Structures Congress April 2018

Structural Peer Review Practice in New York City

Dan Eschenasy, P.E., M.ASCE
Chief Structural Engineer, New York City Buildings

ABSTRACT

The 2008 New York City Building Code introduced the requirement for structural peer review of buildings meeting one or several special characteristics such as: aspect ratio of seven to one, taller than 600 feet, more than 1,000,000 square feet, etc. Based on the author's observations of some 38 peer review reports, the paper presents an analysis of several report elements–level of effort and reporting, relationship between engineer of record and peer reviewer, typical findings. The effect of the reports on the individual project and on the structural design community is discussed. In general, for these tall buildings there are two special areas of difficulty–foundation and wind design. Both are based on respective specialist reports. While the peer reviewer is expected to verify the conformance of the design with the soil and wind tunnel reports, these reports may not subject to a peer review.

INTRODUCTION

The paper describes the process and technical issues related to the application of the code required structural peer review in New York City (2014 New York City Building Code, Section 1617). There are several other major jurisdictions that require peer reviews for certain classes of buildings and their ordinances can be found online. It is though evident that the mere consultation of the text of any regulation is rarely sufficient for understanding the complex effect of the legislation and one needs to become aware of the actual practice as fashioned by the authority having jurisdiction accompanying procedures, accepted interpretations and enforcement. The paper is intended to illustrate the structural peer review process for the benefit of engineers and code writers working outside New York City (NYC).

The author was a member of the NYC technical committee that prepared the 2008 NYCB. During that period he also joined the Buildings Department (NYCDOB) and since 2012 he has been involved in the department's acceptance of peer review reports. The paper does not represent the NYC Buildings Department position, but only describes the author's personal observations drawn from the examination of 38 peer reviews reports that were prepared between 2012 and 2017. Note that for the remainder of the paper reviewed buildings shall indicate buildings for which structural peer review is mandated.

HISTORY

The 2008 New York City Building Code (NYCBC) was a comprehensive revision of the previous 1968 NYCBC. In general terms, the 2008 code followed the International Code Council (ICC) family of codes but also included several major additions and

modifications as deemed necessary by the ad-hoc technical committees. The structural chapter had several sections that did not exist in the 2006 International Building Code (IBC): Structural Integrity –Prescriptive Requirements (NYCBC 1615), Structural Integrity Key Element Analysis (NYCBC 1616) and Structural Peer Review (NYCBC 1617). Later versions of the IBC have incorporated some of the 2008 NYCBC provisions in a new Structural Integrity section (2009 IBC 1614). The 32 members of the NYC Structural Technical Committees met and debated these sections in various meetings starting in 2004. At that time the NYC population and especially the structural engineering community were still strongly under the impact of the events of September 11, 2001 and the subsequent FEMA and NIST reports. Introduction of significant new requirements usually faces opposition from developers afraid of potential increases in costs, but these new sections were adopted with minimal negotiations as they covered issues revealed by the recent disaster and that answered directly to the general consensus of increased safety. Of these three additional sections, the Peer Review section was the least subject to controversy. The finalization of the text was delayed by the discussions related to Structural Integrity – Key Element Analysis as previously it had been decided that the scope of both section would cover about the same type of buildings. Note that NYCDOB regulations mandate peer review in several other special cases (grade 100 high strength reinforcing bars, some wind turbine categories, etc.), but these are not discussed here.

The 2014 NYCBC that was adopted in the following code cycle modified the original 2008 text by excluding some types of seven story structures where bearing walls longer than 10 ft. support over 15% of the structure. All further references in this report refer to the 2014 edition of the code.

THE CODE REQUIREMENTS

Under the previous code (1968 NYCBC), the commissioner had the authority to order peer reviews on individual projects but this power had been exercised only rarely. The new section maintained the commissioner's authority to require a peer review when she saw fit, but also made peer review compulsory for several types of buildings.

The 2014 NYCBC Section 1617 Structural Peer Review indicates the categories of buildings that require peer review and specifies the items that need to be subject of the review. The code requirements are complemented by a Building Bulletin (BB 2015-031) that provides some clarifications on the formal procedure for submitting. BB 2015-031 states that the conclusions need to be clear and without any exclusion. The bulletin includes a standard form for the peer reviewer's final statement. Detailed instructions are provided for the specific steps required for those who elect a phased review submission (foundation and superstructure).

There are six categories of buildings that trigger a peer review report including mainly buildings with aspect ratio larger than seven, buildings taller than 600 ft. or with very large areas, stadiums or arenas for over 3000 occupants and essential facilities with of more than 50,000 sq ft.

The NYCBC 1617 section lists a minimum of 11 design items that need to be evaluated by the peer reviewer such as compliance with code and engineering practice, conformance with architectural plans and major mechanical installations. The reviewer is supposed to perform a sufficient number of independent calculations to verify adequacy of the design. Verification of compliance with structural integrity provisions is required, but design of cladding and various architectural features are excluded.

SELECTION OF PEER REVIEWER AND DISPUTES

The peer review report is intended to benefit the building owner and therefore, the reimbursement and the selection of the reviewer are left to the owner. Despite recent conglomerations of consulting engineer companies, in New York City there are a good number of engineering companies with principals that meet the high level of technical knowledge expected for the performance of the review – principals from 12 different consulting firms prepared the 38 reports discussed here.

The peer reviewer's qualifications need to be acceptable to the Engineer of Record (EOR). It is most probable that to some extent this procedure allows the EOR to offer selection suggestions to the owner. In fact, we observed that when an engineering company had several projects peer reviewed, the reports tended to have same peer reviewer.

With one exception, it was not observed that the selection process has diminished the quality of the review. The one exception was a complicated project, where when confronted with DOB objections the peer reviewer started to act as an advocate for the project. Up to now, the engineers selected for the peer review were highly regarded in the community and the DOB has not been in position to contest the technical qualifications. In one case the department challenged the qualification because of doubtful New York State engineering registration. This occurred when an owner commissioned a reputed Canadian company to review. To be acceptable, the company had to exercise some special state law provisions that permit use of a temporary New York State professional license.

Aside from being competent in the subject, the reviewer must *not engage in any activities that may conflict with their objective judgment and integrity, including but not limited to having a financial and/or other interest in the design, construction, installation, manufacture or maintenance of structures or components that they are reviewing*. [BB 2015-031]

The present interpretation of this requirement is that there should be no conflict of interest in the particular project. This interpretation is necessary to allow local New York City professionals to collaborate on different aspects of a large project, but not the one under review. This mode of selection resulted in almost no need for the authority (DOB) to intervene in disputes as technical differences in opinion were solved prior to the submittal of the report.

THE REPORT SUBMISSION PROCESS

To start an approval process the first form submitted to the department is the Plan/Work Application. The form requires the applicant to mark a box that flags whether the project meets the code thresholds for structural peer review. The peer reviewer is identified by his New York State professional license number. The structural peer review report can be submitted any time during the plan review period, but the computer system will block final project approval in the absence of an accepted peer review report. In two cases it was found that the applicant failed to indicate the need for peer review. It was found that both cases involved height/base ratios larger than seven, and the error was caused by confusion in determining the building height – unlike architectural or zoning height calculations, a building's structural height is defined to include rooftop structures.
Each report and the accompanying structural set and reports are appraised by the Chief Structural Engineer who can accept or make inquiries on specific aspects. Generally, reviewers follow the BB 2015-031 recommendations to enumerate the design changes made following their initial structural peer review evaluation. The report format also allows the reviewers to note some issues of disagreement but only when such issues or recommendations do not reach a level that would contradict or place doubt on the final finding that the project generally meets the code requirements.

Where the wind loads were determined based on wind tunnel tests, the applicants were required to submit the wind reports. In all cases a soil report had to be submitted.
In NYC, the applications for many construction projects and especially those for new buildings are handled by expeditors, a specialized type of consultants who *submit, file, request, negotiate or otherwise seek the approval of applications for issuance of permits*. Their function is not of owner representative but of intermediaries between owner or professional applicants and the DOB. While they bring value by facilitating the application process, they present a problem when they try to mediate issues raised by the department in connection with peer review reports. The DOB expects technical communications to involve directly the professionals.

The reports are expected to be based on the structural set of drawings submitted to the department, but only rarely do the reports use as basis the final set of drawings. Starting the peer review only when final construction documents are ready would create serious delays. This is acceptable as long as the difference between the sets is limited to details as the review needs to be concerned with the primary structure and not with minor errors or omissions. To establish a baseline all reports are required to list each reviewed drawing, including revision dates. In about 2/3 of cases the applicants used the staged submission process that allowed early start of foundation work.

THE STRUCTURES

At the time when the structural peer review legislation went in effect in NYC there were 51 buildings over 700 ft. in height, including 9 built before WWII. With the exception of one residential concrete structure, all other 50 buildings were steel frame structures with

office occupancy. The 2012-17 period under discussion was marked by very strong development in the city, especially for residential construction. For the first time residential skyscrapers reached over 1,000 ft. Residential buildings accounted for over 75% of the reviewed buildings. The height of 22 buildings exceeded 600 ft. and triggered peer review. For the population of peer reviewed buildings, the ratio of concrete to steel structures was about 9 to 1. Almost all of the concrete buildings were flat slabs with shear walls. The lack of available large lots in Manhattan, led to 12 structures less than 500 ft. in height to have ratios over the 7/1 limit that triggers peer review.

The most common foundation solutions involved caissons carried to rock. In a couple of cases it was possible to carry a flat slab foundation to rock. In nearly all cases the design was wind load driven. Overturning was prevented by rock anchors. Buoyancy had to be considered for the few cases where the buildings abutted rivers with corresponding flood potential.

In essence, for the reviewed buildings the main engineering effort was dedicated to limiting wind produced drift and vibrations. Several slender buildings were fitted with damping devices to assure occupant comfort. In no case was a damper used to insure the structural safety of the building and as a result no peer review of the damper was required. During this period no building fell in the review category because of structural design using nonlinear time history analysis or special seismic dissipation methods.

THE STRUCTURAL PEER REVIEW REPORTS

Immediately after the introduction of the code section requiring peer review there have been a number of submittals that contained only a succession of statements testifying compliance with each specific item listed in the section. These type of submittals probably followed procedures allowed by other jurisdictions but in NYC they faced objections from the DOB on grounds that the code actually required a report, not just a statement. In time the firm DOB position was acknowledged and it led to reports with sufficient details to demonstrate the review effort and also allow the department to understand the specific solutions. In many cases the peer review was performed on less than 100% complete documents and attesting adequacy was possible only in terms of “general completeness”. Matters like adequacy of dowels or of cramming large amount of reinforcement in narrow spaces were left to the detailers.

Typically reports use tables to display differences in results between EOR and reviewers. Where the reviewer used computer models prepared by the EOR it was expected that the model was independently verified.

When examining the reports, the author was struck by the fact that reviewers never made observations on the design of caissons, piles or rock anchors even when the drawings showed only a simplified section of the caisson or rock anchor. In several cases drawing notes made reference to the soil report for caisson design, but that section of soil report was never reviewed. In other cases the soil report did not offer any specific data and the use of caissons was just a general recommendation. This lack of design of deep foundation elements might have been in line with the NYC construction management

practice of bidding out (in post permit stage) design of piles or caisson work, but here it was producing designs that were not complete at the time of the peer review. Despite peer review statements deeming the design complete and code compliant, the department objected in each case and required complete caisson design.

This issue was brought up in a meeting with the structural engineering community. Most of the engineers protested on grounds that geotechnical design was outside their expertise. Their reluctance to review the soil report recommendations might have been a consequence of the terms of their professional liability insurance although the code text does not prevent the peer review to be performed by a team of structural and soil engineers.

In NYC, the typical soil report includes a description of soil conditions (as resulting from various borings and tests), recommendations for foundation solutions and determination of seismic characteristics (Site Class and resulting Seismic Design Category). Lately, as a result of repeated cases of damage to adjoining buildings during excavation, the soil reports include also recommendations for adjoining building protection. Excavation and related work, including details of protection of adjoining structures, are shown in a special Support of Excavation (SOE) set of drawings that might be prepared by the project's geotechnical engineer of record or by a different consultant. This SOE set is not required to be peer reviewed since the activities described do not affect the reliability of the new building. Most other recommendations in the soil report, including those related to seismic design, are capable of influencing the new building's structural reliability. Even more, most cases, especially when deep foundations are involved, the soil report may recommend solutions only in general terms, and these need further design and detailing.

The discussions revealed that the lack of geotechnical peer review stemmed from the following text *Review geotechnical and other engineering investigations that are related to the foundation and structural design and confirm that the design properly incorporates the results and recommendations of the investigations*, [NYCBC 1617] where review was interpreted as read or consult or be familiar with. To clarify and avoid systemic DOB objections, a bulletin is being prepared to direct that every element included in the foundation solution and design needs to be subject to peer review.

For most of the tall buildings the design wind pressure was established by wind tunnel tests. There were only two consulting companies that produced the wind tunnel reports. The principals of both these highly reputed companies had been major participants in the development of the ASCE 7 wind chapters. Nevertheless there were a number of hitches that had to be clarified in their first reports. One wind tunnel company was not aware that the NYCBC was lagging in ASCE 7 version (2014 NYCBC code used a slightly modified version of the ASCE 7-05). This company prepared at least one report that latter had to be revised to match the wind speed levels of NYCBC. It became also necessary to ensure that the EORs used load combinations consistent with the typical 50 years wind specified in the NYCBC (that is, the wind loads were to be multiplied by a 1.6 coefficient for strength design as per ASCE 7-05).

Ideally one would wish that the wind tunnel test reports were peer reviewed, but such requirement is made difficult by the extremely limited number of companies qualified for performing such tests and by the fact they all compete for the same jobs. This concern is alleviated when one considers the condition imposed by NYBC 1609.1.1.2.1 *Lower limits on main wind force resisting system that limit* base overturning moments determined from wind tunnel testing shall not *be less than 80 percent of the design base overturning moments determined in accordance with Section 6.5 of ASCE 7.*

For the tall buildings in our population, the wind tunnel loads hovered around 80% of ASCE and in some cases, several percentages lower. Not all reviewers verified this condition that assures a consistent minimum load for all buildings designed under the code provisions. The department had to raise objections. In only one case the structural peer reviewer demanded a separate peer review of the wind tunnel tests.

DISCUSSION AND CONCLUSIONS

In NYC there are about 300 buildings taller than 500 ft. The list includes several buildings built when the local building codes did not have any prescription for wind or other lateral loads. Another significant number of buildings in this height group were designed only for a constant wind pressure of 20 psf. Excluding façade issues, none of these buildings have known structural problems. Aside an added level of confidence for performance under extreme events, what added benefits does the independent structural peer review bring? As standard texts for peer review mandates are not suggested in national standards, the benefits can be measured only within the jurisdiction that oversees the locally crafted mandate. It is difficult to assess the peer review process in other jurisdictions since information is only accidental. For instance, although the city of Miami has adopted the text originated in NYC, the benefits there might be different. As a result of a 1975 decision to concentrate examinations on compliance with fire regulations, the NYC DOB had not commonly performed review of structural designs since. Obviously the public expects unique or large buildings to undergo some level of review but the review of the mandated buildings requires a high level of technical knowledge difficult to find in a buildings department. The NYCBC 1617 provisions guarantee that highly competent engineers perform the review. Also given the size of their investment owners are likely to engage equally high competent professionals for the design but it is worth noting that at least in one occasion the review led to significant redesign.

The peer review gives companies the opportunities to analyze and compare each other's drawings and calculation methods. The companies participating in the peer review process gain knowledge from each other and the standards and quality of design are potentially raised. The introduction of advanced properties for concrete and steel that occurred during this period, most likely gained easier acceptance due to the quality of the review process. The department's expectations cannot become effective mandates without understanding the capacity and the acceptance of the consulting community. Consulting firms want clarity in requirements so they can manage their exposure and

liability. From discussions it became apparent that some code texts needed official clarifications. In the author's opinion without a systematic appraisal of the reports by the agency having jurisdiction, these reports will tend to devolve into simple listings of statements. The DOB evaluation of the reports identified areas (e.g. deep foundation elements) that were not covered by the reviewers. Further assessment of the peer review process needs to concentrate on situations where the specific estimation of extreme loads (seismic or wind) are provided by third parties. It is the agency's obligation to maintain and improve the standard for peer review.

REFERENCES

1. 1968 NYCBC, no author, (2004). *Building Code of the City of New York*, New York , New York City Department of Administrative Services

2. 2008 NYCBC, no author, (2007). *Building Code of the City of New York*, New York, New York City Department of Administrative Services

3. 20014 NYCBC, no author, (2014). *Building Code of the City of New York*, New York , New York City Department of Administrative Services

4. Buildings Bulletin 2015-031, Operational, New York City Buildings

5. Directive no. 2 of 1975, The City of New York, Housing and Development Administration The above documents are available http://www1.nyc.gov/site/buildings/codes/codes.page

6. *Structural Peer Review*, City of Miami www.miamigov.com/building/Docs/DropdownForms/StructuralPeerReview.pdf

7. IBC, 2009, no author, *International Building Code*, International Code Council, ICC, Country Club Hills

8. ASCE 7, (2005), no author, *Minimum Design Loads for Buildings and Other Structures* (ASCE, 2005), American Society of Civil Engineers, Virginia, USA.