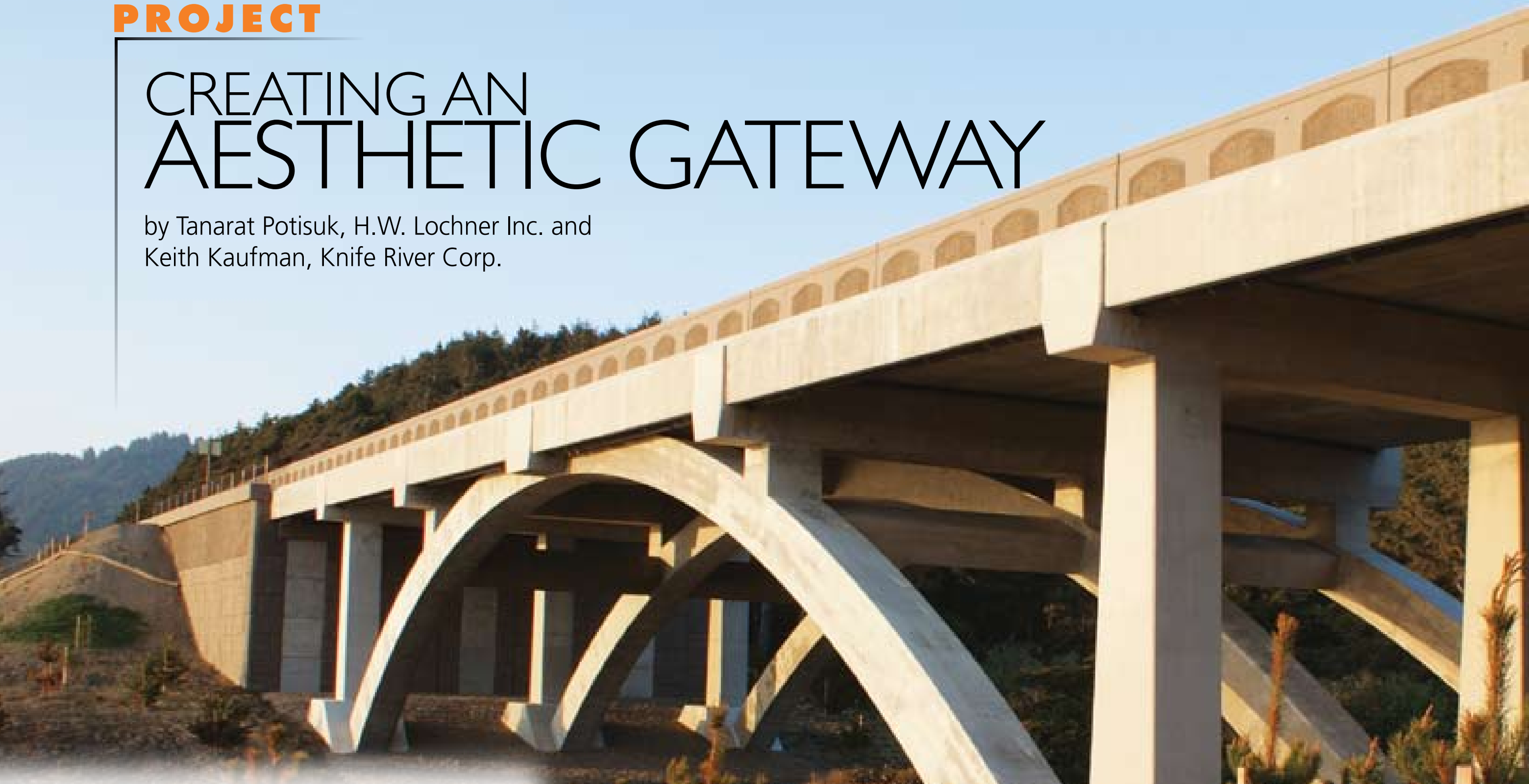
PROJECT

CREATING AN AESTHETIC GATEWAY

by Tanarat Potisuk, H.W. Lochner Inc. and Keith Kaufman, Knife River Corp.



At the top of the arch, the No. 14 reinforcing bars were spliced together to make the arch segments continuous. Then the arches were connected through the crown cross beam.

Spencer Creek Bridge on Oregon's scenic Coastal Highway 101 suits its setting

Officials agreed that replacing the existing 1940s-era reinforced concrete, deck-girder bridge on Highway 101 in Newport, Ore., required sensitivity due to its popular and scenic context. But the suggested precast concrete, post-tensioned deck-arch replacement had to overcome a series of constraints that included poor soil conditions with potential liquefaction during an earthquake. To accomplish the goals, a unique foundation system was created that resists horizontal reactions from the arch ribs.

The original three-span bridge had suffered from severe deterioration, corrosion, and age. Replacing it with a durable design that was aesthetically pleasing was required because of its location adjacent to the Beverly Beach State Park, one of the most popular state parks in Oregon. The highway also serves as the major north-south route along the Oregon Coast and has been designated as a National Scenic Byway and an All-American Road. Aesthetics, functionality, and durability had to blend seamlessly on this high-profile project.

After several years of studies by the Oregon Department of Transportation (ODOT) to consider alternative routes and bridge appearances, a concrete deck-arch bridge was selected as the best way to provide an aesthetic gateway from the park to the beach. This required shifting

profile

SPENCER CREEK BRIDGE / NEWPORT, OREGON

STRUCTURAL ENGINEER: H.W. Lochner Inc., Salem, Ore.

ROADWAY, HYDRAULICS, AND ENVIRONMENTAL ENGINEER: Oregon Department of Transportation

GEOTECHNICAL ENGINEER: Shannon & Wilson Inc., Lake Oswego, Ore.

PRIME CONTRACTOR: Slayden Construction Group, Stayton, Ore.

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

The new Spencer Creek Bridge features six continuous spans supported by three concrete arch ribs. The bridge replaced a 1940s bridge and had to blend with the scenic landscape surrounding it.

A precast concrete design was selected due to the sensitive environment at the bridge site.

part of the highway about 50 ft to the east to accommodate the new bridge. The majority of the roadway shift was located at the south end of the bridge. The bridge span over the creek was lengthened to move the bridge foundation further away from the creek.

Precast Concrete Selected

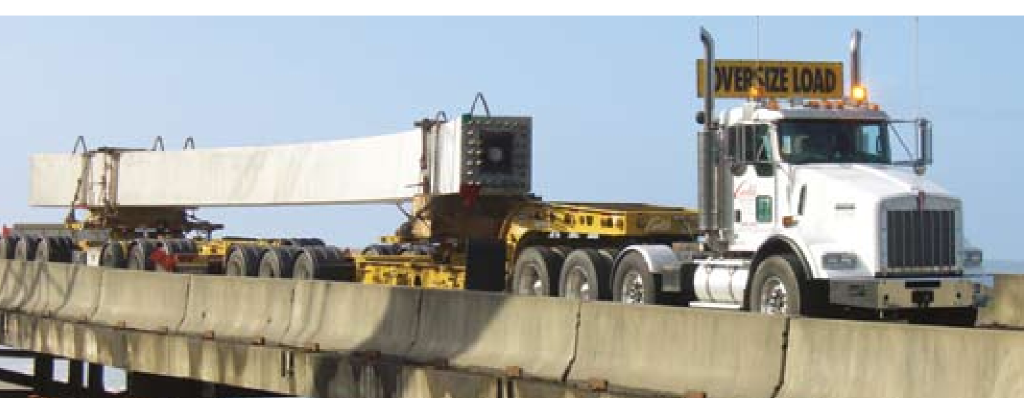
The new Spencer Creek Bridge is 210 ft long and 51.3 ft wide. The superstructure consists of 35-ft-long spans. Four spans are supported on columns over the arch. The two end spans fit between the bent columns over the arch support and the abutments. The arch spans 140 ft and consists of three parallel ribs with a constant width of 3.5 ft and a depth that varies from 4.5 ft to 3.25 ft.

Due to the sensitive environment at the bridge site, precast concrete was chosen for the main structural members, including the arches and beams for the superstructure. That approach allowed the amount of falsework and formwork to be reduced, minimizing the environmental impact. The precast concrete fabricators in the area also were considered to be able to provide better quality products for this coastal region than could be achieved with cast-in-place concrete construction.

Each of the three arch ribs consists of two precast concrete arch rib segments cast at a plant in Harrisburg, Ore. They were delivered to the construction site and connected at the crown with a crossbeam closure pour. Each arch segment was 70 ft long, weighed 160 kips, and contained 28 No. 14 longitudinal reinforcing bars. In addition, the arch segments were post-tensioned to prevent cracking during the shipment as well as to control cracking in service.

Stainless Steel Reinforcement Used

In accordance with the ODOT Bridge Design and Drafting Manual (BDDM), all concrete was required to be high-performance concrete, while stainless-steel reinforcement was required in the concrete decks and crossbeams for bridges in the coastal area. This included all reinforcing bars extending into the concrete deck. As a result, stainless steel was specified for stirrups in the precast slabs. These bars met the Unified Numbering System (UNS) designation S31803, AISI Type 2205, Grade 75. Isolation between different alloys (stainless and black steel) was performed according to ODOT specifications.



Rather than transport upright as originally planned, the precast concrete arches were delivered in their casting position to avoid difficulty in transporting them through some of the sharp turns on the highway.

SIX-SPAN BRIDGE ON A PRECAST CONCRETE ARCH / OREGON DEPARTMENT OF TRANSPORTATION, OWNER

POST-TENSIONING CONTRACTOR: AVAR Construction Systems Inc., Fremont, Calif.

REINFORCING BAR SUPPLIER: Dixon Steel & Supply Company, Roseburg, Ore.

BRIDGE DESCRIPTION: Six-span bridge (including two approach spans) 210 ft long, 51.3 ft wide with continuous spans supported by three precast concrete arch ribs. Each span is 35 ft long and comprises 12 precast, prestressed concrete slabs with a composite cast-in-place concrete deck.

BRIDGE CONSTRUCTION COST: $19.5 million

1.

2.

3.

(Photos 1-3) Upon arrival at the site, the precast concrete arches were rolled into lifting position on precast concrete blocks that used the half-arches' center of gravity to provide the rotating force.

The precaster's recommendations during preliminary design included limiting the arch rib's weight of each segment to 140 kips. However, due to the amount of reinforcement required in the arch segments the weight reached 160 kips. To handle the arch-rib segments in the plant, the arch casting form was strategically positioned so two travel lifts could nest and lift in tandem.

The precaster also worked with the reinforcing bar supplier to provide longer than typical length bars. This avoided the need to splice bars within the arch segments, which would have added time and complexity. Rather than the typical 60-ft-long bars, the supplier fabricated 70-ft-long pieces.

Securing the longitudinal No. 14 reinforcement within the complex steel cage of reinforcing bars also posed a challenge. Typically, the stirrups would be tied into position and the No. 14 bars threaded through by hand. But the grid was too tight to allow that to be accomplished safely and efficiently. Instead, a woven tube that constricts as it's pulled was placed over the end of each bar and then pulled through to the opposite end with a winch. This approach worked efficiently and provided better safety than working with the bars by hand.

Arches Needed Special Handling

The arch segments were cast on their side. They were originally planned to be shipped on their bottom edge—in their final resting position. But the precaster determined that this position would make the arch segments difficult to transport through some of the sharp turns along the highway. Instead, the arch segments were redesigned to be shipped flat in the as-cast position. This required special equipment to handle the segments, necessitating special lifts that were built into the sides of the arch segments for maneuvering at the site.

Upon arrival at the bridge site, the arch segments had to be rolled from their shipping position into the proper alignment for erection. To avoid site-lifting expenses and time, a stack of precast concrete blocks was created at the site to serve as a base for rotating the arch segments. The half-arches' roll axis was offset from the center of gravity, so the arch segments could be picked horizontally from the truck and set with the center of the arch on the blocks. As the weight of the arch segment was transferred to the block support, they would roll into the proper position for final lifting and setting. Sand bags were set over the entire top of the blocks to protect the components as they rolled.

Connecting the two segments of the arch segments also posed challenges. The bottom portions were set in a 3 ½-in.-deep socket, after which it was enclosed by a 3.5-ft-deep cast-in-place, reinforced concrete block. To make the arch segments continuous, the No. 14 reinforcing bars extending from the top end of each segment were connected using metal-filled mechanical splices before placing concrete. The splices provided tolerance for adjusting the longitudinal rebar alignments while retaining the necessary strength.

Precast, prestressed concrete voided slabs made continuous for live load were designed for the bridge superstructure. Prestressing strands extending from the precast slab ends were hooked at bents to provide continuity between the slabs. The cross-members connecting the three arch crowns also served as supports for the precast concrete slabs.

Soil Creates Challenges

Soil in the area consisted of alluvium deposits of silty-sand, clayey-silt, and organic debris. These are generally not suitable for laterally supporting an arch bridge. In addition, there were challenges with anticipated extreme scour and the sensitive environment surrounding Spencer Creek that had to be addressed.

A foundation system was designed using grouped, 6-ft-diameter drilled shafts embedded in bedrock to support the arches and the mechanically stabilized earth (MSE) walls for the approach embankments. Both provide good performance during seismic events.

A unique feature was added to the foundation system by attaching horizontal deadman anchors and struts to the drilled shaft caps. The anchors and struts were buried beneath the 40-ft-high MSE wall backfill. The deadman-anchor system was jacked into the MSE wall fill, using the developing passive earth resistance as the lateral support for the arches. This strengthening method allowed the arches to be set on the weak soil while providing the drilled shafts with additional resistance to withstand the horizontal forces.

The high-performance precast concrete and stainless steel reinforcement were specified to increase life expectancy of the new Spencer Creek Bridge. The design minimized impact to the environmentally sensitive creek and provided an aesthetically pleasing structure. The bridge has been well-received by the community. During construction, many local citizens would watch the arches being created and comment to the construction team on the bridge's pleasing appearance.

Tanarat Potisuk is a structural design engineer at H.W. Lochner Inc. in Salem, Ore., and Keith Kaufman is the chief engineer at Knife River Corp. in Harrisburg, Ore.

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

Spencer Creek Bridge
Looking NE at sunset.

Precast concrete fascia panels are shown being lowered into place along the sides of the bridge to add a smooth face to the superstructure.

Two halves of each precast concrete arch were set into sockets at the foundation and connected with a large cast-in-place concrete blocks.

The precast arches were shipped on their side and rotated on a specially made pedestal to prepare them for lifting into place.

Special lifting hooks were cast into the sides of the precast concrete arches to aid in handling them prior to rotation.

Sand bags were set around the top of the precast concrete blocks to protect the components as they rolled into the lifting position.