Reinventing 690 Market Street

Historic Structure Reclaimed, Vertically Expanded

By Navin R. Amin, S.E. and Vivian L.K. Wan, S.E.

This transformation of an historic office building into a modern residential tower is a testament to the engineer's key role in revitalizing the urban landscape.

690 Market Street dates back to 1890. Originally an 8-story tower built as the headquarters for the San Francisco Chronicle newspaper, it was designed by architects Burnham and Root in the "Chicago School" style that was gaining prominence. At the time, it was considered one of the world's most innovative buildings. It was the West Coast's first steel-frame skyscraper, with a tower that boasted the world's largest clock.

The building withstood the 1906 earthquake but suffered 2 major fires. The clock tower was destroyed, not to be replaced. The building underwent several alterations and expansions, including a 16-story annex in 1905. The Chronicle eventually relocated its headquarters, and the building was "modernized" in the 1960s; the architecturally rich bay windows were destroyed and the remaining façade was masked with a metal and marble cladding.

In 2004, new owners received approval to expand the building to 24 stories and used this opportunity to restore the façade, including re-construction of the original bay windows. The resulting 24-story, 258,000 square foot building contains 44 private and 57 fractional residences.

The complexities of this assignment were considerable. The site, at the intersection of the City's main boulevard and two other major streets, was extremely constricted. In addition, an underground transit tunnel lay beneath the building. Temporary shoring, demolition, and initial design were performed with limited information and no available structural drawings.

Since the building had undergone multiple expansions over the years, the resulting structural components were of various materials (cast iron columns, hollow clay tile floors, unreinforced masonry, steel moment frames, wind gussets and riveted joints). The foundations had various elevations, again with different components: steel grillages, cast iron columns, and brick piers over piles and pile caps.

The structural design team found creative solutions to the various design challenges. The new building has an eccentric core and irregular floor plans; in order to reduce torsional irregularity, it was necessary to optimize stiffness distribution of the combined structural systems. For the new structure, a lateral load resisting system combining shotcrete walls, SMRF and SCBF was devised, and a new foundation was added. The design met the 1997 Uniform Building Code (UBC).

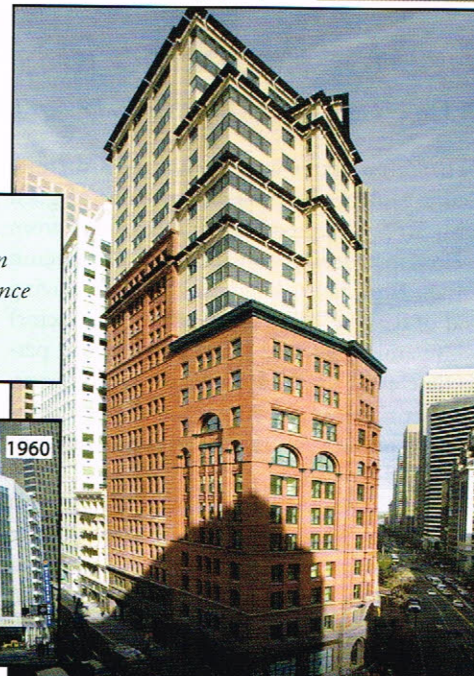
Middlebrook + Louie was presented an NCSEA Outstanding Project Award for The Ritz Carlton Club & Residences in the 2009 NCSEA Excellence in Structural Engineering Awards Program (Category – New Buildings $30M to $100M).

New floor systems and lateral framing were added in core areas. New slabs were tied to existing slabs to form a complete diaphragm. Existing slabs were connected to new shotcrete walls to transfer lateral forces. A non-typical steel braced frame connection detail was designed to accommodate the building's relatively small core bay.

Shotcrete walls were applied to the unreinforced masonry perimeter walls, providing out-of-plane resistance and forming part of the lateral resisting system. The minimal application of 10-inch shotcrete to support these walls was very cost-effective. Various analyses were performed, evaluating the impact of the wall stiffness on the overall building performance during earthquakes.

Several features of the original structural system (perimeter masonry walls, perimeter bay floor framings and slabs) were to be retained in the new design. Great effort was taken to integrate these existing materials, minimize demolition complications and accommodate construction sequencing. For example, new concrete encasements augmented existing cast iron columns and brick piers at lower levels, to support additional floor loads.

A new 5-foot mat foundation integrated various pre-existing foundation elements, and supports the additional gravity loads and overturning moments associated with the vertical expansion. Since the new building has multiple setbacks, transfer girders consisting of double and triple beams support the transfer columns. Special details connect these girders to the concrete-encased cast iron columns. Given the complexity of this project, the outcome was highly successful. Even with complications during demolition and analysis phases, the project was built on schedule. The structural design was also a large factor in achieving budget goals, which are critical to housing projects.



Courtesy of Tom Paiva / Plant Construction.

The use of shotcrete walls directly benefited the owner in 2 ways: sellable space was maximized and, since potential falling hazards from the exterior were reduced, the insurability of the building was enhanced.

The new building is clearly in sync with the historic nature of the environs, including Lotta's Fountain, an iconic San Francisco sculpture at the site where the city annually commemorates the 1906 earthquake.

The owner is touting the building as "an historic skyscraper reincarnated." One major architecture critic stated that the team "seized a once-in-a-career opportunity to make things right on a historic corner of San Francisco."▪

Navin Amin began his structural design career in Chicago, working with the late Fazlur Khan on Sears Tower and other notable buildings. He joined Middlebrook + Louie Structural Engineers in 1997 as a Principal.

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Tips for Reducing RFIs

By Clifford Schwinger, P.E., SECB and Albert J. Meyer, Jr., P.E.

There's no better way to ruin the structural design budget of a project than to be plagued with RFIs (Requests for Information) from contractors during construction. A common refrain from many engineers on the receiving end of RFIs is "Why are they (the contractor) asking this question? The drawings are perfectly clear!" The unfortunate facts, however, are that many engineers are not the best communicators and contractors are, unfortunately, not mind-readers.

Most RFIs originate from flaws in the contract documents. Most flaws can be attributed to either missing or conflicting information. Accordingly, performance of meticulous in-house Quality Assurance (QA) reviews of contract documents is the best way to reduce RFIs. QA reviews are best performed by an engineer who was not involved in the project. A fresh set of eyes on a set of structural drawings will usually find more flaws than will someone who has intimate knowledge of the project.

The QA reviewer must scrutinize the drawings through the eyes of the various contractors who will be reading them and, in doing so, visualize constructing the building from the information provided. This effort also involves becoming familiar with the architectural and mechanical designs as well, and understanding how those elements and systems interface with the structural system.

Missing information

Contractors need to know the dimensions and the dimensioned location of every structural member. Engineers who rely on contractors to "figure it out" will most likely be rewarded with an inbox full of RFIs. Sections should be provided around the entire perimeter of a building, as well as at all locations where anything unusual is occurring – slab depressions, catwalks, roof screens, etc. If a project requirement is to design connections for reactions, moments and axial forces indicated on the drawings, that information must be provided.

Incomplete details

Attention to detail is essential. Typical details, while important, do not always show the entire picture. In particular, multiple conditions occurring at a single location can often cause problems during construction unless they are addressed during design. *Figure 1* illustrates a seemingly straightforward connection, between an HSS girt and a column, that is not buildable as detailed due to conflict with a beam-to-column moment connection occurring at the same location.

Conflicting information

Engineers should strive to avoid duplicating information on the contract documents. Doing so not only adds work, it increases the likelihood that conflicts will occur. If dimensions are shown in a plan view, those dimensions should not be duplicated in the sections. Project requirements delineated in the specifications should not be repeated on the general notes. The author has seen a number of projects where the contract documents refer to the 1989 American Institute of Steel Construction (AISC) Specification, the 1993 AISC Specification and AISC 360-05.

Unrealistic design requirements

Some engineers delegate responsibility for design of structural steel connections to the steel fabricator and, in doing so, often place excessively conservative and difficult to achieve design requirements on those connections. A common requirement by some engineers is to specify that beam shear connections be designed for the "full shear strength" of the beam. The presence of flange copes and bolt holes in beam webs will usually make the design of connections for full shear strength very costly to achieve – often requiring measures such as web reinforcing plates, staggered rows of bolts and otherwise excessive numbers of bolts. A better solution is to show the actual beam end reactions on the drawings. Doing so will reduce connection cost (a benefit that will pay dividends to the project through lower bid prices for steel), improve constructability and eliminate RFIs from the connection designer pleading for the actual end reactions.

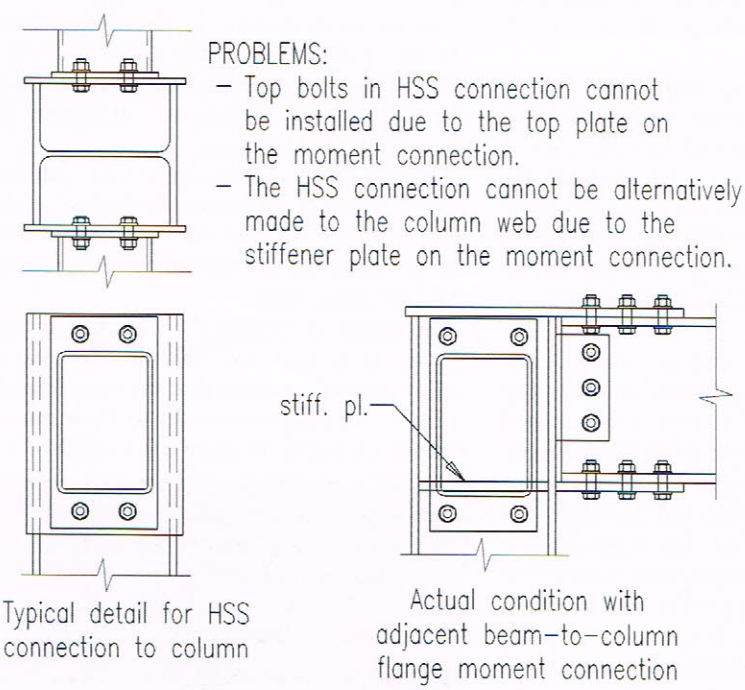

Figure 1: Do not rely on multiple details to piece together what occurs at specific locations. Better to provide specific details showing everything that occurs.

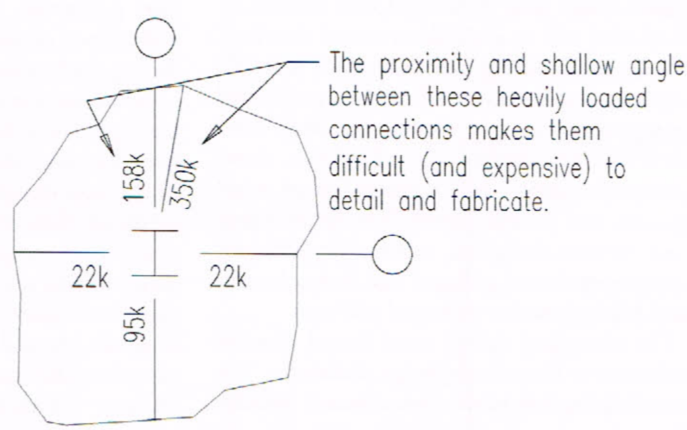

Figure 2: Engineers must consider constructability when framing structures.

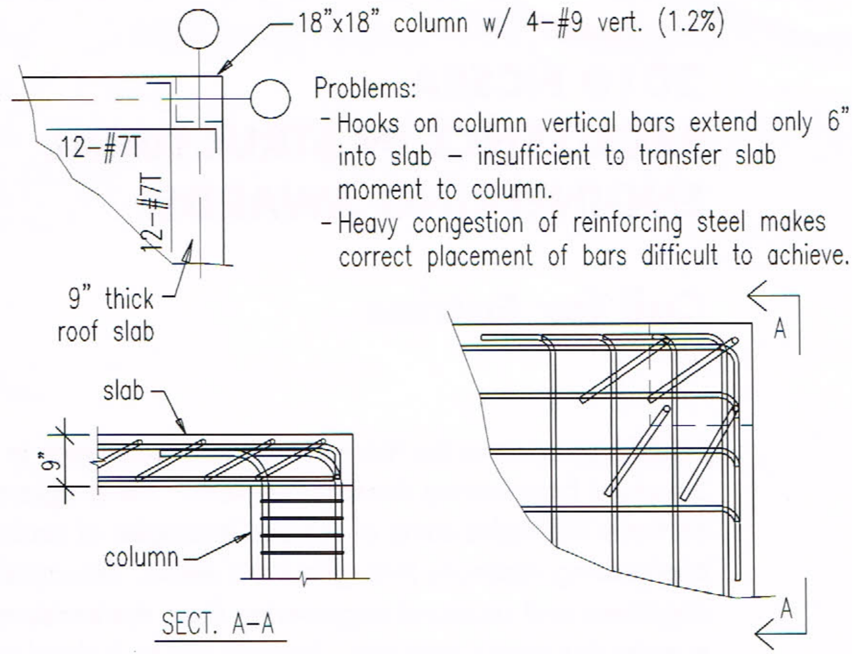

Figure 3: Engineers must consider whether reinforcing steel can be installed and properly developed.

Constructability

While any framing configuration can be easily modeled in a computer, not all can be easily constructed. Consideration of constructability during design will facilitate construction and reduce RFIs. While a computer can easily model eight beams framing to a column, detailing connections for such a condition is extremely difficult. *Figure 2* illustrates a beam-to-column connections that would be very difficult to detail and fabricate. Engineers must consider constructability of steel connections even when they opt to delegate connection design to the steel fabricator's engineer.

Most engineers have experienced at least one phone call from the field asking if reinforcing bars can be cut to facilitate installation. When this call comes in, it usually means that the bars have already been cut. *Figure 3* illustrates a condition at a corner column where standard hooks on the ends of the top reinforcing steel in a slab are too large to permit their proper installation. Areas of heavily congested reinforcing should be examined to determine if all of the reinforcing steel can be installed. With the continued evolution of three dimensional building information modeling (BIM) software, this task is becoming easier to perform.

Coordination issues

While BIM software now provides a valuable tool for design, interferences can occur unless careful coordination of the structural model with the architectural and MEP models occurs prior to construction.

Careful attention must be particularly paid to insure that those structural elements, not documented in the BIM model, will not interfere with elements of the architectural design or mechanical systems. Examples of such structural elements include column base plates, column splice connections, braced frame and truss gusset plates, and secondary structural members, such as joist bridging, brick shelf relieving angle braces, and truss bracing. Examples of such interferences include column base plates projecting into elevator pits and truss gusset plates clashing with ducts and piping.

Likewise, just because a complex section of a building structure can be successfully framed in a BIM model, careful review with the architectural model is required to insure that the geometry between structure and architecture match.

Summary

A comprehensive in-house review of structural drawings and specifications is essential to assure that they are complete, correct and coordinated before they are issued for construction. Such a review will reduce the number of RFIs, facilitate the construction process, benefit the entire design and construction team, improve profitability, and enhance the reputation of the structural engineer.▪

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