Virginia Avenue Over the Clinch River, Richlands

General Description The initial Virginia Department of Transportation (VDOT) HPC program consisted of seven bridges to be built with HPC in the 1995-1997 construction seasons. The Richlands bridge was one of them and it consists of two 22.6-m (74-ft) spans with five American Association of State Highway and Transportation Officials (AASHTO) Type III prestressed concrete I-beams per span. The project was conducted by VDOT in cooperation with the Virginia Transportation Research Council.

Outline of HPC Features The HPC components had both compressive strength requirements and chloride permeability requirements based on the particular member's use in the structure. The requirements for all elements measured at 28 days were:

Element	Compressive Strength, MPa (psi)	Chloride Permeability, coulombs
Beam@Transfer	46 (6600)	
Beams	69 (10,000)	1500
Deck	34 (5000)	2500
Substructure	21 (3000)	3500

Pretensioned Beams Two AASHTO Type II prestressed concrete I-beams were fabricated to conduct research on the bond of 15.2-mm- (0.6-in-) diameter pretensioned strands and to develop concrete mixes and fabrication procedures. The beams, pretensioned with 15.2-mm- (0.6-in-) diameter strands at 51-mm (2-in) spacing, were used to determine the transfer and development lengths of the strands and were tested to failure. All beams failed in flexure at measured loads that exceeded the calculated ultimate load. Pull-out tests were also made on untensioned 15.2-mm- (0.6-in-) diameter strands embedded in a concrete block. The beams for the actual bridge were AASHTO Type III prestressed concrete I-beams, containing 15.2-mm- (0.6-in-) diameter strands at 51-mm (2-in) center-to-center spacing. The concrete mix for the beams is shown below:

I-Beam Mix	per m^3	per yd^3
Type I Cement	446 kg	752 lb
Silica Fume	45 kg	75 lb
Crushed Limestone (No. 7 Coarse Aggregate)	992 kg	1671 lb
Fine Aggregate	801 kg	1350 lb
Water	139 kg	235 lb
High-Range Water Reducer	7975 mL	207 fl oz
Air-Entraining Agent	255 mL	6.6 fl oz
Retarder	957-1148 mL	25-30 fl oz

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.

Substructure The substructure was built using normal concrete with the addition of the permeability requirement.

Deck The deck contained low-permeability concrete with a compressive strength that was 25 percent higher than that used in conventional concrete decks.

Deck Mix	per m^3	per yd^3
Type I Cement	332 kg	560 lb
Fly Ash	83 kg	140 lb
Crushed Limestone (No. 7 Coarse Aggregate)	1023 kg	1724 lb
Fine Aggregate	596 kg	1004 lb
Water	187 kg	315 lb
Air-Entraining Agent	189 mL	4.9 fl oz
Retarder	810 mL	21 fl oz

Concrete Evaluation The following properties were measured for the concrete in the beam and the deck:

- Slump
- Air Content
- Air-Void Spacing Factor (deck only)
- Concrete Temperature
- Compressive Strength at 28, 56, and 365 days (and at 1 day for the beams and at 7 days for the deck)
- Modulus of Elasticity
- Splitting Tensile Strength
- Freeze-Thaw Durability
- Chloride Permeability

Construction The contract was let in late 1996 and the bridge was opened to traffic in December 1997. The general contractor was Patrick Construction Co., Inc.; the precast/prestressed concrete fabricator was Ross Prestressed Concrete, Inc.; and the ready-mixed concrete supplier was McClure Concrete Co., Inc.

Benefits The original design called for seven AASHTO Type III prestressed concrete beams per span, using conventional concrete, and conventional prestressing strands. Because of the research program done as part of this bridge project, VDOT was able to change the design and produce a more economical structure. VDOT's new bridge design used the HPC mix, five beams instead of seven, and the larger diameter [15.2 mm (0.6 in)] prestressing strands at a 51-mm (2-in) spacing. The unit cost (total cost of the bridge divided by the area of the deck) of $\$657/m^2$ ($\$60/ft^2$) was lower than the average cost of $\$743/m^2$ ($\$69/ft^2$) for similar bridges let at that time by VDOT. ■

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