

TCU's redeveloped football stadium opens in time for the Horned Frogs' Big 12 debut.



New Home for a New Era

BY R. JOHN ANIOL, S.E., P.E.,
AND JOEL BARRON, P.E.

AMON G. CARTER STADIUM, on the campus on Texas Christian University (TCU) in Fort Worth, Texas, has been the home of the Horned Frog football team for over 80 years.

During this time the stadium has undergone several renovations and additions to accommodate ever-growing crowds, and the most recent and substantial iteration opened in time for the school's first year competing in the Big 12 Conference.

In an effort to capitalize on their recent gridiron success (the team has finished in the Top 25 nine out of the last 12 seasons and went 13-0 in 2010), TCU essentially decided to start over, building a modern, \$135 million, 46,330-seat stadium—with 25 suites, 2,500 club seats, a 20,000-sq.-ft Founder's Club Lounge and all the latest fan amenities—on the same site as the original stadium. The resulting newly built Amon G. Carter stadium, which includes 3,850 tons of ASTM A992 structural steel, opened on September 8, 2012, with a Horned Frogs win over the Grambling State Tigers.

Schedule

The stadium was constructed in two phases. The first phase included demolition of the existing west elevated grandstand (the first twenty rows, which were concrete cast on grade, remained) and construction of a new west grandstand and north end zone grandstand. This phase began with demolition in December, 2010, after the football season ended. General contractor Austin Commercial had nine months to complete the structure (with a target of September, 2011, to accommodate fans in the lower levels). The second phase included selective demolition of the existing east elevated stands (with the existing at-grade seats to remain) and construction of the new east grandstand during the 2012 off-season; steel fabrication and detailing took place during the football season.

To help expedite the schedule, steel was chosen for the raker beams to support the precast seating units throughout the stadium. Vibration control (lots of excited fans) became the key design consideration for these rakers and resulted in a 60-in.-deep plate



Aerial Photography, Inc.

▲ Southeast aerial view of the stadium.



Thornton Tomasetti

▲ North end zone view of the west grandstand during the season opener.

girder for the 47-ft span in the north end zone. Vibration was checked with AISC *Steel Design Guide 11, Floor Vibrations Due To Human Activity* for rhythmic excitation and confirmed with SAP2000 analytic models to evaluate the raker/frame frequency and acceleration.

Another key to staying on schedule was involving the steel fabricator, Irwin Steel, and steel erector, Derr Steel Erection, early in the design process, during the design development phase. “The collaborative efforts between Thornton Tomasetti, Austin Commercial and Irwin Steel during the preconstruction phase of the project involved structural steel planning,

budgeting, coordination with major trades such as precast seating and the development of connection designs,” commented Don Baker from Austin Commercial. “These efforts not only resulted in the most efficient steel design and steel erection process needed for the aggressive schedule, but also saved time and money.”

Details

Connection details with architectural impact were studied from both aesthetic and ease-of-erection viewpoints. The under-seating inclined bracing connections on the west upper deck are an example of this collaborative process, with

R. John Aniol, S.E., P.E., is a vice president and served as structural engineer of record/structural project manager. **Joel Barron**, P.E., is an associate and served as structural project engineer. Both work in the Dallas office of Thornton Tomasetti and can be reached at janiol@thorntomasetti.com and jbarron@thorntomasetti.com, respectively.





Thornton Tomasetti

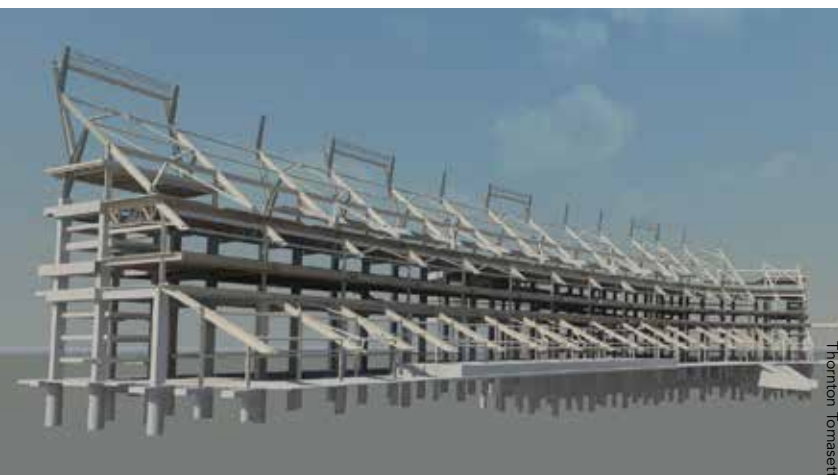
▲ Truss at the Upper Concourse during erection.



Thornton Tomasetti

▲ Inclined bracing connection at the upper seating level.

▼ A Revit model of west grandstand.



Thornton Tomasetti

a double gusset connection of the tube bracing members (a result that satisfied the interests of the architect, engineer and erector). According to a Derr Steel representative, “In addition to the benefit of suggesting connection details that were both erector and fabricator friendly, such as details for the signature ‘lightning bolt’ columns, Austin Commercial and Thornton Tomasetti worked with us to modify numerous connections to accommodate construction considerations.”

Structural steel played an aesthetic role in the design as well. The back column of the west upper seating deck is the iconic lightning bolt or “Y” shape mentioned above, which emphasizes the Art Deco design theme chosen by the architect, HKS. “The unique shape of the upper deck support columns is a key element in conveying the historical Art Deco influence on the design of the stadium,” noted HKS project architect Michael Hessert.

The upper deck columns also support the steel sports lighting truss and catwalk system. At the knuckle, stiffeners matching the 2-in. flange thickness and complete joint penetration (CJP) welds were used to ensure a continuous flange in all three directions. The column/raker connection was detailed as a simple framing (pinned) connection to prevent vibrations from the sports lighting transferring to the rakers, where they might be perceived by fans. To achieve lateral stability, the inclined braces under the seating units carry the lateral loads to a middle column moment frame and to the stub column, which is braced to the upper concourse diaphragm with double angles. A similar bent-back column was chosen for the east grandstand. The challenge on the east side was the 50-ft cantilever needed to support the sports lighting truss and catwalk. A 30-in.-deep column at the knuckle tapers to an 18-in.-deep section at the top to prevent significant wind deflection and support the lights at the required elevation.

On the west side, above the Suite Level, an 8-ft, 6-in.-deep truss cantilevers out toward the field more than 20 ft to support the upper seating bowl lower seating section, as well as the middle seating section and precast bearing walls framing the vomitories. A Vierendeel panel was required in the truss to accommodate an HVAC duct servicing the Club and Suite Levels. Early coordination with Irwin and Derr resulted in details—in this case the splice at the field side column—that allowed the truss to be fabricated and erected as one piece, saving erection time.

During construction of the west grandstand, TCU made the decision to expand the upper deck by extending it to the north, over the already designed Club and Suite Levels. The capacity for this upper deck expansion was included in the initial design; however, the column layout necessitated a different detail. In the final design, the back column under the upper concourse shifts west, away from the field, to frame the north tower so that the W40 raker cantilevers 14 ft back from the middle column, with a smaller upper deck seating arrangement for northern-most three bays.

Other areas of the stadium used steel for aesthetic reasons, including the monumental stair connecting the Champions Club Level to the Suite Level. The stair consists of HSS16×8 stringers cantilevering from the steel-framed Suite Level and bearing on the concrete-framed club level. Similar to the rakers, vibration control of the stair was the driving design focus. Two additional features are a hanging chimney at the Founder’s Club, hung from a



▲ West elevation of the stadium.

Champions Club Level raker, and a hanging bar feature in the Founder's Club Level, hung from the concrete-framed upper Concourse Level.

"The open Main Concourse Level, which offers fans a panoramic view of the playing field, and the Founder's Club seating, located just 22 rows above the field, are distinctive features rarely found at other collegiate venues," commented HKS design principal Bryan Trubey.

The Amon G. Carter Stadium Redevelopment came about largely in recognition of the football program's high level of success, and TCU's move from the Mountain West conference to the Big 12 Conference will result in TCU receiving more national attention in the coming years. The new stadium provides an attractive new backdrop for the next chapter in Horned Frog football history, while also providing fans all the comforts and convenience of a modern, amenity-rich sports venue.

MSC

Owner

Texas Christian University, Fort Worth

Architect

HKS, Inc., Dallas

Structural Engineer

Thornton Tomasetti, Dallas

General Contractor

Austin Commercial, Dallas

Steel Team

Steel Fabricator

Irwin Steel, Justin, Texas (AISC Member/AISC Certified Fabricator)

Steel Erector

Derr Steel Erection Company, Euless, Texas (AISC Member/AISC Certified Erector)

Steel Detailer (East Side of Stadium)

WSP Mountain Enterprises, Inc., Sharpsburg, Md. (AISC Member)



▲ West stands during erection.

▼ "Y" column during erection of the northwest expansion.

