Cowboy Corral

BY DYLAN S. RICHARD, P.E.

An extensive refurbishing gives Oklahoma State University's Boone Pickens Stadium a needed makeover.

CREATING THE APPEARANCE OF A SINGLE BUILDING IN A THREE-PHASE PROJECT MAY SEEM A LITTLE DAUNTING, ESPECIALLY IN A STRUCTURE WITH 80-YEAR-OLD COMPONENTS. Luckily, the team working on Oklahoma State University's (OSU) Boone Pickens Stadium (formerly Lewis Field) is up to the task. The project is currently in the fourth year of a six-year expansion that is creatively transforming the stadium into one of the nation's top collegiate venues. OSU's "The Next Level" campaign was launched in early 2002, and has been fueled by multiple donations from OSU alumnus T. Boone Pickens. So far, fans and press have been delighted with the amenities and luxury of the emerging stadium.

Moving on to "The Next Level"

Due to the project's scale and complexity, it was divided into three distinct sequential phases. Phase 1 included the renovation and expansion of the south grandstands, with new concourses, concession and restroom buildings, preferred-seating levels, and a press box. This initial phase was completed in time for the 2004 football season. The recently completed Phase 2 included a similar renovation and expansion to the north grandstands, just in time for the 2006 football season. Currently under construction, Phase 3 will result in a new west end-zone structure, connecting the newly renovated and expanded Phase 1 and Phase 2 project areas. New grandstand seating will connect the south and north grandstands, each over 80 years old. Phase 3 also will include many of the same amenities, including preferred-seating areas and a new home for all football operations.

A structural steel framing system was selected for this project primarily due to the dimensional and functional similarities to Phases 1 and 2. The project team believed that structural steel will provide the best opportunity to connect all three phases of the project and provide the appearance of a single new building.

Laying the Groundwork

The existing south and north grandstands were originally built in the 1920s and expanded in the 1940s. Typical construction at the time included steel columns on a 20 ft by 20 ft grid braced in both directions with horizontal and diagonal struts and X-braces. The result was an impenetrable forest of small structural steel members. These existing steel structures had been exposed to the elements for many years with little protective maintenance, and contained considerable amounts of rust and signs of deterioration.

In preparation for the new construction, contractors first had to demolish a variety of stand-alone buildings that had been constructed within the steel frames. The steel then had to be cleaned, inspected, and repaired where necessary, and protected with a three-part high-performance paint system. Although engineers determined that the structures were in relatively good condition, severe corrosion had occurred at some locations that had been previously covered up and exposed to high levels of moisture. The repairs ranged from minor strengthening of the steel members to the entire replacement of the members.

Once the integrity of the south and north grandstand steel structures was restored and protected, engineers turned their focus to accommodating the architectural program. Between the two grandstands, a total of 14 new two-story concession and restroom buildings were constructed within the existing web of steel framing. Through strengthening of the foundation system, the second (floor) and third (roof) levels of these buildings were framed with

Right, top: The old stadium was supported by a forest of steel members.

Right, middle: The existing steel had been exposed to the elements for many years, evincing considerable amounts of rust and deterioration.

Right, bottom: Open concourses in the renovated structure replace the plethora of steel bracing elements.

new steel members that attached to the existing structural systems. Additionally, several steel braces were relocated with steel columns and beams strengthened to accommodate a new uninterrupted mezzanine-level concourse that accesses the second level of the concession-and-restroom buildings as well as the existing upper vomitories leading to the seating bowl. When completed, an open, brace-free concourse replaced a forest of spindly steel.

The new club-level seating was accommodated by replacing the top 10 rows of the existing south and north grandstands with nine more spacious rows of club seats. To reduce additional dead load on the existing grandstands—allowing for less need for structural steel strengthening—steel-bent plate tread-and-riser units were used. Extensive field surveys of the existing steel rakers were required in order for the fabricator to provide units that matched up with the existing steel supports and follow the articulating steel column grid. The units were then set and seal-welded to each other and protected with a Neogard roller-applied urethane traffic-coating system.

Clever Design Solutions

The most visible aspect of Phases 1 and 2 are the two new 120-ft-tall structures along the entire length of the backside of each grandstand. They provide elevator, escalator, and stair access to multiple concourses and to the new club, suite, and press levels.

The club levels at the new structures were joined to the new club seating sections on the existing grandstands through an expansion joint running the entire 500 ft length of each building. Suite and press (Phase 1 only) levels were provided above the club levels and club seating areas via 30 ft cantilevers over the top of the existing grandstand structures.

In addition to using 30 ft cantilevers with as little as 32 ft backspans, the architect also planned for 14 ft floor-to-floor heights. The shallowness initially concerned engineers, especially in regard to strength and vibration performance of the cantilevers. The solution was found in a series of steel-braced frames that featured 48-in-deep custom plate girders to provide the needed stiffness in the limited structural height. To accommodate distribution of piping, wiring, and heating ducts, the plate girders were designed with approximately 240 total openings total the south and north structures. Erection of the custom plate girders was simplified through early coordination meetings between the steel fabricator, steel erector, design team, and contractor.

Although the length of the 500 ft Phase 1 and 2 steel structures would ordinarily require an expansion joint, engineers sought ways to eliminate joints in order to allow

Cantilevers are supported by a series of steel-braced frames with 48-in-deep custom plate girders to provide the needed stiffness in the limited structural height. To accommodate distribution of piping, wiring, and heating ducts, the plate girders were designed to include web penetrations.

the new structures to act as single buildings. The new structures were designed to eliminate the need for expansion joints by providing lateral bracing in the long (east-west) axis of the structure with a single brace at the center of the building. This brace provided a central "anchor point." As the temperature changes, this central brace allows the new structure to expand and contract away from and toward the center of the building. Six additional brace frames in the short (north-south) axis distributed along the length of the stadium provide the remaining lateral resistance to the new building. Although exposed steel braces were provided as HSS sections for aesthetic reasons, the project team decided to use WF steel braces at all non-exposed conditions—a cost-effective solution.

Safety First

Although it is always preferable to complete major stadium renovation projects during the off-season, the schedule of this multi-phased project demanded that construction proceed during the various football seasons. Because ongoing work included the sequential removal of key bracing elements that stabilize the existing grandstands against high winds and earthquakes, the design team had to take special steps to ensure safety for fans at each game. The structural engineer continually monitored the construction progress and performed staged structural reviews of the actual work in progress. These analyses, performed by the engineer a day or two prior to every home game, established structural criteria from which the construction manager established a detailed sequence and set of "rules" for removal, replacement, and localized completion of portions of the lateral system by the steel erector. Through this "just-in-time" engineering and construction process, the project progressed without compromising the safety of the structure for fans during game time. Post-game meetings with the construction manager, subcontractors, architect, and structural engineer helped to establish acceptable and target construction progress goals for the next home game.

Looking Forward

Phase 3 will consist of a new, approximately 4,600-ton, steel-framed structure in the west end-zone of the stadium. This structure will close the gap between the south and north structures of the stadium, allowing all seating and concourses to be connected seamlessly. At a distance of over 600 ft north to south, the west end-zone structure will contain a single east-west expansion joint at the center of the building. These two sections of the building will also require an expansion joint at each of their respective interfaces with Phases 1 and 2. MSC

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Structural Detailer (Phase I)
Neubecker Detailing, Fort Worth, Texas (AISC member)

Detailing Software
AutoCAD

Fabricator
W and W Steel LLC, Oklahoma City (AISC member)

Erector
Bennett Steel Inc., Sapulpa, Okla. (AISC member)

General Contractor
Flintco Inc., Tulsa, Okla.