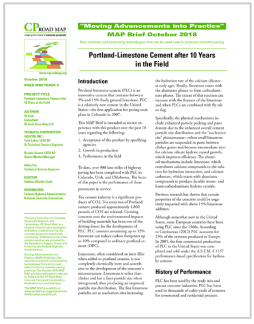
National Concrete Consortium (NCC) E-News October 2018

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 Dale Harrington (515-290-4014).

Moving Advancements into Practice (MAP) Brief


"Moving Advancements into Practice"
MAP Brief October 2018
Portland-Limestone Cement after 10 Years in the Field
Introduction
History of Performance

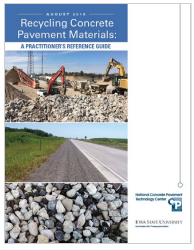
Moving Advancements into Practice (MAP) Briefs describe promising research and technologies that can be used now to enhance concrete paving practices.

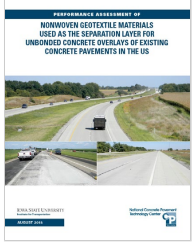
The October 2018 MAP Brief, *Portland-Limestone Cement after 10 Years in the Field*, provides a summary of the benefits, history of performance, differences and similarities with ordinary cement, acceptance by specifying agencies, and case studies.

Download the October 2018 MAP Brief.

Latest CP Tech Center Publications - Three New Concrete Guides for Users

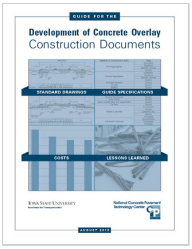
Three new manuals covering different aspects of concrete practices are now available from the National CP Tech Center. These publications are for use by industry professionals interested in the latest information on recycling of aggregates, geotextile use in pavements, and constructing concrete overlays. All three reference works can now be accessed from the CP Tech Center web page.


Recycling Concrete Pavement Materials:
A PRACTITIONER'S REFERENCE GUIDE


PERFORMANCE ASSESSMENT OF
NONWOVEN GEOTEXTILE MATERIALS USED AS THE SEPARATION LAYER FOR UNBONDED CONCRETE OVERLAYS OF EXISTING CONCRETE PAVEMENTS IN THE US

1. **Recycling Concrete Pavement Materials: A Practitioner's Reference Guide**. This guide helps practitioners determine: (1) if RCA is the right material fit for the project; (2) which applications are most efficient in their situation; and, (3) how to manage specifications and field inspections. The guide can be viewed here.
2. **Performance Assessment of Nonwoven Geotextile Materials Used as the Separation Layer for Unbonded Concrete Overlays of Existing Concrete Pavements in the United States**. The use of geotextiles in concrete projects has been increasing in recent years. Their effectiveness as interlayers has been investigated, and they are being employed for pavement rehabilitation and construction efforts. This manual provides an in-depth summary of the performance, construction details, and ongoing optimization of nonwoven geotextile separation layers in paving projects. To view the new report, click here.
3. **Guide for the Development of Concrete Overlay Construction Documents**.

This guide assembles design detail drawings to enhance the successful use of concrete overlays in the field. The report includes examples of construction drawings and helpful information on specification, cost, and design of overlays. To view the new guide, click here.



NCC State Survey

Member states of the National Concrete Consortium (NCC) have the ability to poll other member states regarding specifications, materials, construction, research, or other issues related to concrete paving.

The following table highlights the responses of some of the state DOTs on certain concrete pavement test frequencies as received through NCC and as provided by Maria Masten, P.E., MnDOT, Chairperson NC2, September 21, 2018.

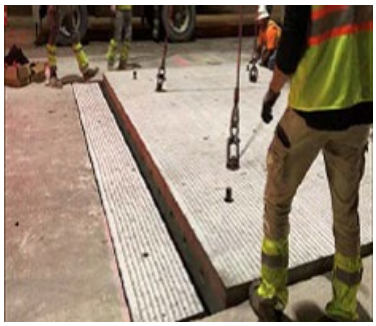
	Plastic Air Content		Slump		Compressive Strength	
	Agency	Contractor	Agency	Contractor	Agency	Contractor
AL	1 per 528 ft	1 per 100 cy	1 per 528 ft	1 per 100 cy	1 per 528 ft	-
CA	1 per day	1 per hour	-	kellyball 1 per 4 hours	-	-
CO	1 per 5,000 sy	1 per 2,500 sy	1 per 5,000 sy	1 per 2,500 sy	1 per 5,000 sy	1 per 10,000 sy
FL	1 per 2,000 sy	1 per 2,000 sy	1 per 2,000 sy	1 per 2,000 sy	1 per 2,000 sy	1 per 2,000 sy
GA	with cylinders	3 per day min	with cylinders	3 per day min	3 sets of 4 per 5,334 sy	-
IA	1 per 700 cy	1 per 250 cy (typ 100 cy)	-	-	-	-
ID	1 per 300 cy	-	1 per 300 cy	-	3 sets/day	-
IL & IL Toll	split 1st 3 QC then minimum 20% of QC	1 per 100 cy, min. 1/day	split 1st 3 QC then minimum 20% of QC	1 per 500 cy, min. 1/day	split 1st 3 QC then minimum 20% of QC	1 per 1,250 cy
KS	1 per day	1 per 500 cy or 2 hr or 4 hr	1 per day	1 per 500 cy	1 set of 3 per week for open-ing	1 set of 3 per opening
LA	1 per 1/2 day	2 per 1/2 day	1 per 1/2 day	2 per 1/2 day	5 cores/lot	

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.

Precast Concrete Panels for Rapid Full-Depth Repair of CRC Pavement to Maintain Continuity of Longitudinal Reinforcement (report date: July 2018)

This Tech Brief describes a recently implemented method for rapid overnight full-depth repairs of continuously reinforced concrete (CRC) pavements using precast concrete panels. This method, developed by the Illinois Tollway, uses continuous longitudinal reinforcement throughout the repair area to make the method applicable for repairing multiple lanes or large areas, as well as for isolated repairs for long-term performance with minimal impact to traffic. The Illinois Tollway successfully utilized this



method for a high traffic-volume expressway in the Chicago metropolitan area.

This project was sponsored by the Illinois Tollway and Federal Highway Administration. The report was authored by Steve Gillen, Horner & Shifrin, Inc., Dan Gancarz, P.E., and Shiraz Tayabji, Ph.D., P.E. Click here to access the full document.

This project is contributing to objectives identified in CP Road Map Track 7: Maintenance and Preservation.

Early-Age Fiber-Reinforced Concrete Properties for Overlays (report date: June 2018)

Fiber-reinforced concrete (FRC) has been used for concrete pavement overlays for a few decades. It is well documented that it improves performance over unreinforced plain concrete in regards to crack initiation and crack propagation. When selecting an appropriate fiber-reinforced concrete for the design of thin overlays, the flexural residual strength is the primary design criteria used. Other material parameters, such as slump, unit weight, air content, compressive strength, shrinkage, and coefficient of thermal expansion, are also commonly measured to determine consistency between mixtures and to be used in design software as the baseline material properties.

One major challenge with the FRC industry and use in pavements is that the test does not specify at what age these tests should be performed. It was hypothesized that the FRC properties change with age and that not having a specified age for the test to be performed would result in variable performance in the field. This research project measured four types of fibers mixed into the same basic matrix and tested fresh and hardened properties used in the field and in designs for FRC from age three to 90 days. The results indicated that the age of testing does influence most material properties. The design-specified flexural strength test for FRC was found to give statistically significant different material properties when tested for the same mixture at different ages. For consistency in future use of FRC for overlay pavements, it was recommended that a specified age be made. For practical purposes, the authors currently recommend an age of 28 days.

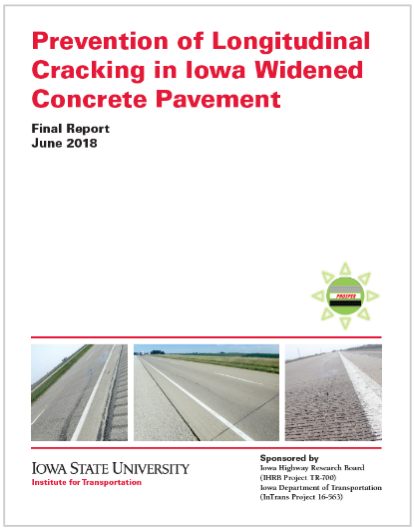
This study aims to investigate the age-dependent changes in flexural and fracture properties of FRCs used in the design of thin overlay pavements. Four different types of steel or polypropylene macro-fibers with different dimensions and different fiber volume contents (0%, 0.5%, and 1.0%) were selected and investigated. No significant changes in compressive strength, free drying shrinkage, coefficient of thermal expansion, and modulus of rupture versus age were identified. Steel FRCs were observed to have a constant or increased residual strength as a function of age while different types or contents of polypropylene FRCs showed varied trends in residual strength versus age. Fracture energy for all FRCs was observed to increase versus age. The residual strength ratio for all FRCs decreased as a function of age, but with only two replicates per age and FRC type, and values were highly variable so no trends were statistically verified. A standard test age, 28 days, is recommended due to the changing residual strength ratio parameter used in thin FRC overlay design.

This project was sponsored by Mountain-Plains Consortium Project 492, University of Utah Department of

Civil Engineering, and Utah Department of Transportation. The study was authored by Min Ook Kim, Ph.D. and Amanda Christine Bordelon, Ph.D., P.E. Click here to access the full document.

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

Prevention of Longitudinal Cracking in Iowa Widened Concrete Pavement (report date: June 2018)



Iowa has adopted 14-ft widened concrete slabs (as opposed to the standard 12-ft concrete slabs) in jointed plain concrete pavement (JPCP) design and construction since the 1990s. The additional 2-ft slab paved beyond the normal traffic path is intended to reduce stresses and deflections at the critical concrete pavement edge location by effectively moving the normal traffic path well away from the edge. However, many widened concrete pavements are now approaching 20 years of service life, and some 14-ft widened concrete pavements are experiencing sudden and significant amounts of longitudinal cracking.

To understand the causative factors contributing to longitudinal cracking in widened JPCP and to provide recommendations for preventing its occurrence, field investigations were performed at 12 sites in spring and summer 2017. These sites included widened JPCPs of various ages, shoulder types, mix design aspects, environmental conditions during construction, and traffic levels. The location and extent of existing longitudinal cracking, including transverse cracking, were well documented. The amount and severity of cracks were linked to traffic level and shoulder type. Concrete cores were also examined to better understand how the cracking had developed. It was found that the 14-ft widened slabs with tied PCC shoulders outperformed the others in terms of producing less cracking, even though they had experienced higher levels of truck traffic.

Widened slabs with granular shoulders were the worst performers, producing higher cracking compared to others. ISLAB 2005 and EverFE 2.25 finite element analysis (FEA) programs were also utilized to demonstrate through numerical analysis the potential of top-down longitudinal cracking for widened JPCP. Transverse joints and wheel paths were found to be critical locations for longitudinal cracking. Widened slabs with skewed joints were also found to have higher potential for longitudinal cracking. Shoulder design alternatives used in Iowa were compared for their effect on longitudinal cracking when they were used adjacent to widened and regular-sized slabs.

This project was sponsored by the Iowa Highway Research Board (IHRB) and written by Halil Ceylan, Sunghwan Kim, Yang Zhang, Shuo Yang, Orhan Kaya, Kasthurirangan Gopalakrishnan, and Peter Taylor. Click here to access the full document.

This project is contributing to objectives identified in CP Road Map Track 6: Joint Design, Materials, and Construction.

Seasonal Variations and In Situ Assessment of Concrete Pavement Foundation Mechanistic Properties (report date: September 2017)

In cold climates, pavement surface and foundation layers are subjected to seasonal temperature variation and freeze-thaw cycles. The number and duration of freeze-thaw cycles in the foundation layers can significantly influence the pavement performance. Seasonal variation in foundation layers is accounted for in pavement design by empirically adjusting the foundation layer moduli values. This paper presents results from in situ falling weight deflectometer (FWD) and dynamic cone penetrometer (DCP) tests conducted over a two-year period at five sites in Iowa; at one of

these sites, temperatures of the foundation layers were continuously monitored during the testing period. FWD testing was conducted to determine the modulus of subgrade reaction (k) values. DCP testing was conducted to estimate California bearing ratio (CBR) values of the subbase and subgrade. Temperature data were analyzed to determine freezing and thawing periods and frost penetrations. Seasonal variations observed in the foundation mechanistic properties were compared with the assumed design values. Empirical relationships between the different mechanistic properties are explored.

This project is in the International Journal of Pavement Research and Technology, Volume 11, Issue 4, July 11, 2018. Report written by Yang Zhang, Pavana K.R. Vennapusa, David J. White, Alex E. Johnson. Click here to access the full document.

This research is contributing to objectives identified in CP Road Map Track 10: Concrete Pavement Foundations and Drainage.

Bridge Service Life Design (report date: June 2018)

High costs and traffic disruption associated with the deterioration of reinforced concrete bridge decks because of corrosion have sparked renewed interest in service life design. Reinforced concrete bridge decks are exposed to chlorides from deicing salts; when the chlorides reach the steel reinforcement, they initiate corrosion. This study supports the adoption of the methodology described in fib Bulletin 34, Model Code for Service Life Design, for reinforced concrete bridge decks in Virginia.

As part of this study, concrete mixture properties and environmental exposure conditions were characterized. Values particular to regions within Virginia and suggested default values were identified and organized in a database to support the development of service life design guidelines. The predicted service life for eight bridge decks using low-cracking concrete and corrosion-resistant reinforcement (VDOT Reinforcement Class I, MMFX, ASTM 1035) was evaluated. The service life model was also implemented in a life-cycle cost analysis for a case study bridge, which found superior reliability of corrosion-resistant reinforcement from a life-cycle perspective.

In addition to supporting the implementation of service life design, several investigations identified key assumptions and variables in the service life model and identified critical areas for future characterization. The partial differential equation for apparent chloride diffusion was solved with both an approximate analytical approach and a numerical approach. Delays in the application of deicing salt were investigated using the numerical approach, and a ramp-type function for surface chloride concentration was explored using the analytical approach. Aging coefficients based on curing were also considered. A sensitivity analysis identified the aging coefficient and the surface chloride concentration as the most critical variables. The study concluded that sufficient data are available to implement the fib Model Code for Service Life Design, but that caution in interpreting results is warranted because of the high uncertainty associated with the most critical variables. According to the results of the service life analyses, the regional climatic variability and differences in mix design across Virginia indicate that a "one-size-fits-all" approach to bridge deck specifications may not be appropriate. The use of corrosion-resistant steel and low-cracking concrete mixtures can provide a substantial (greater than 100 years) bridge deck service life.

This project was sponsored by Virginia Department of Transportation; Federal Highway Administration. and written by Elizabeth Rose Bales, Venkatasaikrishna Chitrapu, and Madeleine M. Flint, Ph.D. Click here to access the full document.

This research is contributing to objectives identified in CP Road Map Track 9: Long Life Concrete Pavements.

Review of National and State-Level Calibrations of AASHTOWare Pavement ME Design for New Jointed Plain Concrete Pavement (report date: 2018)

For the design of new jointed plain concrete pavements (JPCPs), three national calibrations of the AASHTOWare Pavement ME Design have been necessary due to model and database updates. Local calibration is also recommended to better match a state's experience. To date, 8 states have changed the calibration coefficients to local values, while 11 states have implemented national coefficients. This study presents a review of the national and local calibrations and a comparison in terms of, (1) pavement performance prediction and (2) thickness design. It was found that the difference between the local and national calibrations was significant in terms of predicted pavement performance, but much less with respect to thickness design. Furthermore, a full factorial was conducted to study the impact of various design features on the local calibrations. The results showed that the difference between the national and local calibrations decreased as optimum design features such as short joint spacing were used.

This review report was written by F. Mu, J. W. Mack & R. A. Rodden (2018). This report is published in the International Journal of Pavement Engineering. Click here to access the full document.

This research is contributing to objectives identified in CP Road Map Track 2: Design for New and Rehabilitated Pavements.

Implementation of a Precast Inverted T-Beam System in Virginia: Part II: Analytic and Field Investigations (report date: August 2018)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Implementation of a Precast Inverted T-Beam System in Virginia: Part II: Analytic and Field Investigations

http://www.virginiadot.org/vtrc/main/online_reports/pdf/19-r2.pdf

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Final Report VTRC 19-R2

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The inverted T-beam superstructure is a bridge system that provides an accelerated construction alternative for short-to medium-span bridges. The system consists of adjacent precast inverted T-beams with a cast-in-place concrete topping. This bridge system is expected to not experience the reflective cracking problems manifested in short-to-medium-span bridges constructed with traditional adjacent voided slab or adjacent box beams. This report presents the results of three phases of a comprehensive research project to develop and implement an inverted T-beam system for Virginia. The three phases are: investigation of time-dependent and temperature effects, investigation of end zone stresses, and live load testing. The first investigation is of time-dependent effects in composite bridges with precast inverted T-beams. The analysis was performed for a two-span continuous bridge. An analytical study was performed to quantify the stresses generated as a result of differential shrinkage, creep and temperature gradient at various sections in both directions. At the cross-sectional level, an elastic sectional analysis approach using the age-adjusted effective modulus method was used to perform the investigation.

At the structure level, the effects of uniform temperature changes, thermal gradients and differential shrinkage and creep were investigated and quantified in terms of axial restraint forces and restraint moments. It is shown that, by paying attention to detailing and by selecting a mix design for the cast-in-place topping that has relatively low shrinkage and high creep, the potential for excessive cracking can be reduced. The second investigation is of the stresses in the end zones of such a uniquely shaped precast element. The transfer of prestressing force creates vertical and horizontal tensile stresses in the end zones of the beam.

A series of three-dimensional (3D) finite element analyses were performed to investigate the magnitude of these tensile stresses. Various methods of modeling the prestressing force, including the modeling of the transfer length, were examined and the effect of notches at the ends of the precast beams was explored. Existing design methods were evaluated; strut-and-tie models, calibrated to match the results of 3D finite element analyses, are proposed as alternatives to existing methods to aid designers in sizing reinforcing in the end zones. The final section reports the results of live load testing performed on the first inverted T-beam bridge in Virginia on U.S. 360 over the Chickahominy River. A finite element model of Phase I of the U.S. 360 Bridge was created and the live load distribution factors were analytically determined. Live load

tests using a stationary truck were performed on Phase I of the U.S. 360 Bridge with the purpose of quantifying live load distribution factors and validating the results from the finite element analyses. It is concluded that it is appropriate to estimate live load distribution factors using AASHTO provisions for cast-in place slab span bridges.

This project was sponsored by Virginia Department of Transportation and Federal Highway Administration University (FHWA) of through the Virginia Polytechnic Institute and State University. Authors were. Fatmir Menkulasi, Ph.D., P.E., Thomas Cousins, Ph.D., P.E., and C.L. RobertsWollmann, Ph.D., P.E. Click here to access the full document.

This research is contributing to objectives identified in CP Road Map Track 2: Design for New and Rehabilitated Pavements.

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