

**FHWA Cooperative Agreement DTFH61-12-H-00010 (2013-2018)**  
**Technology Transfer of Concrete Pavement Technologies**

# Summary of Accomplishments

IN SUPPORT OF

**Accelerated Implementation and Deployment of Pavement Technologies (2013-2018)**

Sustainability

1



Preservation and  
Overlays

2



Long-Life  
Pavements

3



Innovative  
Concrete  
Materials

4



Advancements  
in Placement

5



IOWA STATE UNIVERSITY  
Institute for Transportation

National Concrete Pavement  
Technology Center






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The Accelerated Implementation and Deployment of Pavement Technologies (AID-PT) program was established by Congress in 2012 with the Moving Ahead for Progress in the 21st Century (MAP-21) Act. At its core, the AID-PT program seeks to move the latest technologies and innovations into practice for the benefit of assisting state highway agencies (SHAs) with improvement of the nation's highway infrastructure.

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Under the 2013–2018 Technology Transfer of Concrete Pavement Technologies cooperative agreement with the Federal Highway Administration (FHWA), the National Concrete Pavement Technology (CP Tech) Center undertook the goal of bringing the latest innovations, knowledge, and technologies to SHAs in support of the AID-PT goals. Technical support and products were provided to SHAs through this agreement to help them become better equipped to manage their investments in concrete pavements. The objectives were to advance the following:

- **Sustainability** aspects of concrete pavements and materials
- **Preservation** and maintenance techniques for concrete pavements
- **Long-life** concrete pavements
- **Innovative** concrete materials
- **New technologies** and advancements in concrete pavement placement

The National CP Tech Center provided nationwide presentations in these five focus areas to an average of about 4,500 attendees/participants each year. This document summarizes some of the accomplishments and impacts from this work. Copies of all of the products that were developed are available on the National CP Tech Center website: [cptechcenter.org](http://cptechcenter.org).



## Sustainability of Concrete Pavements and Materials (Recycled Concrete Aggregate)

The specific goals of this work area were to advance the use of recycled material, industrial byproducts, and blended cements in concrete pavements.

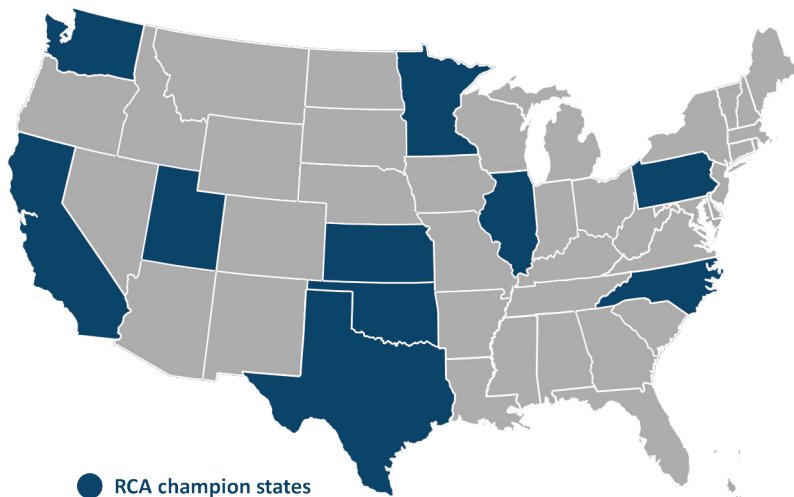


### Guidance on Industrial Byproducts and Blended Cements

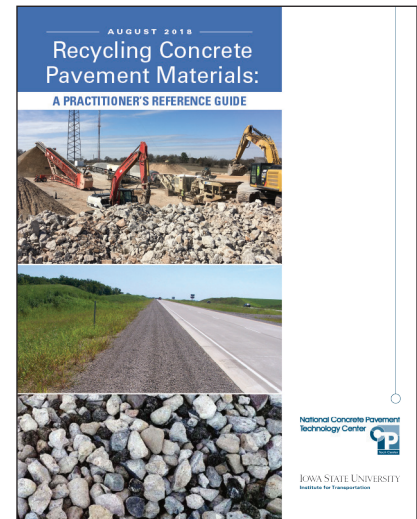
Technical guidance was developed on the use of *Supplementary Cementitious Materials and Blended Cements to Improve Sustainability of Concrete Pavements*. The November 2013 tech brief describes how supplementary cementitious materials (SCMs) and blended cements are used in paving concrete as one way to increase the overall sustainability of concrete mixtures.

### Use of Recycled Concrete Aggregate

In cooperation with the National Concrete Consortium (NCC), an expert task group (ETG)/technical advisory committee (TAC) of champion states was formed in April 2015 to guide the development of technical products and address the technology assistance needs of SHAs on the use of recycled concrete aggregate (RCA). The ETG represented SHAs, industry, and the FHWA.



Based on input from this group of experts, the following technical products were developed.



### Recycling Concrete Pavement Materials: A Practitioner's Reference Guide

This guide is a comprehensive resource for practitioners on how to determine if using RCA is a good match for a project, which applications make the most sense, and how to specify and field inspect these pavements. This guide covers sustainability and economics; project selection; using RCA in pavement base products, concrete pavement, and unbound aggregate shoulders; and mitigation of environmental concerns.

## Survey on Current Utilization of RCA

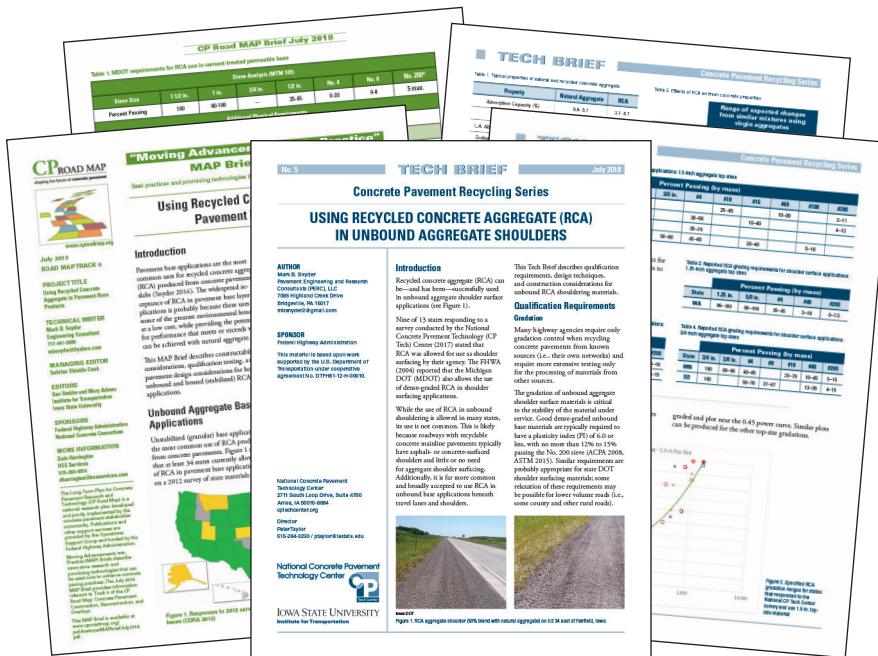
In cooperation with the NCC and the American Concrete Pavement Association (ACPA) contractor members, a two-part benchmarking survey was conducted to identify current usage of RCA as well as understand potential barriers and opportunities to increase usage.

The results of the survey confirmed broad interest in increasing the applications of RCA on projects and the desire for better technical guidance on various project applications. The results of this survey were used to focus the technical products and direct SHA support activities on the areas of greatest interest.



## Concrete Pavement Recycling Website

A resource webpage was developed to provide a technical library of material on concrete pavement recycling to support better understanding of how to use RCA. The Concrete Recycling Resources webpage includes links to the Practitioner's Guide, the eight tech briefs, all of the webinars, the usage survey results, and other technical resources.



## Concrete Pavement Recycling Tech Briefs

As a complement to the Practitioner's Reference Guide, the following tech briefs were developed and distributed:

- Concrete Pavement Recycling Series: Concrete Pavement Recycling and the Use of Recycled Concrete Aggregate (RCA) in Concrete Paving Mixtures
- CP Road Map: Concrete Pavement Recycling and the Use of Recycled Concrete Aggregate in Concrete Paving Mixtures
- Concrete Pavement Recycling Series: Quantifying the Sustainability Benefits of Concrete Pavement Recycling
- CP Road Map: Concrete Pavement Recycling—Project Selection and Scoping
- Concrete Pavement Recycling Series: Protecting Water Quality through Planning and Design Considerations
- Concrete Pavement Recycling Series: Protecting the Environment during Construction
- CP Road Map: Using Recycled Concrete Aggregate in Pavement Base Products
- Concrete Pavement Recycling Series: Using Recycled Concrete Aggregate (RCA) in Unbound Aggregate Shoulders

## Recycling Concrete Webinar Series

A webinar series was developed and presented to nearly 400 SHA and industry participants during 2016 and 2017. The webinars are available on the National CP Tech Center's website.

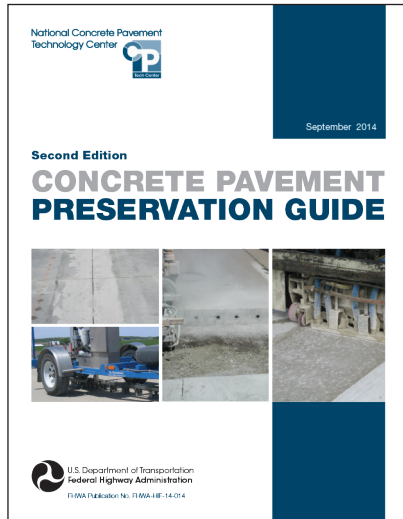
- Introduction to Concrete Pavement Recycling
- Construction Considerations in Concrete Pavement Recycling
- Environmental Considerations in Concrete Pavement Recycling
- Recycling Case Studies in Concrete Pavement Recycling



## Preservation and Overlays

## Preservation and Overlays

This work area provided guidance and technical assistance to SHAs on preservation and maintenance of concrete pavements.



### Concrete Pavement Preservation Guide, Second Edition

One of the cornerstones of the National CP Tech Center's technology transfer efforts on preservation of concrete pavements is the *Concrete Pavement Preservation Guide, Second Edition*, published in September of 2014. The document provides guidance and information on the selection, design, and construction of cost-effective concrete pavement preservation treatments. It is based on a document prepared in 2008 but was revised and expanded to include updated information to assist highway agencies in effectively managing their concrete pavement network through the application of timely and effective preservation treatments. The preservation approach typically uses low-cost, minimally invasive techniques to improve the overall condition of the pavement.

### Preservation Workshops

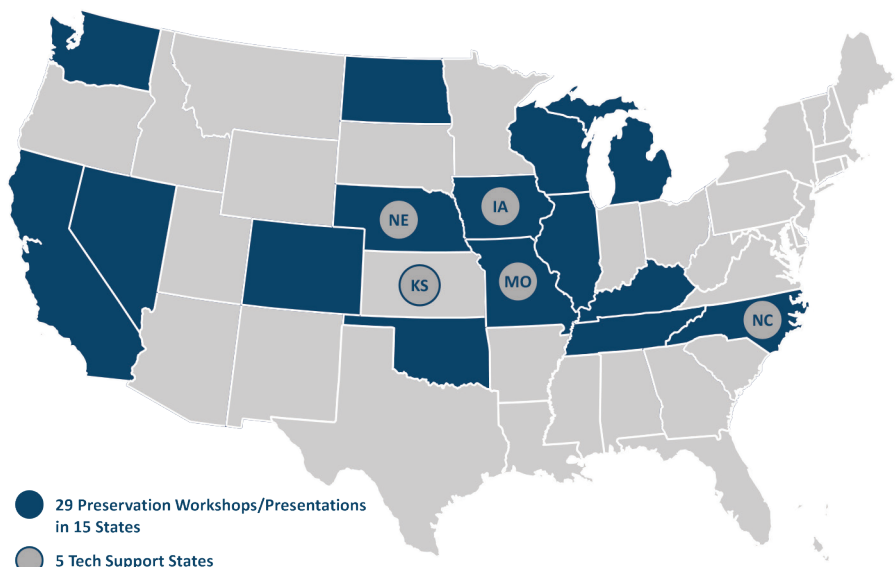
Understanding the latest technologies is integral to pavement preservation and rehabilitation. Therefore, a significant effort was undertaken by the National CP Tech Center to move information from the Preservation Guide into the hands of SHA professionals. To meet the requests for online and on-demand education, 10 online training modules were developed and launched as outreach resources for the Preservation Guide.

Twenty-nine one-day workshops on Portland cement concrete (PCC) pavement preservation and rehabilitation were held in 15 states with 1,200 participants. The reference documents, instructional material, and handouts presented in the workshops consider both optimizing performance and lowering the life-cycle cost of a concrete pavement.

The following topics were covered:

- Introduction
- Preventive maintenance and pavement preservation concepts
- Concrete pavement evaluation
- Slab stabilization and slab jacking
- Partial-depth repairs
- Full-depth repairs
- Retrofitted edge drains
- Load transfer restoration
- Diamond grinding and grooving
- Joint/crack sealing
- Overlays
- Strategy selection

Five states received technical assistance for particular preservation techniques.



## Selected Preservation Workshop Evaluation Comments

"The topics were very well covered and showed great knowledge of application in the field." – *NORTH DAKOTA*

"The photos and examples of each presentation application were very useful. I thought the instructors did a great job explaining everything and giving TDOT new ideas." – *TENNESSEE*



### Pavement Preservation Webinars

As part of the technology transfer, the following six webinars on concrete pavement preservation were presented as part of the ACPA webinar program in 2015 and 2016:

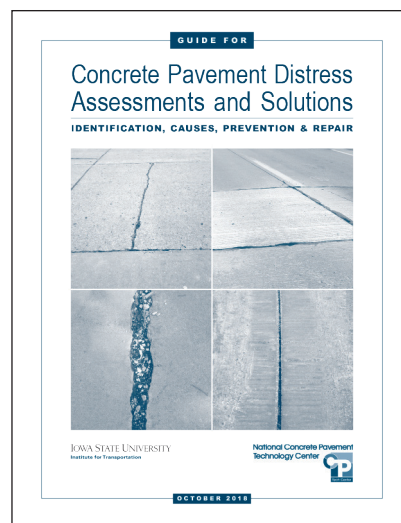
- The Essentials: From Pavement Evaluation to Strategy Selection
- Partial- and Full-Depth Repair Methods
- Tips and Techniques for Specialized Repair and Construction Methods
- What You Need to Understand About Surface Treatments and Restoration Methods
- All About Joint Repairs and Sealing
- Maintaining and Preserving Concrete Pavement Overlays

### Pavement Preservation Reference Website

The National CP Tech Center has provided a summary of web-links for concrete pavement preservation. The Pavement Preservation webpage provides more than 80 individual links to national, state, consulting, and private online resources. The resources include technical reports, technical briefs, guides, websites, and videos on concrete pavement preservation.

### Guide for Concrete Pavement Distress Assessments and Solutions

Selecting a preservation technique requires the proper identification of the cause of the distress. The *Concrete Pavement Distress Assessments and Solutions* manual was developed to assist with this evaluation.



Historically, distresses in concrete pavements have been identified largely through visual surveys, with limited investigation of the underlying cause of the distress and often with limited knowledge of how to cost effectively maintain a concrete pavement in good condition. This document incorporates proven and cost-effective solutions into a framework that assists the user in matching the appropriate solution for a given distress. The chapters of this manual focus on the following:

- What distress is present
- What caused it
- How to prevent its reoccurrence
- What repair options are available

A team of 15 experts from across the country served on the TAC, representing state departments of transportation (DOTs), concrete paving associations, and the FHWA. The National CP Tech Center also provided webinars and tech briefs on pavement distress.



## Concrete Overlay Technologies

Pavement preservation and rehabilitation have been growing in importance nationwide, leading to increased interest in concrete overlays. Concrete overlays are a cost-effective, low-maintenance preservation technique used to extend pavement life. Concrete overlays have been in existence for more than 100 years. Since 1901, thousands of miles of state primary and secondary roads have been successfully rehabilitated with concrete overlays.

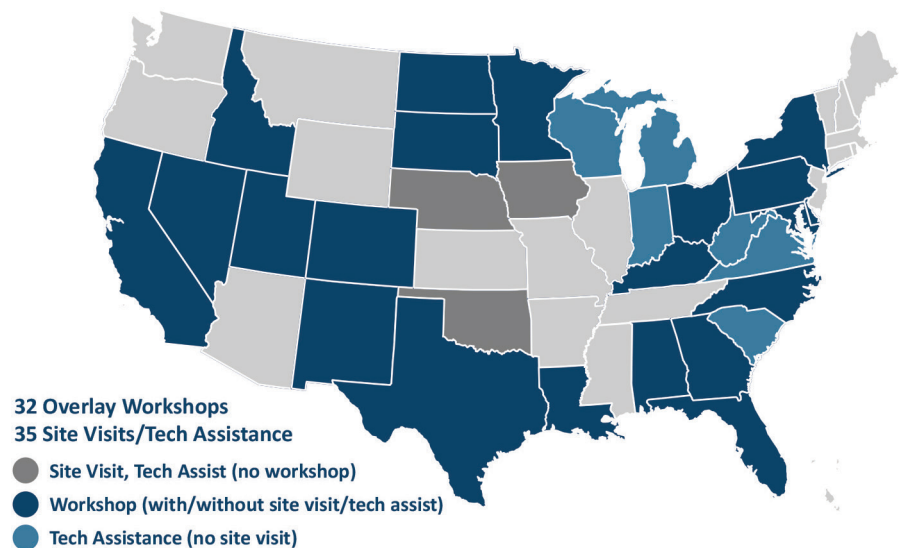
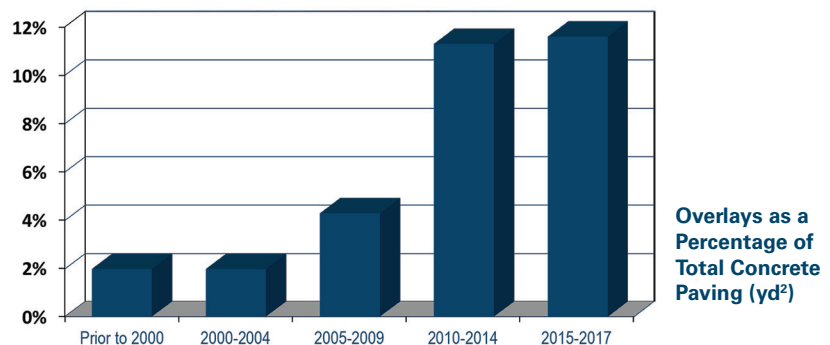
In 2009 (after the release of the Second Edition of the *Guide to Concrete Overlays*), the use of concrete overlays jumped from 2 million square yards to 10 million square yards. From 2009 through 2016, an average of 7 million square yards per year were placed in the US.

From September 2013 through September 2016, 11 different state DOTs that received the overlay training and support under this agreement constructed 15 projects, covering approximately 1,500 lane miles, representing more than \$750 million in construction costs. With the transfer of technical information, concrete overlays have continued to grow in popularity and are a feasible and sustainable rehabilitation method.

## Concrete Overlay Site Visits and Workshops

The National CP Tech Center provided technology transfer in fulfilling 35 site visit and/or technical assistance requests and by providing 32 in-depth workshops, reaching 29 states and more than 1,400 individuals, as part of the Concrete Overlay Field Application effort.

Site visits included 1–2 hour presentations on concrete overlay topics, while the workshops included an overlay candidate evaluation, discussion on possible solutions, and a written report followed by a one-day workshop on concrete overlays. The technical presentations, developed for national audiences, included face-to-face presentations, web-based training, and webinars.

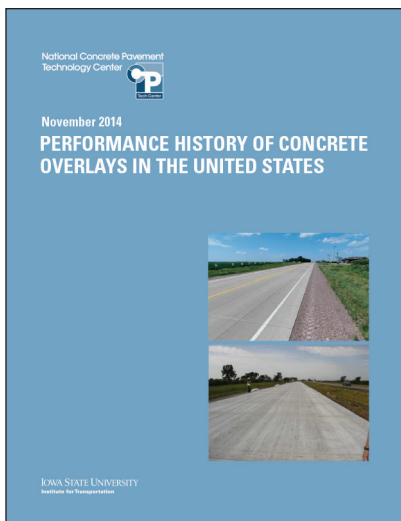


## Selected Overlays Workshop Evaluation Comments

"All information was useful. Instructors/presenters were clear and answered all questions" – CALIFORNIA

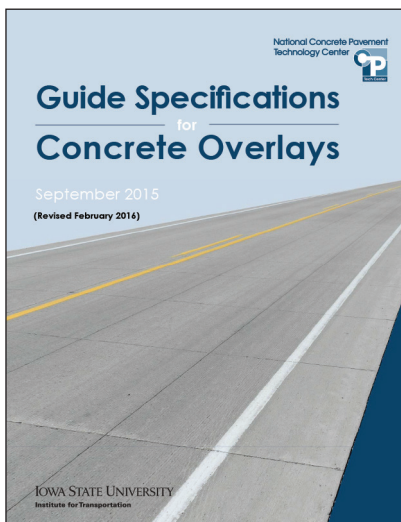
"Having very little experience with pavement working terms, I felt the instructors did great to constantly bring real life and current examples throughout each section. Great understanding and being able to connect ideas." – NEW YORK

"The Concrete Overlay Technical Assistance Program reviewed a 17-mile project on I-85 in North Carolina," SAYS CLARK MORRISON, STATE PAVEMENT DESIGN ENGINEER WITH THE NORTH CAROLINA DEPARTMENT OF TRANSPORTATION (NCDOT). "The team from the CP Tech Center visited the site and conducted a workshop with NCDOT engineers, with two of the recommendations resulting from the workshop resulting in significant savings in both construction costs and time." MORRISON ESTIMATES THAT THE COST SAVINGS IN FULL-DEPTH REPAIRS ALONE WERE AT LEAST \$3.25 MILLION.



## Performance History of Concrete Overlays

The purpose of this document was to demonstrate the applicability of concrete overlays as an asset management solution on a wide array of existing pavement types and roadway classifications. It includes a brief history of the construction of concrete overlays in the US and summarizes the details of 12 concrete overlay projects across the country. It concludes with a short list of additional resources.



## Guide Specifications for Concrete Overlays

This document provides guidance for the development of project

specifications that are tailored for concrete overlay projects. If the DOT's standard specifications are outdated or rarely used, modifications may be necessary to produce a high quality, long lasting, concrete overlay.

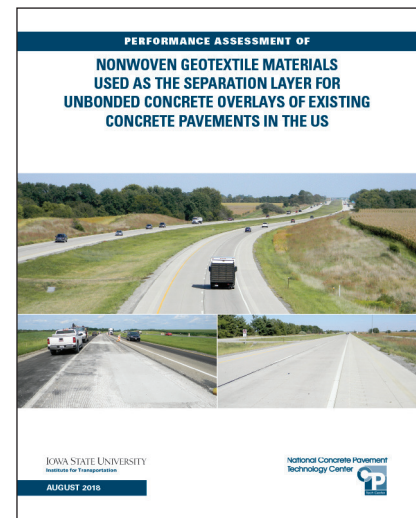


## Guide for the Development of Concrete Overlay Construction Documents

This guide includes all the necessary tools for a pavement designer to develop a concrete overlay project. It includes standard construction details, specifications, costs, and design lessons learned. The standard construction drawings include new details on concrete overlay widening.

These details are a result of design lessons learned, with emphasis on improving performance—for example, under-slab drainage, tied shoulders, and locations of saw cuts. The standard details include guidance commentary and are provided to help the pavement designer efficiently assemble construction drawings. Guide specifications provide supplementary information and give the pavement designer the necessary process and product

information for the development of an overlay project. Finally, a discussion on cost is provided based on actual concrete overlay projects from eight states.



## Geotextile Interlayers

Geotextiles continue to rise in popularity and effectiveness as interlayers within unbonded concrete overlays. *Performance Assessment of Nonwoven Geotextile Materials Used as the Separation Layer for Unbonded Concrete Overlays of Existing Concrete Pavements in the US* covers the purpose, design, project experience, overall performance, construction lessons learned, cost savings, and nine case history summaries dating back to 2008. This comprehensive document, published in 2018, goes into greater depth on the performance, construction details, and ongoing optimization of nonwoven geotextile separation layers.



## Long-Life Concrete Pavements

The work plan identified two activities of national importance for this focus area.

- Develop application guidance for two-lift paving construction
- Host a National Open House

In an effort to coordinate work with other national activities on long-life concrete pavements, the National CP Tech Center participated in a meeting to review the activities awarded under the Second Strategic Highway Research Program (SHRP2) R21: New Composite Pavement Systems project, which included the development of application guidance for two-lift concrete paving construction.

In cooperation with the Illinois State Toll Highway Authority (Illinois Tollway), a National Open House on Sustainable Concrete Pavement Practices was held August 20, 2013. More than 125 participants representing the FHWA, 23 SHAs, consultants, and industry attended the open house. The workshop featured sustainable practices being used by the Tollway, including two-lift concrete paving, use of RCA and fractionated reclaimed asphalt pavement (FRAP) in concrete pavement mixtures, and the application of life-cycle assessment and life-cycle cost analysis techniques.

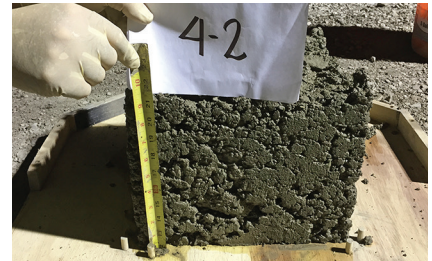
Workshop participants were able to see pavement being placed using the recycled materials as well as participate in a technical program featuring Tollway and contractor experiences. They were also provided with two-lift paving specifications and construction details being used on actual projects.



## Innovative Concrete Materials 4

### Innovative Concrete Materials (Performance Engineered Mixtures)

The focus of this work area was to develop modern specifications for concrete paving mixtures that will be consistently durable in a given environment and have the performance life assumed during the design process. The key is being able to test and field-control parameters that relate to performance. Historically, concrete mixture designs focused extensively on strength, which is not a reliable measure of durability.

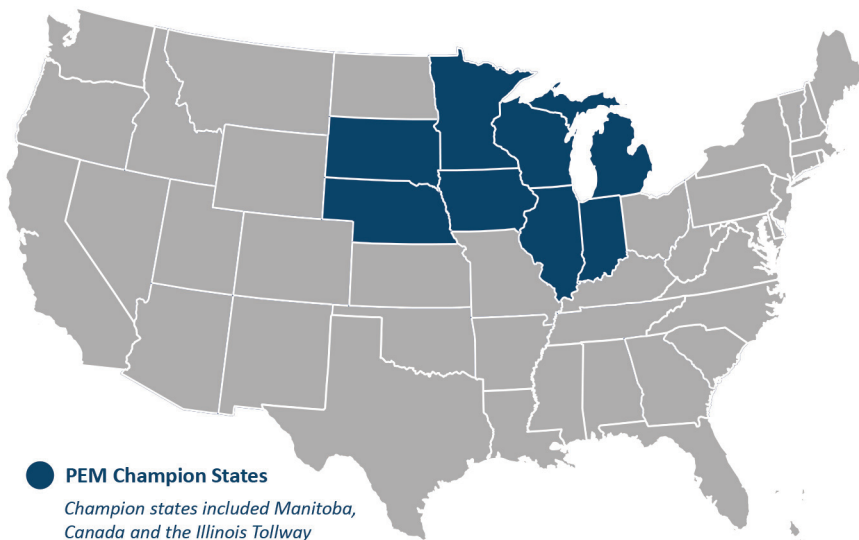


Two executive level groups were formed:

- An oversight ETG was formed representing the ACPA, the National Ready Mixed Concrete Association (NRMCA), the Portland Cement Association (PCA), the NCC, the FHWA, and academia. The group met during the initiative and provided the strategic framework essential for specification development.
- At the April 2015 meeting of the NCC, a partnership was formed between the FHWA and DOT members to establish a performance engineered mixtures (PEM) champion states group to work with the National CP Tech Center on this goal. The champion state members, along with their industry partners, recognized the importance of developing the next generation concrete paving mixture specification. The members were very active in working with the development team by evaluating proposed new test methods, conducting shadow testing on active projects, and reviewing and providing comments on proposed specification language.

The results of this overall initiative culminated with the publication of American Association of State Highway and Transportation Officials (AASHTO) Standard Practice PP 84-17 for developing performance engineered concrete pavement mixtures. This specification represents an advancement from current specifications. The specification is developed around six critical mixture parameters:

- Transport properties
- Aggregate stability
- Strength
- Cold weather exposure
- Reduction of unwanted slab warping and cracking due to shrinkage
- Workability



A national transportation pooled fund study, TPF-5(368), Performance Engineered Concrete Paving Mixtures, was established to support the deployment of the specification into practice. The FHWA, 17 DOTs, and industry currently are involved with these efforts.



# New Technologies and Advancements in Placement

## Workshop for Paving Inspectors

This training course was developed, with expertise from state agencies, industry, and the FHWA, to provide guidance and instruction to inspectors involved in the construction of PCC pavements. The important tasks involved in PCC paving are explained and proper procedures are described. The course is intended for those who have little to no experience in PCC paving field inspection.



The one-day training answers the following questions:

- Why is inspection necessary
- What is quality assurance (QA) for PCC paving
- What is concrete
- What do you need to start a project
- What kinds of equipment are used
- What happens before you start paving
- What happens when you're finally paving
- What is the inspector's role
- What do you look for in urban paving
- What about all the other road building stuff
- What paperwork (including helpful forms) is needed

Three workshops were held in west and north central regions of the US, and a PDF of the presentation slides is available on the National CP Tech Center website.

In addition, a set of field reference checklists were developed as a quick resource for field personnel. The checklists included the following:

- Paver Setup
- Daily Paving Summary
- Pavement Markings
- Subgrade Checks
- Depth Checks
- Paving Items
- Texture
- Air and Slump

TAC members and representatives from nine states were instrumental in reviewing the products.

## IMAGE CREDITS

**COVER** | Top: J-2 Contracting Co.; 2nd: Washington County, Nebraska; 3rd: National CP Tech Center 2013; 4th and Bottom: National CP Tech Center 2008. **PAGE 2** | Top Left: Jerod Gross, Snyder & Associates, Inc.; Top Center: Dan King, Iowa Concrete Paving Association; Top Right: Jason Reaves, South Dakota Chapter, ACPA; Bottom Left: Unknown, *Concrete Pavement Preservation Guide*, Second Edition (page 35); Bottom Center: Todd LaTorella, MO/KS Chapter, ACPA; Bottom Right: National CP Tech Center 2013. **PAGE 3** | Top: Construction & Demolition Recycling Association (CDRA). **PAGE 4** | Right: Jerod Gross, Snyder & Associates, Inc. **PAGE 6** | Left: John Roberts, International Grooving & Grinding Association (IGGA). **PAGE 7** | Upper Right: After Voigt 2017, ACPA. **PAGE 9** | All: National CP Tech Center 2013. **PAGE 10** | Top Left: Angela James Folkestad, CO/WY Chapter, ACPA; Top Right: Jagan Gudimettla/FHWA Mobile Concrete Laboratory (MCL) 2015. **PAGE 11** | Left: National CP Tech Center 2008.

## ABOUT THE NATIONAL CP TECH CENTER

The mission of the National Concrete Pavement Technology (CP Tech) Center at Iowa State University is to unite key transportation stakeholders around the central goal of advancing concrete pavement technology through research, tech transfer, and technology implementation.

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