State Route 22 at Milepost 6.57, Guernsey County

General Description The High-Performance Concrete (HPC) structure is a single-span, prestressed concrete box-beam bridge composed of 12 side-by-side 1219-mm- (48-in-) wide by 1067-mm- (42-in-) deep beams topped with a non-composite asphalt wearing surface. The bridge is 14.6 m (48 ft) wide, with a single span measuring 35.2 m (115 ft-6 in) bearing to bearing. The abutments are stub-type on a single row of H-section steel piles. Construction was phased to eliminate a detour during the replacement of the existing 21-m (70-ft) single-span steel beam and concrete deck structure. The Ohio Department of Transportation (ODOT) conducted the project in cooperation with the University of Cincinnati.

Outline of HPC Features HPC was used in both the beams and the stub abutments. The prestressed concrete beams were designed based on a 41-MPa (6000-psi) release strength and a 69-MPa (10,000-psi) ultimate strength at 56 days. The box beams incorporated 15.2-mm (0.6-in) strands to achieve the most efficient use of HPC's higher strengths. The cast-in-place abutment concrete met a 55-MPa (8000-psi) design strength in 28 days. All concrete was required to have a rapid chloride permeability value of below 1000 at 56 days. Both concrete mixes incorporated the use of silica fume to obtain the required strength and durability requirements. The box beams also included a new shear-key location based on research sponsored by ODOT.

HIGH-PERFORMANCE CONCRETE

Concrete with enhanced durability and strength characteristics. Under the Strategic Highway Research Program (SHRP), more than 40 concrete and structural products were developed. To implement the new technology of using High-Performance Concrete (HPC), the Federal Highway Administration (FHWA) has a program underway to showcase bridges constructed with HPC. The objective is to advance the use of HPC to achieve economy of construction and long-term performance.

Box-Beam Mix	per m³	per yd³
Cement	501 kg	846 lb
Sand	549 kg	927 lb
Gravel #8	1051 kg	1773 lb
Micro-Silica	59 kg	100 lb
Water	155 kg	262 lb
Superplasticizer	8320 mL	215 oz
Air-Entraining Agent	810 mL	21 oz
Retarder	1080 mL	28 oz

Pretensioned Beams The prestressed concrete box beams were made using 15.2-mm (0.6-in) strands at 51-mm (2-in) center-to-center spacing. The box beams are 1219 mm (48 in) wide and 1067 mm (42 in) deep.

Instrumentation The box-beam concrete was tested for compressive strength, chloride permeability, tensile strength, creep, and shrinkage. The average compressive strength for the girders was about 75 MPa (11 ksi), the modulus of rupture was approximately 8.3 MPa (1200 psi), and the rapid chloride permeability was less than 500 coulombs. Shrinkage was about 1000 microstrain and the creep coefficient was 2.1 at 1 year.

The beams for the bridge were instrumented to allow evaluation of prestressing forces, development length, heat of hydration, shrinkage, prestress losses, and flexural strength. Additional evaluation was performed during erection,

temporary phased construction, truck load testing, and actual traffic testing. Data from the actual bridge members were compared to baseline values established from testing two full-size prestressed research beams. Results indicated that the cracking loads of the research beams were higher than that predicted by the American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications for Highway Bridges, but that the difference was attributable to the higher modulus of rupture of HPC. The research beams were loaded to 10 percent greater than the ultimate load predicted by the AASHTO Standard Specifications and they did not fail. Prestress losses were determined to be approximately 18 percent, consistent with the value calculated from the AASHTO Standard Specifications.

Live load tests of the actual bridge showed that the live load distribution was in reasonable agreement with that given by the AASHTO Standard Specifications. The live load deflections were very low (less than L/2000) and the traffic-induced vibrations were not excessive.

Construction The project's letting date was July 1997. The box beams for the bridge were constructed by Prestress Services of Melbourne (KY), who worked with the University of Cincinnati to develop the HPC research beams. Ohio/West Virginia Excavating was the general contractor and the ready-mixed HPC (for the abutments) was supplied by Caldwell Concrete. The project was completed in November 1998. The bridge is open to traffic and functioning well. The University of Cincinnati published a paper on revised beam testing techniques as a result. A High-Performance Concrete Bridge Showcase was held February 23-24, 1999 in Cincinnati, OH.

Benefits ODOT's normal replacement alternatives for this bridge site would be a three-span normal-concrete slab bridge, a single-span steel or prestressed normal-concrete I-beam with cast-in-place concrete deck, or a three-span non-composite prestressed normal-concrete box-beam bridge. The lowest cost would be the box beam, which was the original bridge type selected. Using HPC concrete and 15.2-mm (0.6-in) strands, the box beam's span range increased to offer ODOT a lowest cost single-span alternative by eliminating two substructure units that would be required for the current low-cost structure. In addition, the structure's life will be enhanced because of the durability benefits associated with HPC's low permeability. ■

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