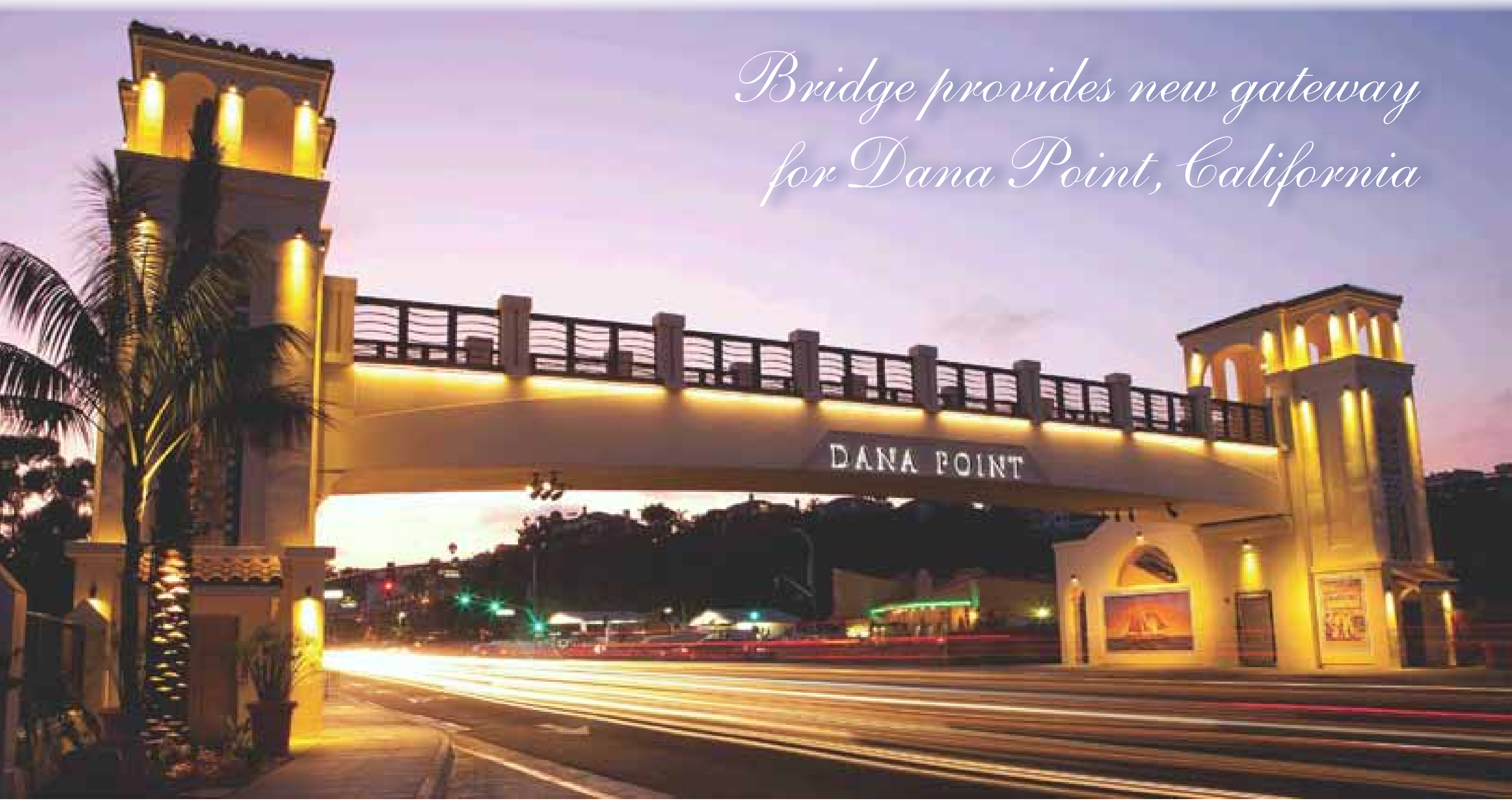
PACIFIC COAST HIGHWAY PEDESTRIAN BRIDGE

by Pieter Goedhart, T.Y. Lin International

Bridge provides new gateway for Dana Point, California



The Pacific Coast Highway Pedestrian Bridge seen at dusk stands as a gateway to the seaside resort community of Dana Point, Calif. Photo: Rob Szajkowski, Photographer.

An iconic pedestrian bridge now spans historic Pacific Coast Highway (PCH). It is the centerpiece of a traffic congestion relief project undertaken by the city of Dana Point, Calif. The single-span precast, prestressed concrete girder pedestrian bridge carries the heavy foot traffic over this main north-south arterial that once caused protracted traffic delays due to its long turning and through red light times required for pedestrians. In addition to enhancing traffic operations, the bridge improves pedestrian safety at a busy intersection and provides an architectural gateway for the community.

Superstructure

The pedestrian bridge superstructure consists of two 109-ft 2-in.-long, variable-depth precast, prestressed concrete girders with precast concrete deck panels and a cast-in-place concrete deck between them to form an H-shaped cross section. Due to the right-of-way restrictions and the city's requirement to maintain full traffic operations on PCH, precast concrete girders were selected for the bridge span. This minimized the construction encroachment on traffic by eliminating the need for falsework in the roadway. The girders are 18 in. wide and vary in depth from 8 ft 0 in. at their ends to 6 ft 5½ in. at midspan. While the bottom of the girder rises 2 ft 0 in. from support to midspan in a parabolic curve, the top of the girder rises 5½ in. to remain 50 in. above the vertical curve of the deck, which also rises 5½ in.

During preliminary design the engineer consulted with local precasters in order to optimize the girder design. The precasting was already complicated since all of the connection inserts, reinforcement couplers, architectural

profile

PACIFIC COAST HIGHWAY PEDESTRIAN BRIDGE / DANA POINT, CALIFORNIA

BRIDGE DESIGN ENGINEER: T.Y. Lin International, Riverside, Calif.

PRIME CONTRACTOR: Excel Paving Company, Long Beach, Calif.

PROJECT ENGINEER: Psomas, Santa Ana, Calif.

ARCHITECT: Thirtieth Street Architects, Newport Beach, Calif.

GEOTECHNICAL ENGINEER: GMU Geotechnical Inc., Rancho Santa Margarita, Calif.

PRECASTER: Coreslab Structures (L.A.) Inc., Perris, Calif., a PCI-certified producer attachment hardware, and lighting conduit had to be in place prior to casting to prevent drilling into the prestressed girders. To simplify the precasting operation, the twenty-five, 0.6-in.-diameter prestressing strands followed a level path through the girder. The strands are near the bottom of the girder section at midspan and the increased depth at the supports eliminated the need for a harped strand configuration. By debonding a number of strands at the ends of the beams, the concrete stresses are maintained within specification limits. The specified concrete compressive strengths were 5000 psi and 4000 psi for the prestressed and cast-in-place concrete, respectively.

Along the top of each girder are nine evenly spaced 5-ft 10-in.-tall pilasters. Each pilaster consists of two, 6 by 6 in. hollow structural steel sections welded to an embedded plate in the top of the girder. They are framed with cold-formed steel sections and coated with plaster. The pilasters support a 4-ft 10-in.-high architectural metal railing that spans between the pilasters. When combined with the portion of the girder above the deck, the top of railing is 9 ft 0 in. above the walking surface.

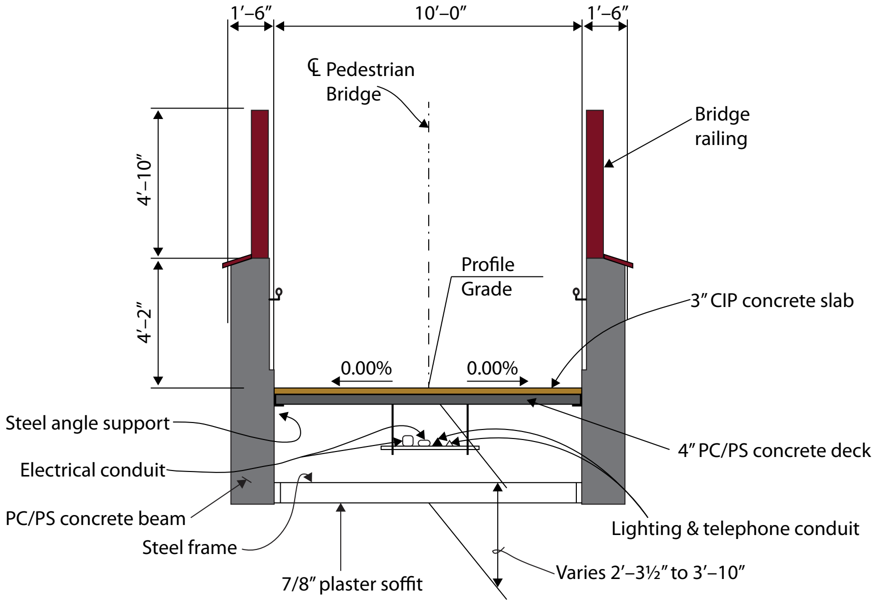
Bridge Deck

The 10-ft 0-in.-wide deck is aligned on a slight vertical curve with the crest at midspan and a maximum slope of 1.68%. There are a total of fourteen 4-in.-thick precast, prestressed concrete panels that span transversely between the girders. The panels are pretensioned with 3/8-in.-diameter strands spaced at 6 in. and reinforced with No. 4 bars at 12 in. on center both ways. The panels rest on steel angles that are bolted to the inside faces of the girders and are covered with a 3-in.-thick topping slab composite with the panels. In addition, the girders are connected with transverse, cast-in-place concrete diaphragms located at the abutments and at midspan below the deck to provide lateral stiffness. The bottoms of the girders are connected with a false soffit that hides the utility ducts that run beneath the deck. The soffit consists of steel framing between the girders with a plaster shell that appears to be monolithic with the girders. Since the power source is at one abutment, all electrical, landscaping, and telephone utilities had to travel through the bridge to the opposite abutment.

Substructure

The abutment towers are 48 ft 8½ in. long by 13 ft 0 in. wide and up to 46 ft tall. The footings are 2 ft 0 in. thick and are stepped at the elevator to allow the extra 4 ft 0 in. for the equipment. The stepped footing also reduced the amount of earthwork. The cast-in-place concrete walls are 12 in. thick and contain architectural reveals and openings throughout. The north side of each abutment provides a stairway

The girders also act as the parapet walls along the walkway of the bridge. Photo: Paul Savage, Photographer.



Typical section showing the components that comprise the bridge. Drawing: T.Y. Lin International.

SINGLE-SPAN, VARIABLE DEPTH, PRECAST, PRESTRESSED CONCRETE GIRDER PEDESTRIAN BRIDGE / CITY OF DANA POINT, CALIFORNIA, OWNER

BRIDGE DESCRIPTION: Decorative, cast-in-place concrete abutments supporting a single-span, 109-ft-long precast, prestressed concrete rectangular girder, 1 ft 6 in. wide that varies from 8 ft 0 in. deep at the abutments to 6 ft 5½ in. deep at midspan with 4-in.-thick, precast, prestressed concrete deck panels and 3-in.-thick cast-in-place concrete composite deck

BRIDGE CONSTRUCTION COST: Bridge cost $3.1 million; total project cost $6.0 million

AWARDS: California Department of Transportation, 2010 Excellence in Transportation Award, Major Structures; *California Construction* Best of 2009 Small Project Award of Merit; American Council of Engineering Companies (ACEC) California 2010 Award of Excellence Merit Award, ACEC Orange County Chapter 2010 Award of Excellence; ASCE Orange County Branch 2009 Project Achievement Award; Orange County Engineering Council 2010 Engineering Project Achievement Award

Sustainability, Aesthetics, and the Community

In order to create a sense of ownership in the project, the city worked with the community from preliminary design through completion. The project added new direct pedestrian access to the adjacent Doheny State Beach at the south abutment. Coordination with state officials resulted in the historic gateway and pilaster style of the park in the new entrance and boundary screen walls. A total of four large mosaics up to 15 ft 9 in. wide and 8 ft 6 in. tall on the street side of each abutment were created by local artists and depict the community's culture and heritage.

This unique bridge required creativity and extensive detail in order to achieve its distinctive appearance. The superstructure girders have formed recesses on the sides along with the city name pronounced with backlit 21-in.-tall stainless steel letters at midspan. At the top of the girders, LED lights run along the full length underneath the decorative railing and pilasters. The abutments contain a variety of decorative elements that include arch openings, corbels, ledges, and insets. Colorful tile accents enhance the stairway and landings. Decorative metal gates located in the openings at the sidewalk level complement the railing along the span. A color acrylic plaster coating is applied to all exposed surfaces, which provides a smooth uniform finish and ties all of the structural elements together. The combination of the LED lighting and strategically placed spotlighting with the detailed architectural elements makes this structure eye-catching both day and night.

Since the bridge is within one-half mile of the ocean, special consideration had to be made to resist the corrosive marine environment. One method was to use epoxy-coated reinforcement in the deck. A second method was to apply a ¼-in.-thick acrylic plaster coating to all exposed concrete surfaces. This coating protects the exterior concrete as well as adds an architectural color finish. Prior to plaster application, the concrete was sand blasted in order to roughen the surface, given that the typical formed concrete surface is too smooth for the adhesion of the plaster. Another requirement for the plaster was that the entire superstructure had to be erected prior to application in order to avoid cracking due to dead load deflections.

access while the south sides incorporate elevator access, which maintains Americans with Disabilities Act (ADA) compliance and allows all persons to utilize the bridge. Beneath the stairs and landing are utility rooms that house the electrical equipment and controls for the lighting and elevator.

Geotechnical Improvements

Situated in Southern California, seismic considerations are a significant part of the design. The design earthquake is from the San Joaquin Hill Blind Thrust Fault that is located about 7 miles from the bridge site and can generate a peak ground acceleration of 0.4g with a 7.0 magnitude. Geotechnical investigations discovered a liquefiable soil layer within the upper 15 ft that has the potential to cause excessive seismic settlement. The typical solution to this problem was to use deep pile foundations, however, the combination of weak soil conditions, the presence of shallow groundwater, and sensitive nearby land use made deep foundations expensive and problematic. As an economical solution, the design team developed an alternative approach using permeation grouting. Permeation grouting consisted of injecting high-pressure grout into the liquefiable soil layer at injection points placed on a grid system spaced at 3 ft in both directions. Each point contained a perforated 2-in.-diameter grout pipe that was injected with a low-slump grout at a pressure of 1000 psi. The limits of the permeation grouting extended 5 ft beyond the footprint of the abutment footing to a depth of 15 ft. When completed, it created a dense subsurface platform that limited the seismic settlement and provided sufficient bearing capacity.

The Pacific Coast Highway Pedestrian Bridge improves traffic operation, provides a safe pedestrian crossing, and provides a structural icon and gateway for the community. The various uses of concrete combined with the extensive architectural detail make for a sustainable, functional, and aesthetic structure that is appreciated by both pedestrians and the traveling public.

Shown in the precaster's plant, the girders contain many embedments to facilitate connections in the field. Temporary trusses provide lateral stiffness during handling and erection. The parabolic soffit was formed by the use of a curved precast concrete filler in the bottom of the form. Photo: Coreslab Structures (L.A.) Inc.

Large murals and other architectural details can also be observed from the roadway. Photo: Paul Savage, Photographer.

Spanning the Pacific Coast Highway, Dana Point's new gateway includes elevators to provide access for those with disabilities. Photo: Coreslab Structures (L.A.) Inc.

Pieter Goedhart is a bridge engineer with T.Y. Lin International in Riverside, Calif.

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