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MOBILE ASPHALT TECHNOLOGY CENTER

U.S. Department of Transportation

Federal Highway Administration

FHWA Technology Deployment Supports Asphalt Pavement Durability & Safety

MID-ATLANTIC ASPHALT EXPO & CONFERENCE

COLLABORATE | INNOVATE | EDUCATE

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ACRONYMS

- AASHTO: American Association of State Highway and Transportation Officials
- ABML-ID: Asphalt Binder and Mixture Laboratory –Implementation Division
- ABT: Asphalt Binder Tester
- AIMS: Aggregate Imaging Measurement System
- AMPT: Asphalt Mixture Performance Tester
- ASTM: American Society for Testing and Materials
- BMD: Balanced Mix Design
- DO: FHWA Division Office
- DPS: Density Profiling System
- FTIR: Fourier Transform Infrared Spectroscopy
- HICP: FHWA Office of Preconstruction, Construction, and Pavements
- ICT: IDEAL Cracking Test
- I-FiT: Illinois Fatigue Test
- MATC: Mobile Asphalt Technology Center
- MTV: Material Transfer Vehicle
- NCHRP: National Cooperative Highway Research Program
- NDE: Nondestructive Evaluation
- PEM: Performance Engineered Mixtures
- PEP: Performance Engineered Pavements
- PMS: Pavement Management System
- PRS: Performance-Related Specifications
- QA: Quality Assurance
- R&D: Research & Development
- RC: FHWA Resource Center
- Sapp: Apparent Damage Capacity
- SCB: Semi-circular Bend
- SSR: Stress Sweep Rutting
- TFHRC: Turner-Fairbank Highway Research Center
- TxOT: Texas Overlay Text
- XRF: X-Ray Florescence

FHWA Mobile Asphalt Technology Center (MATC)

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Meet the FHWA MATC Team

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FHWA Asphalt Technology Deployment

- **Project Site Visits:** provide agencies and industry with first-hand exposure to new technologies (currently, 8 mixture tests, 4 materials tests, and 5 field tests)
- **Customized Training Workshops:** classroom and online training based on field test results and observations
- **Equipment Loan Program:** gain hands-on experience before making a resource commitment
- **Technical Guidance:** based on identified national trends to encourage agencies and industry to evaluate and improve their specifications and practices

Image Source: FHWA

Technologies Demonstrated by MATC

Mixture Tests	Materials Tests	Field Tests
ITC (IDEAL-CT) for crack resistance	X-Ray Fluorescence (XRF) Spectrometer for binder's or markings' chemical elements	Paver-Mounted Thermal Profiler (Pave-IR) for real-time mat placement temperatures
Overlay Test for reflective cracking	* FTIR looks at molecules in binder (lime, polymers,…)	Pulse Induction Technology (MIT-Scan-T3) for in-place mat thickness
Flexibility index test (I-FIT) for fracture resistance	* Binder grading AASHTO M 320 AASHTO M 332	Dielectric Profiling System (DPS) for in-place mat density
* Hamburg Wheel Track Tester	* Binder durability testing (ΔT_c & ΔT_f)	Circular Track Meter for measuring in-place mean profile depth (MPD)
IDEAL-RT for rutting resistance	* Done at FHWA TFHRC labs	Laser Texture Scanner for measuring in-place mean profile depth (MPD)
AMPT suite of tests (|E*|, cyclic fatigue, SSR)		

Other support activities:

PaveME Design analysis

* FlexMAT & FlexPAVE for mix design performance comparisons

Asphalt pavement spec review

Construction density spec review (mat and joints)

Deployment of Field Technologies to Assist Asphalt Pavement Constructability

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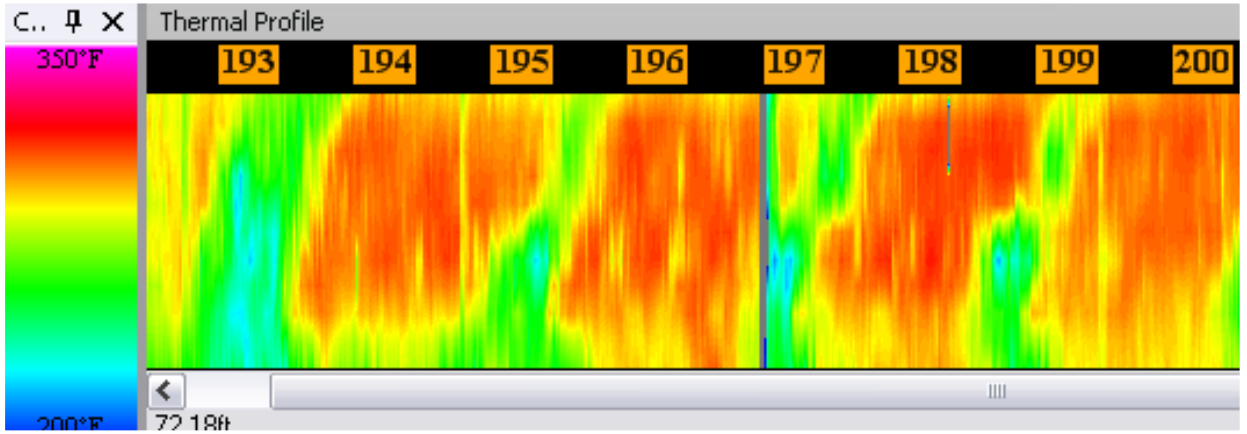
Real-Time Mat Placement Temperatures

Paver-Mounted Thermal Profiler (PMTP)

- Real-time profile of pavement mat before compaction
  - Used for Identifying Segregation and Low-Density Issues
- Infrared Sensors for Measuring Temperature Uniformity of New Asphalt Surfaces
  - Imaging of Mat Surface: 2 to 3 meters behind screed



PMTP Setup

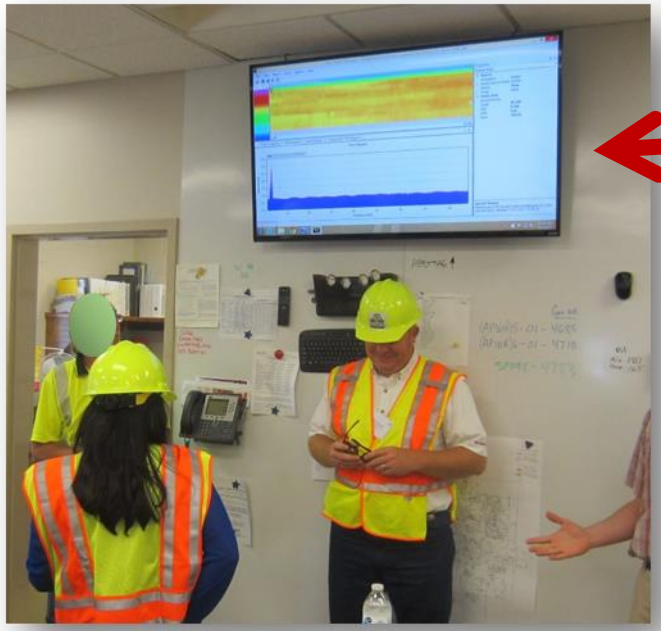
Ready to Use Technology

Latest update utilizes GPS and eliminates need for DMI !

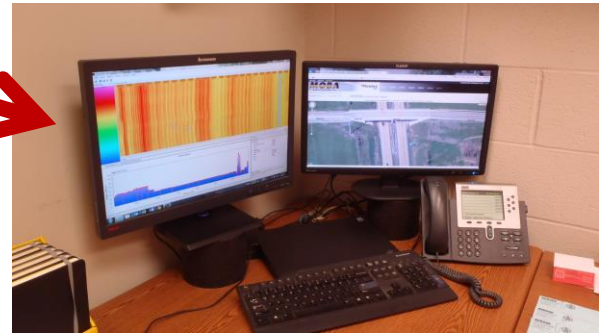
All images source: Travis Walbeck

How it works…

Real-time data visualization & communication between plant and paver to minimize mat temperature differentials while paving



Contractor monitors from the plant…

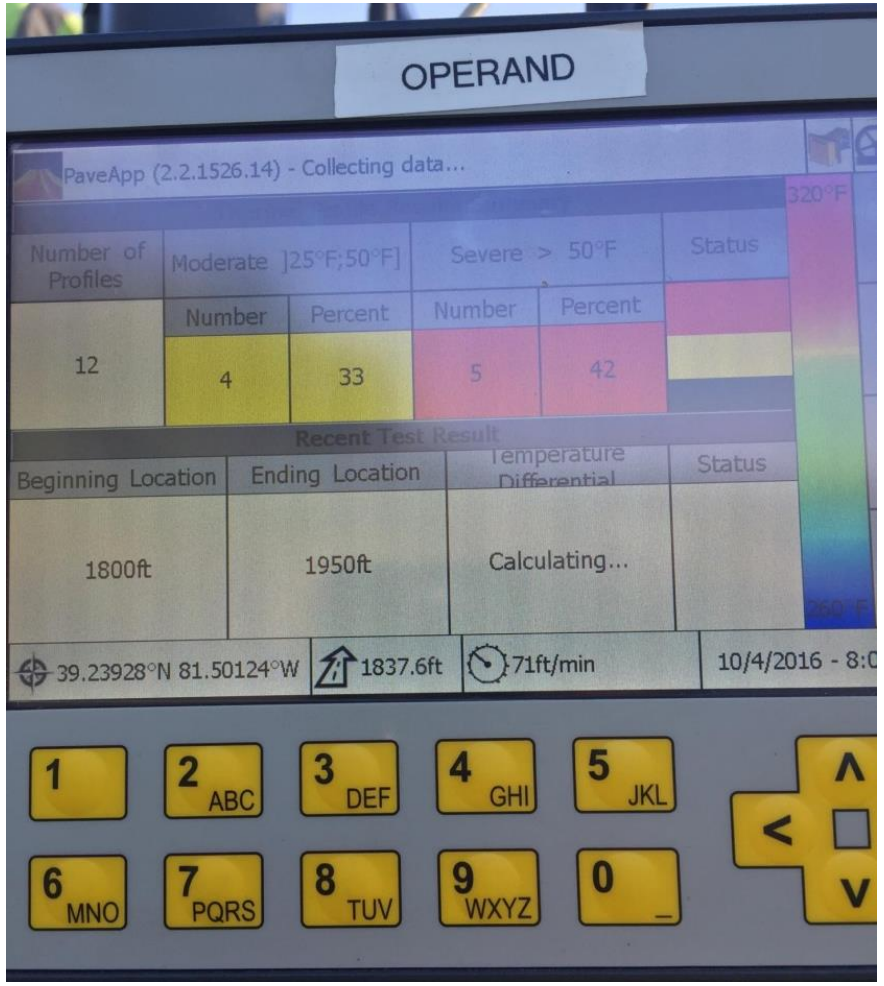


Owner can monitor from anywhere…

Images: SHRP2 (R06 C)

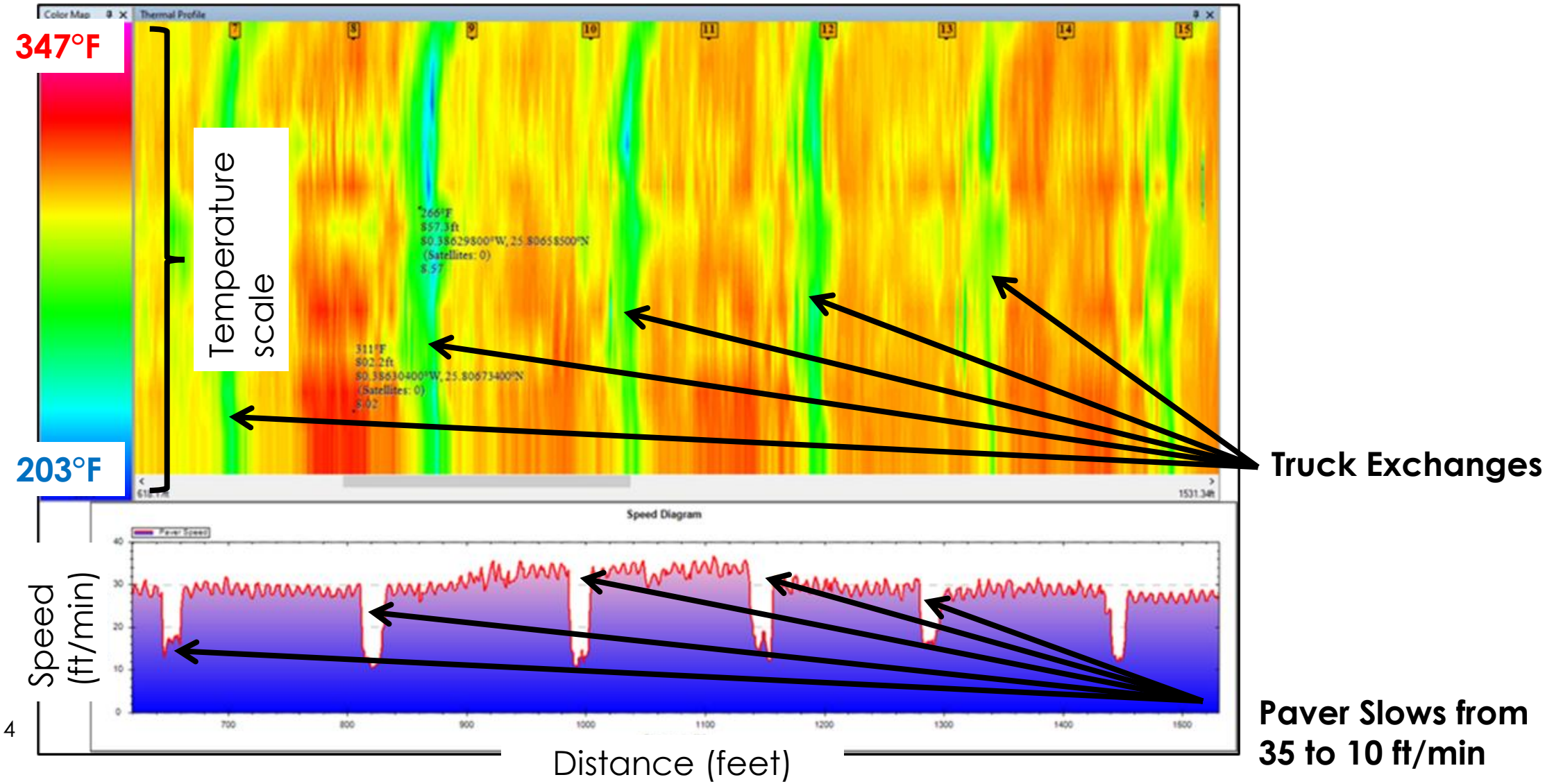
Sample PMTP Output

Source: Harold von Quintus

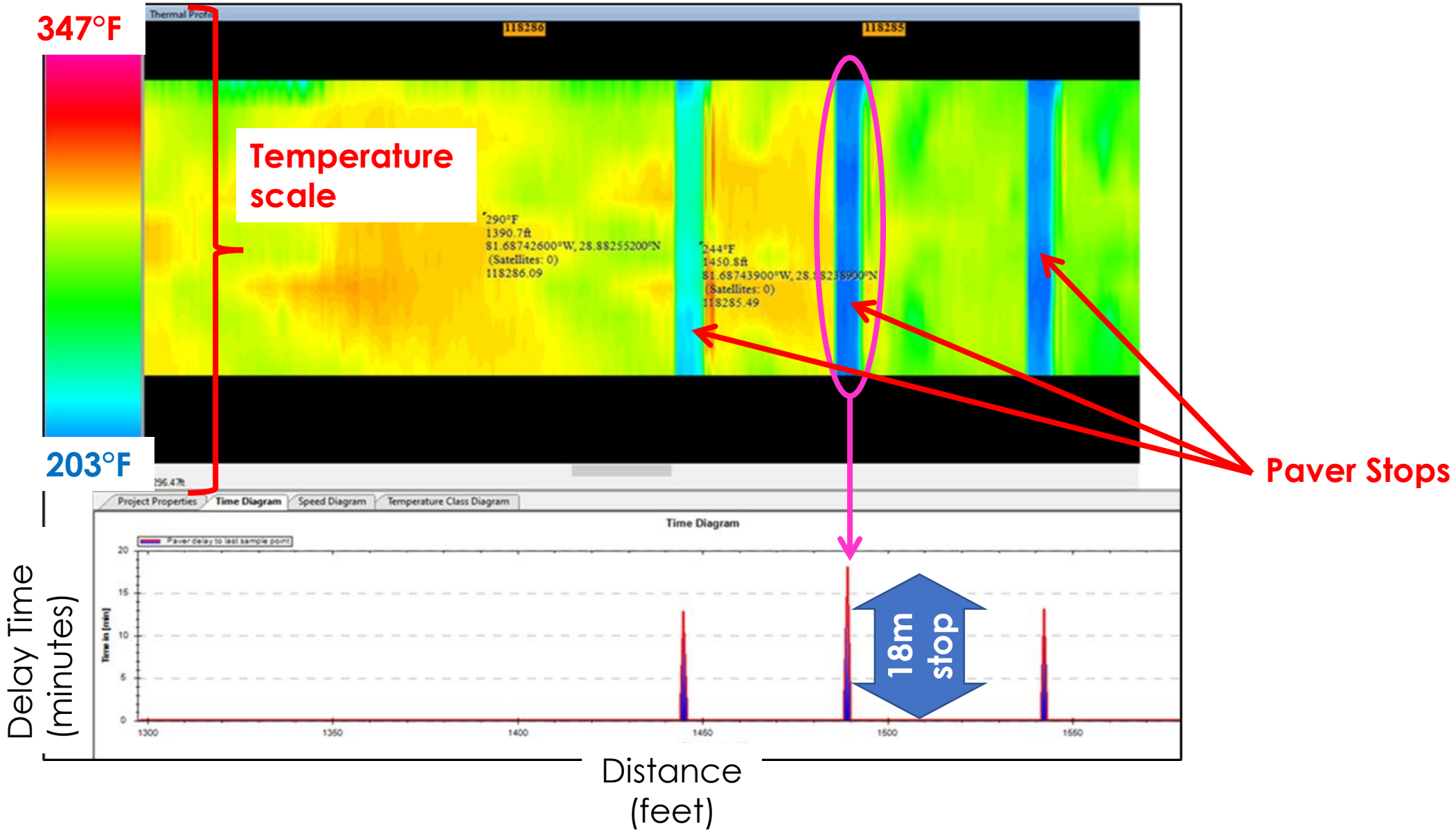


Source: Travis Walbeck

PMTP Thermal Profile: Example



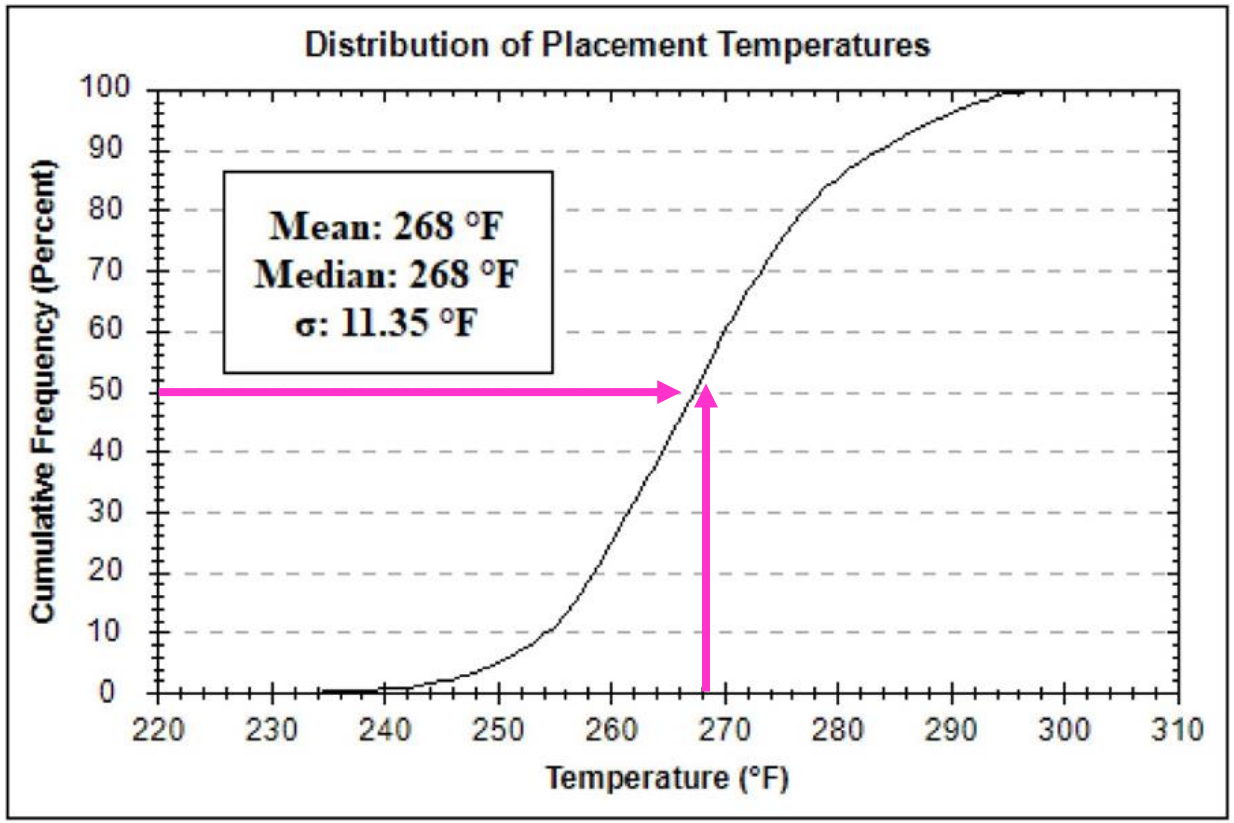
PMTP Thermal Profile: Example



Example: PMTP Thermal Segregation Summary

Total Profiles	Moderate Thermal Segregation (25.0°F < Differential ≤ 50.0°F)		Severe Thermal Segregation (Differential > 50.0°F)	
	Number of Profiles	Percent	Number of Profiles	Percent
6	4	67%	2	33%

Cumulative Distribution of Mat Temperature



Use of PMTP Devices Nationally

Benefits

+ Identify cold spots, segregation, thermal streaks
+ Identify low density areas
+ Control paver delays
+ Adjust speed between trucks

Limitations

- Installation on contractor's equipment
- No existing direct correlation between severe thermal segregation & pavement density

Implementation in 11 states & Eastern Federal Lands

- Alabama, Alaska, Illinois, Maine, Minnesota, Missouri, New Jersey, North Carolina, North Dakota, Virginia, & West Virginia

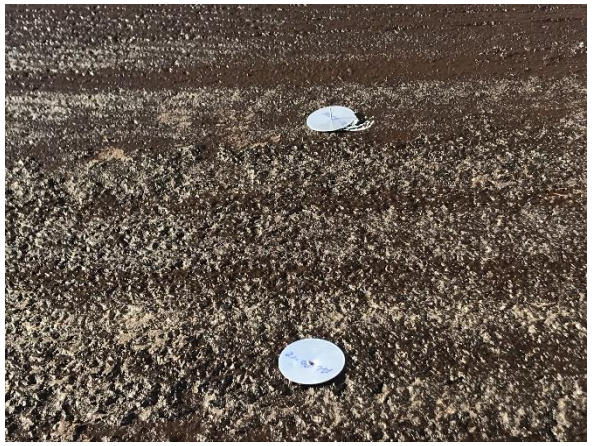
In-Place Mat Thickness Testing

Pulse Induction Technology

Nondestructive Pavement Measurement

- Quality control and agency acceptance
- AASHTO test method (AASHTO T 359-18)
- ASTM test method in the works
- *Not a Federal requirement*

Step 1



Place the target

Step 2

Pave over it

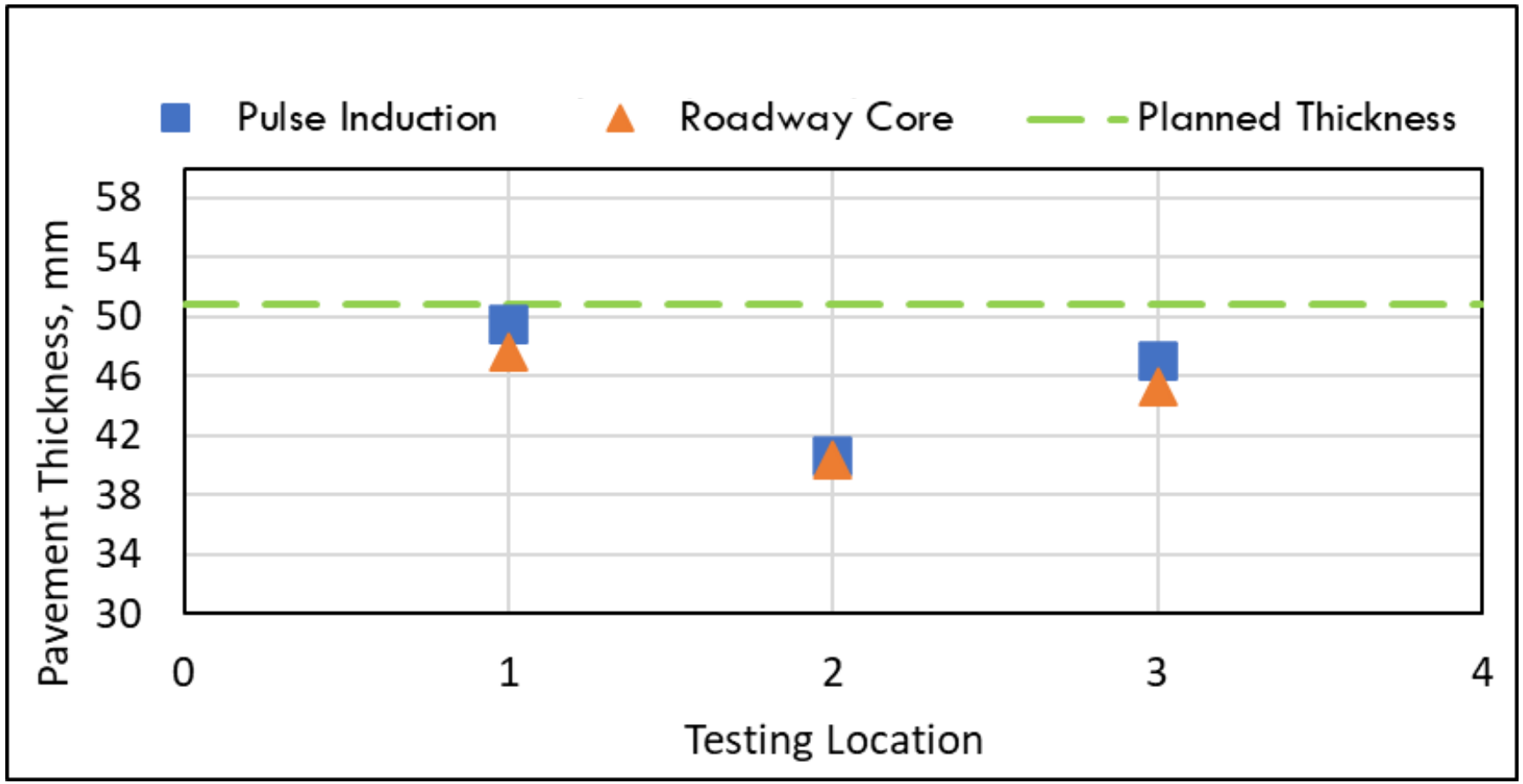
Step 3

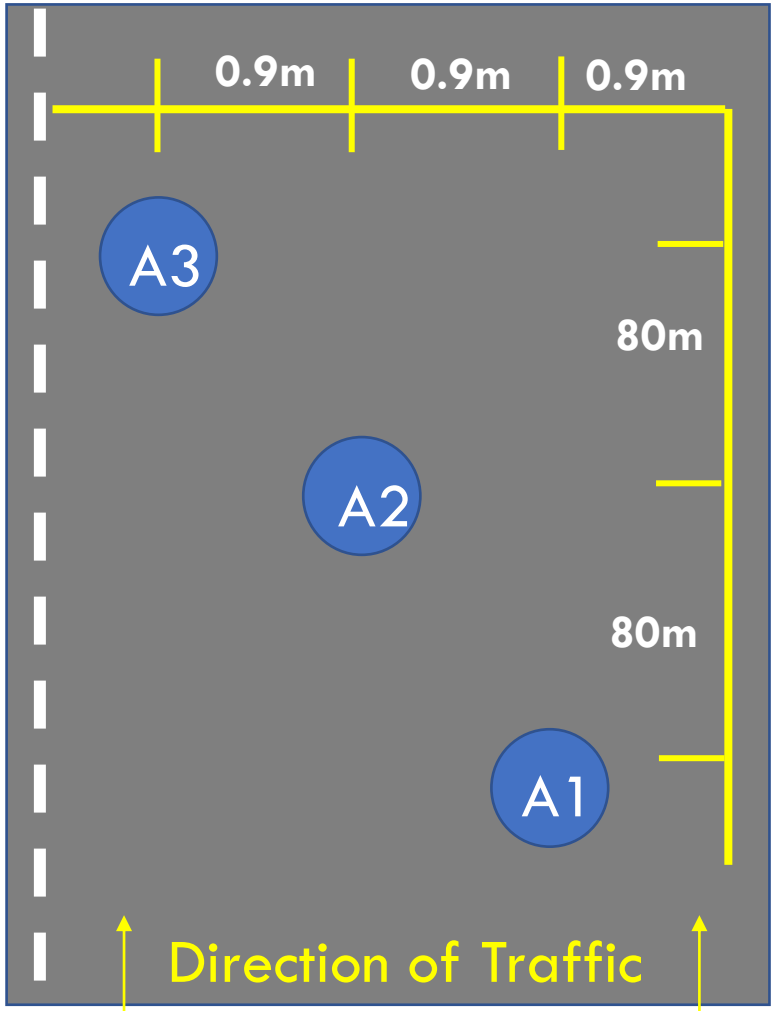
Find targets & measure thickness

*Optional Step

Core & confirm thickness

Pulse Induction Technology – Example 1





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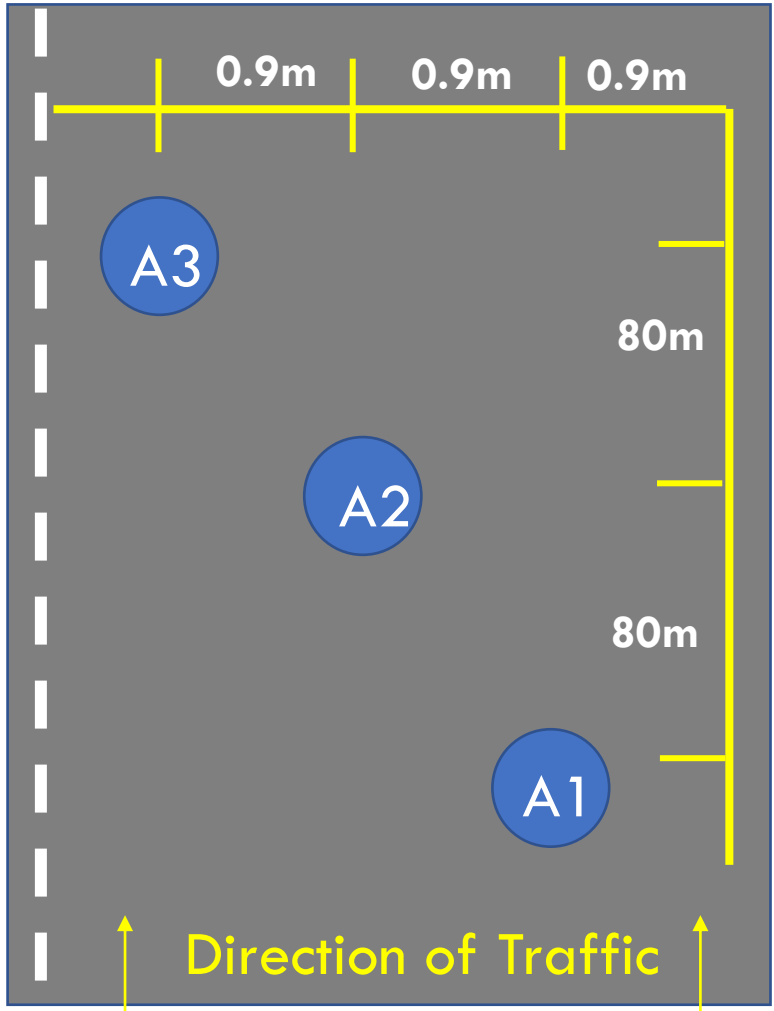
Pulse Induction Technology - Example 2



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Pulse Induction Technology

Benefits

- Easy to use
- High accuracy
- Non-destructive
- Almost real time (rapid)
- Good for QC use e.g., test strips, informing paver adjustments

Limitations

- Presence of existing rebar in existing sublayers
- Presence of excessive moisture on surface
- Windrow paving
- Surface irregularities (non-removal of scabs, uneven existing surface)

Current practice

- Iowa, Minnesota, Pennsylvania, Washington, Wisconsin

In-Place Mat Density Testing

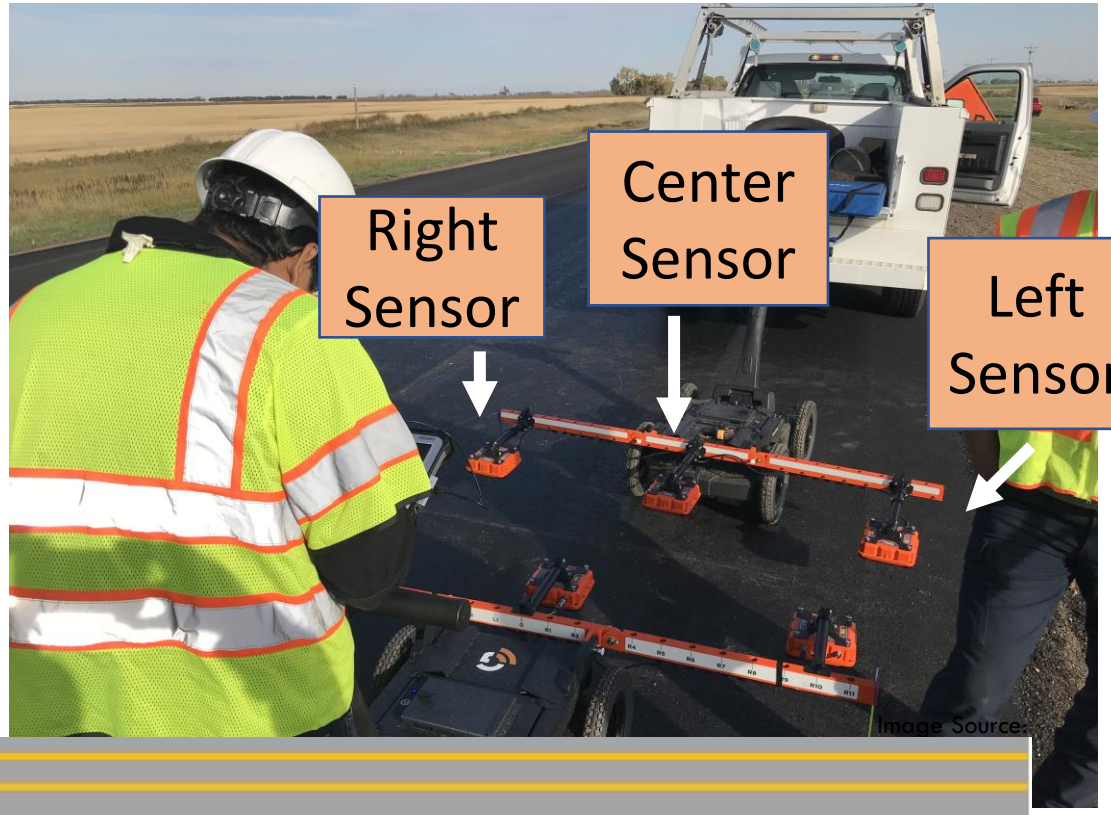
Existing Density Measurement Techniques

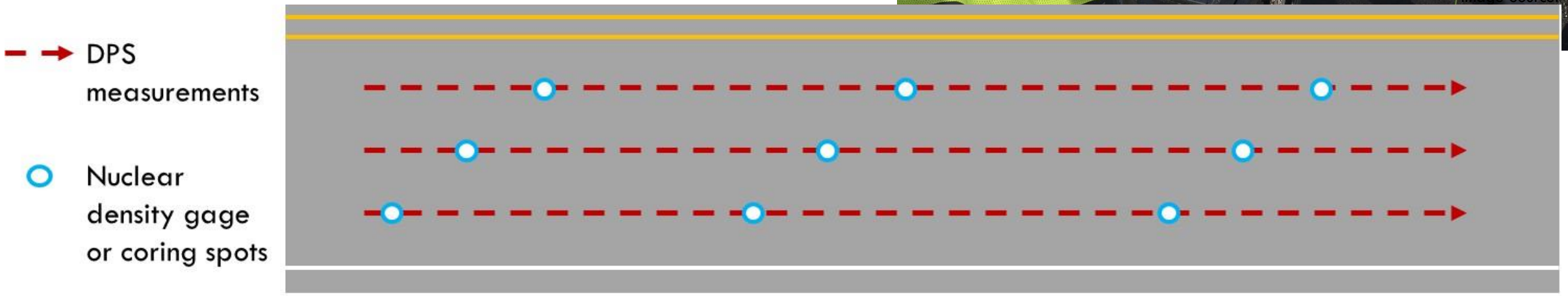
- Coring:
  - Labor intensive, destructive, long turnaround time
    - 1 to 2 days
- Nuclear density gauge:
  - Involves calibration, special handling, training, and certification

- In either case…
  - Low level of testing coverage
  - Greater chance of missing localized areas of concern

Dielectric Profiling Systems (DPS)

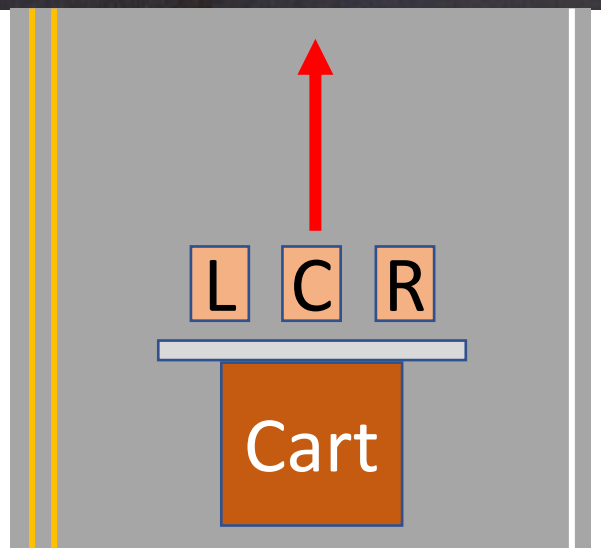
- Coring and nuclear density gauge only used for spot checks on predetermined, random locations
- DPS provides continuous density profile along testing path
- Reduce turnaround times



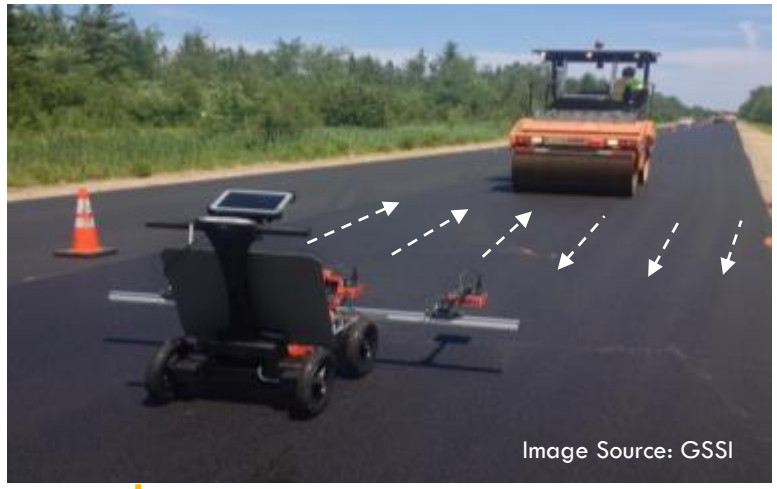


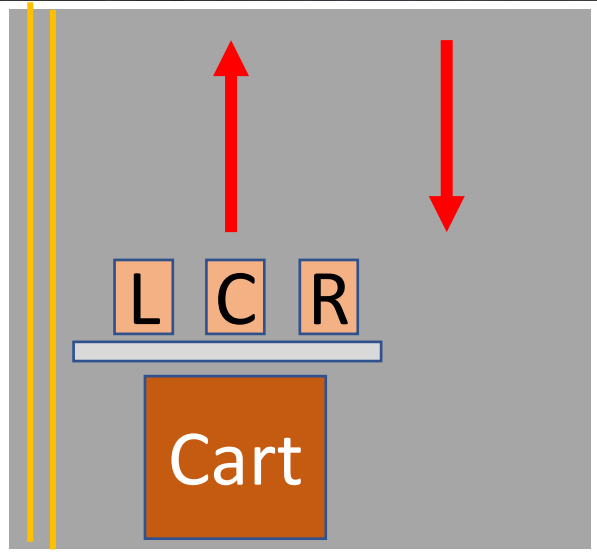
Data Collection Patterns

1-Pass Pattern



2-Pass Pattern





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DPS Output: Relating Dielectrics to Density

Low Dielectric Value → Higher Air Void Content → Lower Density

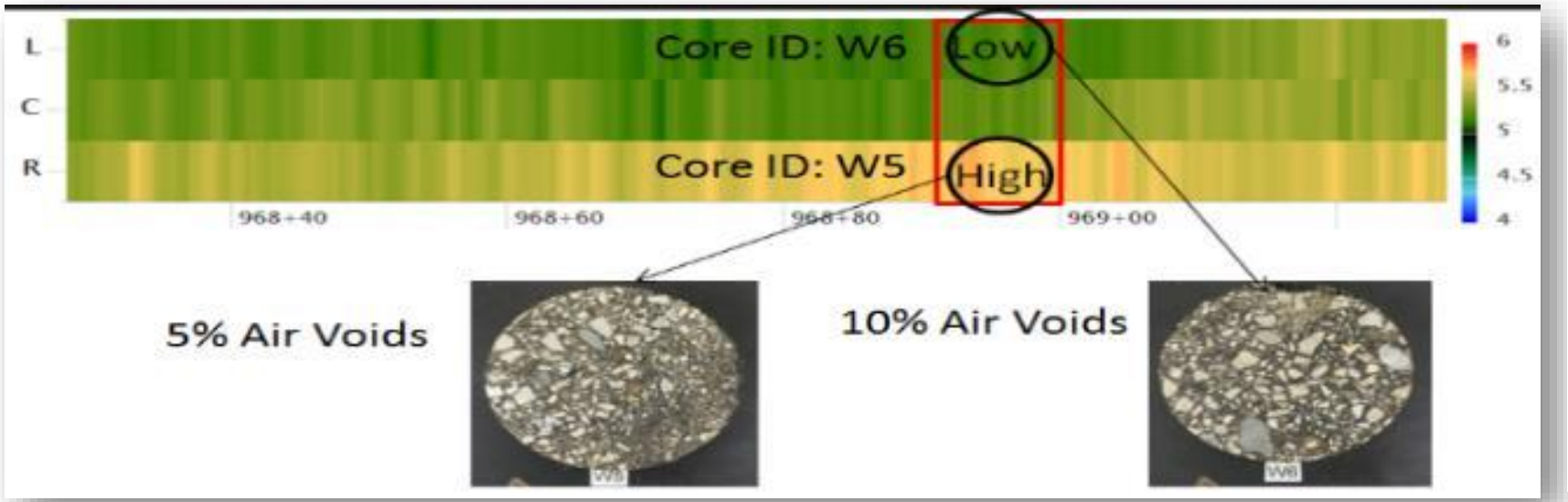

Image Source: GSSI

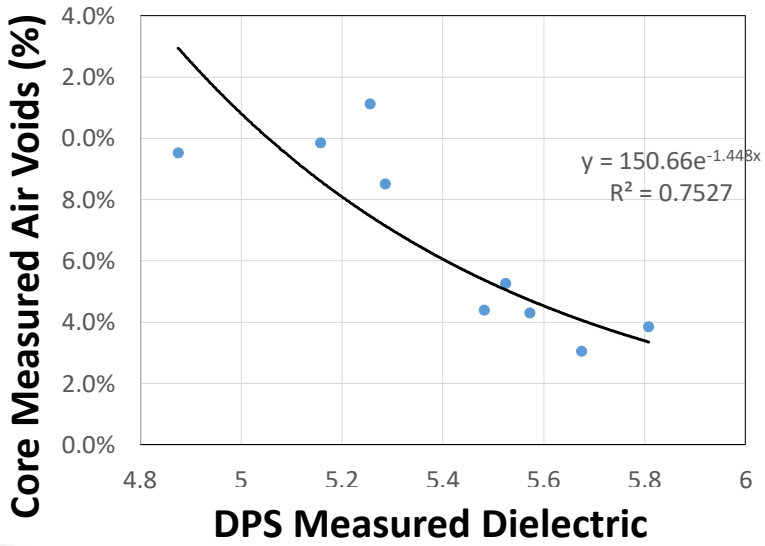

Image Source: FHWA

High Dielectric Value → Lower Air Void Content → Higher Density

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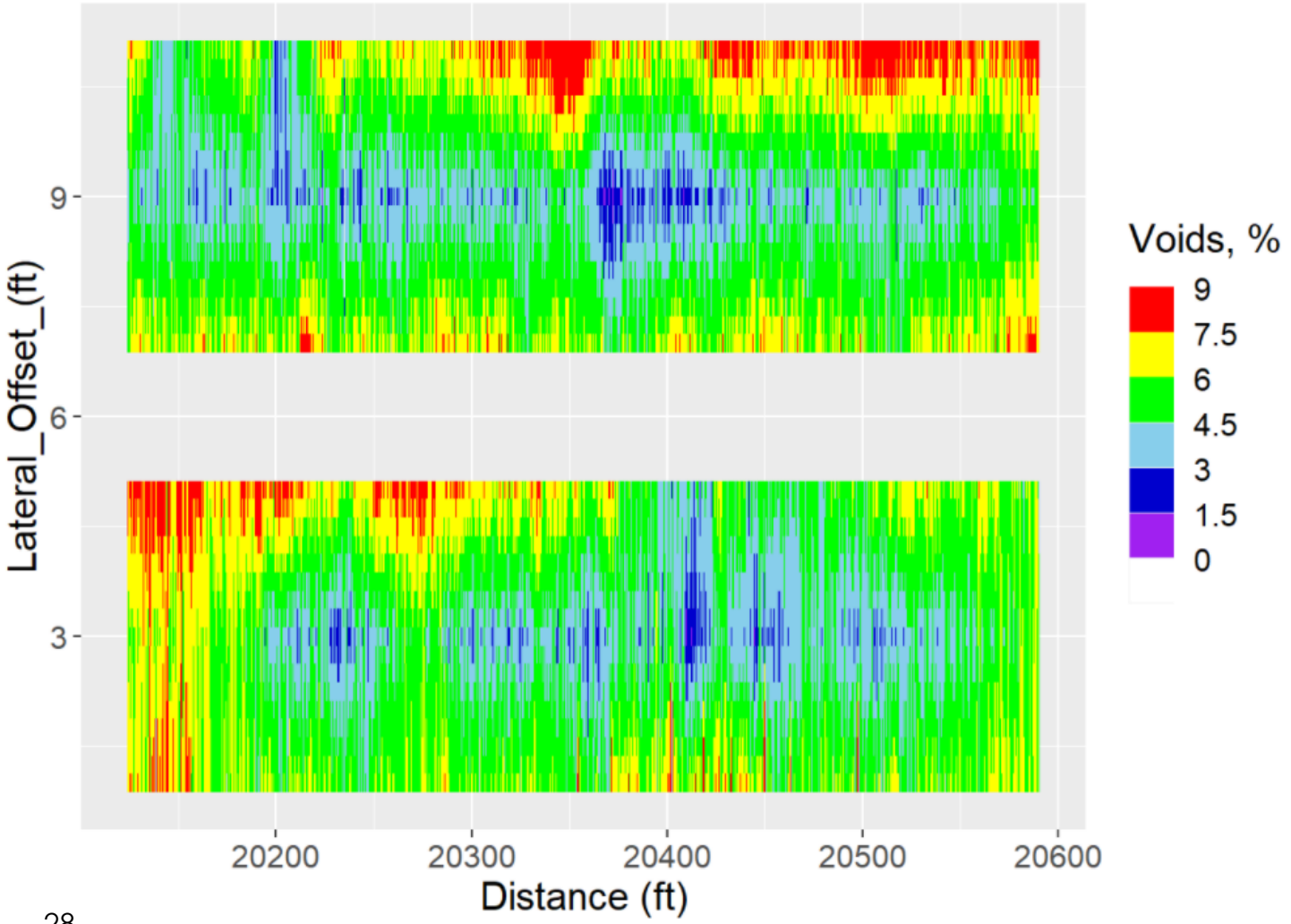
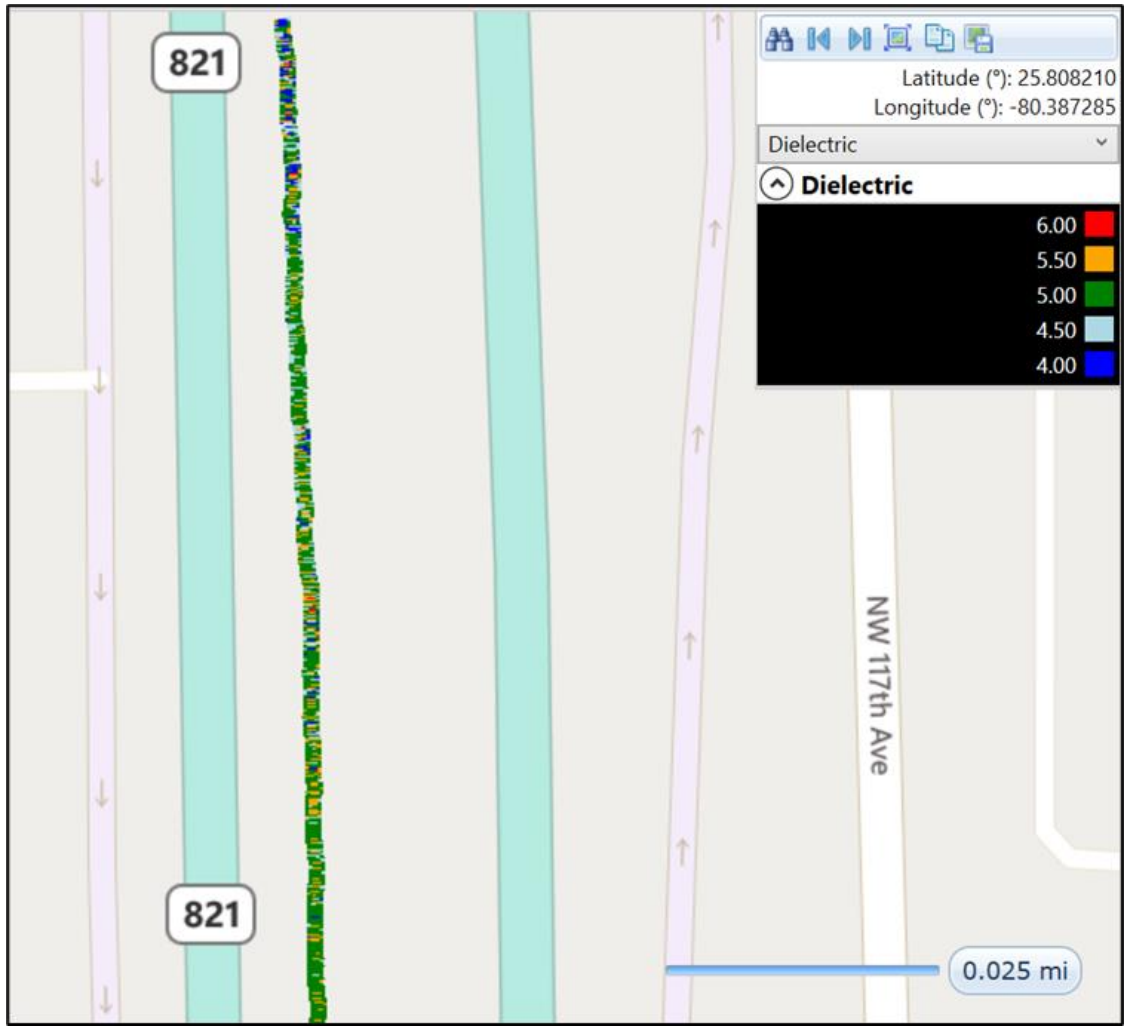
Dielectric Mapping for Mat Density

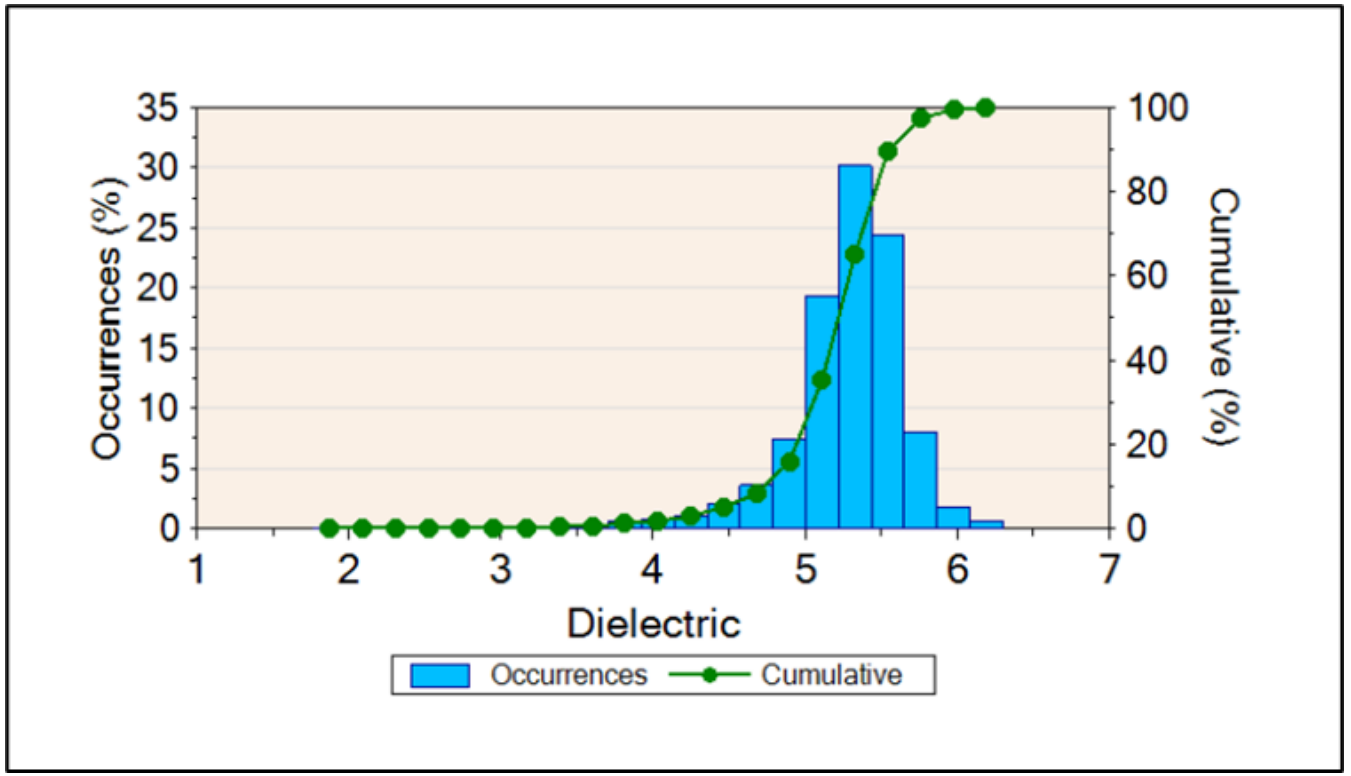


- Helps identify potential areas of low density (start of pull, along paving joints, etc…)
- View dielectric maps in real time

Source: FHWA

DPS Mapping & Dielectric Distribution – Example 1





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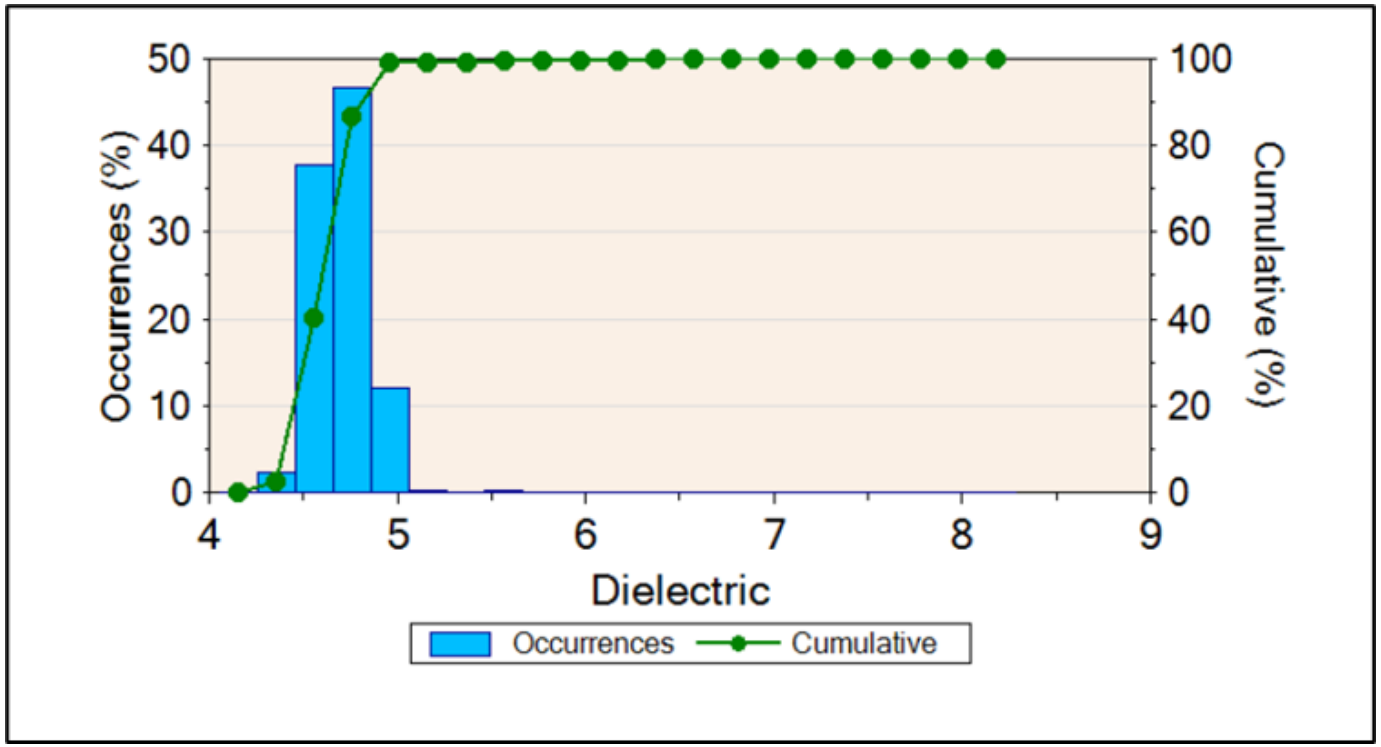
DPS Mapping & Dielectric Distribution – Example 2



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Benefits and Challenges of DPS

Benefits

+ Use as QC tool to identify potential issues with paving & compaction operations
+ Nondestructive testing method
+ Help identify high and low compaction areas
+ Help improve density of mat & longitudinal paving joints

Challenges

- Obstacles to use for acceptance (agency resources, proper validation of contractor data, time to collect, etc.)
- Incorporation in specifications & bids
- Staffing the data collection
- Currently, run manually

Current Activities Related to DPS Nationally

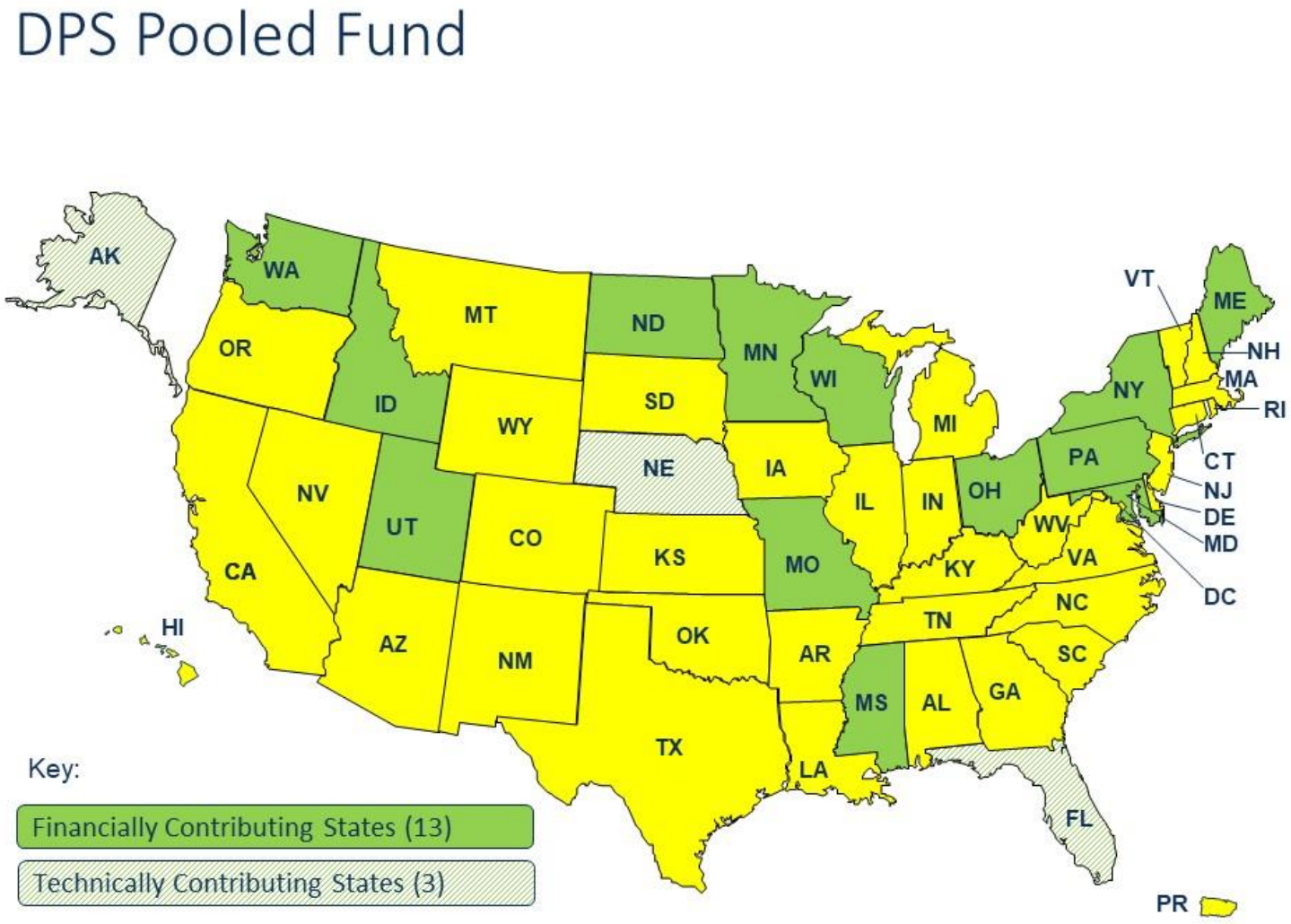
- FHWA and multiple State DOTs participating in a pooled fund study to evaluate use of DPS

Density Profiling System - Office of Materials and Road Research - MnDOT (state.mn.us)

- **Objectives:**
  - Further advance and improve system based on experience and needs to effectively and efficiently support QA programs
  - Support communication
  - Provide training and technical assistance
  - Conduct technology promotion and marketing

DPS Pooled Fund Recommendations

- Current use:
  - States encourage contractors to use to control paving and compaction operations
  - Some agencies require its use for QC only
- Future use?
  - DPS data used as part of acceptance



In-Place Mean Profile Depth Testing

Asphalt Pavement Macrotexture

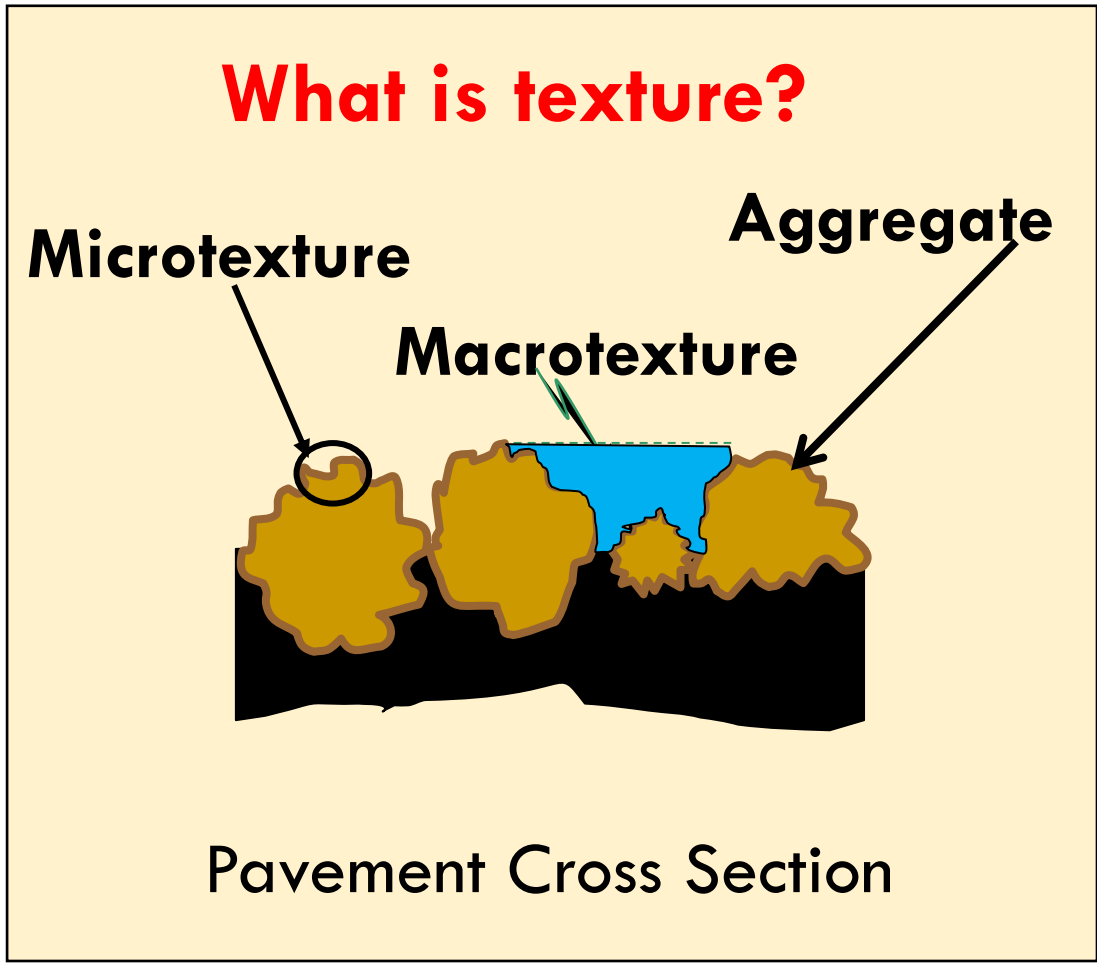
Significant focus on adding life (durability) to dense-graded mixes over the past several years

- Concern that macrotexture may be compromised

Macrotexture – mix surface voids, aggregate gradation driven

- Provides voids/channel to evacuate water – more critical at higher speeds
- Provides friction at higher speeds

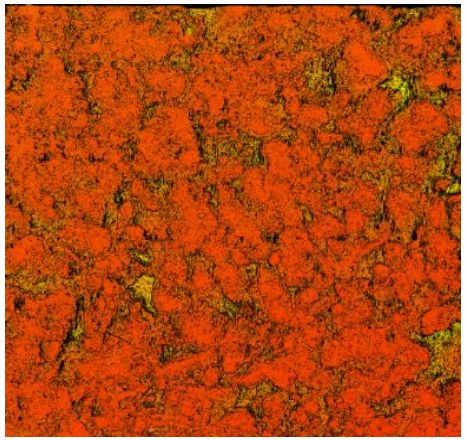
FHWA developing macrotexture test procedure that could be used in mix design, mix verification, & field verification



Existing Macrotexture Technique: Sand Patch

Laser Texture Scanner: Lab or Field

- Lightweight, portable, rapid, 3D scanner
- Utilizes a 100-mm laser line and travels 100 mm to collect a square area
- Measures macrotexture on freshly compacted mats in field and on cores or gyratory specimens in lab



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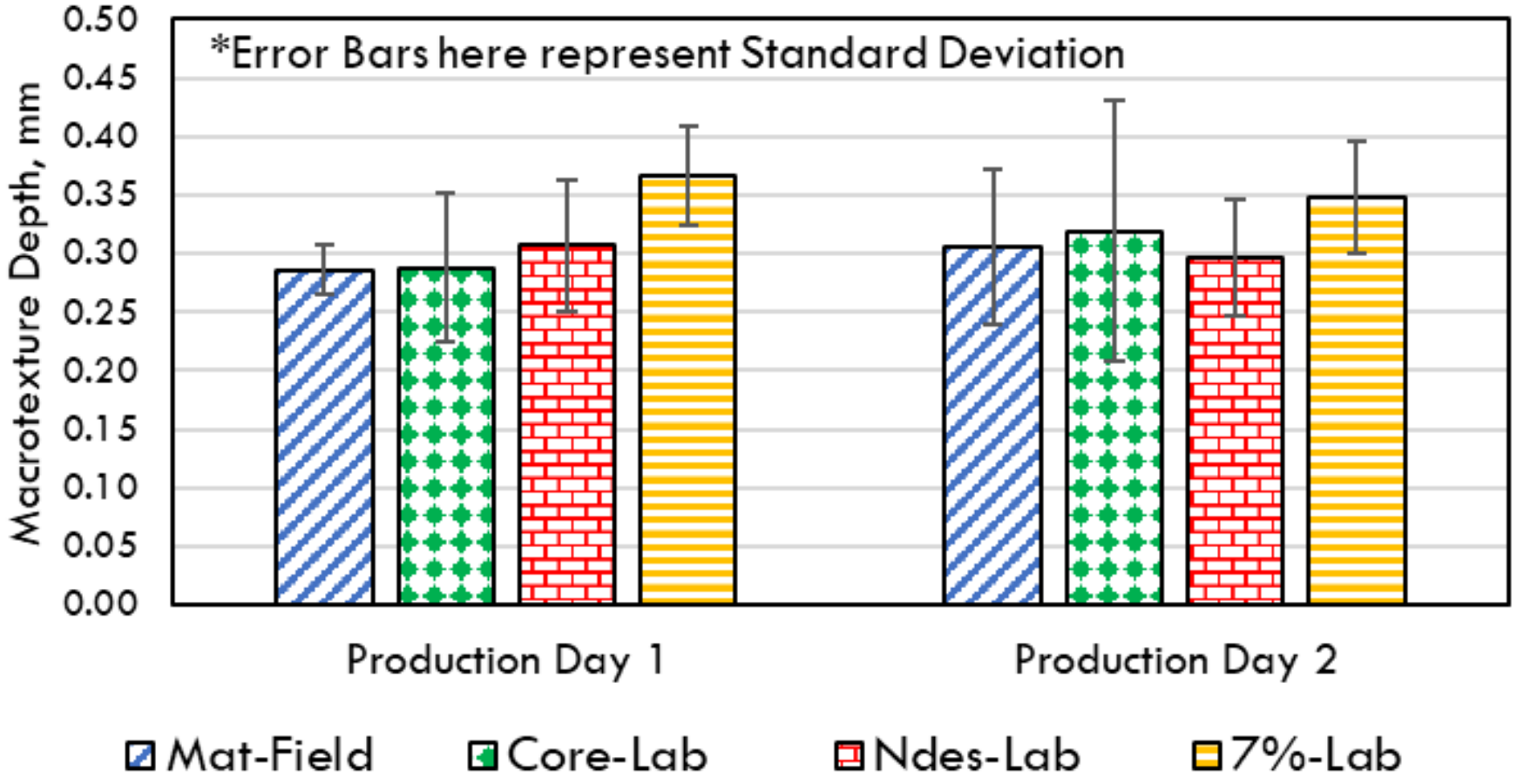
Mean Profile Depth (MPD) Measurements



12.5mm Dense Fine-Graded HMA – **MPD between 0.4 to 0.8 mm** - according to 2022 AASHTO Guide for Pavement Friction

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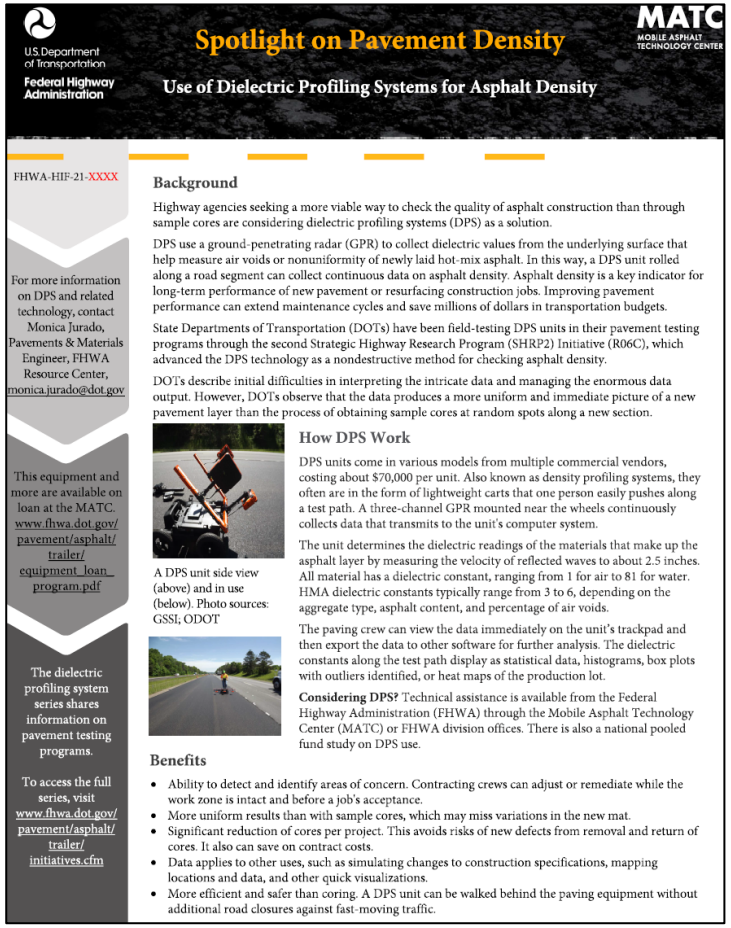
MATC Technology Transfer

- Communication bursts to raise awareness on FHWA efforts



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Spotlight on Pavement Density

Use of Dielectric Profiling Systems for Asphalt Density

FHWA-HIF-21-XXXX

For more information on DPS and related technology, contact Monica Jurado, Pavements & Materials Engineer, FHWA Resource Center, monica.jurado@dot.gov

This equipment and more are available on loan at the MATC. www.fhwa.dot.gov/pavement/asphalt/trailer/equipment_loan_program.pdf

The dielectric profiling system series shares information on pavement testing programs.

To access the full series, visit www.fhwa.dot.gov/pavement/asphalt/trailer/initiatives.cfm

Background

Highway agencies seeking a more viable way to check the quality of asphalt construction than through sample cores are considering dielectric profiling systems (DPS) as a solution.

DPS use a ground-penetrating radar (GPR) to collect dielectric values from the underlying surface that help measure air voids or nonuniformity of newly laid hot-mix asphalt. In this way, a DPS unit rolled along a road segment can collect continuous data on asphalt density. Asphalt density is a key indicator for long-term performance of new pavement or resurfacing construction jobs. Improving pavement performance can extend maintenance cycles and save millions of dollars in transportation budgets.

State Departments of Transportation (DOTs) have been field-testing DPS units in their pavement testing programs through the second Strategic Highway Research Program (SHRP2) Initiative (R06C), which advanced the DPS technology as a nondestructive method for checking asphalt density.

DOTs describe initial difficulties in interpreting the intricate data and managing the enormous data output. However, DOTs observe that the data produces a more uniform and immediate picture of a new pavement layer than the process of obtaining sample cores at random spots along a new section.

A DPS unit side view (above) and in use (below). Photo sources: GSSI; ODOT

How DPS Work

DPS units come in various models from multiple commercial vendors, costing about $70,000 per unit. Also known as density profiling systems, they often are in the form of lightweight carts that one person easily pushes along a test path. A three-channel GPR mounted near the wheels continuously collects data that transmits to the unit's computer system.

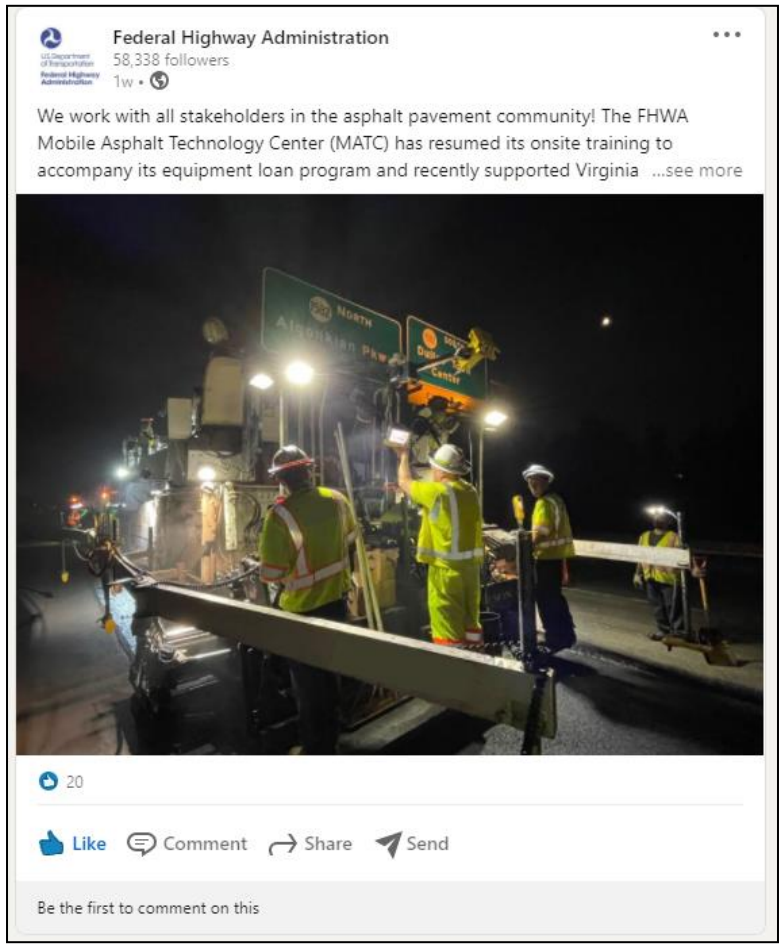
The unit determines the dielectric readings of the materials that make up the asphalt layer by measuring the velocity of reflected waves to about 2.5 inches. All material has a dielectric constant, ranging from 1 for air to 81 for water. HMA dielectric constants typically range from 3 to 6, depending on the aggregate type, asphalt content, and percentage of air voids.

The paving crew can view the data immediately on the unit's trackpad and then export the data to other software for further analysis. The dielectric constants along the test path display as statistical data, histograms, box plots with outliers identified, or heat maps of the production lot.

Considering DPS? Technical assistance is available from the Federal Highway Administration (FHWA) through the Mobile Asphalt Technology Center (MATC) or FHWA division offices. There is also a national pooled fund study on DPS use.

Benefits

- Ability to detect and identify areas of concern. Contracting crews can adjust or remediate while the work zone is intact and before a job's acceptance.
- More uniform results than with sample cores, which may miss variations in the new mat.
- Significant reduction of cores per project. This avoids risks of new defects from removal and return of cores. It also can save on contract costs.
- Data applies to other uses, such as simulating changes to construction specifications, mapping locations and data, and other quick visualizations.
- More efficient and safer than coring. A DPS unit can be walked behind the paving equipment without additional road closures against fast-moving traffic.



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We work with all stakeholders in the asphalt pavement community! The FHWA Mobile Asphalt Technology Center (MATC) has resumed its onsite training to accompany its equipment loan program and recently supported Virginia ...see more

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- Examples of Topics:
  - Enhancing in-place density
  - Spotlight on Pavement Density: Dielectric Profiling System Series
  - Spotlight on Constructability: Pave-IR Series

MATC Equipment Loan Program

Loan Request form submitted via FHWA P&M Engineer in Division Office

- Dielectric Profiling System
- Paver-Mounted Thermal Profiler
- Circular Track Meter
- SmartJig for IDEAL-CT and IDEAL-RT tests
- Laser Texture Scanner
- Handheld XRF Spectrometer for binder testinge
  - Detects limestone, titanium dioxide, REOB

Equipment loan includes on-site training by MATC or consultant, final Lessons Learned document, and post-loan briefing presentation

MATC "Lunch-n-Learn: Asphalt" Series

Pick topics for 1-hr virtual training

Lab Look-In: Test Methods (mixture, binder tests, etc.)

Strengthen your Asphalt QA Program

Pavement Preservation

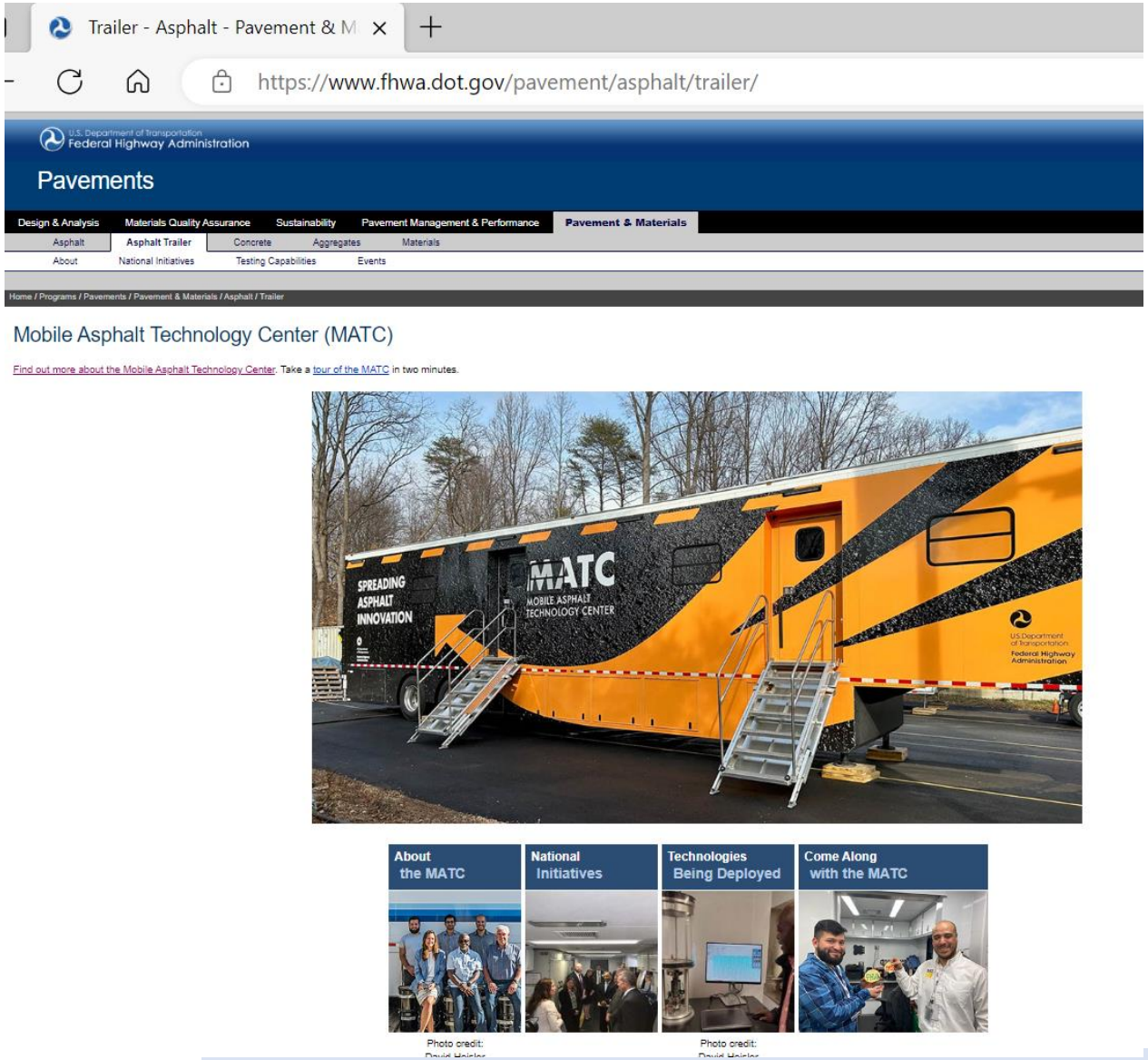
- Tack Coat Best Practices
- Longitudinal Joint Density

- Pavement Design Policy
- Mechanistic-Empirical Pavement Design

- BMD Concept & Tests
- Specimen fabrication tips for BMD tests
- BMD Key Tasks for Implementation

- Sustainability
- Macrotexture & Safety
- RAP Usage
- Resilience

MATC Website



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https://www.fhwa.dot.gov/pavement/asphalt/MATC/

MATC

MOBILE ASPHALT TECHNOLOGY CENTER

SPREADING ASPHALT PAVEMENT TECHNOLOGY INNOVATION

https://www.fhwa.dot.gov/matc

For more information on
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