

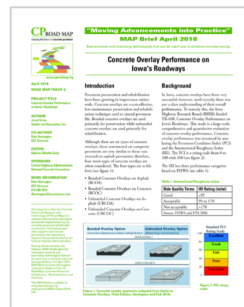
# National Concrete Consortium (NCC) E-News April 2018

***In association with the CP Road Map Program***

The **NCC E-News** is the newsletter of the Long-Term Plan for Concrete Pavement Research and Technology (CP Road Map), a national research plan developed and jointly implemented by the concrete pavement stakeholder community. To find out more about the CP Road Map or to get involved, contact Steve Klocke or Dale Harrington (515-964-2020).

## Moving Advancements into Practice (MAP) Brief

Moving Advancements into Practice (MAP) Briefs describe promising research and technologies that can be used now to enhance concrete paving practices.




The April 2018 MAP Brief, *Concrete Overlay Performance on Iowa's Roadways - 2017*, provides a summary of the research completed in July 2017 on the performance of concrete overlays in Iowa. Approximately 1,500 miles of concrete overlays constructed over the last 40 years in Iowa were reviewed for performance using Pavement Condition Index (PCI) and International Roughness Index (IRI).

**Download the April 2018 MAP Brief.**

## News from the Road

News from the Road highlights research around the country that is helping the concrete pavement community meet the research objectives outlined in the CP Road Map.

### Development of Non-Proprietary Ultra High Performance Concrete

Ultra High Performance Concrete (UHPC) has mechanical and durability properties that far exceed those of conventional concrete. Specifically, UHPC has compressive and post-cracking tensile strengths of around 20 ksi and 0.72 ksi, respectively. Thus, elements made with UHPC are thinner/lighter than elements made with conventional concrete. The enhanced durability properties of UHPC also allow for longer service lives and decreased maintenance costs. However, using UHPC in conventional concrete applications has been cost prohibitive, with commercially available/proprietary mixes costing over 20 times more than conventional concrete mixes.

*Workers pouring UHPC*

The overall objective of this research was to develop and characterize economical non-proprietary UHPC mixes made with materials readily available in Montana. This objective was achieved by first identifying and obtaining suitable, economical materials to be used in UHPC. Specifically, the materials identified and used in this research were Type I/II portland cement, class F fly ash, fine masonry sand, silica fume, and high-range water reducer. UHPC mixes were then developed, characterized, and optimized by using a statistical experimental design procedure (response surface methodology). An optimal mix that provided desired workability and strength was selected for further evaluation through a suite of mechanical and durability tests. The mixes developed as part of this research obtained compressive strengths of approximately 20 ksi with flows of 8-11 inches. The mechanical properties tested in this research were compressive and tensile strength, elastic modulus, and shrinkage. Durability tests included alkali-silica reactivity, absorption, abrasion, chloride permeability, freeze thaw resistance, and scaling.

This project was sponsored by the Montana Department of Transportation, in cooperation with FHWA, and was completed by the Civil Engineering Department, Western Transportation Institute, Montana State University: Michael Berry, PhD Associate Professor; Richard Snidarich, Graduate Research Assistant; and Camylle Wood, Graduate Research Assistant. Click here to access the full document.

This project is contributing to objectives identified in CP Road Map Track 1: Materials and Mixes for Concrete Pavements.

## Field Testing of an Ultra-High Performance Concrete Overlay on Bridge Decks

*Workers pouring UHPC on a bridge deck*

Bridge decks are commonly rehabilitated using overlays, depending on the cause of deck deterioration, available budget, and desired service life of the rehabilitated structure. One emerging solution for bridge deck rehabilitation is thin, bonded, ultra-high performance concrete (UHPC) overlays. As an overlay material, UHPC can provide both structural strength and protection from ingress of contaminates using a 1 inch to 2 inch layer of material.

The first U.S. deployment of UHPC as a bridge deck overlay was completed in May 2016 on a reinforced concrete slab bridge located in Brandon, Iowa. A few months after installing the UHPC overlay, a field inspection of the bridge identified some locations along the deck where delamination may have occurred. To address this concern, a field study was conducted in November 2016 to evaluate the bond between the UHPC overlay and the substrate concrete bridge deck. Researchers from the Federal Highway Administration's (FHWA) Turner-Fairbank Highway Research Center (TFHRC) synthesized photographic evidence, conducted a field inspection of the bridge deck surface using a chain drag, and conducted physical testing of the UHPC-concrete interface bond using the direct tension bond pull-off test. Tested samples were taken back to TFHRC, and the UHPC-concrete interface was subsequently analyzed using scanning electron microscopy (SEM). The pull-off test data indicated that the UHPC overlay and the existing concrete bridge deck were intact, which was confirmed by SEM analysis.

This project was sponsored by the Office of Infrastructure Research & Development, Federal Highway Administration, with the document content prepared by Zachary Haber of Genex Systems, LLC, and Jose F. Munoz of SES Group and Associates, LLC, and Benjamin A. Graybeal. Click here to access the full document.

This project is contributing to objectives identified in CP Road Map Track 6: Concrete Pavement Construction, Reconstruction, and Overlays.

## Low Cracking Concretes for the Closure Pours and Overlays of the Dunlap Creek Bridge

Joints, wide cracks, and poor-quality concretes facilitate the intrusion of chlorides, causing corrosion in bridge decks and substructures. In this study, two parallel bridges located on Route 64 over Dunlap Creek in Alleghany County, Virginia, each with five simple spans, were selected for study. Joints were replaced with closure pours (link slabs) consisting of low permeability fiber-reinforced concretes resistant to wide cracking; overlays consisted of concretes with a low cracking potential and low permeability. Closure pours and overlay concretes had portland cement and a supplementary cementitious material for low permeability. Three different fibers, polyvinyl alcohol, polypropylene, and steel, were used in the closure pours; a compressive strength of 3,000 psi at 24 hours was sought. Latex-modified concrete with Rapid Set cement, but without fibers, was also included since it is commonly used in closure pours. In the overlays, five different materials were used: (1) latex-modified concrete with Rapid Set cement, (2) silica fume concrete (SFC) alone, (3) SFC with shrinkage reducing admixture, (4) SFC with lightweight coarse aggregate, and (5) SFC with lightweight fine aggregate. A compressive strength of 3,000 psi at 3 days was sought.

*Concrete being placed on Dunlap Creek Bridge*

The performance of the closure pours and overlay concretes was observed after two to three winters. Fiber-reinforced concretes with the desired strength and low permeability were achieved in the closure pours. The surveys indicated mostly tight cracks (<0.1 mm [0.004 in] in width) that would resist penetration of solutions. The overlays also achieved the specified strength and low permeability.

There were minimal tight cracks except in one section with the latex-modified concrete with Rapid Set cement in the left lane of the westbound bridge. There were extensive cracks in that section that were attributed to plastic shrinkage from adverse weather conditions at placement and the fact that a truck had caught fire in that lane.

The study recommends that fiber-reinforced concretes be used when early strengths are needed. Further experimental installations with different fibers would indicate the optimum type and amounts for crack control. SFC overlays with shrinkage reducing admixture, with lightweight coarse aggregate, or with lightweight fine aggregate are ready for implementation in the field.

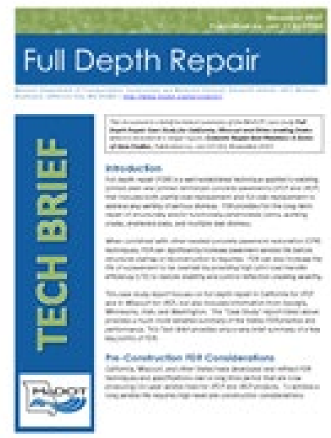
This project was sponsored by the Virginia Department of Transportation in cooperation with FHWA, and was completed by the Virginia Transportation Research Council by Celik Ozyildirim, Ph.D., P.E., and Harikrishnan Nair, Ph.D., P.E. Click here to access the full document.

This project is contributing to objectives identified in CP Road Map Track 6: Concrete Pavement Construction, Reconstruction, and Overlays.

## Case Study Report on Full-Depth Repair

Full-depth repair (FDR) is a well-established technique applied to existing jointed plain and jointed reinforced concrete pavements (JPCP and JRCP) that includes both partial slab replacement and full slab replacement to address any variety of serious distress. FDR provides for the long-term repair of structurally and/or functionally deteriorated joints, working cracks, shattered slabs, and multiple slab distress. When combined with other needed concrete pavement restoration (CPR) techniques, FDR can significantly increase pavement service life before structural overlay or reconstruction is required. FDR can also increase the life of a pavement to be overlaid by providing high joint load transfer efficiency (LTE) to restore stability and control reflection cracking severity.

This case study was completed by the Missouri Department of Transportation Construction and Materials Division, Research Section and in conjunction with FHWA. The case study report focuses on full depth repair in California for JPCP and in Missouri for JRCP, but also includes information from Georgia, Minnesota, Utah, and Washington. Click here to access the [Case Study Tech Brief](#).




*Case study report on full-depth repair*

The full document is a larger report, Concrete Repair Best Practices: A Series of Case Studies, Publication no. cmr 17-013, November 2017. The project was sponsored by the Missouri Department of Transportation (SPR) Construction and Materials Division, in cooperation with FHWA and was written by Michael Darter, Ph.D., P.Eng., Applied Research Associates, Inc. [Click here to access the full document](#).

This research is contributing to objectives identified in CP Road Map [Track 7: Concrete Pavement Maintenance and Preservation](#).

## Concrete Strength Required to Open to Traffic

The current empirical methods for determining traffic-opening criteria can be overly conservative, causing unnecessary construction delays and user costs. The research described here recommends innovative mechanistic-based procedures for monitoring concrete early-age development and evaluating the effect of early traffic opening on long-term damage accumulation. The procedure utilizes recent developments in nondestructive testing to optimize traffic opening timing without jeopardizing pavement longevity. These tasks were achieved via extensive field and laboratory experiments, allowing for the analysis of variables such as curing condition and loading type with respect to the effect of early loading of concrete.

The results of the laboratory and field tests were used to develop a procedure for determining an appropriate timing of subjecting the pavement to wheel loading without causing significant damage. The deliverable for this task is a software program that analyzes the effect of design and opening time decisions on pavement damage. Different criteria are applied for different loading types and roadway design type. This procedure is based upon the maturity and/or shear wave velocity measurements in conjunction with concrete strength and elastic modulus curves, representing in-situ real-time pavement properties. The end result of the software program is a damage ratio that quantifies the damage that results from the opening inputs selected. This tool can be implemented by transportation agencies for optimal timing of traffic opening, making more informed decisions.

This project was sponsored by the Minnesota Department of Transportation and was completed by the Department of Civil, Environmental, and Geo- Engineering, University of Minnesota, by Katelyn Freeseman, Kyle Hoegh, Lev Khazanovich. [Click here to access the full document](#).

To request this document in an alternative format call 651-366-4718 or 1-800-657-3774 (Greater Minnesota) or email your request to [ADArequest.dot@state.mn.us](#). Please request at least one week in advance.

This research is contributing to objectives identified in CP Road Map [Track 2: Track 2: Performance-Based Design Guide for New and Rehabilitated Concrete Pavements](#).

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