The 500-ft-long gantry sits atop a completed cantilever section.

Precast Segmental Bridge Forges Link for Toll Road

by Wayne A. Endicott

Designers faced challenges with four-lane-wide structure that stretches nearly three-quarters of a mile over an environmentally sensitive area in San Diego

The new South Bay Expressway near San Diego, California, provides a 12.5-mile addition that closes a gap in the area's congested highway system. The project includes several innovations for highway construction in California including a three-quarter mile long precast concrete segmental bridge built using the balanced cantilever method, only the second of its kind in California.

profile

THE OTAY RIVER BRIDGE / SAN DIEGO COUNTY, CALIFORNIA

CONSTRUCTION MANAGER: Parsons Transportation Group, San Diego

ENGINEER: International Bridge Technologies, Inc., San Diego

PRIME CONTRACTOR: Otay River Constructors, a joint venture of Washington Group International, Boise, Idaho, and Fluor Daniel, Sugarland, Tex.

CONCRETE SUPPLIER: Hanson Construction Materials, Calif.

PRECASTER: Pomeroy Corp., Perris, Calif., a PCI-Certified Producer

The precast segmental approach proved more cost effective than other alternatives.

The environment played a key role in selecting this technology for the Otay River Bridge, according to Benjamin T. Soule, Senior Bridge Engineer at International Bridge Technologies (IBT) in San Diego, engineers for the project. The bridge is located in an environmentally sensitive part of the San Diego area. "Although the river is not really filled with water for much of the year, the valley is an environmentally sensitive area," he explains.

Several Options Considered

With the bridge crossing the river more than 160 ft above the valley floor, several possible construction materials and methods were considered, including steel and cast-in-place concrete. "The biggest drawback to these methods would have been the falsework required," Soule says. "To work at that height, the extensive falsework would have posed serious challenges to the ecology of the valley."

After considering several alternatives, the construction team, consisting of IBT and the general contractor, Otay River Constructors (a joint venture of Washington Group International and Fluor Daniel) settled on the precast concrete solution. In addition to the environmental benefits, research indicated that the precast concrete segmental approach would be more cost effective than other alternatives, he notes.

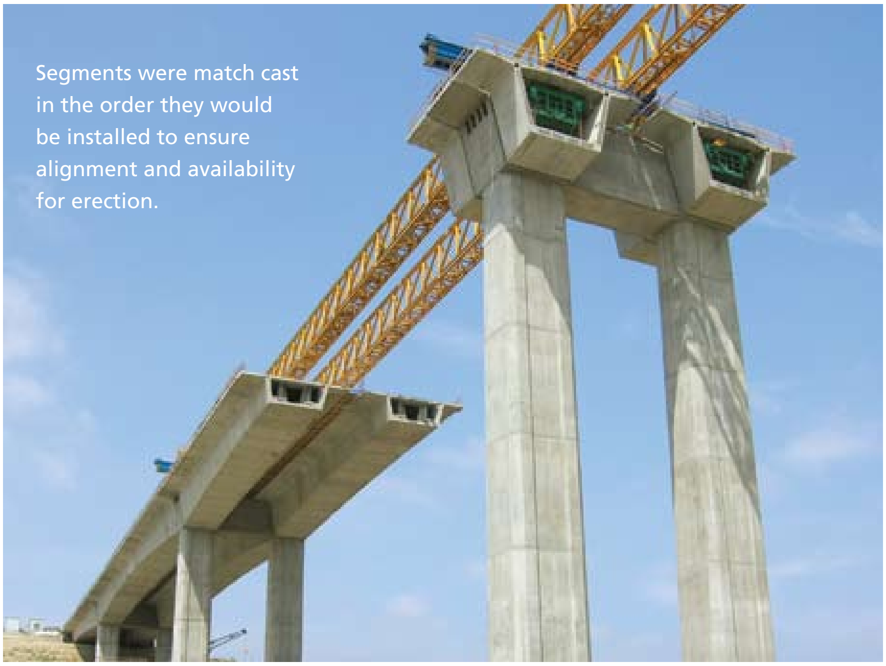
The bridge superstructure is approximately 3280 ft long and consists of side-by-side trapezoidal box girders—one for each roadway alignment. The precast segments are supported by cast-in-place pier caps, which are, in turn, supported by cast-in-place piers that reach as high as 164 ft. The drilled-shaft foundations for the piers include 6-ft diameter by 85- to 131-ft-deep shafts at the bent locations and 4-ft-diameter by 46-ft-deep shafts at the abutments. The shafts are arranged in groups of 10.

The bridge consists of 12 spans. Ten spans have a length of approximately 297 ft. The two end spans are 175 ft long. The bridge was constructed using the balanced cantilever method, with an overhead gantry for setting the segments. The segments, each weighing from 65 to 70 tons, were cast by Pomeroy Corp. in its Perris, California, casting plant and then trucked 90 miles to the site by special heavy-hauling equipment trailers consisting of two low-boys and two transformer decks, according to Daniel Neufeld, project manager for Pomeroy.

Special Forms Created

The segment cross sections ranged from a depth of 16.5 ft at the pier to approximately 10 ft at midspan. Each segment is approximately 10 ft long. The segments were cast in forms manufactured specifically for the job by Rizzani de Eccher of Udine, Italy, Neufeld says.

"The forms are very sophisticated and of very high quality," he explains. They



Segments were match cast in the order they would be installed to ensure alignment and availability for erection.

PRECAST SEGMENTAL BRIDGE / SOUTH BAY EXPRESSWAY, CHULA VISTA, CALIFORNIA, OWNER

GANTRY SUPPLIER: Rizzani de Eccher, Udine, Italy

DRILLED SHAFTS: Anderson Drilling, Lakeside, Calif.

BRIDGE DESCRIPTION: Two side-by-side trapezoidal box girders each slightly more than 3250 ft long broken into 12 spans, built using the balanced cantilever method with an overhead gantry

STRUCTURAL COMPONENTS: 640 precast concrete segments varying in depth from approximately 16.5 ft at the pier to 10 ft at midspan. Each segment is approximately 10 ft long. Each segment weighs between 65 and 70 tons

The decision to build a segmental precast bridge came about through a desire to minimize disturbance to the floor of the river valley.

A Private Highway

The bridge is part of State Route 125, a new highway that will provide direct access from the Otay Mesa border crossing from Mexico to the existing San Diego freeway network. Part of the southern portion of the highway, also known as the South Bay Expressway, is being built by a private consortium and will be operated by that group as a tollway for 35 years before being turned over to Caltrans.

The entire southern portion of the highway, for which the bridge is a major link, will cost an estimated $630 million and is being privately financed. In a unique financing structure, funds for the roadway include bank loans, a $140-million federal loan provided by the U.S. Department of Transportation under the Transportation Infrastructure and Innovation Act of 1998, and private equity capital. In addition, area developers have a dedicated right of way valued at $40 million.

Construction on the northern end of the project will cost approximately $138 million and will provide toll-free links connecting the tollway with the existing San Diego freeway network.

The concrete forms contain a hydraulic manipulator that positioned the previously cast segments.

contained a hydraulic manipulator that positioned the previously cast segment. The segments were match cast with each segment becoming the end piece of the formwork for the next casting to ensure an exact fit between segments. As a result, the segments were cast in the order in which they were erected. The reason for this precision was the exacting quality control demanded by the owner, Neufeld notes. Tolerances between segment surveys were to be between 0.3 and 0.6 mm (0.012 and 0.025 in.).

The segment decks were transversely post-tensioned before they were transferred from the plant to the site, he says. The concrete used in the segments includes 15 percent fly ash and a high-range water-reducing admixture, allowing it to develop high early strengths. Segments contain ASTM A 706 steel reinforcement. Specifications called for the precast concrete production to satisfy the Precast/Prestressed Concrete Institute's quality standards embodied in its Plant Certification Program, as well as the Caltrans Standard Specifications.

In all, 56 precast segments plus the pier segments comprise each span. The

Limited on-site storage area made tight coordination between delivery and erection a must.

Using segmental construction with an overhead gantry allowed many construction activities to be completed away from the site.

precast segments were erected using a gantry, designed by Rizzani, working in opposite directions off each pier. Fourteen pairs of segments cantilever out in each direction from each pier. Shear keys cast into the segments guaranteed a perfect fit, Neufeld says. The 500-ft-long gantry is capable of sliding from one alignment to the other in order to erect both alignments on the same pass; thereby reducing the number of launching stages.

Total casting time for the 640 segments was approximately 16 months, beginning in June 2005, with the final segment cast in October 2006. Three sets of forms were used to complete the job, plus a special form with an expansion diaphragm that was used to cast special segments to be used at each of three midspan expansion joints.

As the gantry placed each segment, the segments were temporarily secured with post-tensioning bars until the final post-tensioning tendons were installed and stressed. The bridge contains a small horizontal curvature over a portion of the alignment, Soule notes. The tendons were grouted according to Caltrans specifications by American Segmental Bridge Institute certified technicians.

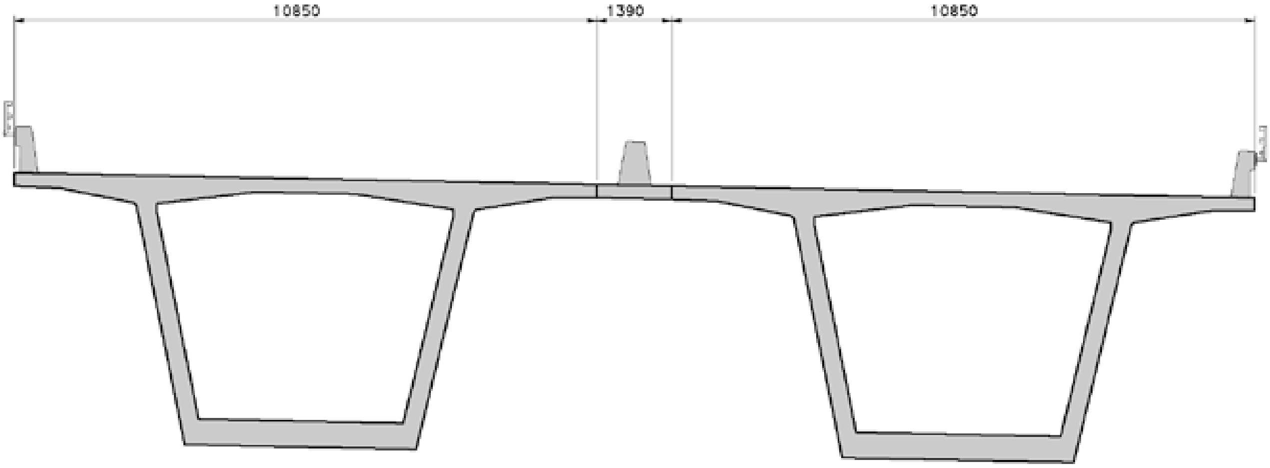
Location Offers Challenges

The location of the bridge presented some unique challenges, Soule says. "We wanted to minimize the environmental impact of the bridge, which is located in one of the last remaining open spaces near San Diego," he explains. "Preservation of the site received top priority from the owners. By choosing segmental construction with an overhead gantry, we were able to complete many of the construction activities away from the site. This allowed us to reduce falsework and pull as many construction tasks as possible out of the valley floor."

The site also presented limited storage capacity, preventing the staging of large numbers of segments at the bridge location. At most, 45 segments could be stored on site at any time. This required closely coordinated delivery and erection schedules, Soule notes.

The bridge will be completed in July 2007. To match the character of the surrounding area, the concrete bridge will receive a tan stain. The result is an attractive, highly functional, and environmentally friendly concrete bridge that will serve the area for many decades to come.

For more information on this or other projects, visit www.aspirebridge.org.



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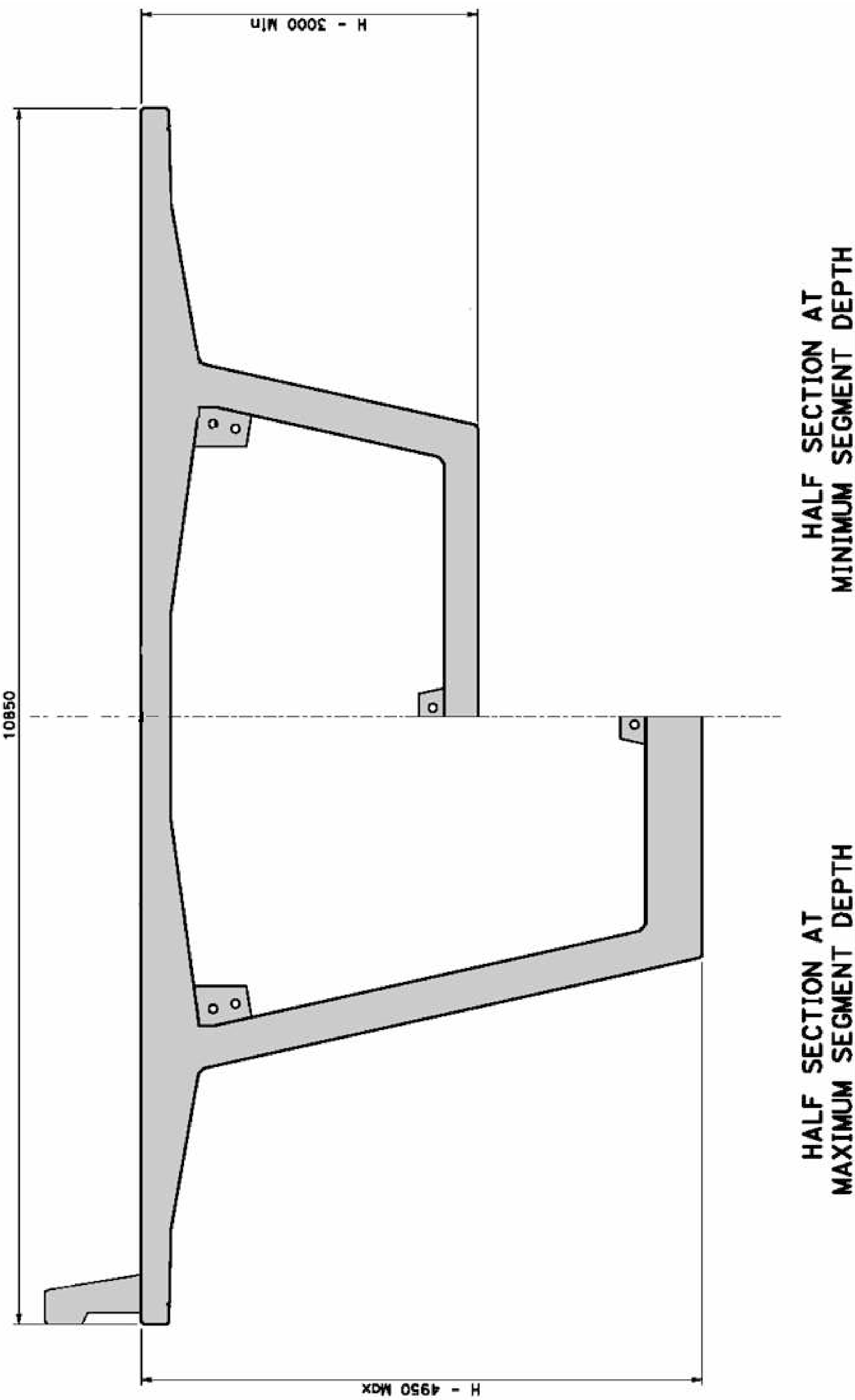
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