National Concrete Consortium (NCC) E-News September 2019

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 Dale Harrington (515-290-4014).

Moving Advancements into Practice (MAP) Brief


"Moving Advancements into Practice"
MAP Brief September 2019
Overview of the *Guide for Concrete Pavement Distress Assessments and Solutions*

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

The September 2019 MAP brief, Overview of the *Guide for Concrete Pavement Distress Assessments and Solutions*, provides a summary of concrete pavement distress, why the guide was developed, organization and scope of the guide, who the guide was developed for, and how to use the guide.

Download the September 2019 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. The research projects and the summaries described herein are the products of the researchers and sponsors.

Durability of Latex-Modified Concrete Mixed with a Shrinkage Reducing Agent for Bridge Deck Pavement (report date: February 2018)

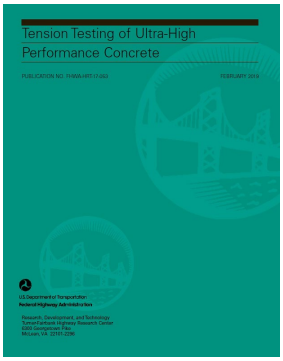
Latex modified concrete (LMC) is used for a bridge deck pavement method introduced in Korea in the 2000s. Currently, it is the concrete pavement method being used for most highway bridges. It has been recommended that mixing with approximately 15% latex, in terms of polymer-cement ratio (P/C ratio), by weight showed no occurrence of cracks with sufficient tensile strength and bond strength of LMC. However, many cracks occur in the actual field, mostly due to drying shrinkage of concrete, requiring frequent repair. Therefore, this study examined the feasibility of applying a shrinkage reducing agent (SRA) that could reduce plastic shrinkage cracks at early age as well as drying shrinkage cracks of LMC. Based on the test results, it was confirmed that adding a shrinkage reducing agent could secure the durability without affecting the fresh and hardened properties of LMC. The compression strength test results presented a 1.7% to 5.7% improvement in strength to the SRA mixture compared to the plain mixture. Length-change test results indicated that SRA mix conditions

presented more outstanding performance compared to mix conditions with the expansive admixture. The amount of shrinkage reducing agent suitable for achieving performance requirements in length change, crack resistance, chloride ion penetration resistance, and scaling resistance was evaluated as 3% by weight ratio of binding material under the limited conditions of the present study.

This report was written by Byung Jae Lee and Yun Yong Kim and was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Science, ICT & Future Planning (No. 2015R1A5A1037548). 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.

Tension Testing of Ultra-High Performance Concrete (report date: February 2019)

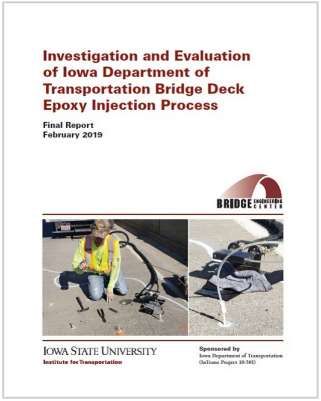


Ultra-high-performance concrete (UHPC) is a class of cementitious composite materials designed to exhibit exceptional mechanical and durability properties, including sustained post-cracking tensile strength. Laboratory tests of structural elements have clearly indicated that UHPC components can exhibit tensile mechanical properties far in excess of those expected from conventional or fiber-reinforced concretes. This study developed a material scale direct-tension test applicable to UHPC that relates the full range of uniaxial tensile behaviors through strain localization and can be completed on cast or extracted specimens. In order to demonstrate applicability, the test method was carried out in parallel with other UHPC tension test methods. This research model allowed for both development of a practical test method along with direct determination of the tensile mechanical properties of two commercially available UHPC-class materials.

The report was written by Benjamin A. Graybeal and Florent Baby. This research project was led by the Federal Highway Administration (FHWA). The French Roads and Bridges Research Agency partnered with FHWA on the planning and execution of the project. 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.

Investigation and Evaluation of Iowa Department of Transportation Bridge Deck Epoxy Injection Process (report date: February 2019)



Since the 1970s, the Iowa Department of Transportation (DOT) has used concrete overlays as a means of restoring its bridge decks and, as a result, the service life of the deck is commonly extended many years. This procedure has proven to be both effective and economically attractive.

Despite that, concrete overlays cannot be considered a permanent repair as they are subject to harsh conditions, similar to the original bridge decks. As time passes, the overlays often become delaminated from the original deck at or near the bond interface, leading to cracking and the intrusion of water and chloride ions, which accelerate the deterioration. A preservation solution involving the injection of epoxy resin into the cracks and voids has been developed and this solution has been implemented with success across Iowa. Even so, the length of additional service life and the most effective methods and materials of injection remain unknown.

The problem is two-fold. First, a better prediction of typical expected service life must be determined to best plan for additional repair or replacement. This requires a study of both previously and newly injected bridges to identify the effectiveness and durability of epoxy injection of delaminated bridge decks. Second, the seasonal constraints imposed on the injection process, coupled with the work load of Iowa DOT maintenance

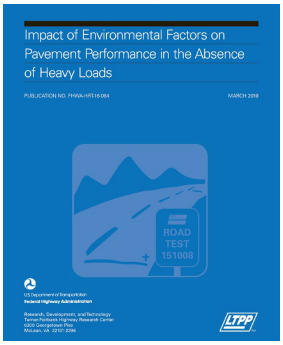
personnel, create a logistical problem; quite simply, there is more work to be completed than can be effectively accomplished in the available time.

A specification detailing the proper materials, equipment, and procedures was developed to enable others to perform the work. Both a field investigation and a thorough review of industry advances and practices were used to develop the specification.

This report was written by Terry J. Wipf, Brent Phares, Justin M. Dahlberg, and Ping Lu. The research was sponsored by the Iowa Department of Transportation and conducted by the Bridge Engineering Center, Institute for Transportation, Iowa State University. Click here to access the full document.

This project is contributing to objectives identified in CP Road Map Track 8: Construction, Reconstruction, and Overlays.

Impact of Environmental Factors on Pavement Performance in the Absence of Heavy Loads (report date: March 2019)



The objectives of this study were to identify and quantify the effects of environmental factors and pavement design on pavement performance in the absence of heavy loads; establish what the environmental effects are and develop recommendations for mitigating these effects through effective designs, materials selection, and construction; estimate the portion of total pavement damage caused by environmental factors; and establish a database of pavement design features, materials properties, and performance to be used in the future for similar analyses.

Site-by-site analyses of the Long-Term Pavement Performance program's Specific Pavement Study (SPS)-8 sections were conducted. Next, researchers determined the effect of environmental factors in SPS-8 and companion sections from other SPSs and General Pavement Studies (GPSs) on the performance of flexible and rigid pavements. Finally, an estimate of the portion of pavement damage caused by environmental factors was made through a comparison of the pavement damage of low-traffic SPS-8 sections with higher-traffic companion SPS and GPS sections.

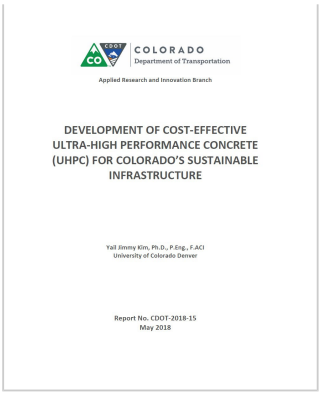
Results showed an average of 36% and 24% of total damage was related to environmental factors for flexible and rigid pavements, respectively, at an age of 15 years. In addition, many results were obtained through an analysis of the performances of SPS-8 and companion SPS and GPS sections. One such finding was that the occurrence of transverse cracking of asphalt-concrete pavement was significantly higher for companion pavements subjected to higher traffic loadings (SPS-1 and GPS-1) than under low-traffic loadings (SPS-8). Transverse cracking also occurred in non-freeze climates. Based on the results from this study, suggestions for improvements to pavement designs and materials to minimize distress and to maximize performance in various climatic regions are presented.

This report was written by Leslie Titus-Glover, Michael I. Darter, and Harold Von Quintus. This research was sponsored by the Office of Infrastructure Research and Development, Federal Highway Administration. The Performing Organization was Applied Research Associates, Inc. Click here to access the full document.

This project is contributing to objectives identified in CP Road Map Track 8: Construction, Reconstruction, and Overlays.

Development of Cost-Effective Ultra-High Performance Concrete (UHPC) for Colorado's Sustainable Infrastructure (report date: May 2018)

This report presents the development of ultra-high performance concrete (UHPC) using locally available materials, which reduce construction costs when compared to commercial products. A UHPC mixture was formulated with the aim of achieving a specified compressive strength of 20 ksi. The report examines implications of various constituent types with an emphasis on silica compounds (silica fume, silica powder, silica sand, finer silica sand, pyrogenic



silica, and precipitated silica), including steel and polypropylene fibers.

Bond tests were conducted to evaluate the development length of the UHPC. Cost analysis shows that the prototype UHPC is up to 74% less expensive than commercial products. The distribution of granular particles is characterized by digital microscopy alongside an image processing technique. Benchmark tests employing the nine mixtures clarify that silica sand and finer silica sand perform better than silica powder from strength perspectives, and the inclusion of steel fibers rather than polypropylene fibers is recommended. High-range water reducers (HRWR) or plasticizers marginally affect the strength of the UHPC. Although heat curing increases concrete strength, the prototype UHPC is designed with conventional moisture curing because of practicality in the field. The workability of the UHPC at a water-cement ratio of w/c = 0.22 is satisfactory with a slump of 8 in. The steel fibers increase the flexural capacity of the UHPC more than 60% relative to the UHPC mixed without fibers and result in a gradual failure mode. The bulk density of silica fume influences the strength gain of the UHPC at seven days, beyond which its effect becomes insignificant. The use of pyrogenic silica and precipitated silica is not suggested.

The applicability of the modulus of rupture equations specified in published specifications and codes is assessed, and new equations are proposed for the developed UHPC mixture using randomly generated statistical data. According to bond tests, the development length of the UHPC is shorter than the requirement of the American Association of State Highway Transportation Officials (AASHTO) Load and Resistance Factor Design (LRFD) Bridge Design Specifications.

A step-by-step procedure is recommended in tandem with quality assurance and quality control for CDOT to implement the UHPC technology in bridge construction.

This report was written by Yail Jimmy Kim. This research was sponsored by Colorado DOT, and performed by the University of Colorado Denver. 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.

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