Lightweight Concrete Facilitates Deck Replacement

by Catherine Higgins, Utah Department of Transportation

Lightweight concrete is not commonly used for constructing bridge decks according to Joshua Sletten, structures design manager at the Utah Department of Transportation (UDOT). However, lightweight concrete was the right choice for the Taggart Bridge, which is comprised of twin structures that carry I-84 over the Union Pacific Railroad. Originally built in 1967, the deck replacement was a priority. Lightweight concrete allowed the bridge deck to accommodate a thicker deck and asphalt overlay to meet the adjoining freeway profile, while not exceeding the load capacity of the older, precast, prestressed concrete girder bridges.

The bridge geometry, along with the requirement to keep the freeway open during construction, presented the initial challenges to UDOT, Hanson Structural Precast, and Granite Construction Company Inc.

Both bridges are three-span structures on a curved alignment. Sixty individual deck panels were designed, and "no two panels were the same," according to UDOT design engineer Robert Nash. He kept dimensions the same where possible but "the location of shear blockouts and leveling devices were different for every panel." Each panel was connected to the beams using reinforcing bars grouted into the top flanges of the concrete beams.

Hanson created precise shop drawings for each precast concrete panel. An indoor precasting yard made production immune to weather delays, and a rigorous internal quality-control process eliminated fit issues at the construction site. Panels used concrete with expanded shale lightweight aggregates from Utelite Corporation, a local supplier.

Granite Construction achieved UDOT's aggressive construction schedule requirements while keeping traffic moving during construction. The precast concrete panels and detailed construction sequence allowed workers to keep pace even during snow flurries and low temperatures.

The project won recognition from UDOT as the Rural Project of the Year for 2011. A

Catherine Higgins is an interactive specialist with the Utah Department of Transportation Communications Office.

Lightweight concrete panels allowed the use of a thicker deck and overlay while not exceeding the capacity of the older beams. Photo: Utelite Corporation.

The panels were connected to the beams through reinforcing bars grouted into the top flanges of the beams. Photo: Utelite Corporation.

Rainbow Bridge

The Positive Impact of Concrete Bridge Preservation

by Chris Ball, Vector Corrosion Technologies

The Rainbow Bridge, completed in 1933 at a cost of $74,000, is the longest (410-ft) single-span concrete arch bridge in Idaho and a landmark structure on the Payette River National Scenic Byway. The bridge is listed in the National Register of Historic Places and designated for rehabilitation rather than replacement.

Decades of exposure to freezing and thawing cycles and deicing chemicals began to affect the integrity of the structure. A consultant's 2004 study assessed the structure and evaluated alternatives to preserve the bridge. This evaluation identified the most destructive corrosion as that which was located in the substructure near the joints and deck drains.

The repair scope included partial and full replacement of railings and curbs, replacement of expansion joints, concrete patching, and corrosion mitigation of the arches. After evaluating a series of alternatives, the consultant and the Idaho Department of Transportation (IDOT) specified two systems to protect distinctly different sections of the structure: electrochemical chloride extraction (ECE) to passivate corrosion in the concrete arch substructure and alkali-activated embedded galvanic anodes in sections that did not receive electrochemical treatment.

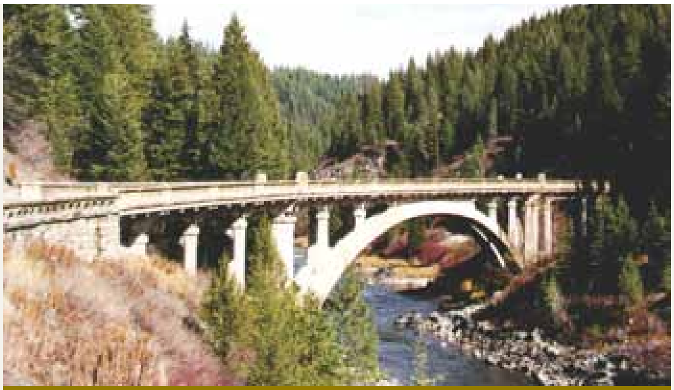
The implementation of the concrete repair and corrosion mitigation plan provided several important benefits:

- Minimal impact on the aesthetics of the historic structure
- Shorter construction schedule and reduced traffic impact
- Sustainable, long-life bridge preservation solution

The Rainbow Bridge, selected "2007 Project of the Year" by the International Concrete Repair Institute, is an example of modern techniques used to preserve a unique historic structure. This signature bridge identifies a local community, serves as a reminder of past successes, and continues to provide an important gateway for the area.

Bridge preservation techniques and strategies are playing an increasing role in mitigating performance concerns as more than 30% of the nation's 600,000 bridges are near their theoretical 50-year service life.

Chris Ball is vice president of Vector Corrosion Technologies.



The historic Rainbow Bridge, Valley County, Idaho. Photo: Vector Corrosion Technologies.

Extending Performance

Since 2008, the U.S. Highway Bridge Program provides flexibility for state transportation departments to use federal funds for bridge replacement, rehabilitation, or systematic preventive maintenance. In 2011, the Federal Highway Administration (FHWA) published the *Bridge Preservation Guide: Maintaining a State of Good Repair Using Cost Effective Investment Strategies*.

This guide provides many examples of cost-effective interventions to extend bridge performance through preventive maintenance. Two techniques detailed in this guide are cathodic protection and electrochemical chloride extraction (ECE). Evaluations of existing bridges determine if these preventative maintenance approaches will achieve bridge service life requirements.

Cathodic Protection

Cathodic protection systems can be galvanic or impressed current (ICCP). Galvanic systems use low maintenance sacrificial anodes. These surface-installed systems include: metalized galvanic anodes, galvanic jackets/encasements, and embedded anodes in concrete repairs.

ICCP systems use transformer/rectifiers to deliver protection via inert anodes. The anodes are placed on the surface, placed in sawcuts, encased in overlays and jackets, or grouted into drilled holes.

ECE

Electrochemical treatments passivate active corrosion by providing temporary current that changes the environment around the reinforcing steel. ECE reduces the level of chlorides and increases the pH in chloride-contaminated concrete. This re-alkalization also increases the pH in carbonated concrete

Widening Hazel Avenue Bridge Over American River

by Ali Seyedmadani, Parsons Brinckerhoff

In 2000, the Sacramento County Department of Transportation (SACDOT) began planning improvements to 2.5 miles of Hazel Avenue from U.S. Highway 50 to Madison Avenue to relieve congestion and improve multi-modal mobility. As part of the Phase I project, the Hazel Avenue Bridge over the American River was widened, multi-use path connectivity was improved, and sound walls and retaining walls were constructed.

The existing bridge over the American River was a 570-ft-long, four-span (127, 157, 157, and 129 ft) reinforced concrete box girder, carrying four lanes of traffic. The project widened the bridge by 37 ft, adding two lanes of traffic and widening the pedestrian sidewalk on both sides of the bridge. The bridge is located 500 ft upstream of the Nimbus Fish Hatchery and 1500 ft downstream of Nimbus Dam on Bureau of Reclamation right-of-way in an environmentally sensitive area. The project was funded with local, state, and federal resources, which required California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) approval.

Project Constraints and Bridge Type

The existing Hazel Avenue Bridge foundations consisted of a spread footing and driven steel pile system. The seismic analysis of the existing bridge indicated deficiencies with the performance of the bridge during a seismic event. The design of the widened structure had to account for the environmental restrictions, limited in-water construction window from June 1st to October 1st, limited access to the site, and the seismic performance deficiencies.

The addition to the existing bridge consisted of 34-ft-long cast-in-place (CIP) concrete pier sections supporting 120-ft-long, 7-ft-deep precast, prestressed concrete bulb-tee beams. The length and stiffness of the CIP pier section was adjusted to minimize the live load differential deflection at the closure between the existing bridge section and the widened section.

The proposed bridge substructure consisted of a single, 15-ft-long, 5-ft-wide oval column supported on a 3-ft-diameter drilled shaft pile group. The size of oval column was adjusted to create the required stiffness and reduce the seismic displacement demand of the combined structure. This structure type allowed a top-down construction method, met all the environmental constraints, minimized environmental impacts, and limited interaction with the river during construction.

Construction

To meet the environmental constraints and the in-water construction work window, a steel trestle work platform system was used for accessing the site. In addition, sheet pile cofferdams were installed during the in-water work window to segregate the work space from the water. The cofferdams allowed the contractor to work within the constraints of the environmental permit and minimize impacts to the river.

As part of the superstructure construction, 70-ton precast concrete girders were erected using two cranes positioned on the existing bridge. The girder erection operation started on Saturday morning and was completed by Sunday afternoon, requiring only a single weekend road closure. For the aesthetic treatment, wave patterns were cast into the girders using formliners. Similar patterns were utilized in the bridge railing system for the pedestrian and multi-use paths along the bridge, thereby carrying this theme throughout the structure.

Other outstanding project elements included the soil-nail wall systems for reducing project impacts and multi-use pedestrian and bike facilities that improve connectivity to the American River Parkway. This includes a multi-use bridge crossing and emergency vehicle access. This project is an outstanding example of a context-sensitive approach to design that results in a cost-effective, aesthetically pleasing, and environmentally sensitive project.

Ali Seyedmadani is the senior engineering manager and a bridge engineer with Parsons Brinckerhoff in Sacramento, Calif.

Hazel Avenue Bridge, a context sensitive solution, meeting public expectation and site constraints.