CP Tech Center Technology Transfer Products/Deployment

NATIONAL CONCRETE CONSORTIUM

September 16, 2015

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Implementation

Implementation

- **Performance Engineered Mixes**
  - Integrating advancements in testing technology, materials and proportioning into new specifications
  - ETG formed to guide spec development and adoption
  - Seven Champion States, plus Illinois Tollway and Manitoba
    - Evaluating tests in the field

Implementation

- **Real-time Smoothness**
  - To continue the efforts to construct smoother concrete pavements that last longer, stay smoother longer, are safer, and save money
  - Measurements of smoothness on Portland Cement Concrete Pavements During Construction – 11 equip loan sites, 8 workshops available, 6 -30 min briefings.

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Implementation

- **Recycling Technologies**
  - As part of the sustainability objectives need to have recycled materials be considered in material selections
  - Must identify barriers, identify best practices, share project experience and lessons learned and support implementation
  - Need to develop model specifications and QC plans
  - Nine champion states will help identify opportunities and expand applications

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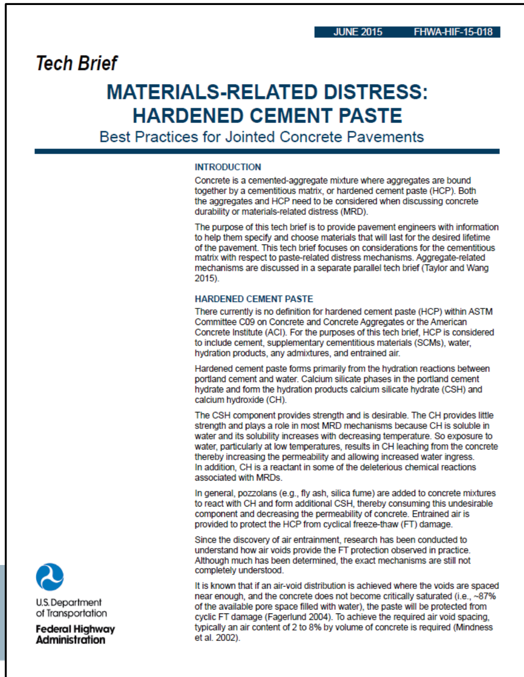
Implementation

- **Tech Transfer Products**
  - Four topics:
    - Materials related distress
    - Aggregate gradation
    - Supplementary cementitious materials
    - Accelerated construction
  - Three transfer methods
    - Tech briefs (3 complete)
    - Webinars (2 in planning)
    - Workshops (later)



JUNE 2015 FHWA-HIF-15-018

Tech Brief

MATERIALS-RELATED DISTRESS: HARDENED CEMENT PASTE

Best Practices for Jointed Concrete Pavements

INTRODUCTION

Concrete is a cemented-aggregate mixture where aggregates are bound together by a cementitious matrix, or hardened cement paste (HCP). Both the aggregates and HCP need to be considered when discussing concrete durability or materials-related distress (MRD).

The purpose of this tech brief is to provide pavement engineers with information to help them specify and choose materials that will last for the desired lifetime of the pavement. This tech brief focuses on considerations for the cementitious matrix with respect to paste-related distress mechanisms. Aggregate-related mechanisms are discussed in a separate parallel tech brief (Taylor and Wang 2015).

HARDENED CEMENT PASTE

There currently is no definition for hardened cement paste (HCP) within ASTM Committee C09 on Concrete and Concrete Aggregates or the American Concrete Institute (ACI). For the purposes of this tech brief, HCP is considered to include cement, supplementary cementitious materials (SCMs), water, hydration products, any admixtures, and entrained air.

Hardened cement paste forms primarily from the hydration reactions between portland cement and water. Calcium silicate phases in the portland cement hydrate and form the hydration products calcium silicate hydrate (CSH) and calcium hydroxide (CH).

The CSH component provides strength and is desirable. The CH provides little strength and plays a role in most MRD mechanisms because CH is soluble in water and its solubility increases with decreasing temperature. So exposure to water, particularly at low temperatures, results in CH leaching from the concrete thereby increasing the permeability and allowing increased water ingress. In addition, CH is a reactant in some of the deleterious chemical reactions associated with MRDs.

In general, pozzolans (e.g., fly ash, silica fume) are added to concrete mixtures to react with CH and form additional CSH, thereby consuming this undesirable component and decreasing the permeability of concrete. Entrained air is provided to protect the HCP from cyclical freeze-thaw (FT) damage.

Since the discovery of air entrainment, research has been conducted to understand how air voids provide the FT protection observed in practice. Although much has been determined, the exact mechanisms are still not completely understood.

It is known that if an air-void distribution is achieved where the voids are spaced near enough, and the concrete does not become critically saturated (i.e., ~87% of the available pore space filled with water), the paste will be protected from cyclic FT damage (Fagerlund 2004). To achieve the required air void spacing, typically an air content of 2 to 8% by volume of concrete is required (Mindness et al. 2002).

U.S. Department of Transportation
Federal Highway Administration

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Training & Technical Assistance

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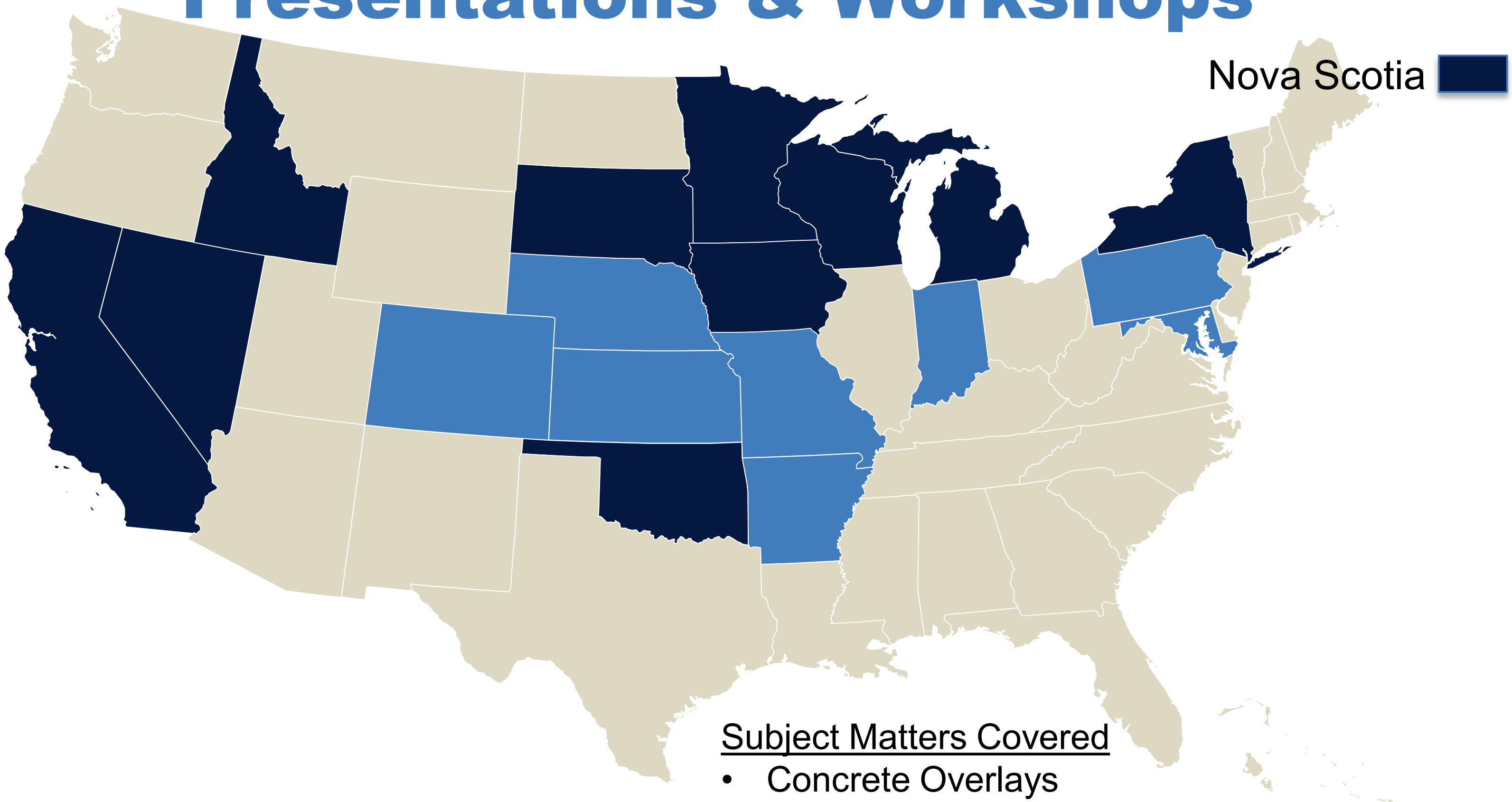
January – August 2015 Technology Presentations & Workshops

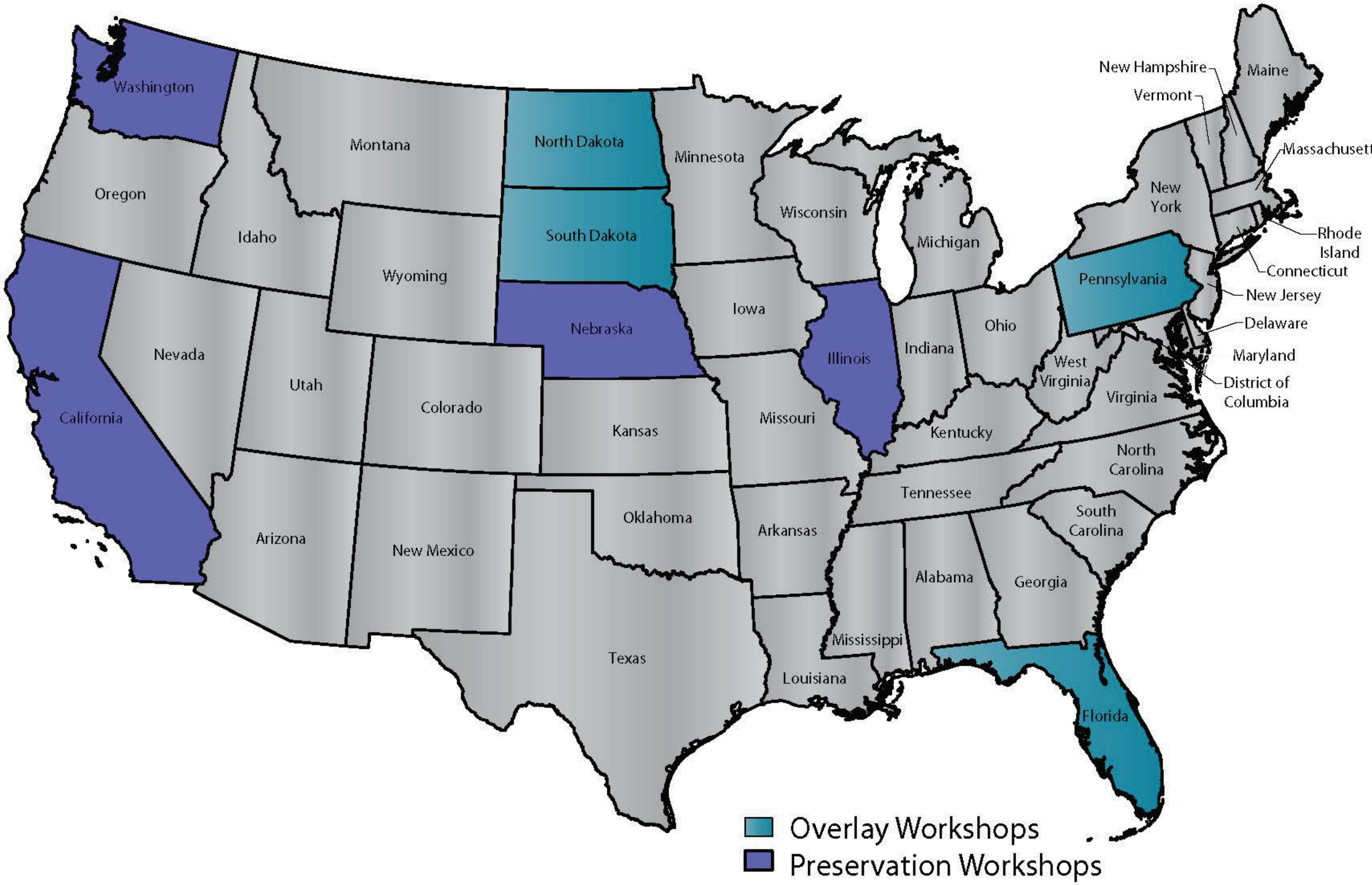


11 Presentations
19 Workshops
5 Webinars
__2__ Terra Member Web-based Training
37 Total (average 6 events per month)

<u>Subject Matters Covered</u>

- Concrete Overlays
- Concrete Pavement Preservation
- Performance Engineer Mixes
- 3D Engineered Models
- Inspectors Training
- Joint Performance
- Pavement Foundation Support Layers
- CP Tech Center Activities

Planned Concrete Overlay & Preservation Workshops



Technical Documents

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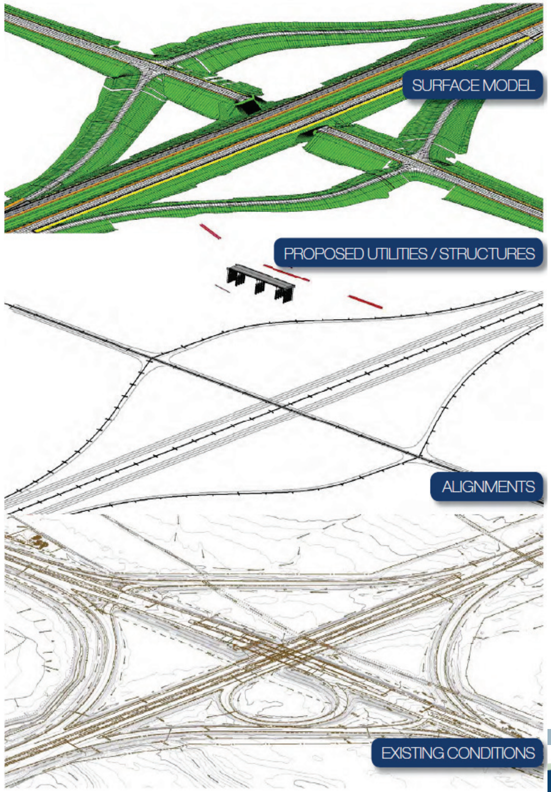
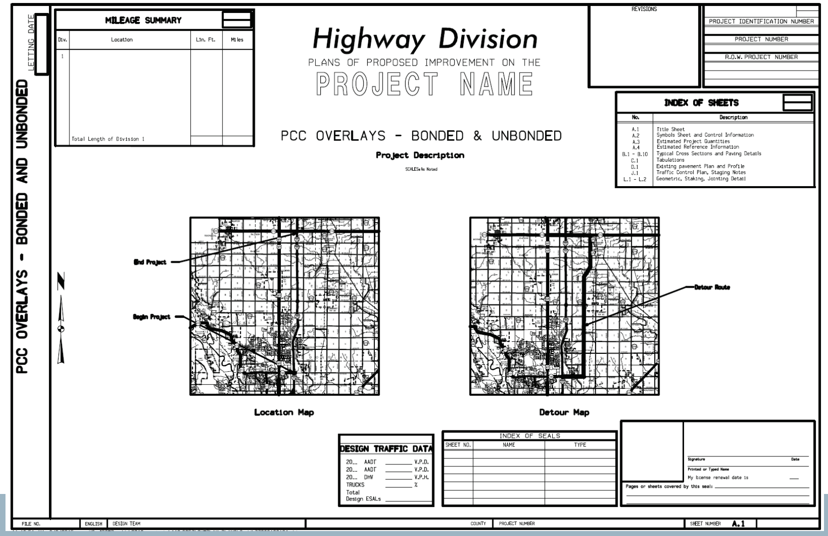
IMPLEMENTATION MANUAL

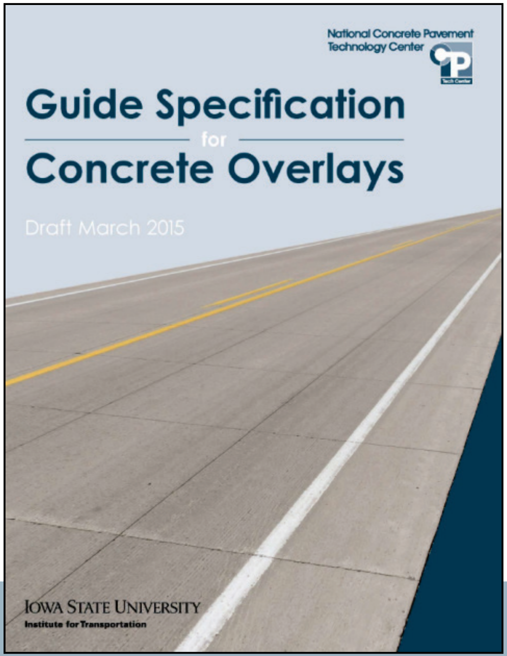
3D ENGINEERED MODELS FOR HIGHWAY CONSTRUCTION: THE IOWA EXPERIENCE



Plans and Specifications for PCC Overlays

- Develop typical concrete overlay plan set
- Developed concrete overlay guide specification
  - Easily modified for use with local PCC specs
  - Encourages use of PCC overlays by more state and local governments





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CP Road Map

E-News

- Bi-monthly newsletter highlighting research in the PCC paving industry
- Each newsletter now includes:
  - Research summaries
  - Called News from the Road
  - MAP Brief

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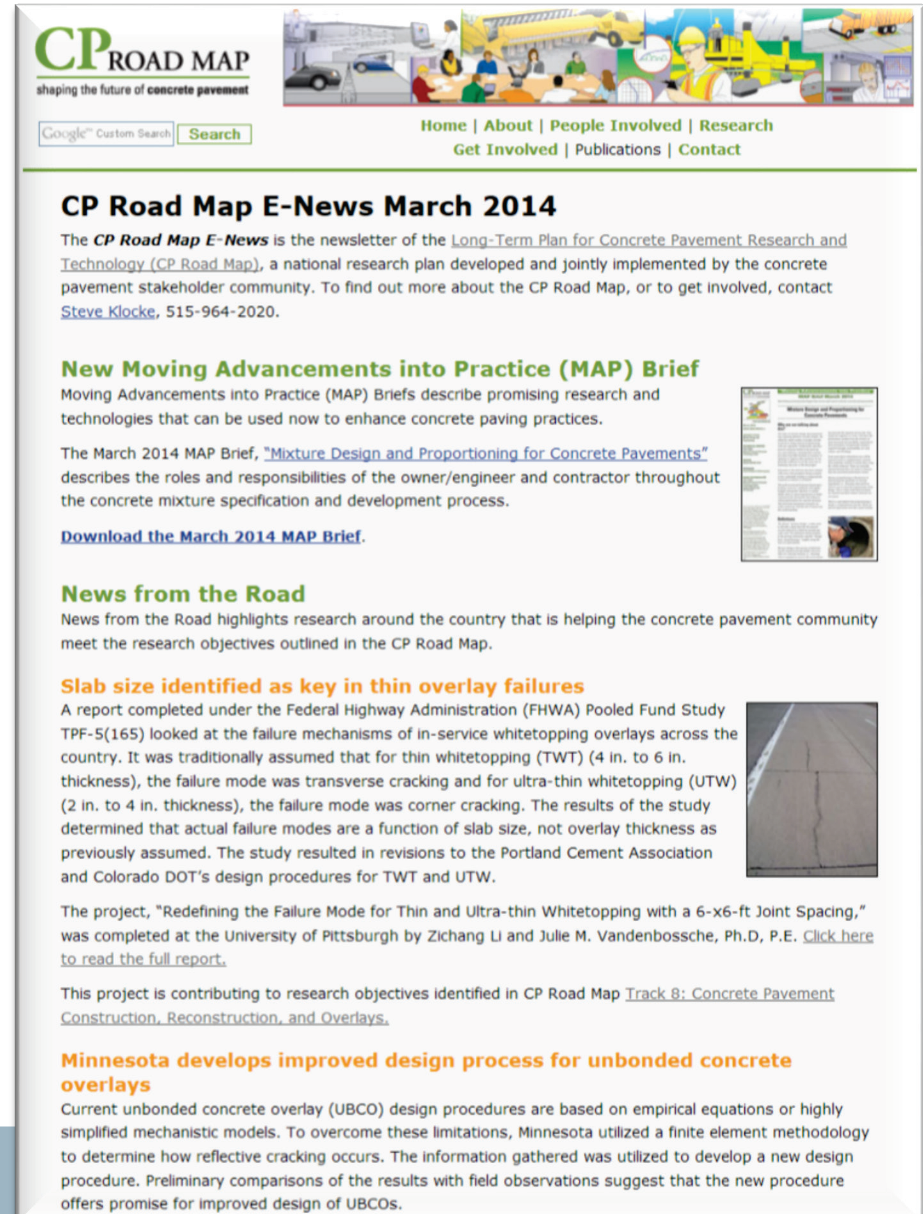

CP ROAD MAP
shaping the future of concrete pavement

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CP Road Map E-News March 2014

The ***CP Road Map 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, 515-964-2020.

New 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 March 2014 MAP Brief, "Mixture Design and Proportioning for Concrete Pavements" describes the roles and responsibilities of the owner/engineer and contractor throughout the concrete mixture specification and development process.

Download the March 2014 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.

Slab size identified as key in thin overlay failures

A report completed under the Federal Highway Administration (FHWA) Pooled Fund Study TPF-5(165) looked at the failure mechanisms of in-service whitetopping overlays across the country. It was traditionally assumed that for thin whitetopping (TWT) (4 in. to 6 in. thickness), the failure mode was transverse cracking and for ultra-thin whitetopping (UTW) (2 in. to 4 in. thickness), the failure mode was corner cracking. The results of the study determined that actual failure modes are a function of slab size, not overlay thickness as previously assumed. The study resulted in revisions to the Portland Cement Association and Colorado DOT's design procedures for TWT and UTW.

The project, "Redefining the Failure Mode for Thin and Ultra-thin Whitetopping with a 6-x6-ft Joint Spacing," was completed at the University of Pittsburgh by Zichang Li and Julie M. Vandenbossche, Ph.D, P.E. Click here to read the full report.

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

Minnesota develops improved design process for unbonded concrete overlays

Current unbonded concrete overlay (UBCO) design procedures are based on empirical equations or highly simplified mechanistic models. To overcome these limitations, Minnesota utilized a finite element methodology to determine how reflective cracking occurs. The information gathered was utilized to develop a new design procedure. Preliminary comparisons of the results with field observations suggest that the new procedure offers promise for improved design of UBCOs.

CP Road Map Briefs

- Moving Advancements into Practice (MAP)
  - August 2015: Spirit of St. Louis Airport Concrete Overlay
  - June 2015: Concrete Pavement Joint Deterioration: Recent Findings to Reduce the Potential for Damage
  - April 2015: Concrete Pavement Curling and Warping: Observations and Mitigation
  - January 2015: Producing Freeze-Thaw Durable Concrete
  - December 2014: Relating Transport Properties to Performance in Concrete Pavements
  - October 2014: Aggregate Gradations for Concrete Pavement Mixtures
  - August 2014: Deicing Salts and Concrete Pavements
  - June 2014: Constructing Concrete Pavements with Durable Joints
  - March 2014: Mixture Design and Proportioning for Concrete Pavements

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Concrete Pavement Assessments & Solutions

Provide State DOT with reference document to identify concrete pavement distress and the causes of the distress. Include technical solutions.

- Identifications methods and techniques already established by FHWA- Distress Identification Manual – (June 2003 last Updated)
- Needs to Identify Causes and Solution Options
- (Will require TAC to accomplish)

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Future Technical Documents

- Full Depth Reclamation of Asphalt Pavements with Cement
- PEM Guide Specifications
- Investigation of Deterioration of Joints in Concrete Pavements
- Impacts of Internally Cured Contraction on Joint Spacing
- Implementation of Thin Bonded Concrete Overlays of Asphalt (BCOA)

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