TECHBRIEF

High Performance Concrete Bridge Deck Investigation

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This document is a technical summary of the unpublished Federal Highway Administration report, *High Performance Concrete Bridge Deck Investigation,* available only through the National Technical Information Service (NTIS).

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Objective

This TechBrief provides a summary of an investigation that assessed the performance of high performance concrete (HPC) bridge decks.

HPC

HPC is a concrete designed to meet a performance specification. Many definitions of HPC have been proposed over the past 15–20 years; one to note is the definition proposed by Goodspeed and later expanded by Russell and Ozyildirim that offers a series of strength and durability-related performance characteristics.[1,2] It recommends that the desired performance of the concrete should be considered and that the performance characteristics should then be set accordingly. Example performance characteristics toward which concrete properties may be focused include chloride penetration, shrinkage, compressive strength, and freeze/thaw deterioration resistance.

Background

In 1993, the Federal Highway Administration (FHWA) initiated a national program to implement the use of HPC in bridges. The program included the construction of demonstration bridges throughout the United States.

As a result, State transportation departments started implementing HPC in their bridges. The construction of these

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bridges has provided researchers with a large amount of data on the use of HPC.

Information about the 18 bridges included in the FHWA program in addition to one bridge in Louisiana was compiled and reported.[3,4] A compact disc (CD) containing the compilation was prepared. The CD contained photographs and cross sectional drawings of the bridges, as well as details about the materials and methods used in construction. Elevation photos of two of these bridges are shown in figure 1 and figure 2.

Figure 1. Charenton Canal Bridge.

Investigation Process

After the bridges were in service for several years, the decks were assessed, and their performance was evaluated relative to the compiled data. The investigations into the performance of the decks included four specific tasks. First, all relevant information pertaining to the construction of the bridge deck was collected. This included items such as concrete mix design, construction practices during and after concrete placement, average daily traffic on the bridge, and maintenance performed. Second, each deck was inspected. This task included standard visual inspection practices, as well as the completion of a detailed crack assessment. Concrete cores were also acquired from select locations. Next, the collected information was evaluated to assess the performance of the decks. Last, the results were documented in individual reports pertaining to each deck. These individual reports can be found in the appendix of the corresponding main report. The 19 bridge decks investigated are listed in table 1.

Figure 2. Highway 199 over Uphapee Creek Bridge in Macon County, AL.

Table 1. Bridge decks investigated in this study.

State	Bridge Name	Location
Alabama	Highway 199	Highway 199 over Uphapee Creek in Macon County
Colorado	Yale Avenue	I-25 over Yale Avenue in Denver
Georgia	SR 920	SR 920 (Jonesboro Rd) over I-75
Louisiana	Charenton Canal	LA 87 over Charenton Canal in St. Mary Parish
Nebraska	120th Street	120th Street and Giles Road Bridge in Sarpy County
New Hampshire	Route 104	Route 104 over Newfound River in Bristol
New Hampshire	Route 3A	Route 3A over Newfound River in Bristol
New Mexico	Rio Puerco	I-40 Westbound Frontage Road over the Rio Puerco
North Carolina	U.S. 401	Northbound U.S. 401 over Neuse River in Wake County
Ohio	U.S. Route 22	U.S. Route 22 over Crooked Creek near Cambridge
South Dakota	I-29 North	I-29 Northbound over Railroad in Minnehana County
South Dakota	I-29 South	I-29 Southbound over Railroad in Minnehana County
Tennessee	Porter Road	Porter Road over State Route 840 in Dickson County
Tennessee	Hickman Road	Hickman Road over State Route 840 in Dickson County
Texas	Louetta Road	Louetta Road Overpass, SH 249 in Houston
Texas	San Angelo	U.S. Route 67 over North Conch River, U.S. Route 87, and South Orient Railroad in San Angelo
Virginia	Route 40	Route 40 over Falling River in Brookneal
Virginia	Virginia Avenue	Virginia Avenue over Clinch River in Richlands
Washington	State Route 18	Eastbound lanes of SR 18 over SR 516

Results

This investigation demonstrated that HPC bridge decks can be constructed to perform well, and they exhibit relatively few cracks after multiple years of service. The investigation did not identify any significant spalling or delamination in any of the decks.

Recommendations

From the data obtained from this study, recommendations on basic concrete mix design parameters have been proposed. Less cracking is anticipated to occur in concrete bridge decks constructed with water-to-cementitious material ratios between 0.35 and 0.40 and cementitious material content between 600 and 700 lb/yd^3 (356 and 415 kg/m^3). Mixes meeting these recommendations are anticipated to possess low to moderate ranges of rapid chloride permeability. Application of appropriate construction practices is also recommended.

References

1. Goodspeed, C.H., Vaniker, S., and Cook, R.A. (1996). "High-Performance Concrete Defined for Highway Structures," *Concrete International, 18*(2), 62–67.
2. Russell, H.G. and Ozyildirim, H.C. (2006). "Revising High-Performance Concrete Classifications," *Concrete International, 144,* 43–49.
3. Russell, H.G., Miller, R.A., Ozyildirim, H.C., and Tadros, M.K. (2006). *Compilation and Evaluation of Results from High-Performance Concrete Bridge Projects, Volume I: Final Report,* FHWA-HRT-05-056, 178, Federal Highway Administration, McLean, VA.
4. Russell, H.G., Miller, R.A., Ozyildirim, H.C., and Tadros, M.K. (2006). *Compilation and Evaluation of Results from High-Performance Concrete Bridge Projects, Volume II: Appendixes,* FHWA-HRT-05-057, 303, Federal Highway Administration, McLean, VA.

Researchers—The technical contract oversight was provided by Ben Graybeal who is the Structural Concrete Research Program Manager at the Federal Highway Administration's (FHWA) Turner-Fairbank Highway Research Center. Additional information can be obtained by contacting him at 202-493-3122 or in the FHWA Office of Infrastructure Research and Development located at 6300 Georgetown Pike, McLean, VA, 22101.

Distribution—The unpublished report (PB2009-115497) covered in this TechBrief is being distributed through the National Technical Information Service, www.ntis.gov.

Availability—The report will be available in November 2009, and it can be obtained from the National Technical Information Service, www.ntis.gov.

Key Words—Bridge, Cast-in-place concrete, Cementitious material content, Crack density, Deck, Durability, High-performance concrete, HPC, Precast concrete, Prestressed concrete, and Water-to-cementitious material ratio.

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