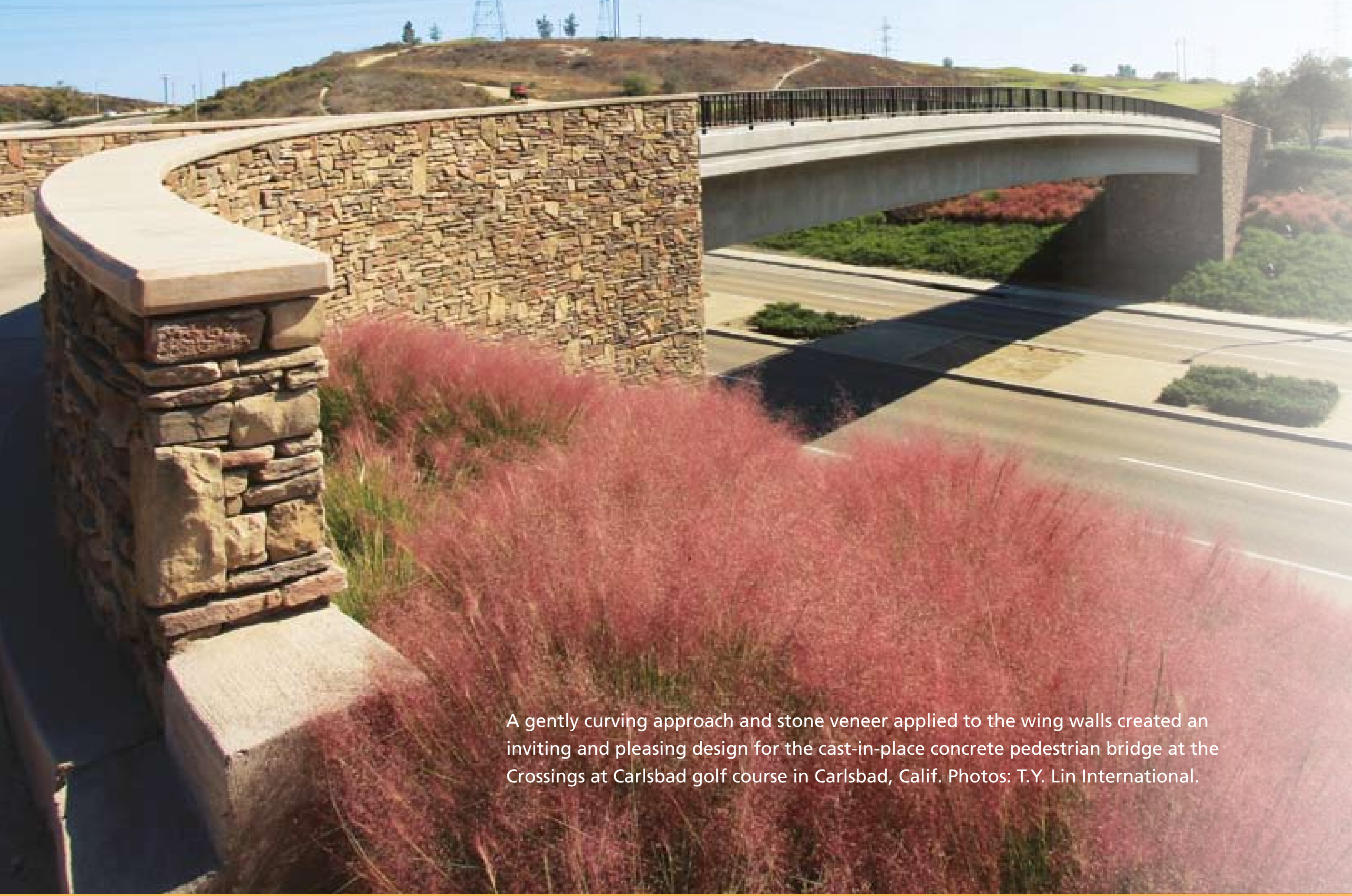
BRIDGE DESIGN BREAKS PAR

by Tony Sanchez, T.Y. Lin International

Golf course's cast-in-place pedestrian bridge offers clean look that complements the clubhouse

Bridges provide connectivity to people and communities. The College Boulevard Golf Cart Bridge in Carlsbad, Calif., achieves these goals by connecting two portions of the city's new golf course in a clean, aesthetically pleasing way that ensured no disruption to traffic below during the bridge's construction. The project's attention to detail has won it two awards from local professional groups, as well as many admirers in the community.

The Crossings at Carlsbad golf course was created by the city to provide citizens with a state-of-the-art, 18-hole championship golf course. The bridge was needed to gracefully span College Boulevard while accommodating golf carts and foot traffic. City officials wanted to create an attractive design that complemented the course's stone-faced clubhouse while providing functional transportation needs and ensuring sufficient clearance above the arterial street.



A gently curving approach and stone veneer applied to the wing walls created an inviting and pleasing design for the cast-in-place concrete pedestrian bridge at the Crossings at Carlsbad golf course in Carlsbad, Calif. Photos: T.Y. Lin International.

profile

COLLEGE BOULEVARD GOLF CART BRIDGE / CARLSBAD, CALIFORNIA

ENGINEER: T.Y. Lin International, San Diego, Calif.

TESTING CONSULTANT: Dudek & Associates, San Marcos, Calif.

PRIME CONTRACTOR: Hazard Construction Co., San Diego, Calif.

CONCRETE SUPPLIER: Palomar Transit Mix, Escondido, Calif.

AWARDS: *2008 Best Pedestrian Bridge, American Concrete Institute, San Diego chapter; 2008 Honor Award, American Public Works Association, San Diego chapter.*

A variety of methods and materials were investigated before the design was finalized. The 199-ft-long College Boulevard Golf Cart Bridge features a clear width of 15 ft, with two 38-ft-long approach spans and a 123-ft-long main span. T.Y. Lin International performed all bridge engineering, including advance-planning studies; type selection; detailed design; final plans, specifications, and estimates (PS&E); and construction-support services.

All of the bridge components were constructed from cast-in-place concrete, totaling about 400 $yd.^3$ ASTM A706 Grade 60 reinforcing bars were used in the concrete, along with prestressing strand. The superstructure for the main span consists of a single-cell box girder that was cast-in-place and then post-tensioned. A 4500 psi compressive strength concrete mix was used for the main span.

The bridge's deck, curbs, and parapet were all constructed of cast-in-place concrete.

Cast-in-place, post-tensioned concrete provided a clear span that eliminated the need for a pier in the street median.

Multiple Concepts Considered

Several options were examined before deciding on this approach. Cast-in-place, post-tensioned concrete provided the capability for a clear span that ensured there would be no pier in the street median. This was an important goal for city officials, as they wanted a clean look that provided safety for drivers. This also eliminated construction in the street that could have caused disruptions or imperiled worker and user safety during the project. Precast concrete was considered, but contractors in California determined it was more economical to produce the required components with cast-in-place concrete.

The bridge was originally designed in 2000, but construction was delayed while the city obtained a coastal permit, which required changes to the golf course. These changes did not affect the bridge's location or design. The bridge is located at the beginning of the course, between holes 1 and 2. It connects the course's west and east portions, which are separated by College Boulevard.

The cast-in-place concrete design provided an additional benefit when the bridge ultimately was constructed. During the planning stages, it had been anticipated that the bridge might need to carry at least one significant water line. However, due to the extended delay prior to construction, the final design and PS&E documents were completed without complete knowledge of utility requirements. The designers knew that the cast-in-place concrete box-girder design could accommodate these utilities if needed.

Water-Line Addition Creates Changes

This foresight paid off, as two water lines were installed in the bridge during construction. Although the depth for a pedestrian structure of this span length could have been reduced to about 4 ft, the designers intentionally used a 5-ft-deep box girder to facilitate installation of the anticipated water lines and supports. The added space also will provide easier access for maintenance personnel.

The extra depth accommodates pressure-relief hardware required since the profile places the high point of the water lines at midspan of the bridge. Other features that were anticipated included access through the bridge deck, which are required to access the utilities, and soffit openings under the bridge, which is needed to drain the bridge void in case a water line ruptures.

In addition to this change, a code upgrade undertaken between the time of the design and the time of construction, tightened vibration

CAST-IN-PLACE, POST-TENSIONED CONCRETE BOX GIRDER PEDESTRIAN BRIDGE / CITY OF CARLSBAD, OWNER

REINFORCING BAR SUPPLIER: CMC Fontana Steel, Etiwanda, Calif.

POST-TENSIONING CONTRACTOR: DSI, Long Beach, Calif.

BRIDGE DESCRIPTION: Golf-course bridge 123 ft long and 15 ft wide featuring a single-span post-tensioned concrete box girder, plus two 38-ft-long slab approach spans

BRIDGE CONSTRUCTION COST: $1.180 million

To avoid backfilling soil against the 25-ft-high abutments, designers created bin-type abutments that would remain empty, significantly reducing earth pressures and overturning forces, which saved considerable cost by allowing smaller foundations.

guidelines for bridges of this type. This necessitated a vibration analysis to ensure that the bridge would meet the new requirements. The design passed the analysis and did not need any adjustments to meet the revised code.

Foundations on the west side consist of 6000 psi compressive strength precast, prestressed concrete piles, while the foundations to the east comprise 4000-psi compressive strength cast-in-place concrete spread footings. Abutments and parapets were constructed from 4000 psi cast-in-place concrete as well.

Innovative Abutments Designed

An innovative approach was used to create the abutments and provide an economical and attractive design. Vertical clearance requirements for the arterial street required abutment heights of about 25 ft. To resist overturning forces from 25 ft of soil behind conventional back-filled abutments would have resulted in extensive and costly pile-supported foundations for both abutments and wing walls.

A more efficient and economical solution took advantage of the narrow width of the pedestrian bridge and used special transverse, hollow bin-type abutments. This design, popular in the 1940s and 1950s before prestressed concrete allowed longer span lengths, consists of a reinforced concrete slab that spans 15 ft transversely between the wing walls. Since the void behind the abutment is not backfilled with soil but remains empty, the large earth pressure and overturning forces that this would have created are avoided. This design allowed the abutments to be supported on smaller foundations, greatly reducing the cost and creating substantial savings for the city.

To tie the bridge's aesthetic design to the design created for the course's clubhouse, stone-veneer was applied to the 1-ft-thick sides of the abutments and wing walls. The stone veneer, which was applied similarly to tile, created a textured appearance for the walls. Colored concrete caps and curbs were installed to complement the veneered approaches.

The veneer installation provided a challenge because the panels had to fit the curved walls. The curve had been necessary due to the grading and pathways laid out for the course, but this functional requirement produced an aesthetically pleasing curvature as golfers approach the structure.

The project met its goals in providing a pleasing and functional addition to the community. This was apparent when it won local awards, which singled out its clean lines, aesthetically pleasing textures, and changing shadows due to overhangs on the exterior girders.

Concrete's economy, durability, and ability to easily conform to the bridge's curves and shape were fundamental to the success of this important component of the golf course. Careful planning, design, attention to detail, and anticipation of future needs resulted in a functional and beautiful bridge that was economical to construct and easy to maintain.

Tony Sanchez is a senior bridge engineer with T.Y. Lin International in San Diego, Calif.

Construction could be handled from the central median on the road below the bridge, avoiding major disruptions to on-going traffic flow.

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Above Photo
2009 Design Awards Winner Best Bridge with Spans More than 150 ft
Angeles Crest Bridge No. 1, Wrightwood, Calif.
Photo courtesy of Pomeroy.

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The 123-ft main span and abutments were constructed of 4500-psi, cast-in-place post-tensioned concrete to eliminate the need for a pier in the street's median.

Transverse, hollow bin-type abutments were used to allow smaller and more efficient abutment foundations.

The use of a box girder allows the incorporation of utilities inside the structure, creating a more aesthetically pleasing and protective design.