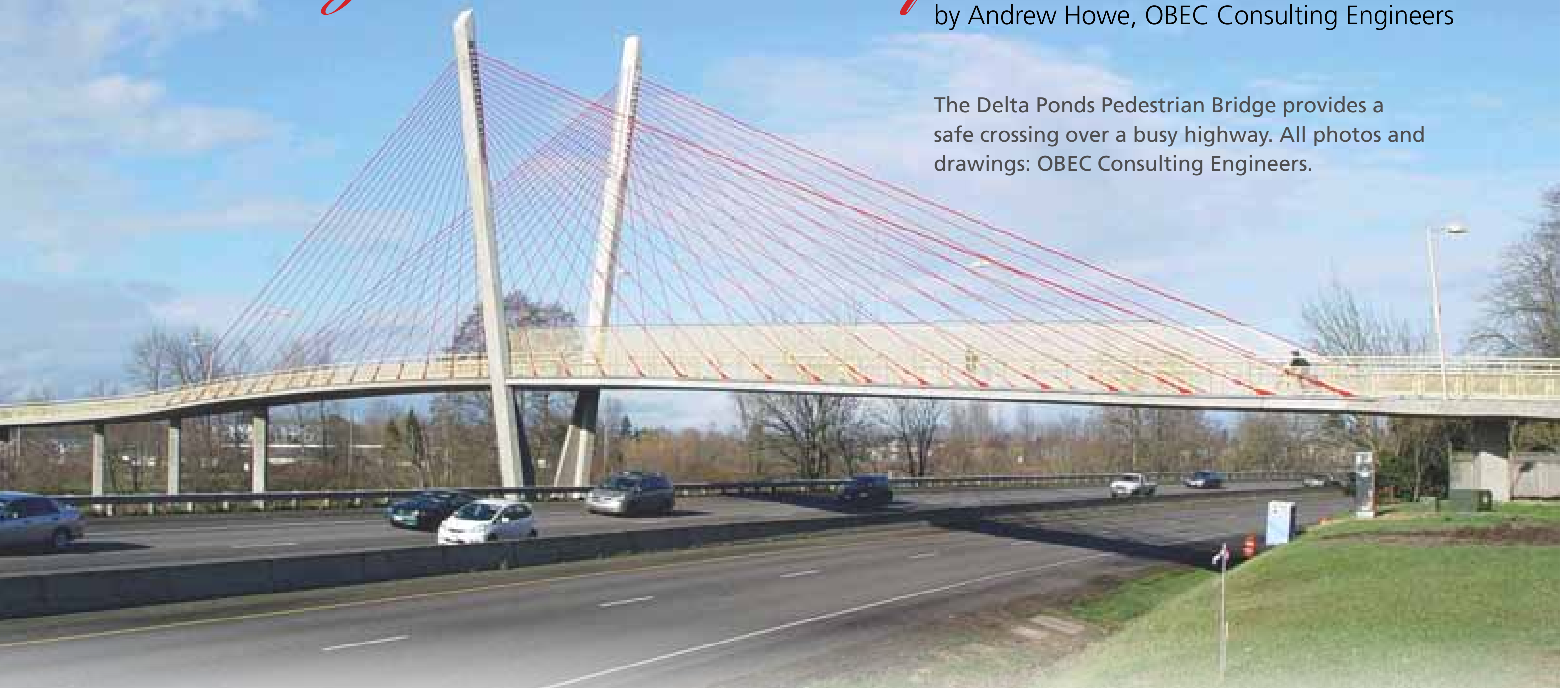
Delta Ponds Pedestrian Bridge

Extending a Sustainable Transportation Network

by Andrew Howe, OBEC Consulting Engineers



The Delta Ponds Pedestrian Bridge provides a safe crossing over a busy highway. All photos and drawings: OBEC Consulting Engineers.

Eugene, Ore., is one of the leading regional areas for non-motorized commuting. A bicycle- and pedestrian-friendly transportation system is a way of life in this medium-sized university town located at the south end of the Willamette Valley. Not surprisingly, the residents of Eugene consider natural space very important and seek environmentally friendly solutions to problems.

As a result, the city of Eugene boasts an extensive path network. The city, bisected by the Willamette River and a four-lane highway, has promoted bicycle and pedestrian commuting by building paths near the river, connected by a series of bridges at strategic points. In north Eugene, Delta Highway runs roughly parallel to the east bank of the river. Historically, bicycle and pedestrian traffic for this 2-mile-long stretch was restricted to crossing the highway at two busy interchanges.

The Delta Ponds Pedestrian Bridge, constructed in 2010, provides a key connection between the neighborhoods east of Delta Highway and the popular riverbank path system to the west of the highway. The bridge skirts the south edge of the Delta Ponds city park and natural area, a backwater pond system hydraulically connected to the Willamette River. The sweeping structure not only provides a much-needed safe crossing of the highway for bicycle and pedestrian traffic that is compliant with the Americans with Disabilities Act (ADA), it also offers a very popular and pleasant vantage point for viewing the surrounding ponds.

Structural Form

The primary feature crossed by the Delta Ponds Pedestrian Bridge is Delta Highway. The bridge also crosses a slough immediately west of the highway and skirts one of the larger ponds in the Delta Ponds system. Keeping a light footprint on the ground dictated a bridge with a total length of 760 ft and out-to-out width of 18 ft 11 in. The width inside handrails is 14 ft.

Because it crosses the highway, the bridge occupies a visually prominent position in the landscape. Trees in the area are seldom taller than 50 ft, and buildings are no taller than two stories, so a properly proportioned structure would blend into this surrounding rather than overpower it. Spans had to be short, allowing slim columns and a shallow deck.

profile

DELTA PONDS PEDESTRIAN BRIDGE / EUGENE, OREGON

BRIDGE DESIGN ENGINEER: OBEC Consulting Engineers, Eugene, Ore.

CONSULTING ENGINEER: Jiri Strasky, Greenbrae, Calif.

PRIME CONTRACTOR: Mowat Construction, Clackamas, Ore.

PRECASTER: Knife River Prestress, Harrisburg, Ore., a PCI-certified producer

CONCRETE SUPPLIER: Eugene Sand and Gravel, Eugene, Ore.

POST-TENSIONING CONTRACTOR: DYWIDAG-Systems International USA, Long Beach, Calif.

Traffic clearances over Delta Highway dictated the bridge soffit elevation, and the short distance between Delta Highway and the required eastern path terminus became a significant issue during design. Because 1 ft of structure depth would add 20 ft of path length (using a 5% maximum grade), minimizing depth from soffit to finished path elevation was an absolute must if the bridge was to fit within the constrained site.

Keeping bridge foundations outside of sensitive natural areas meant that crossing the slough was a significant constraint to address. While the span over Delta Highway was 170 ft, the span over the slough was only slightly shorter at 120 ft. The required span lengths contradicted the use of a shallow, slender structure—unless a somewhat unconventional design was used.

The design team proposed a single-tower cable-stayed bridge, and the city selected it as the preferred structure type. The main cable-supported span was 170 ft with back spans of 120 ft (over the slough) and 50 ft. A series of thirteen 30-ft-long cast-in-place concrete slab spans at the west approach and a single 30-ft-long approach span at the east approach comprise the balance of the bridge's length.

The bridge occupies a visually prominent position in the landscape.

Because the site is surrounding by short buildings and trees, the design team sought to blend the 760-ft-long Delta Ponds Pedestrian Bridge into its surroundings as much as possible.

The Delta Ponds Pedestrian Bridge looking over Delta Ponds. Red LED lighting along the deck edge and the top stay create a stunning effect at night.

Small Footprint

The alignment of the bridge along the south side of the ponds had been used before. A 78-in.-diameter sanitary sewer line was previously constructed between the ponds and the adjacent developed property. This required the bridge to have a small footprint, meaning the use of spread footings or a pile group was not feasible. The solution was to use small-diameter drilled shaft foundations. Bedrock in the area is relatively shallow and light loads meant that drilled shafts wouldn't normally be longer than 30 ft.

Four-ft-diameter drilled shafts were selected and installed within 10 ft of the sanitary sewer. A cast-in-place concrete column sits on each drilled shaft. There are 15 columns with a 2-ft 7-in.-square cross section and 4-in. chamfers at each corner. The tallest column is 33.5 ft long.

Precast "V" Pylon Tower

One of the immediately noticeable elements of the Delta Ponds Pedestrian Bridge is its innovative twin-leg, "V"-shaped pylon, evoking an upside-down delta shape—the mathematical symbol typically used to denote change. The "V" shape was dictated by underground constraints because the 78-in.-diameter sanitary sewer turns to run parallel to Delta Highway,

ASYMMETRIC, THREE-SPAN, CABLE-STAYED CONCRETE BRIDGE WITH 14 APPROACH SPANS OF CAST-IN-PLACE CONCRETE SLAB / CITY OF EUGENE, OREGON, OWNER

BRIDGE DESCRIPTION: A 760-ft-long concrete bridge featuring a 340-ft-long, asymmetric, three-span cable stayed section with fanned stays. The 170-ft-long main span uses partial-depth precast concrete deck panels with cast-in-place composite topping having a combined maximum thickness of 1 ft 2¼ in., which is post-tensioned together with adjacent, cast-in-pace concrete spans.

STRUCTURAL COMPONENTS: 15 precast concrete deck panels, 10 ft long and 18 ft 11 in. wide; precast pylon legs, 86 ft long and 4 ft 0 in. by 2 ft 5¾ in.; 14 cast-in-place concrete approach slabs 30 ft long; fifteen 4-ft-diameter concrete drilled shafts support 2-ft 7-in.-square pier columns; one 8-ft-diameter shaft supports the pylon.

BRIDGE CONSTRUCTION COST: $3.9 million

AWARDS: 2011 Federal Highway Administration Environmental Excellence Award; 2011 American Council of Engineering Companies, Oregon Engineering Excellence Honor Award

The structure's concrete V-shaped pylon tower is an impressive sight for bikers and pedestrians as they cross the Delta Ponds Pedestrian Bridge.

crossing under the bridge and limiting foundation options. Additionally, an existing storm water system crosses under the highway immediately adjacent to the pylon.

The presence of these elements confirmed the tower would require a small footprint. A pylon leg angle of just less than 8 degrees from vertical accomplished this goal, shaving more than 6 ft from the width of the foundation and allowing the use of a single, 8-ft-diameter drilled shaft.

Inconveniently, the pylon had to be located between a busy highway and a slough. Fabricating the pylon legs on site didn't seem manageable, given the limited staging area. The design team specified the use of precast concrete pylon legs. The pylon legs connect to the foundation using plates welded to steel anchors and connect to the deck using threaded inserts to attach reinforcement.

The length of each pylon leg is 86 ft. Its cross section is an irregular shape with outside plan dimensions of 4 ft 0 in. by 2 ft 5¾ in. for almost the full length. The leg tapers to a 4-ft-long knife edge in its upper 3 ft. The use of a precast concrete pylon had several advantages. Tighter controls on concrete mix design, concrete placement, and curing allowed the use of higher-strength concrete in the pylon legs. The specified concrete compressive strength was 6000 psi. Precasting meant higher confidence for concrete consolidation in the congested areas at the stay connections, deck connections, and tower base. To enhance the strength of the pylon legs without increasing their dimensions, two 1⅜-in.-diameter, ASTM A722 post-tensioning bars extended from the base of the legs approximately 60 ft to almost the stay anchorages. The bars were tensioned in the precast fabrication plant to a total force per leg of 332 kips.

Over Traffic

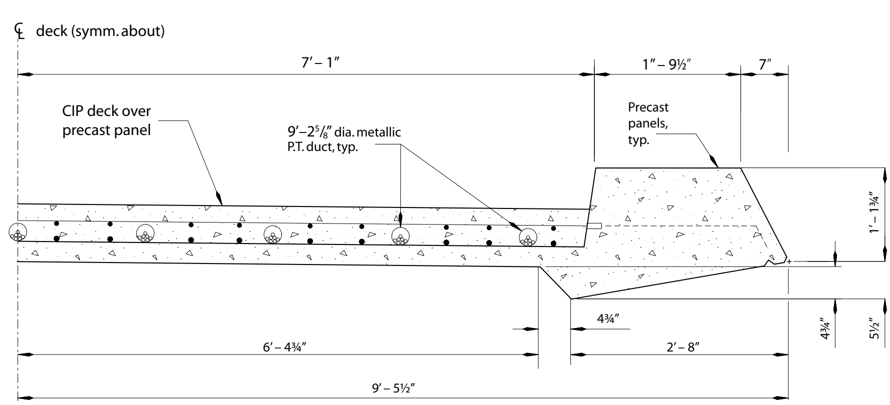
Much of the Delta Ponds Pedestrian Bridge could be constructed on falsework, but this wasn't an option over Delta Highway because of the highway's heavy traffic. Building on previous experience on similar bridges (see *ASPIRE*™ Fall 2010), a construction sequence was developed that cantilevered precast concrete deck panels over the highway. This sequence eliminated the need for daytime lane closures on Delta Highway, minimizing impacts to public traffic.

The back spans and 10 ft of the main span were constructed on falsework in advance of construction over Delta Highway. Precast panels were placed during lane closures at night. The stays were then connected and adjusted during the day. The 15 deck panels were partial depth to limit the handling weight and allow for a cast-in-place topping that provides a smooth riding surface. Precast deck panels were 10 ft long, 18 ft 11 in. wide, and 1 ft 7¼ in. thick at the curbs. The specified concrete compressive strength was 6000 psi.

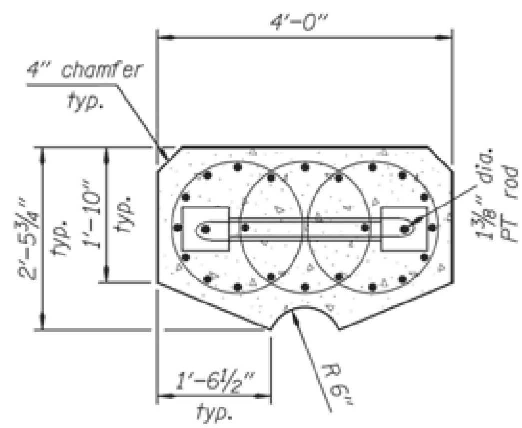
As deck construction advanced, deck grades and stay stresses were checked regularly. Forces in the stays were small, and a simple hydraulic jack system allowed for unloading the lower portion of a stay so that a coupling nut could be turned to adjust the stay length.

Topping It Off

The cast-in-place concrete topping compressive strength was specified to be 5000 psi, the same as the cast-in-place spans. The topping contains a longitudinal post-tensioning system to control stresses in the deck panel joints. The panel joints are designed as they would be in a precast segmental structure, with zero tension under design service loads. This post-tensioning extends just over half the total bridge length, terminating



Half section of the precast deck panel with cast-in-place topping slab and post-tensioning shown. The deck cross-sectional dimensions were constant throughout the bridge.



Section through a pylon leg between the bottom and the first stay anchor.

at a deck joint in span 11. The post-tensioning consisted of nine tendons each with seven 0.6-in.-diameter strands evenly distributed across the deck.

Finishing Touches

Late in the project development, the city of Eugene secured additional funding through the American Reinvestment and Recovery Act (ARRA), which led to the installation of energy-efficient LED luminaires to replace the planned incandescent bulbs.

In addition to the energy-efficient luminaires, the ARRA funds allowed additional aesthetic touches to be added, including red LED rope lights on the deck edge and top stay of the main spans that make the bridge a strong visual experience day and night, pushing the bridge toward "landmark" status within the community.

In November 2010, the Delta Ponds Pedestrian Bridge opened for use. Long awaited by the public, the bridge was instantly appreciated for its graceful form and has become a beacon for bicyclists and pedestrians, adding to Eugene's reputation for accommodating environmentally friendly commuting options.

Andrew Howe is senior project engineer with OBEC Consulting Engineers in Salem, Ore.

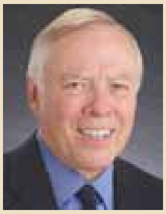
For additional photographs or information on this or other projects, visit www.aspirebridge.org and open Current Issue.

Daytime closures on Delta Highway were out of the question, so crews erected the precast concrete pylon tower and placed the precast deck panels at night.

Placing the main span topping slab on the precast panels. The longitudinal post-tensioning ducts can be seen between the curbs of the precast panels.

AESTHETICS COMMENTARY

by Frederick Gottemoeller



This bridge is an excellent example of how a community can get more use out of a favored and well-loved park. The alignment itself reminds one of a stroll through the woods. It curves around obstacles and over conflicting uses like a meandering park walkway, but in the air.

On its way it creates a dramatic landmark for the community and the park. The tower and cable planes impose an easily understood geometric silhouette on the sky. The tower's arms are simple, thin rectangular prisms. The angle of the tower's arms is well chosen. The tower recalls the triumphant "Touchdown" gesture well known in football. Bracing of the arms at their base is achieved not by thickening the arms, but by thin triangular walls, leaving a V-shaped slot that preserves the view through the tower. The arms end equally well, with a simple diagonal slice.

The semi-harp stay pattern is also well chosen. The stays create a fascinating moiré pattern of interacting lines that shift and change as drivers move under the bridge. The red color brings out the pattern on both sunny and cloudy days. The lighting of the upper stay preserves the bridge's memorable image at night.

Finally, the short spans on the approach allow the thin deck of the cable-supported span to continue unchanged to the abutment, giving the whole structure a unified appearance. Short spans allow thin columns. Even though there are many of them, their thinness and their simple shape means that the views through the bridge are not significantly interrupted. Designers often assume that long spans are better for appearance. That is true in many cases, but this is not one of them. Plus, the economy of the short spans has allowed the community to obtain a signature bridge at a remarkably low price.