CONCRETE BRIDGE PRESERVATION
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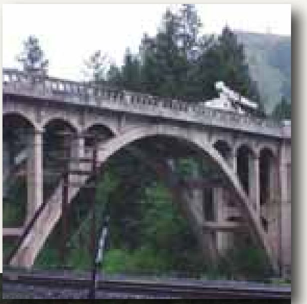
Historic Repairs

Classic bridge is revived with extensive repairs

by Craig A. Shutt

The Upper Perry Arch Bridge, spanning the Grande Ronde River and the Union Pacific Railroad in Perry, Ore., was designed by Oregon's first state bridge engineer, Conde McCullough. Built in 1923, the 309-ft-long bridge features classic McCullough design elements: sweeping arches, railings of gothic-arched panels that support beveled handrails, and decorative brackets.



To rehabilitate the 309-ft-long Upper Perry Arch Bridge in Perry, Ore., which had severely deteriorated, 580 yd^3 of concrete had to be cast in 35 placements, not including the 618 linear ft of precast decorative bridge rail.

But the bridge's deterioration had been unchecked for so long that the Oregon Department of Transportation considered demolishing the bridge. After further inspection and input from an architectural committee, officials decided that rehabilitation was a viable option. The construction team on the project included engineering firm OTAK Inc. in Portland, Ore.; repair contractor Wildish Standard Paving in Eugene, Ore.; and material supplier Masons Supply in Portland, Ore. Officials wanted to salvage as much concrete as possible.

By adding a cast-in-place longitudinal center beam, deck thickness was reduced from 14 to 8 in., which minimized the amount of concrete needed and reduced the dead load of the bridge. Several expansion joints were also eliminated to minimize future maintenance costs. The anticipated extended service life is 50 years.

Deteriorated concrete had to be removed using handheld jackhammers and replaced with repair grout before other work began. All bridge rails, crossbeams, decks, spandrel posts, sidewalk brackets, and corbels were demolished and replaced. The arches and bents were salvaged, 1130 linear ft of cracks were injected with epoxy and unsound, deteriorated concrete was removed and replaced.

Repair work included over 2000 ft^2 of regular cast-in-place concrete repair (up to 2 in. in depth) and 810 ft^2 of deep concrete repair (up to 16 in. in depth). Over 2800 ft^2 of damaged concrete, 65% more damaged concrete than originally anticipated, was removed and replaced with 550 ft^3 of the prepackaged repair mortar.

A total of 306 dentils and 68 sidewalk brackets (corbels) were demolished, formed, and cast in place. Special steel forms were used to fabricate 46 pieces of rail.

All placements for the main arch span were located equally from each side of the bridge to balance loading. The arch ribs supported the formwork and the work platform. After the formwork was removed, the entire structure was patched, ground, painted, and sealed.

The restoration met the goal of recreating the original look of the structure sought by McCullough 90 years ago while protecting the bridge from deterioration for another 50 years. The project was named 2010 Historic Project of the Year by the International Concrete Repair Institute, indicating its success.

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Historic Arch Bridge Widened

Precast concrete structure "hidden" inside concrete arch structure in Lexington, Ky.

by Daryl W. Carter, ENTRAN (now Stantec) and Jeremy Raney, Louisville Metro Public Works & Assets

Rehabilitating a historic reinforced concrete arch bridge requires careful consideration of all factors and close evaluation of the best way to retain aesthetics while providing long-term functionality. Both goals were achieved in widening the River Road Bridge over Harrods Creek in Jefferson County, Ky.

The goal for Jefferson County Public Works officials was to rehabilitate and widen the existing bridge, a three-span, reinforced concrete, filled-spandrel arch constructed circa 1912. The one-lane, 195-ft-long structure, eligible for listing in the National Register of Historic Places, was creating a bottleneck for traffic and safety concerns.

After reviewing options, designers drafted a plan to “hide” the structural support framework of a precast concrete bridge inside the spandrel walls of the existing arches. The new bridge deck spans over the existing spandrel walls to provide sufficient width for a two-lane bridge. The widened bridge consists of three spans (71 ft 6 in., 66 ft 4 in., 71 ft 6 in.), continuous for HS-25 live load. At 32 ft wide, it carries two 12-ft-wide traffic lanes, two 2-ft 10-in.-wide shoulders, and has 1-ft 2-in.-wide architectural concrete bridge rails on each side replicating the original concrete balustrade railing.

The bridge superstructure uses 42-in.-wide by 48-in.-deep precast, prestressed concrete spread-box beams, spaced at 6 ft 3 in. centers. This narrow beam spacing allowed three beam lines to fit between the existing spandrel walls, ensuring newly generated loads were isolated from the existing arches.

The rehabilitated River Road Bridge hides the structural support framework of a precast concrete bridge inside the spandrel walls of the existing arches. Its deck cantilevers 7 ft 9 in. beyond the edges of the box beams to provide for a two-lane bridge.

The newly widened bridge provides better functionality and the same historic appearance as the original. Although local groups were wary, feedback has indicated that the results have been well received, and the project has been perceived as a success. All photos: ENTRAN PLC.

The beams, fabricated with 7500 psi compressive strength concrete, provide significant flexural strength, shear capacity, and have relatively shallow depth. They will also be durable in the moist environment and will not require painting.

Precast concrete deck panels were cast with vertical open slots that align with epoxy-coated shear stirrups protruding from the box beams' tops. Once fit together, these joints were pressure-grouted.

Precast Concrete Deck Used

The bridge deck comprises twenty 32-ft-wide precast concrete deck panels with cast-in-place concrete closures between each panel. The panels vary in width from 5 ft 10½ in. to 7 ft 11 5/8 in. They are approximately 1 ft 1½ in. thick at the crown and taper to 10 in. at the ends. Specified concrete compressive strength was 7500 psi. Panels are pretensioned transversely to the bridge to handle the large deck overhangs, which on one side supports a suspended 8-in.-diameter water pipe. No post-tensioning was used. The panels were topped with a waterproofing membrane followed by a 1½-in.-thick asphalt overlay.

New abutment caps are supported on drilled shafts behind the existing arch rings, cored down through the existing arch thrust blocks to terminate in rock sockets. The pier caps are supported on micropiles drilled through the arch infill and pier stems. They are anchored 11 ft into solid rock.

The existing arch rings also were repaired during the construction. The repairs included chipping out deteriorated concrete, replacing corroded reinforcement, and applying epoxy concrete. Once repairs were completed, the exposed surface of the arches and spandrel walls received a masonry coating finish.

The bridge, which opened to traffic in August 2010, won the award for Best Rehabilitated Bridge in the Precast/Prestressed Concrete Institute's 2011 Design Awards competition.

Daryl W. Carter is a senior bridge engineer/project manager with ENTRAN (now Stantec) in Lexington, Ky., and Jeremy Raney is an executive administrator with Louisville Metro Public Works & Assets in Louisville, Ky. This article is a condensation of a paper presented at the National Bridge Conference held October 22-26, 2011, in Salt Lake City, Utah.

Rehabilitation, Not Destruction

Saving Cass County Bridge No. 123

by Mike Wenning, American Structurepoint Inc.

When Cass County Bridge No. 123 in Lewisburg, Ind., was slated for demolition, public outcry from the town was strong. This five-span Luten arch bridge was built in 1913 to carry CR 825 E over the Wabash River. A Luten arch is a patented concrete arch designed during that time period by Daniel B. Luten, of Indianapolis, Ind. Nearby residents relied on the bridge for daily transportation and respected it for its historic significance, but after years of deterioration, safety had become an issue.

Since plans did not exist for the bridge, significant survey, coring, and field inspection were required to acquire the necessary details. The goal was to return this ornamental bridge back to its original appearance while making it safer by incorporating modern design features. Many of the fine neoclassical elements of this bridge had been completely lost. Engineers relied heavily on historic reference and details gleaned from work on other Luten bridges.

Funding was a challenge from the beginning. During the process of seeking funds, the bridge deteriorated to the point that it had to be closed. Once funds were obtained, the Cass County Highway Department hired American Structurepoint to quickly prepare plans for construction.

The spandrel walls and arches were generally in good condition; however, the massive 8-ft-thick piers were in a dilapi-

Historic references helped determine the design of the piers, which had concentric components reconstructed with extensive detailing.

A temporary support system was placed under the arch on either side of the pier during the construction process.

dated state. Engineers had to determine a way to stabilize the arch while the main supports were replaced. The engineers, and Jack Isom Construction, developed unique methods to safely stabilize the structure during construction. A temporary support system was placed under the arch on either side of the pier. The contractor then excavated all fill from the arch and separately removed each pier in thirds. Some of the existing concrete was found to be in acceptable condition in some areas and allowed to remain, which provided added support during the pier reconstruction. Historic references were relied upon when determining the width and design of the piers, which had concentric components reconstructed with extensive detailing.

Aesthetics and modern safety improvements were priorities during the rehabilitation. The original bridge was very narrow, just 18 ft wide. Therefore, a concrete deck that overhung the existing spandrel wall, and supported by it, was designed to provide a 24-ft width.

The original railings, one of the more unique architectural elements, had previously been removed. Through investigation and surveys, the spindles lining the rail were reconstructed, with the exterior surface perfectly matching the original work of almost 100 years ago. To modernize the railing, the precast concrete spindles were designed with a stainless steel dowel through their center with adequate strength to resist highway impact loads. Proper care was given to concrete texture, which was of great importance.

Bridge No. 123 is now safer than ever before and was restored to replicate its original magnificent appearance. Utilizing quality materials will ensure the longevity of this structure, not only as it is used for transportation, but as it is admired by generations as a work of infrastructure art.

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