Team

Owner:
California Department of Transportation (Caltrans)

Designer:
T.Y. Lin International, San Francisco, CA, and CH2M-Hill, Sacramento, CA (A Joint Venture)

General Contractor:
Kiewit Pacific Co., (a subsidiary of Kiewit Corp., Vancouver, WA)

Reinforcing Bar Fabricator:
Regional Steel, Tracy, CA

Total Project Cost:
$600 million

Total Project Size:
7,434 ft

Photography:
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STRUCTURAL FRAMING SYSTEM

The five-lane, 7,500-foot-long Benicia-Martinez Bridge serves northern California as a lifeline bridge in a seismically active region. The “lifeline” designation requires the structure to remain structurally functional after a major earthquake. To achieve that goal, designers produced the first cast-in-place (cip), reinforced concrete segmental bridge built in California in 20 years.

Lightweight, high-performance reinforced concrete was used for the superstructure to reduce the loading impact on the piers during a seismic event. The reinforced concrete had to weigh approximately 20% less than normal structural concrete while achieving a strength requirement of 10,000 psi and a stringent modulus of elasticity to limit deflection. After more than 100 test mixes and multiple field trials, a concrete mix was selected.

Grade 60 reinforcing steel (rebar) was used in the project. The reinforcing bar was epoxy coated to protect against corrosion, as required by California statutes for structures built over water. Special guidance from consulting engineers was used to develop detailing and spacing of the reinforcing bars to ensure the most effective design.

The design features 344 concrete box-girder segments. The segments were cast using the balanced cantilever method via a traveling form system that erected the bridge in 15-foot sections. This approach allowed work over a hazardous-material site on one side of the bridge by spanning the site without touching the ground during construction. The design makes the bridge one of the longest concrete box-girder span bridges in the United States.

To achieve the seismic design criteria, evaluations included a linear-dynamic analysis based on response spectra and modal superposition techniques. Other evaluation used in the seismic design included both linear and non-linear multiple-support dynamic time-history analyses. These criteria helped the designers create a bridge that could remain structurally functional after an earthquake.

Deep-water foundations featuring large-diameter steel shell caissons produced the most efficient foundations. The substructure contains 17 piers, including 12 piers in water, founded on 99 concrete encased steel piles approximately 8’ in diameter. Acoustic shock waves generated by pile driving were contained by an air-bubble curtain system jointly developed by the contractor and the California Department of Transportation.

The 22 spans range from 313’ to 659’, with 11 segmental spans crossing the Carquinez Strait. The ability to achieve such long spans was facilitated by using lightweight concrete. It also lightens the inertial load on the piers during a seismic event. The concrete provided a density of 125 pcf, less than conventional structural concrete would provide.

To place the concrete efficiently, an on-site batching plant was created, with four trucks being driven onto a barge and floated to the proper pier location for placing the concrete.

Epoxy-coated reinforcing bar was used to provide added protection against corrosion.