Innovations in Concrete Pavement; Activities at CP Tech Center

Hamed Sadati, PhD

National Concrete Pavement Technology Center

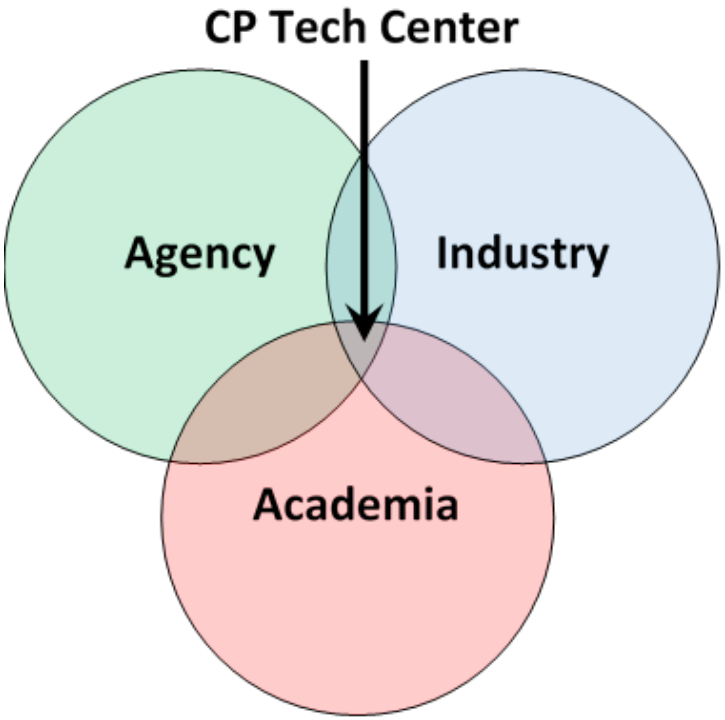
Tech Center

Iowa State University
Institute for Transportation

Making a Difference

Why Do We Exist?

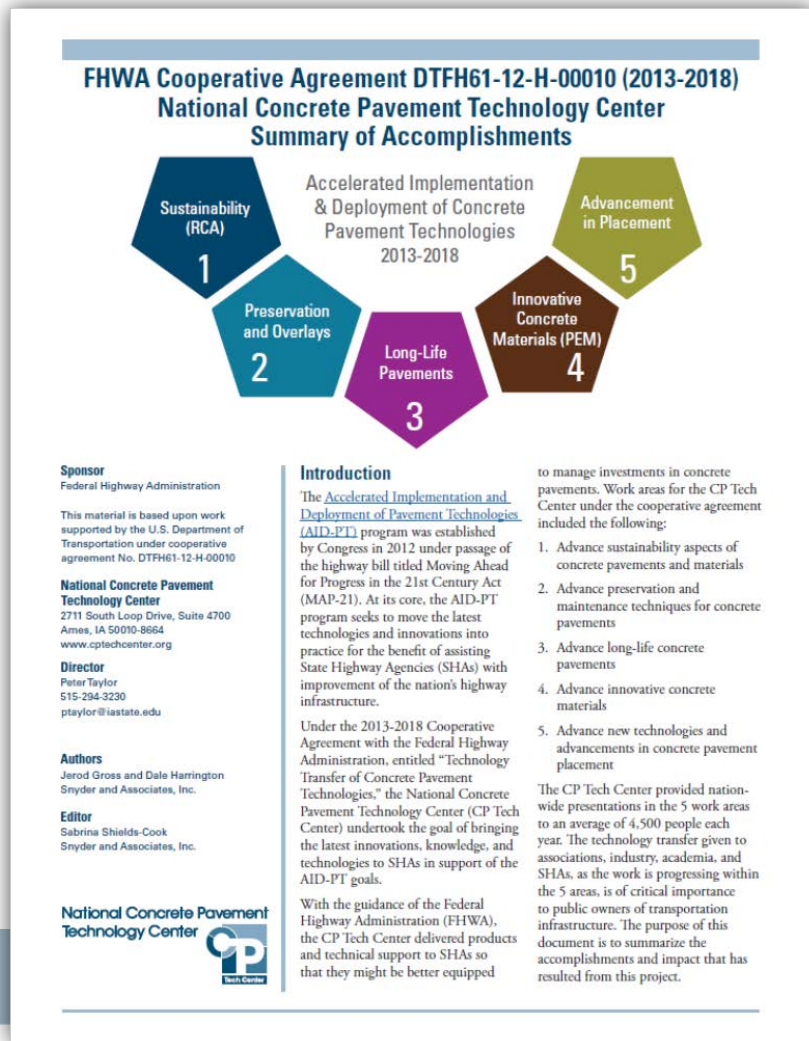
The purpose of the center is to unite agencies, industry and researchers to advance concrete pavement technology



What Do We Do?

- We research
- We solve problems
- We write
- We teach
- We demonstrate

- In all things concrete pavements



FHWA Cooperative Agreement DTFH61-12-H-00010 (2013-2018)
National Concrete Pavement Technology Center
Summary of Accomplishments

Sponsor
Federal Highway Administration

This material is based upon work supported by the U.S. Department of Transportation under cooperative agreement No. DTFH61-12-H-00010

National Concrete Pavement Technology Center
2711 South Loop Drive, Suite 4700
Ames, IA 50010-8664
www.cptechcenter.org

Director
Peter Taylor
515-294-3230
ptaylor@iastate.edu

Authors
Jerod Gross and Dale Harrington
Snyder and Associates, Inc.

Editor
Sabrina Shields-Cook
Snyder and Associates, Inc.

National Concrete Pavement Technology Center

Introduction

The Accelerated Implementation and Deployment of Pavement Technologies (AID-PT) program was established by Congress in 2012 under passage of the highway bill titled Moving Ahead for Progress in the 21st Century Act (MAP-21). 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.

Under the 2013-2018 Cooperative Agreement with the Federal Highway Administration, entitled "Technology Transfer of Concrete Pavement Technologies," the National Concrete Pavement Technology Center (CP Tech Center) undertook the goal of bringing the latest innovations, knowledge, and technologies to SHAs in support of the AID-PT goals.

With the guidance of the Federal Highway Administration (FHWA), the CP Tech Center delivered products and technical support to SHAs so that they might be better equipped to manage investments in concrete pavements. Work areas for the CP Tech Center under the cooperative agreement included the following:

1. Advance sustainability aspects of concrete pavements and materials
2. Advance preservation and maintenance techniques for concrete pavements
3. Advance long-life concrete pavements
4. Advance innovative concrete materials
5. Advance new technologies and advancements in concrete pavement placement

The CP Tech Center provided nation-wide presentations in the 5 work areas to an average of 4,500 people each year. The technology transfer given to associations, industry, academia, and SHAs, as the work is progressing within the 5 areas, is of critical importance to public owners of transportation infrastructure. The purpose of this document is to summarize the accomplishments and impact that has resulted from this project.

Staff

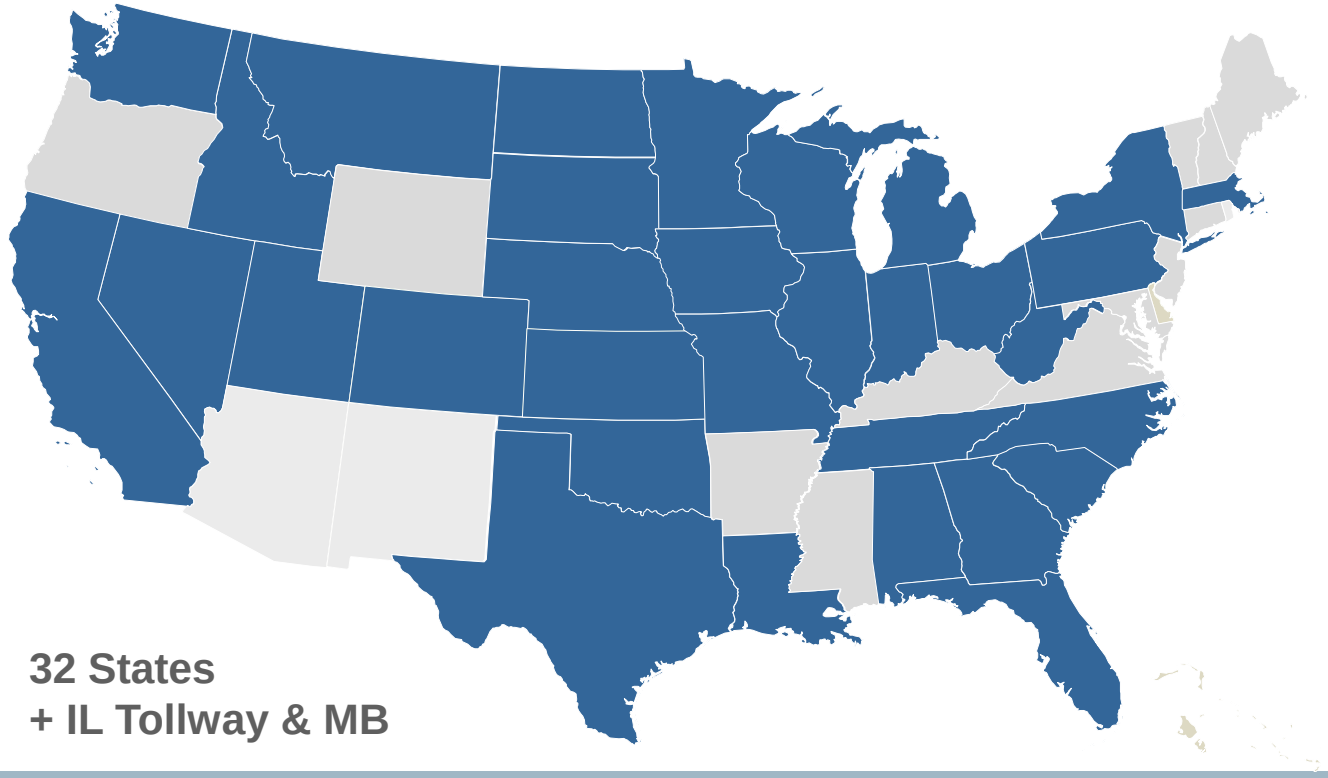
• Dr. Peter Taylor PE	Director
• Steve Tritsch PE	Assoc. Director
• Gordon Smith PE	Assoc. Director
• John Adam	Program manager
• Dr. Hamed Sadati	Engineer
• Dr. Yifeng Ling	Post Doc
• Jeremy McIntyre	Lab
• Sharon Prochnow	Contracts Manager
• Denise Wagner	Admin
• Numerous consultants	

Funding Model

- Operational fund (~15% of 2018 budget)
  - Sponsorships from industry and IA DOT
- Competitively won contracts (remainder)
  - FHWA Cooperative agreement
  - FHWA IDIQs
  - NCHRP
  - State DOT research
  - Transportation pooled funds

Who Is Our Audience?

- State and local agencies through NC2
- Industry through the trade associations



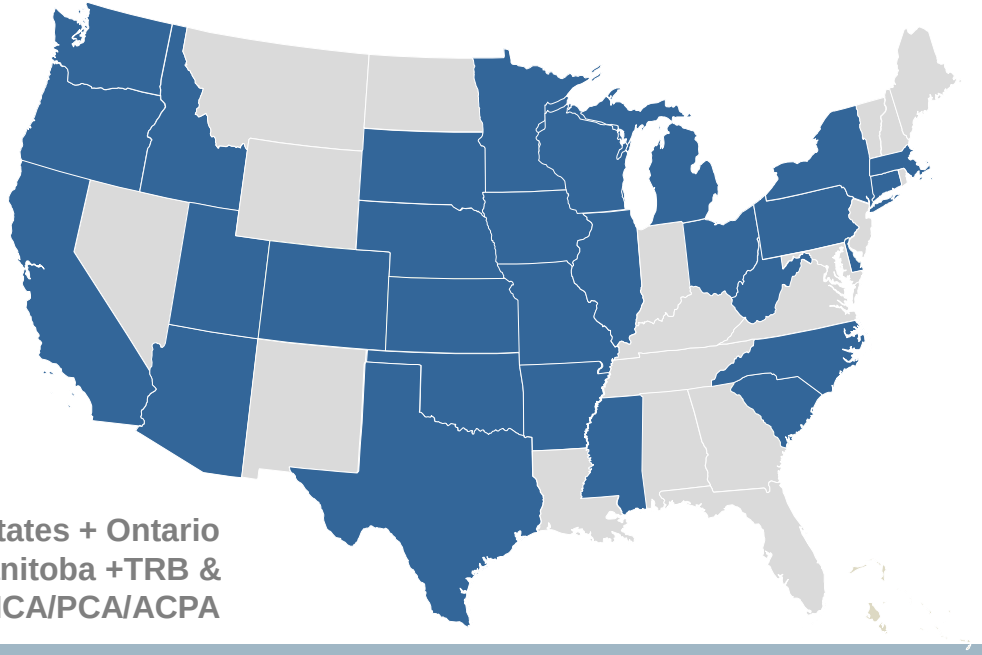
32 States
+ IL Tollway & MB

Engagement

- American Concrete Institute
- AASHTO
- Transportation Research Board
- Cement Sustainability Initiative (CSI)
- ASTM

Training

- Overlays
- Preservation
- Performance engineered mixtures
- Real time smoothness
- Internal curing
- Asset management



29 States + Ontario + Manitoba +TRB & NRMCA/PCA/ACPA

Research

- Internal curing
- Performance engineered mixtures
- Penetrating sealants
- Salt scaling
- Air void systems
- Fiber reinforced overlays
- Joint spacing

- Vibration?
- Sliver spalls in airfields?

Performance Engineered Mixtures

- What do we want?
- How do we measure it?
- Limits?
- Specification language
- Payment issues
- Education
- Implementation

Training and Testing

- Super Air Meter (SAM)
  - Air void characteristics of concrete
- Surface Resistivity
  - Rapid permeability measurement
- Box Test
- V-Kelly
  - Measurement of workability
- Calorimetry
- Maturity
- Sorptivity
- Strength Development
- Oxychloride formation, microwave w/c…

Mobile Labs: FHWA or CP Tech

Internal Curing in Pavements

Data Credit:

Dr. Peter C. Taylor

Dr. Halil Ceylan

Dr. Yang Zhang

Amin Daghighi, PhD Student

Acknowledgement

- Iowa DOT and IHRB
- County Engineers
  - Lee Bjerke
  - Jacob Thorius
- Lightweight Fine Aggregate donated by Buildex
- Contractors: Strebb, Croell

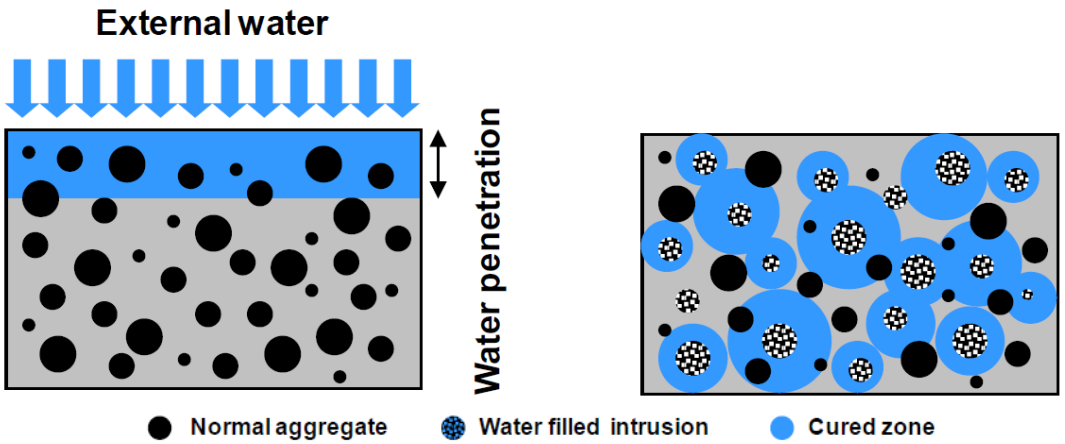
Purpose of the Work

- To perform a full-scale field demonstration of internal curing in pavements
- Demonstrate constructability
- Assess benefits in the field
  - Cracking risk
  - Ride
- Monitor performance

Internal Curing

Why?

- To maintain uniformly distributed moisture content
- Reduce gradients
- Promote hydration

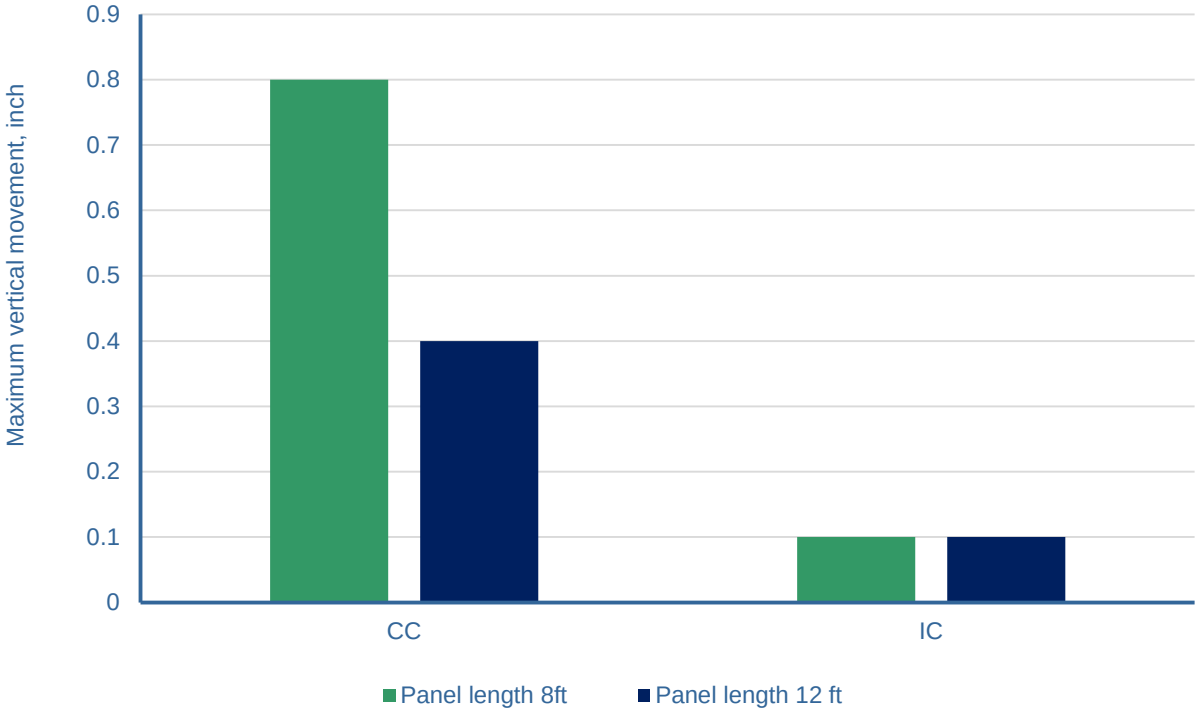


Castro et al (2010), Extending Internal Curing Concepts to Mixtures Containing High Volumes of Fly Ash

Internal Curing

Curling and warping

- Lower temperature gradient and CTE
- Lower moisture gradient
- Lower MoE



This Project

- Build two sections ¼ mile long in
  - Washington Co
  - Winneshiek Co
- Only change to mixtures was replace 35% by volume of fine aggregate with LWFA from MO
- LWFA had to be soaked for 48 hours then drain for 12

Mixture Proportions

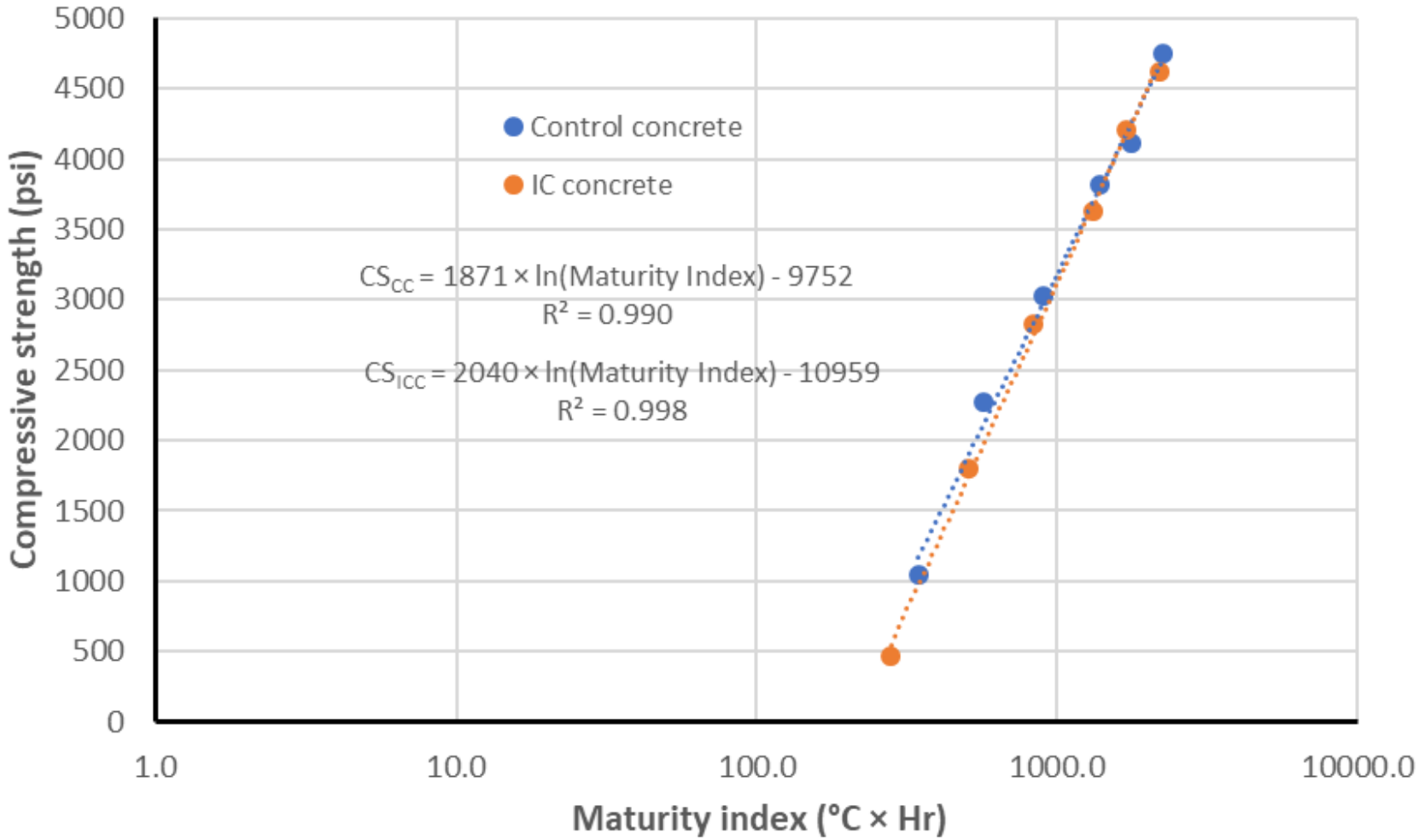
Washington Co, pcy

	Control	Test
Cement	457	457
Fly ash	114	114
Coarse	1672	1672
Int.	0	0
Fine	1376	897
LWFA	0	309
H2O	246	246
Air		
Total	3865	3696

Lab Data Washington

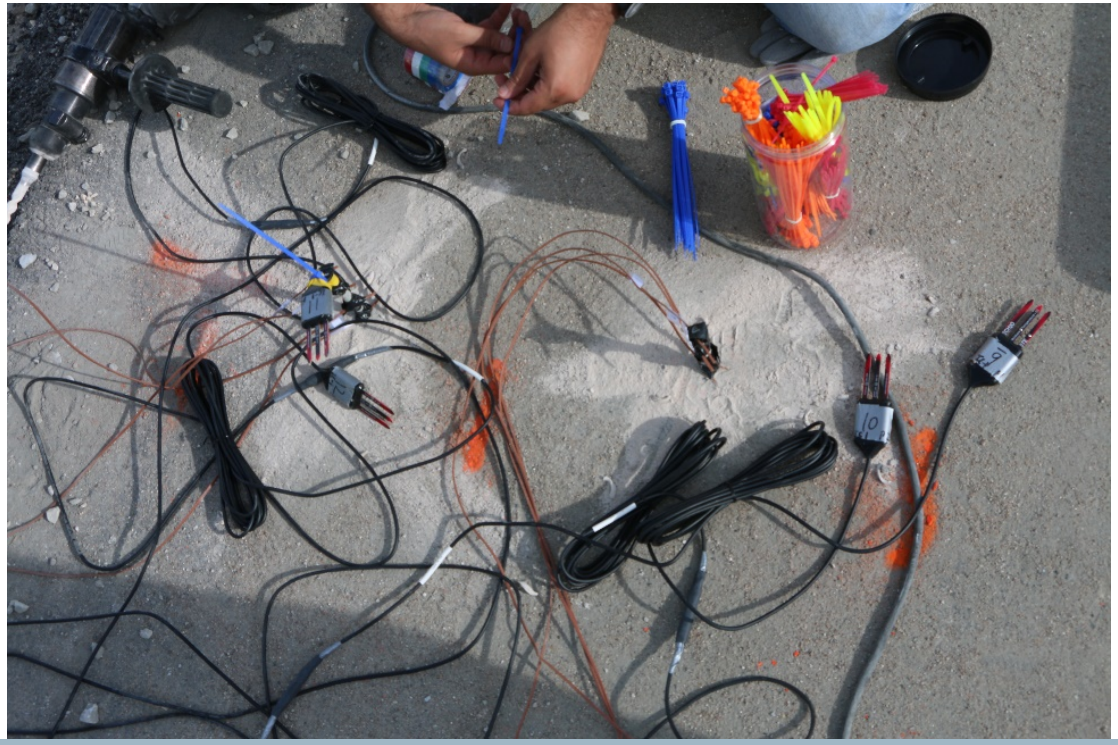
Test	Age (day)	CC	IC
		Average	
Compressive Strength (psi)	7	4200	4810
	28	5470	6015
	90	6230	7100
Splitting Tensile Strength (psi)	7	320	320
	28	325	380
	90	315	440
Modulus of Elasticity (psi)	7	4100	4410
	28	4600	5090
	90	5530	5460
Surface Resistivity (kΩ.cm)	7	10.6	7.6
	28	12	10.5
	90	25.7	24.1

Maturity Washington



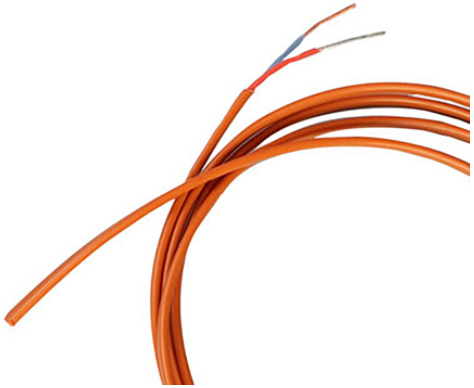
Sensor Instrumentation Plan

- At each site, two slabs were instrumented
- Each slab had 2 sensor trees

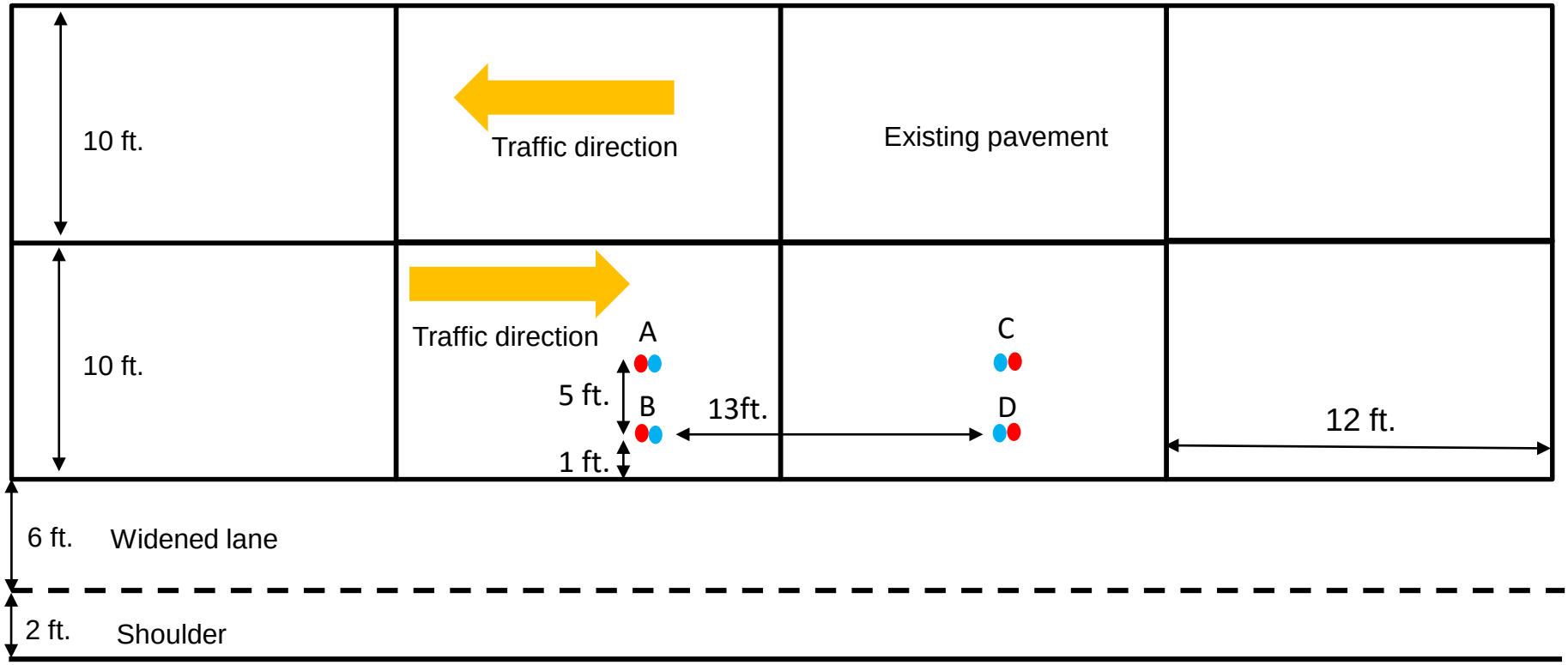


Sensors

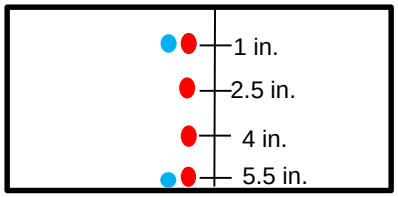
- Meter ECH2O 5TE moisture sensors
- Omega HSTC-TT-20S thermocouple



Washington County Control Site



Pavement section view



6 in. PCC overlay

Cross-section view for each sensor tree

Data acquisition system

Thermocouples

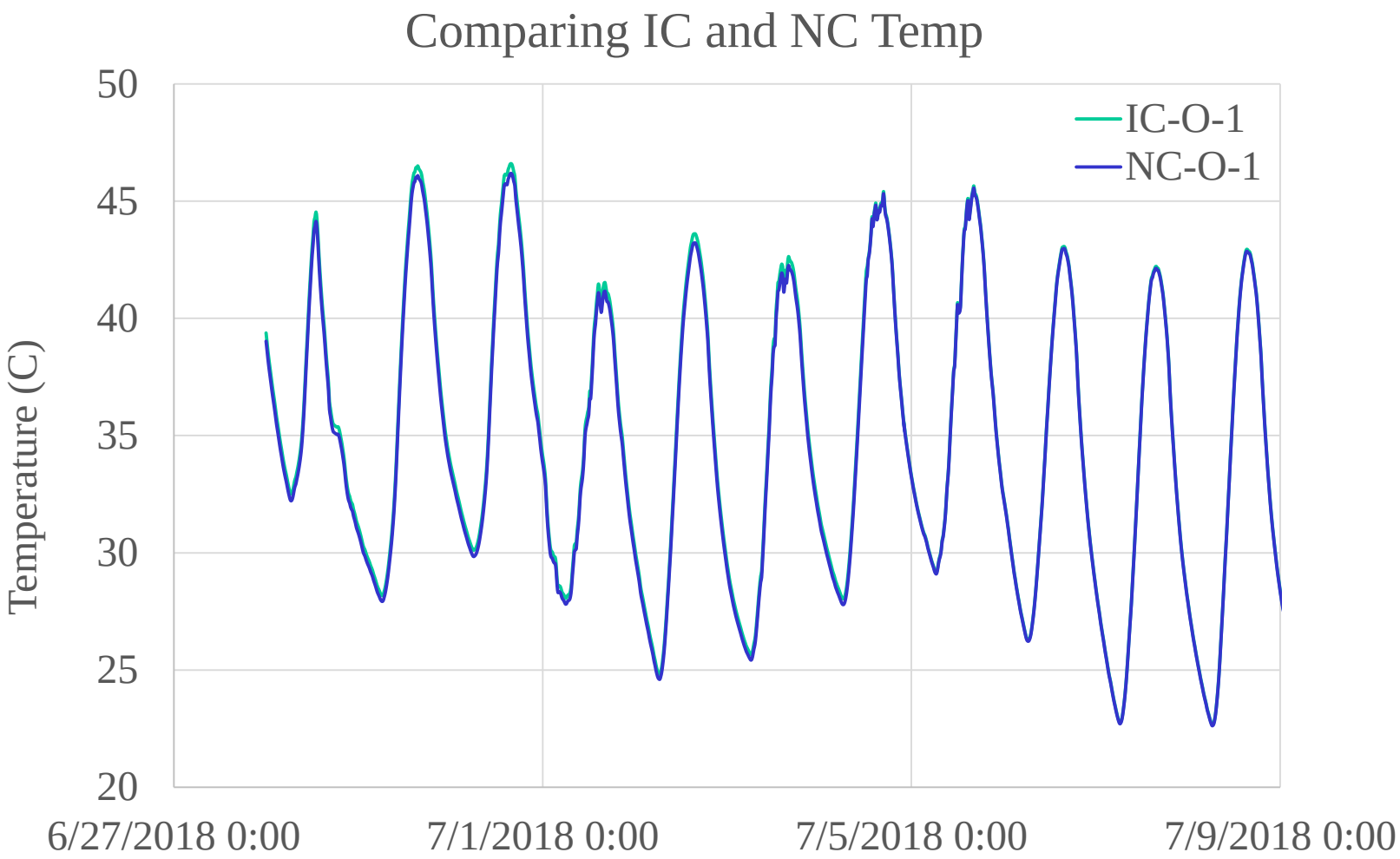
Moisture sensors

Washington County

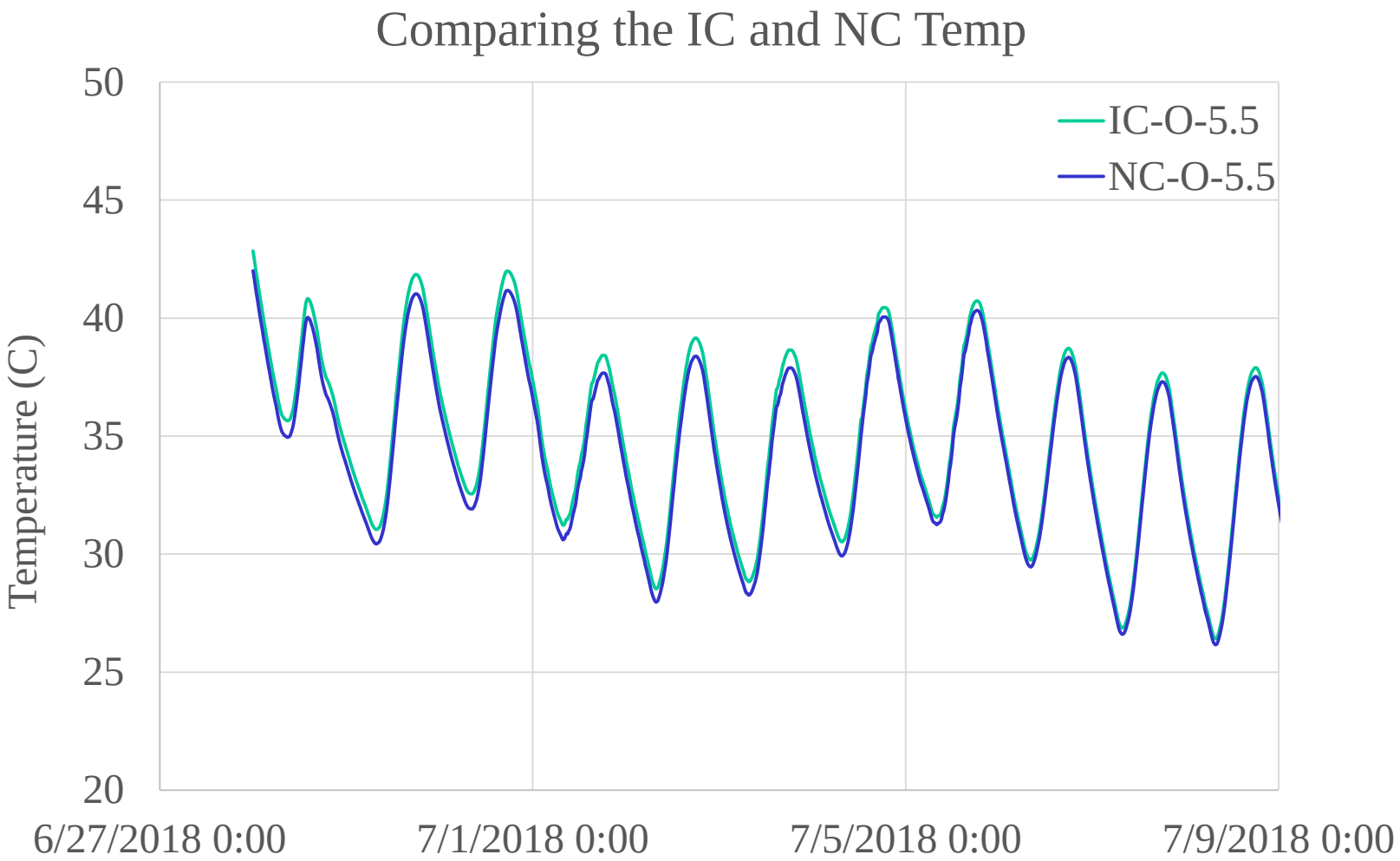
Constructability

- Storing and moisture conditioning the LWFA was not trivial
- IC mixture observed to be a little more “pastey”
- Otherwise no noticeable issues

Temperature Data, Washington County



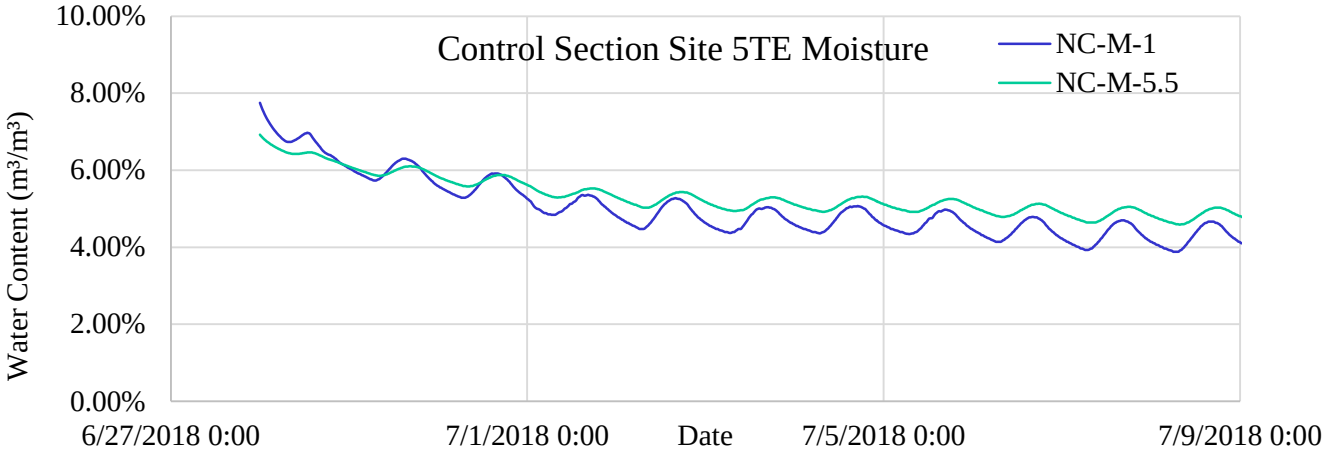
Temperature Data, Washington County

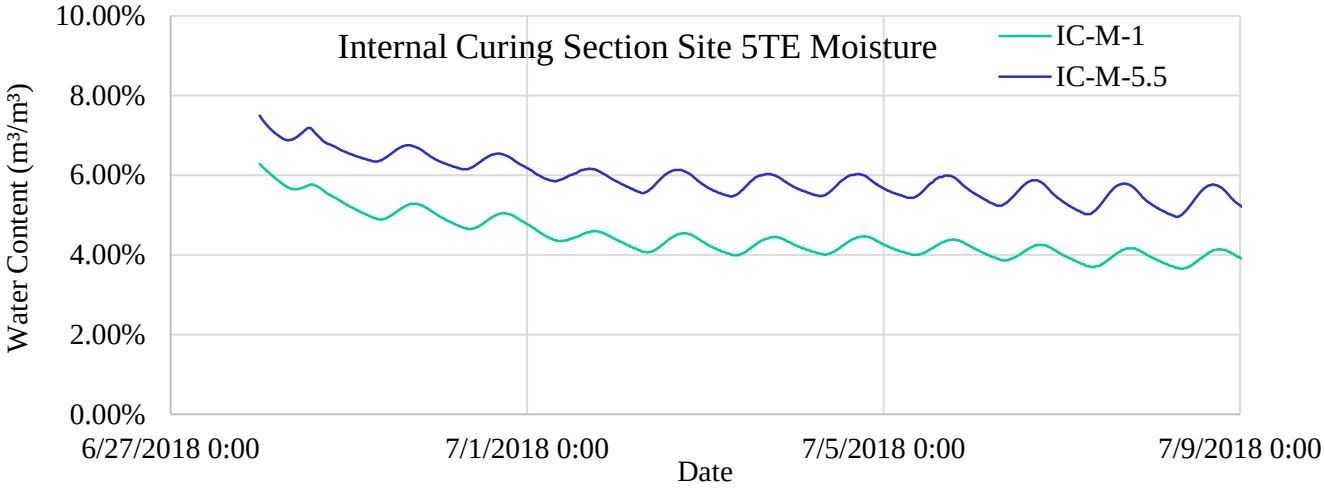


Temperature Data, Washington County

- The deeper sensors in the pavement, show 2 to 3 Celsius Degrees higher temperature for IC than NC in the first two weeks
- After the second week, the IC section shows equal temperature with the NC section

Moisture Data, Washington County





Costs

- LWFA ~$3.00 / cy
- Delivery ~$8.00 / cy
- Handling ~$4.00 /cy

- Life cycle benefits still being assessed – previous projects have been positive

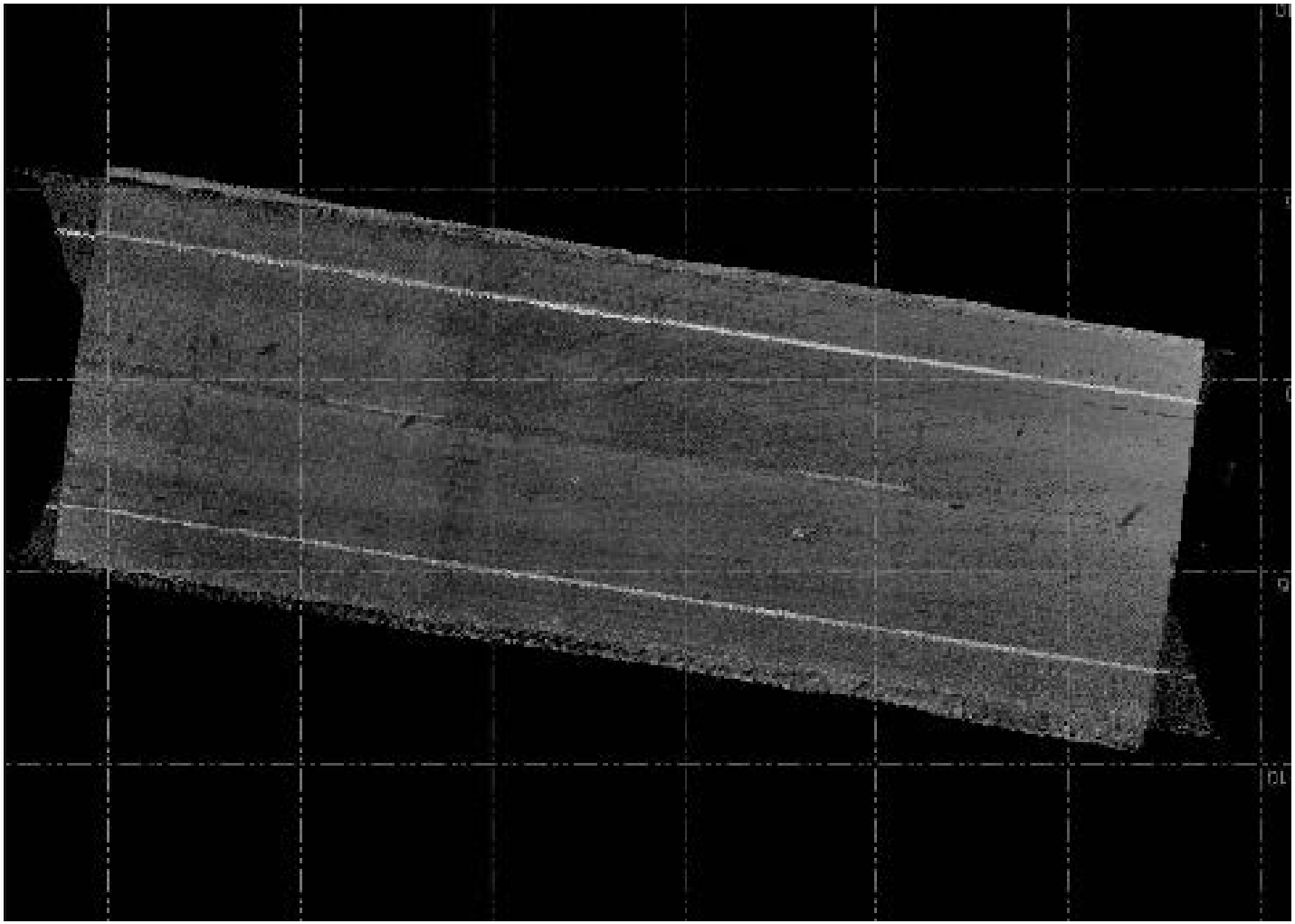
Where Next?

- Monitor warping through the seasons
- Super absorbent polymer (SAP)

Warping

- Using LIDAR
- Measure when it is
  - Hot and cold
  - Wet and dry

Warping



Help?

National Concrete Pavement Technology Center

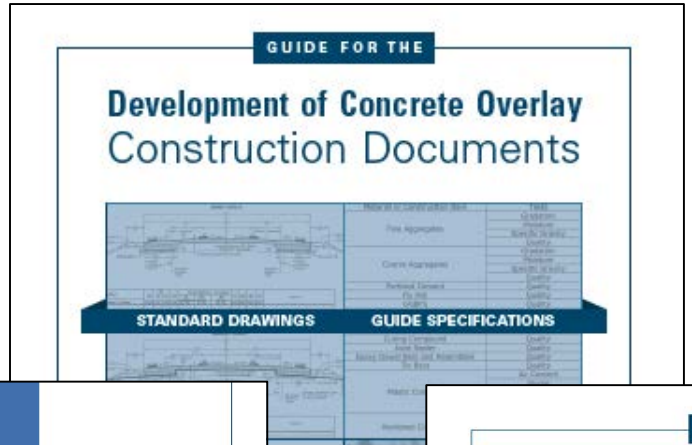
Guide Specification for Internally Curing Concrete

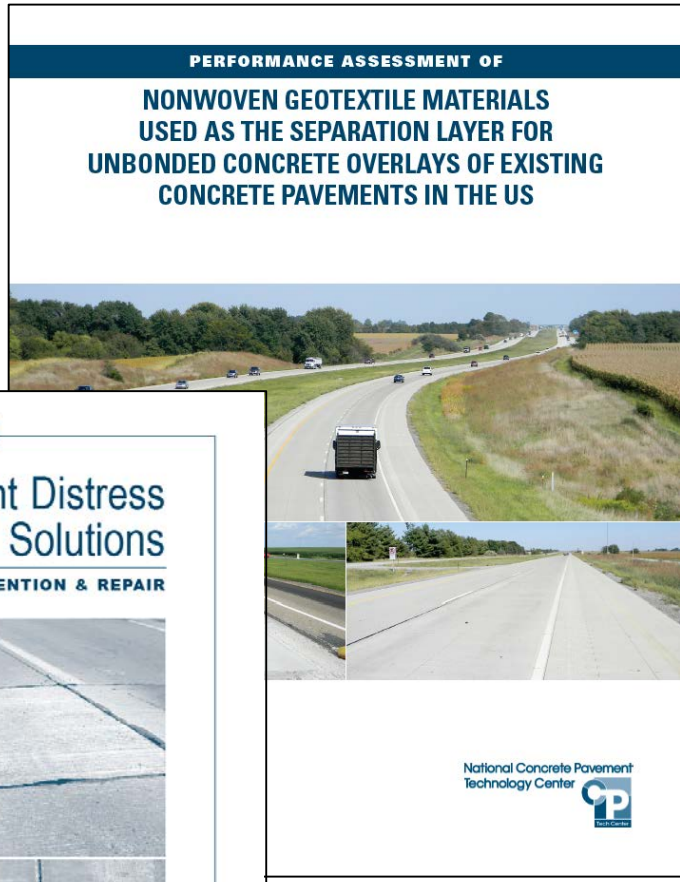
November 2017

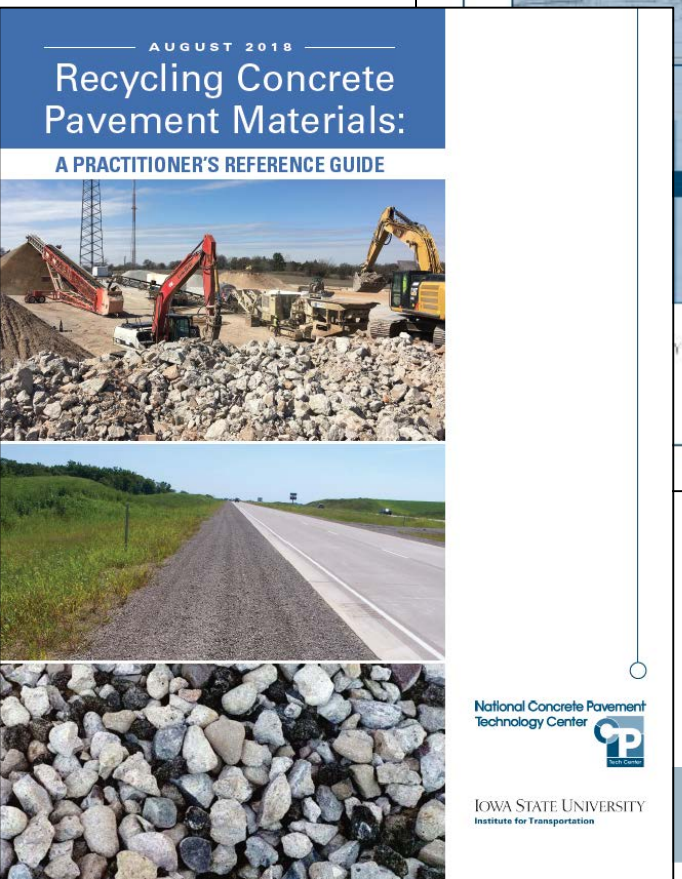
IOWA STATE UNIVERSITY
Institute for Transportation

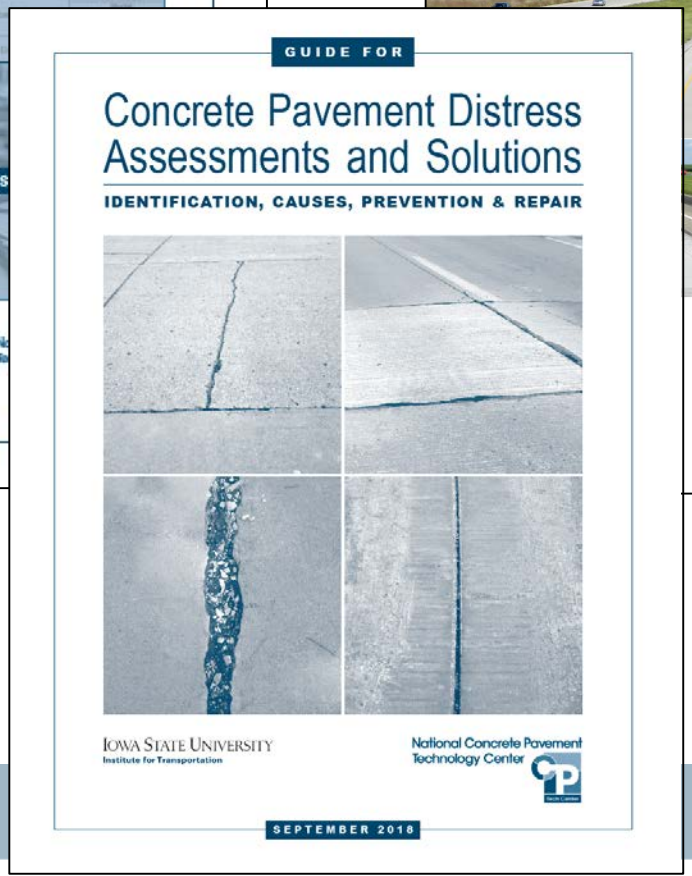
Sponsored by
Federal Highway Administration
Transportation Pooled Fund TPF-5(286)
(Part of InTrans Project 13-482)

Publications



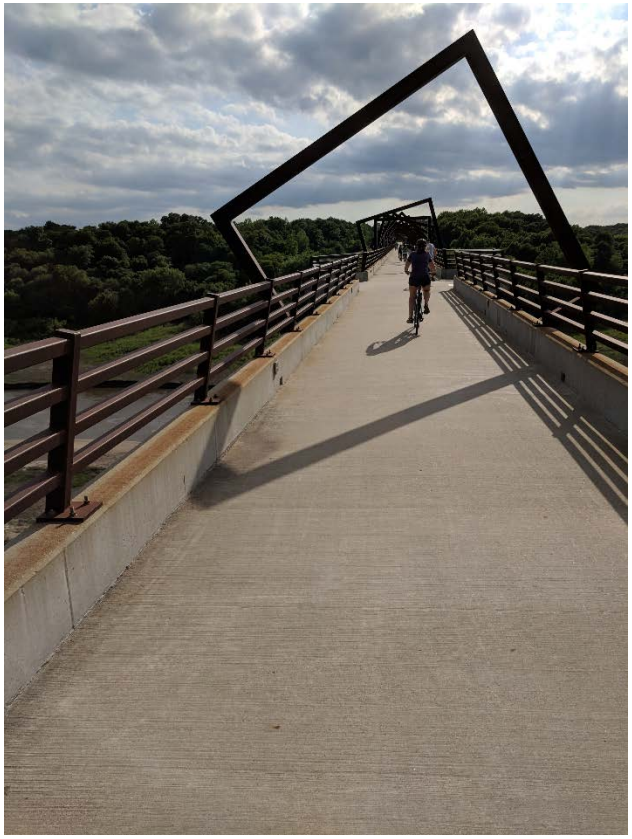






Future Publications

- Cement Stabilized Materials (PCA)
- Cellular Concrete (PCA)
- Concrete Trails (NRMCA)
- IMCP



Summary

- We believe that our model is effective
  - A small core of engaged professionals
  - A broad network of expert consultants
  - Collaboration with many organizations

- We aim to be
  - A resource to anyone building and owning concrete pavements
  - A clearing house of expertise
  - The go-to name for people with questions

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Thank you for helping us make a difference