to levy annually a tax not to exceed five mills on the dollar for the purpose of constructing sewer outlets and sewage treatment plants. The income from this may be anticipated by issuing bonds. While there is no legal limit to the number of years for which this five mill levy may be anticipated, yet it is usually considered unwise and uneconomical to extend the period of years over more than twenty.

In finding the total amount of bond issue which an annual income of $1,344.48 from the five mill levy would make possible over a period of twenty years, it is very convenient to use the following simple formula:

$$B = \frac{T}{F}$$

B = amount of bond issue
T = annual income from taxes

$$F = \frac{r}{(1+r)^{n-1}} + r = \text{interest factor}$$

r = rate of interest
n = number of years to final payment of bonds

In Table I is given a set of interest factors for rates of interest of 5, 5½ and 6 per cent., and for 20 and 10 years to final payment of bonds.

TABLE I—INTEREST FACTORS.

r	n	F
5	20	0.0803
5½	20	0.0837
6	20	0.0872
5	10	0.130
5½	10	0.133
6	10	0.136

Using a rate of interest of 5½ per cent., the rate at which the bonds were finally sold, the possible bond issue over a period of 20 years becomes $16,060, as follows:

$$B = \frac{T}{F} = \frac{\$1{,}344.48}{0.0837} = \$16{,}060$$

It will be observed that this method of determining the amount of bond issue employs the equal annual payment method, which supposes that each year there is deposited in the bank at compound interest equal annual payments with the amount of the loan remaining constant until paid at the end of 20 years by the fund accumulated from the equal annual payments and the compound interest.

In Table II it is shown that the amount of the bond issue possible is the same whether there is deposited annually equal payments in the bank at compound interest, or whether an increasing payment is used to retire part of the loan until the loan is entirely paid at the end of 20 years. For convenience in calculation, $16,000 is used as the amount of the bond issue and $1,340 as the annual income from the five mill tax. It is believed that the results of only three years are necessary to show that the amount of the bond issue possible is the same under either plan of payment.

TABLE II—TOTAL ON DEPOSIT AT THE BANK WITH EQUAL ANNUAL PAYMENTS AT COMPOUND INTEREST—THE AMOUNT OF THE BONDS REMAINING CONSTANT UNTIL PAID AT END OF 20 YEARS BY THE ACCUMULATED FUND.

At end of year	Amount of bonds interest during unpaid drawing current year	Annual income from 5 mill tax	Interest on bonds at 5½%	Annual payment	Interest on annual payments at 5½%	Interest on interest at 5½%	Total on deposit at the bank	Total paid on bonds
1	$16000	$1340	$880	$460	$0.00	$0.00	$460.00	$0.00
2	16000	1340	880	460	25.30	0.00	945.30	0.00
3	16000	1340	880	460	50.60	1.39	1457.29	0.00
etc., etc.								

Total paid on the bonds with increasing annual payments used to retire part of the bonds annually until entirely paid at end of 20 years.

1	$16000	$1340	$880	$460				$460.00
2	15540	1340	854.70	485.30				945.30
3	15054.70	1340	828.01	511.99				1457.29
etc., etc.								

It will be observed in Table II that the total sum on deposit at the bank under the equal annual payment method is the same as the total paid on the bonds under the usual plan of increasing annual payments to the bonding company. If the usual plan is employed of making increasing annual payments to retire part of the bond issue, in the first year $460 of bonds might be retired, in the second year $485.30 of bonds and in the third year $511.99 of bonds. Naturally no bonding company wishes to handle bonds of such amounts as these. The proposition of The White Company of Davenport was accepted by the town council that 31 bonds be issued, each for $500, rate of interest 5½ per cent. payable semi-annually, plus $125 for the expense of printing and issuing the bonds, 4 per cent. interest to be paid by the company on the principal on deposit until drawn by the council.

Since about $18,000 to $20,000 would be required to finance the plant, other sources of revenue had to be

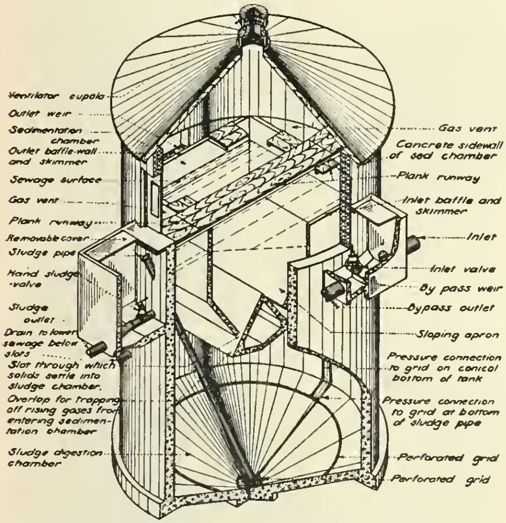


FIG. 2. ISOMETRIC DRAWING OF THE IMHOFF TANK, SEWAGE TREATMENT PLANT AT MONTEZUMA, IOWA.

found and the allowable indebtedness investigated. The constitutional limit of indebtedness in Iowa is 5 per cent. of the actual value of the taxable property. With a taxable value of $268,896 and therefore an actual value of four times this amount, $1,075,584, the allowable constitutional limit of indebtedness was $53,779.20. In view of the present bonded indebtedness of $24,886.73, this meant an allowable increase of indebtedness of $28,892.47.

Certain other facts need to be kept in mind in considering limits of indebtedness and bond issues in Iowa. General bonds, on the one hand, may be authorized by resolution of the council when the indebtedness caused thereby is less than 1¼ per cent. of the actual value of the taxable property. When the indebtedness is from 1¼ per cent. to 5 per cent. of the actual value of the taxable property, the bond issue must be approved by a vote at an election called on the petition of a majority of the voters. Such general bonds may be paid off at will and usually no definite plan for paying them off is adopted.

Special levy bonds, on the other hand, are issued for a definite period of time and do not need a vote at a general election from 1¼ per cent. to 5 per cent. of the indebtedness in any courts. Furthermore, the Iowa State Supreme Court has held that such bonds are not part of the constitutional debt of the city whether below or above 5 per cent. The main idea in the mind of the court seemed to be that under the law the town is not liable, in case it fails to levy or collect the tax specified. Hence, such bonds are not a debt. Furthermore, as each annual installment payment on the bonds become due, and therefore a debt, it is paid. In the Federal Courts, however, such bonds are held to be part of the debt, else the Federal Court has ruled there would be no limit to the amount of bonds for which councils might contract. Accordingly, it should be remembered that up to an indebtedness of 5 per cent., special levy bonds contracted for by town councils are good in all courts. Beyond an indebtedness of 5 per cent., however, such bonds are good only in Iowa. Moreover, such bonds issued in anticipation of special levies may be sold at any time, while bonds sold in anticipation of the two mill regular sewer tax, may be sold only after a definite certified cost of the work is on file and then only for a maximum period of ten years' anticipation.

One additional fact is of importance. By act of the Thirty-Seventh Assembly, approved March 28, 1917, no indebtedness which is incurred by cities and incorporated towns for the purpose of purchasing, erecting, extending or maintaining and operating water works, electric light and power plants, gas works and heating plants, or of building and constructing sewers, shall be charged against or counted as a part of the 1¼ per cent. available for general and ordinary purposes on resolution of the council until the other 3¾ per cent. available for the special purposes enumerated, has been exhausted. Luckily the law provides that after ninety days, injunctions due to illegal proceedings may not be granted.

Putting all these facts together, it was determined that a sewage treatment plant could be easily financed within the constitutional limit of indebtedness of the city, which would enable the bonds to be sold in any state. However, since only $15,500 of the cost could be defrayed by the special five mill levy, other sources of revenue had to be found. Two sources were possible. The regular sewer levy of two mills might be anticipated over a period of ten years, making possible bonds for $4,050, as follows:

$$B = \frac{T}{F} = \frac{2 \times 268.896}{0.133} = \$4{,}050$$

This, however, would leave the town without any funds for maintenance of its sewer system and its sewage treatment plant, except drafts upon the general funds which are apt to be hard pressed without this added burden. Accordingly, the plan of The White Company, as decided upon, is to supply whatever further funds are needed, in addition to the $15,500 already contracted for under the five mill levy, by making a general funding bond issue for an indefinite term of years. This can be authorized by resolution of the council in case the character of the present debt of the town is such that all of the 1¼ per cent. available for general purposes is not exhausted, when the debts properly chargeable to the 3¾ per cent. available for the special purposes above given are so allocated.

If the town had been constructing a general sanitary sewer system at the same time as its sewage treatment plant, then all or a part of the cost of the sewage treatment plant might have been assessed against the property affected, in conformity with the legal provisions relating to the assessment of the costs of sewers against the property. An act authorizing this was passed by the Thirty-Seventh General Assembly April 12, 1917.

Due to the fact that the special five mill levy would amount to a practicable bond issue of $15,500, it was necessary to design the plant so that the cost would not greatly exceed this amount. The contract cost of the plant was $16,100 with M. Tschirgi and Sons of Cedar Rapids successful bidders. With the cost of engineering, legal services, land and extras, the total cost of the plant will probably be about $18,000. This will leave about $2,500 to be raised by general funding bonds. The amount of money available limited the number of filter beds which could be constructed at this time. The two beds under contract will care for the sewage at the present time with no provision for the future. While an extra filter bed would have been a good investment if the funds had been sufficient, yet it seemed far better to make a beginning and take care of the present problem, at least, in hope that changes in the law might make possible additional special levies.

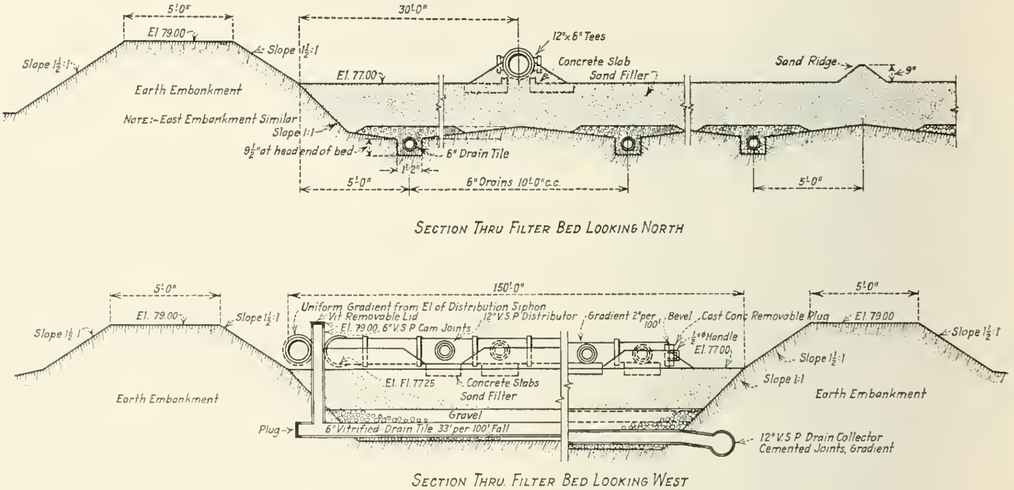


FIG. 3. TYPICAL SECTIONS THROUGH THE FILTER BEDS OF MONTEZUMA, IOWA, SEWAGE TREATMENT PLANT.

The Features of the Plant as Finally Designed

Fig. I shows the general plan of the sewage treatment plant. The old sewer was a 15 in. vitrified tile sewer with uncemented joints. It discharged directly into the creek at a point just above the site selected for the sewage treatment plant. In order to obtain sufficient elevation of flow line to carry the sewage through the plant, it was decided to take up and relay the old 15 in. sewer, beginning at a point about 975 ft. from the old outlet. A junction manhole was built at this point and a new 15 in. sewer on a grade of 0.2 per cent. was laid for a distance of approximately, 1,425 ft. to the inlet manhole at the Imhoff tank. After sedimentation in the Imhoff tank, the sewage is automatically discharged by two alternating siphons upon the two filter beds. It was possible to locate the sludge bed at the southwest corner, as shown.

The Imhoff Tank

In designing the Imhoff tank, the first problem was to decide upon what the population of Montezuma might be 25 years hence. With a population of 1,326 in 1915, it was decided, after careful consideration of the growth of the town since 1885, that it was fair to assume 2,000 in the design of the tank. In Table III are given the settling periods in the Imhoff tank when the estimated average yearly flow of sewage, namely, 50 gals. per capita per day, occurs; and also the settling periods when 50 additional gals. per capita per day of ground water infiltration are reaching the sewers, making a total of 100 gals. per capita per day. It is believed that a population of 1,200 is likely to be connected to the sewers within the next five years, there being from 800 to 1,000 now connected. The settling periods, assuming the sewage to be evenly distributed over the 24 hours of the day, are compared with the settling periods with the flow evenly distributed over 18 hours of the day, as is commonly assumed in design.

TABLE III—SETTLING PERIODS IN THE IMHOFF TANK AT MONTEZUMA, IOWA.

Population connected to sewers	50 Gals. per capita per day Hrs. settling 24 Hrs. basis	Hrs. settling 18 Hrs. basis	100 Gals per capita per day Hrs. settling 24 Hrs. basis	Hrs. settling 18 Hrs. basis
1,200	4.85	3.65	2.42	1.82
2,000	2.91	2.18	1.45	1.09

The area of the gas vents is 23.6 per cent. of the whole superficial area of the tank.

The sludge storage capacity up to within 3 ins. of the bottom of the beam forming the overlaps for the vents, is about 1.67 cu. ft. per capita on a basis of 2,000 future population, and up to the slots is about 1.88 cu. ft. per capita.

It will be observed that a relatively short flowing through period, with ample gas vent area and sludge storage capacity has been obtained in the design. The sewage from the town is fresh, domestic sewage readily settleable. Due to the usual failure to keep the gas vent areas free from gas lifted sludge and to remove sludge from the sludge digestion chamber, it was decided that ample dimensions in these respects were necessary.

Reference to Fig. 2 will show the principal features of the Imhoff tank. In the inlet manhole, it should be noted that a by-pass weir is provided. The elevation of the crest of this weir may be made whatever experience shows is best, in order to allow only the proper amount of sewage to pass through the tank over upon the filter beds. Quantities in excess of this predetermined amount will automatically pass directly over the weir and through the by-pass outlet to the creek. In case it is desired to by-pass the entire flow of sewage, the inlet valve may be closed and part of the by-pass weir removed, in order to give a clean sweep through the inlet manhole into the by-pass outlet.

VIEWS OF FILTER BEDS OF MONTEZUMA, IOWA, SEWAGE TREATMENT PLANT.
FIG. 4. (TOP) DISTRIBUTING SAND OVER THE GRAVELLED TRENCHES.
FIG. 5. THE FILTER BEDS DEC. 17, 1918.
FIG. 6. A DOSE OF SEWAGE FLOODING THE WEST FILTER OF THE COMPLETED PLANT.

The general inside dimensions of the tank are 20 ft. diameter, 24 ft. of depth to the base of the inverted cone with 5 ft. to the apex of the cone.

Two 8 in. slots with 8 in. laps are provided at the bottom of the settling chamber. Double slots should distribute the sludge more evenly in the sludge digestion chamber, assist somewhat in preventing stoppages due to imperfect operation, and decrease the room available for sludge. The sludge pipe is an 8 in. cast iron pipe extending to the bottom of the cone in the sludge digestion chamber. The hydraulic head on the gate-valve on the sludge pipe is 5 ft., which will enable the sludge to be discharged under the head of the sewage above. From the sludge manhole, a 10 in. vitrified pipe sludge line runs directly to the sludge bed. Two pressure connections are provided by means of which water or sewage under pressure may be pumped into the sludge at the bottom of the sludge digestion chamber, in case the sludge becomes so compacted that it will not flow through the sludge pipe. The pump is not to be installed now, but the pipe connections are to be put in so as to be ready for use at any time experience may show agitation of the sludge to be necessary.

One important and rather new feature provided in this tank, is the 8 in. drain visible in Fig. 2, just below the sludge outlet manhole. The flow line of this drain is such that the sewage may readily be drawn down below the slots in case it becomes necessary to work upon the walls of the settling chamber. It has been found in actual operation of Imhoff tanks in towns of the size of Montezuma, that not infrequently the sedimentation chamber is allowed to become completely sludged up and thus transformed into a small septic tank. In order to clean out the sedimentation chamber, it has been found necessary to lower the sewage below the slots and then force the sludge down through the slots, carefully squeegeeing the walls and sloping aprons.

Plank runways are provided over the tank in such a manner as not to interfere with squeegeeing the side walls and slopes of the settling chamber which is likely to be necessary frequently.

The tank has a superstructure of hollow building tile, to be plastered with cement mortar finished to resemble concrete. Two four-light sash doors are provided, one on the east and one on the west. A nine-light window on the north will admit additional light and air.

Siphon Chamber

The inside dimensions of the reinforced concrete siphon chamber are 32 ft. 6 in. x 26 ft. x 7 ft. It was designed of such area that when the sewage is 3 ft. deep, it will automatically discharge enough sewage to cover one filter bed to a depth of 3 ins. The siphons have a drawdown of 2 ft. 8 in.

Two alternating 10 in. siphons are to be installed under the present contract together with the main trap for a third siphon, so that when the third filter bed is added in the near future, the third siphon may be connected without breaking the concrete floor and side wall of the chamber. These siphons have been so located that five may ultimately be installed.

In designing the siphon chamber, an effort was made to insure plenty of head room, light and air for convenience in operation. At the southwest corner of the siphon chamber are two gate valves, one an 8 in. valve to convey the sludge that settles upon the floor of the siphon chamber to the sludge bed, and the other a 12 in. valve to be used when it is necessary to by-pass the sewage around the filters, but through the Imhoff tank. The stems of these valves extend up through pipe sleeves above the roof of the siphon chamber.

The Filter Beds

Two sand filter beds are included in the present contract. Each filter has an area of 60 ft. x 150 ft. On the basis of 200,000 gals. per acre per day, one-half ground water in wet periods, each filter will care for about 400 people. Ultimately five beds will be constructed, thus providing for a population of 2,000, the capacity of the Imhoff tank.

Fig. 3 shows the method of construction employed. On each bed a 12 in. vitrified sewer pipe distributor with 6 in. tees distributes the sewage over sand two feet deep, under which graveled trenches containing 6 in. vitrified drain tile, 10 ft. center to center.

Fig. 4 shows the method used in graveling the trenches and is distributing the filter sand. Every precaution was taken to prevent heavily loaded wagons from passing over the graveled trenches. The sand was dumped, first, at the north end of the filters upon a plank roadway. An ordinary gasoline driven back-filling machine, with a sand buck, was used to distribute the sand over the north half of the filter beds. Then the same general procedure was repeated at the south end of the filter beds. The concrete collector manhole at the northwest corner of the filter beds is clearly visible in Fig. 4. Into this collector manhole come the collector headers into which the 6-in. underdrains run. The 15 in. by-pass, together with the sludge drain from the sludge bed, also comes into this collector manhole. From the manhole one 15 in. outlet runs to the creek bank where a substantial concrete head wall has been constructed. When the two beds are added at the west, their collector header will also come into the west side of the collector manhole where the first length of pipe has already been set.

In Fig. 5 are shown the two filter beds nearly completed on December 17, 1918. The 12 in. distributors with the 6 in. tees are clearly to be seen. The 5 ft. berms around the filter beds have been sodded.

In the foreground is the edge of the cave-in of the Imhoff tank excavation. The contractor did not exercise sufficient precaution in speeding up the excavation of the 30 ft. hole for the Imhoff tank. Accordingly, he was subjected to great expense due to several successive cave-ins. In the middle foreground is seen the area nearly ready for the floor of the siphon chamber.

The Sludge Bed

The sludge bed is 30 ft. x 40 ft. Its construction, while in general similar to that of the filters, differs in the depth of the filtering material. The sludge bed ought to be made as porous as possible in order to drain away the liquid from the sludge quickly Accordingly, a surface layer of filter sand 6 ins. in depth has been placed upon the gravel layer, which has been made about 1 ft. in depth, or double the depth of the gravel layer in the filters. The 10 in. vitrified sludge pipe from the Imhoff tank has been given a sharp grade from the tank, in order to prevent an unnecessary number of stoppages. The elevation of the flow line at the outlet of the sludge pipe has been placed 1 ft. above the surface of the sand in order that the sludge may be run out, if necessary, to a depth of 1 ft. over the sand before beginning to back up in the sludge pipe. It is believed that it will never be necessary to run out from the tank at any one time more than 1 ft. of sludge. It is better practice to run out small amounts of sludge every two to six weeks.

Unit Costs to Date

The unit costs are based on labor at $4 per day of 10 hours until late fall, when the cost was $4 per day of 8 hours; teams at $7 per day of 10 hours, and later per day of 8 hours. The length of haul from the railroad siding to the plant was 1.3 miles, over a fair road with no up-grades. The costs do not include superintendence, overhead and profit.

EARTH WORK

	Type	Estimated cu. yds.	Cost per cu. yd.
Filter beds	Slip work	1060	$0.47
Siphon chamber	½ slip and ½ hand	187	0.78
Imhoff tank	Hand before banks caved	408	0.82
Imhoff tank	After cave-ins with bracing	408	2.70
Sodding berms of filter beds, $0.20½ per sq. yd.			

COST OF FILTER SAND

Cost per ton F. O. B. sand company	$0.35
Freight	0.90
Unloading from cars, mostly box cars	0.063
Hauling by team 1.3 miles	0.39
Unloading from wagons	0.022
Leveling and spreading	0.131
Total cost per ton in place	$1.86
Total cost per cu. yd. of 3,000 lbs	2.78
Total required for two beds	1,390 cu. yds.
Total required for sludge bed	21 cu. yds.

COST OF FILTER GRAVEL.

Cost per ton F. O. B. gravel company	$1.25
Freight	0.90
Unloading from cars, mostly box cars	0.095
Hauling by team 1.3 miles	0.39
Unloading from wagons	0.022
Total cost per ton at filter bed	$2.66
Total cost per cu. yd. of 2,700 lbs	3.59
Total required for two beds	194 cu. yds.
Total required for sludge bed	32 cu. yds.

COST OF 1:2:4 CONCRETE IN CYLINDRICAL WALLS OF IMHOFF TANK, PER CU. YD.

Cement at 6.4 sacks per cu. yd. F. O. B. Montezuma ($2.28 per bbl.)	$3.65
Hauling by team 1.3 miles—to barn 8½c, to job 9c	0.18
Sand, 0.45 cu. yd. at $2.65	1.19
Gravel, 0.90 cu. yd. at $3.59	3.23
Steel reinforcement	1.49
Setting forms and reinforcement	2.93
Mixing and pouring—heating sand, gravel and water	1.98
Total cost per cu. yd. in place	$14.65

COST OF 1:2:4 CONCRETE IN SIPHON CHAMBER PER CU. YD.

(Includes only walls and footings; roof and floor omitted.)

Cement at 6.4 sacks per cu. yd. F. O. B. Montezuma ($2.28 per bbl.)	$3.65
Hauling by team 1.3 miles—to barn 8½c, to job 9c	0.18
Sand, 0.45 cu. yd. at $2.65	1.19
Gravel, 0.90 cu. yd. at $3.59	3.23
Steel reinforcement	1.59
Setting forms and reinforcement	2.18
Mixing and pouring—heating sand, gravel and water	1.65
Total cost per cu. yd. in place	$13.67

COST OF 6 IN. VITRIFIED FARM DRAIN TILE IN FILTER BEDS

Cost of tile per ft. F. O. B. Montezuma	$0.08
Hauling by team 1.3 miles	0.005
Trenching	0.039
Laying	0.01
Graveling at $2.66 per ton and spreading at $0.04 per ft	0.44
Total cost per ft. of trench	$0.574

LAYING 15-IN. VITRIFIED PIPE SEWER MAIN, 1,425 FT. IN LENGTH

Cost of pipe per ft. F. O. B. Montezuma	$0.65
Hauling by team 1.3 miles	0.033
Trenching, including back-filling	0.376
Laying, including mortar	0.077
Total cost per ft. of trench	$1.14
Cost of taking up old 15-in. sewer and back-filling per ft	$0.246

Acknowledgment

The foregoing article by Prof. Dunlap is reprinted from The Transit, Vol. 23, 1919.

Galveston's oyster-shell streets
successfully surfaced with Tarvia

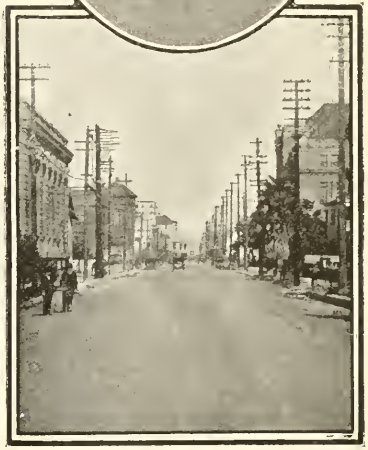
WE have repeatedly claimed that there is a grade of Tarvia and a method of application that will solve practically any road problem—and solve it economically.

Now comes a letter from George H. Willits, City Engineer of Galveston, Texas, telling how Tarvia has improved that city's oyster-shell streets, and at the same time reduced maintenance expense. A portion of Mr. Willits' letter follows:

"Practically *all* of Galveston's streets, outside of the business district, are built of rotted oyster shell, commonly called mudshell. This shell is easily compacted into a smooth, hard road surface which looks very much like concrete. However, this surface will not withstand wet weather nor the abrasion of heavy traffic, becoming very dusty in summer and on account of its white color, causing a disagreeable glare, and in the rainy season soon becoming muddy and full of holes.

"In May, 1917, we began surface treating these shell streets with 'Tarvia-B' and 'A' and trap rock, and have had very fine results from this work. Our streets stay in good surface during all kinds of weather; we have eliminated heavy maintenance bills for shell and do not find it necessary to sprinkle these treated streets as we are compelled to do all untreated shell streets for eight months in the year. The dark color of the Tarvia surface entirely eliminates the disagreeable glare.

"The people of Galveston are very much pleased with the results obtained by surfacing the streets with Tarvia and testify to this by always seeking the treated streets for the heaviest travel."



Three views of the oyster-shell roads in Galveston, Texas, surface-treated in 1917 with "Tarvia-B" and "A." At top are shown 35th Street and Broadway. Lower view shows 20th Street, in the business section of the city.

Illustrated booklet free on request.

We believe we may safely say that no matter *what* kind of a road problem you are facing, Tarvia will help you in the solution—and save you money, too.

Special Service Department

This company has a corps of trained engineers and chemists who have given years of study to modern road problems. The advice of these men may be had for the asking by any one interested. If you will write to the nearest office regarding road problems and conditions in your vicinity, the matter will be given prompt attention.

Tarvia
Preserves Roads~Prevents Dust

The Barrett Company

New York, Chicago, Philadelphia, Boston, St. Louis, Cleveland, Cincinnati, Pittsburgh, Detroit, New Orleans, Birmingham, Kansas City, Minneapolis, Dallas, Nashville, Salt Lake City, Seattle, Peoria, Atlanta, Duluth, Milwaukee, Bangor, Washington, Johnstown, Youngstown, Toledo, Columbus, Richmond, Latrobe, Bethlehem, Elizabeth, Buffalo, Baltimore, Lebanon

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PERSONAL ITEMS

Harry Barker and Robert C. Wheeler announce their association for the practice of engineering and the establishment of an office at 1512 Maiden Lane Building, 170 Broadway, New York City. Mr. Barker has recently been released from military service as Captain of Engineers, U. S. A., but Major Wheeler will remain in the service for a short time as Chief of the Water Supply Section of the Construction Division of the Army. Mr. Barker will be the active director of the firm's work until the release of Major Wheeler.

Special attention will be given to public utility engineering, including valuations, rates, operation and management; to hydraulics; to power development and utilization; water supply and purification; sewerage and sewage disposal; municipal problems, including city transportation and civic improvements; development of new processes; and reports for investors.

Mr. Barker is a graduate engineer (University of Vermont), with over fifteen years broad experience in electrical, mechanical and civil fields. His earlier work included design and testing of power plants, and field and laboratory work in hydraulics. For several years he was an editor of "Engineering News" and "Engineering News-Record," making critical studies of a wide variety of engineering works and particularly of power development and utilization, pumping plants, water works, public utility valuations and rate cases, transportation and other municipal problems. From the early days of the present form of utility regulation he has been consulted in public utility matters and much of his experience has been collected in the treatise "Public Utility Rates," published in 1917 by the McGraw-Hill Book Co., New York. In 1917 Mr. Barker was called from reserve to active military service, being assistant engineer depot officer at the New York Port of Embarkation, and an engineer of camp maintenance and utility operation in the Cantonment and Construction Divisions. After the armistice he was given leave to become associated with Mr. George W. Fuller, member of the Engineers' Valuation Board for the Pittsburgh Railways, which Board assisted the Pennsylvania Public Service Commission in the valuation of the 600-mile street and interurban railway system of the Pittsburgh District.

Mr. Wheeler is a graduate engineer (University of Vermont), who has specialized for ten years in the design, construction and operation of water supply and purification plants, sewers and sewage disposal works. His earlier work was in railroad construction. For over five years he was associated with Mr. George W. Fuller, being particularly identified with the water works and sewerage improvements at Clarksburgh, W. Va., the sewerage and sewage disposal works at Vincennes, Ind., and those for Plainfield, North Plainfield and Dunnellen, N. J. Later he served a term as City Engineer for Summit, N. J., and then became General Manager and Chief Engineer of the New Chester Water Co., of Chester, Pa., and its subsidiaries, the Greencastle Water Co., Greencastle, Ind., the Vincennes Water Supply Co., Vincennes, Ind., and the Delaware Water Supply Co., Delaware, Ind. This office he resigned in August, 1918, when commissioned Captain in the Construction Division of the Army. He served as Assistant Port Utilities Officer at Newport News, Va., and in June, 1919, was promoted and assigned as Chief of the Water Supply Section.

Mr. E. J. Dewine, who for the past two years has been in the Construction Division of the U. S. Army, has joined the International Exposition of Municipal Equipment, New York City, to take charge of the department of streets, asphalt and road machinery. Mr. Dewine has had a wide and varied experience in this field, having begun his experience in 1895 with the Warren-Scharf Asphalt Paving Co., which finally developed into Warren Bros. In 1900 he joined the Southern Paving Construction Co., and for eight years was associated with them, and the jointly owned Southern Clay Mfg. Co. In the succeeding years he was identified with the Southern Contracting Co., the road department of the Barrett Co., and the U. S. Asphalt Refining Co. Mr. Dewine combines with a thorough knowledge of his profession, exceedingly large following.

Mr. J. H. Brewster has joined the staff of the International Exposition of Municipal Equipment, New York City. He is a well known sanitary engineer, and since his discharge from the army has been identified with the engineering department of the New York State Board of Health, where he had direct supervision of the investigation of plants producing milk or milk products, including investigation and reports of plants, design and construction and general equipment installed. After completing his course in chemical and sanitary engineering at the Rensselaer Polytechnical Institute, Mr. Brewster was connected with the American Water Works and Electric Co., of New York City for nearly four years as sanitary engineer, having charge of the operation of water purification plants. Later he joined the Indiana State Board of Health for four years. There his work included the approval of plans for water and sewerage systems, together with the sterilization of water and sewage, the construction and operation of purification plants, and chemical and bacteriological work connected therewith. He made surveys of rivers, lakes and water sheds, and traced the outbreaks of epidemics, as well as other work coming under the control of his department. Mr. Brewster will have charge of the health, water, sewage disposal and milk sections of the International Exposition of Municipal Equipment, and his broad experience will in all probability add much to the success of the Exposition.

THIN PLATE ORIFICES IN PIPE LINES

The selection of the type of meter to be employed in measuring the flow of water through a pipe line should be based upon the consideration of the difficulties of installation, permanency of operation, aacuracy of measurement, and the cost of installation and maintenance. Tests to determine the practicability of employing thin-plate orifices in pipe lines, and the conditions most favorable for their use as measuring devices, have been completed by the Engineering Experiment Station of the University of Illinois under the direction of R. F. Davis, Associate in Civil Engineering, and H. H. Jordan, Assistant Professor in General Engineering Drawing. The results of these tests are given in detail in Bulletin No. 109, entitled "The Orifice as a Means of Measuring Flow of Water Through a Pipe," free on request.

WATER WORKS SECTION

CONCRETE IN WATER WORKS CONSTRUCTION

By A. C. Irwin, Engineer, Structural Bureau, Portland Cement Association, 111 W. Washington St., Chicago, Ill.

Concrete has been used very extensively in various parts of water supply works such as dams, reservoirs, pipe lines, tanks, standpipes, filters, settling basins, power houses, etc. Obviously, a detailed discussion of all these is beyond the limits of a single paper and it will be necessary to confine the discussion to very general terms in order that we may touch upon each of these items, said Mr. Irwin in addressing the Iowa Section of the American Water Works Association.

Dams

Dams for impounding water are very generally of concrete. Concrete dams are usually cheaper than cut stone masonry dams and allow the utmost flexibility in meeting special local conditions. Earth dams, though sometimes low as to first cost when filling material may be excavated from side hills and dumped directly into the dam site, nevertheless have inherent weaknesses. Water flowing over the crest of an earth dam under flood conditions usually marks the failure of the dam. The activity of boring animals has also been responsible for earth dam failures since seepage or a small leak soon grows into a washout unless observed and corrected. Concrete cores in earth dams constitute a step in the right direction and sometimes make the earth dam justifiable, but cannot be said to satisfy all the requirements of permanent dam construction under all conditions. Such a dam may fail by overflow or by a slide of filling material.

Concrete dams may be divided into four general types: gravity dams, simple arch dams, multiple arch dams and buttress and slab dams.

Choice of the type best suited to any particular case must be the result of thorough investigation and consideration of all of the local conditions.

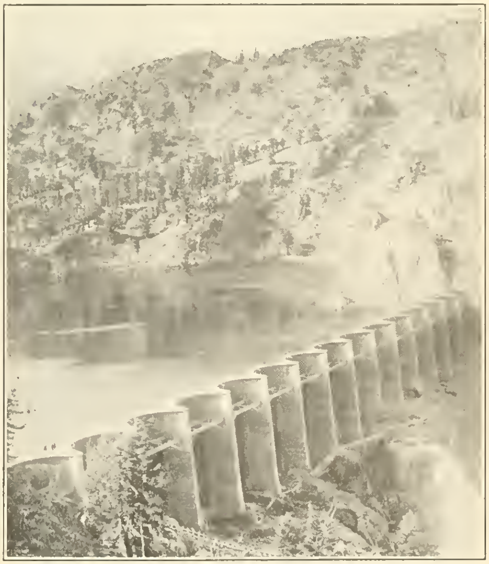
Gravity Dams

Some of the highest and most massive dams in the world are of the gravity type. However, for long and relatively high dams the selection of this type has usually been due to certain favorable local conditions as to supply of materials in large quantities or to a lack of sufficient investigation of other available types.

The gravity dam, of course, maintains its position and resists the thrust of the water by virtue of its weight. Foundation conditions for high and heavy gravity dams must be very favorable in order to assure success. Foundation conditions which because of seams will allow water to get under the dam, or which because of disintegration or erosion will undermine either the toe or heel of the dam, are unfavorable to such construction. Such cases require special treatment such as the construction of a deep cut-off wall under the base of the dam proper, filling the seams in the rock or the construction of aprons both above and below the dam. Upward pressure exerted by water under the base of the dam has been responsible for some bad failures. However, where foundation conditions are favorable the gravity type will usually be found economical for relatively long and low dams.

"Plums" in Dams

In this connection it may not be out of place to discuss briefly the use of "plums" or large stone in gravity dams. Difference of opinion relative to the advisability of using plums exists among engineers but a decision in regard to this point usually may be reached by considering the economies of the particular case. Where the section of the dam is great and if large stones are available at



GEM LAKE MULTIPLE ARCH DAM OF REINFORCED CONCRETE, 700 FT. LONG, 84 FT. HIGH.

the dam site together with proper handling equipment, plums may be used with discretion. These, however, should be kept at least 1 ft. from the face or back of the dam and care should be observed in embedding them to see that no air pockets or hollow spaces exist, especially under the plums. In specifying the use of large stones in gravity dams it is safe to specify that the plums be limited to about 10 per cent. of the volume and that in proportioning the mixture the plums be considered as so much coarse aggregate.

Simple Arch Dams

Where a high dam is required to close a narrow opening between solid rock side hills a simple arch dam will usually be found most economical. The design of such dams presents the simplest case of concrete arch design, since the load is uniform horizontally and exactly known at all points of the height. This enables the engineer to evolve an economical design.

It has been argued that the flow of water over the spillway or through the flood pipes of a dam sets up vibration which in the end proves disastrous. There is, however, little or no data obtained from experience to justify such apprehension. All types of concrete dams except the gravity type are, of course, reinforced, and the existence of countless reinforced concrete bridges and buildings which are constantly subjected to vibration is sufficient proof of the ability of this material to withstand whatever vibration is set up in dams. Nor is there any case on record of a well constructed plain concrete having failed because of vibration. However, if added insurance against such a possibility is desired it may be had by putting in reinforcing. Furthermore, where large temperature changes occur, reinforcing should be used. This constitutes added safety against likelihood of failure from whatever cause.

Multiple Arch Dams

The multiple arch type consists of a series of arches with inclined axes supported by buttresses spaced from 30 to 50 ft. apart. The buttresses take the thrust of the arches and are braced horizontally by struts in continuous lines. Some very high dams of the multiple arch type have been constructed and plans are now being prepared for one in California which will have a height of considerably over 100 ft.

This type, as well as the buttress and slab type, are especially adapted to locations where the foundation is rather seamy or unsuited to the gravity type because of the great expense involved in the preparation of the foundations. The footings of the buttress and lower end of the arches constitute the only points of contact between the foundation and the dam and these limit unfavorable foundation conditions to relatively small areas so that these conditions can be easily cared for.

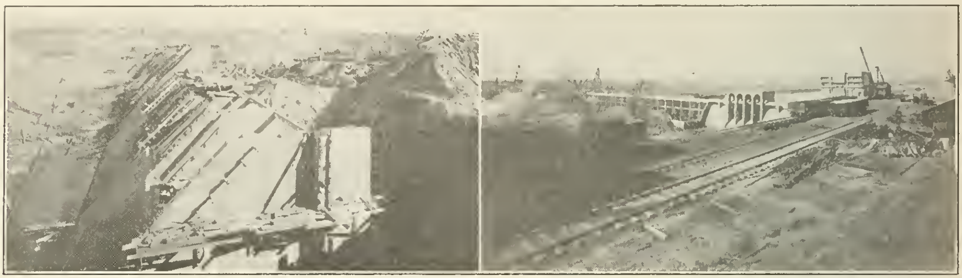
It is apparent that if one of the arches of a multiple arch dam fails, successive failure of the remaining arches of the dam is liable to take place. This responsibility can be obviated by constructing every fourth or fifth buttress as a large pier to take the entire thrust of an arch on either side of it unassisted by the thrust of the adjoining span.

The multiple arch type has an advantage over the buttress and slab type in that it affords economy of construction when foundation conditions or great height require that the buttress or piers be placed at considerable distances apart. In other words, the additional cost of longer spans of the arch type are much less than where concrete slabs are used.

Construction of expansion joints is of course a rather difficult problem in multiple arch dams and it is very doubtful whether they need be constructed at all since expansion and contraction merely produce deflection of the arch rings.

Buttress and Slab Type

This type is especially adapted to long and low dams where the foundation conditions are more or less uncertain. It consists essentially of buttresses or piers the spacing of which need not be uniform, carrying slabs in an inclined position. The principle, of course, is the same as that of the well known counterfort retaining wall but the design is much simpler and more accurate since the thrust of the water is accurately known. In this type of dam expansion joints are easily constructed and variations in the distance between buttresses to take care of undesirable foundation conditions at particular points can easily be made. High buttresses should be braced together with horizontal struts or with diaphragms.



END AND SIDE VIEWS OF AMBURSEN TYPE REINFORCED CONCRETE DAM UNDER CONSTRUCTION, CITY WATER WORKS, OKLAHOMA CITY, OKLAHOMA.

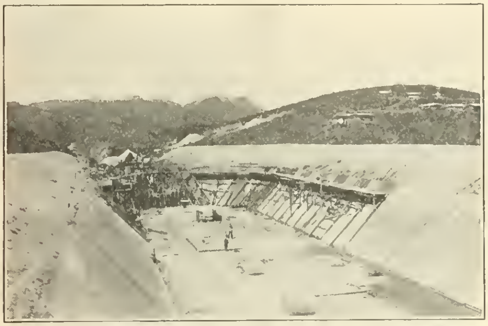
Reservoirs

Reservoirs are usually a part of the water supply system. Impounding or natural reservoirs formed by damming the flow of a stream are common and the cost of them in so far as construction is concerned amounts usually to the cost of the dam.

In planning an impounding reservoir an investigation should always be made of the practicability of impounding more water than is necessary for the supply. The water over and above that required for supply purposes can be utilized in the development of power which will very often justify a much higher and longer dam and the construction of such additional facilities as are necessary to power development. The power so developed may be used for lighting or power purposes in the city served and is usually a large factor in encouraging the location of manufacturing enterprises providing sufficient power at a reasonable cost may be had.

In addition to large storage reservoirs the distribution of water for a large city will usually require the construction of secondary or distribution reservoirs. The location of distribution reservoirs is usually governed by topographical conditions and are usually on a hill or high point of the surrounding country.

Prevention of seepage losses from reservoirs is an important item and especially so where the water is pumped into the reservoir. Seepage losses then constitute a constant loss which is directly chargeable to construction and which must be made up in water rates charged. Such losses should be prevented by making the sides and bottom of the reservoir as impervious as practicable. Paving with stones laid in mortar has been resorted to but it is obvious that concrete linings offer a very attractive and efficient means of preventing seepage losses. Concrete linings are admirably adapted to any type of reservoir whether of vertical or sloping sides. If the reservoir is entirely above ground it will of course be nothing more than a tank, but the usual construction provides that the top of the reservoir be even with or only slightly above the surface of the earth backing.



CONSTRUCTION VIEW OF 5,000,000 GAL. CONCRETE RESERVOIR FOR INSPIRATION CONSOLIDATED COPPER CO., INSPIRATION, ARIZONA.

For slope wall reservoirs the incline is usually from 1½ to 1 to 2 to 1. The thickness of concrete lining for slope wall reservoirs is from 4 to 8 ins., and is usually placed in slabs from 10 to 20 ft. square, depending on whether or not the slabs are reinforced. The slabs are usually laid with butt joints with their ends resting on a sill and the space between the ends of the slab filled with some elastic material to form an expansion joint.

Expansion joints between slabs have been very successfully made by calking with oakum and overlaying the joints with strips of burlap well painted with asphalt.

The Green River storage basin, Tacoma, Wash., was built with expansion joints ¼ in. wide at the bottom and ¾ in. wide at the top. Sills had tar paper laid on top of them before taking the slabs. The joints were filled with refined asphaltum specified to be pliable between freezing and a temperature of 200 degrees F. and not sticky at 100 degrees F. This joint has proven very satisfactory.

As a general proposition slope wall reservoirs as low as 300,000 gals. capacity may be built more economically than one having vertical walls.

Concrete Pressure Pipe

Some are skeptical in regard to the use of concrete for water pressures involving heads of 100 ft. or more. Concrete pressure pipe has been successfully used with pressures up to 80 lbs. per square inch and there is no doubt but that the pressure which may be handled by concrete pressure pipe is limited only by economy in design.

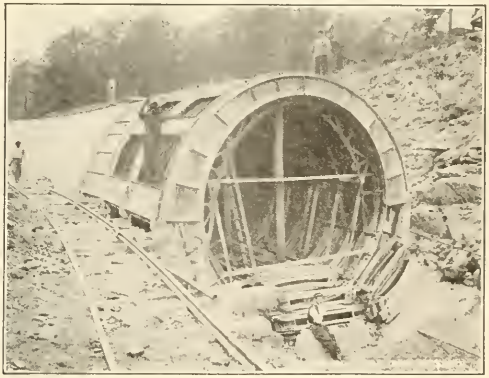
There are certain requirements which pressure pipe must fulfill among which are the following: Ability to resist external and internal pressures; low co-efficient of friction; minimum leakage; low maintenance charges; permanency; provision for construction and expansion, and low cost consistent with the above requirements.

Concrete pressure pipe designed to withstand internal pressure will be found to be strong enough to withstand all ordinary external pressures to which it will be subjected. Reinforcing steel is of course placed in the shell of concrete pipe to assist in withstanding the bursting pressure and some designers use sufficient steel to take the entire bursting pressure. This steel is, of course, not in continuous sheets and therefore requires no complicated and extensive process of manufacture. For long lines of large pipe the pipe is constructed in place or at a convenient point near the general location of its use. Thus transportation expenses are low and the manufacture of the pipe can be given continuous inspection.

It is not our purpose to discuss the design of concrete pressure pipe but I wish to say that regardless of whether or not the strength of the concrete itself in tension is taken into consideration in design, it nevertheless does exist and contributes no small part of the actual strength of the pipe. Where it is not considered in the design this strength of the pipe affords an extra factor of safety.

Frictional Loss in Concrete Pipe

Correct methods of manufacture will produce concrete pipe with a low co-efficient of friction. An interesting test on an actual concrete pipe line would probably be most convincing in this respect. Such a test was conducted on the Sooke Lake water supply conduit for the city of Victoria, B. C. The pipe line is of 42 in. diameter, 27½ miles long and contains 50 per cent. of curves with radii varying from 90 to 150 ft. There are in the line 7 siphons having a maximum head of 94 ft. The tests were conducted by Wynne Meridith, San Francisco Manager of Sanderson & Porter, Consulting Engineers, and the co-efficient of friction (n of Kutter's formula) was found to be 0.01058 at the inlet end and 0.0117 at the outlet of the 27½ miles with the pipe running full



BLAW STEEL COLLAPSING FORM FOR 17 FT. REINFORCED CONCRETE EFFLUENT AQUEDUCT FROM KENSICO RESERVOIR, NEW YORK CITY WATER WORKS.

at the inlet and 6-7 full at the outlet. With 20 ins. of water at the inlet the water level at the outlet was 19½ ins.

Some years ago Marx, Wing & Haskins determined from gaugings on a 6 ft. steel riveted pipe values of n from .013 to .018.

The reinforced concrete pressure pipe line constructed as a part of the Gunpowder water supply for the city of Baltimore consists of 5,000 ft. of 108 in. diameter pipe and 3,000 ft. of 84 in. diameter pipe. This line carries 120,000,000 gals. daily and when tested under a head of 85 ft. the leakage in 24 hours of the entire line amounted to 13,000 U. S. gals., or less than two-hundrdths of one per cent.

Low maintenance on pipe lines must certainly result if the pipe is of such a material that leaks will not develop from corrosion, electrolysis, etc. Concrete, of course, is not subject to corrosion and since concrete pipe must be made sufficiently dense to prevent leakage it follows that the steel reinforcing in the shell of the pipe is perfectly protected so that corrosion cannot be expected. Of course concrete pipe lines as well as those of other materials are subject to such accidents as earth slides and cannot be expected to withstand extraordinary conditions under which no type of pipe line would remain intact. The maintenance, however, on a well constructed reinforced concrete pipe line may with confidence be expected to be low.

Permanence is merely a corollary to low maintenance charges. Rust, rot and decay are not defects of concrete pressure pipe and under ordinary conditions with pressures only for which the pipe was originally designed and constructed, concrete pressure pipe may be considered as permanent.

Expansion Joints

Contraction and expansion will occur in pipe of any material and suitable expansion joints must be provided in concrete pressure conduits if the leakage at joints is to be kept at a minimum. Such joints have been developed for use in precast reinforced concrete pipe and have been successful in practice. As the construction of pipe lines is usually done at temperatures higher than that of the water which will flow through the conduits it necessarily follows that contraction will occur. This will produce cracks at the joints through which leakage of considerable amount will occur if provision has not been made to care for the contraction.

An expansion joint that has been found to take care of expansion and contraction consists of a crimped copper band continuous throughout the circumference of the joint. As the pipe contracts the crimp opens and as the pipe expands the crimp closes. This joint is used in pipes of 36 ins. to 108 ins. in diameter.

It is well to reduce the number of joints by making the units as long as practicable, and each unit should be equipped with an expansion joint. Trench conditions, such as bracing, handling, etc., will usually determine the practicable length to be about 8 ft.

Manufacturing Pipe

Pipe are cast on end and the molds of sheet steel and cast iron must be erected on substantial bases or foundations of reinforced concrete, the surface of the foundations being truly level and finished so that when the cast iron base mold is set and the sheet steel casings are erected the casings will be truly vertical.

In the manufacture of most precast concrete pressure pipe, it is necessary to use 1 volume of Portland cement, 1½ volumes of sand and 2½ volumes of coarse aggregate and this means that 2½ barrels or 950 lbs. of cement is used per cubic yard of concrete. In the manufacture of precast pipe for the Winnipeg Aqueduct it was found necessary to use but one sack of cement to 3.8 cu. ft. of mixed aggregate, or approximately 2 barrels or 700 lbs. of cement per cu. yd. of concrete. (The Canadian barrel weighs 350 lbs. gross or 346 lbs. net.) This minimum quantity of cement was found practicable owing to the very excellent grading of the mixed aggregate which was supplied by the Greater Winnipeg Water District from their own pit at which was located a screening and remixing plant. The concrete is mixed to a quaking or jelly-like consistency, which will easily flow to place when slightly puddled.

The mortar for spigots is made of 1 part cement to 2 parts sand and is mixed to the same consistency as the concrete so as to obtain the same rate of setting as nearly as possible. As the spigot mortar settles more mortar is added until the settlement ceases, when the joint is finished.

Concrete pressure pipe may be successfully manufactured in cold weather with proper appliances for supplying heat and moisture. In fact, where high speed of manufacture is desired, steam curing should be resorted to and this may be carried on regardless of temperature conditions. For the manufacture of large sizes, appropriate handling equipment and appliances should be provided such as traveling derricks, locomotives, cranes and light industrial tracks, cars and locomotives.

New Type Expansion Joint

All that has been said heretofore refers particularly to the copper expansion joint type of reinforced concrete pressure pipe. There has recently been developed a new type of expansion joint which is very efficient. This joint is proposed for reinforced concrete pressure pipe in diameters of 10 to 48 ins. and in lengths of 12 ft., each section of pipe being provided with cast iron spigot ring at one end and a cast iron bell ring at the other, the rings being cast into the concrete.

The faces of the rings bear upon a lead gasket and are accurately machined providing a very true circular surface. The spigot ring is provided with a seat for the gasket, the object being to provide a greater thickness of gasket at the seat and to prevent the gasket being withdrawn when the pipe contracts or is deflected. The lead gasket consists of a thin lead pipe filled with fibre and is compressed into the space between bell and spigot when each succeeding length of pipe is shoved home. A light rope of cotton or jute is placed and a weak joint filler of cement mortar is applied filling the calking space, which is provided in the event it should be necessary to calk the lead gasket joint. The joint has remained tight under test at 110 lbs. pressure per square inch.

Tanks and Standpipes

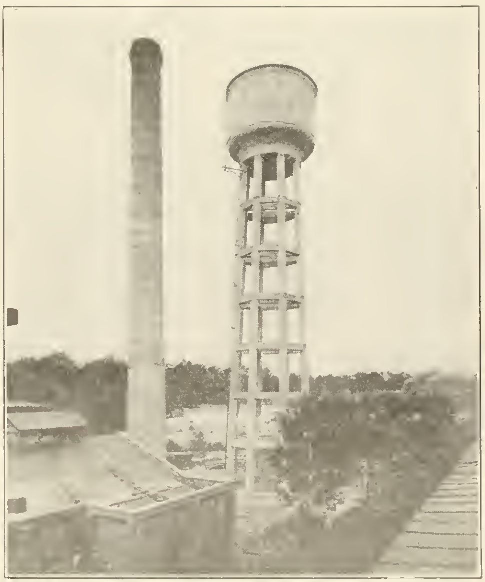
Familiarity with the success that has been attained in the use of concrete pressure pipe prepares us at once to accept the reinforced concrete standpipe or water tank. Here again we have simplicity in design because of ac-

curate knowledge of the pressures to be withstood. Obviously, if concrete pipe can be constructed uphill and down, in and out, to withstand over 100 ft. head of water pressure, there should be no difficulty in building a standpipe of like height and many examples are in existence of concrete standpipe of much greater height than this. The Fulton standpipe at Fulton, N. Y., is 100 ft. high to overflow and is 40 ft. in diameter.

Towers

The supporting tower of elevated tanks may be either of concrete frame work or of the cylindrical type. The latter has a number of advantages. The same forms may be used to construct the supporting tower as are used in the construction of the tank support. These forms are usually what are known as moving or sliding forms, that is, they move gradually upward as the concrete is being placed, thus giving a continuous monolithic concrete shell without any construction joints whatever. In addition to this particular advantage in construction the cylindrical tower furnishes a housing for the riser pipe which protects it from low temperatures and may even be utilized for storage or office purposes.

In the design of concrete standpipes and in fact in the design of such structures of any material, the critical point is usually found in the junction of the shell with the base. The Fulton tank referred to is an example of a successful method that has been used to take care of the expansion



REINFORCED CONCRETE WATER TANK OF BUCKEYE COTTON OIL MILLS CO., ATLANTA, GA.

and contraction at the bottom of a standpipe shell due to variations in water level and temperature. The central portion of the foundation for this tank was constructed higher than the point of contact between the bottom of the shell and the foundation. Thus, space was formed between the inside of the shell and the central raised portion of the foundation. This space was filled with an asphaltic material. The shell of the standpipe proper was not connected to the foundation but rested on a slip joint which allowed movement at the base of the shell to provide for change in the diameter of the standpipe due to variations in pressure. The top of the concrete foundation on which the shell rests was first covered with

OLD AND NEW PUMPING STATIONS OF THE LOUISVILLE, KENTUCKY, WATER WORKS.

graphite paste and sheet copper laid immediately on top. The walls of the standpipe thus rest upon the sheet copper plate which is free to move on the graphite.

This standpipe was constructed with sliding forms and was completed from foundation to overflow in 52 working days. It has been in constant use since 1913 and has proven entirely satisfactory.

Pump Houses

The use of concrete in the construction of buildings of a general nature is too well known to need any particular comment. A pumping station, of course, has some special features required by the fact that it houses machinery and boilers. A pump house therefore best adapted to its purpose is one which will be free from vibration, furnish adequate light and afford security against fire. These requirements are all most ideally met by concrete.

An interesting example of recent pump house construction is that recently completed for the city of Louisville, Ky. This pumping station is located on the bank of the Ohio river just east of the city's old pumping station. As the structure had to rest on sand and gravel and as it was necessary to build the foundation so as not to affect the adjacent buildings, the open well, caisson method was used. Outside dimensions of the caissons are 90 ft. square by 33 ft. deep, with a bay on the river side 61 by 22 ft. and 33 ft. deep. Interior cutting edges were 5 ft. 2¼ ins. above outside cutting edges, thus allowing room for a working chamber in case obstructions were encountered, compelling conversion of the caisson from the open well to pneumatic type. However, this contingency did not arise and the caisson was sunk to its final resting place without mishap. After filling the dredging wells, the foundation became a solid block of concrete, 90 ft. square by 28 ft. thick under the main house and 51 by 22 ft. by 16 ft. thick under the bay. On this foundation the sub-

structure extending to the main floor level was built. This is 83 ft. square at the bottom and tapers to 75 ft. square at the main floor level, which is 7 ft. 6 ins. above high water. The inside of this part of the structure is cylindrical, 67 ft. in diameter, and forms the pump pit. Cylindrical pump pit walls were designed to resist external water pressure and the construction has resulted in an absolutely dry pump well.

The superstructure is 48 ft. high to the under side of the roof. The walls between the large windows forms a series of piers supporting in addition to the roof loads, runway girders for a 30-ton crane.

No concrete shows on the face of the superstructure but back of the 6 and 9-in. ashlar surface is a concrete wall 30 ins. thick, which in reality amounts to piers between the high windows and, as previously noted, supports the runway girders for the 30-ton crane. Stone facing was used in order to make the new station as much like the old one as possible in external appearance.

Construction is being done by the Fruin-Colnon Contracting Co. of St. Louis, Mo., and the Missouri Valley Bridge & Iron Co., Leavenworth, Kans., after designs by J. B. Wilson, Chief Engineer, Louisville Water Co.

Fuel Oil Storage Tanks

At the present time there is a very marked tendency to use fuel oil in the place of coal for the generation of power. There are certainly many advantages to be derived from the use of this fuel. It does away with a considerable amount of the handling expense, leaves no ashes and cinders to be disposed of, and produces but relatively little smoke. Firing with fuel oil is a simple matter and effects economy in labor.

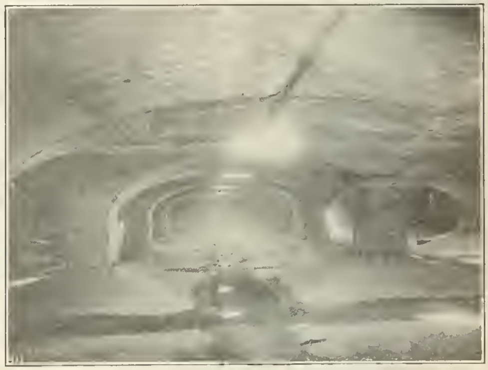
In order that fuel may always be available and that the purchasers of it may have the opportunity to take advantage of market conditions, storage capacity should be provided. The storage of fuel oil has been and is still subject to considerable discussion, especially in regard to the effect that the presence near buildings of such combustible material has on the fire hazard. It is my understanding that there is an almost universal practice to add a very heavy penalty because of the presence of fuel oil in open tanks above ground. This penalty, however, is not added when the oil is stored in concrete tanks below ground. There are further arguments for the underground storage tank. Such tanks do not occupy space near the power plant which is usually required for other purposes. They are entirely out of sight as well as protected against the likelihood of fire from lightning or from other origin.

The design and construction of concrete oil tanks is little or not at all different from concrete water tanks. In fact, it is usual to design them for ordinary hydrostatic pressures, and experience shows that when well constructed entire confidence may be placed in their ability to hold the oil without leakage. Naturally, where the surface of the tank is level with the ground surface and will have to carry loads, the cover must be designed accordingly, and usually requires the use of columns which rest upon the tank bottom.

Water Filters

Filters, whether of the slow sand or mechanical type, have quite generally employed concrete for structures. The slow sand type requires large areas of filter beds, constant attention and a very considerable first cost. I believe also that it is safe to say that a mechanical system of filtration is the one usually adopted in modern water works construction. A very complete and extensive plant of this kind was installed some years ago for the city of Baltimore at Lake Montebello.

Special features of the Montebello filters include handling of wash water at settling reservoirs, head house



INTERIOR VIEW OF LAKE MONTEBELLO CLEAR WATER RESERVOIR CITY WATER FILTRATION PLANT, BALTIMORE, MD.

arrangement, pumping station and covered reservoirs. Complete accounts of this notable water supply development have been previously published in the technical press, and we shall therefore confine ourselves to a very general description of those portions in which concrete was used.

About 50,000 cu. yds. of concrete were used in the construction of the filtration plant, and most of this concrete withstands water pressure or heavy loads. The groined arches of the filtered water reservoir are of 1:2½:5 mixture, but other structural parts are of a 1:2:4 mixture. No waterproofing compounds were used in these structures, as good workmanship and materials were relied upon for securing waterproof work. Steel forms were used in the construction of the groined arches and walls, but were not found to be entirely satisfactory on account of difficulty in erecting and removing them. It is worth while to note in passing that at the present time steel forms are available for construction of this sort, which add a great deal to the ease with which it can be accomplished, and I feel quite sure that in the design of such a filtered water reservoir at the present time a flat slab construction would be used in place of the groined arches, and that standard steel forms for columns and slabs would be used.

The filter tanks of the Montebello filters are 32 to 35 ft. outside dimensions and are supported on the reinforced arches forming the roof of the filtered water reservoir.

The head house of the Montebello filters is also of concrete, and a feature of it is the elevated tower 4 ft. square and 80 ft. high containing the chemical storage bins. This tower has 15 bins which will hold about two carloads of chemicals each.

The pumping station is circular in plan, 84 ft. in diameter, with its walls concentric with the intake shaft and

16 ft. in diameter. The intake shaft is located with its center over the axis of a 12-ft. tunnel that brings the city water supply from Lock Raven. The bottom of this tunnel is 49 ft. below the floor of the pump pit or 72 ft. below the surrounding ground level.

INSTALLATION AND OPERATION OF AIR LIFT PUMPING PLANTS

By Charles J. Deem, Hydro-Pneumatic Engineer, Harris Air Pump Co., 1635 Lytton Bldg., Chicago, Ill.

When air lift pumping first entered the commercial field there were a great many conditions surrounding its operation that were unknown even to the manufacturers of the lifts.

It has been charged by many, and more especially by engineers, that the manufacturers of air lift pumps wish to surround their products with mystery. I can truly say that this is not the case. The manufacturers of air lift pumps, like any other trades people, want to sell all of their products they can, and willingly give all the information regarding its operation that will make it more popular in the deep well pumping field. However, they are limited in this service from the fact that no *master formula* has as yet been devised, whereby infallible rules may be laid down for the proper designing and installing of any and all installations, without any regard for the conditions that exist in the wells, said Mr. Deem, in addressing the Iowa Section of the American Water Works Association recently.

Some fifteen years of experience have taught me that in many, many instances, wells are just as individual in their actions as are persons. Therefore, a properly designed air lift installation, operating satisfactorily in one well, might give entirely different results when installed in another well which to an inexperienced operator might seem to be identical with the first.

While experience is not absolutely essential to the pumping of water from deep wells by the means of compressed air, yet, I know of no engineering field where experience counts for more or is more essential than in air lift pumping.

Some of our best engineers have branded air lift pumping as a system sadly lacking in economy, but in such cases their judgment has been based upon results obtained from improper methods of piping in connection with inefficient air compressors. Many have also become convinced that there is no special merit in the patented air lift pump, and believe that home made devices will answer the purpose just as well. However, in all my years of experience, I have never yet seen one of these home made lifts compared with which a patented pump would not give excellent returns on the small amount of money invested.

How the Lift Operates

Contrary to a popular belief, the compressed air discharged through an air lift pump does not blow the column of water upward after the first discharge. When the static head is lifted from the working head of the well by the first inrush of air, the water is forced out of the pipe in a solid column. After that, the compressed air passing through the pump reduces the specific gravity of the water in the discharge line of the pump. This consequently moves upward by the expansion of the air bubbles, aided by the greater weight of the solid column of water, surrounding the discharge line. In an economically designed air pump, it is imperative that the formation of large bubbles of air be avoided, for these have a tendency to rush upward without lifting the proper amount of water for the stored energy that they contain. Therefore, the pump should divide the air into small streams or jets, creating as many small bubbles as possible in order to give the best economy. The slip of these bubbles constitutes the chief loss in the energy of the air lift. It is figured that this varies as the square root of the volume of the bubbles. Therefore, the smaller the bubbles, the more efficient the air lift.

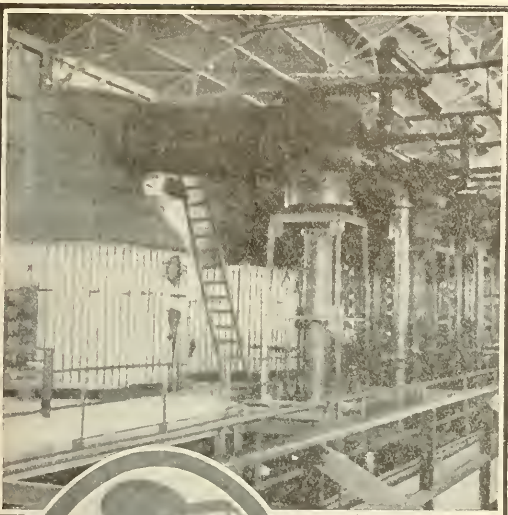
Of course, one of the foremost things to be considered in the installing of a pumping plant, is its efficiency. I presume there is no one word in the English language that is used more in manufacturing and engineering circles than the word efficiency. It is a good strong word, but may be figured from so many different bases of calculation that all conditions in connection with the apparatus must be thoroughly understood before the percentage of efficiency that is claimed for it, can be valued. The only true way I know to figure the efficiency of a pumping plant is to add up at the end of the year the column in the ledger headed operating costs, and to calculate the results from its total. In this column we will also find, if we note down the items, such as repairs, break-downs, and their attendant losses, and read between the lines, the worry that was caused thereby. Then we can determine just how efficiently the system has operated.

Reliability of Air Lifts

In traveling over the country, I find that water works superintendents and manufacturers are more and more demanding workable commercial efficiency from their pumping machinery. They realize that by installing some very closely adjusted high speed apparatus in their wells they may be able, during its short life, to pump water very cheaply per 1,000 gals. But in about nine cases out of every ten, such a pump is sure to cause trouble sooner or later, more often sooner. The small amount saved per 1,000 gals. pumped, during the course of the pump's successful operation, is far more than offset by repairs, shut downs and pulling of wells.

To give you some idea of the faith that the underwriters of the country have in the reliability of the air life system, I will tell you Mr. Judd's experience with them in discarding deep well pumps and installing air lift systems in the city wells in Mason City, Ia. The Board of Underwriters in Chicago granted him 30 points on the key rate of insurance for the fire protection the increased yield of the well would afford the city, and they gave him 130 points because of the reliability of an air lift pumping system. This is something that should be weighed very carefully, for if there is any institution that figures from exact statistics, it is the Underwriters. They don't guess, they know.

No one has yet been able to figure a master formula for the installation of the air lift. However, the manufacturers of air lift pumps have, at a great expense,



Punta Alegre
(Point Pleasant)
Sugar Mills

The engineers and builders of this great Cuban sugar factory used Cast Iron Pipe wherever possible—and in some places where it had hitherto been thought impossible.

Note the condenser tower tank with two lines of 24-inch bell and spigot and flanged pipe for handling sea water.

SERVICE CAST IRON PIPE MEASURED BY CAST IRON PIPE CENTURIES
THE FIRST CAST IRON PIPE EVER MADE IN THE WORLDS HISTORY IS STILL IN SERVICE · MORE THAN 250 YEARS OLD

The entire water supply, both salt and fresh, is handled through Cast Iron Pipe, in sizes from 6-inch to 24-inch diameter, which, with the Cast Iron vacuum pans, condensers and leg pipes in the factory, insures freedom from frequent and expensive replacements.

The Cast Iron Pipe Publicity Bureau
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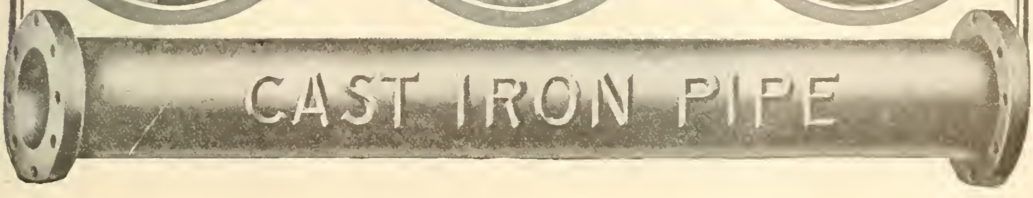


gathered data from laboratory tests and field experience that enable them to construct formulas which cannot be universally applied to all conditions, yet they can define and introduce certain rules which enable them to calculate the requirements for an installation when the exact data are known.

Perfecting Installation Under Service

When exact data are lacking, conditions are usually *assumed* and a lift installed. Then from results obtained, the engineer can, by basing his judgment on experience, proceed to pipe up the well so as to get economical results. To give an illustration of this: some years ago I installed an air lift in a flowing well on a ranch in southwest Texas. The well was eight inches in diameter, about 600 ft. deep and flowed about 20 gals. a minute. The owner of the ranch had only a small compressor, its maximum capacity being 30 cu. ft. of compressed air per minute. A 6-in. pump was installed, 2 ft. in the well, and this 30 ft. of air delivered to it. The head of the well dropped 20 ft. from the surface and the well yielded 530 gals. per minute, accurately measured over a knife-edged weir. Of course, this was phenomenal. Never before or since have I seen such a small volume of air deliver so much water from a deep well.

Recently at Fort Dodge, Ia., we installed a 6-in. pump in a flowing well, located in an island in the Des Moines river. The well was 8 ins. in diameter, 500 ft. deep and flowed 21 gals. per minute. The same size pump was located 200 ft. from the surface and we delivered to it 200 cu. ft. of air. The working head of the well dropped 150 ft. from the surface and yielded 80 gals. per minute. As one can readily see, this proved to be a very uneconomical installation. Yet to all outward appearances, the conditions in the second well were the same as those in the first, and the results were not even comparable. It is in this second well that experience would have been necessary to have piped it up properly had the city decided to use it. However, they had plenty of other water available, so the well was abandoned. But an air lift could have been installed in it that, figuring from the current input at the motor of the compressor to the water discharged in the reservoir, would have shown 30 per cent. efficiency. This could have been obtained by installing a 3 in. air lift and taking 50 per cent. submergence, or, in other words, by placing the lift as far below the working head of the well as we were going to lift the water. This would have yielded 1 gal. of water for 0.63 cu. ft. of air at 67 lbs. pressure. Of course, the starting pressure in this well would have been greater than that of the other wells of the system, yet this could have been offset by the use of an auxiliary air line to lift the head of the well.

Had the original installation in this well been let stand, any one wishing to speak disparagingly of air lift pumping could have, in all honesty, cited it as an expensive mode of pumping water. On the other hand, some manufacturers, wishing to extol the virtues of their air pumps, might honestly print a glowing advertisement of the results obtained in the well first described. They would be equally misleading. The first is a result from what might be termed a freak well, while the installation of a 6 in. pump in the second well would be improper for the best results obtainable by the air lift system. I only cite these two wells to illustrate my point that each well forms an individual problem, and that the same installation in all wells would fail to pump them properly.

Aeration

One reason why the air lift pump proves valuable, where the water contains much iron and sulphur, is that when a well is pumped by air the water undergoes aeration. The air and water are mixed under pressure and this tends to throw off the sulphur gas and precipitates a great deal of the iron; one of the principles on which the iron breaker works is aeration.

Some Advantages of Air Pumping

Many wells pump a great deal of sand and as the air lift has no moving parts in the well, grit has no effect upon it. Any number of wells may be pumped from a central plant and there is no limit to the quantity of water that can be handled. With a properly designed system the extra cost of pumping wells located a mile from the power plant is not material.

It has been stated that an air lift system requires little or no attention outside of keeping the compressor in proper running order. While this is practically true and cited as one of its advantages, yet sometimes it proves to be a disadvantage, because an installation will continue yielding water for years without giving any trouble. Yet there are times when the system becomes unbalanced, the working head of the wells recede, which changes the percentage of submergence, thereby reducing the yield of the well and increasing the amount of air required. So you can see that if the wells were checked up once or twice a year, and changes made to meet the new conditions, a great deal might be saved in operating cost.

Keeping the System Balanced

Sometimes very little things cause a great loss in economy. Not long ago I was called to a plant where a battery of five wells was being pumped from one compressor. The compressor at its maximum speed was barely large enough to pump the amount of water required. The operator told me that when the plant was first installed it gave excellent results, but there had been a decided falling off in the yield of the wells. The system was well designed and should have given good results. Upon investigation, I found that two of the wells were much weaker than the other three, and that they operated at about 15 lbs. less pressure than the other wells. When the engineer had balanced up the system, he had set the regulating valve at the well head of these two weaker wells so as to admit only enough air to pump the water that they would economically yield, and, of course, had left the valves wider open on the strong well. When starting the system pumping, the operator discovered that many times these two weak wells did not come in. Their static head being the same as the stronger wells, and being supplied with much less air they did not start so easily. In order to overcome this he had thoughtlessly taken a wrench and opened the valves of these two weaker wells. Of course, any force follows the line of least resistance, and the larger part of the volume of air, made by the compressor, rushed into the weaker wells from which it could not lift the same amount of water as it could have done from the stronger wells. Therefore, this system was out of balance and giving poor results.

through no fault of the Air Lift or the man who installed it. When air lift systems are counted excessively costly to operate, I think it may safely be concluded that there is good cause for this, and that the chances are the troubles may be easily removed.

Determining Size of Pump

A great many mistakes are made when installing air lifts, especially by novices in the business, in choosing the size of the pump to be used to deliver economically a certain volume of water. In order to make that as plain as possible, I will give a concrete example:

If we wanted to lift 150 gals. per minute from a well with a working head 80-ft. below the surface, the most economical pump to be installed would be at 3½-in. lift at 65 per cent. submergence. Under these conditions, this pump should yield 1-gal. of water for every 0.3-cu. ft. of air at 67-lbs. pressure. As one can easily figure, the pump would be located 229-ft. from the surface. Now suppose instead of being able to get 65 per cent. submergence, we can get only 40 per cent. submergence. In order to deliver 150 gals. per minute under these conditions, a 4½-in. pump should be used and one could expect 1-gal. of water for every 0.59 cu. ft. of air at 25-lbs. pressure.

By a little figuring the engineer can ascertain that it required 1.1 more horse power to raise the water in the second instance than it did in the first. And I gave it, hoping to be able to show that even though conditions be vastly different in various wells, a properly designed air lift can be made to yield good results. But, of course, there are places and conditions under which some other type of pump should be used.

As can be noted from this example, as the submergence decreases, the size of the discharge line should increase. But this is only a general rule and the conditions in the well to be pumped wholly govern the change to be made.

Variable Diameter Discharge Line.

Of late years some firms have been advocating a variable discharge line. I mean by that some firms wish to start with a smaller pipe and expand toward the point of discharge, the theory being that by allowing the compressed air more space in which to expand, it will lend more of its energy toward lifting water. On the other hand, some firms advocate turning this type of installation upside down, as it were. That is, they reduce the line toward the point of discharge, the theory being the same as the reason for choking the muzzle of a gun in order to keep all the gases behind the shot until it leaves the barrel. Of the two systems, so far as observation goes, the latter is to be preferred. I have seen it produce excellent results under some conditions. That is, it gets more water with greater economy than it would be possible to get from a uniform discharge line, made of standard pipe sizes.

I suspect the friends of the expanded discharge line system will challenge this statement and point to some installations they claim are a great success. I have seen one or two of these but they have invariably been installed in excellent wells that yielded large quantities of water very economically, not because of the system of expanding the discharge line, but in spite of it. However, improvements are being made in the system of piping and each year shows more practical results. My firm has recently placed on the market a new pump, which under very exacting conditions has shown 15 per cent. more efficiency than is possible to obtain with the design it supercedes.

The Booster Pump

Another improvement in the air lift system that I wish to mention briefly is known as the booster pump. This pump, or tank, is located on the well top and automatically separates the air and water as it is discharged from the well, and retains just enough pressure from the separated air to force the water to the point of discharge. This is indeed a great improvement, when the water must be transferred long horizontal distances toward the point of discharge. This point may be at the surface or to an elevation. Hitherto, when horizontal distances had to be considered, unless the water was delivered to an elevated tank and allowed to flow by gravity, the air would get ahead of the water in the discharge line thereby materially reducing the efficiency of the system. However, the booster very efficiently overcomes this condition.

I realize that I have given no tangible data on the air lift, but as I have endeavored to explain that from the varying conditions that exist in all wells any statements regarding the air lift system as a whole, must be of a general nature. Some manufacturers have, at no little trouble and expense, conducted exhaustive, systematic tests in natural wells or in artificial wells constructed for the purpose of maintaining any desired submergence by feeding water into their tops. The data thus gained are authentic for the conditions under which they were gathered. However, in the field, nature does not make a habit of supplying her wells with water by pouring it in at the top. So you see we revert back to the same point from which we started. That is, each well presents a separate problem.

Another thing that has materially aided in the efficiency of the air lift system is the perfecting of air compressors by the various manufacturers. The standard compressors now offered on the market in nearly every instance operate on from one-third to one-fourth the horse power that was required by the compressors built some 10 or 12 years ago. Not only is the economy of these machines much greater but also the mechanical parts have been greatly simplified, thus making the air compressor one of the most economical machines now on the market.

I have followed the success of the air lift pumping system for 15 years and have been personally connected with it all of this time in practical field work and have become a more ardent advocate of it each day.

NECESSARY STEPS IN REVISION OF WATER RATES

By John N. Chester, of Chester & Fleming, Engineers, Union Bank Bldg., Pittsburgh, Pa.

Assuming that conditions beyond the control of the water company have created the necessity for a larger gross income, which can only be derived by revising upward the rates charged the water consumers and patrons, the present article is an answer to the question: "What are the necessary logical steps to be taken?" The 10 steps follow; with special reference to Pennsylvania conditions:

1. Get together with the community if you can and in your negotiations do not forget the other fellow.

In other words, in every change you make or condition you impose, put yourself in the consumer's place and try to realize its fairness from that angle.

2. Be prepared to begin your activities with clean hands.

That is, you should for the past five years, at least, have had available at all times enough water and facilities for and have been rendering continuous service; the supply as to purity should have been above question; and no reasonable consumer should be able to charge you with discourteous dealings.

3. A value—tentative, actual, or otherwise, as a basis for rate making should be available.

This value can scarcely be the face value of your stock and bonds; it can seldom be what you paid for the plant, but it is, according to the Public Service Act, akin to the book or historical cost of plant and business, or the cost of reproducing your plant and business, less depreciation. The above may be obtained in one of three ways: an audit, an appraisement, or a reconnaissance by some one sufficiently expert to fix, after a casual survey, a tentative value from which an approximate fair return may be computed—subject, of course, to its being substantiated in a hearing or checked by experts mutually chosen by both parties.

4. Operating expenses which include repairs and maintenance.

These should be tabulated by years for the last five years and your operating expenses as of today should be set out, and from the two a forecast of next year should be made by applying present day prices to average or estimated necessary quantities of material and wages.

5. A reasonable amount should be allowed for administration, or salaries of executive officers and executive office expense.

We too often find companies failing to carry on their payroll that very necessary officer—a superintendent, preferring apparently to swell somebody's head by giving the individual performing the function of this office the title of secretary or treasurer, and some times president or vice president, which titles belong only to executive officers and not operating officers, and if an individual performs the services of one of the administrative officers as well, his pay should be divided between operating and administrative expenses, and administrative officers, be their duties ever so small, and this includes directors, should be compensated for service rendered, and a part of this service, it must not be forgotten, is responsibility assumed.

6. A fair amount should be set aside for depreciation.

This may be obtained from observation, or it may be computed scientifically, and in either case—functional depreciation must not be overlooked.

7. Over and above operating expenses, depreciation,

and administration, each property is entitled to a fair return on its investment.

A fair return has, by different decisions of our commission, been fixed at 7 to 8%. No greater than the latter should be hoped for, and no less than the former accepted without invoking the aid of the court of last resort. This last statement is not intended to imply that a hearing before the Public Service Commission is a necessity if rates are to be raised or revised; on the contrary, nearly as many controversies as have been heard by the Commission have been adjusted between the municipality served and the water company to the satisfaction of both and with very much less expense; but an adjustment having been reached amicably or by decision of the commission or courts, the next problem that confronts us is:

8. Distribution of burden or casting of an equitable rate schedule that will assure you operating expenses, administration, depreciation and a fair return.

You will need first to ascertain the amount chargeable for public fire protection, after which an equitable charge should be fixed for private fire protection, and the total to be obtained from these two subtracted from the gross is the amount yet to be equitably distributed to the consumers. Many of you yet have in force the antiquated flat rate, which should at this time be eliminated or arrangements made to eliminate it as fast as possible and to substitute therefor the only fair method of vending water, to-wit: meter service, and if you have yet to begin the application of meters, let me advise that you apply them first to your industrials, next to your commercials, and then by classes to your domestic consumers, setting the first meters on the users of water for power—such as operating washing machines, sewing machines, etc.; next, to the owners of sprinklers of large lawns, the next class might be all of those having water closets or bath rooms; and lastly, the one spigot users, and especially those with no sewer connections; but this is digressing, for the problem is to work out a meter schedule that will equitably distribute that portion of the burden chargeable to domestic, commercial and industrial consumers; and accompanying the rates, which, to be legal, must be filed with the Public Service Commission, there should be a set of

9. Rules,

The first of which are generally those relating to application for water, methods of making tap, providing meter, etc., which must necessarily differ with localities, franchises, and previous customs, it being best in the writer's opinion not to disturb usages long in vogue that seem fair and equitable, although they may not be as modern as similar practice elsewhere; but in addition to all of the above sufficient clear, concise, and practical rules should be added to guide both operator and consumer in the future conduct of the business and in a way that will eliminate controversy and still promote an equitable conduct of affairs.

10. This brings us to the last act of the drama, which is the enforcement of the new rules and rates, which in many cases requires courage, and in all cases, fortitude, which should be accompanied by the utmost courtesy extended in the way of investigation of complaints, willingness at all times to interpret clearly things which the consumer fails to see or understand, but never lacking firmness, which can only exist where the individual is saturated with belief in what he undertakes to enforce.

The foregoing paper by Mr. Chester was recently presented before the Pennsylvania Water Works Association at Atlantic City, N. J.

EFFECT OF WAR-TIME PRICES ON WATER WORKS VALUATION

By E. W. Clausen, City Attorney, Atchison, Kansas.

The first economic question in water works valuation at the present time is the effect of war-time prices and in this connection it is interesting to note that there is a decided difference between value and price, said Mr. Clausen in addressing the League of Kansas Municipalities.

Things have a market price at present which cannot be said to represent the true value, and the Courts have decided that this is the fact. Probably the most recent expression on this subject is the following statement of the Illinois Public Utilities Commission:

"As joint petition of the Southern Illinois Light & Power Company and the Centralia Gas & Electric Company for authority to purchase and sell electric and gas property of the Centralia company has been dismissed by the Illinois Public Utilities Commission. On the question of war-time prices, the decision says: 'The Commission cannot subscribe to a valuation which is based upon war-time prices in a case where substantially no investment has been made under war-time conditions. To do so would result in burdening a public already carrying a heavy load of war-time prices with increased costs of service received from plant and equipment which has experienced no added usefulness because of the war-time situation. Such a burden so placed could benefit only the interests selling the property, to the permanent disadvantage of the public which receives the service and the utility which would assume the responsibility of operating it upon a financially sound basis. We do not wish to be understood as condemning investment wisely and prudently made in the necessary development of utility property during war times. In many cases extensions and betterments have been made in the interests of the public good under these unusual and trying conditions. Capital so invested is entitled to consideration, but such does not appear to be the case to any marked extent in the present case'."

Of course, there is a war-time appreciation which should be allowed and so many of the commissions are now approving the principle of determining the cost of reproduction, accepting a ten year average price under present war-time conditions depreciating according to the age of the property and then appreciating to cover war-time advances. And this appreciation has averaged from 25 to 35 per cent. It has been thought fair to allow such appreciation in view of the fact that there is no assurance that war-time prices will come back to normal in less than possibly 20 years.

SOUTHLAND METER BOXES

A No. 11 oval Southland water meter box is here illustrated. The box forms a combination housing for curb-cock and water meter. The box is of cast iron. Provision is made for securing a lifting hold through removal of the lid. A concrete walk or pavement is not damaged in removing a box of this type. The cover locks with the "wonder" lock, so called because of its simplicity. The unlocking key serves as a handle with which to remove the cover. When the key is removed the cover is automatically locked in position. Only this special key will unlock the cover. All parts of this locking cover are of non-corrosive solid bronze. This Southland meter box is a product of the H. W. Clark Co. of Mattoon, Ill. The Clark Company also manufacture round meter boxes in cast iron and sheet iron, black or galvanized. The round boxes are made in two sizes, 12 and 18 ins. high, respectively.

The Southland box illustrated is in many respects a complete departure from the regular line of meter box construction. Attention is called in particular to the unique combination feature of housing the curb cock in the same box with the water meter, thus eliminating

THE SOUTHLAND WATER METER BOX.

the use and consequent expense of the independent curb cock, making a great saving to the water department.

The plumber has quick and convenient access to the curb cock, but the meter can be reached only by the use of the key required to operate the lock of the box lid.

This box can be lifted straight up after unlocking the lid, so that tunneling may be done on either side for several feet, if need be, to reach and repair a leak under the concrete walk or pavement. The box is then replaced through the original opening required for its setting.

EDITORIALS

NOT A DAY TO LOSE

The demand of the American people for the construction of hard-surfaced highways has become so great that the best efforts of the road producing agencies of the country will prove insufficient in 1920, unless every business day of that year is properly utilized. Literally, there is not a day to lose. The year must be one of long days and of intense application to work.

So keenly are these truths appreciated by leading federal and state highway engineers that they are doing all they can to concentrate attention on the importance of immediate attention to every detail of the 1920 highway building campaign that can possibly be handled in advance of the construction season. Field operations of necessity depend on the seasons, but so far as legal, financial and office operations are concerned the construction season of 1920 should be regarded as beginning on the first business day of the year.

Almost like a call to arms in the urgency of appeal are the messages recently sent to all highway workers by highway officials. To a large degree the highway building agencies are to be on trial before the public. The public, having voted the requisite funds for road construction, will demand the production of the roads and will be impatient and intolerant of delays.

Every effort should be made to award construction contracts early. Every road contractor in the country who is equipped and qualified to handle road construction work should have construction work to do as soon as the weather and soil conditions will permit. The contractors will undoubtedly be glad of the opportunity to get set for the season at a very early date. They will appreciate the opportunity to round out their financial plans and their organizations, and to get materials and equipment on the ground ready for use when the season opens. It is for local highway authorities to make this plan possible by awarding contracts much earlier than in former years.

We have before remarked on the practice of pushing the construction season "off center." Because of procrastination in the winter months in the handling of the requisite preliminary work, many good construction days are lost at the beginning of the season. An effort is made to replace the fair, wasted days of spring with the later inferior days of early winter. This plan is not only indefensible, but is a reflection on the construction industry. Let us overcome this early-season inertia. Even the farmer of a generation ago was forehanded enough to grease the harness and fatten his horses in advance of the opening up of spring's work. Surely the workers in the construction field can do more than they have done in preparation for the opening of their busy season.

The people are calling for good roads and they must not be disappointed. There is not a day to lose.

CONTROLLING RADICAL LABOR ON THE COAST

As radicalism in the labor movement began to attract attention it must have been a surprise to many, as it was to us, to note that the excesses of the radicals were so largely confined to the far West. We are fond of idealizing the great West and many of us who have never been west of Kansas are pleased to think of that great region as the unspoiled portion of our country, a place where the simple virtues are still popular. It was surprising, therefore, and a bit disappointing to read of the depredations in that virgin land of the bomb-throwing gentry. But if we lost anything of our regard for the real West when the crimes against law and order were committed out there, we have regained it all in reading how the city of Seattle is gaining control of its radical labor element. The successful plan, described in this issue, is being adopted in other coast cities, where "a new declaration of independence for America" is being made. Every reader will find the article interesting, not only, but reassuring as well. All will admire the workings of the modern vigilance committee known as the Associated Industries. In publishing the article we are departing somewhat from our usual strict adherence to our own field, but this question is one quite as much in the minds of our readers as any other.

WHO ARE THE ENGINEERS?

Who are the engineers? We put the query in this form in preference to: When is an engineer?, as the latter suggests levity, whereas we are quite serious. Yet the second question leads directly to the point.

Assuming that a young man has had academic preparation for an engineering career and that he has also had some practical experience in engineering work, just when does he leave off being an engineer assistant" or a "clerk in an engineer's office" and become an engineer?

The questions asked are largely rhetorical in that they are intended to inspire thought rather than to draw out answers. It has been observed that well established engineers are coming more and more to object to the practice of calling every man an engineer who is attached to an engineering organization and performing any of the minor, technical tasks usually entrusted to the young and inexperienced. The chief engineer of a railroad, for example, recently objected rather pointedly "to calling engineer employes engineers."

It can scarcely be hoped that engineers will all hold the same views on these questions. However much alike all doctors may look to laymen they do not all look the same to the initiated. The same is true of lawyers. Yet the public knows much of doctors and lawyers as classes of men. This form of group recognition by the public is something engineers are workig for. We do not believe it is going to help engineers to deny the use of the name to the young men; it would only add to the confusion in the public mind to attempt to carry the classification idea too far.

The plan long in vogue will not only be hard to change, but should not be changed. Let engineers use the name "engineer" as they have for the past generation, qualifying it as need be by such words as young, civil, practical, graduate, etc. Let us spend our energies in acquainting the public with the men we have called "engineers," rather than in attempting at this time to draw too many fine distinctions between men engaged on what in general terms and in common usage has been called engineering work.

WHAT ENGINEERS POSSESS IN COMMON

Engineers possess in common the earning power of the ability to render their professional services to the public. Anything that cheapens the price of engineering service lowers the income of every engineer. This fundamental truth has been too long ignored by many engineers of the employing and executive classes.

Take the case of the young railway civil engineer offered only $75 a month by the bridge engineer of the road to take a party into the field and make the surveys for the location of the piers and abutments of a five-span steel bridge. That bridge engineer, and we state an actual case, in "holding down" his subordinate was cheapening the price of his own services.

Our well known desire to see the earnings of young engineers increased has not been only in the interest of young engineers. It falls largely to young engineers to perform what we may call the visible or tangible classes of engineering service. The peculiar working tools of the engineering profession are used almost exclusively by the young men. These surveying and drafting operations, elementary though they are, serve more to identify the engineer than all else combined. Cheapen the price of these services and you cheapen the price of all engineering service. We must all go up or down together.

Our great interest in organization work to increase the compensation of engineers rests on our belief that this is the only way to get results. Engineers who could not be expected to advance their subordinates above the market price should gladly co-operate to increase the market price. This movement, unless obstructed from within, will benefit all in the profession.

REFLECTIONS OF A KETTLE TENDER

It will be remembered by our readers that during the war this magazine did all it could to keep alive a proper interest in public works. While others seized the opportunity to chase the nimble shekle into munition plants, cantonments and shipyards, or appealed to passion in denunciations of the enemy and all his works, we considered it our duty to remind our readers that plans must be under way during the war for use after the war. We kept faith with our field, we think, without opposing in spirit the rulings of our government. The job was not always a pleasant one, and it was everything but profitable, but to the best of our ability we kept our particular "home fires burning." Many have since said that our persistent attention to the public works field during the war did much to insure the great activities in that field after the war.

That it was wise and in the public interest to keep alive during the war the interest in public works programs all will now agree. Of course, we were not alone in our efforts in that direction. Speaking of the activities of state highway engineering organizations during the war, A. R. Hirst recently said in his presidential address to the American Association of State Highway Officials: "We did fight and fight successfully in order that the great highway movement be not utterly crushed in the midst of the manifold demands of war, because we felt that by keeping together the nucleus of a highway organization, despite many shortsighted attacks, we were doing the American people a real service. It was not pleasant work, nor profitable, to those of us who were in the midst of the storm. But it was worth while and the fight was won, even though for a time the production of ukuleles was ruled, by the powers that be, as more important than the production of highways."

In a recent letter to all state highway departments Thomas H. MacDonald, chief of the U. S. Bureau of Public Roads, said: "It is a matter in which the State Highway Departments may take a large measure of satisfaction that road building is the one big public activity which got under way early in 1919, which opened a large field for unemployed labor, which offered a market for construction materials and which has continued to increase in volume as the months have passed." There is a summing up of the value of keeping the old kettle hot during the war.

Whatever our part may have been, whether small or great, we have much satisfaction in remembering it and it is gratifying, of course, to know that the wisdom of a course once questioned is now above criticism.

Many "rolls of honor" grew out of the war. We confess that we have one. On it are inscribed, in deathless bronze, the names of those who remained loyal to this magazine during the war. Now that pleasanter times have returned we shall not fail to preserve this, our own, roll of honor.

PREPARE NOW FOR CAPACITY PRODUCTION OF NEW HIGHWAYS IN 1920

By Thomas H. MacDonald, Chief of the Bureau of Public Roads, Washington, D. C.

(Editor's Note: The people have voted to spend hundreds of millions of dollars on the construction of roads in 1920. They expect results. If the people are not to be disappointed every nerve must be strained by all workers in the highway field in preparing for the supreme test in 1920. The following letter from Mr. MacDonald has been sent to each State Highway Department; it contains specific suggestions of the greatest, immediate importance).

It is a matter in which the State Highway Departments may take a large measure of satisfaction that road building is the one big public activity which got under way early in 1919, which opened a large field for unemployed labor, which offered a market for construction materials, and which has continued to increase in volume as the months have passed. It is too early to have definite figures available for this year's production of roads and total expenditures, but it is estimated that the expenditures during 1919 for hard surfaced highways, exclusive of sand-clay and similar types, will total approximately $138,000,000. The largest previous year's total expenditures for like purposes that of 1916, was $136,000,000.

Funds Available for 1920

But the test of the road building organizations is ahead. The estimated summary of the funds which will be available for highway work during 1920 for the construction of surfaced highways is as follows:

Brought forward from unfinished work 1919 contracts...	$165,000,000
Funds available from state and county taxes and federal aid	273,000,000
One-fifth state and county bond issues not before available	50,000,000
One-third of the unexpended balance of state and county bond issues previously available	45,000,000
Available from new bond issues to be voted on the fall of 1919 and spring of 1920	100,000,000
Total	$633,000,000

This large total is more than four times the amount of money that has been expended during any previous year for like purposes. To accomplish the physical undertaking of putting into actual road construction this sum, or anywhere near this sum, is tremendous. It is so much greater than any program that has heretofore been attempted that a great increase in the principal factors controlling the actual production of highways is absolutely essential. These principal factors are material supplies, shipping facilities, labor supply and contractors' organization.

Shipping Facilities

The acute deficiency of open top cars demands that our first attention be directed towards increasing shipping facilities for road materials. These facilities may be increased by two methods; first, by the more efficient use of open top car equipment, and second, by a large increase in the supply of new cars. During frequent conferences with the Railroad Administration it has become apparent that a more efficient use may be made of the present open top car equipment by starting the shipping season earlier than has been the general practice in the past. It has been customary to wait until contractors' organizations were ready to begin work before starting the shipment of materials. Under these conditions many thousands of open top cars lie idle during the latter part of February, all of March, and the earlier part of April. In the spring of 1919 the number of open top cars that were idle totaled more than 250,000. As the season advanced and road contracts were actually under way, the car shortage manifested itself here and there almost continuously, but at three different times complaints received at this office were general.

We must recognize that if a strike threatens the railroads, road material will not be moved because it is not perishable. If the movement of coal demands the cars, there will be a shortage of cars for the movement of road materials. The importance of the movement of road materials must be impressed upon the public and the railroads, and for the present the road builders must correlate their calls for service so far as possible with the situation which exists—that at any critical moment when shipping facilities are involved, road materials will be the first to suffer.

Therefore, everything possible must be done to facilitate transportation of road materials under these handicaps. Railroad transportation has become too important a factor in the amount of work that can be accomplished to allow it longer to be regarded as incidental. It has become the biggest item in road production.

Award Contracts Early

Contracts should be awarded as early as possible that the contractors may know the amount of materials they will require at different points and they should be encouraged to place their orders for the materials requiring rail transportation as long in advance of the time they will be actually required as possible. The placing of materials in storage piles involves some expense but this expense is small in comparison to the loss occasioned by lack of materials when the contractors' organization is waiting.

From the experience this year and in view of the greatly increased program for next year it seems apparent that contracts which are not awarded during the winter months will have little opportunity of being supplied with materials which require rail hauling. Again contracts should be awarded early and contractors should be encouraged to place their orders so that the material producers will operate their plants during all seasonable weather. In the past, too many contracts have been held until later in the year and material supplies have not been started moving during the period when the car supply is at its maximum. Also, contract prices have usually been lower for work awarded early in the season, and the State Departments and the Federal Bureau must recognize and respond to the public confidence which has been shown by the appropriations of large sums for highway improvement, by adopting every method that will help to secure the lowest prices and the most efficient expenditure of these funds.

In view of the greatly enlarged program of road construction and the large amount of unfinished contracts which will have to go over because of lack of road materials it would seem unnecessary to further accent the need for taking advantage of the supply of open top car equipment in February, March and April.

It is apparent that many contractors who have not before been so engaged are looking to the highway field, and that the contractors' organizations will be expanded. The labor shortage may in part be met by improved machinery and equipment, but the transportation and the supply of materials cannot be so readily or quickly expanded to take care of the greatly increased needs. Unless a forward looking policy recognizing these conditions is adopted at once, it is not apparent that a greatly increased production of roads will be possible next year over the miles constructed this year, yet the public is demanding of road building organizations a greatly increased production.

Every official in an administrative capacity in the road building organizations knows that it is common for the public to demand great activity and immediate production of roads as soon as bonds have been voted. The fact that more than four times as much money is available for roads next year than has been true heretofore means that these demands will become intensified and it will be a difficult task to impress upon the public the fact that the production of roads is controlled by factors largely outside of the control of the highway officials.

The only possible relief is to use the present transportation and materials production agencies in the most efficient manner possible, and at the same time bend our efforts to obtain an increased car supply and an increased production of road materials. But these policies, to be effective, must be adopted by the State Department and the Federal Bureau individually and collectively, at once, and the first step is to place under contract during December and January as great a mileage of roads as possible. In doing this the Bureau wishes to co-operate with and aid the States in every way possible.

DESIGN AND CONSTRUCTION OF WORKS IN INTER-RIVER DRAINAGE DISTRICT

By Albert S. Fry, Morgan Engineering Co., 622 Goodwyn Institute Bldg., Memphis, Tenn.

The Inter-River Drainage District of Butler County, Missouri, is among the larger projects which have been undertaken for the reclamation of overflowed lands. The district is located in southeast Missouri, including 127,500 acres of land between the Black and St. Francis Rivers just north of the Arkansas-Missouri state line. The northern boundary of the district is formed by the foothills of the Ozark Mountains. At the present time construction work is going forward in this district, which will be completed within the next few years.

Design

The reclamation of this area falls into two divisions: first protection against floods from the rivers lying on either side, and second, the removal of local surface water.

The flood control problem offered the most difficulties. A few miles north of the upper boundary of the district the St. Francis River leaves the Ozark foothills. Above this point the river has a drainage area of about 1,350 square miles of hill land. The river valley in the hills has a steep slope, and following heavy rains on the headwaters of the river, the water from the hills runs off rapidly. The result is that all of the waters from the hill shed rush out on to the flat lands of the alluvial plane through which the river flows after leaving the hills. The fall in the river through this alluvial plane is flat and the water coming out of the hills finds a channel only large enough to carry about one-seventh of the extreme flood flow. The remainder of the water overflows the channel of the river and spreads out along either side, flooding the adjacent lowlands.

On the west side of the Inter-River District, the Black River has created a situation similar to that of the St. Francis River. Above the district the Black River drains about 1,230 square miles of land, which is hilly in character. Heavy storms on the head waters of the Black River cause floods in the same manner as those on the St. Francis. The watersheds of the two rivers, lying side by side, tend to produce floods on both rivers at the same time.

VIEWS OF OPERATIONS IN THE INTER-RIVER DRAINAGE DISTRICT, BUTLER COUNTY, MO.
Clearing Right of Way for Levees.
First Run Levee Showing Borrow and Berm.
Cultivating Land Inside of Levee with Flood on Outside.

In planning protection for the Inter-River District against floods, levees were planned to be built along both rivers which would prevent overflow waters from getting into the district. In the design of the levees along the St. Francis and Black Rivers, the height of levees was designed to allow 3 ft. of free board above the estimated future high water plane. The crown width of levees is 6 ft. and side slopes $2\frac{1}{2}$ to 1 on both river and land sides with the exception of a portion of the Black River levee where the slopes were made 2 to 1. The average height of the levees varies from 10 to 14 ft. A little more than 54 miles of levee in all are required.

Other methods of flood control, such as detention basins on the head waters of the rivers, floodways, and increased size of channels were all investigated and considered, but none of these proved economical in comparison with the levee system for the Inter-River District itself. If the whole of the alluvial valleys of these rivers had been acting as a unit to secure protection, then the detention basin plan would prove advantageous, but for the protection of the Inter-River District area itself, the size of the district is not large enough to bear the burden of the construction of dams to form detention basins.

The second part of the reclamation problem involved the designing of a system of interior drainage canals to provide local drainage and to furnish outlets for future tile systems. The system designed, and which is being constructed, includes 208 miles of channels. The smaller of these are 12 ft. wide on the bottom and average from 6 to 8 ft. deep with side slopes of 1 to 1. The largest channel, which will be the main outlet channel for the interior system, will be 55 ft. wide on the bottom, 10 ft. deep and have side slopes of 1 to 1. The interior lateral drains are so planned that nearly every acre of land is within half a mile of a satisfactory drainage outlet.

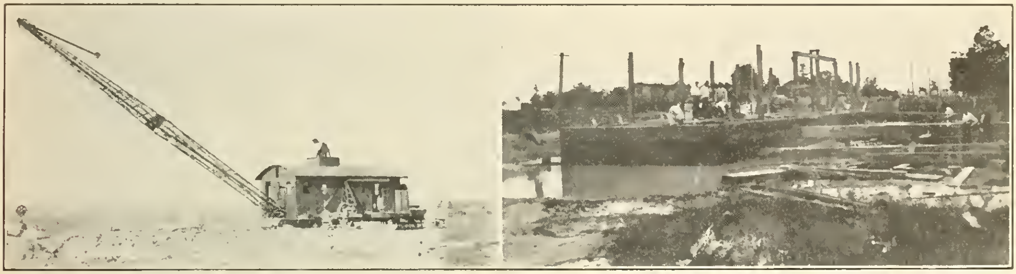
Construction

The Inter-River District was ready to let contracts for construction just after the United States had entered the war. The greatest need for the district was the building of the levees to control the floods from the Black and St. Francis Rivers. In view of this need, the Capital Issues Committee, in passing on the district granted permission for the construction of the greater part of the levees. Contracts for the levee work were then let to the Callahan Construction Co. of Omaha, on the basis of a profit sharing contract, details of which require the district to purchase all equipment and furnish all funds for running the job, the contractor managing the work and dividing with the district any saving in the cost of construction below a fixed base price per cubic yard.

After the levee work was well under way, the war ended and the district was free to contract for the remainder of its work. The balance of the levee work and all of the drainage canal excavation was let to the same contractor under an arrangement similar to that for the first levee contract.

The construction of the levees was begun in September, 1918. Four Monighan, 3-T walking drag line excavators were installed. These machines have booms 70 ft. long and carry buckets of 3½ cu. yds. capacity. All of the machines are oil burners and are run by Fairbanks-Morse engines. All four machines are also exact duplicates, so that parts can be interchanged. At a central point in the district, a storehouse and machine shop has been set up. In the storehouse is kept all the supplies necessary for repairs and for keeping machines in operation. Oil tanks have been built to store fuel oil. Portable wooden houses have been built for the men to live in. These houses are so built that they can either be transported on wheels or on runners, depending on the condition of the ground. In supplying the machines with oil and supplies, teams and tractors are both used and on part of the work a barge has been used for taking supplies down the river. Oil is distributed along the right-of-way ahead of the machines in 50 gal. drums.

The greater part of the levee line ran through timbered land and it was necessary to clear the right-of-way for widths varying up to as much as 200 ft. before the levees could be built. Part of the clearing was done by contract work and part by the district's own forces. The heaviest clearing was done by the district itself, in order that the general average price for clearing might not be influenced by reason of high costs on parts of the work which were especially difficult to clear. In snaking logs off the right-of-way, a tractor has been used to good advantage.



VIEWS OF CONSTRUCTION EQUIPMENT USED ON INTER-RIVER DRAINAGE DISTRICT.
One of the Walking Dragline Excavators—Launching the Hull for One of the Floating Dredges.

In order to secure protection as early as possible from the floods in the rivers, a large part of the levee work has been constructed by first throwing up a levee to an average height of about 8 ft., this being sufficient to protect against the regularly recurring floods, although it would not afford relief from extreme floods. No attempt has been made to crown the first run levee. In throwing up the 8-ft. section, the drag line machine excavated earth from the farthest limit of the borrowpit and placed the material on the outer or river side of the levee, the borrowpits in all cases being on the river side of the levee. In returning to complete the levee, the remainder of the borrowpit excavation is being made, the earth being thrown over the first run levee and joining this so that the full section levee is obtained.

The base of all levees is plowed before any levee material is placed. Where objectionable material is found in the base, the base is stripped to such a depth as the objectionable material extends before any levee material is put in place. Muck ditches are dug below the center of the levee wherever the levee line crosses low or objectionable ground. Traverses in the borrowpits are left at frequent intervals, the purpose of these being to prevent the flow of water outside of the levee following down the line of the pit and deepening and widening the borrowpit to an extent to endanger the levee. A berm of 30 ft. has been left between the outer toe of the levee and the nearest edge of the borrowpit in most of the work, although wider berms have been used in certain special instances.

In building the levees quite a number of old slough channels have been intersected. These channels at the point of crossing ordinarily are deep and banquettes have been constructed on both the land and river sides at such places. In the case of most of these sloughs, they have served as overflow channels, carrying the waters away from the river and into the district, rather than serving as channels to drain the waters of the district into the rivers. Therefore, stopping the slough channels does not complicate the drainage problem to an appreciable extent.

When the levees are completed, the slopes will be seeded so that the resulting sod will protect the slopes.

The construction of the levees will require the placing of 4,272,000 cu. yds. of earth. At the present time about one-third of this has been constructed. In the interior drainage system 7,225,000 cu. yds. of earth excavation is required. None of this work has yet been done.

To dig the drainage canals, six floating dipper dredges are being built and will soon be in operation. When the drag lines, which are building the levees, have completed their levee work, they will be used on the drainage canal work in addition to the dredges.

The results of the levee construction are already apparent. One of the accompanying illustrations shows a recent high water in the Black River which would have overflowed the land adjacent had not the levee been built. As it was, the levee held out the water and the farmer on the inside was able to plow up to the inside of the levee and carry on his farming operations, altogether oblivious of the fact that the Black River was in flood.

The Inter-River Drainage District was planned by the Morgan Engineering Company of Memphis and the construction work is being carried out under their direction and supervision.

MINERAL AGGREGATES FOR BITUMINOUS PAVEMENTS

By Wallace L. Caldwell, Director Department Roads and Pavements, Pittsburgh Testing Laboratory, Birmingham, Alabama

We are today facing a vital problem which must be solved if the great road building program mapped out for this country, is to be carried out. That problem is the serious shortage of road building materials, particularly of aggregates for bituminous pavements. We must encourage in every possible way, the development of new supplies of such materials, but, at the same time, we must not overlook the quality of these materials," said Mr. Caldwell in addressing the American Society for Municipal Improvements.

This shortage has already resulted in the development of new sources of supply, but the slightly increased production has by no means met the demand. Some of the new materials being sold and used are far from satisfactory and will undoubtedly cause a number of failures within the next few years.

The writer is connected with a large number of current projects and on nearly every contract, difficulty is being experienced in securing sufficient supplies of satisfactory aggregate materials. In order to overcome the delay caused by this shortage, available but inferior materials are being offered. Delays are costly and inconvenient and therefore a decided tendency to permit the use of unsuitable aggregate materials has been noted, both on the part of contractors and city officials. It will invariably be found that the use of such materials will eventually be much more costly than any ordinary delay.

Mineral Aggregate of Greatest Importance

The public and even some city officials consider the bitumen to be the one important element in a bituminous pavement but engineers familiar with pavement construction are aware that the mineral aggregate is of much greater importance. Many failures can be attributed to the use of inferior aggregates, but only a comparatively few to the use of an inferior bituminous cement.

Causes of Failures of Bituminous Pavements

The writer has investigated a large number of failures of different types of bituminous pavement and has endeavored to differentiate the causes and percentages of failure. The percentages given below are not of universal application, but represent approximately the causes of failure encountered in the writer's investigation. The failures considered are failures of the wearing surface as distinct from failures caused by improper subgrade and foundations.

Unsuitable Mineral Aggregate	30%
Improper Manipulation at Mixing Plant	25%
Poor Workmanship on Street	15%
Bad Weather Conditions	15%
Bitumen of Improper Consistency	10%
Bitumen Unsuitable for Paving	5%
	100%

Testing the Aggregates

In spite of its importance, it is only recently that general attention has been given to the physical testing of aggregates for bituminous pavements. Even today most specifications are extremely vague and indefinite as to the quality of aggregate materials. The specifications of the United States Bureau of Public Roads, of several state highway departments, and a few cities have recognized the value of such tests and have made their requirements as definite as the present state of our knowledge of physical testing permits. Hundreds of specifications are being prepared every year, in which even the data available at present is not recognized. The only definite test commonly specified is the mechanical analysis as determined by laboratory sieves. Aside from this test the acceptance of aggregate materials is ordinarily based upon visual examination and personal opinion, both of which have their value, but some more definite standards are needed, especially in these days when many inferior materials are being used, often under the supervision of men of limited experience.

In this paper only the aggregate materials commonly used in mixed method pavements will be discussed. The essential properties of sand, filler and the usual coarse aggregates will be described briefly.

Sand

Although many able authorities have written upon the essential properties of sands for bituminous pavements, it seems advisable at this time to call attention to some of the salient points regarding sand.

Sand is the water-worn detritus of crystalline rocks and is largely composed of quartz, although calcarious and feldspathic sands are known. It is the writer's opinion, and the experience of others seem to bear this out, that for paving purposes satisfactory results are in general obtained only from quartz sands.

Sands may be classified, as to source, as beach, river and bank sands. A great variety of sands are found in each class, but in general the sands of greatest value are secured from rivers and banks, although many sands from the beaches of the Great Lakes have been used satisfactorily. Sea beach sands are sometimes used, but as a class are not so satisfactory as the other sands mentioned.

Before discussing the physical properties which are necessary in a sand, it may be stated that very little real quantitative data regarding the physical properties of sands for bituminous pavements is available. This is a fruitful field for research and is well worth the time of qualified investigators. Professor Abrams and others ably investigated the properties of concrete sands, and if our knowledge of bituminous pavements is to be advanced it is essential that similiar investigation be made as to essential properties of sands for use in bituminous pavements. This is a complicated field of research which offers many practical difficulties, but nevertheless the problems which need solution can and will be solved.

The writer is glad to report that certain investigations have been under way in his laboratories for some time and that progress is benig made. In due time results will be secured which will be of value.

In the meantime we can best secure satisfactory results by availing ourselves of the information which has been accumulated through experience and observation. Although this information is largely empirical, it serves as a useful guide.

Angular Sand Grains Are Best

Both theory and experience have shown that sands having angular grains are best suited for bituminous pavements. Rounded grains do not have as many points of contact as angular grains, and therefore a mixture in which such grains are used is not stable and is more readily displaced by traffic than a mixture containing angular grains. This applies to sand used in both fine and coarse aggregate pavements.

In order that a film of bitumen, of sufficient thickness, may adhere to each sand grain, the surface of the grain should be somewhat rough or pitted. Sands with smooth and polished grains are frequently encountered but their use should be avoided because the individual grains are sometimes so thinly coated with bitumen that a proper bond between the different particles of the mineral aggregate cannot be secured.

The sand grains should be hard and tough, so that the individual grain will not readily wear away under the abrasion of traffic and fracture under impact. Of course, the small size of the sand grains and the cushioning action of the bituminous cement so largely reduces the danger of fracture that toughness is a much less important factor than in the case of aggregate of larger size, such as gravel and crushed stone. Several failures have been attributed to the use of sands with soft grains. As yet no satisfactory means of ascertaining the hardness and toughness of sands have been devised. There is, however, a need for such tests, and in connection with the investigations previously mentioned, the writer has developed certain methods for making these tests. Before arriving at any definite conclusion as to the value of these tests it will be necessary that many check tests of several hundred different sands be made.

Impurities in Sand

The amount and character of the impurities found in sand largely determine its value. Clay, loam, mica and organic matter are common impurities, and in sufficient amount each one is a most important factor in determining the quality of mixture.

Clay is found either finely divided and evenly distributed through the sand or in the form of small clay balls. If only a small percentage of clay is present in a finely divided state and the clay itself is not plastic, little harm will be done, in fact, a large percentage of the clay will be removed by the fan on the heating drum of the asphalt plant. However, if the clay is plastic and present to the extent of more than 5 per cent. the sand grains will be coated with a hardened film of clay, after pasing through the drum. This film will prevent the bitumen from adhering to the actual surface of the sand grains. The film of bituminous cement is easily broken away from the sand grains, permitting water and traffic to disintegrate the pavement.

Clay balls, when present in any appreciable quantity, are a source of even greater danger than evenly distributed clay, and engineers should take a decided stand against the use of sands containing such material, because disintegration is quite certain. The clay balls at the surface of the pavement are removed by water and traffic. This allows water to work down into the pavement gradually softening the clay balls scattered throughout the mass. Eventually this results in serious disintegration of the pavement surface. This condition is of more common occurrence than is often realized.

Mica in Sand

In certain sections of the Country where the sands have been formed by disintegration of granites and gneisses, mica is almost a universal constituent of the sands. If present in any appreciable amount, trouble may be experienced, since the mica grains cannot be satisfactorily coated with bitumen and will not resist traffic. In practice the writer has ordinarily rejected sands containing over 3 per cent. of mica, as estimated with the microscope. Organic matter, usually in the form of roots, twigs and leaves, is found in many sands. When the hot sand is screened through an 8 mesh screen, as in the case of sheet asphalt, the greater portion of such material will be removed, but when the type of pavement requires the use of a larger size screen, the roots and twigs will pass through into the mixture. Such material in the mixture is a source of weakness and either the sand containing it should not be used or else it should be screened out.

Grading of Sand

The grading of sand is, of course, one of its most important properties. In fact, experience and theory have demonstrated most clearly that the grading must be within certain narrow limits if satisfactory results are to be secured. Sand is used in several types of pavement, both by itself and combined in various percentages with several kinds of coarse aggregate, but in every class of pavement the grading of the sand is an important factor. From the standpoint of the practical asphalt man, sands are often classified as fine, medium and coarse.

The fine sand contains a high percentage of 100 and 80 mesh grains, the medium a high percentage of 50 and 40 mesh material, and the coarse a preponderance of 30, 20 and 10 mesh grains. In most sections of the country, medium and coarse sands of proper quality are more readily secured than the fine. Sands containing a sufficient percentage of the fine 100 and 80 mesh grains must be found since without these fine grains a satisfactory pavement will not be produced, regardless of the type of pavement.

An engineer is fortunate indeed who can find one sand which will fill all requirements as to grading. Such sands are found but they are rare. Ordinarily mixtures of two, three, and even four sands must be made in order to produce a properly graded aggregate. Specifications customarily fix the percentage of 200 mesh sand at a maximum of 5 per cent. This limitation is based upon sound reasons and should be invariably followed, in fact, it has been the writer's practice, to limit the 200 mesh sand to 3 percent. whenever possible. The 200 mesh material in a bituminous mixture should be composed of filler, and not sand. Sand grains even though they pass the 200 mesh sieve are much coarser than the greater portion of a properly ground dust and do not function as a filler in any respect. Sands containing up to 10 or 12 per cent. of 200 mesh grains have been used with little or no filler, it being assumed that since the percentage of the 200 mesh material was within the required limits, no other material of this size was needed. Such mixtures are unstable and invariably result in failure.

Investigate All Sources of Supply

Too frequently, the sands most readily available, even though not entirely satisfactory, are used. Usually a brief investigation and a sand survey will locate other supplies within reasonable shipping distance. Quite commonly the new supplies will be better than those previously available, particularly in those regions where suitable sands have not been developed, owing to lack of demand. Before deciding upon the sands to be used on any job the writer has invariably investigated all possible sources of supply, both developed and undeveloped. The results obtained have usually justified these investigations.

Filler Requirements

Filler, which is finely ground mineral dust, is ordinarily used in all types of mixed method pavement, except bituminous concrete pavement with a mineral aggregate of crusher run stone or pit run gravel. Its use produces a dense pavement, reduces liability of displacement, enables a softer asphalt cement to be used, and causes the surface to be less susceptible to damage from water.

An ideal filler should be finely ground, not merely so that a considerable percentage will pass a 200 mesh sieve, but so that at least 60 per cent. will be a true dust or impalpable powder, as determined by the elutriation test. It is this powder which really serves as the filler and which produces the results required of a filler. The remaining portion of the filler simply serves as sand. The grains of the filler should have a surface which will absorb a heavy film of bitumen. Very hard dense grains do not absorb a sufficiently thick film of bitumen to permit such grains to fulfill all the functions of a filler even though the material be ground to the requisite fineness.

The filler should be so constituted, chemically, that it will have no harmful action upon the bitumen and so that water will not in any way react with the material. The material should not be light and fluffy but should have a weight of at least 90 lbs. per cu. ft. Lighter materials are readily blown away when being placed in the mixer, with the result that the mixture has a variable and always low percentage of filler. Closed mixers eliminate this difficulty but are found on only a few plants. Light weight fillers, when used in sheet asphalt often produce a fluffy mixture, which will not rake well and which does not take compression as it should.

Portland Cement Fillers

Among the fillers commonly used, are Portland Cement, Ground Limestone, slag dust and ground silica. Nearly every kind of pulverized mineral has been used at one time or another. Practice has clearly shown Portland Cement to be the most successful filler and Limestone dust to be relatively second in value. Portland Cement seems to produce a somewhat denser mixture than any other filler and when heavy traffic must be provided for, its use is advisable. The reason for this is somewhat obscure, but principally is due to the slightly porous nature of the Portland Cement grains. This property results in each grain absorbing a certain amount of bitumen and permits the formation, around the grains, of a tenaciously held and rather thick film of bitumen.

Limestone dust has been used with entire satisfaction. Slag dust, has not been extensively used but has given good results wherever used. It would not be advisable to use the dust from an acid slag, because of the hard, glassy nature of the material, but no criticism can be made of the dust from a basic slag. Silica dust, from a number of different sources, has been widely used. No serious trouble has resulted from its use but in general it has not given as good satisfaction as certain other materials.

Good filler is scarce today, the production having fallen below the demand. Many products, which cannot be classed as a dust in any respect are being offered. Products having 50 per cent. of material passing the 200 mesh sieve but containing very little actual dust, as determined by the elutriation test, are not uncommon. In several cases agricultural limestone containing 20 or 25 per cent. of 200 mesh material with coarse grains as large as 1/4 in. has been used and has been called filler. Ground stone such as this contains no true dust and simply serves as a source of fine and intermediate aggregate, with the result that the mixture contains no filler.

Rock Requirements

Limestone, Dolomite, Trap Rock and Granite are the rocks most commonly used in bituminous construction, although sandstone, gneiss, and certain other rocks have been used to a limited extent. The rock should be sufficiently hard to resist the abrasive action of traffic and tough enough to withstand the impact of iron-shod hoofs and of vehicles. It should be clean and free from clay. If the rock contains fine screenings it should be freshly crushed, since the dust tends to collect on the surface of the larger pieces and, if, once wet, forms a scum on the surface, which is dried and baked when the stone is passed through the heating drums. This film effectually prevents the adherence of the bitumen to the surface of the rock. The individual pieces should be as nearly cubical as possible, since stone which crushes in slabs or slivers produces a mixture which cannot be compressed to as great a density as if a stone of cubical fracture is used. Slabby pieces of stone are more easily fractured by traffic and thus are likely to cause the pavement to ravel. A stone having a structure and surface which will permit of absorption of a certain amount of bitumen is to be preferred to a stone with a hard, dense surface which will permit of no impregnation.

Physical Test for Rock

Fortunately satisfactory physical tests have been devised for rock. The U. S. Bureau of Public Roads and others have made thorough investigations of the methods and interpretations of these tests. Hubbard & Jackson in Bulletin 370 U. S. Department of Agriculture have tabulated a great amount of data and have given valuable interpretation of the results of their tests. Too few specifications call for these tests and it would seem advisable for the Society to make a study, through a proper Committee, of the definite physical requirements which should be specified for the different classes of bituminous pavements under all conditions of traffic and climate found in Muncipalities.

Requisite Toughness

It has been the writer's experience that for City pavements, subjected to ordinary traffic, no rock having a French Coefficient of wear of less than 8, or a toughness of less than 8 should be used. Under very light residential traffic it is sometimes permissible to permit the use of a rock wth a toughness of 7, and French Coefficient of 6, but under no circumstances should an aggregate of lower value be used. For heavy City traffic the requirements should be increased to a French Coefficient of wear of at least 10 and a toughness of between 10 and 14 depending upon the density and nature of the traffic and the size and character of the aggregate. Binder stone should have a toughness of at least 7. Of the two tests toughness is undoubtedly of the greater value when considering the quality of rock for a bituminous pavement.

The grading of the crushed stone is of vital importance and in bitulithic and asphaltic concrete pavements is given careful attention. The density of any coarse aggregate mixture is dependent upon the proper grading of the stone. In some cases, stone as received from the quarry may be of the proper grading but often a combination of crushed stone of different sizes must be used. In bitulithic pavement the stone is screened into various sizes, each size stored in a separate bin and recombined in the proportion desired, by weighing a definite amount from each bin.

Chats or Trailings

Since their use is rather widespread it will be well to mention chats or trailings from certain ore mines. The two materials of this class most commonly used, at least in the eastern half of the country, are from the zinc mines of eastern Tennessee and the Joplin, Missouri, District. The Tennessee chats are a limestone, averaging 97 per cent. Calcium carbonate are very hard and tough, have an unusually high specific gravity, and a decidedly cubical fracture. The surface of the pieces of rock is perfectly clean, washing being a part of the ore dressing process. Most excellent results have been secured from this material. The Joplin Chats are a flint, are hard and tough, have a good cubical fracture and are clean, but have a very smooth surface which does not hold a thick film of bitumen. However, excellent results have been obtained in many pavements with these chats. In the process of manufacture both materials are so crushed that they will pass a 2 mesh sieve. They are, therefore, used almost entirely in Asphaltic Concrete Pavements of the Topeka type.

Blast Furnace Slag

Crushed blast furnace slag has in the past been used to a limited extent in the wearing surface of bituminous pavements. Its use is increasing and it has been recognized as a satisfactory aggregate material used by a number of cities and counties, and at least one state highway department, that of Ohio. Slag has been used in some bituminous pavements for several years with apparently good results. The writer has had certain pavements in which slag aggregate was used, under observation for the past 2½ years. No trouble which can be attributed to the slag has developed as yet. Two general classes of slag are available, basic, containing a high percentage of lime and magnesia and a relatively low percentge of silica, and acid, containing a higher percentage of silica. Basic slags are tough and hard, whereas acid slags are often brittle. Basic slags have a porous and somewhat absorbent surface; acid slags have a glassy surface, which is unsuited for bituminous pavements. Ordinarily basic slags only should be used. The following are typical analyses of the two classes of slag.

CHEMICAL ANALYSES OF TWO CLASSES OF SLAG

	Basic	Acid
Silica	35.55	39.50
Alumina	12.04	14.00
Iron Oxide	.62	.52
Calcium Oxide	41.35	40.00
Magnesium Oxide	8.45	4.00
Total Sulphur	1.28	1.32
Physical Tests		
French Coefficient of Wear	6.2	3.6
Toughness	11.0	6.0
Hardness	15.6	15.5

Slag is more difficult to test than rock due to greater difficulty in securing representative and suitable samples for some tests, but usually the methods of testing used for rock meet all requirements. Slag should not be too badly honeycombed and should be clean and free from blast-furnace down-comer dust. It has been thought by some that possibly some constituent of slag is harmful to the bitumen. Sulphur is usually the constituent blamed, but it is clear that there is no sound reason for this opinion.

Gravel

Gravel has been used as a coarse aggregate in nearly every type of bituminous pavement. Because of the nature of the material and the characteristic rounded grains, it does not give as satisfactory results as a crushed stone. When crushed stone is used, the angular fragments will key together and the results will be better than if rounded gravel is used.

Many gravel deposits contain clay either evenly distributed or in the form of clay balls. The results will be about the same as in the case of sand containing clay.

Toughness and hardness tests are not made on gravel, but the coefficient of wear is determined either by the Deval method used for rock, or by a modified method in which six cast iron spheres 1.975 ins. in diameter and weighing 0.95 lb. are placed in the cylinder with each charge. The French coefficient of wear on a good gravel will be about 12. The mechanical analysis of gravel is of great importance and every effort should be made to keep the grading within the proper limits for each type of pavement.

HIGHWAY BRIDGES OF STEEL AND CONCRETE

By Charles D. Snead, Bridge Engineer, Department of Public Roads, Frankfort, Ky.

Engineers and laymen who are connected with courts, boards or commissions are deeply interested in the cost of bridges, the selection of the proper type of structure, how to secure good work and what is necessary in maintenance to preserve the present structures and prevent deterioration of future structures.

In approximating the cost of any structure, it is necessary first to know as far as possible all local conditions. This information is secured at the time of making the survey and the more time spent in determining true foundation conditions, availability of local building materials, labor conditions, condition of roads for hauling, cost of teams, storage facilities for supplies, co-operation of the landowners, officials and people in general, is time well spent and will be many times repaid to the company, county or state, both in accuracy of the estimates of costs and in the preparation of the final design. Again, before we can estimate accurately—or for that matter, approximately—the cost of a structure, we must have a plan that fits the particular conditions from which to estimate.

Influence of Local Greed on Costs

There is one element which enters into bridge construction which is often overlooked and yet is of vital importance. Local parties, desiring to make a small fortune at the exepense of the corporation, state or contractor, will often raise the price of materials and gouge the public and contractor. This is a large reason why contractors will bid high upon the work and why people oftentimes complain of costs. For example, at the time a survey was made in one locality, 3 cts. per cu. yd. would have bought gravel and sand and teams could then be secured for $5 per day. Six weeks afterwards the same sand and gravel went up to 50 cts. under the same identical conditions and the cost of teams to $8. These men were the same highly respected, church-going, sanctified citizens who, while professing to be thoroughly interested in public improvement were interested in the improvement only insofar as they could dig into their neighbor's pockets.

Then the people wondered why the estimate was too low and criticized the engineers for being impractical theorists.

Estimating Costs

In estimating the cost of a bridge, the unit cost of every item must be carefully approximated. The cost of cement delivered, the cost of sand, stone or gravel, labor, the cost of form lumber, together with a knowledge as to whether this could be again used, the cost of excavation, the cost of finishing and protecting the work and the cost of hauling—all of these must be carefully estimated, and finally, a reasonable profit must be figured for the contractor.

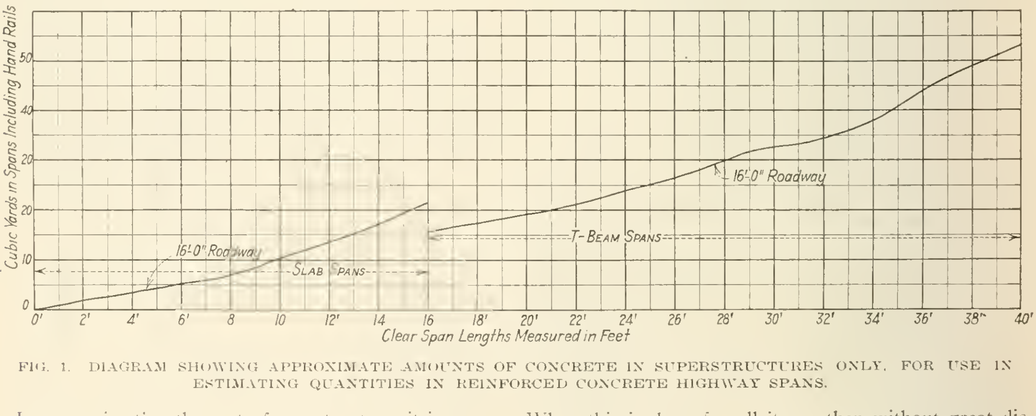


FIG. 1. DIAGRAM SHOWING APPROXIMATE AMOUNTS OF CONCRETE IN SUPERSTRUCTURES ONLY, FOR USE IN ESTIMATING QUANTITIES IN REINFORCED CONCRETE HIGHWAY SPANS.

When this is done for all items, then without great discrepancies we should be able to approximate the cost of a structure if we know the quantities involved.

From the accompanying curves we may quickly approximate the yardage and tonnage of steel in concrete spans with 16-ft. clear roadway.

The yardage in plain abutments will be approximately the same for steel and concrete structures (greater for steel structures). This yardage may be approximated roughly by multiplying the height in feet from crown of roadway to the bottom of foundations by the following amounts: (the yardage including wing walls and represents two abutments for 16-ft. roadway spans):

For abutments up to 10-ft. multiply height by 10.

For abutments between 10-ft. and 15-ft. multply by 14.

For abutments 15-ft. to 20-ft. multiply by 15.

For abutments 20-ft. to 30-ft. multpily by 19.

The yardage in plain piers for 16-ft. roadway spans may be roughly approximated by multiplying the height in feet from top of pier to bottom of foundation by 3.3. These figures will give values far closer than mere guesses.

For steel structures designed to carry a 15-ton tractor and a concrete floor, we may estimate the weights of the structure without sidewalks by Kunz's formula and the added cofficient "X."

$$W=(0.12L+12)\ (1.6-0.03B)\ BLX.$$

Where W equals weight of steel in pounds.

Where L equals length of span in feet.

Where B equals width of roadway in feet.

Where X equals 1.7 for high rivetted trusses (85 ft. to 170 ft. for 16-ft. roadway).

Where X equals 1.43 for high pin connected trusses (140 to 200 ft. for 12-ft. and 16-ft. roadway).

Where X equals 1.67 for high rivetted trusses (85 ft. to 170 ft. for 12-ft. roadway).

Where X equals 1.6 for low rivetted trusses (40 ft. to 80-ft. for 12-ft. and 16-ft. roadway).

In Defense of Heavy Construction

It should be remembered if structures built of steel are properly maintained there is no reason why they should not last for 30 or 40 years, perhaps longer. The public has been fooled so long by the old-time representatives of bridge companies about the capacities of bridges that many officials, and engineers too, are at sea and believe the statement that the plans of state departments are designed for too heavy loads and weigh too much.

What man 15 years ago would have predicted the present highway loads? What man dreamed then of fleets of 5-ton trucks, each when loaded to capacity weighing 10 tons and which, by actual weight, have been often found to be 50 per cent. overloaded? What man can definitely state that in the life of bridges no such loads will ever be of frequent occurrence? No man can make such statements without a large probability of being badly reversed in years to come. Again the extra weight in the state spans doesn't all come from the live load they carry. No one doubts but that the old type of wooden floor is doomed. At best, wooden bridge floors are expensive and costly to maintain. We know concrete is heavier than wood and naturally requires more steel to carry this added weight. But there is added weight to the state plans to add to the life of the bridge, added years of service at a very small first cost by the elimination of poor details, thin plates; yes, plates thinner than one-fifth of an inch—details which if neglected rust out and destroy the strength of the whole structure.

The Substructure

There are many men in responsible charge of work who not only are wholly ignorant of the design of masonry abutments and piers and foundations, but who gloat over their ignorance and term it "practical." They build year in and year out abutments founded on sand, mud, soapstone, blue clay, etc., too thin to stand and give service even if founded upon solid rock. These structures stand as monuments to their judgment sometimes for five years, sometimes longer, but more often less, and then—without warning perhaps—fail; proving again that it is the exception which proves the rule. In 14 years' experience I do not remember of more than about one dozen structures in which the substructure when properly designed and placed did not more than exceed the cost of the superstructure. The first costs of bridges can be made cheaper by defying the laws of nature, by omitting piles and not securing the proper foundations and at the same time the treasury can be depleted in the rebuilding and maintenance of such structures.

Maintenance

There is one point upon which too much emphasis can not be laid. The first cost of a bridge should not govern its type; that is, whether the structure is to be of steel, concrete or wood. Structures must be designed and constructed not only with sufficient carrying capacities to care for modern traffic, but also so that the yearly maintenance charges will be a minimum. This cannot be determined without estimating maintenance charges.

In general, it will be found, for spans up to 40 ft., unwise to construct them of steel when the permanence of concrete is considered. This does not mean that longer bridges made up of short spans may not be economically constructed of concrete, nor that concrete arches should not and must not be built for the longer spans.

Maintenance costs vary greatly. They depend upon labor, local material for bridge floors, the kinds of structures, nature of the stringers, whether wooden or steel, and other factors. For these reasons each case must be decided upon its merits and while much data has been collected regarding such costs, this data has not been so arranged as to be of general application under varying conditions. With a wooden floor and steel stringers, an allowance of 5¾ cts. per year per square foot of structure will not prove excessive, and this should at all times be added with interest compounded in estimating the final cost of a steel structure, and then the life of the steel structure should not be estimated over 30 years in comparison with concrete with a life based at 50 years. If the difference is slightly in favor of a steel structure, remember we are dealing with approximations and build with concrete.

Contractor and Inspector

The secret of good workmanship is simple, intelligent inspection of your work and the employment of a good contractor. Good work costs money. Avoid the contractor who is always anxious to tell you how your work should be done. This man is in business for himself and he probably thinks you are ignorant. If he can do something cheaper and make more money for himself, he will tell you. It is money he is hunting. Get a contractor who has been doing the class of work desired; get an intelligent inspector, one who knows his work and good workmanship will result. Plans will be followed without "ifs" and "ands." In the selection of your inspector, pick a trained man, if you can find one thoroughly experienced, but in all events choose an experienced man. If he follows the specifications and knows good work, there will be no doubt as to the final appearance of the structure.

Just a few words about maintenance. Concrete bridges require practically no maintenance but must be inspected to see that there is no scouring action, to see that the cushions have not worn through and that drain holes are open and operating. These things should be attended to immediately. The tops of concrete structures should always be finished off smoothly without pockets to hold water and should be sloped or rounded to drain it off. This will prevent the water standing on the structure causing the cushion to become muddy and also prevent the water from being absorbed by the concrete.

Inspection of Steel Bridges

Steel structures must be regularly inspected. If spots need cleaning and repainting this should be done and possibly for a period of a year or more repainting the entire structure may be delayed without damage to the structure. When repainting is necessary, do not allow the structure to continue to rust through the idea that the money can be saved until another year. You are paying dearly in interest in the life of your structure. Have your structure thoroughly cleaned before repainting and use only the best paints for your work.

Inspect your bridges with concrete floors and see especially if they are the arch type of floor commonly found in this state, whether or not they have not punched through. If the structure contains a wooden floor inspect closely for decayed planks. Decay is a disease and will travel from one plank to the other if they be in contact and neglected. Do not put concrete floors upon bridges designed for wooden floors; they are weak enough already, no doubt, for modern traffic. Inspect abutments for movement, and if movement is taking place, get an engineer to advise you what to do. Evidence of movement may be indicated by buckling hand rails or bottom chords or by the pier or abutments leaking.

In conclusion, if bridges are designed of equal strength according to the same specifications, it should be remembered their costs will be approximately identical. When you cheapen your first cost, be sure that you have not lessened the strength nor the durability of the structure. It is possible to reduce the cost of structures by temporary or makeshift abutments which surely will fail in time. It is possible to put in thin metal and poor details and reduce the cost at the expense of the life of your structure and it is possible to reduce the safe carrying capacities of spans and eliminate cost. None of these can be recommended. If your structures seem bargains, it is well to see from what portion the moths have taken their meals. Kentucky will stand for any amount of money properly expended, getting a dollar value for a dollar. She will not stand for waste of her funds in worthless bridges, and there will come a day when the people will fully realize modern traffic is delayed, not by muddy roads, but by bridges bought not for what they were, but for what they cost.

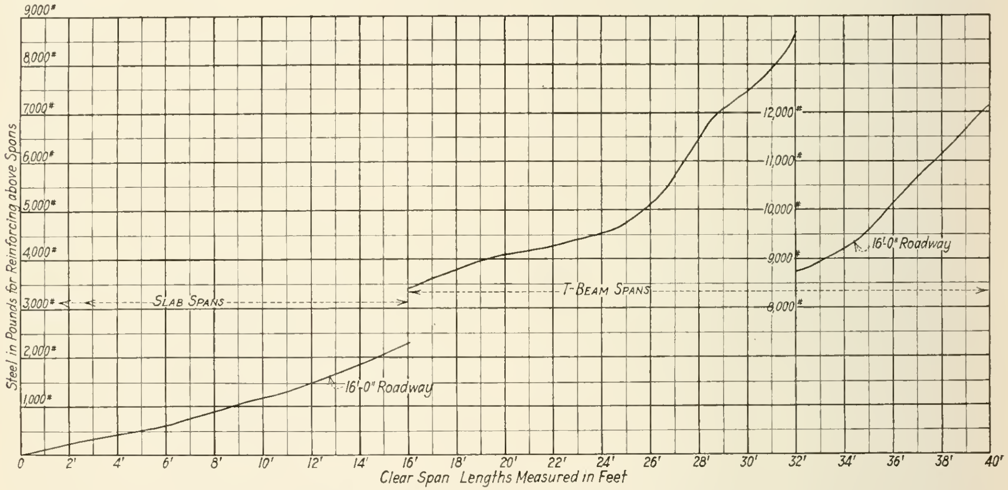


FIG. 2. DIAGRAM SHOWING APPROXIMATE AMOUNTS OF STEEL REINFORCEMENT FOR ESTIMATING QUANTITIES FOR SLAB AND T-BEAM SPANS WITH 16 FT. ROADWAY.

Acknowledgment

The foregoing paper by Mr. Snead was presented before the Kentucky Highway Engineers' Convention at Owensboro, Ky., on Nov. 14, 1919.

THE PROPOSED NATIONAL DEPARTMENT OF PUBLIC WORKS

By W. B. Gregory, Tulane University of Louisiana, New Orleans, La.

Do we need a Department of Public Works? This question is now before Congress, and the attitude of the engineers of the country should be a large factor in its solution, said Mr. Gregory in addressing the American Society for Municipal Improvement.

Several departments of the National Government have overlapping interests. Instances of mutual working agreements are comparatively rare. Each department has its own rules and regulations, its own ideas, specifications, methods and specific objects. The race for departmental supremacy is often as prominent as the object to be attained by official activities. The overhead charges, the duplication of efforts, the cross purposes, the multiple accounting and the technical and clerical help, the duplicated property and equipment, duplicated traveling expenses, all tend to increase the cost and lower the efficiency of the work as a whole.

Since the Conference of Engineers, Architects and Constructors was held in Chicago, April 23-25, 1919, the technical press of the country has published a great deal of information regarding the proposed National Department of Public Works. The purposes of the conference are therefore known to the technical men of the country. They will bear repetition until the hope becomes a reality.

The conference was called by the Engineering Council, representing the four great Founder Societies.

At the conference 84 societies were represented, the total membership aggregated 105,000 engineers, architects, constructors, chemists and geologists.

There was remarkable unanimity among the delegates, as all agreed on the desirability of a grouping of the Public Works of the Government under one head. Only in minor details were there differences of opinion.

The Jones-Reavis Bill

The bill, S-2232, embodying the results of the conference, was introduced in the upper house by Senator Wesley L. Jones, of Washington, and in the lower house by Representative Frank G. Reavis, of Nebraska, July 25, 1919.

The bill proposes far-reaching changes in the executive machinery of the federal government. The Federal Department of the Interior will become the Department of Public Works, if the legislation proposed is enacted. The main idea is to assemble all engineering activities of the Government in one department.

Such bureaus of the Interior Department as are non-engineering in character are to be placed under the jurisdiction of appropriate departments, while engineering bureaus from other departments are to be included in the Department of Public Works. The bill proposes that the Patent Office is to be removed from the Interior Department and placed under the Department of Commerce. The Bureau of Pensions is assigned to the Department of the Treasury. The Bureau of Education goes to the Labor Department. The Bureau of Indian Affairs is also assigned to the Department of Labor, with the proviso that the engineering and construction work and the land and mineral surveys now performed under the direction of the Bureau of Indian Affairs are to be prosecuted under the Department of Public Works. St. Elizabeth's Hospital and the Freedman's Hospital in Washington are assigned to the Treasury Department. Columbia Institution for the Deaf and the Howard University go to the Bureau of Education under the provisions of the bill.

On the other hand, the Department of Public Works is slated to absorb the Supervising Architect's Office of the Treasury Department; the Construction Division, River and Harbor Improvements, Mississippi River Commission and California Debris Commission of the War Department; the Bureau of Standards and the Coast and Geodetic Survey of the Department of Commerce; the Bureau of Public Roads and the Forest Service of the Department of Agriculture.

The Public Health Service is to remain, temporarily, under the Treasury Department, although some were of the opinion that it ought to go to the National Department of Public Works. The bill will probably not pass as written. There will be much discussion and probably some changes before it becomes a law.

The Secretary and Assistant Secretaries

The bill provides that the Secretary of Public Works "shall, by training and experience, be qualified to administer the affairs of the department and to evaluate the technical principles and operations involved in the work thereof." The measure excepts from the foregoing provision the Cabinet officer who is at the head of the Department at the time of the passage of the bill.

Four assistant secretaries, each to be paid $7,500 per annum, are provided and their duties outlined. One assistant secretary is to have administrative jurisdiction over all matters of engineering design and construction. Another is to have charge of architectural design and construction. The third is to have jurisdiction over all scientific work and surveys, while the fourth assistant secretary is to be in immediate charge of all land and legal matters. The assistant secretaries are charged with the duty of co-ordinating and bringing into efficient relationship all the activities of the department so that it may be harmoniously and efficiently administered.

An important feature of the bill is the proviso that the engineer officers of the U. S. Army detailed on non-military work are to be assigned by the Secretary of War to like duties under the new department for not over two years. This enables the Secretary of Public Works to make gradual transfer of improvements and instrumentalities to civil administration without detriment to public interest. Members of the Corps of Engineers may, under the direction of the Secretary of Public Works, be detailed by the Secretary of War to temporary duty in this new department for such instruction, training and experience as is desired.

Need for the Department

The case briefly stated is as follows: The United States Government is annually engaging in public works that may be classified under the heads of engineering, architecture and construction; in many instances the work of one office overlapping another, resulting in lack of efficiency and waste of public funds. This state of affairs is the natural outcome of the rapid development of the country, the growth of interests and offices that were ever expanding.

Has not the time arrived to group all of the engineering activities of the United States under one head—to turn over this work to the specialists,—to effect economies by preventing duplication of work and overlapping of projects? When the finances of the country are under discussion we turn to the experts in finance. When in need of legal advice we consult the lawyers. When we are ill we call in a physician. If satisfied that self interests are eliminated, we are willing in general, to follow the experts who have given mature study to a particular line. Engineers and architects are professional men, highly trained in particular lines. Most of them are college graduates in courses that are quite as difficult as those of any other profession. They deal with the eternal laws of the universe and the application of forces and materials to the betterment of society. It cannot be denied that they stand high as citizens, yet they are often too occupied with their own problems to consider those of their profession as a whole or of the community in which they live.

Public Duty of Engineers

Engineers are not easily organized. If they had pulled together a little over a third of a century ago when a previous attempt was made to group the engineering activities of the Government, they would not have met defeat at that time.

Engineers are accused of being unresponsive. It is said that they are aloof and indifferent when it comes to matters of a public nature. These charges, it must be admitted, have often been justified in the past. It is the duty of all engineers to disprove them for the future.

The participation of engineers in the World War has called attention to the importance of their work. It was largely an engineer's war. The profession of engineering has never occupied so dignified a position in the world as at the present time. Shall we admit that we are incapable of so organizing that our petitions will receive a respectful hearing at Washington?

Let us remember that our cause is not a selfish one. We seek to abolish the waste of effort and of funds incident to work costing millions of dollars annually, to replace conditions that are disordered and scattered with others that are orderly and efficient. This accomplishment will benefit all the people and will be another step in the path of progress that eventually will prove the falseness of the assertion that republics can neither be efficient nor economical. Incidentally, the profession of engineering will receive some long delayed but merited recognition.

This is a matter of good citizenship—of broad practical patriotism. We expect experts to take the initiative in their special fields. The people of this country expect the engineers to lead the way in engineering matters. Here is a question that involves the public good and therefore the interests of every individual living in this wide country. To turn back is impossible. We must win and every engineer must be a missionary in spreading the gospel of the National Department of Public Works until the public shall know the truth and with us demand the necessary legislation—for the good of all.

SOME FEATURES OF THE HIGHWAY PROBLEM

By E. R. Conant, Consulting Engineer, Brunswick, Georgia.

When we stop to consider that there are several hundred thousand miles of roadways in the United States, and when at this date there are 7,000,000 motor vehicles; and, further, when improvements of road and bridge construction are proposed aggregating hundreds of millions, if not billions, of dollars in cost, we begin to realize what a stupendous problem lies before us in getting a highway system in shape to accommodate modern methods of transportation.

Engineers are called upon to make a scientific study to determine what types of construction should be followed considering initial cost, durability, deterioration, and still further what construction should be carried out for motor vehicle traffic so as to keep down as low as possible the maintenance and operation cost of motor cars.

Financing Highway Construction

Another most important feature of the problem is that of the method of financing construction. During the past year or two there has sprung up almost over night a demand for good roads. County units and states have fallen over each other to get road bond issues out. Unfortunately, highway engineering, which is a science, has not advanced far enough, and in connection with this, federal and many state highway organizations are not equal to the occasion, and are not in a position to cope with the problem. It must be admitted, however, that administrative heads and engineers have not had time to work out and formulate plans and design proper types of highways to meet many cases, and it is to be expected that mistakes will occur, but fortunately the people are being educated to the necessity of proceeding with caution, and to see the necessity for adequate, administrative organizations, federal as well as state. Those observing the start in the problem of highway construction see features that need attention. The issuance of low-term bonds for construction of highways with a type that under no condition can be expected to last one-half the life of the term of the bond, is entirely wrong and should be corrected.

A Market for All Good Pavement Types

Regarding types of construction, it is very apparent that with the great mileage of roadways to be constructed there need be no fear on the part of those interested in promoting any standard type of pavement that there will not be a call for that type to the limit of the ability to furnish material for it, but no one type is applicable for all sections, and promoters of various pavements should study out locations where their particular type is applicable. It should be borne in mind that certain types applicable for trunk lines through states where heavy motor traffic is anticipated will not be applicable for general county road construction on account of the cost. Therefore, unnecessarily heavy sections should not be required where underlying soil conditions and prospective traffic permits of lighter construction.

Use of Local Materials

Again, many mistakes are being made in not adopting types of roadways involving the use of materials that can be used most economically in the locality where construction is under way. It is wrong to consider the use of material where rail transportation and hauling is out of proportion to the cost of the material. In calling for proposals, it is wrong to submit specifications that are not on equal bases, or if they are not on equal bases, the relative value of the types should be fixed and stated before bids are received, so that contractors may be in a position to give proper weight to their expectations of being considered if their bid price is not the lowest. It is folly to think of using standard specifications for various states, and even in the same state requirements may and will vary at different localities.

Design Features

Too much stress, in many instances, is being laid on details regarding surveys, and too little as regards the feature of straightening out old highways and in considering the elimination of grade crossings. It is very well to call for the lay-out of the highway with railroad curves with all functions of such curves required, but to be consistent, more weight should be laid on the study of the character of the underlying soil. It is possible to work out quantities of cut and fill so as to bring about their equalization, but attention should be given to the character of the material which is moved, for in some instances it would be better to waste material excavated and go to an additional cost of getting suitable material for the sub-surfacing of the roadway.

Many specifications are too exacting as regards the use of certain materials. To take, for example, sand: many sections of the country do not have sand deposits where the requirement of it for tensile strength meets that with the use of Ottawa sand. Where the specifications require 100 per cent. tensile strength of the sands as compared with Ottawa, good judgment and economy would often result if a little variation were allowed as regards the tensile strength of the sand, by making an adjustment with additional cement to the mixture. Too much stress is often laid on the requirements for a rigid base, where, under certain conditions a flexible base could be obtained at lesser cost, and when local material would result in economy and equally as good a type of construction.

There is no question but that time will bring about a greater improvement as regards the method of construction of our system of highways, and the sooner the people are educated to see the necessity for the formation of strong state organizations, and with the expected large appropriations for federal aid, should encourage through their representatives the passing of a bill creating a federal highway commission through which a national systme of highways can be worked out and proper organizations formed successfully to formulate and carry out the projects.

FOUNDATIONS FOR WARRENITE—BITULITHIC PAVEMENTS AND ROADS

By George C. Warren, President Warren Brothers Co., 142 Berkeley St., Boston, Mass.

At the outset let us consider three general propositions:

1. Practical experience is the best guide. "The Proof of the Pudding is in the Eating."

2. One remedy for every disorder is unscientific and not good practice and savors of the "quack" in medicine. Similarly, an engineer who holds that one type of construction of either foundation or wearing surface is the most efficient and economic for all, or most conditions, has a "one track" impractical mind.

3. The essential requirements of a pavement foundation are:

a. Resiliency.

b. Strength.

Between these two more or less compromise must be given, dependent upon the conditions of each particular road and here is where the broad evenly balanced mind of the engineer is essential.

As a third and only somewhat less important consideration the speaker includes:

c. As close union between the base and surface as is practical with due consideration to the other factors. It will be noted that we place strength of foundation second. This is not accidental. In fact the writer, after a large experience, believes that extreme strength of foundation,

WARRENITE-BITULITHIC PAVEMENT LAID OVER OLD MACADAM.

which necessarily includes rigidity, is actually detrimental under many if not most conditions of sub-soil and drainage.

Resiliency in Pavement Foundations

Resiliency, on the other hand, is an extremely important factor in consideration of the matter of wear and tear of the pavement or road surface. Where natural or proper economic artificial drainage is provided and the sub-soil is of a character which can be rolled to a reasonably solid condition, resiliency can be given first place in consideration of the foundation for stable, monolithic resilient pavement or road surface.

On the other hand, if a road or pavement sub-base is weak through poorly drained or weak sub-soil, strength of foundation with its attendant evil of rigidity becomes the most important and controlling factor for consideration. It is futile to say that because a certain type of foundation was a success or failure on road "A" that it will be the same success or failure on road "B," the conditions of which are very different.

The highest degree of tensile strength and its attendant rigidity necessarily carry with them the certainty of more or less cracking from contraction and heaving from expansion under climatic changes, because of the fact that there is no "give," short of a break. Serious cracks in a pavement foundation will cause corresponding cracks in the wearing surface. In the writer's home city of Boston he has seen granite block pavement laid on a rigid Portland cement concrete base, and rigid filler actually cracked through the granite block under sudden temperature changes. The strength and rigidity of both base and surface clearly caused the cracks. The cracking is immediately followed by serious wearing of the edges of the cracks under normal traffic.

If we want to break a surface with the blow of a hammer we would place it on a rigid, solid stone or anvil, knowing that if we should place the substance on a sheet of rubber (which is the acme of resiliency) the blow would have no effect whatever. So in a pavement surface. If other conditions including drainage, sub-soil and character of wearing surface make the use of a resilient base practicable, then the wear and tear on the wearing surface under the blows of traffic are vastly less than if laid on a rigid base.

Surfacing Old Macadam

With these general principles let us consider details.

Macadam roads, whether of crushed stone, gravel, slag or oyster shells, are resilient and still solid enough to hold weight of traffic as distinguished from the motion of traffic.

There are in existence today such macadam roads which have cost millions of dollars and which as a wearing surface would not sustain the traffic of modern motor vehicles, but which if not removed would provide an economic base either in whole or if worn too thin with proper surface addition of new metal. There are too many years and too varied practical experience behind us to permit controversy of this engineering proposition.

In the experience of the organization with which the writer is associated this has been successfully demonstrated by:

a. Fifteen years' successful results of use in more than one hundred municipalities and under all the widely varying climatic conditions of the United States and Canada.

b. Used to the extent of over eight million square yards.

And yet we find strong agencies working a powerful propaganda intent on preventing the economic conservation of these millions of past expenditures.

Reference to a few specific instances under widely varying traffic and climatic conditions should suffice as follows:

Highland Avenue, Birmingham, Alabama,	Laid in 1904
Dartmouth Street, Boston, Mass	Laid in 1903
Commonwealth Avenue, Boston, Mass.,	Laid in 1915
Sheridan Road, Chicago, Ill.,	Laid in 1906
Michigan Ave., Chicago, Ill.,	Laid in 1907
Columbia River Highway, Oregon,	Laid in 1915

VIEWS OF WARRENITE-BITULITHIC PAVEMENT LAID OVER OLD MACADAM.
Left: Sheridan Road, Chicago. Right: Michigan Boulevard, Chicago.

Incidentally, periodic traffic records on Michigan Avenue, Chicago, will be of interest:

Date of Record	Motor Driven Vehicles	Horse Drawn Vehicles	Totals
Aug. 16, 1907	1,884	1,024	2,908
July 26, 1912	10,462	126	10,598
Sept. 2, 1919	20,179	25	20,204

Note in the twelve years the total traffic increased seven times while in the same period the horse drawn traffic had reduced from over thirty per cent. to only one-eighth of one per cent. This shows how rapidly the horse is becoming nearly obsolete as a means of pleasure traffic. As to truck traffic we are rapidly approaching the same condition which means new problems and elimination of a considerable number of the old problems of road construction as to both foundation and wearing surface.

In order to avoid disturbance of the old macadam, as far as possible, it is important to "humor" the grade and as closely as practicable, follow the old established grade merely knocking off the humps, using the material to fill the depressions. On country roads particularly, regardless of the type of old construction or new foundation or wearing surface the best practice is to merely level off and build on the old grade. Under general country road conditions no harm results from raising the grade a few inches and, generally speaking, the economic advantages are very great both in drainage and first cost, as well as subsequent maintenance by slightly raising the road surface above the surrounding country.

In conclusion of the subject of surfacing old macadam, it should be borne in mind that the integrity of the old road-bed should be carefully proved by test holes or still better test trenches across the road at frequent intervals. If such test develops a depth of, say 6 ins. or more, of well compacted crushed stone, gravel, slag or oyster shells with the coarse aggregate predominating, it is safe to say that the foundation is adequate for such a stable, dense monolithic water-proof surface as we are discussing. If such tests show a deficiency of such old metal then there is still enough of any old material to make its conservation most economic for reinforcing by the surface addition of a more or less varying depth of new metal.

New Compressed Stone Base.

The principles embodying this construction differ only slightly from those which pertain in the case of old macadam base.

VIEWS OF WARRENITE-BITULITHIC PAVEMENT LAID ON OLD MACADAM FOUNDATION.
Left: Dartmouth Street, Boston, Mass. Right: Commonwealth Avenue, Boston, Mass.

First attention should be given to drainage, and second to compression of the sub-grade. With a well drained, well compacted sub-grade there need be no question of the sufficiency of a well laid compressed stone base, under most traffic and climatic conditions.

It is desirable that the lower portion of the base shall be of as large stone as the local conditions permit. If crushed stone is used it is desirable that the largest particles will be as large as 3 to 4 ins. in diameter. If economically available it is desirable to lay a lower course of quarry or field stone, preferably slabs, about 4 ins. thick, laid on the flat side. Often in country road construction through stony or mountainous country such as prevail in New England and the mountainous regions of the far West and many other sections, such slabs or other large pieces of stone are not only the best but the least expensive material for the bottom of the base. The large stone should, of course, be supplemented by the laying of a sufficient quantity of new smaller stone to provide the desired depth and contour and the whole compressed by heavy roller until a sound base which will not creep or compress under further rolling is provided.

Under the extremely heavy traffic of war conditions in France and Belgium, it was found that rather flat stone as a lower course and a total depth of 8 to 9 ins. of metal would sustain the weight of the immense motor truck and artillery traffic, but without an additional substantial wearing surface it would not long sustain the motion of traffic.

This construction of new compressed stone base and Warrenite-Bitulithic surface has been practically and sucessfully used to the extent of over 12,000,000 sq. yds. during the past 18 years, and over 3,000,000 sq. yds. are under construction and contract during the present year.

Some notable examples are:

1. The entire State of Oregon, including a large mileage now under contract with the State Highway Department and in nearly every city and county of the state, beginning with the City of Portland in the year 1903, since which date over 2,000,000 sq. yds. have been laid in the City of Portland alone. Of all this vast area of Warrenite-Bitulithic in the State of Oregon laid during the past 18 years, all is on what this paper discusses as "resilient" bases, to-wit:—either Old Macadam, New Compressed Stone or Dense Bituminous Concrete.

2. In Salt Lake City and elsewhere in the State of Utah, over 200,000 sq. yds. have been in practical, successful use in the city alone during the past 10 years, and over 30 miles of country road in the several counties during the past 3 years. In Utah, portions of compressed base are crushed stone and other portions are iron furnace slag. The celebrated Orange Grove Avenue, Pasadena, California, is laid on compressed stone base, has had no repairs and the contour is in perfect condition after nine years' use.

3. Within the past two weeks following about 7 years' practical, successful experience the City of Twin Falls, Idaho, has contracted for over 300,000 sq. yds. of Warrenite-Bitulithic laid on new compressed stone base.

Dense Bituminous Concrete Base

In connection with Warrenite-Bitulithic surfaces dense bituminous concrete base has been adopted during the past seven years to the extent of over 3,000,000 sq. yds. in over 50 municipalities and we can say without equivocation that, there is no type of foundation which as a whole has resulted in so nearly absolutely and uniformly successful results.

It will be noted that the Warrenite-Bitulithic surfaces unite to a high degree with old macadam and new compressed stone bases, because the surface becomes compressed into the spaces between the upper portion of the base stones. In the case of dense bituminous concrete base the unity of the surface to the base is absolute, because both courses being of the same character under the heat of the surface mixture and the pressure of the roller becomes absolutely united so there is no line of cleavage and possible displacement.

The total depth of dense bituminous concrete base and Warrenite-Bithulithic surface ranges from 4 to 5 ins. The mineral aggregate of both courses may be either crushed stone or gravel. In the far West where bituminous materials are comparatively cheap and where clean, sound gravel is economically available, this construction has been generally laid at lower cost than is possible with an adequate depth of a rigid Portland cement concrete base. In the East under past low prices of the cement, Portland cement concrete base has had the advantage in the first cost and consequently very little bituminous concrete base has been laid in the East. Under present uniformly high cost of Portland cement, however, in many if not most places the dense bituminous concrete base construction is now generally as low if not lower than the Portland cement concrete base.

Portland, Oregon, has 500,000 sq. yds. and Pendleton, Oregon, having high altitude, and rigorous climatic conditions 150,000 sq. yds. of this surface construction, Warrenite-Bitulithic on dense bituminous concrete base where they have the practical test of seven years' successful use. California, Arizona, Idaho, Utah, Montana, Washington, Wyoming and British Columbia have large areas.

Following this successful use in all the far West states and provinces, the United States Army Department supplemented by the U. S. Bureau of Public Roads, adopted dense bituminous concrete base for the Warrenite-Bitulithic pavement on all of the principal roads of Camp Lewis, (near Tacoma) Washington, to the extent of approximately 150,000 sq. yds. We can say without fear of contradiction that no cantonment roads of any type whatever have proved as uniformly successful under the rigorous army cantonment traffic as the roads referred to in Camp Lewis, where local bank gravel was used as the mineral aggregate of both wearing surface and base.

The foregoing paper by Mr. Warren was presented at the 25th annual convention of the American Society for Municipal Improvements held at New Orleans, November 11-15, 1919.

THE AMERICAN HIGHWAY PROBLEM

Presidential Address of A. R. Hirst at Annual Convention of American Association of State Highway Officials at Louisville, Ky., Dec. 8, 1919.

The American people, almost as one man, are demanding, and that instantly, a modern and comprehensive system of highways and are willing to pay the price. They have at last realized that the price of building highways which will serve the needs of the present and of the logically to be expected traffic is far less than the price they must pay if the present embargo of mud continues. Never, I believe, since the days of early railroad development have the American people been so determined to change instantly their means of transport and not even then were they so willing to pay the cost, provided they could get the results.

People Demand Results

What are the results they are now demanding and what are some of the problems that grow from these demands?

They are expecting the states which had no highway organizations three or even two years ago, which had done no preliminary work and in some of which hardly a mile of modern rural highway had ever been built, to create an organization full sprung from the earth, and to build instantly hundreds of miles of modern roads costing millions upon millions of dollars. In the older states in the highway game, better prepared with organizations and contractors, and with some knowledge of material and construction conditions, they are asking us to double, triple or quadruple our annual output of roads. It is probably fair to estimate that the expenditure for modern highways in rural America in 1919 was about $200,000,-000 and that the sum desired to be expended for them in 1920 exceeds $600,000,000. In other words, the people of America desire approximately to triple their highway expenditures and to do it in one year.

Highway Program Dwarfs the Railroad Record

We are wont to think of the era of railroad building in America as presenting the greatest of engineering problems and that its solution was an astounding exhibition of the capacity of American engineering genius. However, the problem confronting American highway engineeds today far exceeds the old one in magnitude. In the record five years of railroad development (1879 to 1883, inclusive) there were built 40,000 miles of railroad costing, as nearly as I can ascertain, about $20,000 a mile, on the average, or $800,000,000 in all. In the five years from 1920 to 1925, inclusive, the American highway engineer will be expected to build probably 100,000 miles of highway costing not less than $3,000,000,000. Even allowing for the depreciated dollar, the yardage of earth to be moved, the amount of materials to be furnished and transported, and the labor required is probably at least double that required in the former enterprise.

Some of Our Problems

It may be of interest to list some of the tremendous problems facing the executives of state highway departments in this work of speeding up the national highway program to meet the American demand.

Trained Engineering Help

1. The Problem of Trained Engineering Help to make the Surveys and Plans, the Preliminary Investigations and to Perform the Inspection.

This is a problem largely for American educators but with the present shortage and the very restricted output of young engineers, due to the war, it is an acute one demanding immediate attention. I might add that, in my opinion a four-year course is longer than is necessary for the preparation of much of the help that is needed, and a solution should be sought along the lines of the winter short courses of our agricultural colleges. We must have hundreds, yes thousands, of trained men at the earliest possible date and four or five years hence will not do.

Materials of Construction

2. The Problem of Materials of Construction.

Nothing is more certain than that there will be an acute shortage of materials in 1920 and thereafter, unless there is substituted in place of the present hit and miss methods an intensive study of all available road materials in every state and unless the most strenuous methods are used to develop every available source of supply. The expensive production and delivery of road materials during the winter season is going to be necessary, especially in the northern states with short construction seasons. Every state must establish a road materials department, the sole function of which will be to locate, test, develop and arrange for the proper delivery of all available materials. Already there are rumors of combinations of material men to purchase and control all sources of highway materials. It is up to the states to protect their people by getting sufficient material sources in state and county hands before it is too late.

Cement

3. The Problem of Cement.

It seems obvious that much, if not all of the so-called permanent surfacing will be either cement concrete or other surfacings on a cement concrete base, and that practically all drainage structures will be built of concrete. Unless there can be had the most absolute and fair federal control of the price of cement the bidding between municipalities and states and between contractors for cement is apt to drive the price up to the point of impossibility. In lack of federal control, the erection or purchase by the states of cement mills or state control of the output of certain mills would seem to be only a rudimentary conception of the duty of protecting the public against unduly inflated prices. The present unfair arrangement between manufacturers and dealers whereby dealers who never see or handle the cement must be paid hundreds of dollars for every mile of road built of concrete or with a concrete base must also be controlled effectively. States which buy millions of barrels of cement annually and pay always (no bad accounts) must get at least the dealer's price.

Car Service.

4. The Problem of Car Service.

Car service has been execrable on practically every railroad. We have been handicapped day after day and month after month by the criminal neglect of the present railroad officials to recognize the fact that highway building is a great American industry. If construction is to be carried on with materials delivered by rail, better car service, and in the northern states, a longer season for shipments is necessary. Possibly the time will soon return when freight revenues will mean something to American railroads and when it will not be an insult to a railroad man to offer his company freight business. I sincerely hope so. Until then we ought not depend on materials involving a railroad haul except where no other source of supply is humanly possible. If the railroads are allowed to come out of their present state of coma and will give us the proper type of cars, enough of them, and reasonable service at fair prices in the installation of unloading sidings conveniently near the work, their revenues can be very materially increased, our costs decreased, an l our work speeded up.

Even in this railroad problem we must interest ourselves because we can never build our roads unless this American "sleeping beauty," our railroad system, is given an injection of dynamite and made to live again.

Efficient Construction Organizations

5. The Problem of Efficient Construction Organizations and Fair Prices.

The contracting problem we always have with us. We need every competent highway builder available and we need immediately to multiply his number two to five times in the various states. We must encourage those good contractors who are now available and develop many new ones. To do this good prices will have to be paid and fair treatment given. On the other hand, we must not hand over our clients' pocketbooks to the contractors with the injunction "take what you think is right, but please return us the cover." Unless some restraint is exercised, with the amount of work there is to be done and with the universal feeling existing that "my road must be built no matter what it costs" prices will be driven up and up without regard to proper cost, values or profits.

In this connection it is my belief that each state should immediately develop a moderately large construction organization fully equipped to do a portion of all classes of its work. Then in case prices on certain work are extortionate, the work may be done by force account. This plan has the advantage of developing and training the nucleus of a larger day labor organization if one should later prove necessary. It also gives at all times a true index of the cost of various kinds of work on the basis of actual and recent state experience. We cannot know the actual cost of work unless we are actually in the construction game.

Every state has availed itself, I believe, of the offer of war equipment from the federal government. Large supplies of many things useful in highway work, especially motor trucks, have been or will be received. The organization of a proper department to receive, fit for use, and handle this equipment is no mean problem. The states should carefully consider whether this equipment should not be made the basis of building up a permanent thoroughly well equipped day labor organization as a means of protecting itself now and in the years to come.

I also believe it necessary for adjoining states to co-operate with a view of keeping prices for work fair and uniform under the same conditions. If adjoining states are going to bid against each other the cost of work in all of them will be sent up to the prohibitive point without any ultimate advantage to any state. It should be possible for the states to get together on this matter. Costs are quite figurable for each job and with a uniform system of allowances for the use of machinery, profits and contingencies it should be possible to put work in all states on an approximately equal basis of attractiveness. These allowances must be generous, because we must attract the best contractors, but they need not, and should not, be wasteful. This problem is the most acute of all our problems and should be given immediate and serious attention by every state. I can think of no way in which more millions can be unnecessarily spent in the next few years than by allowing unbridled and useless competition for contractors and materials to prevail between municipalities.

Labor

6. The Problem of Labor.

We speak blithely of millions of dollars for the construction of thousands of miles of road. This program means men, far more men than have ever been employed in this work before. But men are scarce and other productive labor must not be raided. Our farms, our mines, our factories, and our mills must be allowed to produce largely and at a reasonable cost. We should not pay our labor, or allow such prices to contractors as will enable them to pay their labor, a sum per day greatly in excess of the going wage for like work in that vicinity. Whether we pay high prices for labor or whether the contractor does, it is our responsibility, because the prices we pay for work determines the prices which can be paid for labor. In other words, we must not bull the labor market to the disadvantage of other production. This is public work, its continuance depends upon the support of the whole public, and we must be careful not to alienate this support by forcing our work at undue prices, thus upsetting local labor situations. This policy is not only right from the standpoint of expediency, but is also economically sound.

Improved Location and Alignment

7. The Problem of Improved Location and Alignment. We have, in the past been too prone to build along the old established lines of highways. This has been the easy course and it has been taken. But the new traffic conditions are so different and so intense that in considering the construction of a main trunk highway all of the old governing considerations, such as saving the buying of new lands for right of way, utilizing old cuts and fills, saving an existing bridge or a few good culverts no longer bind us to the old locations. We must connect the centers of population because they are the points from which things and persons come and to which they wish to go. In building a modern highway between these fixed points we can feel free to exercise our untrammelled judgment and build where the road will ultimately cost the public the least. Shortness of distance, freedom from dangerous curves and from railroad grade crossings, and reasonable grades are now the principal ends to be sought and practically nothing else counts.

Cost of construction has become secondary. If the very conservative sum of 10c per mile is allowed for each mile of travel saved, the saving of a mile in distance on highways carrying the following average number of vehicles per day will save the traveling public the given amount per year, which is the interest at 5 per cent. on the amount given in the third column.

VALUE OF A MILE IN HIGHWAY DISTANCE SAVED

Average Number of Vehicles per day	Saving to Owners Per Year	Saving Capitalized at 5% Equals
100	$3,650	$73,000
250	9,125	182,500
500	18,250	365,000
750	27,375	547,500
1,000	36,500	730,000
2,000	73,000	1,460,000
5,000	182,500	3,650,000
10,000	365,000	7,300,000

I believe that these figures are unassailable and that they demonstrate that when building our main highways for all the years to come, saving in distance in the layouts is the supreme consideration and should be given much more attention.

Other Important Problems

Many other important problems could be named and briefly commented on but this paper will be too long if continued along these lines. I cannot, however, resist naming without comment some of the other things with which an efficient state highway department must also concern itself.

8. A Proper System of Records of the Cost of All Construction and of Acounting for all Funds Available.

9. Proper Publicity of Plans and Results, Not Only in the Local Press, but in the National Press.

10. Proper Care of Traffic During Reconstruction.

11. Proper Touring Maps for the information of the People of the State and of Other States.

12. Proper Marking of the Main Traveled Roads, Keyed to the State Maps.

13. Proper Accommodations for the Traveling Public in the Way of Garages, Hotels, Public Parking Places and Comfort Stations.

14. Complete Knowledge and Study of, and, if Necessary, the Design of Labor and Time Saving Devices and Equipment.

15. A Study of Plant Layouts and Equipment for Various Types of Construction Under Varying Conditions.

16. A Study of the Grade Crossing Situation and a Strong Campaign for Improved Conditions.

17. The Holding of Road Schools and Short Courses for the Instruction and Inspiration of all Classes Engaged in Supervising and Constructing Highways.

18. Helping to Formulate and Pass Adequate Highway Legislation so that the State May Keep Pace with other States.

The Coming Battle

It may readily be seen from this hasty survey of some of the attendant problems that these changed highway conditions and this spirit of getting hitherto unheard of results have, instead of making our task easier, but served tremendously to increase our problems and responsibilities. We are on the threshold of a new epoch in highway construction in America, but instead of congratulating ourselves today that the long fight for highways is won, we should rather gird our loins for the impending battle. Added responsibilities bring added fears to the executive who thinks and spur him on to new efforts and new devices for developing himself and his organization to meet the new conditions.

The coming battle is all the more serious because from time immemorial the American people, while always willing to pay the price for the work they desire, have never been willing to pay the price of the proper supervision of it. "Millions for public works, but a pittance for those who must design and supervise the building of them" seems to be the American spirit. Our national and state legislative halls are filled with men who appropriate millions and tens of millions with very little thought of the organizations necessary to expend them properly, and with much less desire to provide proper supervision than to further the prestige of themselves or of their political party.

Federal Policy

As a case in point. It was with the greatest difficulty that the present Congress could be induced to fix the salary of the very competent present head of the Federal Bureau of Roads $6,000 a year, although this bureau will in the years 1919 to 1922, inclusive, supervise from the federal standpoint and protect the federal interest in the expenditure of probably two hundred millions of federal money and with it the expenditure of three hundred millions more from the states and local units. When a Federal Highway Commission is proposed to be created to expend billions in the layout, construction and maintenance of the proposed Federal Highway System, the salaries of the commissioners and of the chief engineers are fixed, under protest, at $10,000 each per year, and we are told that Congress will never stand for these salaries and that they will probably be cut to much less before the bill becomes a law, if it should become a law. The National Congress is probably the most niggardly employer in America, unless some of the states bear off the unenviable palm. It seems hopeless to expect a continuously efficient organization in any federal bureau unless Congress shall see a new light and fix public salaries to fit the imposed responsiblities.

It is interesting, although disconcerting, to note the almost total lack of interest on the part of road promoting organizations in the fundamental problem of getting proper administrative bodies to control the highway programs. We have good roads associations, trail associations, highway councils, etc., ad infinitum, all seeking to promote the construction of roads in detail or in mass, and urging the nation, the states and the counties to spend millions or billions on highways of all kinds, classes, sorts and conditions.

The sole idea seems to be to get money and more money to build highways. It does not appear to matter to them what kind of highways, who builds them, or whether the people get a dollar's worth or a dime's worth for a dollar. Men are in these associations who make millions every year, who control organizations which are solely designed to get efficient dollar for dollar results, and who pay their executives what they are worth. Yet when they get into the field of public service they seemingly forget all the rules which made their own business a success, and expect a thousand dollar man to be the eighth wonder of the world, and world-beating organizations to grow overnight with no possible financial encouragement. Unless business men of this class wake up and devote more thought to the basic problem of getting efficient organizations to spend the money, I fear a real disaster to our highway programs.

Politics and Salaries

All of us have probably in the past derided the possibility of getting effective results out of town and county highway efforts because (we said) politics had too great a part in road work in those units and that they would never pay the salaries necessary to get competent planning and supervision of the work. And yet in 34 of the 48 states which now have state highway departments, the Governor may change the personnel of the state highway department so as to control it during his term of office. In many of these states the highway law is deliberately so framed that a new Governor may make a clean sweep of the state highway department the minute he assumes office, if he so desires. In most cases he seems to have desired it. There have been at least 127 different executive highway officials in these 34 politically organized state highway departments in the grand total of 296 years of their existence, or a change every 2 1/3 years (on the average) in each state. The oldest executive officer in charge of highway work in any American state has served his state nine years in that capacity.

A state highway department is not right or it is not wrong just because it has a Republican or a Democrat at its head, or because one brand of Republican or Democrat is in control when another brand of the same political party comes into power. A state highway department is right when it is well organized to get efficient and economical results and is wrong when it is organized or unorganized to produce inefficient and uneconomical results.

Let us consider the salaries paid the executive officers of the state highway department. There is one who is paid $20,000 per annum; two $10,000; one, $8,000; two, $7,000; two, $6,000, and eight, $5,000; while 32 of them are paid less than $5,000, and 20 of them receive $3,600 or less. In this connection it should be remembered that the highway work expected to be supervised by a state highway department is now in few cases less than three million dollars a year and in many states it has reached, or will soon reach, as much as fifteen, twenty or twenty-five millions. What business organization in the world would pay on a similar scale for similar responsibilities or would expect to receive adequate results under such conditions?

I speak of these matters not in a spirit of fault finding, but in order to interest you in the great problem of building up public opinion to the point where, for its own protection, it will insist upon the proper organization of every agency which deals with the expenditure of these great aggregations of highway funds.

Clean Cut Efficiency

We must, by every means in our power, by precept and example, preach the doctrine of clean cut business efficiency in American highway administration. In doing so we will go up against the age-long prejudice of the American people against paying their public servants a living or a proper wage. From top to bottom the scale of public salaries is wrong. The constitutional and other officers of the nation, of the states, of the counties, and of all other municipalities are, practically without exception, being paid, not on a basis of what their services are or should be worth, but on a basis fixed (in most cases long years ago) with due regard to the "honor" which must accrue to the holder of a public office. The universal custom was, is, and possibly always will be, to figure that the prospective holder of the job will be a politician with other interests or means and that the salary won't matter, or that joy at getting the "plum" of public office will dwarf all material considerations.

There is or should be an honor in being selected for public service—and worthy public servants appreciate and feel that honor. It may be, although I doubt it, worth while for the American people consistently to penalize those who work for them by paying them less than a living wage or less than the work would command if done for a corporation, or if done for the individual citizen in his private capacity. But the trouble with the system is that when the American people have before them a piece of really constructive work, like their present highway program, the policy falls down absolutely.

We must help the American people by making them realize that with hundreds of millions, even billions, to be expended in the next few years the building of highways is a profession and a business and not a political football to be kicked around like the proverbial pup. This is not selfishness. Most of us are in this highway business because we love the work and because we want to help build up the states and the nation. I doubt if there is one man here who has made good or who is capable of making good who cannot leave his present state position and make more money working for himself or in employment in commercial lines. But the work must go on and it must go on well and we must feel an interest above a mere financial interest in the jobs we hold, if we are worthy of them.

Money is not all—the satisfaction of creating, of building; of creating and building well; of helping to build a county, a state, or a nation, is worth more than a few hundred or a few thousand dollars a year if one can manage to live. We can't afford to pinch pennies and bandy words just for ourselves, but in the interest of the compentent and "up and coming" highway organization which must be created in every state to protect the interests of the people of the state, we can afford to fight for the right.

Unless there occurs a radical change in the American spirit of expecting much from their public servants and giving little, not one of us here will ever get rich or even attain a competence in the public service. We will, on the contrary, fight on and on until disgruntled politicians finally get us, or a younger and better qualified man supplants us. With the best of our youth, our enthusiasm and our strength gone, we will retire full of wounds, without money and without honors to make a new start in middle age. Such is the almost inevitable fate of the servants of the American people. But we can retire with honor unsullied and with our flags still flying. Later those who now fight the good fight for right standards and thus help make the path of their successors easy, may be recognized as public benefactors. When these pioneers are dead and buried, as is the custom here, they will be acclaimed as, after all, worth while and possibly even monuments will be erected to some of them.

I trust that nothing I have said in regard to state highway organizations will be wrongly construed. The present organizations, with very few exceptions, are and have been, doing effective work with limited opportunities. Where there is trouble it is in most cases due principally to the damnable political obsession of our American Commonwealths. In too many states it is not even debated that the old political motto, "to the victor belongs the spoils," is the law and the gospel, and the idea that the victory of any political party or of a faction of any political party should not carry with it the transfer of all offices with the Governor's control is not even considered, but a total overturn is taken as a matter of course. County and state officials without number have been thrown out of office for no other reason than that "they have held the job long enough, someone else should be given a chance." If a bank or a railroad, or any other corporation adopted the idea that political belief was the hall mark of efficiency or that long continued service was a valid reason for discharging their personnel, public confidence would be lost, their stocks would be a drug on the market and the corporation itself would become bankrupt.

In fairness to my home state, Wisconsin, it should be stated that we have a non-political highway commission, the operations of which have been entirely free from political interference by the Governor or anyone else. I state this because there may be some idea that my remarks originate from dissatisfaction with conditions in my own state, which is not the case. Conditions, laws and public sentiment there are good and improving fast. I have, however, long been a student of American highway administration, have followed changing state laws and personnels, and have attended practically all national highway meetings for years. As a result of these observations I believe I can safely say that the great American highway problem will never be solved rightly until we get our state and county organizations safely established on the sole basis of well paid efficiency.

The American public must be convinced that if they will play politics with their public officials they should confine themselves to routine offices where almost anybody can get by because someone else does the work anyway. They must be convinced, on the other hand, that the highway departments of the states and of the counties come into a different class and that here merit and knowledge should be the sole criterion in selecting and keeping their officials, and that here at least, length of training and service is of tremendous value and a necessity if efficient and economical results are to be secured.

The professions of highway engineering and of highway building must be dignified so that they attract the best engineers and the best construction men in America. This is important, not only for the immediate future, but especially so for the years to come. Not only must we strive to attract and keep the best we have, but we must get the coming men. We need all the brains and all the talent we can muster. To attract the best young men, good working conditions, a clean atmosphere in public service, adequate compensation and a reasonable chance of advancement must be offered. Less than this will not serve.

Therefore, let us dedicate ourselves to this work of helping to make all highway organizations efficient instruments, able and competent to carry out the American purpose of building a highway system befitting the greatness of the American nation. Than this, we can do the American people no greater service.

SUGGESTED ECONOMIES IN BRICK STREET AND ROAD CONSTRUCTION

By Will P. Blair, Vice-President National Paving Brick Manufacturers' Association, Cleveland, Ohio

The economies of highway improvement embrace distinctive divisions of sufficient importance to be treated separately. There is that economy which bears a relation to the use of the road; there is that economy which pertains to the adaptation of the kind of road to the uses of traffic it is expected to bear. But fundamental to all road economies is that economy which is possible in the construction of every kind of road. What is necessary to include and what should be excluded is of paramount interest at this time.

Standard Paving Brick

In the construction of brick roads, we have not yet developed the use of tools and appliances to that extent which we should, which will lessen the actual labor necessary in brick street construction. However, this factor of construction economy is receiving attention and much progress has been made recently. The manufacturers of vitrified brick have had the courage to adopt a standard size paving brick, the dimensions of which are 3x4x8½ ins. This is a distinct step in economy, both in the matter of increased production and convenience in use.

Sub-Soil Conditions

It is true that we have made progress out of the visualization which we are able to exercise through the long experience in the use of a great variety of types of brick pavement construction. We can almost unerringly draw out of this experience and observation many points of economy even in the absence of knowledge of underneath soil conditions and the resulting behavior of the same, physical and climatic. Being obliged to accept these conditions, we can provide against some known behaviors. We do know that soils saturated with water under the influence of low temperature, create an expansion almost irresistible in the force of its strength. This force irregularly exerted from underneath breaks and cracks the superstructure, if brittle in character, almost regardless of the strength of the superstructure.

We know that in the absence of such saturization pavements are not subject to such destructive force. Thus we see some brick pavements injured by this cracking process. We do not find the individual units of the brick pavement injured to any extent. On the other hand, there are hundreds of miles of brick pavements resting upon soils so thoroughly, naturally or artificially, drained that no apparent injury is exerted. The brick in such pavements held in alignment, do not show any perceptible wear. The life, therefore, of such pavements is unknown. They would last indefinitely.

Broken Stone Base and Bituminous Filler

Extremely moist soils often, when not frozen, furnish such unstable support that shock-effect in the nature of crystallization finally exerts injury. Out of a study of these influences has grown a belief that a rolled broken stone base will so perform a drainage function as to stabilize soil support and at the same time afford sufficient voids that frozen moisture content will cause but little expansive force, so that a broken stone base is a great assurance against injury from frost action.

An added assurance against injury is the employment of a bituminous filler which possesses qualities of adhesion and cohesion sufficient to hold the brick in place and yet afford a yielding quality which results in an adjustment and re-adjustment following any expansive force.

Therefore, a combination of the two, a rolled broken stone base with a Bituminous filler, unites against injurious effects in a most wonderful way. These qualities, thoroughly understood, combine an element of economy so great that it may be regarded as real progress in economy of brick road construction.

But the purpose of this paper is to call particular attention to some things which we have hitherto failed to do in the construction of brick streets and roads and other things which we have allowed to be done or carelessly submitted to, which really amount to encouragement or actual approval and against which we have been unwilling to protest.

Curbs on Country Roads

Curbs are required along the sides of the edges of city streets as a part of the gutter provision for the flow of water and as a wall to support the lawn or sidewalks at grade elevation. They form a part of the finish which contributes to the tasty appearance of the street. But how often do we come in contact with that influence which has grown out of conditions of years gone by, when great gutters were dug along the streets upon the theory that the surface of the street itself could be more readily drained thereby. Hence we have deep expensive curbing and unnecessary high crowns to streets for which there is no earthly reason. The crown of the street and the height of the curb should never be more than necessary for the proper surface drainage.

In highway improvement along routes not paralleled by sidewalks experience has shown that where monolithic or semi-monolithic construction is used by laying the brick in green mortar or mixture of sand and cement and filling the joints with a cement filler, curbs are not needed.

Experience has also demonstrated that curbs are not needed where asphalt fillers are used. The practice of making the curb an integral part of the foundation is more harmful than beneficial. A trough is formed which holds the water, permitting it to subside into every chance crevice and opening in or underneath the pavement instead of the needful provision for an unimpeded flow from off and away from the pavement.

Experience has further shown that a curb independent of the base and set up against the pavement performs its supposed function with but little effect. The frost raises the curb out of place or, with a moistened condition outside the curb, it is easily pushed away, leaving the base without any embankment support whatever.

A gravel, broken stone or slag embankment or shoulder which would be subject to compaction by the occasional over-lapping of vehicular wheels has proven a far better protection. A still better protection is a berm penetrated with a bituminous material which will allow readjustment of a possible displacement.

The curb for brick paved country roads is therefore largely a useless and costly appendage, incurring an expenditure of from three to five thousand dollars per mile that represents a waste pure and simple.

It has never been contended by any one that a curb built flush with the pavement was to bear any part of the traffic. In fact it never does. Then why not put the expense of the curb into additional width of wearing surface—to satisfy the growing demand for a wider roadway?

There are conditions upon hillsides and through heavy cuts where a curb becomes a necessity either for water disposal or for protection against water. But such are but mere exceptions to an almost universal rule.

In the matter of specifications for road improvement our largest efforts have been in the direction of perfecting, by description and nomenclature, the materials out of which the artificial superstructure of pavements is to be made. We have diligently searched and provided for, as to what constitutes and how quality may be ascertained, both with reference to the units of material as well as by specific and understandable directions, as to how these materials may be brought together in placement to the best advantage.

Lack of Knowledge of Soils

The economic value of all of this, however, is dependent entirely on the agencies which injure and destroy this artificial superstructure and the units of composition. These agencies are recognized as arising from two sources. That of traffic on the one hand and on the other the behavior from natural causes of the underneath soil condition. The destruction from traffic because of its visibility, has drawn from us our greater attention and study. But soil conditions, which exert a far greater influence on the durability of pavements than traffic itself, we do not understand. At the moment no engineer is able by any description, by any nomenclature, or by any classification of various characters of soils, to correlate them to such scientific treatment as will render injury on account of possible conditions, proof against injury to the pavement itself. We are so uncertain of our ability to characterize soil quality in relation to its ability to resist or influence moisture content by capillary attraction, that we merely visualize and we do sometimes say, drain here and drain there, as a kind of excuse or camouflage of our own ignorance, and in practice we install a pavement of exactly the same design, 5, 10, 15 or 20 miles in length, regardless of the condition upon which we place this track for traffic.

We are unable to direct how the sandy clay muck sections of our road or street sections shall be dealt with. Who knows in truth and in fact, just what you and I mean by the unintelligible terms of clay plastic or muck soils? Why not be satisfied by saying stiff asphalt, shale brick or rock cement? If we do not say so in so many words we act as far as we do act, under the undefinable and uncertain term of "sufficient drainage." The absurd and unscientific way in which we have dealt with the underneath soil conditions in highway improvement, or our failure to deal at all with it, should bring us to realize that as highway engineers we have yet some work to do. To place reliance of sufficient support of traffic upon certain artificial slab strength of costly structure, without knowledge of what is already in existence, and regardless of its worth for that purpose or without knowing with what small relative expenditure certain treatment may render its condition inadequate is but an acknowledgment of inability to economize and prevent great waste. Where, how and to what extent our drains shall be placed in each kind of soil to maintain in greatest stability we do not know, and if we should know, we have no means of intelligent nomenclature to convey that to others to interpret our meaning.

When we can classify or rate soils by some simple and inexpensive means of ascertaining its ability or limitation of capillary properties, and name the classification, and then correlate that soil to necessary treatment to maintain its stabilization and also to say what that treatment should be, we can then say whether our drains shall be 8 ft. apart or 20 ft. apart. Whether they shall be 3 or 8 ins. in diameter, whether they shall be 3 ft. or 4 ft. under the ground.

The writer realizes the magnitude of the task required to gain the information necessary to put into practical effect a workable specification which shall effect a cure for the conditions complained of.

However, the research work is under way, to be pursued with persistence until met with success or failure. It can not well be an exclusive effort. Suggestions will certainly be welcomed.

Acknowledgment

The foregoing paper by Mr. Blair was presented at the annual convention of the American Society for Municipal Improvements.

DOES IT PAY TO DETERMINE VOID PERCENTAGES IN COARSE AGGREGATE FOR CONCRETE PAVEMENT?

By William G. Crandall, C. E., Assistant Engineer, New York State Highway Department, 282 Central Ave., Cohoes, N. Y.

In the New York State Highway Department, it has been and is the custom in preliminary estimating of concrete pavement for a mix of 1:1½:3 to figure 1.9 bbls. cement, 0.84 cu. yd. stone, and 0.42 cu. yd. sand as the factors to use in obtaining the cubic yard price of concrete. Inasmuch as the percentage of voids in the aggregates determines the value of the factors, and a variation in the factors means a difference in the cubic yard cost of concrete, it would seem that a field investigation of the voids in the aggregates would warrant itself, to determine whether or not a contractor would increase or decrease his bids on the engineer's estimate of the concrete pavement by varying the factors, all other items in the analysis being considered equal for the purpose of comparison. Before working out a comparative analysis to show in dollars and cents what this difference means, it is necessary to explain the accompanying tables and curves.

Tables and Curves

The tables show the quantities in 1 cu. yd. of concrete based on 3.8 cu. ft. cement per barrel for proportions of 1:2:4 and 1:1½:3, the two mixes used by the New York State Highway Department in concrete pavement construction.

The purpose of these tables is to show at a glance what proportions of coarse and fine aggregate to use for either of the above mixes, based on the void percentages in the coarse aggregates. In the tables, the sand voids range from 25% to 45% and the stone voids from 30% to 50% by increments of 5% and the accompanying curves are used to obtain interpolated values of factors when the voids in either of the coarse aggregates vary from a multiple of 5%. The tables and curves show also the cubic yard and percentage excess of cement in sand and mortar in concrete.

TABLE I—QUANTITIES IN ONE CUBIC YARD OF (1:2:4 Mix) CONCRETE BASED ON 3.8 CU. FT. CEMENT PER BBL.

Voids		Cement		Sand	Stone	Surplus Cement in sand		Surplus Mortar in stone	
Sand	Stone	Bbls.	C. Y.	C. Y.	C. Y.	C. Y.	% comp. to sand	C. Y.	% comp. to stone
25	30	1.34	.189	.377	.755	.095	25.2	.245	32.5
30	30	1.36	.192	.385	.768	.077	20.0	.231	30.0
35	30	1.39	.196	.392	.784	.059	15.1	.216	27.6
40	30	1.42	.200	.400	.800	.040	10.0	.200	25.0
45	30	1.45	.204	.408	.816	.020	04.9	.184	22.5
25	35	1.39	.196	.392	.784	.098	25.0	.216	27.6
30	35	1.42	.200	.400	.800	.080	20.0	.200	25.0
35	35	1.45	.204	.408	.816	.061	15.0	.184	32.5
40	35	1.48	.208	.417	.833	.041	9.8	.167	20.0
45	35	1.51	.213	.426	.851	.021	04.9	.149	17.5
25	40	1.45	.204	.408	.816	.102	25.0	.184	22.5
30	40	1.48	.208	.417	.833	.083	19.9	.167	20.0
35	40	1.51	.213	.426	.851	.064	15.0	.149	17.5
40	40	1.54	.217	.435	.870	.043	9.9	.130	14.9
45	40	1.58	.222	.444	.889	.022	5.0	.111	12.5
25	45	1.51	.213	.426	.851	.106	24.9	.149	17.5
30	45	1.54	.217	.435	.870	.087	20.0	.130	14.9
35	45	1.58	.222	.444	.889	.067	15.1	.111	12.5
40	45	1.61	.227	.455	.909	.045	9.9	.091	10.0
46	45	1.66	.233	.465	.930	.024	5.2	.070	7.5
25	50	1.58	.222	.444	.889	.111	25.0	.111	12.5
30	50	1.61	.227	.455	.909	.091	20.0	.091	10.0
35	50	1.66	.233	.465	.930	.070	15.1	.070	7.5
40	50	1.69	.238	.476	.952	.048	10.1	.048	5.0
45	50	1.73	.244	.488	.976	.024	4.9	.024	2.5

TABLE II—QUANTITIES IN ONE CUBIC YARD OF (1:1½:3 Mix) CONCRETE BASED ON 3.8 CU. FT. CEMENT PER BBL.

% Voids		Cement		Sand	Stone	Surplus Cement in sand		Surplus Mortar in stone	
Sand	Stone	Bbls.	C. Y.	C. Y.	C. Y.	C. Y.	% comp. to sand	C. Y.	% comp. to stone
25	30	1.68	.237	.355	.710	.148	41.7	.290	40.8
30	30	1.71	.241	.361	.723	.133	36.8	.277	38.3
35	30	1.74	.245	.368	.736	.116	31.5	.264	35.9
40	30	1.78	.250	.375	.750	.100	26.7	.250	33.3
45	30	1.81	.255	.382	.764	.083	21.7	.236	30.9
25	35	1.74	.245	.368	.736	.153	41.6	.264	35.9
30	35	1.78	.250	.375	.750	.137	36.5	.250	33.3
35	35	1.81	.255	.382	.764	.121	31.7	.236	30.9
40	35	1.85	.260	.390	.779	.104	26.7	.221	28.4
45	35	1.88	.265	.397	.795	.086	21.7	.205	23.8
25	40	1.81	.255	.382	.764	.159	41.6	.236	30.9
30	40	1.85	.260	.390	.779	.143	36.7	.221	28.4
35	40	1.88	.265	.397	.795	.126	31.7	.205	25.8
40	40	1.92	.270	.405	.811	.108	26.7	.189	23.3
45	40	1.96	.276	.414	.828	.090	21.7	.172	20.8
25	45	1.88	.265	.397	.795	.166	41.8	.205	25.8
30	45	1.92	.270	.405	.811	.149	36.8	.189	23.3
35	45	1.96	.276	.414	.828	.131	31.6	.172	20.8
40	45	2.00	.282	.423	.845	.113	26.7	.155	18.3
45	45	2.05	.288	.432	.863	.094	21.8	.137	15.9
25	50	1.96	.276	.414	.828	.172	41.5	.172	20.8
30	50	2.00	.282	.423	.845	.155	36.6	.155	18.3
35	50	2.05	.288	.432	.863	.137	31.7	.137	15.9
40	50	2.09	.294	.441	.882	.118	26.8	.118	13.4
45	50	2.14	.301	.451	.902	.098	21.7	.098	10.9

Method of Figuring Quantities.

Following is the method of figuring quantities in one cubic yard of (1:2:4 mix) concrete based on 3.8 cu. ft. cement per barrel.

Take for instance a 40% sand and a 45% stone

Mix 1		Void %		Void	Swell
2	×	0.40	=	0.8	0.2
4	×	0.45	=	1.8	0.2

Stone Factor=4÷(4+0.2+0.2)=0.909 cu. yd.

Sand Factor=½×0.909=0.455 cu. yd.

Cement Factor=¼×0.909=0.227 cu.yd.

Cement Factor=(0.227×27)÷3.8 cu. ft.=1.61 bbls.

Method of Figuring Surplus

Cement 0.227 cu. yd.
0.182 Voids in sand (0.455×40%).

0.045 Cement swell.
0.455 cu. yd. sand.

0.500 mortar.
0.409 Voids in stone (0.909×45%).

0.091 motar swell.
0.909 cu.yds. stone.

1,000 cu. yds. (check).

As stated above, the usual practice in the New York State Highway Department is to use in figuring a 1:1½:3 mix for concrete pavement, 1.9 bbls. cement, 0.84 cu. yd. stone and 0.42 cu. yds. sand. While this may be good practice in preliminary estimating to disregard void percentages entirely, still, the same practice may be followed in the field.

In testing voids in stone and sand, especially the latter, there may be a variation of as much as 25%, depending on the physical condition of the aggregate.

Time to Take Void Percentages

Different void percentages may be obtained from sand in the bank and loose in piles, dry sand, sand containing different degrees of moisture, dry sand shaken or tamped, and sand being treated with water after the sand, cement and stone is mixed together. Therefore, especial precaution should be taken by the engineer on the road to take void percentages at the time directly previous to the actual mixing of the ingredients and in the physical state that the coarse aggregates exist directly previous to their incorporation to form the concrete. These void percentages should be taken every day and also when the character of the aggregate would tend to show a variation, as when a coarse pocket of sand would be evident in a bank from which a fine grade was being taken.

After these void percentages of sand and stone are derived the factors entering into the mixture may be obtained at a glance from the curve.

Example of Value of Void Determination

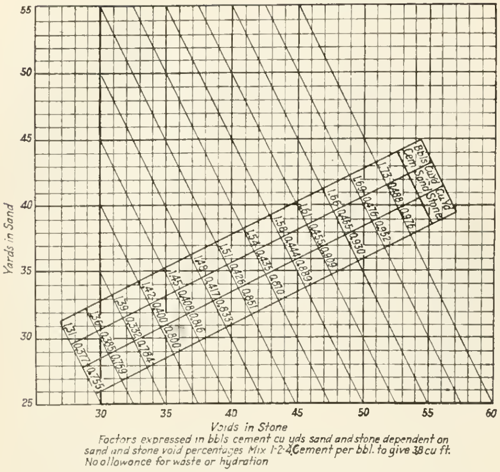
Assume the following analysis of cement concrete pavement:

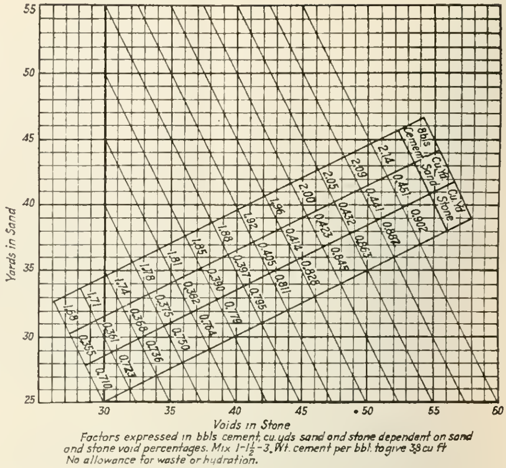
Cement.		Stone.		Sand.	
F. O. B.	$2.35	Bin	$2.25	Royalty	$1.25
Handling	.08	Haul, 1 mi.	.45	Wash, screen,	
Haul, 1 mi.	.08			Haul, 1 mi.	.45
			$2.70		
	$2.51				$1.70

For 1:½:3 mix use 1.9 bbls. cement, 0.84 cu. yd. stone and 0.42 cu. yd. sand.

Cement $2.51 at 1.9	$ 4.77
Stone $2.70 at 0.84	2.27
Sand $1.70 at 0.42	.71
Manipulation	2.50
Water and joints	.30
	$10.55
Profit, 20%	2.11
Waste and overhead, 10%	1.06
	$13.72
	Say $13.75

Suppose a contractor made a void test of the coarse aggregates in the field under approximately the physical conditions the stone and sand would be, when mixed, and determined a sand void of 35% and a stone void of 40%. From the curve the factors entering into the computation would be cement, 1.88 bbls.; sand, 0.397 cu. yd.; Stone, .795 cu. yd.





DIAGRAMS FOR OBTAINING INTERPOLATED VALUES OF FACTORS WHEN THE VOIDS IN EITHER OF THE COARSE AGGREGATES VARY FROM A MULTIPLE OF 5 PER CENT.

Applying these factors to the above prices we have

Cement $2.51 at 1.88	$ 4.72
Stone $2.70 at 0.795	2.15
Sand $1.70 at 0.397	.67
Manipulation	2.50
Water and joints	.30
	$10.34
Profit, 20%	2.07
Waste and overhead, 10%	1.03
	$13.44
	Say $13.45

The difference is .30 per yd.

In a road 5 miles long, 18 ft. wide, section 6 in.-8 in.-6 in., Parabolic, the number of cubic yards, 10,756, at $ .30 would mean a saving of $3,226.80, which it seems would be worth a preliminary investigation before submitting bid on a concrete pavement.

CHARACTERISTICS OF KENTUCKY ROCK ASPHALT PAVEMENTS

By Rodman Wiley, Chief Engineer, Kentucky Rock Asphalt Co., Paul Jones Bldg., Louisville, Ky.

Kentucky Rock Asphalt is a natural product composed of about 92½ per cent. silica sand and 7½ per cent. of bitumen. It is quarried, crushed and pulverized to about the consistency of coarse meal. It is not heated and no material, either sand or bitumen, is added. It is transported by water from the plant to Bowling Green, the nearest available railroad station—unloaded from the barges into railroad cars, or else stored ready for shipment. It is therefore possible to make prompt shipments.

When building an entirely new road, using Kentucky Rock Asphalt as a surfacing material, an ordinary macadam outfit is all that is needed. It is rolled with either a tandem roller or else a roller of the macadam type.

The following represents a test of a sample of the sand made by the Bureau of Public Roads, Washington, D. C., 1919:

	Per cent. of Aggregate
Passing ¼ in. screen, retained on 10 mesh sieve	1.1
Passing 10 mesh sieve, retained on 20 mesh sieve	3.2
Passing 20 mesh sieve, retained on 30 mesh sieve	3.5
Passing 30 mesh sieve, retained on 40 mesh sieve	8.7
Passing 40 mesh sieve, retained on 50 mesh sieve	9.9
Passing 50 mesh sieve, retained on 80 mesh sieve	43.2
Passing 80 mesh sieve, retained on 100 mesh sieve	13.2
Passing 100 mesh sieve, retained on 200 mesh sieve	9.7
Passing 200 mesh sieve	7.5
Total	100.0

Cheapness

Especially in Kentucky, Kentucky Rock Asphalt is the least expensive of all permanent types of pavement because it is used in such a manner as to utilize the local materials; can be laid over a limestone base, a sandstone base, and by using about 4 in. of crushed limestone can be laid over a road that has already been surfaced with bank or river gravel.

In the October, 1919 issue of "Southern Good Roads" there appears an address entitled, "Hard Surface Roads," by Mr. E. J. Wulff of the Bureau of Public Roads at Washington, delivered at the annual meeting of the North Carolina Good Roads Association, Wrightsville Beach, August 13-15. He said, in part:

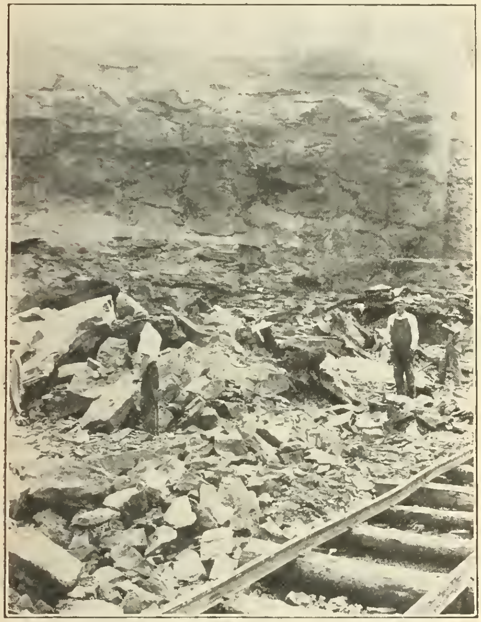
"Generally speaking, all asphalt pavements laid in the form of sheet present their best appearance if laid on a macadam foundation. By reason of the very small adjustment due to the expansion and contraction, due to temperature changes which take place in the entire surface and foundations as well, a pavement of this kind is singularly free from unsightly cracks that must inevitably appear, when the pavement is laid on a rigid foundation like concrete."

I consider it not only good engineering, but good common sense to use the local materials as much as possible.

Kentucky Rock Asphalt is laid cold, without the addition of any extra material. It is used just as it comes from the hand of nature, requires no expensive plant to lay and no expert labor. It is as near a fool proof type as it is possible to lay.

Durability

Tests show that the material which has been down for as long as 10 or 15 years is practically as live today as it was when laid. The method of laying it has been standardized after years of careful study and much experimenting; laid on a good macadam foundation it has been down for as long a period as 10 years without any maintenance, and some of the roads have been subjected to severe traffic—a mixed traffic, composed of narrow steel tired vehicles, horses and mules heavy shod, light and heavy automobile trucks, caterpillar tractors, traction engines and pleasure automobiles. In that time the pavement has shown very little wear and today is smooth, having the appearance of the best sheet-asphalt pavement.



VIEW SHOWING THE QUARRYING OF KENTUCKY ROCK ASPHALT.

Sample Section at Bowling Green

A sample section was laid at Bowling Green, Ky., in August, 1907, by B. F. Heidel of the Office of Public Roads, Washington, D. C., under the direction of Vernon M. Pierce, of the same Department. B. F. Heidel in a letter July 1912 said, in part:

"Speaking of Kentucky Rock Asphalt which was laid on the Cemetery Pike at Bowling Green, Ky., August 1907, this material was from the quarries of the Wadsworth Stone & Paving Co., on Green River, where it was prepared for use on the road by crushing. No other material either sand or bitumen, was added to change the consistency of the crushed native product. The rock asphalt applied to the wearing surface of the stone at atmosphere temperature and at no time during the construction was artificial heat applied, either to the wearing course of the stone or to the rock asphalt. Annual inspection has been made since that time by engineers from the Office of Public Roads in the Department of Agriculture. The reports show 'that the pavement has remained practically unchanged in appearance, with little evidence of wear, and the bitumen has retained its life to the present time.' ".

Columbus, Ohio Test Road

I recently returned from an inspection of the Nelson Avenue Experimental Road at Columbus, Ohio, where 17 types were laid under the direction of the Ohio State Highway Department in 1909. Today, after 10 years' service, the pavement is in excellent condition and no funds have been expended for maintenance. A sample taken from the edge of the road and analyzed by the Pittsburgh Testing Laboratory in October 1919, showed 7.42 per cent. of bitumen.

The 18th Street road out of Louisville leading to Camp Henry Knox is Kentucky Rock Asphalt for about 7½ miles. It has been down for a number of years and carries a heavy mixed traffic and for the past two years has withstood from 4,000 to 5,000 vehicles per day.

Ease of Maintenance

It is an easy type of pavement to repair. It requires no plant, no special tools, no expert labor. It is laid cold. You merely cut back the edges of a hole to where the surface is at a proper grade, leaving the edges perpendicular to the foundation, clean the hole and fill it with new material and tamp it down. A section of the pavement can be removed with a knife, the material crushed with the fingers, and the hole repaired with the same material that is taken out.

In regard to the section laid at Bowling Green, Ky., Circular No. 89, Office of Public Roads, Washington, D. C., reads in part, as follows:

"It is resistent to deformation under a load, yet sufficiently plastic to break the severity of the blow from a horse's hoof, and thus in a measure avoid the harmful effects on animals of a rigid pavement.

Kentucky Rock Asphalt can be laid on either a broken stone base or a concrete base, or can be used to resurface old brick streets. It has been successfully used for sidewalks. Sidewalks laid in Washington Park, Cincinnati, are good after 12 years service. The majority of walkways in the Ohio State University grounds are Kentucky Rock Asphalt, and this season about one mile has been laid at the Western Normal School at Bowling Green. It is an excellent material for the floors of warehouses, and is used extensively for station platforms, and is now being successfully used to patch sheet-asphalt and other forms of bituminous pavements, as well as macadam roads.

The material is uniform. It is tested before it goes to the crusher and again tested after leaving the crusher, and the bitumen contents runs between 7 and 8 per cent., usually around 7½ per cent."

Shipping to Distant Points

There is found in the 1914 Kentucky Geological Report the following statement by Mr. Owen Bryant:

"In considering the use of this rock in its crude form as a road building or paving material, the question arises what freight rate will preclude the possibility of competing with other products when initial cost is the prime consideration? In the first place initial cost should not be the prime consideration in a matter of this kind, as the durability of the various materials used as road coverings varies to a considerable degree. The ultimate cost, renewability and character of surface as well as the initial cost, should govern the selection of a material for this purpose. If these factors are given their proper weight in considering bids on a contract, this black rock ought to compete with any other material known with a fair possibility of success, excepting at such distances from its source as would make the freight excessive. As this rock only contains from 5 to 12 per cent. of asphalt, the freight paid would be mainly upon the sand, which together with some small amount of impurities constitutes the balance of the material, i. e., from 88 per cent. to 95 per cent.

PLANT FOR GRINDING AND PULVERIZING KENTUCKY ROCK ASPHALT. EACH MACHINE HAS A CAPACITY OF 350 TONS PER 10 HOURS.

To make the asphalt content compete with other materials when loaded down with freight charges against such a large proportion of sand, which can be very cheaply obtained by most consumers, would seem ridiculous at first, but a study of the expense of purchasing and operating machinery which will produce as thorough a mixture as nature has produced in the form of this black rock, seems to show that aside from a saving of from three to five cents per square yard of pavement in place, the black rock offers additional advantages from being a perfect mechanical mixture of the materials, requiring no preliminary heating of either the asphalt or the sand, a considerable advantage when the disagreeable features attending the use of these heated materials in a residence district are considered, more especially when portable melting and heating plants are used. It is also advantageous because it offers a surface which does not become slippery. The sand grains in the black rock pavement offer much more resistance to skidding wheels than the ordinary asphalt pavement surface will offer. In the writer's opinion, the use of any crushed argillaceous or calcareous material on the surface of an asphalt pavement will result in the production of a thin, slippery coating when the pavement is wet and heavy traffic is passing over it. Limestone or cement does not stand up under traffic, and pure quartz sand will."

The foregoing paragraphs are excerpts from the address of Mr. Wiley at the November meeting of the Kentucky Highway Engineering Association.

ECONOMIC STATUS OF GUARANTEES FOR PAVEMENTS ON ROADS AND STREETS

(Editor's Note: The matter following is from the final report of the committee on the above subject made to the American Road Builders' Association on Nov. 7, 1919. The members of the committee are: Francis P. Smith, Chairman; J. J. Hill, C. M. Pinckney, J. H. Wait and T. J. Wasser.)

KENTUCKY ROCK ASPHALT PAVEMENT ON VIRGINIA AVE., HOPKINSVILLE, KENTUCKY. LAID IN 1917 ON A BROKEN STONE BASE.

It has been suggested that it would be helpful if the Committee were to indicate what it considers a proper period of reasonable life without repairs for various kinds of pavement under different conditions. An earnest effort to compile such a table which would cover all possible conditions clearly showed, however, that the wide variation necessary in a general schedule would render the figures worthless and would probably lead to a very heated discussion as to whether the figures cited were to be regarded as a measure of the life of various types of pavement when laid upon different kinds of foundations and subjected to traffic of various densities and the attempt was therefore abandoned. Each set of conditions must be given individual consideration, and the Committee believes that the determination of such reasonable periods in any particular case would not be extremely difficult and that any competent engineer can do this satisfactorily.

The Committee's recommendation that the guarantee bond be supplemented by a cash retainer was based largely upon the difficulty sometimes experienced in having necessary repairs made within a reasonable time and was designed to provide a means of enforcing this necessary provision of any paving contract without first having to resort to a law suit. As a rule, a municipality has no fund available for this class of work and the cash retainer therefore serves two purposes.

What a Cash Retainer Accomplishes

1st. It tends to bring the contractor back to make the repairs, as he knows he will collect some money toward the expense involved.

2nd. It gives the municipality cash with which to make the repairs and thus avoids the necessity of going through the formalities, and oftentimes difficulties, of securing an appropriation with all the attendant delays.

Percentage Retained

In this connection the Committee recommended that a greater percentage be retained on resurfacing work as compared with new construction in order to provide for approximately the same amount of retained money per square yard of finished pavement in both cases. This did not mean, as was assumed by some members, that the Committee felt that resurfacing work, properly conducted, involved any greater guarantee liability than new construction work. On further consideration of the matter the Committee believes that reasonably adequate protection would be assured to the municipality by a reduction of the amount of the retained moneys from 10 and 20 per cent., as at first recommended to 5 and 8 per cent. respectively. It further feels that such a provision cannot be justly held to be a curtailment of a contractor's working capital.

In arriving at this conclusion your Committee takes the position that 15 cts. per square yard to cover guarantee liabilities may be assumed as a fair average. On this basis the following figures may be considered as typical and illustrative of the principle involved:

	Resurfacing	New Work
Construction cost per sq. yd.	$1.50	$2.50
10% profit	.15	.25
Guarantee	.15	.15
Total	$1.80	$2.90
Retained (8%)	.15	5% .15
Payment on completion	$1.65	$2.75

In both cases the contractor receives a payment equal to his construction cost plus profit, the municipality retaining an amount practically equal to the sum included by the contractor in his bid as necessary to cover the guarantee provisions. This amount per square yard is the same for both types of construction and has not been expended by the contractor in his work and will not be expended by him except where defects in construction have occurred. While held by the municipality, the contractor will be paid interest on it. This amount, while sufficient to cover ordinary defects in workmanship and insure the making within a reasonable time of necessary repairs, is totally insufficient to cover extensive repairs rendered necessary by serious defects or failure of the work, protection against this being assured by the guarantee bond.

The Committee further believes that the criticism that its provision as to forfeiture of all retained moneys in case of failure to make ordered and necessary repairs is too drastic, is well founded and has modified its progress report in that respect by providing that the city may make these repairs at the expense of the contractor and such expense shall be deducted from the retained money. When any part of the retained money is due to the contractor only such balance as has not been expended by the municipality shall be considered to be due and payable. When the cost to the city of such repairs exceeds the amount of retained money, the balance shall be recoverable from the sureties.

It therefore submits as its final report all of its progress report down to the paragraph commencing "For new construction involving grading," etc., and adds thereto the following:

For new construction involving grading, foundation and wearing surface, we would recommend that an amount equal to 5 per cent. of the aggregate cost of these items be retained.

For surfacing on an old foundation we would recommend retaining an amount equal to 8 per cent. of the cost of surfacing.

In the case of a 2-year guarantee the whole of the retained moneys should be payable at its expiration and not before. In the case of a 5-year guarantee, one-fourth of the retained moneys should be payable two years after the completion of the pavement and the balance in three equal installments. The date when payments of retained moneys become due shall be governed by the clause previously recommended for pavements completed and accepted between November 1st and May 15th.

If the contractor, having received notice from the engineer, fails to make and complete the ordered repairs within a reasonable time (not to exceed 30 days in any case) the city shall have the right to undertake and complete the ordered repairs at the expense of the contractor or his sureties.

PROPER GRADE OF CREOSOTE OIL FOR WOOD PAVING BLOCKS

By K. M. Waddell, Chief Chemist, The Jennison-Wright Co., 2463 Broadway, Toledo, Ohio

A great deal has been said about the proper grade of creosote oil for the treatment of wood paving blocks, but it is seldom definite reasons are given in support of the grade advocated that can be understood by the layman. The present article is free from chemical formulas.

The requirements of an efficient wood preserving oil, particularly one that is adapted to the treatment of pav-

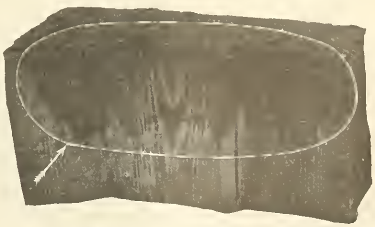


FIG. 1. THIS WOOD PAVING BLOCK TREATED WITH A DISTILLATE OIL WAS UNDER TRAFFIC THREE YEARS AND LIGHT OIL EVAPORATED.

After a heavy rain the block absorbed moisture as shown above; rain was followed by a severe freeze which expanded the blocks, the line of demarkation shows how far the moisture penetrated, and the pavement buckled.

ing materials, are very high, and a great many failures are directly traceable to a lack of consideration of the necessary qualifications.

Characteristics of a Good Oil

We may briefly summarize the most important needs of a good oil as follows: 1, toxicity; 2, waterproofing values; 3, permanence; 4, penetrance.

The oil must be highly toxic in order to prevent the growth of the small decay producing plant organisms by poisoning all the food with which they come in contact. It must be impervious to water, in order that the

FIG. 2. THIS BLOCK WAS TREATED WITH KREOLITE OIL, UNDER TRAFFIC THREE YEARS, TAKEN UP AND FACE IMMERSED IN WATER 24 HOURS.
Arrow shows that moisture did not penetrate appreciably.

moisture content of any untreated portion of wood on the interior of the timber does not become high enough to promote decay. Further, the absorption of water causes the wood fiber to expand with an almost resistless force, sometimes ending in disastrous results if adequate provision has not been made to take care of this expansion. It must be permanent in that both of these characteristics are retained indefinitely and are not depreciated by a loss of the valuable ingredients through evaporation or leaching. Finally, it must be a good penetrating oil in order that wood is treated to the greatest possible depth.

It is not reasonable to expect to meet all the requirements of an efficient preserving oil with any single oil taken just as it comes from the manufacturers, for in every instance these particular oils exist as by-products of some phase of the coke and gas industries, and consequently are not manufactured with the same degree of uniformity as would be the case were they made the principal product instead of the by-product. The result is that we can only produce an oil of the desired characteristics by carefully compounding a number of oils whose characteristics have been individually determined by careful technical analyses.

A Blended Oil

Kreolite oil, which is a product of the Jennison-Wright Company, is just such a blended oil. It is compounded from analyzed oils to the exact formula which technical research and practical experience have shown to represent the most efficient timber-treating oil.

Kreolite oil is a highly antiseptic oil, as laboratory tests have shown that it contains from 10 to 20 times the amount of toxic materials necessary to prevent decay. But the real criterion as to the permanent toxicity of an oil is found in the length of life of the treated material under actual service conditions, and here our records are incomplete for material treated with Kreolite oil has never been known to decay. Its permanent toxicity and waterproofing values are largely due to the manner in which certain light and heavy oils are blended. These oils are mutually soluble in each other, there being just enough of the lighter and more volatile oils to completely flux the high boiling oils at the treating temperature. Upon exposure there is an evaportion of the extreme light oils in the outer layer of cells, leaving the heavier oil as an impenetrable film. This action is analogus to the formation of a paint film due to the evaporation of the lighter solvent, except in this instance probably an evaporation of less than 1 per cent. is sufficient to protect the bulk of the oil, as practically all of it is contained within the interior of the block, out of contact with the air. The formation of this film, of course, prevents any further evaporation of oils or the passage of moisture in or out of the wood.

Surface Tension

The efficiency of a waterproofing surface is evidenced by the phenomena of surface tension, or the force that draws a drop of water into a ball on the leaf of a pond lily, or the gathering together of mercury spilled on a non-attractive surface. If a drop of liquid is brought into contact with a surface of material for which it has no affinity, the attraction of the particles of liquid is principally inward and towards its center of gravity, and the drop assumes a spherical shape. In fact it is apparently surrounded by an elastic bag which holds the liquid together and prevents it from passing into the surface with which it is in contact. On the other hand, if there is an affinity between the liquid and the surface of the solid, the outward attraction reduces the surface tension, destroying the elastic bag effect with the result that the drop flattens out and the individual particles of

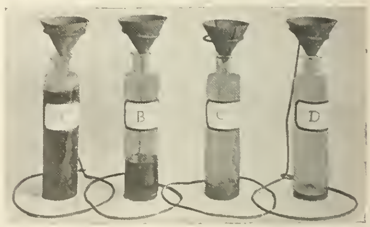


FIG. 3. SHOWS THE COMPARATIVE AMOUNT OF WATER PASSING THROUGH OILED FILTER PAPERS IN TEN MINUTES.
A treated with light distillate, B medium distillate, C heavy distillate and D Kreolite oil.

the liquid pass into the interstices of the solid. The two cases represent a waterproof and a non-waterproof surface, respectively.

Some Simple Experiments

That the surface tension of water is higher when in contact with Kreolite surface than it is when in contact with a surface treated with an ordinary coal tar distillate is easily proven by a simple experiment.

Take two filter papers or blotters of the same degree

"Tarvia-KP" sand and stone are turned over by hand until all stones are coated

The hole to be patched is cleaned out and the bottom and the sides are painted with "Tarvia-KP"

The mixture is shoveled into the hole and is well tamped

Workingman in foreground is scattering screenings over seal-coat. Then patch is again tamped

Tarvia-KP

FOR COLD PATCHING

—used now will save dollars later!

"TARVIA-KP" is the highway official's "handyman" for quick, dependable patching work on every type of road.

Used now, it will save many dollars of expensive repair work in the Spring. Freezing won't hurt it!

Hundreds of highway officials use Tarvia throughout the winter whenever the roads are free from snow. Thus they fortify their roads against the destruction of winter, and are able to get an early start with their spring surfacing.

The illustration shows how easy it is to use this remarkable *cold* patching material. "Tarvia-KP" is practically fool-proof. Can be stored up in spare moments and used at any time. Order some now.

Interesting booklet showing each step in patching a road with "Tarvia-KP" free upon request. Address nearest office.

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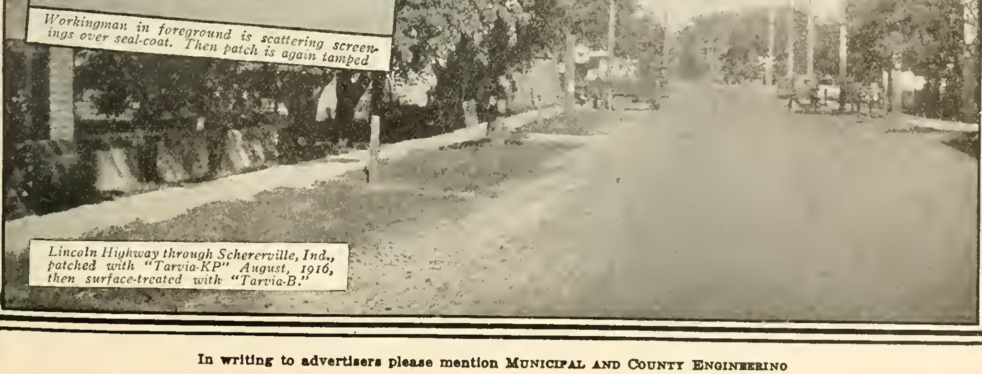

Lincoln Highway through Schererville, Ind., patched with "Tarvia-KP" August, 1916, then surface-treated with "Tarvia-B."

TABLE I—COMPARATIVE AMOUNTS OF WATER PASSING THROUGH FILTER PAPERS TREATED WITH DIFFERENT TYPES OF PRESERVING OILS, AS A TEST OF THEIR WATER PROOFING VALUES

(The Apparatus used in this test shown in Fig. 3)

Kind of Oil	No. of Tests	Appearance of First Drop	Total Through in Ten Minutes
A—Light Distillate	6	3 seconds	203 cc
B—Medium Distillate	5	10 seconds	58 cc
C—Heavy Distillate	6	39 seconds	15 cc
D—Kreolite Oil	13	150 seconds	3 cc

of porosity and on one of them place a drop of distillate oil and on the other a drop of Kreolite oil. Allow the oil to spread out and dry for a few minutes and then on each oiled surface place a small drop of water. In a few moments the water spreads out on the distillate oil surface and is quickly absorbed by the pores of the paper, while in the case of the Kreolite oil surface the water assumes a permanent spherical shape and usually evaporates before it penetrates the surface. It is needless to point out the comparative efficiency of the two surfaces.

A modification of this experiment is obtained by dipping filter papers into the oil, allowing them to dry, rolling them into little filter funnels, filling them with water and measuring the amount of water that will pass through in a given time. A number of experiments were conducted along this line, the results of which are shown in Table 1, and the apparatus is shown in Fig. 3. These results compare very favorably with the results obtained by soaking blocks treated with the different oils and weighing the amount of water they will absorb.

The penetration of oil into wood is not alone a function of its viscosity but is largely dependent upon the amount and size of the particles of oil-insoluble matter which are suspended in the oil. A great deal of attention is paid to this point in the blending and use of Kreolite oil, and largely for the purpose of keeping this insoluble matter to a minimum our filter press was installed. We know of no other instance where a filter press has been installed and operated for the single purpose of maintaining the quality of a preserving oil. The result of this treatment, however, is an oil which always yields a satisfactory penetration.

As we have said previously in this article, the blending of Kreolite oil is not a hit or miss proposition, but it is compounded with an accuracy only attainable by scientific control. For this purpose, a complete and modern chemical laboratory has been installed and is in constant use.

From these data it is then possible to calculate the exact amounts of each material to bring the resultant blend up to the Kreolite formula, and this is finally confirmed by a complete analysis of the finished product, which should show an exact reproduction of the Kreolite standard.

AMERICAN PLANS FRENCH RECONSTRUCTION

Major George B. Ford, who was official town-planning consultant of Newark, N. J., has been with the American Red Cross in France since 1916, studying the reconstruction problems of the country as a member of various commissions. Under a recent French law, every community that has been wrecked, or even partly wrecked, in the war, must have a town plan drawn up. Before a single permanent building can be constructed in any community this plan must be approved by the provincial authorities, and by the Minister of the Liberated Regions. Major Ford has now been appointed town planning consultant of the French government, and will have the final decision upon the new plans of 3,000 devastated towns and cities of northern France. Major Ford is best known for his work at Beloit, Wis., in the model town of the Fairbanks-Morse Company. He is author of the New York building law. In France he has participated in many governmental conferences to explain his plans. An official of the French Ministry of the Liberated Regions said recently: "This new law, and the present movement in France to seize this opportunity to beautify northern France in the rebuilding, owe a great deal to this American Red Cross engineer, who has been a veritable missionary in France of town-building."

TRADE NOTES

Washington has been selected as a district headquarters by the Asphalt Association, whose main office is in New York. This is another evidence of the growing industrial importance of the Nation's capital, as most of the large industries are now recognizing that decisions of great moment are constantly being made by Federal departments and bureaus. The Asphalt Association is composed of the leading producers of asphalt and maintains a corps of engineers, chemists and economists to aid in working out problems of highway construction and maintenance involving such types as sheet-asphalt, asphaltic-concrete and asphaltic-macadam. It is estimated that this year more than 40,000,000 sq. yds. of these types will be laid in the United States, the Nation's capital having the unique distinction of having the largest percentage of sheet-asphalt pavement of any city in the United States.

Maj. Harry D. Williar, one of the most brilliant engineer officers in Pershing's famous First Division, will have charge of the Washington office of the Asphalt Association in the Munsey building. Major Williar is a Marylander, receiving his training as an engineer on the State Road Commission and later with the Paving Commission of Baltimore. At the outbreak of the war he entered the officers' training camp at Fort Myer and was one of the engineer officers selected to go to France with the original Pershing expedition. Included in the Washington district are the states of Maryland, Pennsylvania, Delaware, Virginia and West Virginia.

The Franklin Institute, acting through its committee on Science and the Arts, has awarded its Edward Longstreth Medal of Merit to John Walter Ledoux of Swarthmore, Pa., for the Simplex Venturi Meter manufactured by the Simplex Valve and Meter Company of Philadelphia.

WATER WORKS SECTION

HYDRO DEVELOPMENT FURNISHES POWER FOR MUNICIPAL WATER SUPPLY

By Edwin C. Hurd, Assistant to Charles H. Hurd, Consulting Engineer, Merchants Bank Building, Indianapolis, Ind.

That turbines may be used advantageously on low head water power installations has been recently demonstrated at the plant completed at Rockford-on-White River, near Seymour, Ind. Operating on a minimum head of less than 4 ft. the new plant successfully furnished the city of Seymour with water, even before the dam was closed. This was made possible by a specially constructed tailrace of careful design, extending about 300 ft. downstream from the pumping station.

Previous to the installation of the hydraulic plant, water was supplied to the city of Seymour by a steam plant which was operated with fair success. However, with the outbreak of the war and increase in the price of coal and other added expense, the management gave consideration to more improved methods and sources of economy, which resulted in the water power development.

The present pumping station is located on the east bank of White river, at the site of the "old ford," at which was located the old Rockford Mill. This mill was originally operated by water-power, the head being produced by a low timber dam which was anchored into the flat rock composing the bed of the stream. The river has but a very slight fall, which, with the somewhat limited possibilities for back-water, made the problem intricate when consideration was given to the cost of construction consistent with the economies to be obtained.

About five years ago, in connection with construction of filters for the purification of water, a 3-ft. concrete wing dam was built on the rock foundation for about one-third the distance across the river, and angling slightly up-stream from the pump house site. This dam was made use of in the new project, by first constructing a 5-ft. concrete dam from the opposite shore for about one-third the distance, then by a closure with a 3-ft. section in the intermediate third. The two 3-ft. sections are equipped with automatic crest gates to operate at times of high water or flood.

While the water rights acquired through the purchase of the mill permitted the construction and maintenance of a 6-ft. dam, an analysis of flowage in the river proved that by use of ordinary construction such a dam would be practically submerged throughout a considerable period and available power could not be exepected on an average for more than nine months during the year. It was conceived by the expenditure of an amount equal to the additional cost of a 6-ft. dam, in the development of the tailrace and the construction of a diverting wall below the power building, that sufficient power would be available for pumping purposes for at least eleven months during the average year. This construction which tends to divert the flow, as well as to increase the velocity of the current in the main channel and being most effective during the periods of high water, has proved extremely satisfactory and more than the estimated results have been realized.

The features of more than usual interest in the power and pumping plant installation are the methods of direct connection of the turbines to the high pressure power pumps without intermediate transmission and the fact that the seasonal demand for power corresponding to the use of water varies inversely as the stage of the river which gives maximum power during low water periods, making the plant more or less automatic, and to a degree, self-regulating.

FIG. 1. HYDRO POWER STATION OF THE SEYMOUR WATER COMPANY LOCATED AT ROCKFORD, INDIANA, SHOWING FLARING CONSTRUCTION OF TAIL RACE.
FIG. 2. UP STREAM VIEW OF LOW DAM ROCKFORD HYDRO INSTALLATION SHOWING CREST GATES IN OPERATION.

The turbines for the plant are 52-in. diameter, improved vertical type, furnished by the Leffel Company, Springfield, Ohio. The power pumps are of the heavy duty,

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double acting plunger pattern, built by the American Pump Company and supplied by the Dravo-Doyle Company of Pittsburgh. A single-stage centrifugal pump delivers raw water under low head into the sedimentation basin of the filtration plant. This pump was furnished by the American Well Works and is driven from the main power shaft, as is also the electric generator for lighting and general use.

FIG. 3. DOWN STREAM VIEW SHOWING JUNCTION OF TAIL RACE WATER WITH THE MAIN CURRENT. Note the swells and wave action on opposite shore due to high velocity in main channel.
FIG. 4. BED OF RIVER BELOW THE DAM DURING LOW FLOWAGE AND CONDITION OF MAXIMUM POWER.

The success of this installation demonstrates in a striking manner the possibilities of developing power for lighting or pumping service for municipalities located on or near rivers and streams, and present conditions relative to the cost of fuel and the more recent attitude of legislative regulating bodies concerning the use of water for power purposes, increases the tendency toward this class of construction and investment.

MUNICIPAL WATER AND LIGHT PLANT MANAGEMENT

By J. C. Manning, City Manager, Hays, Kansas.

In discussing the subject of municipal light plant management, I wish also to touch upon municipal water plants in connection with light plant management, as in so many municipalities you find both under the same management, said Mr. Hays in addressing the League of Kansas Municipalities.

In my first report to the Commissioners of Hays, and analysis of conditions as I found them. I prefaced it with the statement that it was not unlike any other city of the same size and class. In this report I called attention to the waste and inefficiency of management and I will venture to say that the same conditions that existed in Hays exist in 80 percent of the cities of Kansas, or any other state for that matter, and I feel that the few that are the exception to this class will bear me out in what I have to say and I trust that all will feel that the criticisms that I offer are of the constructive type and not destructive.

Many Municipal Plants are Inefficient

Mr. Emerson McMillan, Chairman of the Board of the American Light & Traction Company, in his address on public ownership of public utilities before the National Civic Federation in New York on September 11th, made this statement: that municipal ownership of public utilities is unsuccessful at the present time, and will remain so as long as the present form of city government exists, saying that plants under private ownership are not only more efficient, but give a better service at a lower cost to the public. Mr. McMillan stated that the cost of municipally owned utilities is usually higher when all the legitimate items of expense are given consideration, and the equipment installed in a municipally owned plant is usually too poor for efficient service or is badly adjusted to the operating demands and gives as the cause of this the lack of business methods and lack of organization. The sad part of the whole matter is that in most cases of municipal ownership it is just as Mr. McMillan has stated, although it is not necessary that it should be and the reasons for such a condition are easily explained. First, it is caused by the employment of inefficient help and second, by political interference.

Plants Do Not Know Their Costs

Very few municipally owned light plants know whether they are running on a paying basis or not. Especially is this true of the smaller cities and villages as very few of them know the value of their light plant, what the total output is, what they have spent for repairs, reconstruction, plant additions, or overhead. This information can only be brought about by the installation of proper instruments and meters and by the introduction of proper time cards and cost finding methods.

A great many cities who employ a manager or superintendent for their light plant and water plant, pay him a good salary and then handicap him by curtailing his authority and expenditures, as the average man in civil life may not readily see the advisability of spending $300 to $500 for meters and instruments that he personally cannot see the use of.

Value of Operating Records

For instance, I have been called upon to analyze the condition of cities and when I get there, find they are making a special rate for some industry or firm without the faintest knowledge of what their current is costing them. No successful retail merchant would undertake to sell goods without knowing the cost of the commodity. Think of a successful baker selling bread without knowing what his flour, yeast, potatoes, salt, sugar, shortening and labor cost him. Still, when he gets on a city council, he will permit the sale of electrical energy without knowing the unit cost per kilowatt hour of coal, water, boiler

compound, labor, interest, depreciation and overhead, and little does the average councilman know that the cost of production is greater at certain hours of the day than at others. In many cases the unit working is not an economical one for the load they are carrying.

For instance, I recently visited a plant where they were firing two 150 H. P. boilers for 35 kil. hour load or about ¼ load for one boiler. When I asked the fireman why he was running two boilers, his reply was so as to have plenty of steam when the load comes on. Now, had that plant installed indicating watt hour meters and kept a log sheet recording the load every hour, the fireman would know at just what hour in the day his peak load would come on and he could have carried a bank fire in one boiler until about an hour previous to the time this load would come on. This log sheet would also show the manager of this plant which fireman was producing the best results and entitled to the highest wages.

In other plants I find cities furnishing electricity for pumping water where they have been very careful to meter the current used in pumping water but paid no attention whatever to how much water they were pumping. Consequently they had no way of knowing the cost per 1,000 gals. of pumping water. In other plants they had the light and water plant in the same building, the same boilers furnishing steam for both plants without any way of determining the distribution of the steam between light and water.

Plant Management

The greatest cause of failure of municipally owned utilities, is on account of the interference of the city officials. In privately owned plants the directors employ a manager and put him in charge of a plant with full authority. When he comes in with a requisition for material or equipment and can show the directors that it is necessary for economical operation or a good investment, it is purchased for him, or if that manager discharges an engineer or some other employe for incompetency, he is upheld in his act. While in most cases of municipally owned plants the manager or superintendent must go before the city council and tell his troubles and they leave the purchasing of the equipment desired to some one that knows nothing at all about the working conditions or the quality of the article in question but purchase the equipment wherever it can be purchased the cheapest without the least regard for quality or adaptability and when he discharges some one, he stirs up a hornet's nest.

An Example of Political Interference

For illustration, in Kansas City the mayor started out with good intentions. He employed a high-class business man and put him at the head of the board of public works. Business methods not fitting in with the organization of the board of public works, he was transferred to the head of the water board. Likewise, business principles failed to fit in here and he was asked to resign. When I read of this, the Kansas City Star Slogan "Do you Know" struck me, but after a wait of about 30 days the "Do You Know" was answered by the Star itself, when it stated that the mayor wes feeling his way towards the governorship of Missouri and the mayorship of Kansas City. This gentleman is the very best illustration of why most municipally owned utilities do not pay.

How to Run a Light Plant Efficiently

Municipally owned light plants can be run successfully in any city under proper conditions. It must have a manager or superintendent capable of running it and that man should have full charge. I do not mean by this that he should be turned loose with no one to check him but he should be chosen after careful consideration of his ability, personality and habits; and after being chosen he should be allowed to demonstrate his ability and if not successful should be removed. He should be under the supervision of the Board of Public Works, or the Light and Water Committee if it is a city of councilmanic form of government. His authority should extend to all branches of city service in which his department is effective. For instance, if it be a municipally owned light and water plant, he should be in full charge of office, plant, lines, public watering places, sewers, etc. All purchases should be made on requisition and as far as possible should follow the requisition to the letter.

In operation there should be no difference between municipally owned utilities and privately owned. There should be complete valuation of all utility property, complete records kept at the power plant. All coal, ash, water, should be weighed, fuel oil metered, feed water temperature recorded, log sheets should be kept showing all this, also indicating watt hour load at all hours. All current should be metered, including street lights, at the switch board, all services should be metered, meter records should be carefully kept both in the field book, in the ledger, and in addition to this, a card index of each meter showing manufacturing number, city number, and a complete history of the meter showing dates of test, repair and change of location.

All time cards should show careful distribution of time, separating repairs, reconstruction, inside wiring, and attention to service and assistance to other departments. Stock room sheets should be kept, showing material used on each job as this will be the check against perpetual inventory sheets. Carbon copies should be made of all work orders, and a work order should be made for each job no matter how small. Courtesy and service should be the watchword and the meter man should be one of the most carefully chosen of the entire organization as he is in contact with the customers more than anyone else. I am a firm believer in the Statler idea—"The customer is right," and I find it a great deal easier upon listening to complaints to say that maybe we are in error than to say that we are right and then have to apologize.

The commission manager form of government was adopted in Hays April 5, 1919. Upon taking over the city managership, I found waste and inefficiency at every turn. The municipal light and water plant lost $5,500 the previous year and $2,300 in outstanding accounts. It was a fitting example of the conditions I have sighted. In 6 months we have spent $3,500 on putting the light plant in shape, have increased the returns 75 per cent. by cutting out waste and making collections and are giving much better service. How did we do it? By applying business principles to city government, by having a set of commissioners that are clear thinking business men,

who back the manager to the limit and at the same time keep thoroughly posted on what is going on.

In conclusion I want to say the last and greatest duty of a manager is to see that all bills are collected on date of maturity. It is a strange thing to me that so many plants have such large outstanding accounts when all they need to force collection is a screwdriver. But I find in a great many municipal plants they are afraid to use it or are not backed by the city officials when they do use it.

POLLUTION OF DEEP WELLS AT LANSING, MICHIGAN

By Major Edward D. Rich, State Sanitary Engineer, State House, Lansing, Mich.

The population of Lansing is estimated at about 60,000, and its area is about 16 square miles, only about two-thirds of which is fully built up.

Wells

The city has always been supplied with water taken from deep wells. There are 32 such wells in use at present, which vary from 350 to 400 ft. in depth and take their supply from what is known at the "Coal Measure" sandstone. The rock formation is covered with from 20 to 100 ft. of sand, gravel and mixed clay. Various strata are encountered between the bottom of the overlying earth and the water-bearing horizon.

The wells are cased with iron pipe driven a short distance into the upper rock layers, but it is doubtful if these casings fit tight enough against the rock walls to exclude any seepage that might follow down along the casing. On account of the age of some of the walls it is possible that some of these casings have deteriorated enough to permit some leakage through the pipe itself. The casings vary in diameter from 8 to 20 ins. and the present water consumption is about 8,000,000 gals. per 24 hours.

Pumping

There are five separate stations pumping directly into the distributing mains. Central station is situated just east of the center of the city. Pennsylvania Ave. station is about a mile south of Central station; Seymour street station is about a mile and a quarter northwest of the Central station; Townsend Street station is in the southwest part of the city, at the corner of Isaac and Townsend sts., and Logan street station, the last constructed, is about a mile west and a little north of Central station. Originally, many of the wells flowed to a slight extent but there was not sufficient head to furnish any great quantity of water and pumps were installed.

Suction Pipes

As the demands of the city grew and the pumping increased in volume the ground water level receded to some extent and it became necessary to install deep well pumps at Central station to increase the yield. Logan St. station being on higher ground than the rest was equipped with a triple stage deep well pump, electrically driven, when it was constructed. Pennsylvania Ave., Townsend St., and Seymour St. stations are all pumped through horizontal suction mains connected to each of the wells. The length of the suction main at Pennsylvania Ave. is about 3,500 ft. and at Townsend St. about 1,000 ft. while the Seymour St. line is considerably shorter. At each well a drop suction pipe extends down into the casing for about 20 ft., leaving an annular space of about half an inch between the pipe and the casing. The drop pipe is connected with the horizontal suction line by means of a "T" just above the top of the casing. The top of this "T" is tightly capped. Between the "T" and the horizontal suction line there is a gate valve and a check valve.

The growth of Lansing during the past five or ten years has been very rapid and it has been difficult to obtain enough water from the city wells to supply the rapidly increasing demands. Consequently it has been necessary on account of increased pumping to maintain a heavy suction vacuum particularly at Pennsylvania Ave. and Townsend St. On account of the depth of the wells they have always been considered pollution proof. For this reason, and also because in the early days the nature of the transmission of water-borne diseases was not clearly understood by water-works officials, insufficient precautions were taken to make the joints at the top of the wells absolutely tight.

Improved Pipe Connections

In later years apprehension of the possible entrance of pollution has led to the use of more efficient pipe connections. This has been accomplished by means of flanges on both the drop pipe and the casing with a rubber gasket securely bolted between them. This, of course, insures a water-tight joint if reasonably good workmanship is available. When some of the older wells were constructed it was attempted to obtain a watertight joint by placing concrete around the opening between the drop pipe and casing and extending it up a few inches to form the bottom of the valve chamber or manhole built over the well to give access to the valve. These valve chambers are not watertight, and particularly at the Pennsylvania Station they have been regarded as a source of possible contamination, inasmuch as they are subject to flooding at times of high water from the Red Cedar River, which carries a considerable sewage flow from the eastern part of the city and from the City of East Lansing. It is believed however that most of the wells at the Pennsylvania Station were constructed with flange and gasket joints. It has been customary to collect samples at this station whenever high water indicated the possibility of contamination, but only once or twice has anything suspicious been discovered.

The clearness of the water, the depth of the wells, and the absence of epidemics or serious sickness all tended to create a false sense of security and led to a lack of that watchfulness which should always be maintained over every water supply. The upper layers of the rock are coarse, poorly cemented, and very likely to develop fissures capable of transferring laterally any pollution which might reach these openings through abandoned wells or other excavations deep enough to communicate with them.

Townsend St. Station is on Townsend St. at the foot of Isaac St., and only about 200 ft. from the Grand River. Townsend St. runs approximately parallel to the course of the river. In Townsend St. and in Ann St., which is practically a continuation of Townsend St., there are five 6-in. wells connected to a single horizontal suction line about 1,000 ft. in length. Two other wells, one 10-in. directly behind the station, and another 6-in.

about 200 ft. west of the station on Isaac St. complete the series of wells.

Sewage Contamination

A sewer which serves quite a large portion of the southwestern part of the city extends along Townsend St. and Ann St. and lies only 10 or 15 ft. from some of the wells. This sewer discharges directly into Grand River above the pumping station. During normal stages of the river this sewer has a free outlet and no excessive pressures are maintained in the pipe. At times of high water, however, the river rises to such height as to set back the sewage to a height above the tops of most of the wells connected with the Townsend St. station. Under such circumstances, of course, this sewer is under hydraulic pressure, and the joints being far from tight offer a ready means for sewage to percolate through the sandy soil into the valve chambers.

This pumping station has for a number of years been looked upon with a certain degree of suspicion and it has been customary to shut it off during high water stages. When this is done the ground water rises nearly to the top of the casings, thus preventing an extensive amount of pollution from settling into the wells and reaching the lower level. But when the station is running and drawing heavily upon the wells there is a strong tendency to draw in polluted ground water through any leaks that might be present in the suction lines. Heavy rains caused the Grand River to rise 8 ft. on March 15, 1919, reaching a river stage of 12 ft. This placed a static head of 2½ ft. on the sewer at the wells and forced concentrated sewage into sandy soil around them. Through an oversight the station was not shut down at that time and the vacuum of 22 in. normally maintained pulled in such a quantity of highly polluted ground water that dysentery was epidemic by the 18th.

Dysentery Epidemic

The first complaint reached the State Department of Health from the Olds Motor Works, a large factory located about a quarter of a mile west of the Townsend St. station, that a large number of their men were sick from bowel trouble. The Department collected a sample of water and took action by ordering the station shut off at once. On the 20th a notice was published to boil all city water used for domestic purposes and the water department was directed to make the arrangements necessary for chlorinating the supply by means of the emergency machines furnished by the Department of Health. Systematic sampling of the supply at all the pumping stations and at various points on the distributing systems was begun at once. Seymour St. station alone showed safe results and has since continued to do so with one or two minor exceptions, all others being reported as unsafe or suspicious. On March 25th arrangements had been completed for chlorinating at the rate of 1.5 p. p. m. at Central and Pennsylvania Stations. Continued flushing of dead ends was ordered and this, together with the chlorination, resulted in sterilizing the water in the mains by the 29th. Chlorination has been maintained ever since.

Inspection and Repairs

On the 22nd the Townsend St. wells were carefully inspected and a plainly audible leak was found at the top of well "C." There was also a poorly made and leaky shred-lead joint at well "D." A defective flange at the top of the casing of well "H" was also admitting surface water which although some distance from the sewer was probably polluted to some extent. All the other wells appeared to be tight. The old manholes were torn out and all the wells ordered repaired. This was done with standard flange couplings wherever possible. In some instances it was found impossible to lift the drop suction pipes for the purpose of fitting the flanges. In these cases the casings were cut off a few inches below the "T" and a poured lead joint about 6 in. deep was put into the annular space and thoroughly caulked. There is no doubt that such a joint is fully as impervious as a flange coupling. Concrete manholes were ordered built at each of these wells.

After these repairs were completed samples taken from the Townsend St. station, which had previously been connected so as to pump to waste for sampling purposes, showed continued gross pollution. It was attempted to obtain samples from the individual wells by shutting off all but one and pumping that in the usual way. This proved unsuccessful, however, due either to inability to shut the valves at the various wells absolutely tight or to the fact that the suction line and pump had become so seriously polluted as to communicate contamination to pure water, which might be drawn to the well being pumped. In order to study the individual behavior of each well sampling devices were installed at the top of each well between the "T" and the horizontal suction line. This made it possible to pump all the wells at the same time and to obtain samples from each before its output came into contact with that of the others.

After a series of about 75 samples had been collected from the individual wells the State Department of Health ordered on June 14th wells "E" and "F" permanently disconnected and plugged. Marked improvement in the quality of the water delivered by the Townsend St. pump followed immediately and subsequent samples have indicated that the other wells have slowly returned to their normal state of purity.

Typhoid Epidemic

The number of cases of dysentery which occurred during March and April is conservatively estimated at 3,000. The fact that dysentery is not a reportable disease in Michigan, makes it impossible to obtain complete statistics of the number of cases. Dysentery was followed by an epidemic of about 82 cases of typhoid fever, with eleven deaths.

It is, of course, impossible to estimate the economic loss directly due to the pollution of the Lansing water supply, but some idea of its magnitude may be obtained from the following table showing the affect of the epidemic on the employes of the Olds Motor Works.

EFFECT OF THE DYSENTERY EPIDEMIC ON OLDS MOTOR WORKS

Date	Men Absent	Output Cars
March 19	171	138
March 20	418	88
March 21	1.703	19
March 22	2.100 (shut down)	0
March 23	Sunday	0
March 24	486	104
March 25	413	137
March 26	395	123

Normal production, 150 cars per day.
Loss of wages, $30,000.

The officials of the Reo Motor Car Co. report the average number of men absent from that factory March 20th

Cast Iron Pipe in the City of Albany

From an old "Minute Book" of the Bureau of Water of the City of Albany, N. Y.—*By courtesy of Wallace Greenalch, Water Commissioner.*

At a meeting of the Trustees of the Albany Water Works, at the office of the Treasurer on the 18th March 1813.

Present—The President—Mr. Hale, Mr. Hutton & Mr. Brinckerhoff.

A Communication from Stephen Van Rensselaer Esquire was read and ordered to be filed.

Resolved that the Clerk Cause the following advertisement to be inserted in the several news-papers printed in this City, for one month—to wit.

"Cast iron Conduits for the Albany water works wanted.
"Notice is hereby given, that proposals in writing will
"be received by the Subscriber, in behalf of the Trustees of
"the Albany Water Works, for furnishing, by contract
"one hundred tons of Cast iron Conduits of a bore of six
"inches diameter, three feet in length, and five Eighths
"of an inch thick—The proposals are to be accom-
"panied by two pipes, Connecting together, Spigot and
"faucet fashion, with an entrance of two inches, as
"samples of the Casting, and must be forwarded to the
"Subscriber, by the first day of May next, and are to spe-
"cify the shortest time at which the above, or any less
"quantity of such Conduits, can be delivered at the City
"of Albany. By order of the Trustees of the Albany W. Works
Albany March 1813. J. V. S. Clk."

At a meeting of the Trustees of the Albany water works, at the office of the Treasurer on Saturday the 1st May, 1813.—

Present. The President—Mr. Hale, Mr. Hutton & Mr. Brinckerhoff.

The Treasurer laid before the board sealed proposals from applicants for furnishing Cast iron conduits, agreeably to the advertisement published by the board, which when opened, were found to be as follows, to wit:

1. From Thomas Trenor of Bennington, offering to furnish them at the rate of $128 ℔ ton—of three feet in length.
2. From Eliphalet Sturtevant of New York, offering at $140 per ton of three feet in length, or $120 of two feet long.
3. From Holley & Coffing of Salisbury in Connecticut, offering them at $120 per ton in joints of the length of two feet only.

The Board having taken each of the said proposals into due Consideration—Thereupon

Resolved that the proposals from Holley & Coffing of Salisbury be accepted of; and that the Treasurer be directed in behalf of this Board to notify them accordingly and that the Board are ready to enter into a contract; also that the Treasurer direct said Contractors to prepare and send on to this City without delay, two hundred joints of two feet long Carefully Cast, as a fair sample of the work, agreeably to a description to be laid down in paper by the Superintendent and enclosed to them, in order that

There is now 164 miles of cast-iron pipe in the water system of the City of Albany, and much of the pipe bought in 1813, though not now in use, is still in the ground in perfect condition.

THE FIRST CAST IRON PIPE EVER MADE IN THE WORLD'S HISTORY IS STILL IN SERVICE
SERVICE
CAST IRON PIPE
MEASURED BY
CAST IRON PIPE
CENTURIES
MORE THAN 250 YEARS OLD

The Cast Iron Pipe Publicity Bureau

1 Broadway NEW YORK

to April 10th as 150. Loss of wages $15,000. Estimated loss to the Company $40,000. This factory employs about the same number of men as the Olds Motor Works.

Chlorination Renders Water Supply Safe

Chlorination has rendered the Lansing city water supply safe for domestic purposes since April 1st. Systematic sampling several times each week was carried on until about August 1st., after which the interval between the collection of samples was considerably increased because no serious results had been found. The city has provided itself with chlorine machines and installed them at all stations except Seymour St. where the results of continued sampling justify its use without treatment. Over 800 samples of water were collected and analyzed during the course of the investigation. A chart has been prepared on the basis of these analyses showing the progress of the typhoid epidemic and the results of the tests, together with the stage of the river and record of rainfall for the entire period covered by the investigation.

Lessons from the Epidemic

The principal lesson we should learn from this epidemic is that deep wells situated in the midst of urban development require the same watchful care as would be accorded to a shallow well supply or to a surface supply known to be subject to periodical contamination, even though their depth and manner of construction would seem to preclude the necessity for such care. Assuming that such wells are constructed in the best manner possible there are still three avenues by which dangerous pollution may suddenly gain access: First, Deterioration in joints and piping. Second, Pumping in excess of the normal capacity of the wells tends to open the texture of the rock in the case of sandstone and to enlarge any fissures that may be present, and thus make the entrance of surface water seepage easier. Third, The careless abandonment of old wells penetrating the same water-bearing stratum, whether drilled for water, oil or salt, without plugging them tightly enough to exclude surface water.

It has been suggested that the State of Michigan pass a law requiring all such wells to be plugged. It is doubtful if such a law would be feasible. It might look effective on paper but it would seem that its enforcement would be attended with many difficulties.

In the construction of deep wells we certainly need a better class of workmanship than is often obtained and a thorough inspection of all that is going on during the course of the drilling for the purpose of ascertaining the exact amount of casing driven into the ground and of collecting samples of all the materials passed through during the operation. It is quite likely that in many instances double casings should be used, the first reaching down as far as it is possible to drive it into the upper layers of the rock, and the second placed inside and extending to a depth sufficient to cut off all ground water likely to be subject to pollution. A water tight packing should be placed between the bottom of the inner casing and the rock wall to accomplish this result.

The bitter experience of Lansing indicates that no matter how perfectly deep wells may be constructed and how remote their possibility of contamination may seem to be it is a matter of the greatest importance that systematic sampling be carried on with sufficient frequency to detect any possible dangerous symptoms before they reach epidemic proportions.

The foregoing paper by Maj. Rich was presented before the Sanitary Engineering Section of the American Public Health Association at its latest annual meeting.

HOW THE RADICAL LABOR ELEMENT IS BEING CONTROLLED IN SEATTLE, WASHINGTON

By F. R. Singleton, of Publicity Department, Associated Industries of Seattle

Seattle is breaking the domination over her industries of the radical element of organized labor which has held almost absolute sway in that city for the past three years, and has so restricted production and increased production costs that her ship yards, lumber mills, and many lesser industries have been finding it hard to compete with those in which the labor situation was less acute. She was beginning to lose commerce to other Pacific ports where the labor cost of handling cargoes was less. She was losing new industries seeking location on the Coast, which avoided Seattle because of industrial conditions.

Seattle Going "Open Shop"

Seeing her opportunity of becoming the greatest city on the Pacific Coast and one of the great ports of the world slipping away from her, Seattle has risen in the might of an American city, and is breaking the tightening bonds which were beginning to strangle her industries and commerce. Seattle is rapidly going "open shop." Seattle has declared her independence of organized labor rule and is refusing even to deal with the radicals in control of organized labor in the city, whose course since the signing of the armistice has proven them to be no better in their actions, sentiments and purposes than the I. W. W.

They do not call it "open shop" in Seattle. They call it the "American Plan of Employment" which, as defined by the "Associated Industries of Seattle," the organization leading the movement to success, means that every man shall be protected in his inalienable right to work, regardless of political, religious or labor affiliations; that every employer shall be protected in his right to run his own business and to hire employes without having to gain the permission of an autocrat of labor.

Public Opinion Gains Control

The open shop is being established in Seattle by the breaking of a series of strikes, designed by the radicals in the labor movement as a substitute for the general strike, by which they planned to bring about the paralysis of industry in Seattle and so discourage employers that they would be able to take over industry themselves under a soviet system. The open shop is being established by the force of public opinion as the result of an intensive campaign in the Seattle dailies, conducted by the Associated Industries. Pages on pages of advertising informed the Seattle public that the industries and commerce of Seattle were being attacked by the radicals of organized labor and that, if their domination over organized labor and the industries and commerce of Seattle were not broken,

the population, industry, commerce and prosperity of the city would decline.

Americanism in Industry

The response was prompt. The Chamber of Commerce, the Rotary Club, the Kiwanis Club and all other civic and commercial organizations of the city took action demanding the end of radicalism and sabotage in Seattle, and endorsing the open shop in industry. These declarations were published in page advertisements, and at the end of ten days of this intensive advertising, the public sentiment in Seattle was overwhelmingly in favor of Americanism in industry, and the power of the radicals was broken. Where, a year ago, the closed shop was strongly supported by public opinion in Seattle, today the public is demanding open shop, and any employer who signs a closed shop agreement with any labor union will be exceedingly unpopular.

Movement Not Against Unionism

The movement in Seattle is not against unionism, but against the domination of unionism and industry by un-American radicals. The Associated Industries, in its publicity, has repeatedly recognized the right of workers, as well as employers, to organize; has endorsed the principle of collective bargaining; has declared that there shall be no discrimination against union men under the American Plan, and has urged employers not to take advantage of unemployment to cut wages. The Associated Industries has been consistently American and so has won the confidence of the public and of the conservatives of union labor.

Loyal Workers Declare Independence of Radicals

Seattle is winning industrial independence by the power of organization. While the individual employer, with a few exceptions, in the past has been unable to withstand the radicals who ruled Seattle labor and has bowed to their dictates, the employers of Seattle collectively, banded together along with many other citizens in the Associated Industries, have been able to defy the radicals and to establish open shop in every Seattle industry in which a strike has occurred or a contract broken by the unions, during the past three months. In rapid succession, the building industry, the job printing industry, the merchant tailors, the dyers and cleaners, the jewelers, the shoe repair shops and the master piledrivers have declared and established their independence of radical domination, meaning that the unions have lost control of industries in which thousands of men and women are employed.

Existing Contracts with Labor Respected

Seattle would progress on the open shop road much more rapidly, under the stimulus of public opinion, if it were not for the fact that the Associated Industries has taken a strong stand against the breaking of existing contracts with labor unions. One of the cardinal principles of the organization is that employers must keep faith with each other and with employes, and so the open shop movement progresses as strikes occur, unions break contracts and existing contracts expire.

General Strike Starts It All

The Associated Industries was formed in Seattle as a result of the general strike of last February. The revolutionary character of that attempt was recognized by the public and the necessity of cleaning the radicals out of organized labor was brought home. There was much open shop sentiment as a result of the general strike but, as a large percentage of union labor in Seattle is loyal American, the majority of employers favored giving the unions a chance to clean house of the radicals before taking any drastic steps. The Associated Industries, led by Frank Waterhouse, a leading citizen of Seattle, with large shipping and industrial interests, was organized to band all employers together in an effort to bridge the chasm between the employers and employes by giving the employes such a square deal that the revolutionary appeals of the radicals would fall upon deaf ears, and that labor would throw the I. W. W. and other radicals out of control of Seattle unions. During last spring and summer, the Associated Industries grew rapidly in membership and influence, and endeavored consistently to cultivate better relations between employers and labor, and to promote a square deal for the employe, the employer and the public in general in Seattle—but the unions failed to clean house.

Impossible Wage Demands

The final declaration for the open shop in Seattle came when Mr. Waterhouse became convinced that the radicals still in complete domination of the unions, were attempting, by a series of strikes, to paralyze the industries of Seattle and take them over. Advance information of this plan was verified by events. On Sept. 2, the carpenters and some of the other unions in the building trades struck to enforce impossible wage demands, in spite of the vital public need of more homes and other buildings and the willingness of the employers to arbitrate. They arrogantly stated that their demands involving $10 a day wage for carpenters and other exorbitant increases, must be granted first, and then they would talk arbitration. The job printers, the tailors, the dyers and cleaners and piledrivers followed in rapid succession and the air was full of talk of strikes in other industries.

On October 14, Seattle contractors, backed by the Associated Industries of Seattle, declared open shop in the building industry, after six weeks of fruitless negotiations with the unions to bring the strike to a settlement on terms which would not make it impossible for new buildings to be undertaken. Their action, announced in page advertisements in the daily newspapers, was applauded by the public. On October 31, the Building Trades Council voted to call the strike off. The strikers returned at their old wages and under open shop conditions.

It took only one seven-column, fifteen inch advertisement in the Seattle dailies, announcing open shop and inviting men to work under the American Plan, to establish the piledriving industry on the open shop basis. The fight has been harder with the job printers, the tailors and the dyers and cleaners, but the employers in each of these three industries declared unequivocally for the open shop and are making it stick. The employing printers have been drawing men from all over the United States to take the place of those strikers who refuse to return to work, and are gradually building their forces up to normal. The tailors have been greatly helped by the fact that all the associations of employing tailors in the cities of the Pacific Coast, as far south as San Diego, California, have followed the example of Seattle and have declared open shop. The dyers and cleaners have gotten back many of their old employes and are back to normal in their operations. To have granted the demands made in any of these lines would have amounted practically to turning over the business to the employes.

Unions Turn Against Strikes

The declaration of open shop by the building contractors was a body blow to union labor radicals and disarranged their plans to bring about industrial paralysis by involving one industry after another in strikes. A sentiment against strikes developed in the unions, and no more strikes were called.

Once decided for the open shop, the Associated Industries conducted an intensive publicity campaign in the three loyal daily newspapers of Seattle. In a series of ten page advertisements, beginning October 29, the Associated Industries aroused the community to the danger of radical domination and demanded that the industries of Seattle be run on the American Plan. The campaign was assisted greatly by the newspapers themselves in strong editorial and news publicity.

At the end of ten days, public sentiment was strongly in favor of the open shop.

Then came the murder of four former soldiers by the I. W. W. during the Armistice celebration parade at Centralia, Washington, a few miles from Seattle and the suppression by the government of the disloyal Union Record, the organ of the radicals to crystallize sentiment in Seattle against the Reds in control of labor. The sentiment grew so strong that the elimination of the radical alone can save unionism in Seattle.

Movement Spreads to Other Coast Cities

The movement for the American Plan, the open shop, has spread from Seattle to the other cities of the Pacific Coast, and the Pacific Coast expects to see it sweep the country until the right of all Americans to work without being subjected to coercion and intimidation is established. San Francisco, Portland, Spokane and Tacoma have organized "Associated Industries" on the Seattle plan. The Pacific Coast is making a new declaration of independence for America.

FLUSHING AND CLEANING WATER MAINS

By William Molis, Superintendent of Water Works, Muscatine, Ia.

Our way of flushing and cleaning water mains at Muscatine, Ia., is to gate off a main on both sides, say for a half mile or a few blocks at one flushing. We start at some high point in the system, either by opening hydrants or a flush gate if we have them. If no flush gate is available, then we start at the high point by opening hydrants down the line until we get to the end. This same procedure must be taken in the cross sections, the same as for main lines, said Mr. Molis in addressing the Iowa Section of the American Water Works Association.

This flushing process is mostly done at night, when it will inconvenience the least number of people. In the outlying districts we usually flush mains in the day time. We must have a good force of men on the job to be ready to answer a fire alarm to open up our gates quickly.

Flushing a 16-in. main or larger is not an easy task; we have to open a good number of hydrants to do the work right. Where we have a streamer connection on our hydrants by opening these we get a good flow and it is easier on the pavements.

We have two flush gates in our system, one with a 6-in. and the other an 8-in. opening, which opens into a large sewer or creek. I would not advise emptying into a sewer that is too small, as this causes all kinds of trouble by overflowing into cellars.

If you have much deposit to wash out, you will surely have some trouble with your meters, which have to be cleaned out after flushing.

EXPERIENCE WITH A BROKEN 24-IN. WATER MAIN

By S. L. Etnyre, Superintendent of Water Works, Council Bluffs, Iowa

Before describing our recent experience with the blow-up of a 24 in. water main, I will briefly describe its history and its importance in the operation of the plant, said Mr. Etnyre, in addressing the Iowa Section of the American Water Works Association.

This main was laid on Broadway, in the year 1882, running from the Broadway Pumping Station at 37th street to 21st street, a distance of 8,500 ft.; from this point to 8th street is 5,323 ft. of 20 in, thence to the high level storage reservoirs, 5,200 ft. of 16 in. Up to 1915 all the water for the city was supplied through this 24 in. pipe. On account of the importance of this main, and owing to the fact that with increased consumption the pressure materially increased, it was found necessary to lay an auxiliary 16 in. main from the Broadway Station to 21st street, and this was completed in 1915. With the reservoirs' storage it was calculated that the 16 in. would supply the city in the case of any mishap to the 24 in. Two 24 in. valves were cut in the Broadway main and a drain laid into the sewer from the main at its lowest point.

In 1884 the Broadway main broke at 30th street, a section 12x24 ins. blowing out at the bottom. No flaws were noticeable. In 1908 this main broke at 28th street, a triangular section 18 ins. at the base and 6 ft. long blew out at the side. No flaws were noticeable. In 1909 on the west side of 34th street the pipe broke as if pulled apart. No flaws were noticeable.

The normal pressure carried by this pipe was 105 lbs. On October 6, 1919, our last break took place on the east side of 34th street, a 12 ft. section splitting on its side its entire length. A Crosby pressure chart taken at the pumping station showed that the pressure dropped suddenly from 125 lbs. to 17 lbs. The volume of water escaping through this break was enormous, resulting in the drop of pressure all over the city, and many parts even at moderate elevations were without water until the valves were closed. From measurements taken at the high level reservoir, making allowance for the normal city consumption, over 1,000,000 gals. had run out through this break. Fortunately, however, there was no material damage to private property.

The chart also plainly showed the time of closing the valves. Some time was lost in this work by the breaking of a 24 in. valve stem. Pumping to the city through the 16 in. main was started immediately upon the closing of the valves. The drain valves into the sewer were then opened, and when the pipe was broken into it was found to be entirely free of water. It is also remarkable that all valves proved to be water tight. The defective section was broken up with sledges, and replaced with a new length and the main ready for service within 15 hours from the closing of the valves. During the time the repairs were being made less than 1% of the consumers of the city were without water, and but for the breaking of the valve stem above referred to less than one-half of the 1% would have been without water.

From examination of a small piece of the pipe along the line of fracture, it was noticed that the original casting is well preserved and that at one point some of it shows on the fractured surface, indicating a casting defect at this point.

A careful examination of the fracture, however, does not warrant the assumption that this condition prevailed to any extent. The thickness of the shell along this line was a good average with the rest of the pipe, being approximately 1 in. The question that now naturally suggests itself is: "What is the reason for this break?" Of course, the water pressure was partly responsible, but is not the complete answer. We know by looking at the pressure chart it was not caused by "water hammer." The thickness of the shell seems adequate for the pressure it has to carry; it is a good grade of metal and there is no evidence of serious flaws on the fracture line or elsewhere when broken into small pieces.

TEARING DOWN A BRICK SMOKE STACK

Disposing of an old brick smoke stack by the usual method is a slow and costly procedure. Scaffolding has to be built and workmen begin at the top removing the bricks one by one with a mortar pick.

A stack stood at the plant of the Cadillac Motor Company, Detroit, Michigan. It was 125 ft. high and built round on a hexagonal base. It was desired to remove the chimney quickly so that rebuilding on the site could be promptly gotten under way. It was decided to blast it down with dynamite as surrounding buildings had already been torn down and no damage was to be feared.

Ten holes were drilled in three faces of the hexagonal base. They were made about 18 in. deep and 3 ft. apart. All holes were on the same side of the stack—the side toward which it was desired to have the stack fall in case it should fall at full length on the ground.

Two and a half pounds of dynamite were loaded in each hole and well tamped in with moist clay. Electric blasting caps were used so as to get an instantaneous shot. In all 25 lbs. of 40 per cent. dynamite were used.

The shot was a success from every standpoint. The result was that the stack merely crumbled on its base, the blast having shot its support out from under it. No bricks were scattered beyond 20 ft. from the base. Even if buildings had been very near, no damage would have resulted.

The fall broke up the chimney into sections small enough to be handled by one or two men, although comparatively few of the bricks were broken except immediately contiguous to the blasts.

It required less than two hours to tear down the stack and but a few additional hours to clear away the bricks and mortar so that building operations could be commenced on the site.

MORE ATTENTION TO HUMAN SIDE OF MUNICIPAL ENGINEERING

Presidential Address of E. R. Conant at Annual Convention of American Society for Municipal Improvements.

Let us consider not only the technical, but also to a greater degree than heretofore, the human side of municipal engineering and endeavor to start a movement that will stimulate the interest of engineers, and especially of municipal engineers along social and economic lines. That the engineer's position before the public may be strengthened by dealing with the human side of the engineering question is illustrated by the recent results obtained by the American Association of Engineers, a comparatively new organization. In that association the engineers are united in a single purpose, and by their intensive co-operation there is better opportunity for properly dealing with communities through representatives from their organization, urging thtir cause and exerting their influence in order to obtain recognition.

Engineering Articles in Popular Mediums.

While it is very well to create a good feeling between us, to maintain a high standard of ethical honor, yet the engineer must become more closely identified with public and political affairs. He must exert his influence in his community by appearing at public assemblies and by taking part in public gatherings when the interests of the community are at stake. He should not alone be satisfied with preparing technical articles for exchange among his brother engineers, but, in the writer's opinion, the confidence of the public in general in the engineer would be promoted if he would prepare articles involving engineering practices and discussions of interesting engineering works, for magazines that have a wide circulation. If these articles, prepared by the engineer, were disseminated before the public in terms not too technical, it would be one means of educating the public to the value of the engineer. We note that during the war much appeared in the press concerning the engineer's part upon the battle-field and in war industries work, and why, in peace, should this not be kept up?

Licensing

The writer advocates the promotion and protection of the professional engineer, as well as the protection of the public, through a licensing system under state control, whereby the engineer must qualify for every special class of engineering covered by his license. Iu certain states this is being done, and we can go to far away Africa to observe an example as regards the recognition of the professional engineer, as the majority of the general superintendents and assistants operating the railroads and harbors, as well as all land surveyors, are licensed before they can be employed.

Better Compensation

The reconstruction period is wrought with perils only labor and tradesmen obtain. The relation between employer and employe must be determined upon the basis of fair play and good will. Engineering organizations should consider and participate in working out plans whereby the conditions of a large body of engineers and allied professional men can be ameliorated. We must co-ordinate our efforts and lay out a definite plan of activities.

One of the organizations that is advancing the status of the municipal engineer is the City Managers' Association. The growth of this recent organization shows that the recognition of the engineer is increasing. Of late years the city manager plan has received an impetus and, in many respects, it appears to have advantages over any other plan before tried. The City Managers' Association and our organization encourage a form of municipal management that promotes efficiency and economy, and the two associations should co-ordinate their efforts.

Improving the Conditions of the Municipal Engineer

Let us deal, for the moment, with the municipal engineer, and discuss how his condition can be improved. We have referred to the city manager plan, but this plan must originate in a community by the public, but at the same time, the engineer can be instrumental in initiating and furthering the movement, whereby the public may be educated to the plan. The engineer, to improve his condition, should be interested in economic and social problems that arise in his community. What a small per cent. of engineers are willing, or are capable, of taking part in discussions at public meetings? How very few furnish articles to the press dealing with the work that they are engaged upon or, outside of this, touching upon problems that mean so much to a community? Engineering articles that would be laid before the taxpayer must be given in a lucid and not too technical manner. At this time they are needed to off-set a large amount of literature that is distributed for the purpose of aiding commercialism and which often misleads the public. The engineer should be able to combat detrimental influences and should have the character and stamina to fight his case, and endeavor to make the public understand and realize that the engineering profession is as important as the profession of law or medicine. The value of information and advice to the public is largely based upon its source. The best corporation lawyer in the world could not give as sound engineering advice as the average technical engineer. The honest politician attempts to mould the public mind for the public's good, but he cannot be considered competent to speak intelligently on engineering matters or policies. The engineer of today, to improve his status, should not confine his activities to as great an extent upon technical problems as in the past.

The best interests of all engineers, and especially of municipal engineers, are furthered by their becoming identified with organizations such as ours, the American Association of Engineers, the City Managers' Association, and perhaps others.

Engineers Should Be More Independent

Some states are forming independent societies composed of municipal engineers and allied professional employes. If competent engineers would only accept municipal positions where politics did not enter to such an extent as to cripple their engineering activities and work, and who, when petty political activities did enter, would acquaint the public with the true conditions, and then, if necessary, resign, the time would speedily come when better conditions would exist. It is unfortunate that there are so many engineers who are willing to act and serve under the power and dictates of the politician. A licensing system properly conducted, co-ordinating with state societies of municipal engineers, would, to a considerable degree, bar many incompetent men who call themselves engineers from obtaining municipal situations that should be filled only by the competent engineer.

Assuming the city engineer to be competent and that he remains so, and providing his tenure of office is to extend over the period that permits of improvements being made from funds that are available during his employ, there would be a great incentive for him to plan work for the future, to store up valuable information, and if he plans his projects in a proper manner, to become a great benefit to the community.

The average layman, and especially the politician, either intentionally or unintentionally, usually do not understand the work and study of the engineer. They too often gauge his value by the amount of detail work he does, when actually, if he is a good administrative officer, he places this work upon his subordinates. The municipal engineer should be permitted to take part in the making up of budgets. In fact, he should almost be considered one of the administrative officers, to solve problems, even if a portion of the work digresses somewhat from strictly technical lines. He should become acquainted with laws and ordinances, and gain the good will of the legal department.

It is unfortunate that there is not a more general realization of the importance of designing and planning work by the municipal engineer. This requires experience, skill and ability. The non-technical man is less capable of performing these functions than of looking after merely the construction and maintenance work. Information that comes to us indicates that the position and standing of the municipal engineer is improved, that the percentage of engineers employed by municipalities is greater than heretofore who are competent to plan work, who work upon their own initiative, and who refuse to be controlled by the political branch of the city administration.

Let us wake up to the fact that holding close communion among ourselves is very well in one sense, yet it does not awaken the layman and public officers to the value of the engineer; therefore, let us resolve to go outside of the camp and employ proper, ethical methods of educating the public to the value of the engineer's services.