SH-55 Over North Fork Payette River Bridge

by Leonard Ruminski, Idaho Transportation Department

Completed bridge with concrete barriers and piers stained to match local stone. All Photos and Figures: Idaho Transportation Department.

The project is located in the small resort town of Cascade, Idaho, on a two-lane scenic highway that is also a vital north-south link within the state for both commercial and tourist traffic. Any prolonged traffic interruptions on this highway would have significant impacts as there is no practical detour available.

The existing 65-year-old, three-span steel girder bridge crossing a 20-ft-deep, 190-ft-wide river was classified as structurally and functionally deficient, and was originally scheduled to be replaced in 2017. However, due to excessive corrosion of exposed pier piles, the bridge could no longer support heavy truck loads, causing traffic restrictions along the route and impeding commercial traffic.

The Idaho Transportation Department (ITD) temporarily addressed the issue by encapsulating 50% of the corroded piles with epoxy-filled jackets, which allowed lessening of traffic restrictions. But to achieve full mobility as soon as possible, the bridge replacement completion had to be accelerated by two years and was set for October 2015.

To minimize impacts on the traveling public and local businesses, the new structure was to be erected by accelerated bridge construction methods with precast concrete elements that would allow rapid assembly in the field.

The bridge removal and replacement were to be performed in two stages while maintaining two-way traffic through the construction site at all times. This required a 10-ft shift in the permanent roadway alignment and construction of long, mechanically stabilized earth (MSE) retaining walls at each end of the new bridge, due to right-of-way limitations. MSE walls with precast concrete panel facing were also used instead of conventional wingwalls at each abutment.

The bridge layout is oriented on a north-south alignment. Access within the river was only available on the east side of the bridge, where a modular temporary work platform was erected along the existing bridge during stage 1 construction. This working bridge was used to remove the eastern part of the existing bridge and to construct stage 1 of the new bridge. On the west side of the bridge, the existing topography at abutment 1 and the wetland area at abutment 2 made access and construction of a working platform impossible. Low-hanging electrical power lines also ran parallel along the east side of the bridge, making crane operations difficult. Therefore, during stage 2 construction, the remaining part of the existing bridge was used to support equipment for installing piles and the precast concrete pier wall and to allow erection of the girders. Piles for the new bridge were installed through openings cut in the existing deck, so the new pile spacing was designed to fit between the existing bridge girders. Using the existing bridge as a work platform

profile

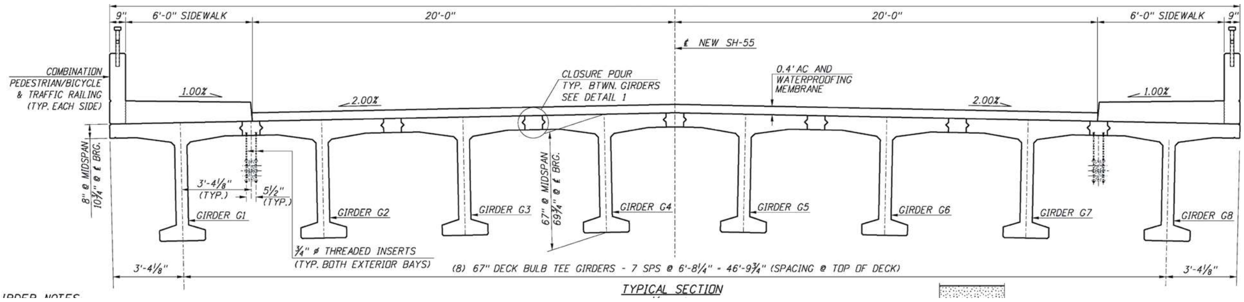
SH-55 OVER NORTH FORK PAYETTE RIVER BRIDGE / CASCADE, IDAHO

BRIDGE DESIGN ENGINEER: Idaho Transportation Department, Boise, Idaho

PRIME CONTRACTOR: RSCI, Boise, Idaho

PRECASTER: Hanson Structural Precast (now Forterra Structural Precast), Caldwell, Idaho—a PCI-certified producer

PILE FOUNDATION INSTALLATION AND PRECAST CONCRETE ERECTOR: Inland Crane, Boise, Idaho



Bridge cross section with closure-pour detail between deck bulb tees.

to support heavy equipment was questionable; however, with careful analysis, equipment placement restrictions, and the prior strengthening of the corroded piles, it was determined to be possible.

New pile installation was complicated by large cobbles and boulders that required predrilling and the use of temporary casings. Templates were used during pile driving at the pier and abutment locations to achieve the tight installation tolerances required for fitting the precast concrete substructure components to the piles.

Of particular interest was an innovative method of pier-wall installation within the deep river that eliminated the need for time-consuming and expensive cofferdams. The 30-in.-diameter steel shell piles were arranged in a single row and driven through water into the riverbed, cut off just above the water line, leveled, and filled with concrete. The pile penetration into the riverbed also had to be increased to account for 12 ft of potential scour. Fourteen-inch-diameter centering pipes were cast in the top of shell piles, and were used to align and secure the lower segment of the pier wall to the shell piles. Inverted U-shaped precast concrete lower pier-wall segments were positioned directly on top of the shell piles to completely hide them from view above the water, enhancing aesthetics. The hollow upper pier-wall segments were then erected and filled with high-early-strength concrete with fibers. Polypropylene fibers in the amount of 1.5 lb/yd^3 were added to the high-early-strength concrete to reduce shrinkage cracks of the fast-curing, highly cementitious material. Using hollow pier-wall segments kept their shipping weight below 30 tons, simplifying transportation, erection, and reducing cost. Precast concrete abutment pile caps with 30-in.-diameter corrugated metal pipe pile block-outs were erected on top of HP piles and the block-outs were filled with high-early-strength concrete with fibers.

Deck bulb-tee girders were erected and top flanges connections were made with 10-in.-wide closure pours. Top flange transverse reinforcement protruded 9 in. into the closure pours. Epoxy-coated upper bars were used for improved protection against corrosion, while the lower bars had end terminators. These devices provided adequate development and pull-out resistance. Closure pours were then filled with high-strength grout with fibers, resulting in a robust and durable moment-resisting connection. Since the ends of the deck girders were cast within the integral abutment and pier diaphragms, and no conventional deck placement was required, intermediate diaphragms between girders were not needed. This approach also simplified and accelerated construction.

High-early-strength concrete with fibers was used for the integral pier and abutment diaphragms, allowing removal of the formwork after 24 hours, considerably less than the form curing time required for conventional concrete. After the approach slab, sidewalk, and parapet placements, the entire riding surface was covered with a spray-applied waterproofing membrane and a double layer of asphalt. Finally, asphaltic-plug expansion joints were placed at the end of each approach slab.

Due to its location next to a recreational resort and within beautiful natural surroundings, the new structure had to be aesthetically pleasing and blend with the environment. This was achieved by texturizing and staining the exterior surface of the precast concrete pier-wall segments, MSE wall panels, and concrete parapets. Formliners were used on the exposed surface of the pier walls, MSE walls, and parapets to create a textured concrete surface and enhance aesthetics. Staining of the textured surface was then applied after casting with variable colors to match the natural colors of the rock rip-rap and surrounding rock formations.

Innovations and Accomplishments

All elements of the superstructure and substructure of the new bridge, except sidewalks and parapets, consisted of precast concrete components, allowing quick field assembly. This reduced inconvenience to the public, reduced economic and

IDAHO TRANSPORTATION DEPARTMENT, OWNER

BRIDGE DESCRIPTION: 250-ft-long, 53.5-ft-wide, two-span (124-ft each), precast, prestressed concrete deck bulb-tee girders supported by integral piers and integral abutments. The bridge carries two 12-ft-wide lanes of traffic with two 8-ft-wide shoulders and two 6-ft-wide sidewalks.

STRUCTURAL COMPONENTS: Eight 67-in.-deep deck bulb-tee girders per span, precast concrete abutment pile shell caps and precast concrete pier walls consisting of multiple segments approximately 6 ft high, 5 in. thick, and 26 in. wide. Cast-in-place closure pours between deck girders using high-strength grout with fibers; cast-in-place abutment and pier diaphragms using high-early-strength concrete with fibers

BRIDGE CONSTRUCTION COST: $4,100,000

AWARDS: 2016 PCI Design Awards: Best Bridge with Main Span from 76–149 feet, Honorable Mention in All-Precast Concrete Solution Category; Idaho Business Review 2016 Top Projects: Honorable Mention in Transportation Category

Stage 1 upper pier segment erected. Workers are placing temporary bearings for deck girders. Projecting vertical bars will be cut at deck girder locations.

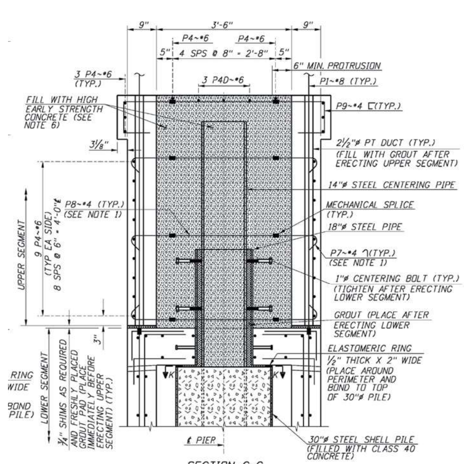
Stage 1 deck girder erection from existing bridge.

environmental impacts, improved safety during construction, and provided a high-quality, durable, low-maintenance, and aesthetically pleasing bridge structure.

The innovative method of pier construction eliminated the need for deep cofferdams and forms within the river, significantly reducing cost and construction time and providing the appearance of a solid wall while hiding steel shell piles. Using multiple hollow pier-wall segments reduced their shipping weight, making their transportation and erection easier and less expensive.

The 10-in.-wide closure pours between deck bulb-tee girders filled with high-strength, fast-curing fiber-reinforced grout, were less expensive than comparable ultra-high-performance-concrete-filled closure pours, but still provided a strong, effective, and durable connection.

Girder continuity over the pier was achieved by extending the top flange longitudinal reinforcement into the pier diaphragm and splicing it with the reinforcement of the girder in the adjacent span using mechanical couplers. Developing bottom flange strands into the pier diaphragm provided a positive-moment girder connection. The girders were framed at the pier and abutments by cast-in-place integral diaphragms using high-early-strength concrete with fibers. The use of integral abutment and pier diaphragms increased structural redundancy and eliminated exposed bearings and expansion joints, reducing



Cross section of pier wall showing the filled pier shell and pile cap details.

Deck surface after girder closure pours have been completed.

future maintenance requirements. They also improve seismic performance and bridge resilience against high water velocities during floods.

Using high-early-strength concrete with fibers instead of conventional concrete for cast-in-place concrete significantly reduced in-form curing time requirements and the formation of shrinkage cracks, which improves long-term performance. Its overall unit cost premium was negligible, considering the benefits and relatively low volume required for this project.

A variable top flange thickness (8 in. minimum) along the length of the deck bulb-tee girders was designed to mitigate the effects of upward girder camber and eliminate the requirement of variable asphalt thickness along the span, simplifying paving operations. A spray-applied waterproofing membrane on all deck surfaces covered with a double layer of asphalt ensures a well-protected, long-lasting deck and approach slabs, reducing future maintenance requirements.

Summary

The successful and timely completion of this challenging project was only possible with the use of precast concrete elements. Using simple and practical details with allowance for tolerances and field adjustment along with an innovative construction procedure enabled the contractor to assemble the bridge structure on schedule and within budget. The bridge structure was assembled within a four-month period compared with 10 to 12 months for a similar structure using conventional construction methods.

Leonard Ruminski is a technical engineer 2 with the Idaho Transportation Department Bridge Section in Boise, Idaho.