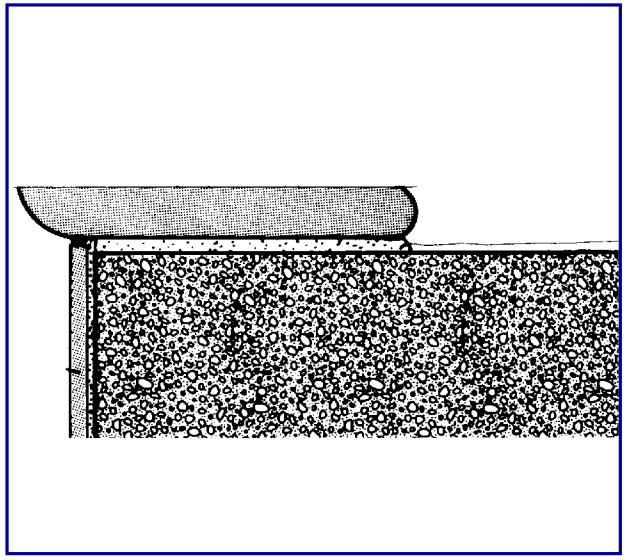
HOW-TO BOOKLET #3062

CONCRETE MIXING

TOOL & MATERIAL CHECKLIST

- ❑ Cement
- ❑ Gravel
- ❑ Water
- ❑ Shovel
- ❑ Sand
- ❑ Mixing Tub
- ❑ Mixing Hoe or Mixer
- ❑ Gloves

Read This Entire How-To Booklet for Specific Tools and Materials Not Noted in The Basics Listed Above.



Concrete is a mixture of sand, gravel or other aggregates, and Portland cement (not a brand name) mixed with enough water to form a semi-fluid state. The mixture is then placed into a form to harden. In its pre-mixed state, it is known as "cement." Once mixed and hard, the term becomes "concrete," e.g., a "bag of cement;" "a concrete driveway or walkway."

There are many manufacturers of cement, which comes packaged in 1-cubic foot bags that weigh 94 pounds. There are five basic cement types. The type most used in home construction is Type I, Type II is used for massive structures such as bridges and pilings and provides some sulfate resistance. Type III hardens quickly and it generates more heat in the drying process. It most commonly is used on commercial structures such as smoke stacks, in which the forms are moved quickly as the material sets up. It is also a product used for winter construction and rush jobs. Type IV is a low-heat producing cement and it is used for massive structures. Type V offers a high sulfate resistance; it is used in areas with high sulfate content in water and the soil.

AGGREGATES

The second material used in concrete is called aggregate which is a fancy catch-all term for sand and gravel. Aggregate ranges in size from dust-sized pieces of sand up to 2-1/2 inch stones used as larger "fill." Ideally, aggregate combines these sizes to provide the strongest type of concrete; the small particles fill in around the larger particles.

For most residential masonry projects, the aggregates used are sand and gravel or crushed stone. Do not use so-called "sharp sand" that is sometimes used for mortar. "Bank run" sand is best because the rounded, various-sized particles of this type of sand work to an advantage in the concrete. The sand particle size can be as large as 1/4-inch in diameter.

Gravel/stone. The second aggregate, which is called coarse aggregate, can be either gravel or crushed stone. The stones may be as large as 1-inch. They can be screened for uniform size, or they can be bank run, which may also include some coarse sand along with the gravel sizes.

Usually, the larger the aggregate, the more economical the material will be to buy. The concrete will require less cement and the finished project will suffer less from shrinkage. However, don't use aggregate larger than one quarter of the thickness of the placement. This means that if the concrete will be 4 inches thick, you can use up to 1-inch size gravel or crushed stone. A 6-inch thick slab can include 1-1/2 inch stones.

Another consideration is the practicality of moving a mix containing the larger stones. If you have to shovel the concrete some distance down a form, it is a lot harder to shovel the larger stones than the smaller aggregates.

It is a general rule to place concrete as close to its final location as possible. Excessive movement can separate the water from the cement aggregates. If you must move the concrete more than 10 feet in the form, use 1/2-inch or smaller aggregate. Larger 3/4-inch, stone can be used in a flat slab where you won't have to move the material quite as far. For a large foundation, where you will be dumping directly into the forms and you won't need a smooth surface, you can use larger aggregates. Aggregate size also depends on the size of the spacing in the reinforcing bars or mesh. The stones should be no larger than three-fourths the opening between the bars, or the stones can get caught in the mesh of the bars and prevent the concrete from settling into position.

WATER

The third ingredient in concrete is water. The water should be free of foreign materials and impurities. A good rule is to use only water that is fit to drink.

You don't want to use water out of a stream or lake that is muddy and dirty. If you do use clean lake water, however, filter it some way so it is free of any foreign materials such as leaves and grass.

HOW MUCH CONCRETE MATERIAL DO YOU NEED?

There are several techniques to prepare concrete for a project:

- You can buy the dry ingredients separately and mix them.
- You can buy a dry complete mix to which you simply add water and stir.
- You can buy concrete from an already-mixed company. This is delivered to the project site and is ready to go.

In the first technique, you will need a mixing machine or a box in which to mix the different dry ingredients. This is hot and heavy work, although it doesn't take much skill.

In the second technique, you also will need mixing facilities. This technique is expensive because the yield from a typical 80 pound bag is 2/3 square foot. This bagged material is excellent for small projects such as anchoring a basketball goal or clothesline post or used as a pothole or broken curb patch.

The third technique is ideal for larger jobs. You build the necessary forms, call the company, and a driver arrives at an appointed time and dumps the concrete load where you want it. It is up to you, of course, to shovel, level, float, and finish it. Be aware that most already-mixed plants won't deliver less than 1/2 yard and some won't deliver less than one full yard of concrete.

CONCRETE FORMULAS

Cement, sand, coarse aggregate and water must be present in the correct proportions to create a durable, long-lasting job. Incorrect proportions result in a project that will crack, flake, or chip. There should be enough large aggregates to make an economical mix, yet enough small aggregates to fill the spaces around the larger ones—and enough cement to hold all materials together. In addition, there should be the right proportion of water to provide proper hydration. Either too much or too little water can cause big trouble.

Adding water. Adding the correct amount of water in a concrete mix is a tough problem. It is compounded by the fact that sand contains varying

CUBIC FEET OF CONCRETE IN SLABS

Area, Square Feet (Length x Width)	Thickness, Inches 4	5	6
50	17	22	25
100	33	41	50
200	68	84	100
300	100	124	150
400	135	168	200
500	168	208	250

TABLE 1: PROPORTIONS BY WEIGHT TO MAKE 1 CU FT OF CONCRETE

	Air-entrained concrete				Concrete without air			
Maximum-size coarse aggregate, inch	Cement lb.	Sand lb.	Coarse aggregate lb.*	Water lb.	Cement lb.	Sand lb.	Coarse aggregate lb.*	Water lb.
3/8	29	53	46	10	29	59	46	11
1/2	27	46	55	10	27	53	55	11
3/4	25	42	65	10	25	47	65	10
1	24	39	70	9	24	45	70	10
1 1/2	23	38	75	9	23	43	75	0

* If crushed stone is used, decrease coarse aggregate by 3 lb. and increase sand by 3 lb.

TABLE 2: PROPORTIONS BY VOLUME*

	Air-entrained concrete				Concrete without air			
Maximum-size coarse aggregate, inch	Cement	Sand	Coarse aggregate	Water	Cement	Sand	Coarse aggregate	Water
3/8	1	2 1/4	1 1/2	1/2	1	2 1/2	1 1/2	1/2
1/2	1	2 1/4	2	1/2	1	2 1/2	2	1/2
3/4	1	2 1/4	2 1/2	1/2	1	2 1/2	2 1/2	1/2
1	1	2 1/4	2 3/4	1/2	1	2 1/2	2 3/4	1/2
1 1/2	1	2 1/4	3	1/2	1	2 1/2	3	1/2

* The combined volume is approximately 2/3 of the original bulk.

amounts of water. Sand falls into several wet categories: damp, wet, very wet. To determine which, squeeze a handful of sand into a ball. If it holds its shape, yet leaves no noticeable amount of moisture on your hand, it is considered wet sand.

Damp sand will fall apart after being squeezed. Very wet sand holds its shape and leaves moisture in your hand. In fact, water may run out of your hand. Construction sand can usually be considered "wet."

The charts give water quantities on the basis of **wet** sand. If you have damp sand and follow Table 1, decrease the quantity of sand by 1 pound and increase the amount of water by 1 pound. If the sand is wet, use 1 pound more sand and 1 pound less water. If you follow Table 2, it is best to use wet sand, since water affects the bulk of sand.

Proportions also vary according to the size of the coarse aggregates in your mix, and the addition (or exclusion) of air-entraining agents.

Air-entrained concrete. Air-entrained concrete is necessary in areas in which concrete must withstand freezing and thawing temperature shifts and de-icing treatments. Air-entrainment is the process of introducing millions of microscopic air bubbles into the concrete. The air bubbles permit enough space for the absorbed water to expand when the water freezes, so the concrete does not crack or break. Air-entrained concrete is also easier to place and finish than regular concrete, because the tiny air bubbles act as lubricants while the concrete is still plastic.

Air-entrained Portland cement in specially marked bags can be purchased at many building supply stores. However, if it is not available in your area, you can add an air-entraining admixture. This is available from a hard materials dealer—one who handles cement, stone, rock, gravel, and so on.

Whether you buy already bagged air-entrained cement or add the agent, hand mixing is ineffective for entraining air. A mixing machine must be used.

FIGURING CUBIC FOOTAGE

The biggest problem for the non-professional is figuring the amount of concrete needed and then figuring the amount of materials or ingredients needed to make up the concrete. Here are several tips to make the job go easier:

Measure the inside of the form and then convert all dimensions to inches. Multiply the width times the length times the height or depth of the concrete—depending on whether the placement is a slab or wall. This will provide the cubic volume in inches. To get cubic feet, divide this figure by 1,728. The table on page 2 is a quick way to figure the amount of concrete you will need for a given measurement. Multiply the length times the width of the slab. Then refer to the amount given for the depth of slab. The table gives the amounts for 1 cubic foot. Multiply the proportions for each material by the amounts given in the table. The result will give you a good idea of the amounts needed of each component material.

If you are building a large patio or driveway, you should work in terms of cubic yards. To convert from cubic feet, divide the footage by 27.

It's a good idea to plan for more concrete than you need. The amount of extra material depends on the project. Plan for between 10 and 15 percent for walls and footings and 20 percent for slabs.

MEASUREMENT TECHNIQUES

Once you have determined the amount of concrete needed, the next step is to determine how much of the different materials you will need—if you are mixing the concrete yourself.

Volume method. This is perhaps the easiest method. Use a shovel to move the cement, sand, and gravel into the mixing location and then just count the shovelfuls. If you're using a power mixer, turn on the mixer and throw in the shovelfuls. The dry materials will mix together as you go.

Weight method. Use a specially marked bucket. Weigh the bucket and then determine a set weight such as 10 pounds. Weigh each ingredient separately and make an identifying mark for the level of 10 pounds for each ingredient. Then just count the bucketfuls as you put the correct proportions into the mixing container. Cement: red; sand: yellow; gravel: green.

Adding water. Measure the amount of water you add. If you get too much water and do not have enough cement to add to it to correct the situation, you can ruin an entire batch of concrete. Use a bucket that has a known capacity so you can make an accurate measurement.

The strength of the concrete will depend on the amount of water used. If too little water is used, there won't be enough to provide a good fluid state that can be worked easily and will ensure that each and every solid particle is coated and bonded. You should use as much water as possible without creating a problem with the workability and smoothness of the concrete. Too much water results in concrete that is unworkable and hard to set up. The cement particles will float up to the surface and, worst of all, weaken the concrete.

As a rule of thumb, professional masons consider 6 to 7 gallons of water the correct amount of water per bag of cement, depending on the dampness of the sand the size of the aggregate.

TROUBLESHOOTING PROBLEMS

Below is a list of problems that can occur when working with concrete mixtures. They may be helpful when you get into trouble:

Too much, too little water. One problem that you will soon figure out is that the more water is added to the mix, the easier the mix is to work, and also the easier it is to place the mix into the forms.

Try pulling the concrete up in a series of ridges with a hoe. If the ridges slump back down and can't be seen easily, there is too much water. If you cannot create distinct ridges, there is too little.

Poor mixing. Make sure you have mixed all the ingredients properly and thoroughly, scraping them from the sides and bottom of the mixing box. The concrete mix should be an even color. Light or dark streaks indicate poor mixing.

Remedying a poor mix. If the mix is too wet, it doesn't have enough sand and aggregate for the amount of cement paste. Add 5 to 10 percent more sand and aggregate, mix it well, and test. Repeat this until the mix is correct. Keep careful notes of the added amounts; when you make the new batch, you will follow the revised figures for sand and coarse aggregate.

If the mix is too stiff, it has too much aggregate. Don't try to remedy the problem by adding water alone. Instead, add a cement-water solution that has proportions of 2 to 1. Unfortunately, in most cases even this will not work and you will have to start from scratch with decreased amounts of sand and coarse aggregate. Experiment, keeping track of the decreased proportions, until you have a satisfactory mix. You may have to try several small batches before you produce the right mixture.

Mortar mixes. These can vary, of course, and there are lots of pet formulas floating around. Below is a good rule of thumb formula for Portland cement mortar and for masonry cement mortar. The formula makes just 1 cubic foot, of mix—enough to lay 25 bricks.

- **PORTLAND CEMENT:** 16 pounds of Portland cement mixed with 8-1/2 pounds of hydrated lime mixed with 100 pounds of dry sand. Add enough water to make a fluid, smooth mixture—about 2 gallons, maybe three. Check as you mix.
- **MASONRY CEMENT:** 31 pounds of masonry cement mixed with 100 pounds of dry sand. Add from 2 to 3 gallons of water, but check as you go.

USING ALREADY-MIXED

If you have a large project such as a driveway or patio, we recommend concrete from an already-mixed company. This company—or transit-mix concrete—has some definite advantages such as less cost and special ingredients such as air-entrainment.

There are several possible limitations, however, that must be considered before you order. The first is whether the truck can get to the forms. Most trucks have chutes that let the driver move the concrete as much as 20 ft. That is about the limit. If the truck cannot get close enough, you will have to move the material in wheelbarrows to the final location. If there is any doubt about your situation, and if you are dealing with a fair amount of material, it would be a smart idea to have the concrete dealer come out and look at the site.

Concrete trucks are extremely heavy. Fill areas around new house construction or even around older homes may be too soft to support the weight. The result is a stuck truck. A more serious result might be a tipped truck. Even in dry weather on normal ground, concrete trucks sometimes tear up a yard. Try to plan a route that will cause the least amount of damage to your property. If access is via your neighbor's property, better get permission for the truck to use this access before you order.

If you have to move concrete by hand, let the dealer know. Some companies charge for extra time. And, most important, have the job ready to go, i.e., the forms built and the finishing equipment handy. The driver will dump the load and go. You had better be ready to work the material. You won't have much time—usually an hour or less.

Ordering and scheduling. Just give the dealer the dimensions of your project. He will figure out how much material is needed. You often can buy reinforcing bars and mesh from this dealer if you can't find it at your home center or building products store. If you can, specify that the load be brought to you early in the morning. This timing will give you time to work the job properly.

Almost always, the truck will bring a bit more mix than you need. Since the truck may have to be rinsed and dumped, you should have an area available in which to dump the excess. If just a little is left over, the material can be put in a wheelbarrow and kept until the pour is completed. After the forms are filled, you may need a shovelful or two in places that looked full during the placement.

Soak the form and the subgrade with water the night before you start the job. Or moisten the subgrade just before the placement.

Make sure that you have properly prepared the site and that you have all tools on hand. It is smart to have a couple of helpers for a large pour.

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