A new hotel tower fits right in along a high-profile stretch of Chicago's downtown riverfront.

TIGHT Quarters

BY DAVID NICKELL, SE, MARTIN WHITE, SE, AND MATTHEW ANDERSON

A PROMINENT BLOCK OF WACKER DRIVE stands out from the rest, thanks to the facts that it intersects with Chicago's most well-known street—Michigan Avenue—and borders an abrupt bend in the Chicago River. As such, a gap in a string of buildings perfectly aligned by street-facing façades was that much more noticeable.

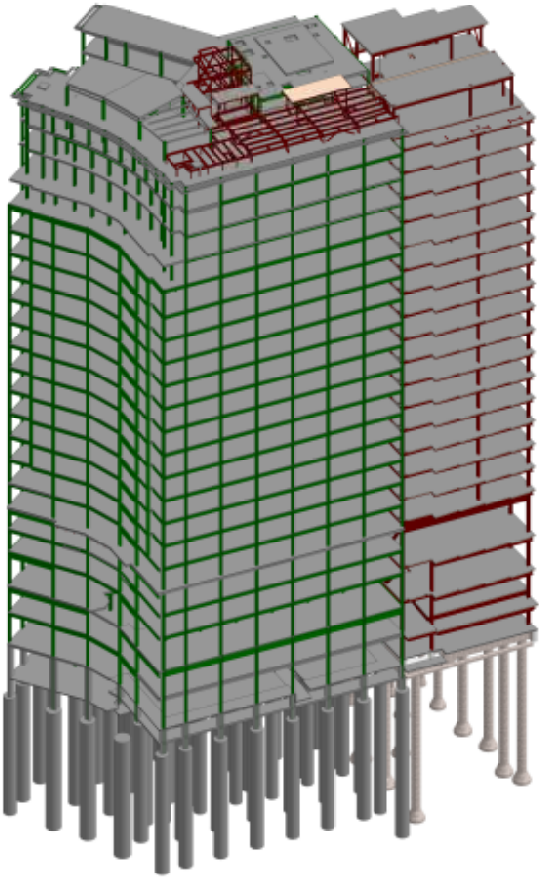
The block contained three 20-story-plus buildings—two abutting one another at the western end and then the gap, with the easternmost tower, the 1923 London Guarantee Building, creating a sharp corner at the intersection with Michigan Avenue. The effect was that of a missing tooth in the block.

But the gap is now filled by the new LondonHouse Hotel addition. The project included the renovation of the 280,000-sq.-ft London Guarantee Building and construction of a new adjacent 22-story 70,000-sq.-ft steel-framed structure on a vacant spot of land, roughly 46 ft by 98 ft, that had previously been used as a surface parking lot. The new addition consists of 22 stories of hotel services and guest rooms, as well as a rooftop deck and penthouse structure that spans both the new and existing buildings. The hotel was named for a famous jazz club, the London House, that made its home in the 1923 building from the mid-1950s to the early 1970s.

Due to the tight footprint for the new addition between two Chicago landmarks, demanding program requirements and the unique shape of the project, structural engineer TGRWA was tasked with solving several unique structural challenges.

The entrance to the existing building.

The LondonHouse Hotel sits at one of Chicago's most prominent intersections.



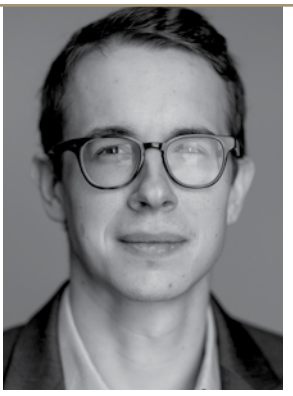
A structral model of the existing (green) and new (red) framing systems.

Hybrid System

The lateral system for the new addition was the greatest structural hurdle, challenging the design team to develop a creative and efficient solution to meet the architectural and cost constraints of the project. Per local building code requirements, wind load was the controlling lateral criteria. After iterating through several designs, TGRWA provided a solution involving an inventive hybrid lateral system.

This system employs concentric steel braced frames to address north-south wind loading, a solution that provided drift performance to accommodate differential lateral movement of the joint between the new and existing buildings. East-west wind loading was a more complex situation. The addition's program was unique in that it did not include an elevator core—instead relying on the elevators in the existing building. This removed the possibility of the more conventional approach of positioning braced frames or shear walls at the core to use as the lateral system. Because of this hurdle, TGRWA's hybrid design used braced frames in the north-south direction and used the steel moment frame lateral system of the existing building in the east-west direction. The aforementioned lack of an elevator core, combined with the desire

David Nickell is a principal, **Martin White** is a senior engineer and **Matthew Anderson** is a project engineer, all with TGRWA, LLC, in Chicago. The authors would like to acknowledge **Roger Reckers, SE,** the firm's principal in charge of the LondonHouse project.



◀ Various views of the double-web plate girder erection. There are four of these girders in all, each framing to a single wide-flange column and transferring the load of the 18 floors above the ballroom level.

for clear views at the front of the building (overlooking Wacker Drive and the Chicago River), required that the new steel structure rely on the existing building's lateral system in only one direction—while allowing slip in the perpendicular direction. A specially designed expansion joint was situated between the new and existing structures to allow this movement. The load was transferred from the diaphragm of the new structure to the existing structure using a "snow plow" drag strut system. At several locations on each floor, new steel members extended from the new structure to the existing structure and distributed the load through the existing clay tile diaphragm. This hybrid approach greatly reduced the required material and labor costs of the lateral system when compared to a more conventional solution. It also provided the hotel with significantly more usable space.

Another challenge was meeting the building program's requirement of a two-story column-free ballroom on the third floor of the addition. After numerous support options for the column-free space were investigated, TGRWA designed four double-webbed plate girders, each supported by a single wide-flange column, to transfer the load of the 18 floors above the ballroom level. Where other options would have eliminated prime hotel rooms in order to accommodate the structural demands, this system facilitated the maximum amount of usable space possible, supporting 1,600-kip column loads and spanning 60 ft to the exterior walls within the 60-in.-deep ballroom ceiling space. Detailed finite element design produced efficient web openings for mechanical ductwork, thus maximizing the ceiling height.

When it came to positioning the portion of the steel-framed rooftop terrace structure atop the existing building, the supports for this assembly were strategically placed on the existing columns and beams below in order to reduce reinforcement requirements for the existing framing as much as possible. The remaining new steel for the rooftop structure was

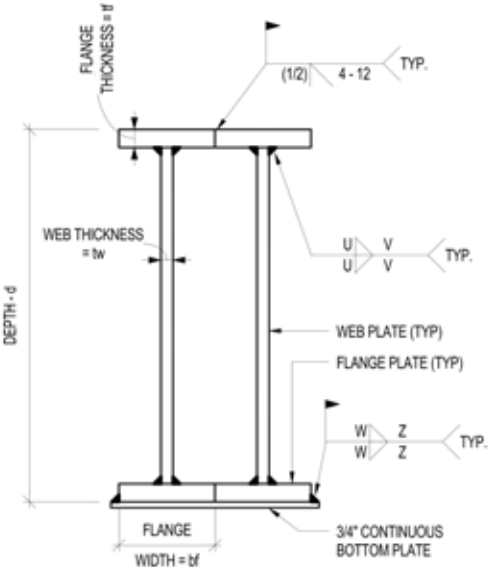
▲ Framing view from the back side of the building.

▲ Slab edge framing and attachment to the adjacent building.

then positioned to accommodate the space's program, including a luxurious rooftop bar. Per the *City of Chicago Building Code*, the new terrace structure was required to support a design load more than three times the capacity of the existing roof. To accommodate this increase in demand, more than 20 of the 60 steel I-beams reinforced with steel plates or WT sections in the existing building were located at the roof level. The end result was a reinforced rooftop terrace with sweeping views of the Chicago River and streetscape below.

Tight Fit

Steel erection in a dense urban central business district is always tricky. For the new LondonHouse tower, it was even more of a surgical procedure (especially for the large transfer plate girders) as the already tight job site was closed in by two landmarked buildings on either side and a semi-accessible alley immediately behind. In addition, the site fronts one of the busiest streets in downtown Chicago in terms of both vehicles and pedestrians, Upper Wacker Drive.



NOTES:
1. ALL PLATE GIRDER STEEL TO BE GRADE - 50

➤ Double-plate girder sample detail.

➤ The varied façades on the block; the two left-most façades are the LondonHouse.

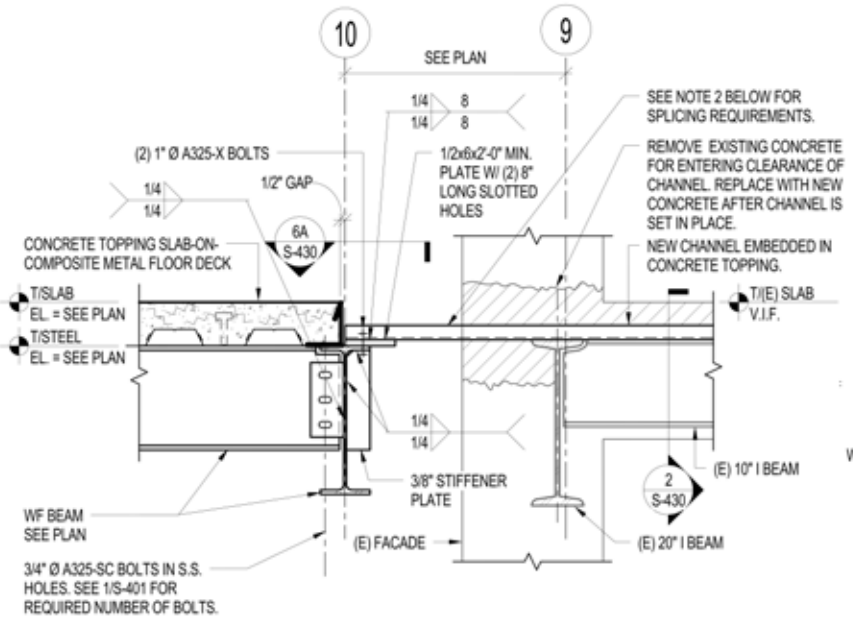
As such, staging and delivering the steel had to be closely planned so that the disruption to pedestrians and traffic was limited. Beams for the typical framing were staged on Upper Wacker Drive and were set in place by the tower crane, but a different approach was required for the much heavier plate girders. After Upper Wacker Drive was shored from below and a special permit was obtained for the heavy loading on the elevated street, a second crane was mobilized to assist with lifting the plate girders. During the design phase, it was determined that the plate girders needed to arrive on site in two pieces to accommodate the tower crane's lifting capacity. Each of the two individual 60-ft-long girders were welded together longitudinally in the field, creating a single double-web section. All of this work was completed in a single workday to reduce the impact on the surrounding traffic.

After the plate girders were installed, the tower crane was able to erect the framing up to the 20th floor. Once this work was completed, the crane was disassembled using a gantry crane, which was then used to install infill beams in the now voided space. A Spydercrane was hoisted and used to install the final four floors of steel.

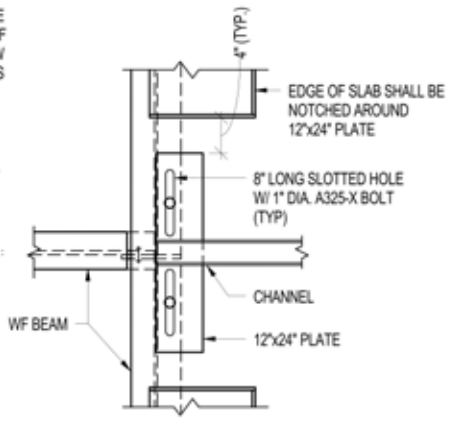
Now open, the hotel contains 450 guestrooms and its rooftop deck pro-

▲ The job site was closed in by two landmarked buildings on either side and a semi-accessible alley immediately behind.

▼ A "snow plow" wind strut.



6 SLAB EDGE DETAIL AT EXISTING BUILDING



6A PLAN

NOTES:
1. REFER TO 12/S-401 FOR SLAB EDGE REQUIREMENTS NOT SHOWN.
2. AT LOCATIONS WHERE NEW CHANNEL DOES NOT SIT DIRECTLY ON (E) 10" I BEAM, WELD BOTH SIDES OF CHANNEL TO (E) 20" SPANDREL I BEAM WITH 2" OF 1/4" FILLET WELD.
3. CONTRACTOR TO SPLICE CHANNEL AS REQUIRED. REQUIRED FACTORED (LRFD) CHANNEL AXIAL FORCES ARE AS FOLLOWS:
   a. C3x6 CHANNELS: 50 KIPS
   b. C6x13 CHANNELS: 80 KIPS

NOTES:
1. REFER TO 6/S-430 FOR INFORMATION NOT SHOWN.
2. SLAB-ON-METAL DECK AND LIGHT GAUGE STOP NOT SHOWN FOR CLARITY.

- Slab edge detail.
- The new steel structure is 22 stories and 70,000 sq. ft.
- The rooftop deck, which spans the old and new buildings.


Goettsch Partners


TGRWA

vides impressive views of the Chicago River and the downtown area—all framed with approximately 900 tons of new structural steel. With its combination of renovation and infill, old and new steel and historic and modern construction, it blends the past with the present in an ever-changing city. ■

Owner
Oxford Capital Group, LLC, Chicago

Architect
Goettsch Partners, Inc., Chicago

Structural Engineer
TGRWA, LLC, Chicago

General Contractor
W.E. O'Neil Construction Co., Chicago