PEM Update

NESMEA 2019
OCTOBER 22, 2019 • PORTLAND, ME

MICHAEL F. PRAUL, P.E.
FHWA, OFFICE OF PRECONSTRUCTION, CONSTRUCTION, & PAVEMENTS

Unless otherwise noted, FHWA is the source of all images in this presentation.
PEM vs. PRS

Performance Engineered Mixtures

- Initiative promoting engineering concrete mix designs to perform in their service environment. PEM also promotes a number of new test technologies along with enhanced QC practices.

Performance Related Specifications

- “QA specifications that describe the desired levels of key materials and construction quality characteristics that have been found to correlate with fundamental engineering properties that predict performance.”

Source: Transportation Research Circular E-C137, Glossary of Highway Quality Assurance Terms
We Are Horrible With Change

- Timeframe for widespread use of SCMs
- 28-day strength testing
- Slump test
Evolution of Concrete Testing

Concrete

- Slump Cone: 1922, ASTM C143
- Pressure Meter: 1949, ASTM C231
- Rapid Chloride Permeability Test: 1981, FHWA/PCA

Cars

- 1920
- 1940
- 1960
- 1980
- 2000
## Implementing PEM

### Prescriptive
- Agency dictates how the material or product is formulated and constructed
- Based on past experience
- Minimal/uncertain ability to innovate
- Requires agency to have proper manpower and skill set to provide oversight

### Performance
- Agency identifies desired characteristics of the material or product
- Contractor controls how to provide those characteristics
- Maximum ability to innovate
- Reduced oversight burden on the agency
PEM-related Specification Changes

- **Colorado**
  - Surface Resistivity
  - Box test
  - V-Kelly
  - Removed Min/Max cement content
  - Allow up to 50% fly ash

- **New York**
  - SAM for acceptance

- **Wisconsin**
  - SAM for mix design approval

- **Many others evaluating**
PEM Pooled Fund Emphasis

- Implementation
- Education and Training
- Adjustments in specifications based on field performance
- Continued development of a knowledge base relating early age properties to performances
PEM Pooled Fund Partners

- FHWA
- State Departments of Transportation (DOTs)
- Industry (American Concrete Pavement Association, Portland Cement Association, National Ready Mixed Concrete Association, others)
PP 84 Implementation Incentive Funds

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

- FHWA PEM Implementation Incentive Funds
- “New” QC Plan?
- Box test experience
- Contractor moving forward
- Similar experience in Wisconsin

Images: Pixabay
Box Test

- Developed by Dr. Tyler Ley, Oklahoma State University
- Mixture response to vibration
  - Consolidation check
  - Edge slump check
- Easy visual check
- Mix design tool
  - Evaluate the gradation
  - Cementitious content
Box Test

- A workability test
- Simple, quick, easy (lends itself to QC)
- Included in AASHTO PP 84 (PEM)
- Structural concrete equivalent in development
Box Test

Consolidation Issues

Edge Slump Issues

4 Over 50% overall surface voids.
3 30% - 50% overall surface voids.
2 10% - 30% overall surface voids.
1 Less than 10% overall surface voids.

Consolidation Issues

Edge Slump Issues

Bottom Edge Slumping
Top Edge Slumping

If deflection is more than ¼” then it fails
Box Test

Project A

Finishability Issues

Project B

Edge slump Issues
FAST Act Section 503 (c)(3)
(B) Goals.- The goals of accelerated implementation and deployment of pavement technologies program shall include:

- (i) the deployment of **new, cost-effective designs, materials, recycled materials, and practices** to extend the pavement life and performance and to improve user satisfaction;
- (ii) the reduction of **initial costs and lifecycle costs** of pavements, including the costs of new construction, replacement, maintenance, and rehabilitation;
- (iii) the deployment of **accelerated construction techniques** to increase safety and reduce construction time and traffic disruption and congestion;
- (iv) the deployment of **engineering design criteria and specifications** for new and efficient practices, products, and materials for use in highway pavements;
- (v) the deployment of **new nondestructive and real-time pavement evaluation** technologies and **construction techniques**; and
- (vi) the effective **technology transfer** and information dissemination to accelerate implementation of new technologies and to improve life, performance, cost effectiveness, safety, and user satisfaction.
FHWA Cooperative Agreement with Iowa State University

Advancing Concrete Pavement Technology Solutions

The purpose of the Agreement is to...

- Deploy innovative technologies to improve pavement performance
- Develop and transfer new technologies
- Deliver tools and guidance documents to States to support the increased knowledge of concrete materials, concrete pavement design, construction, and maintenance
FHWA Cooperative Agreement with Iowa State University

Six Work Areas

1. Extending pavement life and performance
2. Reduction of initial costs and lifecycle costs of pavements
3. Deployment of accelerated construction techniques
4. Deployment of design criteria and specifications for new practices/products/techniques
5. Deployment of non-destructive testing and real-time pavement evaluation techniques
6. Technology transfer and information dissemination
WOPR No. 02 – Performance Engineered Pavements

- Performance Engineered Mixtures (PEMs)/AASHTO PP84
  - Model QC Plan template for highway projects (with guidance)
  - QC control chart tools
  - Model performance specification

- Precision and Bias Statements
Suggestions for Cooperative Agreement
Implementing the Super Air Meter (SAM)

- Concerns with device durability
- Concerns with data variability
  - Multiple causes
  - New algorithm
- Concerns with time to perform
- Questions about appropriate use
  - QC?
  - Mix design approval?
  - Acceptance?
Current Portland Cement Concrete PWL Acceptance States

Map source: https://www.openstreetmap.org/copyright
Establishing PWL Spec Limits

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If 90 PWL = Upper Spec Limit
90 PWL: 1 Limit $z = 1.28$

$$Z = (\text{Mean} - \text{Spec. Limit}) / \text{Std. Dev.}$$
Spec. Limit = Mean + (Z * Std. Dev.)

Upper Spec Limit
Calculated

0.30

Calculated 90 PWL

Freq

SAM Number
Establishing PWL Spec Limits

**State R**

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If 90 PWL = Upper Spec Limit
90 PWL: 1 Limit $z = 1.28$
$Z = (\text{Mean} - \text{Spec. Limit})/\text{Std. Dev.}$
Spec. Limit = Mean + (Z * Std. Dev.)
Upper Spec Limit
Calculated 0.33

**State T SAM**

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If 90 PWL = Upper Spec Limit
90 PWL: 1 Limit $z = 1.28$
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Spec. Limit = Mean + (Z * Std. Dev.)
Upper Spec Limit
Calculated 0.23

**State R SAM PWL**

**State T SAM**

Calculated 90 PWL
### Establishing PWL Spec Limits

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$90 \text{ PWL: } 1 \text{ Limit } z = 1.28$

$Z = \frac{\text{Mean} - \text{Spec. Limit}}{\text{Std. Dev.}}$

Spec. Limit $= \text{Mean} \pm (Z \times \text{Std. Dev.})$

Calculated 0.24

#### State V SAM

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$Z = \frac{\text{Mean} - \text{Spec. Limit}}{\text{Std. Dev.}}$

Spec. Limit $= \text{Mean} \pm (Z \times \text{Std. Dev.})$

Upper Spec Limit

Calculated 0.36
# SAM Data Analyzed

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<td>0.124</td>
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Payment Plan with 5% Incentive

PF = 0.5PWL + 55

Estimated PWL

AQL

RQL
PWL Hypothetical Pay

- Hypothetical payment scenarios
- PWL Spec with upper specification limit from pilot population

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• FREE to the host
• Host provides: Room, projector, attendees
• Under a cooperative agreement, FHWA/ACI provide instructors, all training materials
• 1-2 month lead time
• States may request multiple presentations
• Agreement expires September 18, 2020
• Contact: Tom Yu
  o tom.yu@dot.gov
  o (202) 366-1198
Chemical Admixtures for Concrete

Chemical Admixtures for Concrete

Seminar Overview

TBD

Continuing Education

American Concrete Institute 0.75 CEUs (1.5 PDHs)

Location

A facility of your choosing

Registration:
7:45 a.m.
Workshop:
8:00 a.m. - 5:00 p.m.

Who Should Attend

The seminar is designed to make this course beneficial to a broad range of attendees including DISP engineers, concrete production managers, plant managers, project superintendents, construction supervisors, QC/QC managers, advertising, contractors, and concrete producers.

Topics to be covered

- Introduction to Chemical Admixtures
- Air entrainment of concrete
- Water reducible admixtures
- High range admixtures
- Superplasticizers (Viscosity-Modifying Admixtures)
- Retarding admixtures (Temperature Control, Accelerators, and other Chemical Additives)
- Admixtures for High-Performance Concrete

Free Resource Materials

- ACI 318-08, "Chemical Admixtures for Concrete"
- ACI 318, "Guide for the Use of High-Range Water-Reducing Admixtures (Superplasticizers) in Concrete"
- ACI 305R, "High Range Admixtures"
- ACI 355R-95, "High Range Water-Reducing Admixtures"
- ACI 355, "High Range Water-Reduction Admixtures"
- ACI 355R-95, "Water-Reducing Admixtures for Hot Weather Concretes"
- ACI 305R-95, "Water-Reducing Admixtures for Cold Weather Concretes"
- PCI Technical Series #1, "Chemical Admixtures for Concrete"
- PCI Technical Series #11 (Revision 5)
- "Guide to the Control of Concrete Quality" - 14th Edition (Chapter 6)
- "Concrete Materials" (ACI Committee 201), Volume 2

Chemical Admixtures for Concrete

Faculty

Two of the following will be your instructors:

Barry H. Kail, P.E., is a Technical Service Manager with BASF-Urban USA, Memphis, LA, and has over 20 years of experience in the concrete admixture industry. He is a member of ASC and ASCI, and is a registered professional engineer. He is an active member of ASCI, and has been an instructor for PCI and AIAG training programs.

Charles E. Bass, P.E., M.ASCE, is Manager of Engineering Services at BASF Corporation, a leading manufacturer of specialty concrete admixtures headquartered in Cleveland, OH. He has been involved in technical sales and marketing for over 15 years. He has managed and coordinated numerous technical seminars and field training seminars across the United States and Canada. He has also served as an editor of PCI and ASCI publications.

C.K. Ogundari, Ph.D., is a Principal Research Scientist with the Virginia Transportation Research Council (VTRC) at Virginia Tech, VA, which is responsible for developing, testing, and evaluating innovative materials, technologies, and practices for transportation applications. He has been involved in research on transportation sustainability for over 10 years. He has served as a keynote speaker at numerous national and international conferences and workshops. He has received numerous awards, including the Virginia Department of Highways and Transportation Award for Outstanding Research, and he is a member of the American Society of Civil Engineers (ASCE).
Cementitious Materials for Concrete

Seminar Overview

This seminar, presented under a cooperative agreement between the Federal Highway Administration (FHWA) and the American Concrete Institute (ACI), will introduce and enhance fundamental knowledge and understanding of cementitious materials used in concrete. The presentations will discuss the importance of various cementitious materials in their respective performance, design, and construction of reinforced and non-reinforced concrete. This information will be helpful in addressing the performance, safety, and sustainability of concrete infrastructure for a particular project and the necessary personal understanding and preparation for the field behavior of concrete in a construction project.

Who Should Attend

This seminar is designed to benefit anyone in the concrete industry, including DOT engineers, plant managers, quality inspectors, field supervisors, contractors, and students.

Free Resource Materials

- ACI 211.1, Standard Practice for Selecting Water-Reducing Admixtures for Normal, High-Performance, and High-alkali Concrete
- ACI 211.2R, Guide to the Selection and Use of Admixtures for High-alkali Concrete
- ACI 212.2R, Guide to the Selection and Use of Admixtures for Low-alkali Concrete
- ACI 212.3R, Guide to the Selection and Use of Admixtures for Low-alkali Concrete
- ACI 212.4R, Guide to the Selection and Use of Admixtures for Low-alkali Concrete
- ACI 212.5R, Guide to the Selection and Use of Admixtures for Low-alkali Concrete
- ACI 212.6R, Guide to the Selection and Use of Admixtures for Low-alkali Concrete
- ACI 212.7R, Guide to the Selection and Use of Admixtures for Low-alkali Concrete
- ACI 212.8R, Guide to the Selection and Use of Admixtures for Low-alkali Concrete
- ACI 212.9R, Guide to the Selection and Use of Admixtures for Low-alkali Concrete
- ACI 212.10R, Guide to the Selection and Use of Admixtures for Low-alkali Concrete
- ACI 212.11R, Guide to the Selection and Use of Admixtures for Low-alkali Concrete
- ACI 212.12R, Guide to the Selection and Use of Admixtures for Low-alkali Concrete
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- ACI 212.15R, Guide to the Selection and Use of Admixtures for Low-alkali Concrete
- ACI 212.16R, Guide to the Selection and Use of Admixtures for Low-alkali Concrete
- ACI 212.17R, Guide to the Selection and Use of Admixtures for Low-alkali Concrete
- ACI 212.18R, Guide to the Selection and Use of Admixtures for Low-alkali Concrete
- ACI 212.19R, Guide to the Selection and Use of Admixtures for Low-alkali Concrete

Faculty

Two of the following will be your instructors:

- David L. Miller, PE, ACI, is a Technical Service Manager with Buzco Uniforms USA, Memphis, LA, and has over 30 years of experience in the concrete construction industry. He is the Chair of ACI Committee 212, Quality in Concrete, and serves on several ACI Committees for mix design, materials, certification, and education. He was named an ACI Fellow in 1999. He has served as President of the ACI Louisiana Chapter. He is also an active member of ASTM international, involved in committees for concrete, concrete and cement aggregate, and concrete pipes. He has been an instructor for PCA and NRMCA training programs.

- Daniel C. Gonsalves, PE, ACI, is a Senior Technical Services Manager, Training Manager for the ACI Group, Concrete FX, Groton, MA, and has over 30 years of experience in the concrete construction industry. He is a member of the ACI Board of Directors and Chair of ACI Committee 212, Quality in Concrete. He has served on several ACI committees for materials, concrete, certification, and education. He was named a Fellow of ACI in 2010. He has served as President of the ACI Kansas and Iowa Minnesota Chapters and as a member of the ACI Iowa, Nebraska, and Kansas chapters. He is a Licensed Professional Engineer in Kansas and Wisconsin.

- Paul A. Eberl, PE, ACI, is the Director of Professional Development at ACI. He is the Chairman of the ACI-ASCE Education Foundation Board of Directors and serves on several ACI Committees for concrete and cement. He has served as a member of several ACI committees for materials, concrete, and certification. He was named an ACI Fellow in 2010. He has served as President of the ACI Kansas and Iowa Minnesota Chapters and as a member of the ACI Iowa, Nebraska, and Kansas chapters. He is a Licensed Professional Engineer in Kansas and Wisconsin.

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Self-Consolidating Concrete

Self-Consolidating Concrete

FHWA/ACI One-day seminar

Location
A facility of your choosing

Continuing Education
American Concrete Institute

Seminar Overview
This seminar, presented jointly with the Federal Highway Administration (FHWA) and the American Concrete Institute (ACI), will provide highway and transportation professionals with a comprehensive understanding of self-consolidating concrete (SCC). The two-and-a-half day course will clearly explain how SCC can be used to achieve higher and more durable concrete in transportation projects. In addition, a case study component will provide an overview of projects in the geographic area that involved SCC and relate their experiences working with the material.

Who Should Attend
The seminar is designed to provide significant benefits to a broad range of attendees, including DOT engineers, civil engineers, material testing technicians, specifications, project supervisors, construction superintendents, QC/QC managers, in-house contractors, and concrete producers.

Topics to be covered
- History and Basic Overview
- Standardization Efforts and SCC Test Methods
- Moisture and Workability of SCC
- Fresh and Hardened Properties of SCC
- Admixture and Compressive Benefits of SCC
- SCC in Difficult Shaft Construction
- Concrete by Visual Inspection Procedure
- Specifications and Standards

Faculty
Charles Biseli, Ph.D., PE, F ACI, is Manager of Engineering Services at BASF Construction Chemicals, LLC, a leading manufacturer of specialty construction chemicals based in Cleveland, OH. He specializes in providing technical literature and technical guidance in the utilization of admixtures and high-performance concrete technologies and chemical additives for concrete products. He is also responsible for the high-performance concrete and chemical technologies used at BASF's U.S. facility.

Aileen K. Schleisner, Ph.D., PE, is a Senior Associate Professor at Auburn University, where she teaches courses in engineering and fabrication, structural design, and concrete materials in the Civil Engineering Department. She received her B.S. and Ph.D. in civil engineering from the University of Texas at Austin. She is a member of ASCE, Structural Concrete Institute (SCI), Properties of Concrete, and a member of ACI Committee 318, Investigators of Concrete of East Africa, and C2T Settling Consolidating Concrete. She was a technical member of ACI Committee 318 - "Self-consolidating concrete for precast, cast-in-place, and lightweight concrete elements." She is a technical member of ACI, TBI, ACI-220, and ACI-230 and is a technical reviewer for the AASHTO Guide for Concrete Materials Research in 2014.
Questions?

- Contact info
  Michael.Praul@dot.gov
  207-512-4917