

## About the Speaker

- Mike Praul is the Senior Concrete Engineer with FHWA
- 34 years with FHWA
- Manages Mobile Concrete Technology Center program and leads FHWA's PEM initiatives
- Lives in Augusta, ME with wife Jody
- Loves dachshunds



U.S. Department of Transportation  
Federal Highway Administration

## FHWA Program Update



National Concrete Consortium, Spring 2021 Meeting  
April 13, 2021

**MICHAEL F. PRAUL, PE**  
**SENIOR CONCRETE ENGINEER**  
**FHWA, OFFICE OF INFRASTRUCTURE**



U.S. Department of Transportation  
Federal Highway Administration  
Office of Infrastructure

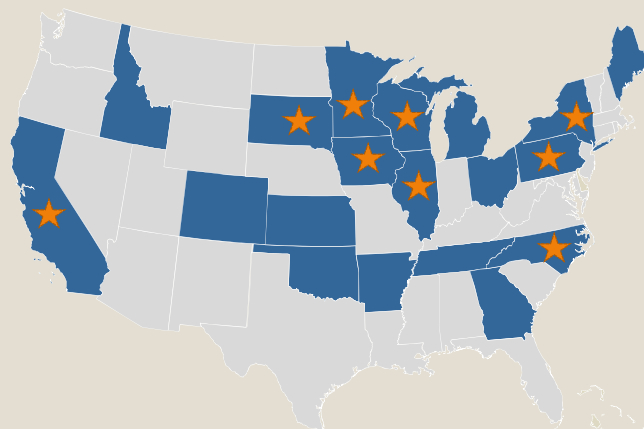
*FHWA is the source of all images in this presentation  
unless otherwise noted.*

## Pavement and Materials Program Areas

### FHWA P&M Program Areas



## PEM Implementation Incentive



19 States + FHWA & Industry (November 2020)

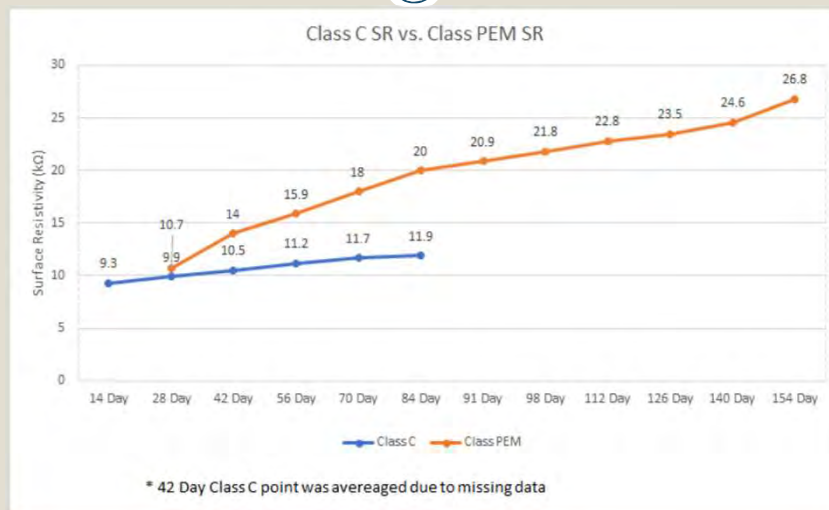
★ Performance-Engineered Mixtures (PEM) Implementation Incentive Pilot Project

## New York Project Highlights

- PEM approach is beneficial to State and industry
- PEM mix tested better in all tests vs. Class C
- 2<sup>nd</sup> supplier was reluctant to participate
  - Determined QC requirements were not much more than they currently do
  - Mix looked and placed better than Class C
- Needs
  - Training in new tests
  - Understanding roles and responsibilities in a performance specification (including QC monitoring)
  - Consider 56-day testing for resistivity
- **Developing next project in NYC area (structural)**



## New York Surface Resistivity Testing



## North Carolina Project Highlights

- **Box Test**
  - Highly useful in mix development and evaluation (contractor)
  - Simple, easy test. Potential to add to specification (NCDOT)
- **Super Air Meter**
  - After some training, readily incorporated into quality control (QC) (contractor)
  - Doing more shadow testing and consider future use (NCDOT)
- **Surface Resistivity**
  - Easy. Readily incorporated into QC (contractor)
  - Easy. Affordable equipment. Will equip all State labs. (NCDOT)
  - UNC-Charlotte working to develop 28-day result to correlate with 56-day results



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## North Carolina Project Highlights

- “Valuable experience” (contractor and NCDOT)
- “Due to project schedule, we were unable to apply the PEM criteria during the preliminary mix design phase. However, going forward, **we intend to implement PEM guidelines on future PCCP (portland cement concrete pavement) projects.**” (contractor)
- “The Department will continue to explore PEM to see how these tests and other AASHTO PP 84 provisions will work with our daily operations.” (NCDOT)
- **NCDOT will pilot PEM bridge project.**



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## Iowa Project Highlights

- **Box Test: 45#/cy reduction in cement**
  - Contractor now using to develop mixes
- **Super Air Meter comments**
  - Need for technician training
  - Attention to detail for correlation testing
  - Concern with gauge durability
- **Surface Resistivity**
  - Invaluable information for agency and industry
  - Easy to perform, no changes needed
- **Expanded typical QC requirements without issue**
- **2020 project use proposed by contractor. Approved!**



## Iowa Impact Analysis

- Collaboration with MCTC
- Comparison of conventional and performance engineered concrete mixtures

| Year   | Std mixes |      | PEM  |
|--|-----------|------|------|
|  | 2019      | 2019 | 2020 |
|  | QMC       | QMC  | PEM  |
|  | ML        | ML&S | ML&S |
| Material constituents [lbs/yd <sup>3</sup> ] |           |      |      |
| Cement                                       | 463       | 427  | 399  |
| Fly ash                                      | 116       | 107  | 100  |
| Slag or other pozzolans                      | 0         | 0    | 0    |
| Coarse aggregate                             | 1188      | 1427 | 1441 |
| Intermediate aggregate                       | 0         | 0    | 0    |
| Fine aggregate                               | 1744      | 1708 | 1752 |
| Water  | 274       | 214  | 199  |
| Total aggregate:                             | 2932      | 3135 | 3193 |
| Total weight:                                | 3785      | 3883 | 3891 |



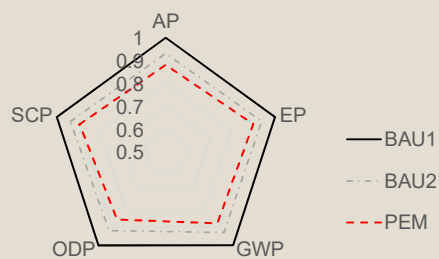
## Life Cycle Impact Assessment

- TRACI 2.1 by the U.S. Environmental Protection Agency
- Impact categories:
  - Acidification potential (AP)
  - Eutrophication potential (EP)
  - Global warming potential (GWP)
  - Ozone depletion potential (ODP)
  - Smog creation potential (SCP)



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## Preliminary Results: Mixture Comparison



- Reduction of cement by 36 lbs/yd<sup>3</sup> → 7% savings in all impacts.
- Reduction of cement by 64 lbs/yd<sup>3</sup> → 10-14% savings in all impacts.



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## Total Savings: Shoulder

### Greenhouse gas emissions from



### Total CO<sub>2</sub>-eq savings

- 1 m<sup>3</sup> of concrete= 21 kg.
- Shoulder (6' by 8"- Iowa project from 2019)= 12.4 t/ mile.



Source: <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>



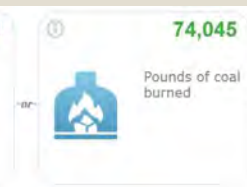
U.S. Department of Energy  
National Renewable Energy Laboratory

## Total Savings: Main Line + 2 Shoulders per Mile



### Total CO<sub>2</sub>-eq. savings:

- Shoulder (6' and 10' by 8"- Iowa project from 2020)= 33.1 t.
- Main lane (12' by 11"- Iowa project from 2020)=34.1 t
- TOTAL= 67.2 t



Source: <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>



U.S. Department of Energy  
National Renewable Energy Laboratory

## FHWA Mobile Concrete Technology Center (MCTC) Program



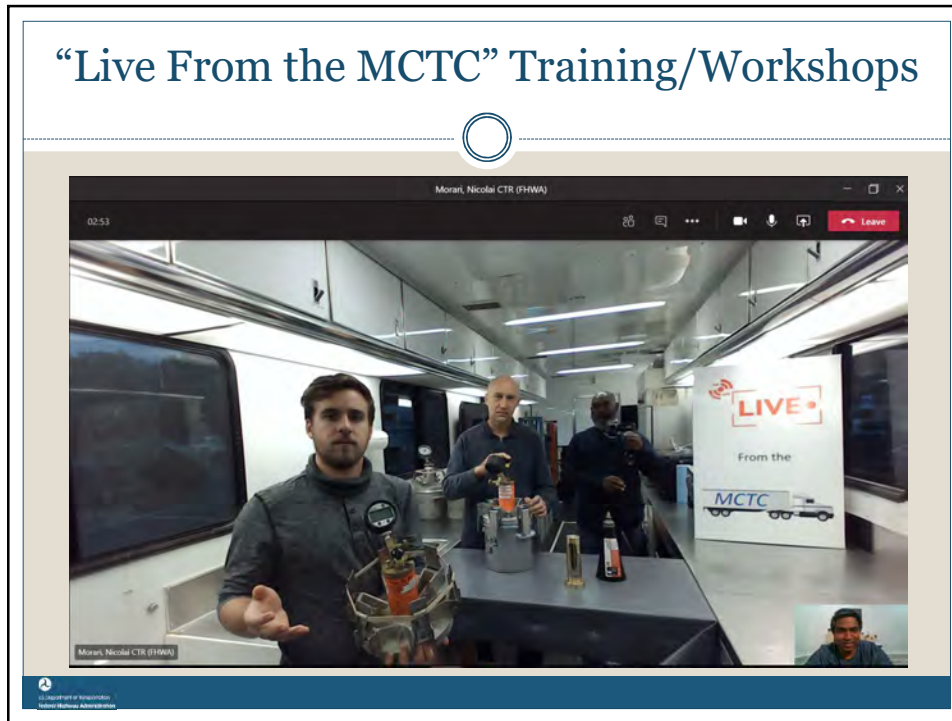
## 2020 Program Activities

- Live training
- Virtual tours (conference)
- Training video briefs: “how-to’s” of MCTC equipment being deployed
- Turner-Fairbank Highway Research Center collaboration
- Equipment Loan Program
- Technical assistance/data analysis
- Specification reviews
- Technical publications



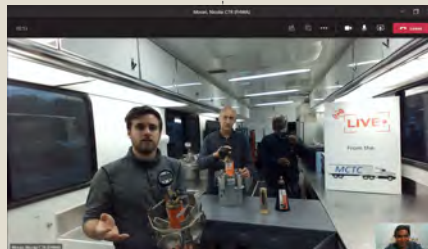


## “Live From the MCTC” Training/Workshops



## “Live From the MCTC” Topics

- Super Air Meter (SAM)
- Surface/Bulk Resistivity
- Maturity
- Box Test/V-Kelly
- Semi-adiabatic calorimeter
- Phoenix (fresh water content)
- MIT Scan T3
- MIT Dowel Scan
- HIPERPAV
- Optimized gradation software



## Endorsement

“I was at the MO/KS ACPA workshop and the Live Tour of the MCTC was absolutely fabulous - clear, informative, and **felt like we were together** (as much as 2021 could allow anyway). Jim & Josh did a fantastic job leading this effort!”

Jesse Jonas  
ACPA-Missouri



## One-Pager Series

- Effort to use MCTC data and experience
- Narrowly focused
- Meant to stir interest and point reader to resources
  - 1<sup>st</sup> : Cement Content
  - 2<sup>nd</sup> : Optimized Mix Design
  - 3<sup>rd</sup> : Cores vs. Cylinders
  - 4<sup>th</sup> : NDT Thickness Measurement
  - 5<sup>th</sup> : Surface Resistivity
  - 6<sup>th</sup> : Texture of Concrete Pavements
  - 7<sup>th</sup> : Maturity
  - 8<sup>th</sup> : Curing
  - 9<sup>th</sup> : Workability
  - 10<sup>th</sup>: Air Entrainment
  - 11<sup>th</sup>: Stringless Paving



### QUICK & REAL-TIME ASSESSMENT OF DOWEL BARS

Proper alignment is essential to ensure quality and functionality

Assessment of hardened concrete pavements can be useful, but not actionable – especially when it comes to identifying longitudinal or vertical misalignment, depth deviation, or side-shift of dowels. During a site visit to a Minnesota DOT project, the FHWA's Mobile Concrete Technology Center (MCTC) identified a real-time solution for quality control and inspection that quickly locates dowel bars and its bars during concrete placement.

#### THE CHALLENGES

**Dowel Alignment:** Placement is a serious challenge. Despite diligent care, dowel breaks and dowels placed with a dowel bar inserter (DBI) may become misaligned. Barter anchoring mechanisms and DBI alignment aids are critically important to ensure that dowel bars are properly located over the spans.

#### Testing Issues:

- Common assessment methods, like coring and pulling, are labor intensive and sometimes impractical.
- Core assessments are typically conducted on hardened concrete.
- Problems can't be identified during construction.

#### INNOVATIVE SOLUTION

Using pulse induction technology (e.g., AISCAN-UT), already a proven tool for measuring pavement thickness nondestructively, concrete professionals can assess the presence of dowel bars while the concrete is still plastic. Significant dowelbar, barter misplacement, and dowel issues can be identified and corrected during construction.

#### Benefits:

- Quick and easy to use and handle
- Real-time assessment, immediately tailored the score, allows for real time corrections
- Handheld device
- Creates quality control
- The same device can be used to determine pavement thickness, performing dual functions

#### Limitations:

- Readings are non-numerical and therefore should not be used for final acceptance
- Technology is less effective if dowel bar and its bars are not close together.

#### SOLUTIONS IN ACTION

With a variety of benefits, this versatile pulse induction technology is used by both agency inspection and contractor quality control. The Minnesota DOT has successfully implemented the technology for locating dowel bars and its bars.

[Link to the MNDOT Spec](#)

LEARN MORE ABOUT THIS PROGRESSIVE NEW APPROACH TO QUALITY CONTROL AT  
[WWW.FHWA.DOT.GOV/PAVEMENT/CONCRETE/TRAILER/INDEX.CFM](http://WWW.FHWA.DOT.GOV/PAVEMENT/CONCRETE/TRAILER/INDEX.CFM)

PUB #



## TFHRC Update



# Turner-Fairbank Highway Research Center



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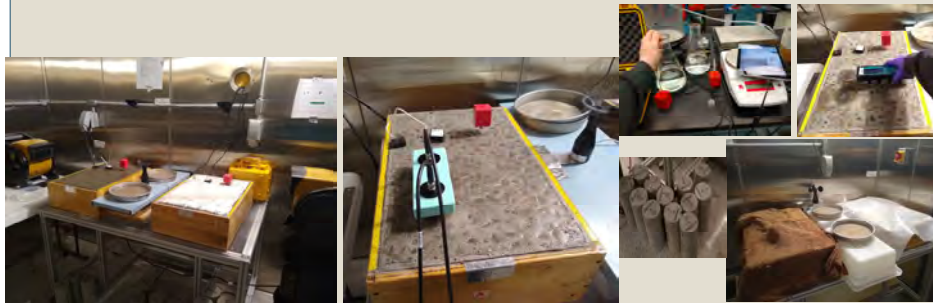


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## Curing Quantification



Identify implementation-ready technologies to provide a tool to quantify if curing best practices are followed.



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Contact: [Robert.Spragg@dot.gov](mailto:Robert.Spragg@dot.gov)

## AASHTO Resistivity Task Force

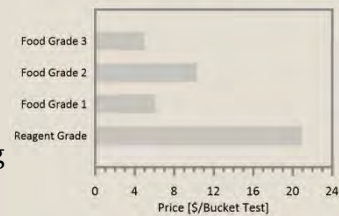
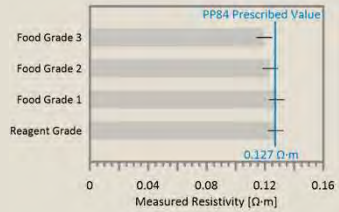
- **AASHTO COMP 3C Task Force 20-01: Resistivity**

- 19 members (8 DOTs & Others)
- Meeting since November 2020

- **Harmonization where applicable**

- **Consensus on how to specify curing**
  - Specifically looking at the “Bucket Test”
  - Proportions vs. measurement of solution

- **On going efforts at FHWA are looking to see if strength/resistivity can be conducted on same specimens in curing solution**

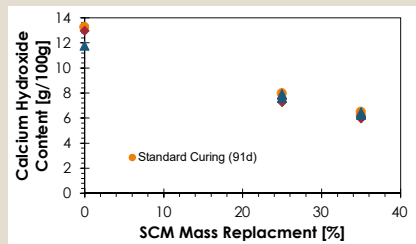


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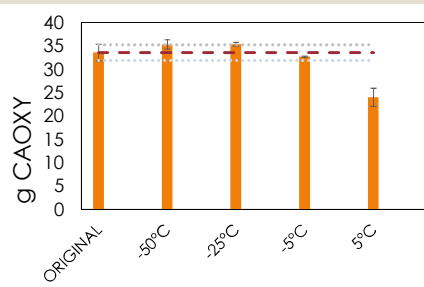
## Extension of Existing Tests

- **Accelerated Curing To Determine Transport Properties**



Montanari, et al. (2021). Accelerated Curing of Concrete Mixtures for Resistivity and Formation Factor Evaluation. In Preparation.

- **Increased Accessibility of Calcium Oxychloride Testing**



Montanari, et al. (2020). Quantification of Calcium Oxychloride by Differential Scanning Calorimetry: Validation and Optimization of the Testing Procedure. Submitted to *Advances in Civil Engineering Materials*.

Contact: Robert.Spragg@dot.gov



Is your agency experiencing **premature joint deterioration in concrete pavements** or **interested if CaOXY evaluation** might be a useful addition to your pavement program?

Robert.Spragg@dot.gov



## FHWA-TFHRC Aggregates & Petrographic Lab Program

### Materials Performance in Highways



- Alkali Aggregate Reactions in Concrete
  - Alkali-Silica & Alkali-Carbonate
- Research Highway Materials & Aggregates in – Concrete, Asphalt, & Granular Bases
- Several University Exploratory Advanced Research (EAR) and Small Business Innovative Research (SBIR) Projects on Fly Ash & the Quality of Entrained Air-Voids in Concrete
- Provide Forensic Microscopy Help to State DOTs, FHWA Offices, NTSB, etc. on Pavement & Concrete Investigations – *Identify Rock Types, Minerals, Micro-Cracks & Reaction Products*



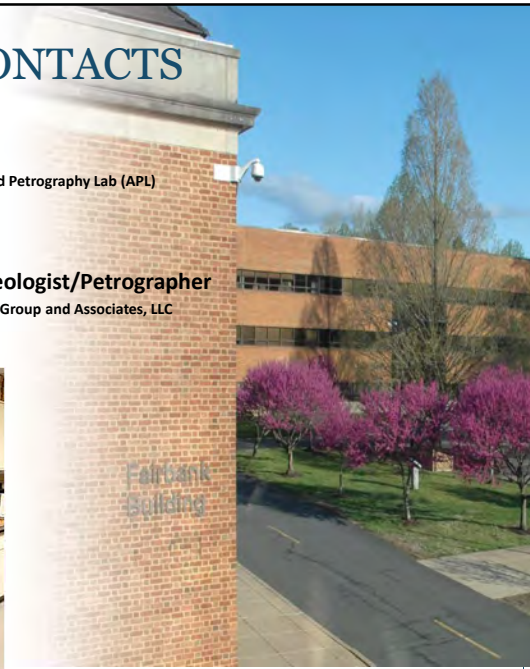
## Example Forensic Petrography and Research Investigations

- Alkali Reactive Coarse Aggregates – Siliceous & Carbonate Constituent Effects
- Open-Graded Aggregate Tested in Geotech Lab Large-Scale Shear-Boxes
- Aggregate Quality – Cause of Low Concrete Strength in Slip-Form Pavement
- Coarse Aggregate Polishing in Low Friction Asphalt Pavement
- Organic Materials in Natural Sand Failing the Organic Colorimetric Test
- Evaluation of Recycled Concrete Aggregates (RCA) from Urban Rubble
- Rebar Shadowing in Bridge Deck Placement Over Prestressed/Precast Panels
- NTSB Investigation of the Hardened Concrete Mixture Properties in Bridge Failure & Investigations of Bus Crashes Involving Asphalt Pavements
- Blend Aggregate Properties in Stripping Asphalt Mixture Tested in the Lab



## CONTACTS

- **Mr. Richard (Rick) Meininger, PE**  
Federal Lab Manager of the HRDI Aggregates and Petrography Lab (APL)  
✉ [Richard.Meininger@dot.gov](mailto:Richard.Meininger@dot.gov)
- **Dr. Mengesha Beyene, Ph.D.; Geologist/Petrographer**  
Contract Lab Manager; Petrographic Expert, SES Group and Associates, LLC  
✉ [Mengesha.Beyene.ctr@dot.gov](mailto:Mengesha.Beyene.ctr@dot.gov)





## Questions?



*Image Pixabay*

Contact info:

[Michael.Praul@dot.gov](mailto:Michael.Praul@dot.gov)

207-512-4917