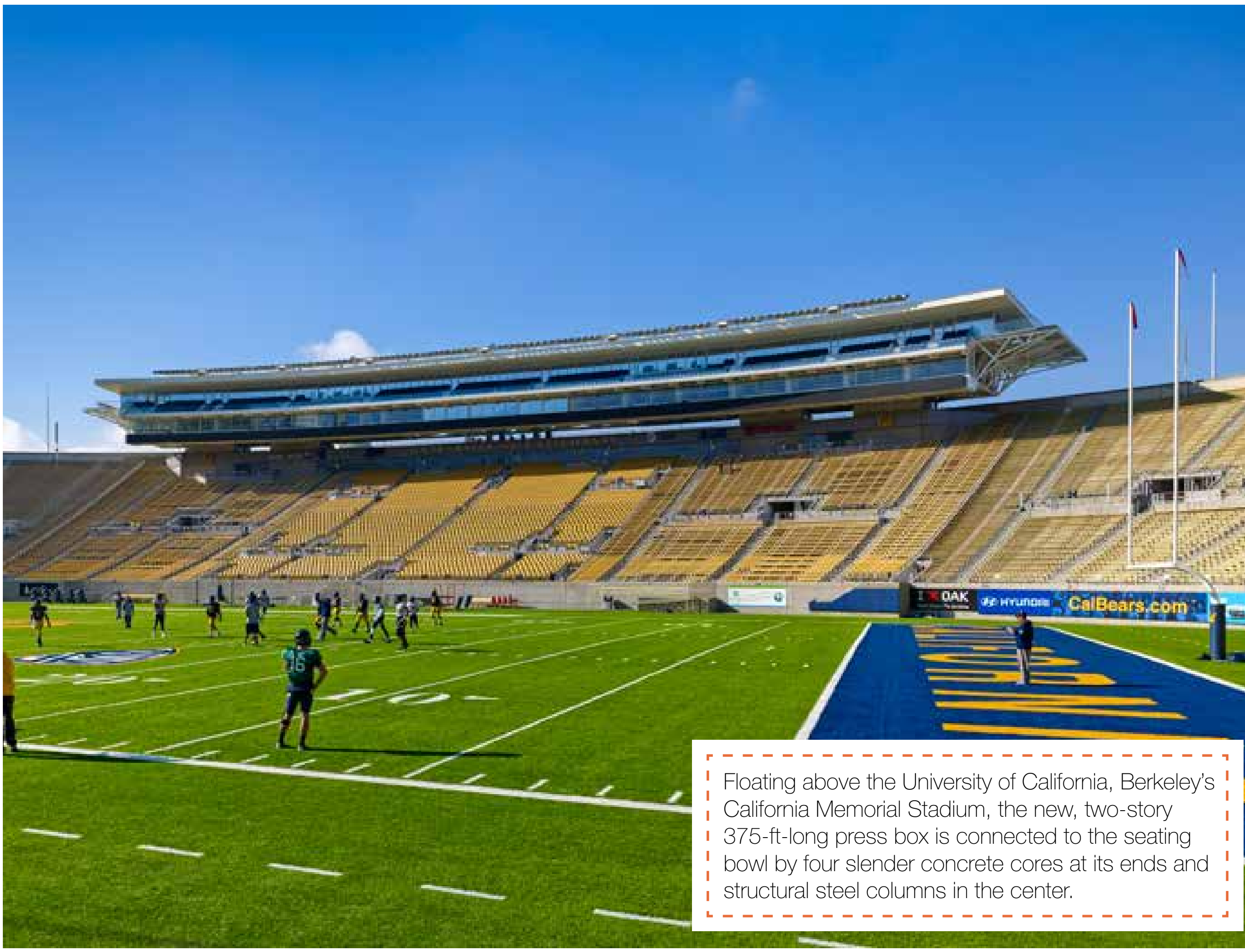
U.C. Berkeley California Memorial Stadium Press Box

Berkeley, Calif.



Floating above the University of California, Berkeley's California Memorial Stadium, the new, two-story 375-ft-long press box is connected to the seating bowl by four slender concrete cores at its ends and structural steel columns in the center.

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Project Team

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The University of California, Berkeley, Calif.

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STUDIOS Architecture, San Francisco

Structural Engineer
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General Contractor
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Consultant
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The Herrick Corporation, Stockton, Calif.

Steel Detailer
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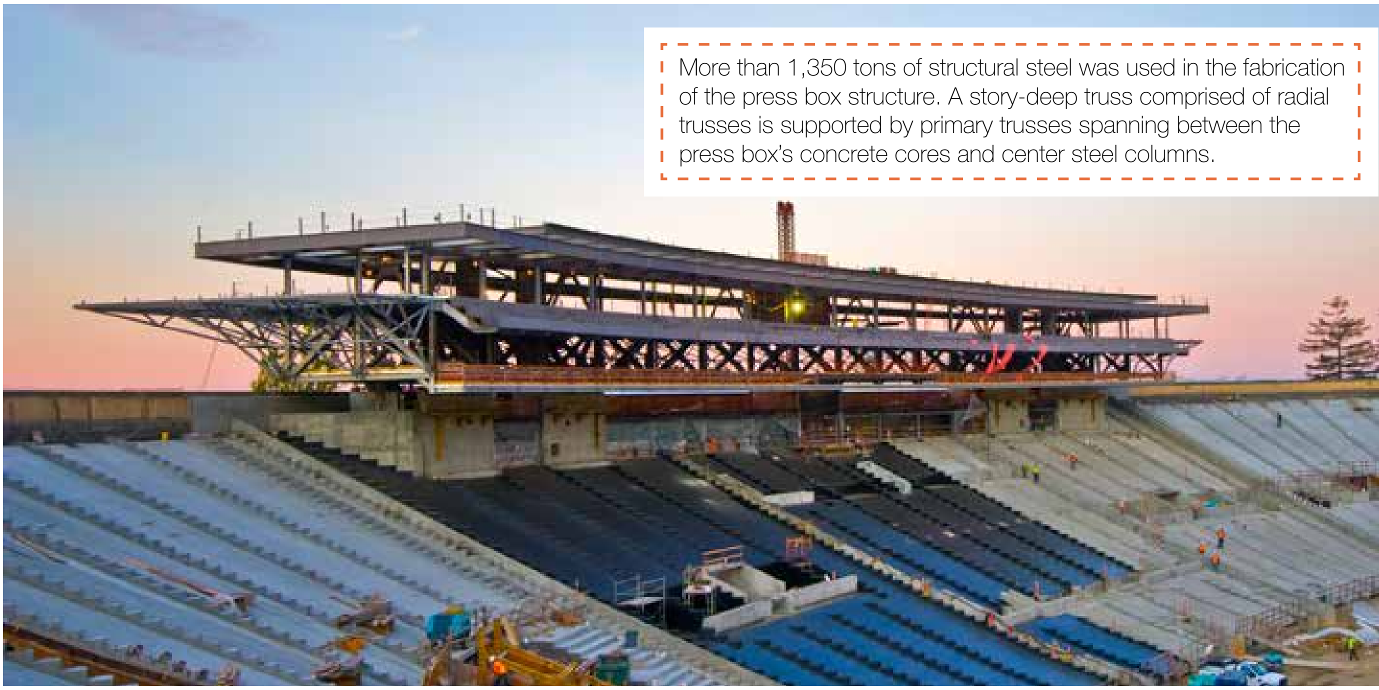
Content provided by Forell/Elsesser Engineers, Inc., San Francisco

Steel Pin Assemblies Lend 'Pivotal' Support for New Football Stadium Press Box

Sixteen large-diameter high-strength steel pin assemblies support the steel-frame press box and pivot atop cores during a seismic occurrence while helping to make the two-story, 375-ft-long structure appear to float above the stadium bowl.



More than 1,350 tons of structural steel was used in the fabrication of the press box structure. A story-deep truss comprised of radial trusses is supported by primary trusses spanning between the press box's concrete cores and center steel columns.

The University of California, Berkeley's California Memorial Stadium has endured as one of the most picturesque venues in college football from its opening in 1923 to the present day. Upon discovering that the stadium was at particular risk in an earthquake—a scenario further exacerbated by the fact that the stadium sits directly over the Hayward Fault—the university undertook a $215 million project to seismically retrofit as well as modernize the stadium.

The "crown-jewel" of the project is the new long-span two-story structural steel press box that seemingly floats atop the new west portion of the stadium. One of the main architectural design goals for the $40 million press box was to achieve a floating effect to the press box by reducing the number of press box supports to a bare minimum. The resulting press box structure is 375 ft long with two main spans of 100 ft long and end-span cantilevers of 33 ft.

The shape of the press box follows the curvature of the existing exterior wall and is supported by four concrete cores—two at each end—and four center structural steel columns. The press box is two-stories with the first floor housing the print, radio and TV media functions and the second floor housing a club space with views and seating facing the field. The outer side of the press box features a dramatic 33-ft cantilevered hollow structural section (HSS) balcony with a glass deck that faces campus and offers panoramic views of the San Francisco Bay and Golden Gate Bridge. The area for each level is 10,200 sq. ft and 12,500 sq. ft respectively.

The main structure of the press box consists of a story-deep space truss comprised of radial trusses that are supported by primary trusses spanning between the concrete cores and center steel columns. The occupant load for the entire press box is more than 1,700 people, and greater than 1,350 tons of structural steel was used in its construction.

Because the stadium rests on the active Hayward Fault, the seismic design of the press box and supporting concrete cores utilized several design innovations to allow for good seismic performance. The concrete cores that support the press box also provide its main vertical access. These tall, slender support elements, with the lumped press box mass at the top, create a dynamic incompatibility with the surrounding bowl structure. This incompatibility had to be addressed, otherwise a major seismic event could cause substantial damage to the concrete cores directly below the support points for the press box. The solution involved

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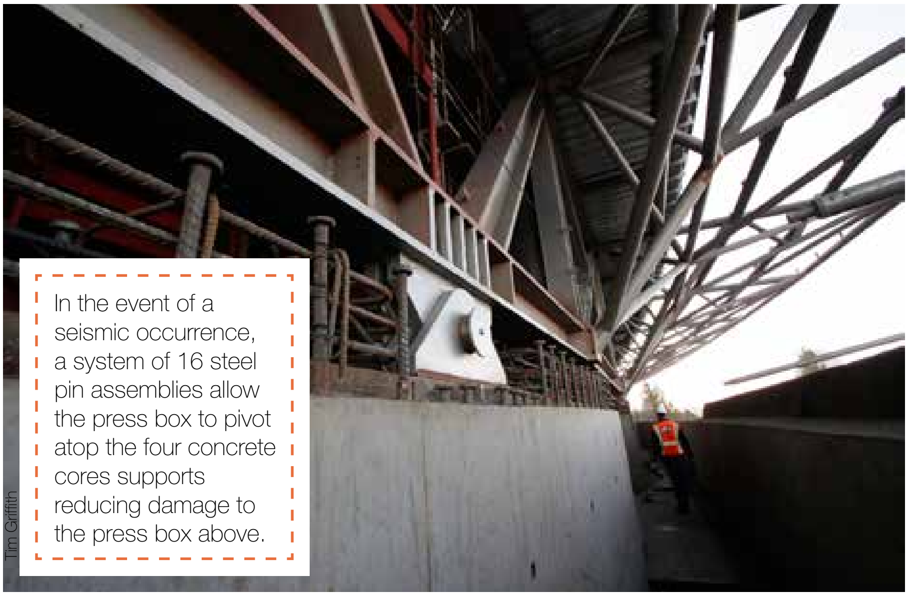

In the event of a seismic occurrence, a system of 16 steel pin assemblies allow the press box to pivot atop the four concrete cores supports reducing damage to the press box above.

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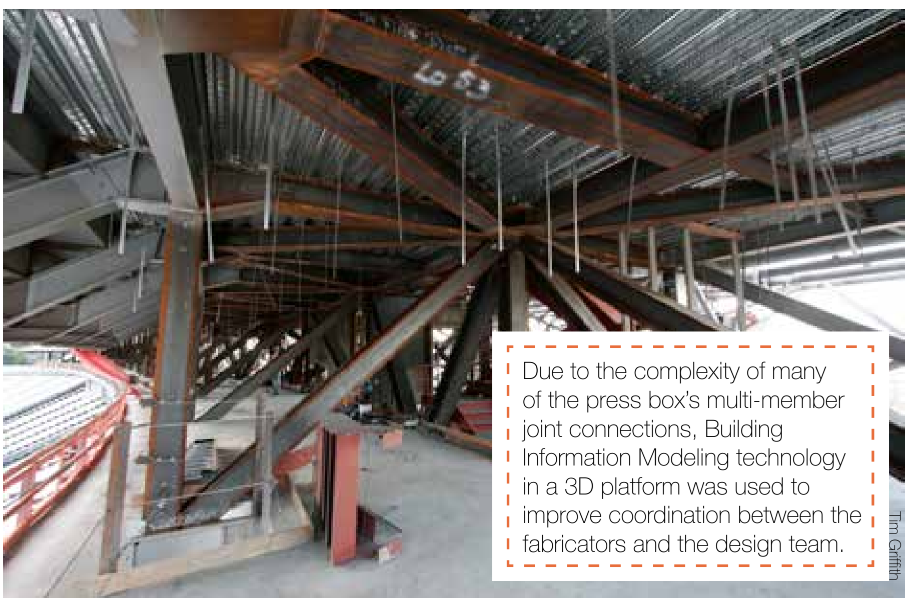

Due to the complexity of many of the press box's multi-member joint connections, Building Information Modeling technology in a 3D platform was used to improve coordination between the fabricators and the design team.

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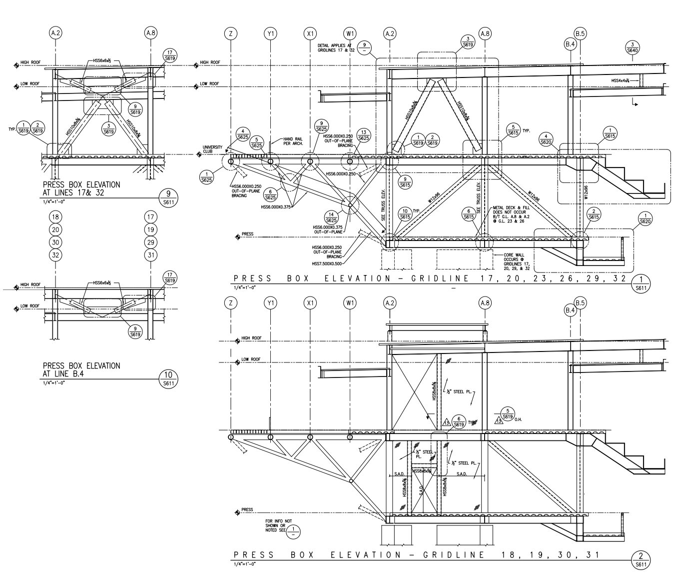

Press box elevations such as these were helpful in the coordination of the main truss system, as well as the various elements that cantilevered off the main space truss: glass balcony, seating, and roof sections.

seismically separating the cores and press box structure from the surrounding bowl, allowing them to move completely independent of the main bowl structure.

The concrete cores were designed to rock at their bases to alleviate the seismic demand on them. The cores also were vertically post-tensioned to provide stability and a restoring force when rocking. Fluid viscous dampers (shock-absorbers) were added within the bowl structure where it links to the cores to provide a mechanism to dissipate seismic energy and to control movements and accelerations in the press box. Sixteen dampers were used in the design of the stadium, each with 220-ton axial force capacity.

As the core wall system rocks in an earthquake, the large drift angle of the cores would cause large bending and shear forces in the press box above. In order to alleviate these forces and economize the design, the press box was supported on steel pins—eight 6-in. pins at the bottom of the four W14 steel columns and eight 7-in. pins (two each) at the center of the concrete cores. The pins allow the press box to pivot on the cores and minimize damage to the steel structure. Each large-diameter high-strength steel pin is sandwiched by five 100-ksi steel gusset plates. The entire press box structure is supported on 16 of these pin assemblies.

The top level club space of the press box has a 33-ft cantilever balcony framing off the main press box space truss supporting a walkable glass deck. This balcony structure is also a space truss comprised of numerous small-diameter pipe sections. This balcony truss system, which includes seismic and out-of-plane bracing, has several multi-member joint connections with some joints connecting up to eight pipe members. Due to the complexity of these joints, coordination was required to take place in a 3D platform (Revit and Tekla) between the fabricators and design team.

The modernization and seismic upgrade of the stadium required careful coordination and collaboration between the construction team and design team to bring this state-of-the-art press box to rest elegantly on top of the renovated stadium bowl. The stadium was able to re-open on time for the 2012 football season.

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Because of the tight site, surrounding neighborhood and topography, trusses had to be assembled on the stadium football field.

Truss Assembly and Erection Sequencing Critical to Press Box Construction

Due to the complex nature of the site and surrounding neighborhood, limited space was available on site to allow for erection and construction of the press box. To address this issue, the steel fabricator and erector and the general contractor enlisted a 750-ton Liebherr crawler crane with 276-ft boom and 65-ft counterweight extension with a ballast wagon attachment to erect the main press box truss in five large segments. The crane was the largest available that would fit through the stadium tunnel without having to be modified.

The main space truss of the press box was assembled and welded on the playing field, adjacent to the seating bowl. Carefully selected splice locations were determined to ensure each of the five truss segments would be within the crane's capacity for weight and reach. Each of the five segments exceeded 75% of the crane's capacity and therefore were considered critical picks. The largest pick of the five truss segments was 165 tons at 160-ft reach, which took the crane to over 95% of its capacity.

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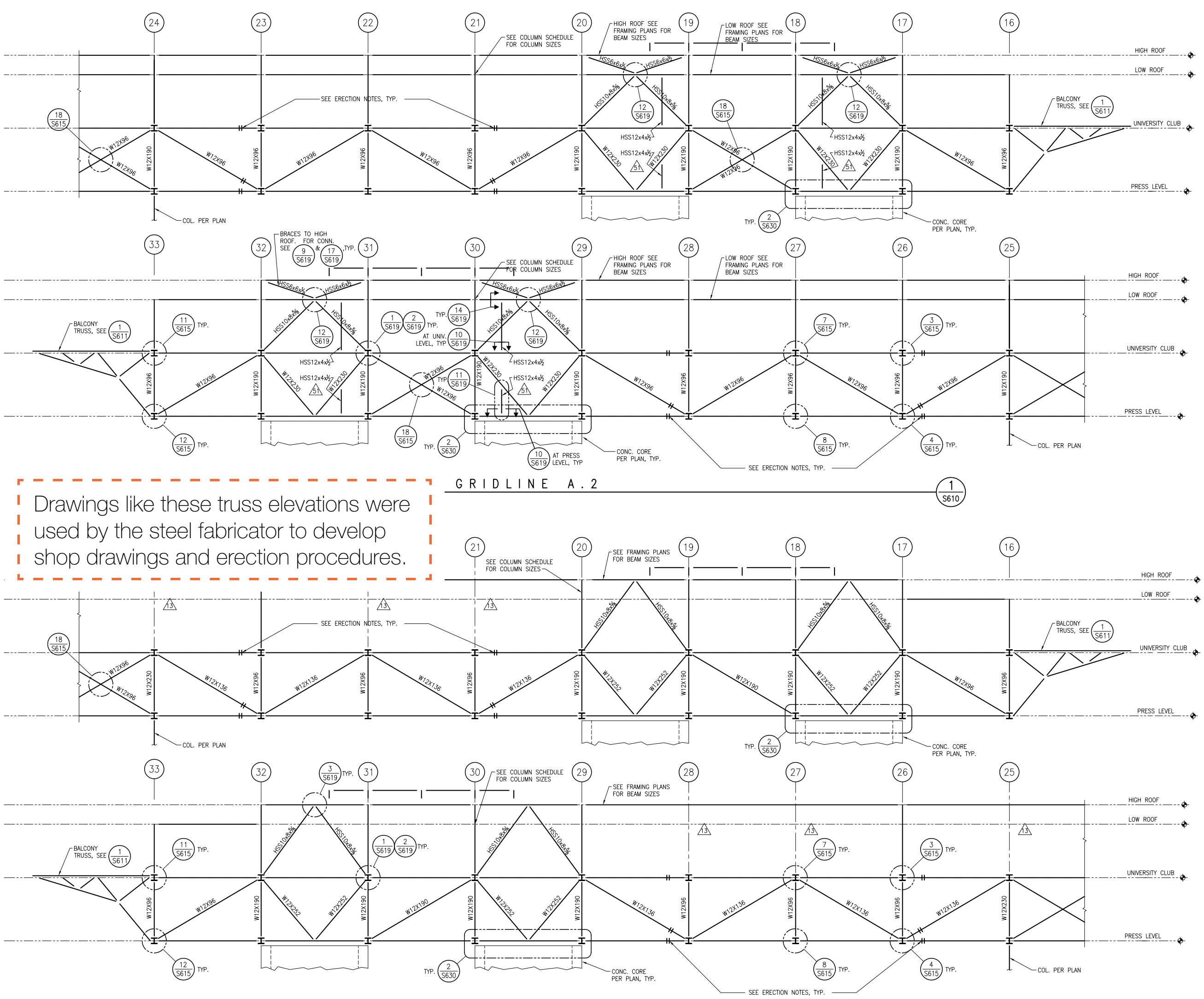
A 750-ton crawler crane starts to raise one of five segments of the main space truss into place.

The new press box towers above the newly reconstructed California Memorial Stadium.

An aerial view of the stadium and press box in context with the neighborhood.

Structure Facts

Dimension:	Two 100-ft-long main spans; HSS balconies cantilever 33 feet at both ends.
Total Length:	375 feet
Levels:	Two stories: 10,200 sq. ft and 12,500 sq. ft
Development Cost:	$40 million (press box)
Structural system:	Story-deep space truss comprised of radial trusses supported by primary trusses spanning the concrete cores and steel columns.
Innovative design:	Floating design follows wall curvature; 309-ft-long main curved wide-flange truss
Structural steel:	1,350 tons



Drawings like these truss elevations were used by the steel fabricator to develop shop drawings and erection procedures.