Hamilton County, Ohio, uses high performance concrete to reduce chloride penetration, minimize deck cracking, and provide 75-year service life.

Spread Box Beams Provide Economic Solution

by Stephen J. Mary and Matt Yunger, Hamilton County, Ohio

Willey Road Bridge in Hamilton County received the 1998 PCI Bridge Design Award for the Best Rehabilitated Bridge.

The Bridge Department of Hamilton County, Ohio, is responsible for the inspection and maintenance of 521 bridges on the county road system—mainly in the greater Cincinnati area. The department strives to preserve historic structures whenever possible and has received three awards in "Recognition of Outstanding Efforts in the Rehabilitation of Historic Structures" from the Ohio Department of Transportation.

By state law, each bridge structure must be inspected annually. Bridges determined to be structurally or functionally obsolete are included in the Capital Improvement Plan for rehabilitation or replacement. This article describes the replacement of one of our bridges using high performance concrete (HPC).

As the Hamilton County Engineer's Office (HCE) anticipated replacement of the Zion Hill Bridge, which had a prestressed concrete box beam superstructure on older concrete and stone abutments, there were several considerations to be addressed. The goals for this project included improvement of the approach geometry, installation of a new water main on the superstructure, a bridge service life of 75 years, and a cost-effective structure.

Spread box beams provide an economical solution for the new Zion Hill Bridge.

The water main was located between, and protected by, the spread box beams.

To minimize stream disturbance and environmental impacts, the existing massive stone and concrete rear abutment would remain in place as a retaining wall.

Many county bridges in Ohio, including those in Hamilton County, use adjacent box beams with an asphalt wearing surface. For this project, adjacent box beams could not accommodate the deck overhang required to improve the roadway geometry. The HCE in conjunction with the engineering firm of Parsons Brinckerhoff, Inc. determined that a bridge using spread box beams (48 in. wide by 39 in. deep) with an 8-in.-thick cast-in-place reinforced concrete deck could be designed with a substantial deck overhang to flatten the curve at the rear abutment. The overhang varied from 2 ft near midspan to 7 ft close to the rear abutment. The HPC deck was made composite with the box beams.

The use of spread box beams, with a 7-ft 10-in. center-to-center spacing reduced the project cost by eliminating half the number of box beams needing to be fabricated and shipped to the jobsite. The 3-ft 10-in. clear span between the beams allowed the 16-in.-diameter water main plus insulation and casing to be placed between the box beams. In comparing the usual adjacent beam design to the spread beam design, it was determined that the costs of the reinforced concrete deck necessary with the spread beam design were less than the additional costs for the extra beams in the adjacent beam design.

The specifications for the box beams, supplied by Prestress Services Industries of Melbourne, Kentucky, included the use of silica fume in the concrete and epoxy-coated reinforcement. Inserts were installed in the sides of the beams for water main hangers and the concrete diaphragms. Inserts were also installed in the top edges of the beams to facilitate deck forming. Concrete compressive strengths at 1 day averaged 7400 psi, while preshipping strengths averaged 9100 psi for the four prestressed concrete box beams.

The specifications for the HPC in the deck included a maximum water-cementitious materials ratio of 0.40, maximum slump of 6 in., minimum compressive strength of 4500 psi at 28 days, silica fume admixture at 7 percent by weight of cement, Cortec MCI-2005NS migrating corrosion inhibitor, and 2 pcy polypropylene fibers with $^3/_4$-in. minimum length. The blending of aggregates for a uniform gradation was also required. The contractor—Tri-State Concrete Construction of Cincinnati, Ohio—and the concrete supplier—Harrison Concrete of Harrison, Ohio—were encouraged to minimize the cement content to help reduce the potential for plastic shrinkage cracks. Once the mix design was submitted by the supplier and approved by the bridge department, a test slab was completed to ensure the air content, compressive strength, and workability of the concrete mix.

Deck curing consisted of the application of a curing compound as soon as the finishing process was complete. A wet burlap cure with continuous soaking for 7 days was also required as soon as practical without marring the surface.

Hamilton County has been using HPC mix designs with great success. Approximately 90,000 ft^2 of reinforced concrete deck as part of 11 different bridge projects has been placed successfully with minimal or no deck cracking. Hamilton County believes that high quality concrete begins with a good mix design, which includes maximizing aggregate sizes by blending, protecting the reinforcing steel, and reducing water and paste in the mix. A dense and crack-free concrete slab is the goal. The use of chemical admixtures that compensate for reduced water content, fibers to control plastic shrinkage cracking, good curing practices, and sealers, where appropriate, all contribute to achieving a 75-year service life.

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