Salt Creek Half-Viaduct Bridges Rehabilitation Using Full-Depth Precast Concrete Deck Panels

by Dr. Keith Kaufman, Knife River Corporation

Heavy haul trucks that travel between Portland, Ore., and Weed, Calif., have few route options. Trucks can stay on Interstate 5 (I-5) and deal with multiple passes between Eugene, Ore., and Medford, Ore., before climbing the Siskiyou Summit that is south of Ashland, Ore., and continuing on to Weed. Another popular freight route uses Oregon Route 58, which heads east out of Eugene and over the Cascade mountains to Highway 97 near Chemult, Ore. That route then follows a relatively flatter grade to Weed by avoiding the Siskiyou Summit.

A 1933 construction photo at the Salt Creek Tunnel's west entrance with a half-viaduct bridge visible. Photo: Oregon State Archives.

Oregon Route 58 is a two-lane highway that leaves the Willamette Valley at an elevation of 500 ft and climbs the Cascade Mountains, reaching a peak elevation of 5100 ft at Willamette Pass. An integral part of this route is the Salt Creek Tunnel, which lies west of the summit at an elevation of 3850 ft. Four half-viaduct bridges are located outside the tunnel: one to the west and three to the east. At each of these locations, the westbound lanes are on grade while the eastbound lanes are supported across multiple grade openings using reinforced concrete deck-girder bridges or half viaducts

The geometry of the tunnel grade was modified by lowering the roadway to improve vertical clearance. Other improvements include applying shotcrete to the walls, and upgrading utilities. The four viaducts also required reconstruction to alleviate years of deterioration and improve the safety of the system. The Oregon Department of Transportation (ODOT) completed a redesign in 2012.

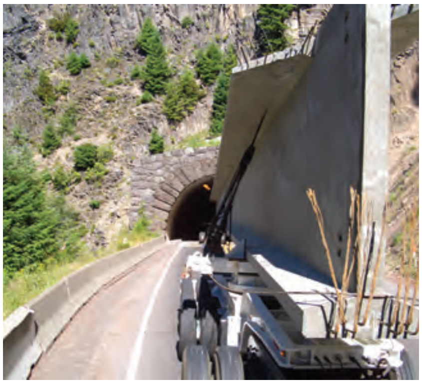
Design

Due to historical requirements, the new bridges had to simulate the T-beam construction of the existing bridges. Therefore, the engineer of record (EOR) detailed a spread 42-in.-deep precast, prestressed concrete box-beam system carrying a 10-in.-thick cast-in-place (CIP) composite concrete deck that would receive a 4-in.-thick asphalt overlay. The thick deck and overlay help resist potential debris slides and avalanche impact. Furthermore, the EOR limited the live load deflection at the longitudinal joint between the eastbound viaduct and the westbound grade so that the asphalt overlay could be continuous over the eastbound and westbound lanes.

The individual span lengths are 50 ft on all viaducts with two to five spans in each bridge. The four bridges include longitudinal grades of 4% to 5%. Three of the bridges are on a horizontal curve with a constant cross slope.

The EOR's design included a precast concrete-friendly design for the box beams. All pile caps were parallel, being normal to the chord of the arc. Therefore, all precast concrete box beams were the same casting length. A chamfer or fillet detail was included at the ends to incorporate the proper offset to the curve. The fourth bridge is on a tangent. However, it included a reverse super-elevation.

ODOT specified its three-tube curb mount rail. The exterior of the curb included a formliner for aesthetics. These details are visible from the Salt Creek Trail below the roadway.

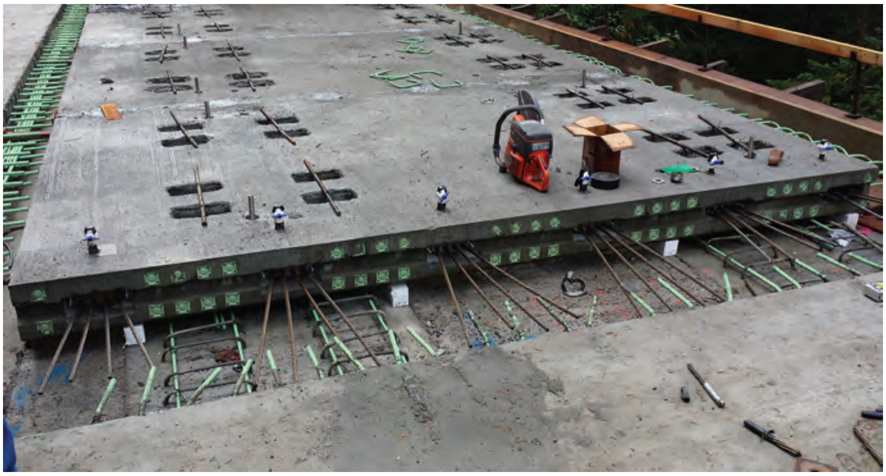


A heavy haul truck uses the Salt Creek Tunnel. The truck transports a girder through the east portal to another project. Photo: Knife River Corporation.

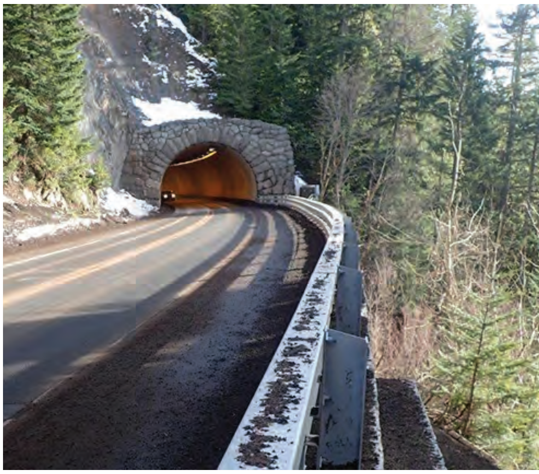
Value Engineering and Special Considerations

The construction site and schedule were very restricted. The weather limited construction to the late spring, summer, and early fall, depending on snow. Oregon Route 58 was closed during weekday nights to allow for construction. Daily closures were limited to 15 minutes to allow alternating single-lane traffic movements.

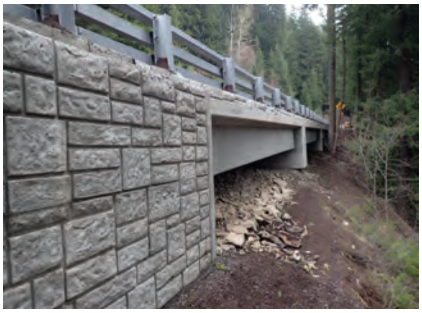
After the bid, the contractor contacted the manufacturer of the precast concrete box beams, Knife River, and asked whether a full-depth precast concrete deck panel could replace the CIP deck. A post-tensioning supplier, DSI, was contacted and details were provided for a system used in Utah that was pretensioned transversely and post-tensioned longitudinally. This system was submitted and approved. For the three bridges on a horizontal curve, pie-shaped deck panels were detailed. The panel width was set to match the rail-post spacing of 9 ft so that all panels were the same in each bridge.



Precast concrete deck panel with joint and pocket details visible. Photo: Knife River Corporation.



This photo shows westbound traffic exiting the west tunnel portal. A completed half viaduct carries east bound traffic into the tunnel. Photo: ODOT Region 2.



Typical elevation of completed half-viaduct bridge. Photo: ODOT Region 2.

Some special considerations are discussed in the following sections.

Substructure

The CIP caps at all piers are supported on piles. The top of the pile cap is parallel to the deck cross slope. Between the eastbound and westbound lanes, precast concrete gravity blocks were stacked. The tops of the gravity blocks received a keyed coping slab to complete the westbound lane.

Box Beams

The box beams were erected parallel to the cross slope. An integral diaphragm was cast over each pier to lock the superstructure to the substructure. The box beams have a straight strand pattern with a few top strands to minimize camber and stresses at the ends.

Precast Concrete Deck Panels

The 10-in.-thick precast, prestressed concrete deck panels were pie shaped with an exterior dimension of 9 ft and an interior dimension less than 9 ft to match the roadway geometry. The transverse shear key between panels included pockets at the post-tensioning duct for splicing. Reinforcement was extended longitudinally to complete the exterior curb and rail, and also to complete the interior closure. At each abutment, a CIP concrete panel was cast to complete the deck.

The transverse prestressing of the deck panels included two rows of ten 1/2-in.-diameter, Grade 270 pretensioned strands, a row at the top and bottom. Longitudinally, post-tensioning tendons were spaced at 2 ft 6 in. Each tendon included four 0.6-in.-diameter, Grade 270 post-tensioning strands. The concrete compressive stress in the deck from prestressing after losses was approximately 500 psi transversely and longitudinally.

Composite Action

Due to the arc geometry of the panels and linear alignment of the box beams, a unique system was incorporated to complete the composite section. A similar system was used in the Bronco Bridge in Denver, Colo. (see the Summer 2013 issue of *ASPIRE*™). Four-legged No. 5 stirrups were extended from the top of the box beam into the buildup. Then, No. 5 ties were placed in the blockout. Longitudinal bars were added to complete the reinforcement of the connection.

Construction Sequence

The construction sequence was:

1. Precast concrete box beams were erected.
2. Diaphragms were cast to connect the ends of the box beams to each other and to the pile caps.
3. The precast concrete deck panels were erected on the box beams.
4. The composite reinforcement (No. 5 ties) was added in each blockout and secured to the longitudinal reinforcement. Leveling screws and rigid-foam strips were used to establish the build-up geometry and provide a form for the CIP composite concrete.
5. Longitudinal post-tensioning ducts were spliced at the transverse joints and then the transverse shear keys were cast and cured. Longitudinal post-tensioning was applied and ducts were grouted. The panels were post-tensioned for the length of the structure.
6. The build-up and shear pockets received the composite concrete to complete the structural system.
7. To complete the superstructure, closure panels, traffic barrier, and a longitudinal edge casting between the precast concrete deck panels and the CIP grade slab over the eastbound lane were installed, followed by an asphalt overlay and a saw-cut joint.

Summary

The project had many challenges. However, the use of precast concrete components allowed the project to be completed rapidly in the difficult environment.

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