International Place, Tower III

International Place Tower III was presented an Outstanding Project Award (Building Project $5M to $25M in Construction Value) in the NCSEA 2002 Excellence in Structural Engineering Awards program.

The recently completed 3-tower office complex at the corner of Poplar Avenue and Massey, known as International Place, is a beautiful complement of architectural elegance and natural wooded landscaping. But Tower III is significantly different than II and I in its internal structure. The structural engineering task to create the third identical building in a new code and construction environment was an exercise in "out-of-box" problem solving and pure ingenuity. From this project we can learn and apply some techniques toward structural analysis and reduce the cost of construction for future projects. This type of strategy increases the structural engineer's role in a project and inherently increases the value of structural engineering as a profession.

The original plans for International Place called for three towers, which were designed and constructed in the late 1980's. Tower I and II structures have structural systems of reinforced concrete joists and post-tension concrete girders along with interior reinforced concrete shear walls. Tower III was originally designed at the same time as Towers II and I, with all three of the original designs as "wind-only" lateral resisting systems. Since Memphis/Shelby County has since adopted seismic criteria into the code, Tower III design had some significant problems as a "copy job".

Because the original vein from which the exterior stone was quarried was expected to "run dry," stone for all three towers was purchased at the same time. The stone for Tower III was fabricated and crated for future use. This created a unique situation when it came time to design Tower III: the exterior dimensions of the façade had to match the old curtain wall system. Therefore, the existing stone set the exterior geometry and exterior column locations, as well as the typical floor-to-floor height of 12-feet 6-inches. *Lesson: Identify the Client's concerns and investments in the project and focus the engineering solution toward mitigating those key concerns.*

The first challenge was that the new design would have to be structurally revised to accommodate the current seismic criteria under the Standard Building Code, 1994 Edition, while maintaining the original exterior envelope for the warehoused stone. The seismic criteria for the Memphis, TN, site was Seismic Performance Category C with an Effective Peak Velocity Related Acceleration Coefficient (*Av*) of approximately 0.19, according to the Standard Building Code 1994 Edition. A lateral analysis of the original design revealed the original core area would have to be increased dramatically to accommodate the required longer shear walls. This would decrease the rentable square footage per floor plate by approximately 20 to 25%. An alternate solution had to be devised to keep the square footage similar to the original plan, accommodating the fixed vertical and horizontal geometry of the exterior curtain wall system.

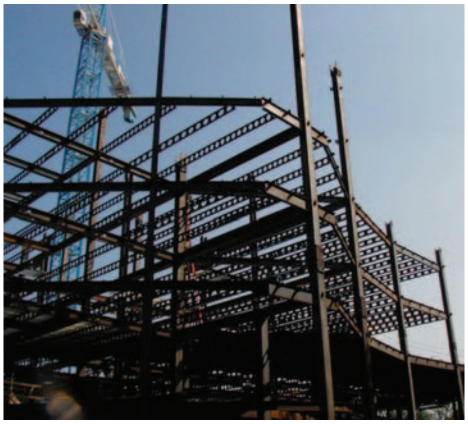
Pre-purchased, pre fabricated, warehoused stone façade set the geometry for each floor and created a challenge to convert from its original concrete design to the new steel design.

Tower III is positioned immediately on Poplar Avenue and looks identical to the previously constructed Towers I and II. This was a key Client expectation.

Alternative structural systems were considered with a stocky, height-restricted structural steel design prevailing, which reduced the total weight of the structure by 50% and therefore reduced the seismic forces by 50% or more. Structural steel could be erected faster than the cast-in-place concrete alternative, therefore meeting the tight schedule requirements for a successful lease agreement. *Lesson: Actually investigate all alternate systems and their real contribution to schedule, design and cost. Be aware of past paradigms, which may cloud your investigative thoughts. Make sure you get paid for these services.*

The mechanical system would fit under a 15-inch structural steel depth envelope only if the sprinklers were located to pass through the structural steel at pre-defined locations. Typical floor framing consisted of composite castellated beams (Smartbeam by SMI) spaced at approximately 5 feet and spanning some 45 feet. This allowed the typical sprinkler piping to pass through the aligned holes, but more importantly, it gave a full 15-inch depth with less steel. The large girder sections provided thick webs that virtually eliminated web hole reinforcing where the piping passed through the girder. The geometry was detailed on the structural documents so the fabricator and the general contractor could easily fabricate and align the piping holes. *Lesson: Don't be afraid to show more information on the drawings in order to clarify a particular system. This saves construction administration cost to your firm and provides the Contractor and Client confidence in your work. It is hands-on marketing. Also, seriously evaluate the cost of the web opening design. The cost savings are significant, but*

spotlight



Difficult geometry with castellated beams create intense challenges to the structural design.

the design time can be large. Present this to the Client with the expected savings in construction. If the difference is significant, the Client will engage you for additional services to provide the net savings. Make sure you get a calendar time deadline extension for the additional services.

The SMI Smartbeam provided two advantages over conventional structural steel. First, Smartbeam was cost effective over typical structural steel when accounting for the depth restriction and additional web hole fabrication and reinforcing. The Smartbeam comes with hexagon shaped holes at regular intervals that allowed smaller peripheral sprinkler piping to pass through without special hole fabrication. Second, the castellated beam design properties were recently added to the design tables of the RAM Analysis software for composite steel design. Sheridan Structural Solutions, Inc. used a Smartbeam definition in its framing model, and the software cranked through the laborious 100 calculations per castellated beam in minutes. Without this software, the Smartbeam option would not have been feasible.

In addition to the use of stocky gravity framing, the moderate seismic forces had to be resisted by a series of moment-resistant frames. Early in the design, welded moment connections were considered, but the post-Northridge criteria raised concerns. With the moderate seismic forces, the wind design in the north/south direction was comparable in magnitude to the seismic forces. Drift controlled the column and beam sizes for the depth-restricted frames, and a reduction in the Response Modification Factor (*R*) to a value of three (*R=3*) allowed the requirement for AISC Seismic Provisions (*1997 yellow book*) to be waived. With the large column sizes for beams (W14x120) and the large frame column sizes (W14x233), complete penetration flange welding in the field would be a very expensive venture. Therefore, with the Seismic Provisions no longer required, bolted extended end-plate moment connections were used with limited use of column stiffeners or web doubler plates. *Lesson: Tonnage does not equate to cost directly! The fabrication preparation time, fabrication labor, field welding and resulting testing are large cost items that can be minimized by using large structural sizes and eliminating the column stiffeners and doubler-plates. AISC design guides have tables to help determine how much weight can be increased in a column before it pays to included stiffeners. These values need adjusting for the local area of construction, and can be revised with the help of a local fabricator.*

Castellated beam framing provided for the cost effective design as well as provide a 15-inch structure depth with prefabricated holes for sprinkler mains.

Construction began on Tower III in early February 2001 and was completed in April 2002. In just over four months, 2,011 tons of steel was erected in a "just-in-time" process, on a very tight site.

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