Virginia Route 33 Bridges
West Point, VA

Eltham Bridge

Lord Delaware Bridge

Two bridges were completed in 2007 carrying VA Route 33 across the Mattaponi and Pamunkey Rivers that run on each side of the town of West Point in eastern Virginia. Just below West Point, the two rivers join to form the well-known York River. Route 33 is one of the few major highways in the eastern part of the state, and traffic was being interrupted by the opening of the two old swing spans in the existing bridges and by rail traffic crossing the highway at grade. The next bridge across the York River is about 25 miles downstream at Yorktown, so this pair of bridges is a key river crossing for the citizens of coastal Virginia. The average daily traffic on the two bridges was about 15,000 each day in 2004, when the replacement of the existing bridges was begun.

On the east side of West Point, the 3,545 ft long Lord Delaware Bridge crosses the Mattaponi River and adjacent marshland with 28 spans. On the west side of town, the 5,354 ft long Eltham Bridge spans the Pamunkey River and adjacent marsh land and railroad tracks with a total of 49 spans. In both bridges, the main spans consist of two 880 ft long post-tensioned spliced girder units. Each of these units has spans of 200-240-240-200 ft, including end span, haunched pier and drop-in girder segments. The bridge over the Pamunkey River also included a 248 ft long steel girder double leaf bascule span. Both bridges carry two lanes of traffic with a shoulder in each direction, for a total out-to-out deck width of 70.3 ft.

Construction began in 2004 on the two bridges, both of which were designed by the firm of Parsons Brinckerhoff Quade and Douglass. The Lord Delaware Bridge was constructed by a joint venture of McLean Contracting, Inc and Bryant Contracting, Inc. Tidewater Skanska (now Skanska USA Civil Southeast, Inc.) built the Eltham Bridge. VDOT was represented during construction by the firm of Wilbur Smith Associates. The bridges were opened to traffic in 2006 and 2007, respectively.

Because of poor soil conditions at both sites, the bridges utilized high performance, lightweight concrete for the deck and pretensioned concrete girders for spans over 120 ft. For the Mattaponi River Bridge, 2,195 ft of the 3,454 ft long bridge was designed and constructed using lightweight concrete deck and girders; for the Pamunkey River Bridge, 2,169 ft of the 5,354 ft long bridge used lightweight concrete deck and girders. The use of lightweight concrete allowed for longer spans and reduced the foundation loads, which resulted in a more economical structure. Lightweight concrete was also used to fill the grid deck in the bascule span on the Pamunkey River Bridge, providing a solid and quiet riding surface and reducing the mechanical requirements for opening the span.

The specified minimum concrete compressive strength for the cast-in-place composite deck was 5,000 psi with a density of 120 pcf. The specified minimum concrete compressive strength for all girders was 8,000 psi with a density of 125 pcf. The designers also specified limiting values for the modulus of elasticity, creep, shrinkage and permeability for both the girder and deck concrete as shown in Table 1. The lightweight concrete was also subject to the VDOT standard permeability requirements of 1500 coulombs for the girders and 2500 coulombs for the deck. Researchers at the Virginia Transportation Research Council (VTRC) tested the materials used in the bridges and continue to monitor their behavior and performance.

Table 1: Requirements for Lightweight Concrete for VA Rte 33 bridges[1]

Type of Concrete	Design Compressive Strength (psi)	Creep Notional Coefficient	Shrinkage Notional Coefficient (microstrain)	Unit Weight (pcf)	Air Content (%)	Modulus of Elasticity (ksi)
PS Girders	8,000	4.2	450	125	4 ¨ö ¡¾ 1¨ö	3,400
Deck	5,000	3.5	550	120	5 ¨ö ¡¾ 1¨ö	2,700
Note: The values for unit weight include the weight of reinforcing and prestressing steel.						

The freeze-thaw resistance and air content for the lightweight and normal weight deck concretes were also tested for the Route 33 bridges. The test results are summarized in Table 2. The test results indicate satisfactory durability for both the normal weight and lightweight concretes, with the exception of one batch of normal weight concrete. The results show the lightweight concrete to have better freeze-thaw resistance than the normal weight concrete.

Table 2: Freeze-thaw and air content for the deck mixes used in teh Rte 33 Bridges[2]

Batch	Air Content (Fresh Conc.) (%)	Weight Loss (%)	Durability Factor	Surface Rating
Pamunkey NW B1	6.0	17.0	96	3.1
Pamunkey NW B2	7.0	26.7	70	1.8
Pamunkey NW B3	5.7	8.6	91	1.4
Mattaponi LW B1	7.0	6.6	102	1.5
Mattaponi LW B2	5.2	2.8	103	0.9
Pamunkey LW	5.7	6.1	107	1.0
NW=Normalweight, LW=Lightweight				
Acceptance limits at 300 cycles: Weight Loss ¡Â7; Duability Factor [3] 60; Surface Rating ¡Â3				

Specifications requirements and test results for the lightweight concrete deck for the Pamunkey River Bridge are shown in Table 3. The test results were obtained from the concrete supplier. The relatively consistent behavior of the test results over a 6 month period demonstrates that the concrete supplier could produce lightweight concrete with consistent properties.

The maximum permeability requirement, measured by the rapid chloride permeability test (RCPT), was achieved for all samples tested. This indicates that the lightweight concrete deck has the necessary concrete quality to resist penetration of chlorides into the concrete that could lead to initiation of corrosion of the reinforcing steel. From observation of the bridge decks at the west end of the Mattaponi River Bridge less than a year after the bridge was

opened to traffic, both the normal weight and lightweight concrete decks were essentially free from cracking, another critical measure of deck resistance to deterioration from corrosion.

Table 3: Deck Concrete Properties for Pamunkey River Bridge[3]

Compressive Strength at 28 days (psi)	
Specification requirement:	5,000
Average value: 59 samples	5,99
Permeability at 28 days (coulombs)	
Specification requirement:	2,500
Average value: 17 samples	989
Fresh Concrete Denisty (pcf)	
Specification requirements: Including weight of reinforcement	120
Range of values:	111.8 to 117.5

The deck received a textured finish at placement. Where necessary, the deck was ground to remove surface irregularities. Finally, the riding surface of the deck was grooved transversely prior to being opened to traffic. A typical photograph of the deck on the Mattaponi River Bridge is shown to the right. No difference in weathering or wear has been observed between the two types of concrete decks after the short period that the bridge has been open to traffic.

In November 2007, VDOT was recognized for the Lord Delaware Bridge replacement project by the The National Partnership for Highway Quality (NPHQ - a partnership of federal, state, and roadway industry leaders and officials that promotes highway quality, safety, and service to the highway user). The project was selected as the 2007 State Winner in its National Achievement Award. It was recognized that the project had successfully addressed a range of difficult environmental, transportation and construction issues. The innovative use of bulb-tee girders to allow longer spans and reduce the number of foundations was recognized as one of the key factors that contributed to the success of the project.

Information for this article was taken from a number of sources, including the VDOT website for West Point bridges, project plans and specifications, and the following papers:

1. Castrodale, R. W, and Harmon, K. S., ¡°Specifying Lightweight Concrete for Bridges,¡± Paper 147, Proceedings, 2008 Concrete Bridge Conference, St. Louis, MO, NCBC, May 4-7, 2008.

2. Ozyildirim, C., and Davis, R. T., ¡°Lightweight HPC Bulb-T Beams in the Mattaponi River Bridge,¡± Paper 37, Proceedings, 2005 National Bridge Conference, Palm Springs, CA, PCI, October 16-19, 2005.

3. Castrodale, R. W, and Robinson, G. M., ¡°Performance of Lightweight Concrete Bridge Decks,¡± Paper 75, Proceedings, 2008 Concrete Bridge Conference, St. Louis, MO, NCBC, May 4-7, 2008.

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