The Adaptive Reuse of Soldier Field

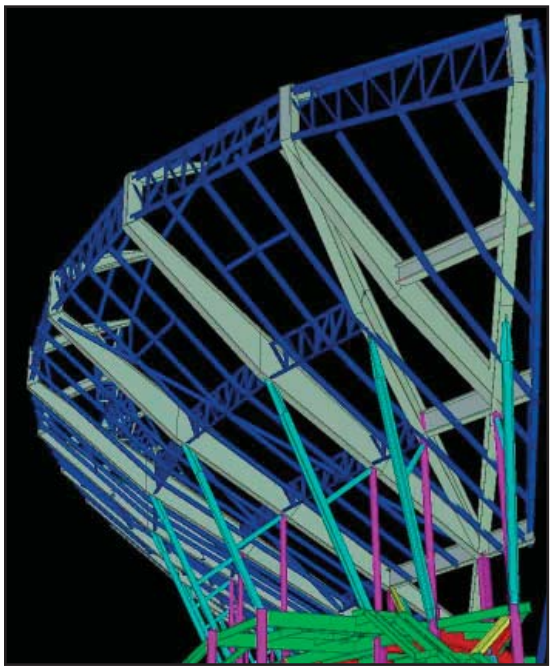
Chicago, Illinois

By Joseph Burns, P.E., S.E, FAIA, and David McLean, CEng, MIStructE, MIEI

The Adaptive Reuse of Soldier Field project was presented an Outstanding Project Award (Other Structures category) in the NCSEA 2005 Excellence in Structural Engineering Awards program.

The award-winning adaptive reuse of Chicago's historic Soldier Field tackled complex geometry and steel construction innovations within a 20-month construction schedule, making it one of the NFL's fastest built stadiums. The renovation consisted of fitting a new 61,500-seat stadium bowl within the 1920's shell of the existing facility, as well as adding a new partially underground parking garage for 2,500 cars. Owned by the Chicago Park District, Soldier Field was a major component of the master plan for the 17-acre Lakefront Redevelopment Project, which also called for a new park located on top of the underground parking garage, a sledding hill, children's garden, new street furniture and water elements.

As the oldest venue in the NFL, Soldier Field lacked amenities associated with modern stadiums, including unobstructed sightlines, diverse concessions, adequate restroom facilities and club seating. The re-design by the joint venture team of Lohan Caprile Goettsch Architects and Wood + Zapata of the stadium interior created a modern facility while preserving the beloved landmarked exterior. The architectural solution was an asymmetrical design with general admission seats stacked on one side of the stadium and stacked luxury suites atop two cantilevered club decks on the other. That configuration, a first in NFL stadiums, saved enough space to fit a 61,500-seat stadium inside the historic colonnades.



Xsteel 3D model of the underside of the West Grandstand

Structural Steel Frame

The structural design, provided by the Chicago office of the Thornton-Tomasetti Group, called for a 13,000-ton structural steel frame that provided great design flexibility. Stadium seats are supported on precast concrete risers that span between main structural steel rakers spaced on 40-foot centers. The rakers supporting the upper grandstand cantilever posed two challenges. They cantilever 60 feet, one of the longest such cantilevers supporting a sports crowd, and the cantilever extends outward, over the historic colonnades, rather than inward toward the field.

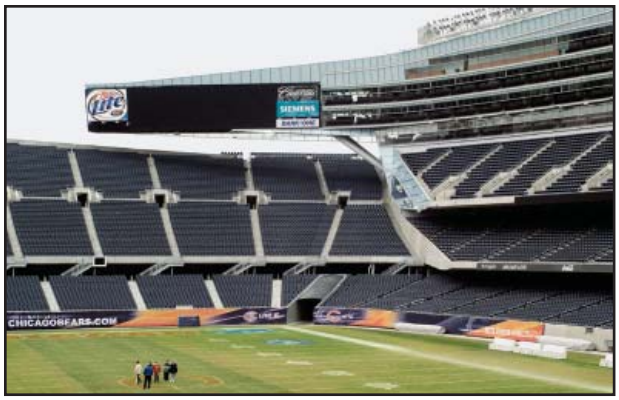
Because the luxury suites and club seating are located on the east side of the stadium, the grandstand seating on the west side is lower and, therefore, much closer to the field — so low that it clears the historic building by inches. The structure for the suites wraps around the corners of the field, cantilevering over 100 feet of the end zone seating and providing support for two massive video displays measuring 84 feet long by 23 feet high.

Northwest view of the underside of the West Grandstand with the tuned mass dampers (TMDs) visible at the top. Photo courtesy of Thornton-Tomasetti Group.

Tuned Mass Dampers

The upper grandstand cantilever's steel frame presented the challenge of maintaining spectator comfort amidst synchronous crowd movements of sports fans or concertgoers. This problem is typically solved with the addition of more columns, but that option was unfeasible because of the historic colonnades below the cantilever.

To provide needed vibration control, 21 tuned mass dampers (TMDs) were incorporated at the tips of the cantilever of the grand-



North Scoreboard

stand. The TMDs, weighing approximately 20 tons apiece, comprise a concrete mass supported on air springs, tunable steel springs and a tunable viscous damper connected to the structural frame. Sixty-four accelerometers were attached to the grandstand to monitor its movement. Thornton-Tomasetti used finite-element modeling software to model the structure and the crowd's forcing function on it, and to determine the placement of the TMDs. To confirm the theoretical results of the modeling, a custom "Vibration Shaker" was attached to various locations on the grandstand. The shaker operated by rotating two sets of weights in opposite directions to induce a measurable vibration into the structure. This test confirmed the frequencies at which resonance would occur and assisted in tuning the TMDs. With the TMDs operating in place, the accelerations remain within the limits for spectator comfort.

3D Modeling

To accelerate the steel fabrication and erection process, Thornton-Tomasetti, in a joint decision with the project team members, used Tekla's Xsteel 3D modeling software to produce a full-size, annotated computerized model. Once the model was in place, piece drawings for fabrication and general arrangement drawings were produced automatically. Generating 3D models for each of the stadium's four quadrants, Thornton-Tomasetti was able to prepare documentation for the steel beams, beam sizes, member forces and camber required for each beam and column. The steel fabricator then used the 3D models to complete the connection detailing, prepare shop drawings and prepare the computer numeric control download for the machines used to cut and punch the steel.

Because only the connections required examination, the drawing review process took only five days instead of the usual 10, saving valuable time. Using Xsteel also helped avert costly miscues from design to fabrication and installation. The 3D geometry of the steel work was also available to Permasteelisa Cladding Technologies, facilitating design and assembly of the non-rectilinear panelized cladding system.

Faced with the challenges of a site restrictions and a compressed construction schedule, the project team responded with a spectacular design, innovative engineering and the latest technology. In honoring Soldier Field as its 2003 Overall Project of the Year, *Midwest Construction* noted the difficult geometry, the time savings by designing in three dimensions, and the teamwork required to get the project completed.▪


Pipe supports of the North Scoreboard. Photo courtesy ©David B. Seide/Defined Space, Chicago.

Joseph Burns, P.E., S.E., FAIA, is a Managing Principal with the Thornton-Tomasetti Group and served as principal-in-charge for the adaptive reuse of Soldier Field. David McLean is a Vice President with the Thornton-Tomasetti Group and served as the project manager.


Northwest corner of the Grandstand. Photo courtesy ©David B. Seide/Defined Space, Chicago.

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