Close Quarters

By Christopher P. Milano, P.E.

A confined site in the heart of Boston's Back Bay area is home to a new 18-story residential tower.

Developed by Raymond Property Company, Trinity Place is one of the first residential projects to be completed in downtown Boston in the last 10 years.

The 18-story, 104 unit luxury condominium building is situated on a difficult 26,000 sq. ft site adjacent to Boston's public library, the Copley Square hotel and the a Copley Place complex. The building also features below-grade parking, on-site concierge services and a state-of-the-art fitness center.

Trinity Place consists of a five-story "low-rise" from which rises the 18-story portion of the tower; the roof is a 50'-high gable, clad with lead-coated copper. The typical floor-to-floor height is 10'-4" which allowed the developer to accommodate 18 occupied floors while conforming to local height restrictions.

Childs Bertman Tseckares (CBT), Inc., the architect for Trinity Place, selected precast panels as the exterior skin. Prefabricated steel clips are shop attached to support the panels to the steel building columns. CBT worked closely with the precast manufacturer during design to provide an efficient, coordinated product that could be installed with a minimum number of field changes.

In addition, CBT worked closely with the developer to provide efficient space planning for the residential units. The general framing scheme consisted of a 14'×28' bay, with 3" composite metal deck spanning 14'. This layout minimized the number of floor beams while giving the architects the flexibility of raising ceiling heights in an otherwise tight floor-to-floor space.

Foundations

Significant challenges with regard to foundation design occurred due to Trinity Place's location in the heart of Boston's Back Bay area and subsequent adjacency to existing buildings.

The north side of the site is approximately 50' from the existing foundation of the historic Boston public library. On the west side, the foundation of Trinity Place comes within inches of the Copley Square Hotel (built in 1890). Along the south side of the site, the building fronts on Huntington Avenue. Of significant concern along this face was the proximity of the building to an on-ramp for the Massachusetts Turnpike, running parallel to Huntington Avenue within 35' of the site. Since each of these existing structures was sensitive to potential earth movement a program was established to monitor existing structures during excavation and throughout the building construction.

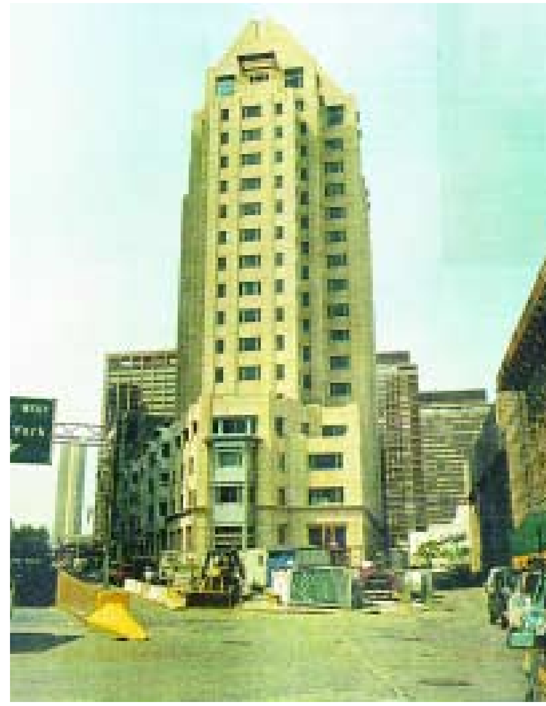
The building is supported on a 5' thick mat foundation bearing on marine deposits, approximately 40' below existing grade. The mat supports the interior building columns, many of which are offset or transferred at upper levels to coordinate with public spaces (at the first floor) or with the layout of the below-grade parking.

A tower crane erected the structural steel framing and the precast panels. As is often the case on similar urban sites, the mat foundation also provided the support for the tower crane and personnel hoist, located within the building to avoid placing them on adjacent public streets.

The perimeter foundation walls were constructed with 2' to 3' thick slurry walls. The slurry walls, in conjunction with cross-lot bracing, allowed for excavation to proceed within the very confined site without restricting access to the surrounding streets.

Superstructure

As noted earlier, the basic framing scheme was based on a 14'×28' module. This bay spacing, along with the use of 3"×16-gage composite metal deck flooring, resulted in reasonable beam depths (generally less than 18"), allowing the architect to achieve ceiling heights of 8'-10" between the floor beams. One alternative to the heavy gage deck was to use lighter gage deck and provide temporary shoring during the placement of concrete. However, studies by construction manager Turner Construction Co. indicated that the lighter gage deck and associated shoring would adversely impact their schedule. As a result, the 16-gage was used to span 14'. During construction of the high rise portion of the building, Turner Construction was able to erect, deck, detail and



place a 6 ¼" lightweight concrete slab every 10 to 14 days.

This floor system resulted in a number of benefits to the design and construction of the building:

- The 3 ¼" lightweight concrete slab on 3" composite deck provided a 2-hour rating;
- The use of the 16-gage deck eliminated the need for temporary shoring during concrete placement;
- The 14'-0"×28'-0" module, with the deck spanning 14', reduced the number of floor beams and achieved a 10' 4" floor-to-floor height; and
- A majority of the beams that spanned parallel to the deck were "non-load-bearing", thus reducing the overall tonnage on a square foot basis.

Lateral System

An additional advantage of the 14' column spacing arose when options were investigated for the building's lateral system. Because of the closely spaced columns and low floor-to-floor height, it was evident that moment frames at the exterior longitudinal column lines would provide an efficient system. This system made for clear openings up to 10' wide along the exterior walls allowing the architects to provide large windows to take advantage of the views of the Charles River and downtown Boston. A combination of W24 and W14 columns were used in conjunction with W18 beams to complete the moment frames.

Studies of the moment frames evaluated opportunities to save time during construction. For example, one study determined the cost and time advantages to shop fabricate the moment frame girder-to-column connection. The study looked at potential savings to use "pre-fabricated" moment connections, thereby eliminating the full penetration field weld at the girder-to-column connection. However, the fabricator, AISC-member, Cives Steel Company of Gouverneur, NY, and the erector, elected to proceed with the field welded moment connections in lieu of the shop fabricated option. To help maintain the schedule of turning over a floor every 10 to 14 days, the erector employed a separate crew of welders to perform the full penetration field welds. As the welding was completed at each level, certified weld inspectors from PSI of Canton, MA, performed ultrasonic testing on each of the welds.

In the transverse direction, braced frames were located along the demising walls of residential units, thereby minimizing the impact on the unit floor plans. Where necessary, the brace configuration was adjusted to allow corridors to pass between units. Brace members consisted of HSS (generally 10"×10" and 8"×8") and wide flange shapes in single diagonal and inverted-V configurations.

One unique feature of the lateral system is a "hat" truss within the framework of the gable roof. The hat truss limits drift due to wind loads to acceptable levels without an associated premium in steel tonnage.

When the building experiences lateral loads, the hat truss helps to restrain the bending of the building

frame by introducing a point of inflection in its deflection curve. The resulting reversal in the curvature reduces the overall lateral movement at the top of the building. By placing the rigid truss at the top of the building, with connections to the exterior columns, the braced frame of the structure can no longer rotate at the top as a cantilever.

Structural software performed the design and analysis of the steel framing, making it possible to test various bracing schemes to identify the optimum solution. In addition, the software generated steel tonnage for the gravity and lateral system prepared cost estimates prior to completing the construction documents.

This project has been extremely successful in identifying the need for new residential units and bringing them to market in a timely manner. The entire building foundation and superstructure was constructed in approximately 12 months. Pre-excavation and slurry wall construction started in October 1998, with topping off of the structural steel in September 1999.

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