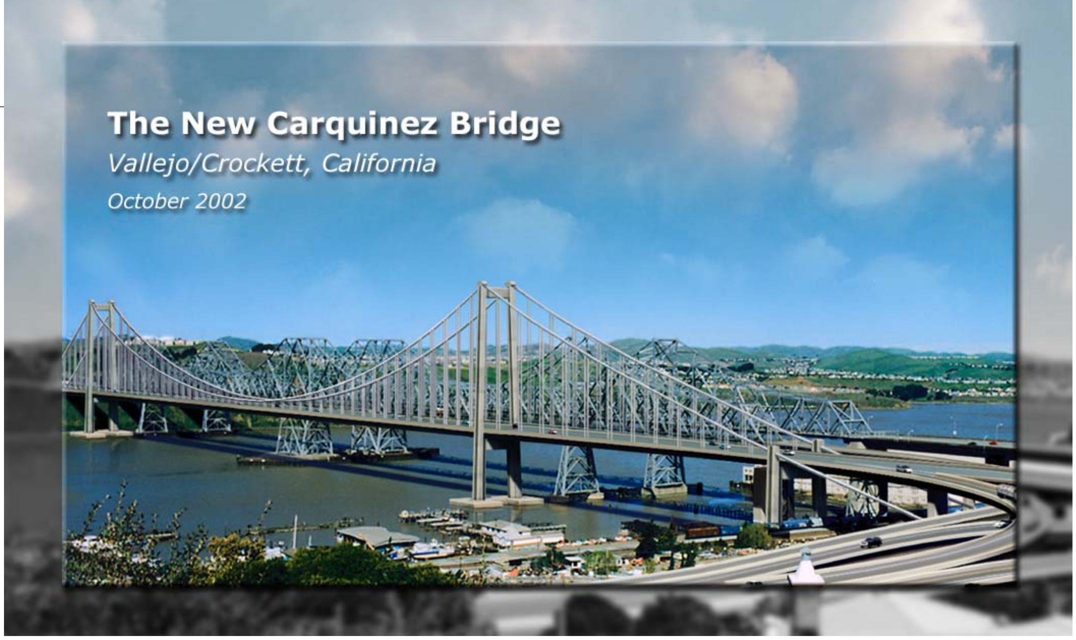

The New Carquinez Bridge

Vallejo/Crockett, California

October 2002

Client:
California Department of Transportation (CALTRANS)

Program Duration:
1997—2004

Program Value:
$188 million

Parsons Services:
Environmental services, bridge type studies, initial design, final design and engineering support during construction

The new Carquinez Bridge will span the windswept Carquinez Strait 20 miles northeast of San Francisco, just miles from three active earthquake faults. It is the first major suspension bridge to be built in the U.S. in over 35 years and the first designed to today's stringent seismic standards. It replaces one of two previous structures and will be completed in early 2004. The first, built in 1927, was privately owned until the state of California bought it in 1941. Faced with growing traffic needs, the state then built a second bridge across the Strait in 1958.

Both of the early structures are multi-span cantilever steel truss bridges with maximum spans of 1,180 ft. Seismic retrofit studies conducted for Caltrans concluded that the 1927 bridge would be more costly to upgrade than replace, and that the 1958 bridge could continue service after seismic upgrade. This conclusion set in motion the replacement of the older bridge with a new span meeting today's stringent seismic safety standards.

Together, the two older bridges on Interstate 80 carry more than 105,000 vehicles daily on three substandard lanes, a volume that is expected to increase to 128,000 vehicles by 2010. The new Carquinez Bridge will have four westbound traffic lanes to accommodate increased traffic. A spacious pedestrian/bike travel way will be added to the 1958 bridge.

Caltrans initially considered four different structural types for the new bridge. To help refine the selection process, Caltrans commissioned Parsons, a leader in the design of long-span bridges, to prepare initial designs for two bridge types: cable-stayed and suspension. Caltrans then chose the suspension bridge as its final design.

In addition to the type studies, Caltrans asked Parsons to perform final design and engineering support during construction. Parsons developed detailed design criteria that encompassed state-of-the-art suspension bridges as well as very demanding site conditions: three active earthquake faults, a significant risk for river scour, and a history of strong winds.

Since the new bridge is a need of Caltrans' mandated seismic safety program, the design was completed on a fast track basis with final design plans being delivered in just a year. Parsons' San Francisco and New York offices shared the design effort and continue to work closely together to support the client's needs during the construction phase. Electronic data sharing between the two offices helped seamlessly advance the substructure and superstructure designs and the support services work product. With Parsons' engineering support, construction of the main towers and foundations is complete and cable spinning is now well under way.

Superstructure box girder trial assembly progresses in the dry-dock prior to shipment to the Carquinez Bridge Site. A total of 24 box girder units will be suspended from the new main cables and welded together forming a 3,464 ft. continuous stiffening girder weighing upwards of 14,000 tons.

Construction at the new Carquinez Bridge

The new suspension bridge will have an overall length of 3,464 ft. with a clear main span between towers of 2,389 ft. and incorporates state-of-the-art advancements in the design of orthotropic steel box girders. The closed steel box girder of the suspended superstructure is 10 ft. deep and 95 ft. wide, and is the first of its type in the U.S. Its floor system has the rigidity and strength to carry traffic and to resist torsion from wind, seismic, and other asymmetrical loads. Since a 100-year return period wind event could reach speeds of 162 mph in the Strait, the box girder's streamlined shape also resists wind and minimizes dynamic and buffeting wind response, (the "galloping" and buffeting caused by winds attacking from various angles). The design also incorporates the latest advances in fatigue endurance, the performance of which Parsons earlier validated in full-scale testing.

The new bridge also sets the standard for seismic safety. Seismic criteria required that the bridge be designed for the maximum credible earthquake from three major faults: a quake measuring 8.0 on the Richter scale from the San Andreas Fault, 7.25 from the Hayward Fault, and 6.5 from the Franklin Fault.

As is typical of the elegant silhouette of suspension bridges, two hollow-shaft reinforced concrete towers soar 395 ft. above the pile caps, bearing the load of the twin 20-inch diameter main cables. Each tower leg is integral with the reinforced concrete pile caps at its base. Two prestressed—concrete cross struts—one below the roadway and one at the tower top-connect the tower legs to form the frame structure. The tower foundations posed one of the biggest construction challenges of the project. In a unique design approach that also saved costs, each tower leg is supported on just six piles. The piles–10 ft. in diameter with 1.75-inch thick steel casings driven to rock—are 180 ft. long. Once the casings were driven to rock they were cleaned out and rock sockets were drilled an additional 150 ft. beyond the casing tip. This modern large-diameter pile design replaced the older and costly method of constructing massive open-dredged gravity caissons similar to those of the existing bridges.

Parsons, long a worldwide leader in the design and construction engineering of cable-supported bridges, has more than 20 recent suspension bridge assignments around the world totaling more than $4 billion in constructed value.