

# PROGRESS WITH PERFORMANCE ENGINEERED MIXTURES (PEM)

*2019 MCA Winter Conference*

*February 20, 2019*

*Plymouth, Mi.*



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## *THE JOURNEY TOWARD PERFORMANCE ENGINEERED MIXES (PEM)*

- Near the millennium, concerns about concrete durability and poor pavement performance became a common topic of discussion in many concrete intensive states.





## ***WHAT'S HAPPENING ?***

Ankeny, IA



West Des Moines, IA



## ***THE DISCUSSIONS . . . .***

- Aggregate Durability/Gradation
- Chemical Reactions ASR/ACR
- Poor Air Entrainment
- Poor Consolidation- Workability
- Sawing Practices
- Effects of Deicers and Deicing Practices
- SCM/Admixtures
- ?????????????????





## ***THE JOURNEY TOWARD PERFORMANCE ENGINEERED MIXES (PEM)***

- 2013 –FHWA established an Expert Task Group (ETG) to further discuss and explore an action plan responsive to the concerns.



## **A modernized Specification . . .**

- Require the things that matter
- Measure them at the right time
- Develop test methods (4 New Tests)
- Develop “Guide Specification” (AASHTO’s PP-84)
- Develop tools to proportion mixtures
- Conduct Shadow evaluations (RIGHT NOW)
- Later
  - Guide/monitor Pilot projects
  - Develop PWL models
  - Guide in Q/C Programs





## What should we measure to get **Good Concrete**?

1. Transport (permeability) - To reduce transport of aggressive unwanted fluids in order to survive the environment
2. Freeze/thaw durability - To reduce expansive damage to the concrete pavement in northern regions
3. Aggregate Stability - To eliminate reactive / incompatible aggregate
4. Workability - To improve concrete placement that impacts concrete durability & improves rideability.
5. Strength - To ensure concrete pavement carries intended vehicle loads without failure
6. Shrinkage - To reduce preventable cracking



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## How should we measure to get **Good Concrete**?

Tests for those critical properties

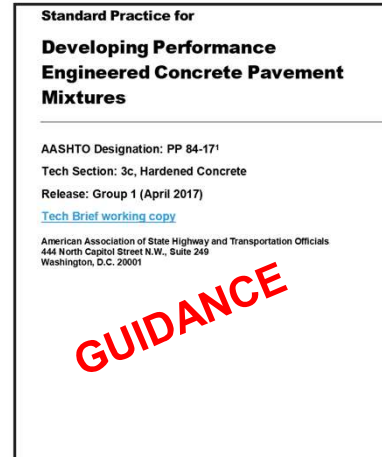
- V-Kelly (*Workability*)
- Box (*Workability*)
- Resistivity / Formation Factor (*Transport*)
- SAM (*Cold Weather Resistance*)
- Bucket / (*Sorptivity*)
- Dual ring (*Shrinkage*)





## Standard Practice for Developing Performance Engineered Concrete Pavement Mixtures (PP 84-17)

- Standard Practice – guidance for FHWA-State DOTs-Industry
- A dynamic “**work-in-progress**” that initiates our endeavor to embrace Performance Engineered Mixtures
- Each State may be different



## THE PEM INITIATIVE

- A partnership of agency and industry to
  - Understand what makes concrete “good”
  - Specify the critical properties and test for them
  - Design the paving mixtures to meet those specifications



**Initiative** can mean a personal quality that shows a willingness to get things done and take responsibility. An **initiative** is the start of something, with the hope that it will continue.





## ***A TRANSPORTATION POOLED FUND PROJECT (2017)***

PERFORMANCE ENGINEERED  
CONCRETE PAVING MIXTURES (***PEM***)



## ***OBJECTIVES***

- Focus on successful deployment of performance engineered mixtures
- Build upon the foundation of work accomplished to date by FHWA, PEM Champion States and Industry, working cooperatively to design and control concrete pavement mixtures around key engineering properties.





## ***PEM/TPF PROJECT EMPHASIS***



- Implementation
- Education and Training
- Adjustments in specification based on field performance
- Continued development of a knowledge base relating early age properties to performance



## ***THE PEM/TPF PARTNERS***

- Federal Highway Administration (FHWA)
- State Departments of Transportation (DOTs)
- Industry (ACPA-PCA-NRMCA-SCA-Others)





## The Team

- FHWA - Gina Ahlstrom, Mike Praul
- Researchers – Jason Weiss, Tyler Ley
- Consultants – Tom VanDam, Cecil Jones
- CP Tech – Peter Taylor, Gordon Smith,  
Jerod Gross

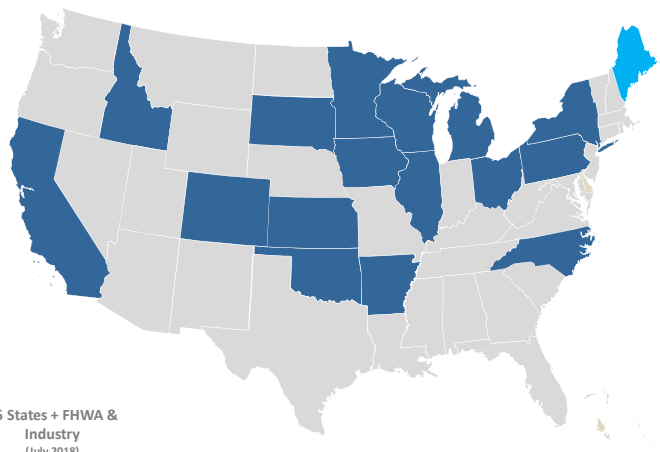


Oregon State  
University



Diversified  
Engineering  
Services, Inc

## PEM POOLED FUND PARTICIPANTS TPF-5(368)



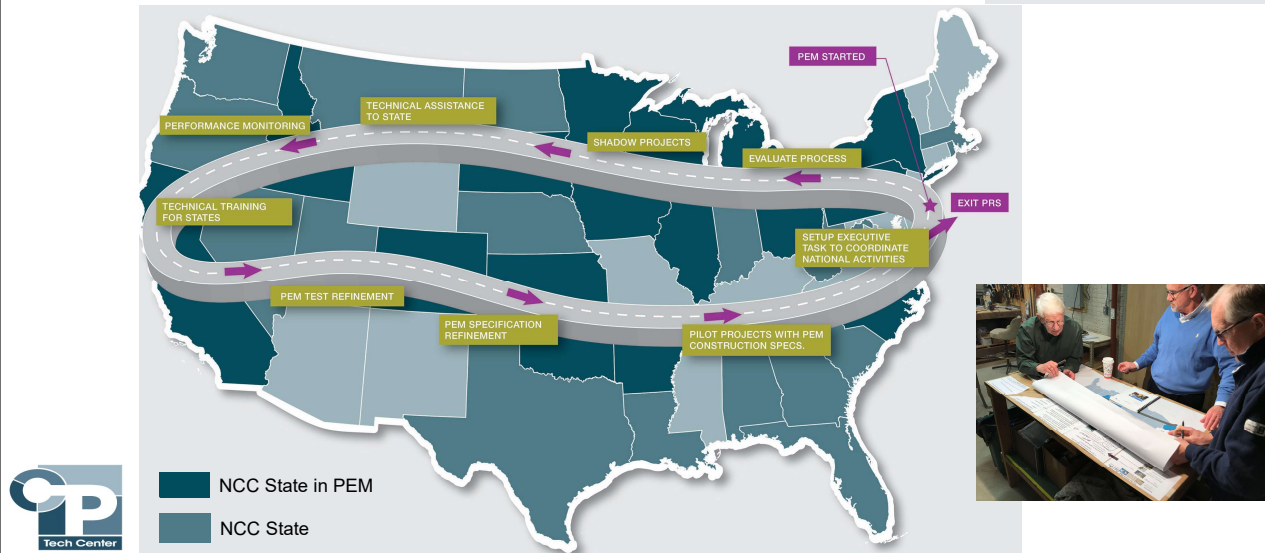
16 States + FHWA &  
Industry  
(July 2018)





## How Do We Get There?

### THE ROAD TO PEM



## PEM Activity 2018

- MCT/PEM Open House/Demo in CO - May 2018
- MCT/PEM Open House/Demo in MN - July 2018
- MCT/PEM Open House/Demo in IA - July 2018
- Shadow Testing – IA, SD – July, September 2018
- FHWA Incentive Program Participation – MN, IA, NC, PA, NY, SD, WS, IL (Independent PEM work in MI, KS)
- PP-84 Guide Specification Update 2019
- Test Refinement/Development
- Equipment Loan Program from FHWA
- Shadow testing data collection
- Industry Collaboration
  - (ACPA-PCA-NRMCA-SCC)





## Quality Control

- PEM acknowledges the key role of QC in a performance specification
- QC testing and control charts
  - Unit weight
  - Air content/SAM
  - Water content
  - Formation Factor (via Surface Resistivity)
  - Strength



## Prescriptive vs Performance Specifications

- Goal of PEM is to **understand how critical properties relate to performance**
- PP 84 provides a range of options for each property moving from prescriptive to performance choices.
- Initially, prescriptive options prevail while specification requirements are being confirmed for the more performance-based tests.
- Ultimately, the performance options will allow innovation and cost-effectiveness, with acceptable risk, for all parties as we understand how to set the tests limits.





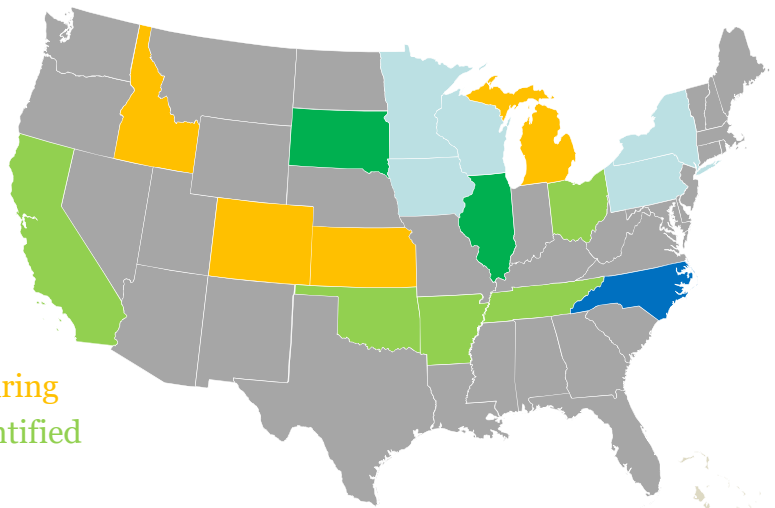
## PP 84 IMPLEMENTATION INCENTIVE FUNDS

- Available to pooled fund participating states
- (A) \$40,000 for two or more new tests in the mix design/approval process (shadow testing acceptable)
- (B) \$20,000 for one or more new tests in the acceptance process (shadow testing acceptable)
- (C) \$20,000 for requiring an “enhanced” QC Plan from the contractor
- (D) \$20,000 for requiring the use of control charts
- Report required within 4 months of construction



## Implementation Incentive Funding

- A, B, C, D
- A, B, D
- A, B
- Considering/Preparing
- Project not yet identified





## PEM Activity 2019

- One-day engineering level PEM Workshop
- Specification review and SHA assistance in establishing their PEM implementation strategy
- Technician training
- QC/QA Plan (Co-Op)
- Test refinements and new tests (AASHTO Task Force)
- PP-84-20 revision
- Construction specification development
- FHWA Incentive/Shadow Testing Projects NC, KS, IL, ID, WI
- MCT/PEM Open House/Demos in NC, CA, KS



## Next Steps

- Tests
  - Standardize
  - Precision and Bias
  - Training
  - (Certification)
- Specifications
  - Test frequencies
  - One on one conversations with agencies
- Longer term – pilot contracts





## Why We're Excited

### Concrete Evolution

- PEM: It's our "Superpave"
- Most significant field-level advancement in decades
- Answers the question "With our loss of staff and resources, how are we going to be able to get the job done in the future?"
- Collaboration with industry (It's more than just the tests!)



## PEM RESOURCES

[www.cptechcenter.org](http://www.cptechcenter.org) and then click on PEM



March 2017

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National Concrete Pavement  
Technology Center



IOWA STATE UNIVERSITY  
Institute for Transportation

#### An Innovative Program for Pavement Reliability

The Performance Engineered Mixtures (PEM) program is designed to provide the tools for agencies to specify, and contractors to deliver, concrete mixtures that reliably and sustainably meet the needs for concrete infrastructure.

The PEM program will result in concrete pavements consistently achieving the performance life of the design. The program is based on the concept of measuring and controlling the concrete mixture around engineering properties that actually relate to performance:

- Identifying critical mixture properties for long-term durability specific to any climatic environment
- Achieving these properties through measuring the performance-related engineering parameters of the mixtures
- Developing a specification for mixtures
- Providing technical guidance and project-level support for preparing and delivering concrete mixtures that meet the specification





## DELIVERING CONCRETE TO SURVIVE THE ENVIRONMENT

- The framework is in place
- Now we focus on the details of implementation



[www.cptechcenter.org](http://www.cptechcenter.org)