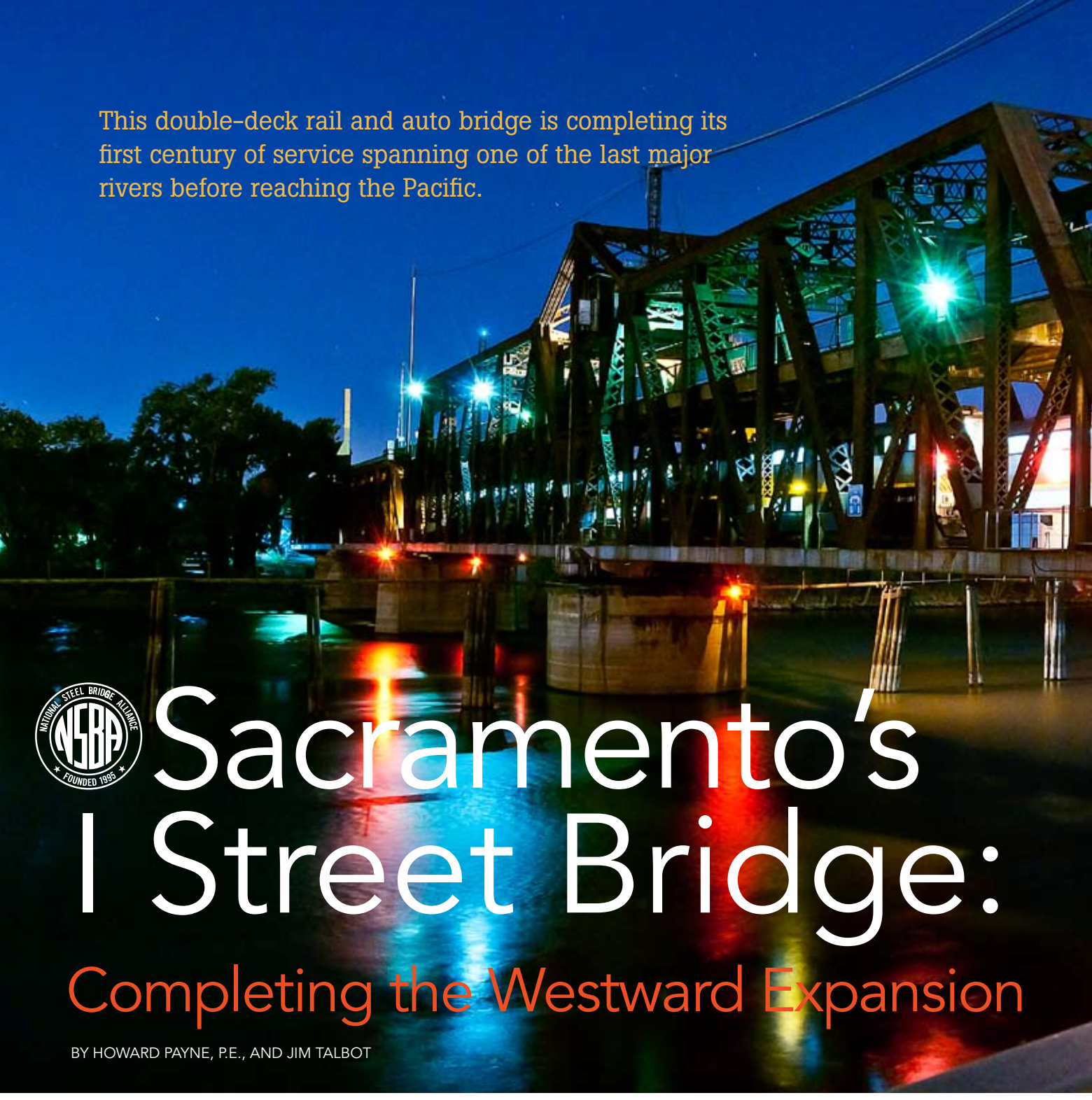


This double-deck rail and auto bridge is completing its first century of service spanning one of the last major rivers before reaching the Pacific.

Sacramento's I Street Bridge:

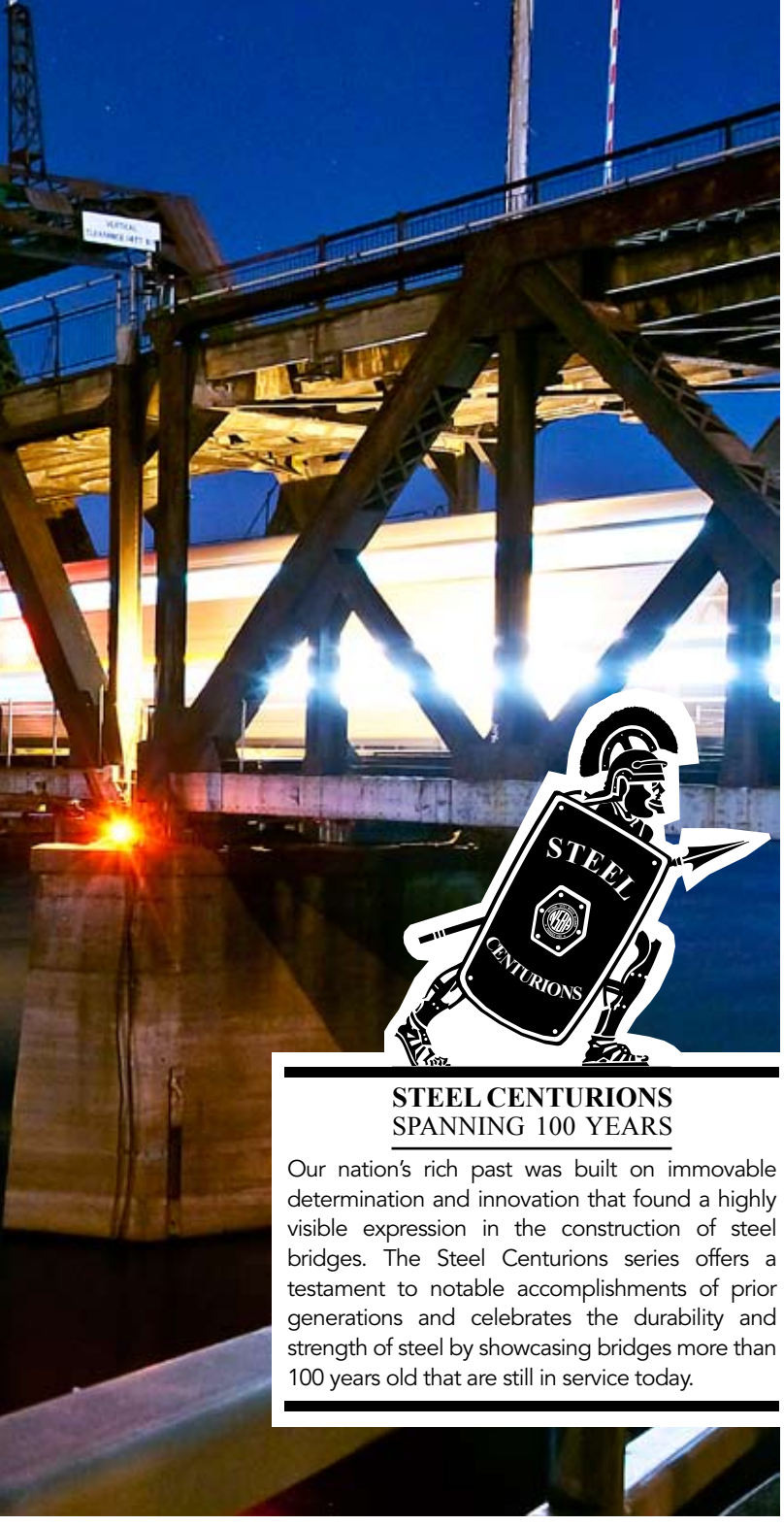
Completing the Westward Expansion

BY HOWARD PAYNE, P.E., AND JIM TALBOT

THE 100-YEAR-OLD, STEEL, I Street Bridge in Sacramento, Calif., carries rail, auto, and pedestrian traffic across the Sacramento River. A double-deck steel truss, the bridge consists of three fixed spans—two 167 ft and one 109.6 ft in length—plus a 394-ft span that swings open over a center pivot. The heaviest swing bridge in the U.S., its overall length is 2,194 ft, including approaches. The bridge has about 30 ft of clearance over low water and about 100 ft of clearance on each side of the pivot pier for barges and pleasure craft.

Railroad width clearances of 14 ft per track on the bottom deck originally determined the 30-ft width of the bridge. The upper deck provides 9-ft lanes for vehicle traffic bracketed by 5-ft sidewalks for pedestrians. To cope with the narrow passage, truckers and bus drivers sometimes turn in their rear view mirrors while on the bridge.

Today the bridge is on the main line of the Union Pacific Railroad. It carries about 40 trains a day, 32 of them being Amtrak transcontinental passenger trains and Caltrain commuters, and the remainder Union Pacific freights. It is busy enough that two trains at a time can be seen on the bridge. On the upper deck the I Street bridge carries about 10,000 vehicles a day, serving the north area of West Sacramento and downtown Sacramento. Openings for rivercraft today are minimal, but were frequent early in the 20th century when commerce was primarily waterborne.



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The bridge also serves rail traffic for the inland Port of West Sacramento. Situated 79 nautical miles from the Pacific Ocean, this barge and ship facility moves rice, wheat, corn, lumber, machinery, and containers. The ship canal is currently being dredged from 30 to 35 ft, which will accommodate 75% of the world's fleet.

Historical Background

Sacramento and West Sacramento were originally parts of large Mexican land grants. In 1848 John Sutter, Jr., made the city's first block plan, beginning development of the city's waterfront and ports. The California Steam Navigation Company, one of the first major businesses in the area, built docks and warehouses. Sacramento became the focus of the 1849 gold rush, and West Sacramento was its agricultural supplier. Farmers provided grain, corn, livestock, melons, and potatoes, and operated commercial salmon fishing. In 1856 the Sacramento Valley Railroad was built toward the east from Sacramento to Folsom.

The steel bridge sits on the site of multiple timber bridges constructed in the latter part of the 19th century. Earlier bridges resulted from efforts by railroad companies to push west to the San Francisco Bay Area. All of the railroad's metal work originated in the eastern United States and was shipped around Cape Horn. This led to the development of large railway shops in northwest Sacramento, which became the major industry in the west for many years.

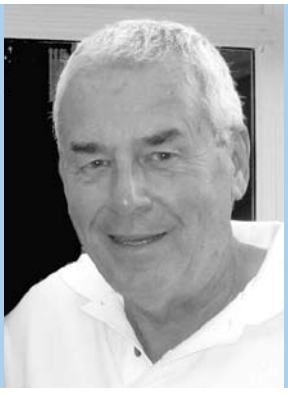
By 1869 the Central Pacific Railroad ran from the eastern side of the Sacramento River to Promontory Point, Utah. The Sacramento terminal served as a convenient off-loading point for railroad materials. But the railroad did not cross the Sacramento River, which meant passengers and goods had to be transferred to river boats.

Over a little more than 50 years, four timber bridges preceded the present structure.

- In 1858 a toll swing bridge carried pedestrians and loaded wagons across the river. It had distinctive, curved laminated truss chords and a swing span supported by a timber tower and cables.
- In 1869 the California Pacific Railroad Company bought the first bridge and replaced it with a new Howe truss timber bridge with a 200-ft draw span, a single railroad track and mixed traffic.

▲ The swing span design of Sacramento's I Street Bridge follows that of the Howe truss, with vertical members and diagonals that slope upward toward the center.

Howard Payne, P.E., was a bridge engineer with Caltrans for 18 years. Now retired, he also has served as a docent at the California State Railroad Museum, located next to the I Street Bridge in Sacramento. Jim Talbot is a freelance technical writer living in Ambler, Pa.



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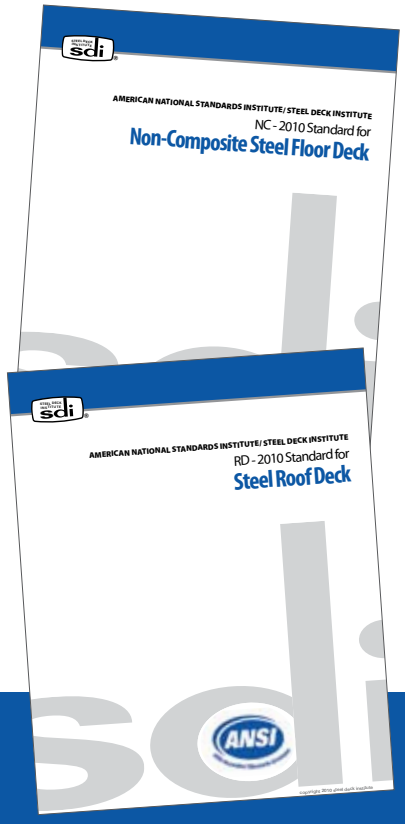

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UPDATED
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Peter Brungs

▲ Supported by a 42-ft-diameter pivot pier in the Sacramento River, the 394-ft swing span of the I Street Bridge weighs in at 3,374 tons.

- The Central Pacific Railroad took over in 1876 and rebuilt the bridge. As the railroad yards and shops grew, this bridge became a one-track bottleneck within the two-track system.
- In 1893 the Central Pacific became the Southern Pacific railroad. It built a larger and stronger timber bridge that had the same configuration as the present bridge—two tracks on the lower deck and a wagon road on the upper deck.

Enter Steel

Construction of a new $786,000 steel bridge began in 1910 with John D. Isaacs as consulting engineer for the railroads. Design of the fixed spans incorporates vertical members with diagonals that slope downward toward the center. Additional bracing in the lower sections characterize these spans as Baltimore trusses, a subclass of the Pratt truss. The swing-span design follows that of the Howe truss, with vertical members and diagonals that slope upward toward the center. It also has additional bracing in the lower section.

Loading specifications for the lower deck followed the Harriman Lines common standard rail model. The design for highway traffic on the upper deck supports 100 lb/ft^2.

The Missouri Valley Bridge and Iron Company, supplemented with Southern Pacific workforces, built the pier foundations. The American Bridge Company, located in Western Pennsylvania, furnished the steel superstructure, totaling about 4,500 tons. Weight of the swing span topped out at 3,374 tons. The cities of Sacramento and West Sacramento shared in the cost and maintenance of the upper deck.

The piers extend down about 55 ft, penetrating a layer of boulders and gravel prevalent in the region. A principal structure is the 42-ft diameter center pier built on an octagonal-shaped caisson, 54 ft in diameter and 80 ft tall. This pier stood taller than any buildings in Sacramento at the time. Crews set the caissons for the remaining stream piers inside of cofferdams.

Workers constructed timber fender piers upstream and downstream from the center pier, completing it in August, 1911. They erected the swing-span truss on this pier in the open position, using a straddle leg traveler, with access from the west side. Slowed by the difficulties of winter construction in the stream, and the time it took to cast and cure the concrete deck,

the bridge finally went into service in April 1912. But the date commonly accepted for bridge construction is 1911, which is cast on a steel plate on the diagonals over each truss portal frame.

The trusses consist of shop-fabricated and field-riveted built-up box sections made from web plates and angles, cover plates, and lattice bars. Canted eyebars over the center pier support the trusses in their cantilever position, and give the bridge its distinctive profile. An operator in the central control house opens and closes the bridge.

In the open position, the calculated deflection of the cantilevered ends was about 5 in. Designers shortened the supporting eyebars to raise the deflected bridge ends about 4 in. while open, making the bridge continuous over the center pier and keeping some tension in the eyebars. As the span closes, wedges lift the ends into place and locks provide stability.

The bridge design ensures that the swing span always achieves balance over the pivot pier. The original center bearing was a phosphor bronze crowned disk, having a 52-in. diameter and 6-in. thickness. It sat between two nickel-steel bearing plates 5.5 in. thick.

The swing span was designed to open in either direction and powered by two 75 HP direct current electric motors. The motors sat near the center of the span, driving a gear train. The span takes about five minutes to open, and another five to close and restore traffic. A set of balance wheels run about ⅛ in. above a steel perimeter track to keep the cantilevered ends from tilting. The wheels carry no weight except that to overcome forces such as wind. A powered automatic latch at each end of the span assists in centering the bridge.

Improvements

In 1993 the bridge's center bearing began to chatter. While the entire swing span was jacked up during bearing replacement, new hydraulic motors were installed in place of the original DC motors.

Originally the roadway at the west end of the bridge jogged abruptly as it moved away from the track alignment, a configuration that caused numerous accidents and fatalities. In 1937 and again in 1959 this roadway section was lengthened with modern, safer curves.

A white navigational stripe runs along the bottom chord in sharp visual contrast with the weathered, dark brown superstructure. Fortunately, the steel suffers minimal rusting in the dry Sacramento Valley climate.

What of the future? The I Street Bridge is listed in both the California Register of Historical Resources and the National Register of Historic Places. The bridge is well maintained mechanically, and its weathered look is simply evidence of a century of aging gracefully. Meanwhile, the nearby Tower Bridge on Capitol Avenue, or M Street, has become a city symbol that gets all of the publicity. A lift bridge with architectural towers, the Tower Bridge was built in 1935 and has since been painted gold. But it's the I Street Bridge that still carries the mainline load, a true Centurion. MSC