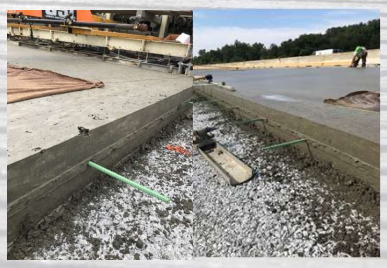
A PEM milestone and beyond…



Gordon Smith, PE
Associate Director

IOWA STATE UNIVERSITY
Institute for Transportation

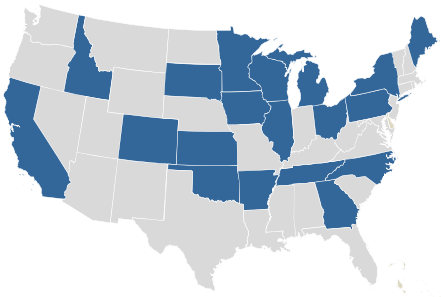
National Concrete Pavement Technology Center
Tech Center

NCC Fall Meeting 2022
Detroit, MI

Performance Engineered Mixtures (PEM)

- A broad initiative with a goal of implementing performance specifications for concrete, including an increased emphasis on durability

ACPA
AMERICAN CONCRETE PAVEMENT ASSOCIATION



SCA
SLAG CEMENT ASSOCIATION

PCA Since 1916
America's Cement Manufacturers™

U.S. Department of Transportation
Federal Highway Administration

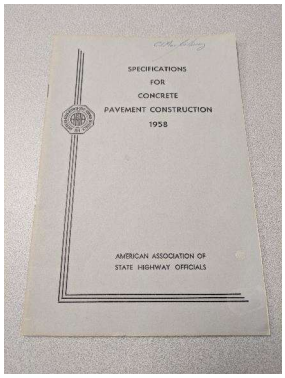
RMC RESEARCH & EDUCATION FOUNDATION

2

PEM?

A program to develop a better specification for concrete mixtures

- Understand what makes concrete “good”
- Specify the critical properties and test for them
- Prepare the mixtures to meet those specifications



3

Critical Properties

- Transport properties (permeability)
- Aggregate stability
- Cold weather resistance
- Strength
- Shrinkage
- Workability

4

A Better Specification

- The right properties measured at the right time
  - Prequalification
  - Process control
  - Acceptance
- A buffet of approaches
  - Prescriptive: w/cm, paste volume
  - Performance: Formation factor

Standard Practice for

Developing Performance Engineered Concrete Pavement Mixtures

AASHTO Designation: PP 84-20[1]

Tech Subcommittee: 3c, Hardened Concrete

Release: Group 1 (**)

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Our PEM Team

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

U.S.Department of Transportation
Federal Highway Administration

Oregon State University

OSU

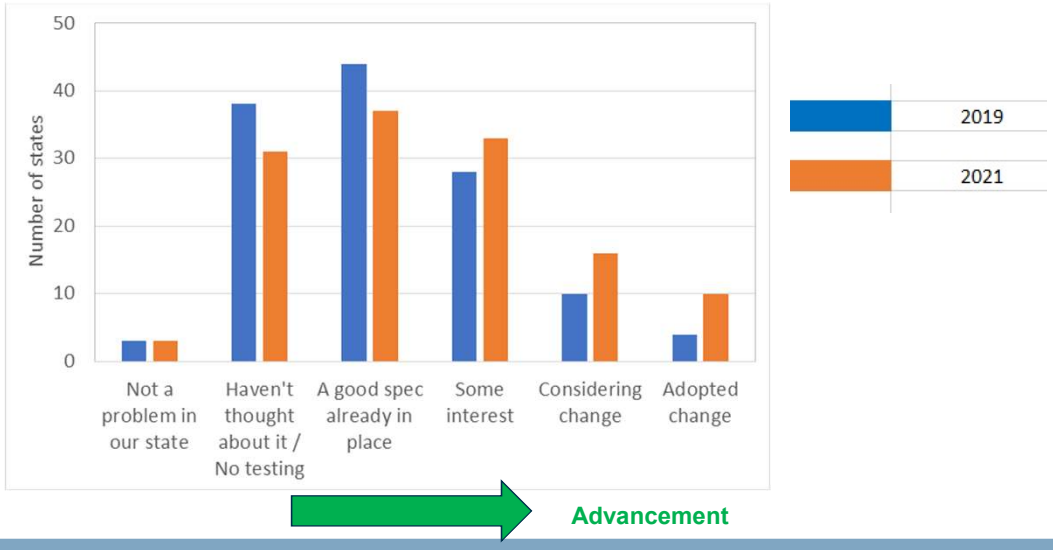
NCE

Diversified Engineering Services, Inc

National Concrete Pavement Technology Center

Iowa State University
Institute for Transportation

PEM State Specifications



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2022 PEM Update

- Resistivity Webinar
  www.cptechcenter.org/pem
- Test training in Idaho & Oklahoma
- PEM TRB Circulars (NY, IA, MI, NC, WI)
- 2022 MCTC PEM visits: NY & MN
- SPS-2 Testing
- Final Report
- TAC Update

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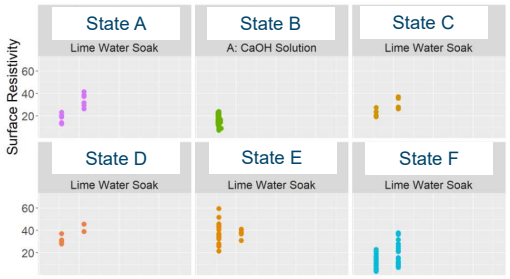
PEM Data: Shadow Testing

- Data from state PEM shadow tests & MCTC PEM tests
- Plots for fresh properties: air, SAM, Box, VKelly
- Plots for hardened properties: surface resistivity, hardened air, strength
- Individual state results
- Summary in final report
- States will have access to plot data



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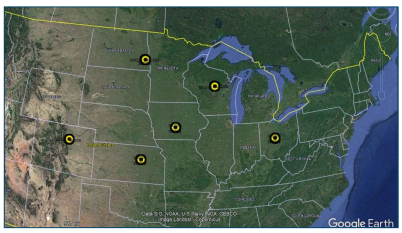
PEM SPS-2 Testing

Comparing performance and PEM tests with pavements from LTPP program

SPS-2 Project	Date(s) Cored	Sections Cored	Number of Cores Obtained
Colorado	06/23/2021	3	7
Iowa	09/21-22/2021	6	18
Kansas	12/08-09/2021	6	17
North Dakota	07/28/2021	6	20
Ohio	09/28-29/2021	6	19
Wisconsin	08/04-05/2021	8	19
	Total:	35	100



SPS-2 Data:

- Air, cement type, cement amount, SCM, w/cm, # aggregates, 20+ years of distress type / performance noted

Testing for:

- Hardened Air, Oxychloride, Porosity, Resistivity, Distress / performance

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PEM SPS-2 Testing


Colorado

Iowa


Kansas

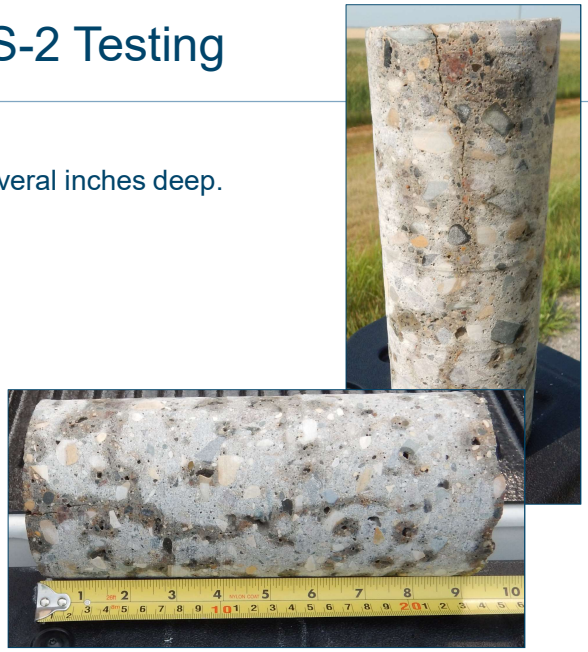

North Dakota


Ohio


Wisconsin

PEM SPS-2 Testing

- North Dakota
  - Thin cracks on surface were in fact several inches deep.



PEM Technical Report

- Executive Summary
- Introduction
  - Justification
  - Sustainability
- State Case Studies
- Exceeding the Goals
- From AASHTO PP-84-17 to AASHTO R 101 *(April 2022)*
  - Background
  - Justification for the test methods
  - Test Methods Summary
- Data Summary
- Training Summary
  - Test training
  - Workshops
- State Agency Assistance Summary
- State Agency Specifications
- Accomplishments
- Conclusions & Future Work
- Appendix (R 101 commentary, MCTC reports, FHWA state reports, LTPP SPS-2 testing, state mixtures & materials, shadow projects)


Standard Practice for
Developing Performance Engineered Concrete Pavement Mixtures
AASHTO Designation: R 101-22[1]
Technical Subcommittee: 3c, Hardened Concrete
AASHTO
American Association of State Highway and Transportation Officials
555 12th Street NW, Suite 1000
Washington, DC 20004

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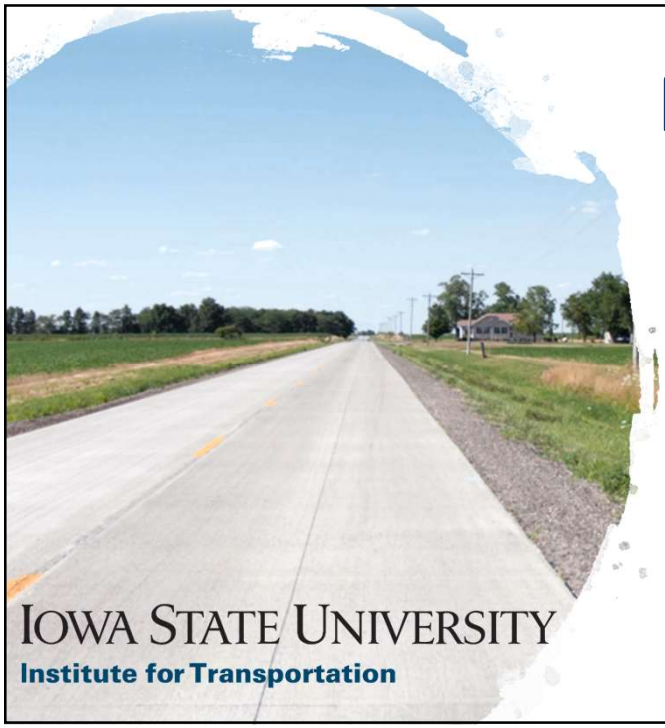

Moving Forward with SPEC…

NCC Fall Meeting
September 27, 2022

IOWA STATE UNIVERSITY
Institute for Transportation

National Concrete Pavement Technology Center

Leif G. Wathne, P.E.

Tech Center

SPEC – Sustainable Performance Engineered Concrete

PEM pooled fund:

Specify, measure, and deliver concrete paving mixtures that perform as intended for their design lifetime

Link to sustainability is undeniable…

Successful effort in accelerated time frame. AASHTO R101. Changing practice!

Only up to point of delivery… but what happens then…?

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Steps to Long Life

Target performance	Design Levers	Batching
Workability Durability Strength	Gradation Paste Volume Cementitious Admixtures	Uniformity – Water – Cementitious system – Aggregates Mixing – Time – Energy

SPEC

Transportation	Placement	Finishing
Mixing Workability – Time and weather – Added water / admixtures Uniformity	Handling / Vibration - Bleeding - Segregation - Air void system - Water movement	Surface finish Curing Sawing

SPEC – Sustainable Performance Engineered Concrete

- **Fundamental philosophy remains unchanged!**
- PEM consistently produce reliable high performing mixtures at the plant…. but what happens during:
  - Transport
  - Placement
  - Finishing
  - Sawing
  - Curing, etc.

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SPEC – Sustainable Performance Engineered Concrete

- Continue to assist state agencies on specification improvements and procedures to enhance performance
- Continue shadow and pilot projects
- Continue to offer program training
- Explore operational innovations to further advance reliability of concrete pavements

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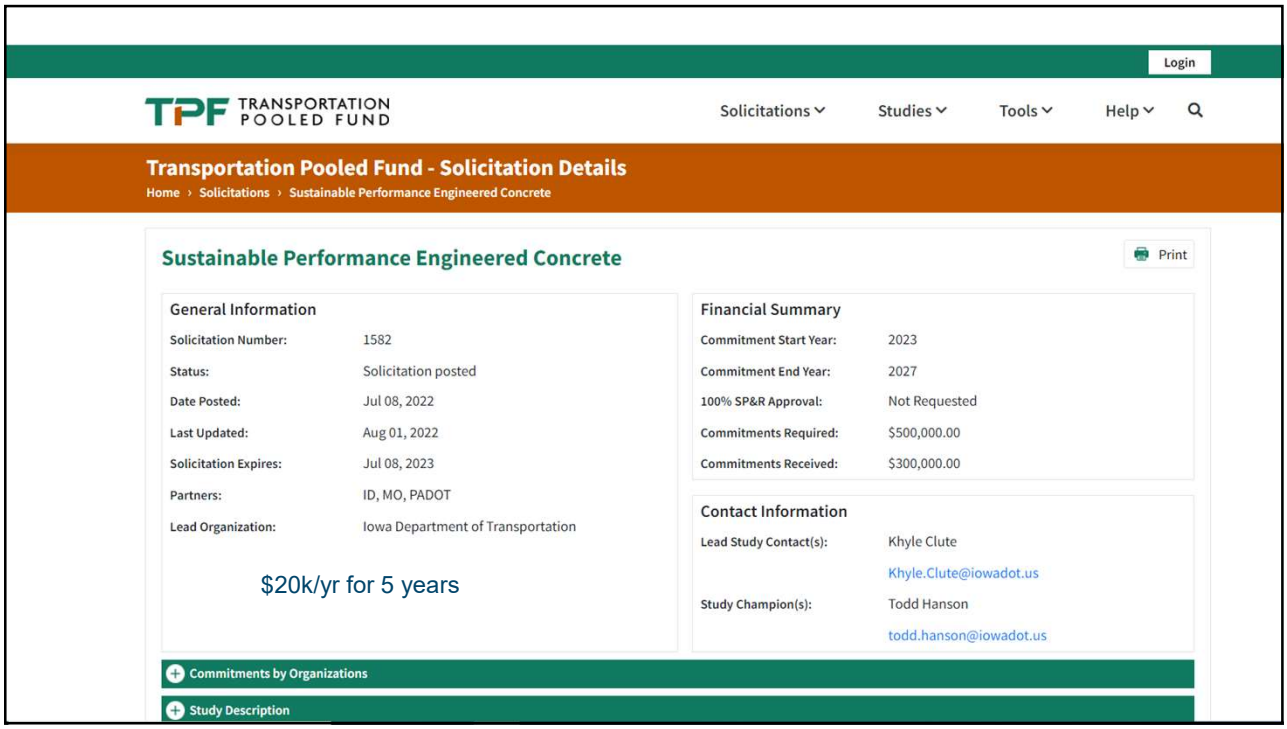

Continue the work of PEM through Sustainable Performance Engineered Concrete (SPEC)

Establish a sound understanding of concrete properties and how they are affected by workmanship, develop / select appropriate test methods for evaluation at or behind the paver, and provide tools for contractors to ensure compliance

Join agency and industry to further advance concrete as a sustainable and durable product.

See Pooled Fund details at:

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Sustainab

Establish a
they are affe
methods for
contractors

**Join agenc
advance cc
and durabl**

See Pooled

(SPEC)

and how
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Measurement at Trials

Purpose

Will the mixture comply with specification?

Is the mixture suitable for construction system?

Is the mixture rugged enough?

- Workability – VKelly, Response to vibration, water movement, air movement
- Bleeding and segregation – C232 or new
- Air void system – SAM, foam drainage
- Durability - Resistivity
- Strength - C39
- Paste content - Mortar layer and Finishability

Measurement at Delivery

Purpose

Is the mixture what was ordered?

Is the mixture uniform?

Do we have to call batch plant or adjust construction process?

- Workability – VKelly, slump, by eye?
- Air void system – C231, SAM?
- w/cm – Phoenix or new?

- Others?

Measurement at Acceptance

Purpose

Is the mixture what was specified?

Is the structure what was specified?

- As specified, typically
  - Strength, C39, Maturity
  - Resistivity, TP119
  - Air, C231
- Other
  - Consolidation
  - Dimensions
  - Stability
  - …