A faceted façade, creative cantilever and tightly spaced top define the structural system of Manhattan's new center of trade for diamonds, gems and jewelry.

The GEM of the Big Apple

BY STEPHEN V. DESIMONE, P.E., AND JAMES J. BONANNO, P.E.

THE DIAMOND District has a new jewel to wear—a big one.

Located at 50 West 47th Street in New York, the International Gem Tower (IGT) is a 32-floor, 520-ft-tall steel-framed office building with a parapet elevation of 560 ft. and three cellar levels excavated to 45 ft below grade. Class A office space in New York requires that the floor plates remain unobstructed by structural columns so that floor plans can make the most efficient use of the space. To meet this requirement, the structural bays were laid out on a 30-ft × 40-ft grid, with W18 beams spanning in the long direction between the perimeter spandrel beams and girders at the building's core.

The steel framing was erected in two phases. The first included steel for two of the below-grade levels and the ground floor and used 690 pieces of steel totaling 2,000 tons. The second consisted of superstructure erection, which used 7,900 pieces of steel weighing a total of 10,130 tons.

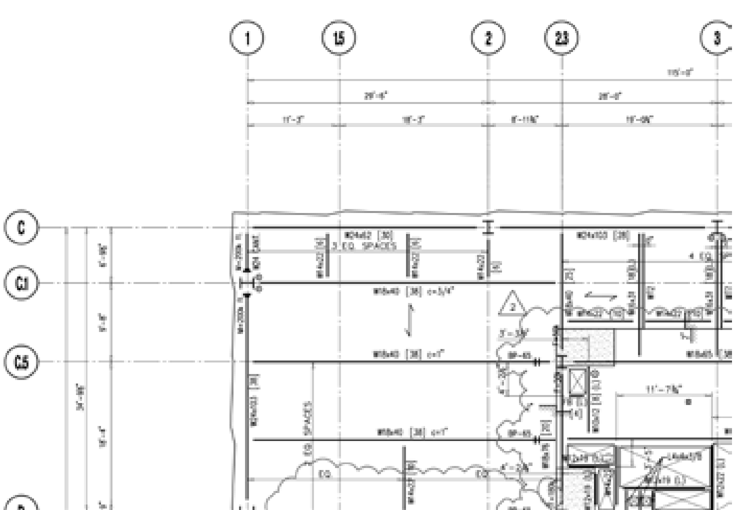
Banker Steel

Going West

One of the project's more interesting aspects was how it maximized floor area. Instead of constructing an additional four floors at the top of the building, the owner decided to extend the office floor plates by cantilevering trusses 13 ft over a six-story building immediately to the west of the IGT, and as such purchased the air rights to the building. Since the trusses were too deep to ship by truck and too far from the street to erect in one piece, they were assembled in the air in the narrow space between the tower and the adjacent building. The trusses are between the sixth and seventh levels of the tower and extend over the

Framing for the 520-ft-tall International Gem Tower was erected in two phases, the first of which included steel for two of the below-grade levels and the ground floor; the second phase consisted of superstructure erection.

adjacent building to carry the tower's western perimeter columns. They are comprised of W14 chords and diagonals and were field bolted while each piece was held in place by the crane. Although the trusses took up a full week of crane time, the pace of erection accelerated once the floors became typical. The decision to use trusses did add to the steel fabrication cost, but since they allowed for the decrease in building height, the corresponding reduction in erection cost offset the truss premium.



The faceted façade of the building is illustrated in this photo (left) as well as this diagram (above) of a portion of the 17th floor.

The tower's lateral force resisting system, designed to react to wind loads, was provided by a stiff braced frame around the central elevator core. As with the elimination of the gravity columns in the occupied floor space, the client required that none of the lateral elements be located within the condominium floor area. The solution was to supplement the core braced frame system with six east-west outriggers at the sixth-floor mechanical level and above the roof. These elements connected to the elevator core columns and engaged the perimeter columns, providing an efficient cost-effective means of controlling the building's deflections and resisting the building's overturning moment without adding large amounts of steel tonnage and cost at the core. W14×730s,

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◄ ▲ Rooftop steel, including a stiff braced frame system around the central elevator core.

▲ The project used 12,130 tons of steel.

◄ The tower, in real life and in Revit.

built up with 2-in. plates across the flanges, and W14×605s were used as the outriggers at the sixth and roof levels, respectively.

Control of the geometry for the perimeter slab edges at each floor was another interesting aspect and challenge. Given the project's name and its Diamond District location, the architect designed an exterior façade that simulates the appearance of a cut diamond. The façade required close control of the concrete slab edges, whose geometry alternated on each floor. And rather than forming slab edge to mimic the faceted shape, a ⅜-in. structural steel plate was welded to the spandrel beams around the building perimeter. This solution allowed precise control of the slab edge dimensions since the geometry was imported into fabricator Banker's Tekla model directly from the architect's Revit model, thereby ensuring that no deviations would occur. Additionally, this steel plate was designed to carry the concrete slab loads, live loads and vertical curtain wall loads, which eliminated the need to add expensive and labor-intensive reinforcement to the concrete at the slab edges.

Rooftop Maze

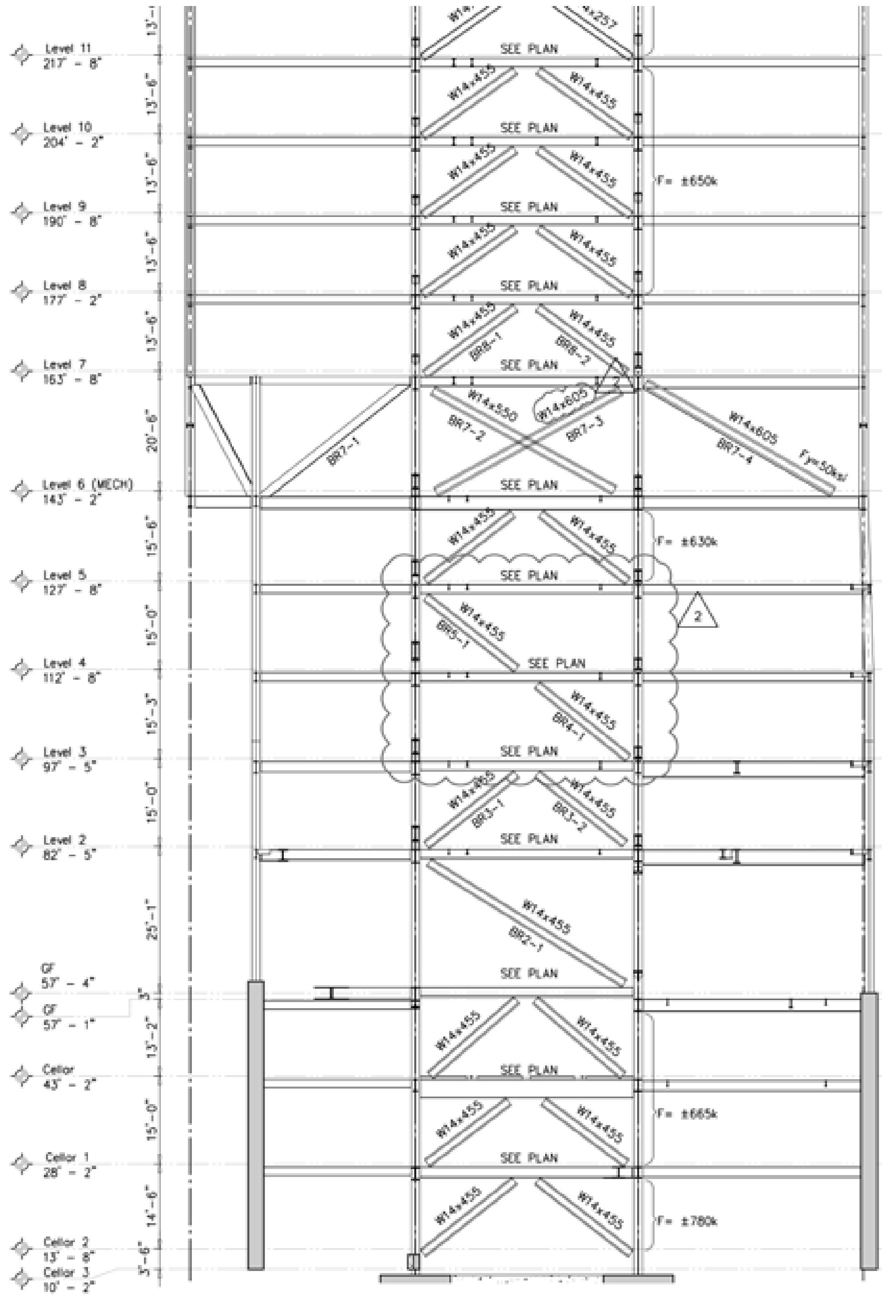
Another challenge was integrating numerous programmed spaces and usages above the roof level. Three two-story tall cooling towers were located at the north side of the roof, three emergency generators were located on the east side of the roof and a water tank on steel dunnage was located near the south side of the roof. In addition, the steel-framed parapet wall rose 40 ft above roof level and was braced against wind loads by horizontal steel members back to the elevator core, which were supplemented by diagonal kickers down to the roof level at the corners. Lastly, the window-washing equipment was mounted on a steel-framed catwalk level constructed 5 ft below the top of the parapet and traveled on two steel wide-flange W24 tracks along the building perimeter, with tight-radius elements at the four building corners. The coordination of these numerous, closely spaced mechanical units on a roof also occupied by a 2,000-sq.-ft mechanical penthouse required needling steel elements through any vacant spaces around equipment or through the outriggers. Virtually all of the connections needed to be skewed, which added additional out-of-plane loads and moments to the already robust connection designs. The complicated interplay of structure, mechanical equipment and architecture at the top of the building was facilitated by the close coordination of each consultant's Revit model. As with the faceted slab edges, each piece was test fit into the model and the geometry was imported directly into the Tekla model and used directly for the production of shop drawings.

➤ An elevation drawing of the lower levels of the tower.

This real-time BIM process afforded the immediate resolution of any detailing problems, eliminated the need to write any RFIs and virtually eliminated the use of the "Revise and Resubmit" approval comment during the shop drawing review process. All shop drawings and calculations were submitted and reviewed electronically, entirely eliminating paper copies of erection plans, piece drawings and calculations. As a matter of fact, weekly design and construction coordination meetings were attended by Banker's detailer throughout the project, where the Tekla model was reviewed and coordination issues were resolved. Between meetings, coordination continued between Banker and DeSimone daily by video conference, with the 3D model being manipulated in real time by the detailer while the model was viewed and coordinated by DeSimone's engineers in its New York office.

The construction of the building in the middle of crowded Manhattan sidewalks and streets added yet another dimension of difficulty. Since there is no staging area available at street level, the building loading docks were designed so that trailer trucks could be backed in off of the street. One lane of traffic north of the building was closed so other delivery trucks could feed the man-and-materials hoist at that location. Steel deliveries were shaken out on the deck below the erection floor, and crane jumps were staged at night and on weekends since those were the only times streets could be closed to provide lay-down space. Finally, at the end of the project, the dismantling of the crane required the erection of a second temporary crane at roof level, which lowered the tower crane in pieces to the street below.

The collaborative spirit fostered by the building owner and embodied by all of the design team members, the steel fabricator and the erector combined to create a flawless gem on 47th Street. ■



ELEVATION LINE E.3

SCALE: 1/16"=1'-0"

Owner
Extell Development Company

General Contractor
Tishman Construction

Architect
Skidmore, Owings and Merrill, LLP, New York

Structural Engineer
DeSimone Consulting Engineers, New York

Steel Fabricator
Banker Steel Co., LLC, Lynchburg, Va. (AISC Member/AISC Certified Fabricator)