Ruth's New DIGS

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Built in the image of its former self, new Yankee Stadium carries on the architectural—and hopefully, winning—tradition of the House that Ruth Built.

OLD YANKEE STADIUM WAS KNOWN by many as the House that Ruth Built and was considered to be one of the shrines, if not *the* shrine, of Major League Baseball. Of course, the Yankees have a whole new set of star players these days—and as of this season, a brand-new stadium.

New Yankee Stadium consists of five seating zones (encompassing approximately 53,000 seats in all) within the bowl: the Field, Main, Suite, Terrace, and Grandstand levels. The Field and Main concourses were constructed with concrete, with the balance of the stadium framed in steel. The cast-in-place portion of the structural bowl was constructed simultaneously with the completion of construction documents and the fabrication of the surrounding steel superstructure. The building's lateral system is a mixed system; the lower portions of the structure are supported by continuous and uniformly distributed moment frames, and the rest of the stadium supported by a series of continuous and discreet bracing elements to provide circumferential stability. The lower Field and Main levels are supported by steel framing and are stabilized by the concrete moment frames, and supplemented by steel moment frames in the circumferential direction. The steel portion of the stadium is approximately 12,000 tons.

Vibration Consideration

To maximize seating and unobstructed views, the Suite and Terrace levels are cantilevered approximately 50 ft beyond the support columns of the Main level below. These long steel-framed cantilevers used full-story trusses hidden within suite walls. Wide-flange members with a maximum flange width of 8 in. were used in order for the trusses to fit within the suite walls; the depth of the trusses is approximately 24 ft.

Designing these cantilevers required a detailed evaluation of the vibration characteristics. Published design guidelines, including AISC vibration guidelines, do not specifically address vibration performance characteristics for long cantilevered structures supporting seating bowls, where both vertical and horizontal modes of vibration may be coupled. Historical precedents for limiting a main-bowl cantilever's fundamental vertical frequency to 3.5Hz have been successful in previous sports facilities to limit perceived vibration to an acceptable level. In addition to this guideline, an analysis was performed for each typical cantilever bent by applying spectator-forcing functions through multiple frequencies and capturing the acceleration response at resonance. Steel tonnage was then optimized within the cantilevers to limit the vibration response of the main cantilevers to within typical AISC acceptance criteria.

Photos by Chris Linder

The historic frieze that was an ornamental icon of old Yankee Stadium serves both an ornamental *and* structural purpose in the new stadium. (3D model created in Tekla Structures.)

Rendering by Thornton Tomasetti/ Koch Skanska/Canam

The new incarnation of Yankee Stadium uses 12,000 tons of structural steel—and seats a whopping 53,000.

More Modeling

The project team for Yankee Stadium incorporated building information modeling (BIM) at the very early stages of design. The structural elements—including steel, concrete, deck and precast components—were modeled in Tekla Structures to provide both a medium for aesthetic review of the structure and to accelerate procurement and fabrication schedules for the steel. All steel member information—including sizes, elevations, and geometry—were included in the completed model and issued to the erector/fabricator team in sequences that suited their preferences. These models were used for advance mill orders and as the basis for completed fabrication models.

Because of the aesthetic importance of the exposed steel connections, the connection design of all major steel elements was completed on the structural documents. All major exposed connections were further modeled in Tekla Structures, allowing connection design and geometry to be modified to suit the architectural aesthetic requirements. Fabrication models were also submitted for review prior to detailed shop drawing submissions for approval, allowing for a simplified and expedited approval process.

The Frieze

Perhaps the best example of the successful use of BIM and 3D modeling in the stadium design is the signature element of the Yankee Stadium brand: the historic frieze that ringed the old Yankee Stadium prior to its renovation in 1974. The old frieze was ornamental in nature, with a backup truss structure providing its structural support, and initial concepts for the new stadium followed a similar approach. However, the structural engineer eventually offered a different approach in which the frieze in the

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new stadium would serve both ornamental *and* structural functions, and would be constructed as a self-supporting structural element. The 1,465-ft-long frieze ringing the new stadium is constructed of single 350-lb/ft units, between bents, of ⅝-in. continuous plate (laser cut) for the arches and openings, and 8-in. x 6-in. curved standard hollow structural sections (HSS). The sections are supported by built-up inverted columns at each bent and cantilevered from the main canopy girders.

Since the frieze is self-supporting, the visual appearance is the same from both the field and the upper seating; the connections were detailed such that there are no visible connections from the field side of the frieze, creating continuously clean lines. These critical details were modeled in Tekla Structures, allowing the team to visualize and modify the connection shape and geometry, such as adding chamfers to end plates to lessen their visual impact, and resulting in a signature element seamlessly connected to the main structure.

Yankee Stadium certainly pays its respects to its former self but also serves as a symbol of a new era for the team. Attendance has been high at the stadium so far this season—and there's still plenty of baseball yet to be played. MSC

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