MATC

MOBILE ASPHALT TECHNOLOGY CENTER

U.S. Department of Transportation

Federal Highway Administration

FHWA Technology Deployment Supports Durability & Safety

ACAF

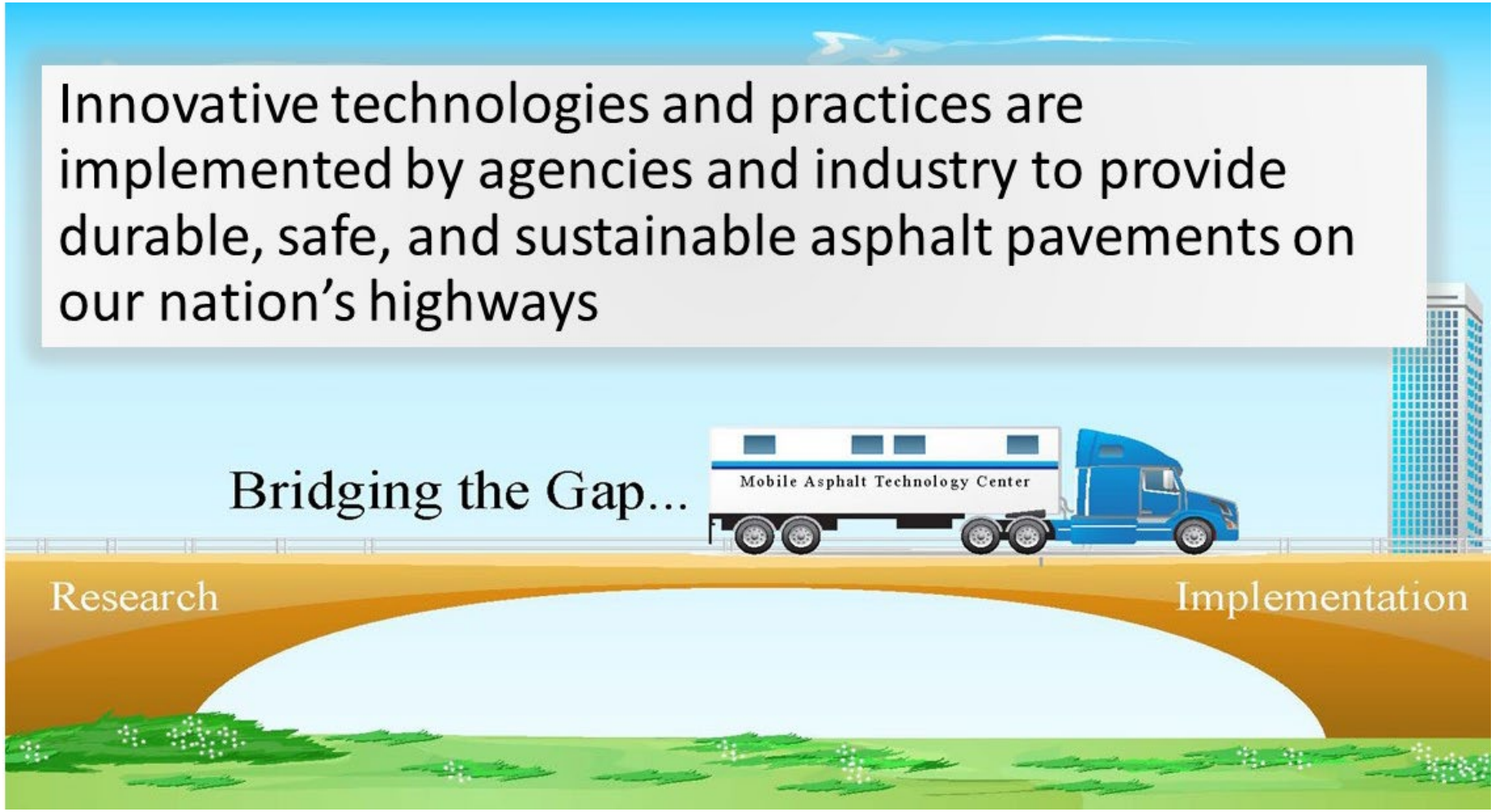
FHWA Disclaimers

- Contents of this presentation do not have the force and effect of law and are not meant to bind the public in any way.
  - This presentation is intended only to provide clarity to the public regarding existing requirements under the law or agency policies.
  - Compliance with applicable statutes or regulations cited in this document is required.
- All AASHTO and ASTM standards mentioned in this presentation content are non-governmental, voluntary standards and are not required under Federal law.
- The approaches and methods discussed in the presentations are not Federal requirements unless otherwise stated. Some items may be required by state policy or specification.
- Unless otherwise noted, FHWA is the source of all images in this presentation.
- The U.S. Government does not endorse products or manufacturers. Trademarks or manufacturers' names appear in this presentation only because they are considered essential to the objective of the presentation. They are included for informational purposes only and are not intended to reflect a preference, approval, or endorsement of any one product or entity.

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)



MATC
MOBILE ASPHALT TECHNOLOGY CENTER

U.S. Department of Transportation
Federal Highway Administration

Meet the FHWA MATC Team

Brendan Morris
Project Manager
Asphalt Design, Production, Field Operations,
Quality Control / Testing

Derek Nener-Plante, PE
FHWA Resource Center

Leslie Myers, Ph.D., PE
Federal Program Manager

James Barker
Senior Laboratory Technician
Electro/Mechanical
Mixture Design / Testing

Johnatan Gutierrez
Materials Lab Technician
Lab Operations /
Materials Testing

SME: Nam Tran
Subject Matter Expert
Asphalt Materials Data Analysis

SME: Michael Huner
Subject Matter Expert
Materials and Construction Specifications

Ram Veeraragavan, Ph.D.
Project Engineer
Data Analysis
Performance Testing

Otto Arrieta-Cardenas
Field Technician
Field Operations /
Field Testing

MATC
MOBILE ASPHALT TECHNOLOGY CENTER

U.S. Department of Transportation
Federal Highway Administration

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

MATC MOBILE ASPHALT TECHNOLOGY CENTER
U.S. Department of Transportation Federal Highway Administration

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 for real-time mat temperatures
Overlay Test for reflective cracking	* FTIR looks at molecules in binder (lime, polymers,…)	Pulse induction test for in-place pavement thickness
Flexibility index test (I-FIT) for fracture resistance	* Binder characterization testing (delta T_c, delta T_f)	Circular Track Meter for measuring mean profile depth
* Hamburg Wheel Track Tester		Dielectric profiling system (DPS) for in-place density
IDEAL-RT for rutting resistance	* Done at FHWA TFHRC labs	Laser-based measurement of mean profile depth
AMPT suite of tests (|E*|, cyclic fatigue, SSR)		

Other support activities:

PaveME Design analysis

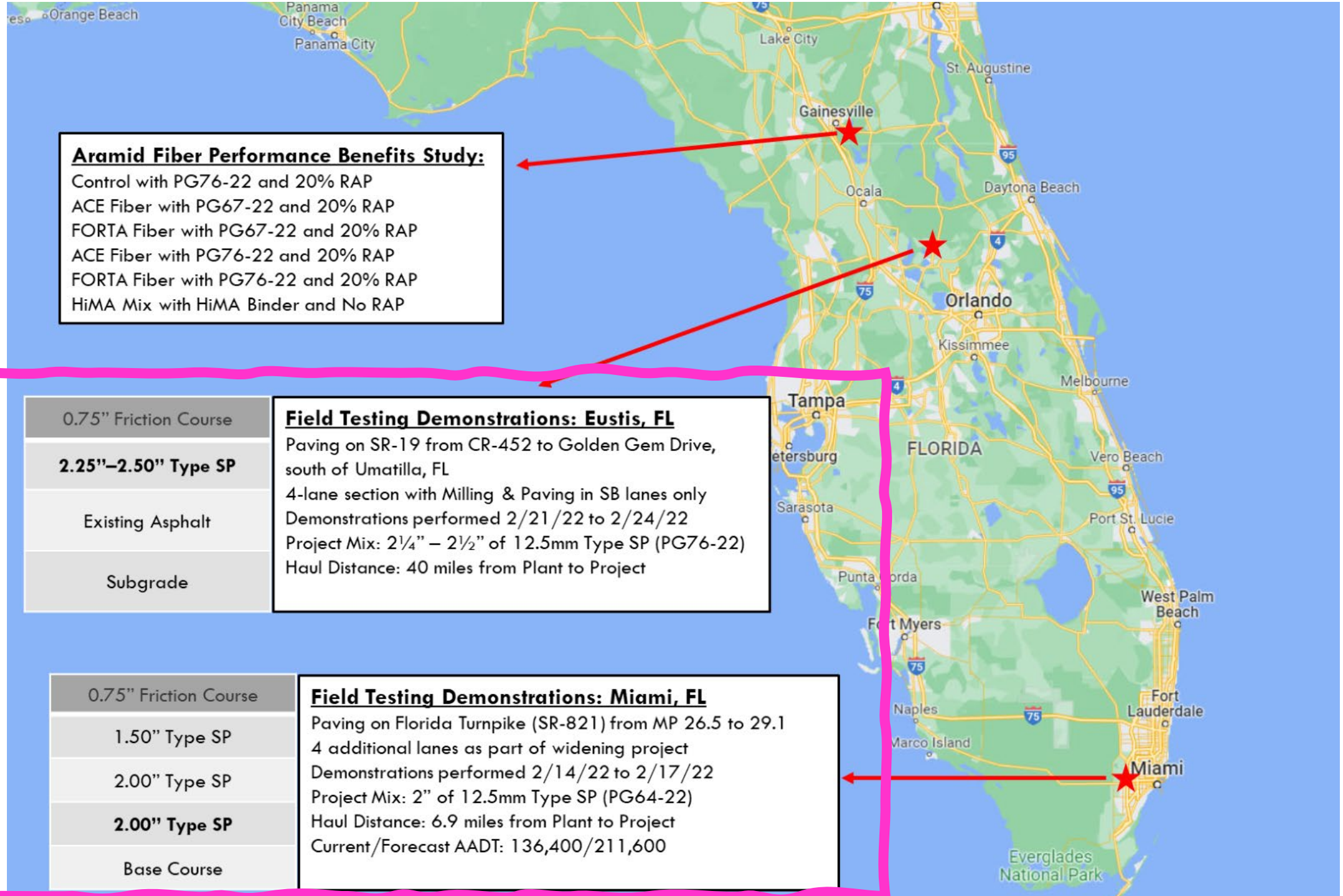
* FlexMAT & FlexPAVE for mix design performance comparisons

Asphalt pavement spec review

Construction density spec review (mat and joints)

MATC Visit to Florida

Feb 2022



Aramid Fiber Performance Benefits Study:

Control with PG76-22 and 20% RAP
ACE Fiber with PG67-22 and 20% RAP
FORTA Fiber with PG67-22 and 20% RAP
ACE Fiber with PG76-22 and 20% RAP
FORTA Fiber with PG76-22 and 20% RAP
HiMA Mix with HiMA Binder and No RAP

0.75" Friction Course
2.25"–2.50" Type SP
Existing Asphalt
Subgrade

Field Testing Demonstrations: Eustis, FL

Paving on SR-19 from CR-452 to Golden Gem Drive, south of Umatilla, FL
4-lane section with Milling & Paving in SB lanes only
Demonstrations performed 2/21/22 to 2/24/22
Project Mix: 2¼" – 2½" of 12.5mm Type SP (PG76-22)
Haul Distance: 40 miles from Plant to Project

0.75" Friction Course
1.50" Type SP
2.00" Type SP
2.00" Type SP
Base Course

Field Testing Demonstrations: Miami, FL

Paving on Florida Turnpike (SR-821) from MP 26.5 to 29.1
4 additional lanes as part of widening project
Demonstrations performed 2/14/22 to 2/17/22
Project Mix: 2" of 12.5mm Type SP (PG64-22)
Haul Distance: 6.9 miles from Plant to Project
Current/Forecast AADT: 136,400/211,600

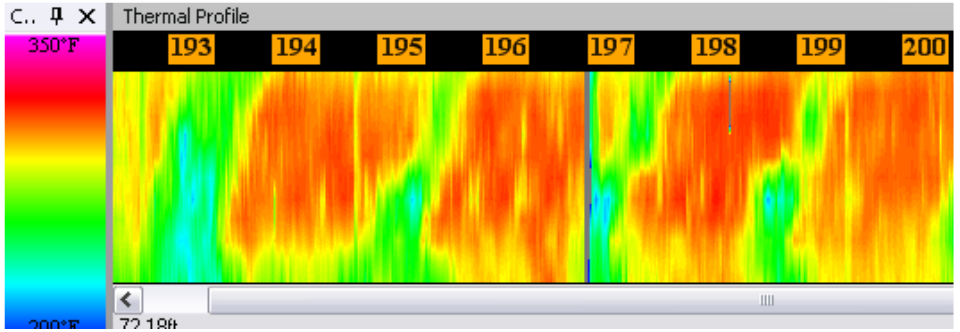
Deployment of Field Technologies to Assist Asphalt Pavement Constructability

MATC
MOBILE ASPHALT TECHNOLOGY CENTER

U.S. Department of Transportation
Federal Highway Administration

Paver-Mounted Thermal Profiler (PMTP)

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



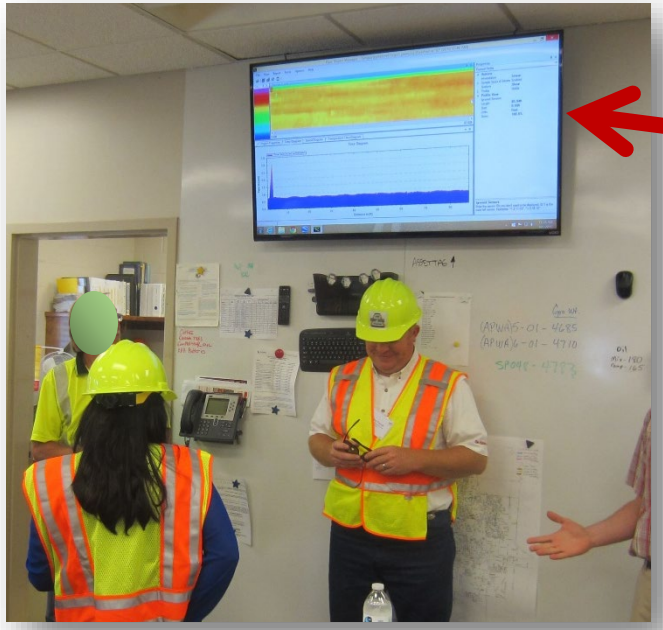
PMTP Scanner

Ready to Use Technology

All images source: Travis Walbeck

How it works…

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



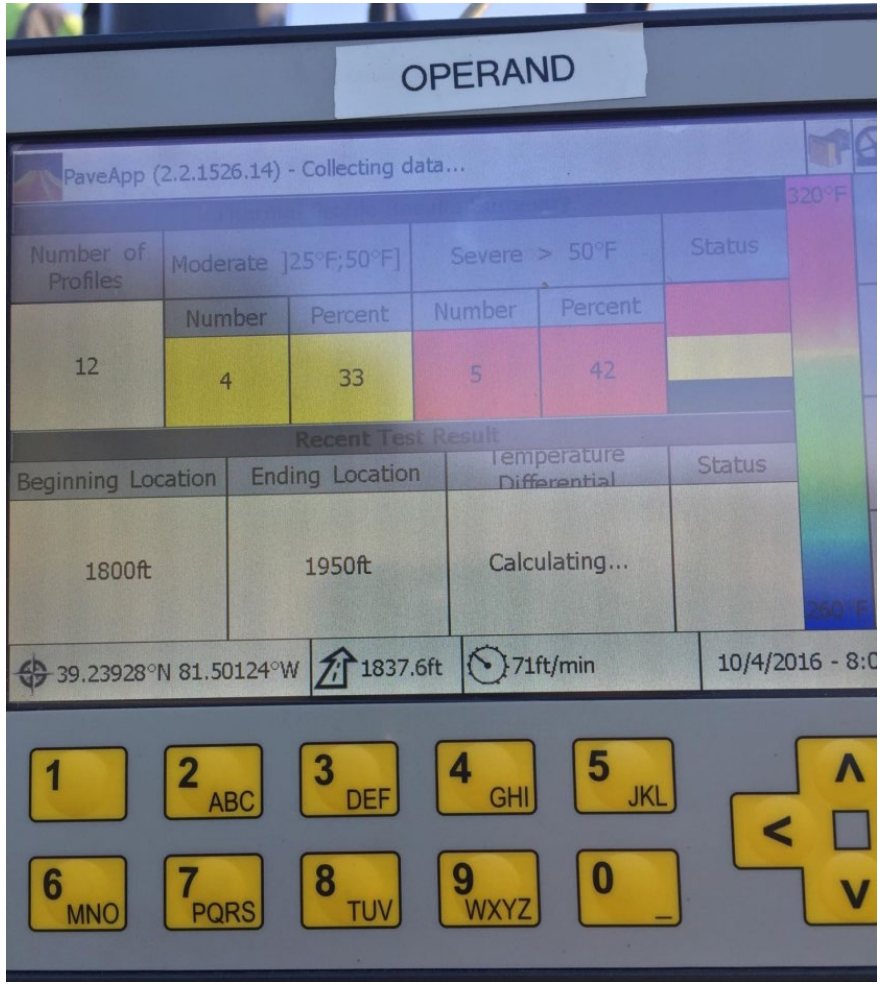
Contractor monitors from plant

Owner monitors from anywhere

Images: SHRP2 (R06 C)

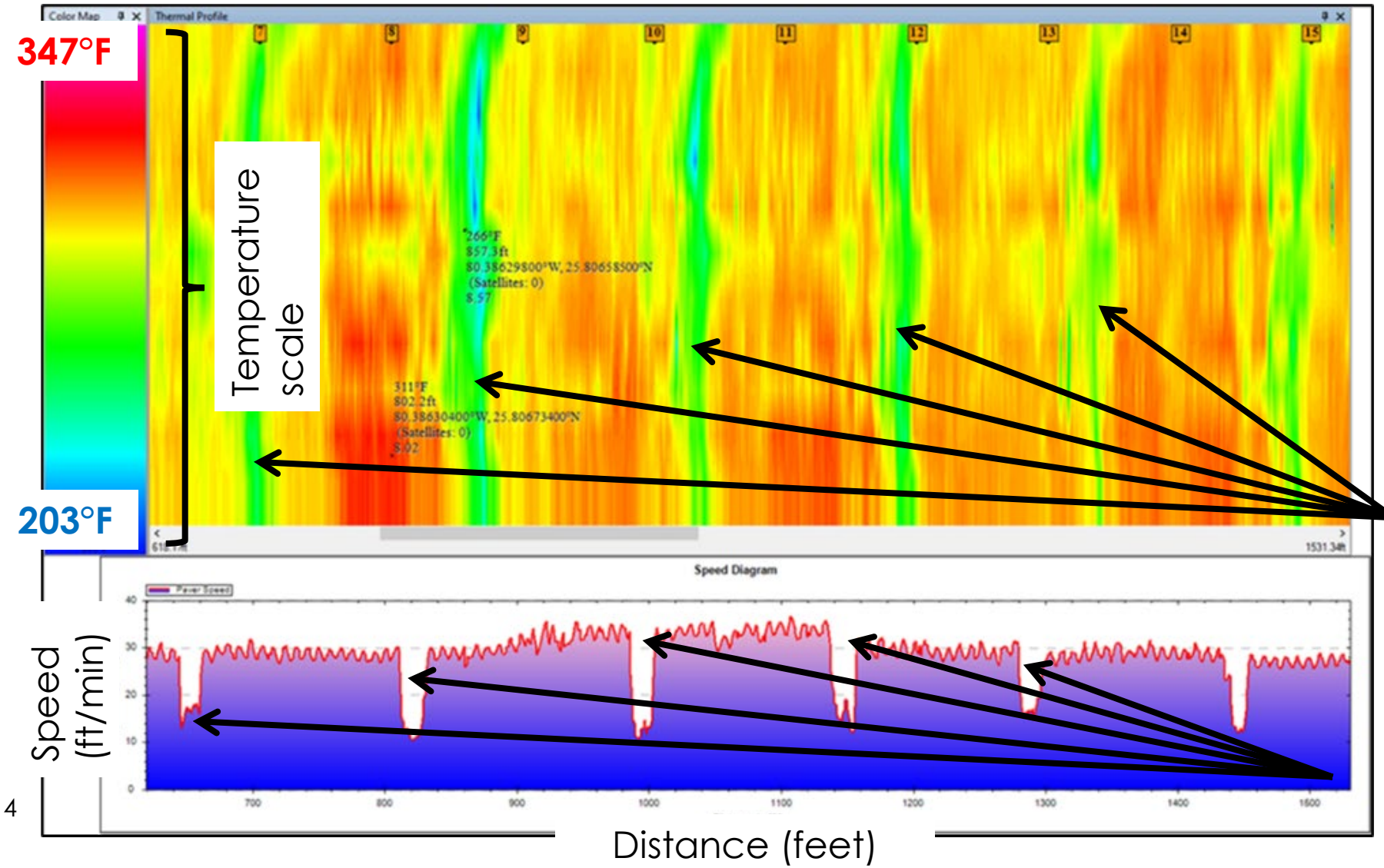
Sample PMTP Output

Source: Harold von Quintus

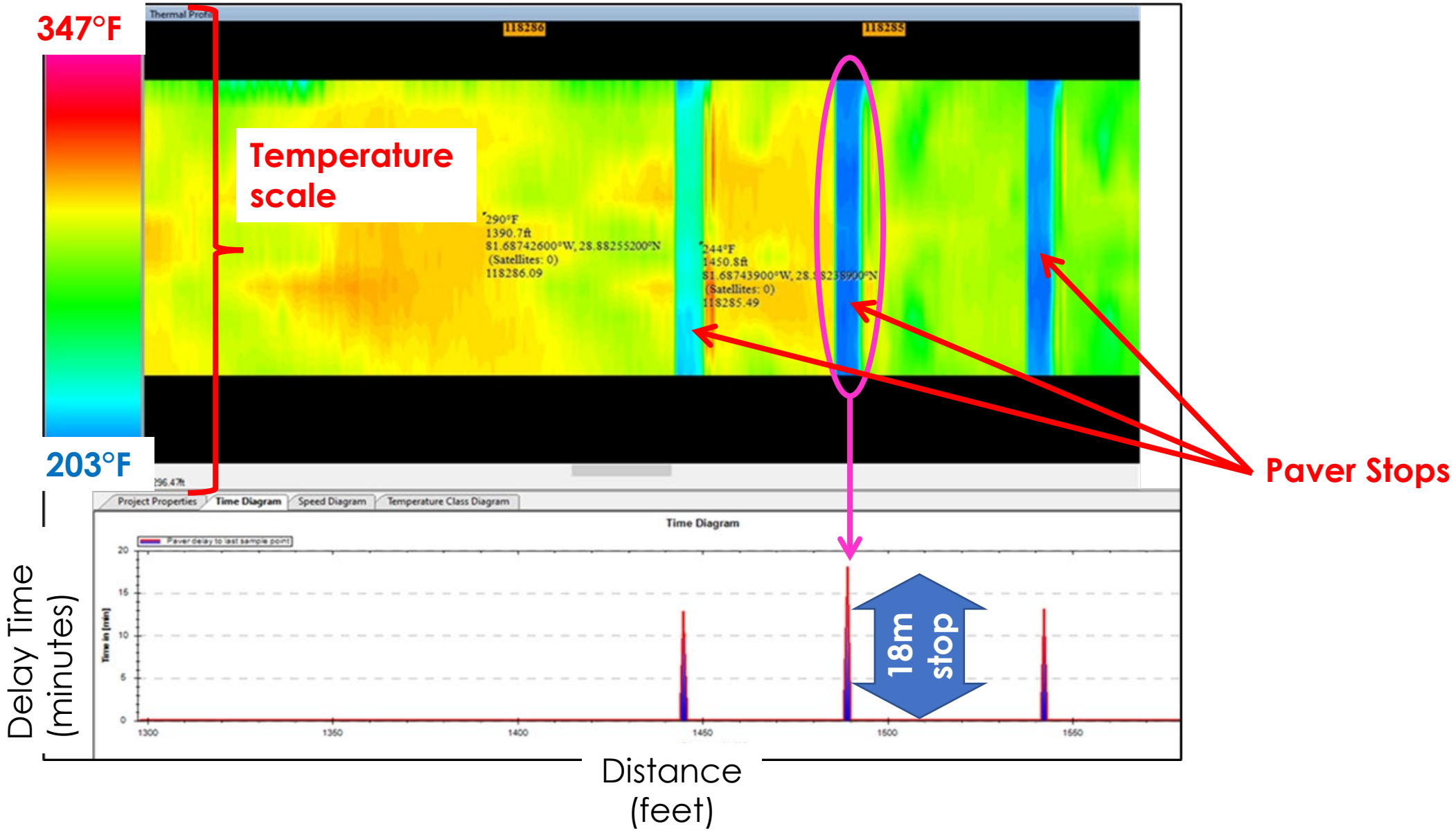


Source: Travis Walbeck

PMTP Thermal Map: FL Turnpike (SR-821), Miami



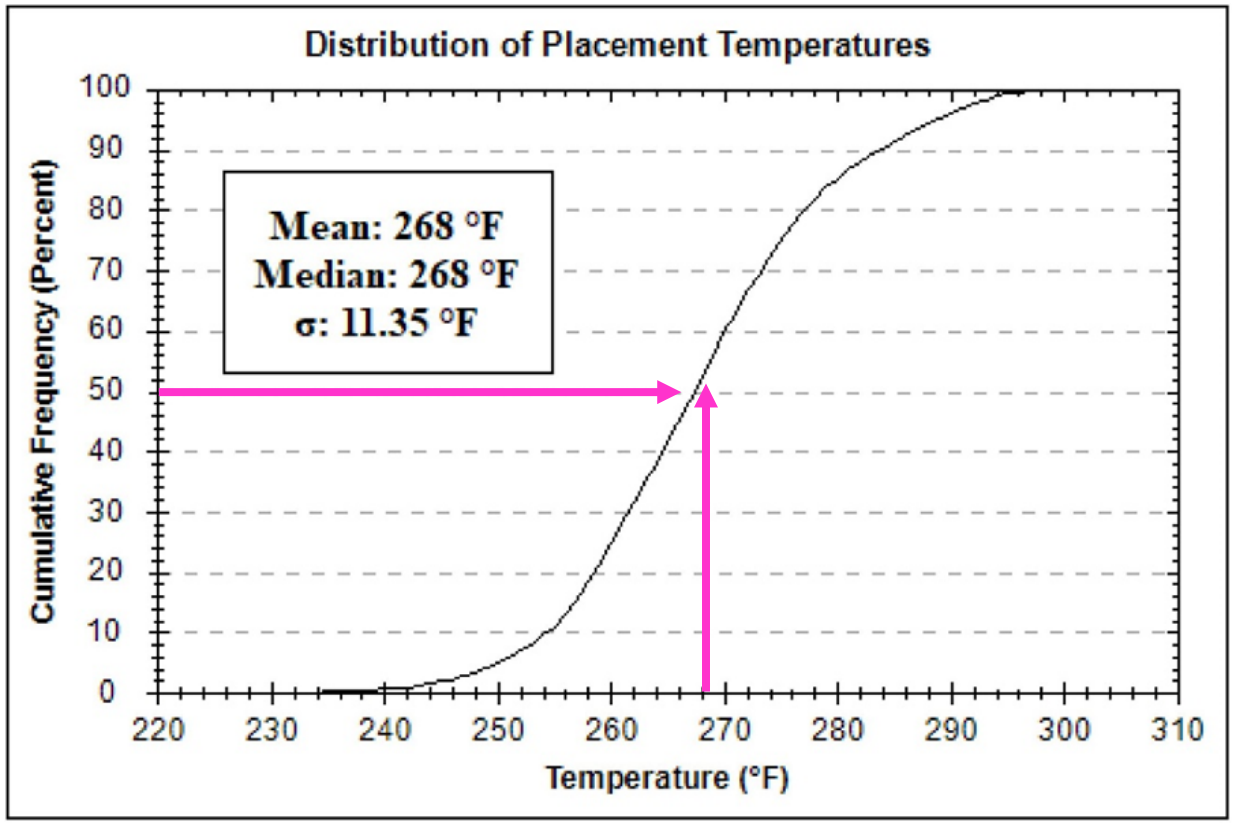
PMTP Thermal Map: SR-19 near Eustis, FL



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

Current Limitations

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

Implementation in 12 states & Eastern Federal Lands

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

Macrotexture Testing

Asphalt Pavement Macrotexture

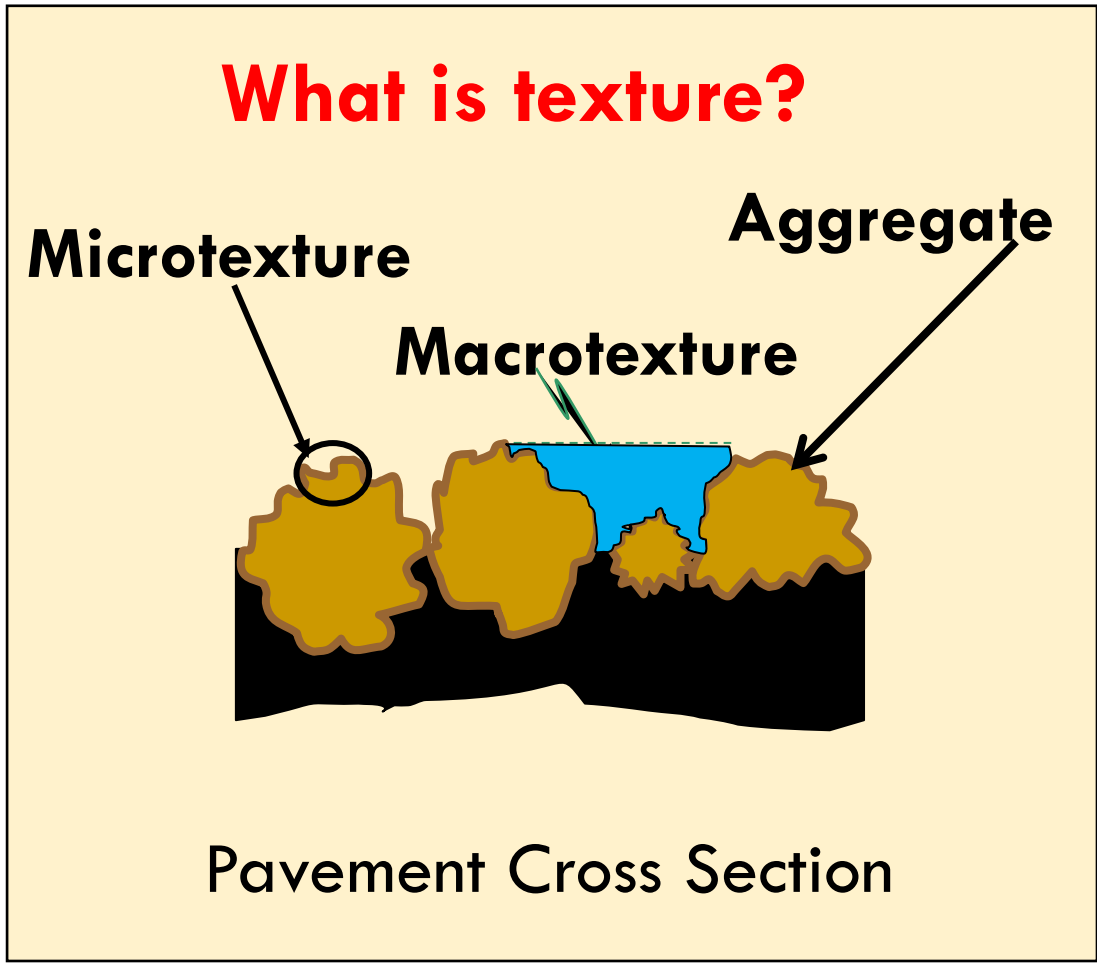
Significant focus on adding life (durability) to dense-graded mixes over the past several years

- 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

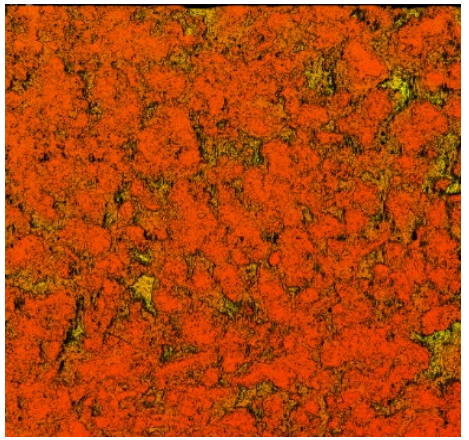
FHWA developing macrotexture test procedure that could be used in mix design, mix verification, & field verification



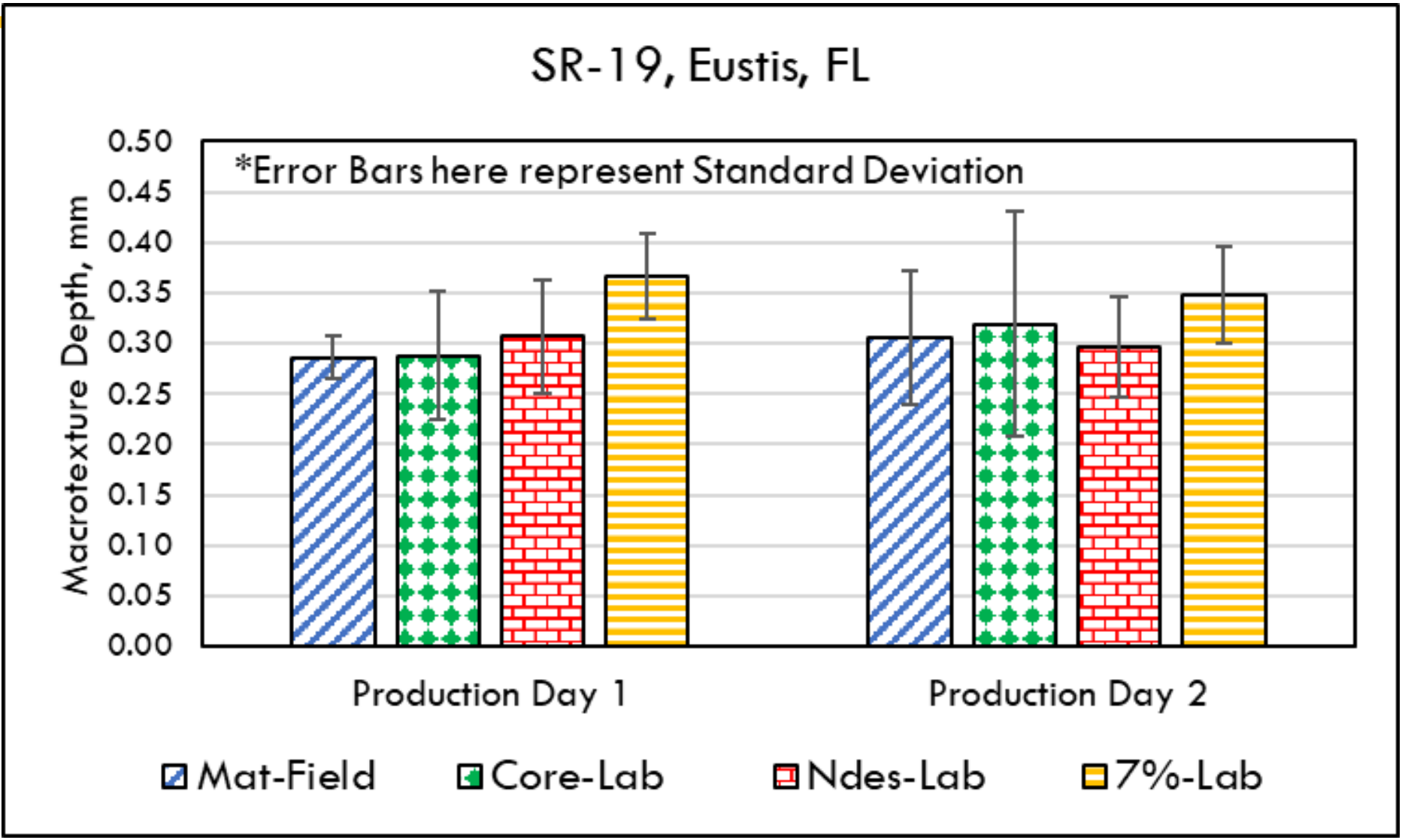
Existing Macrotexture Technique: Sand Patch

Laser Texture Scanner in 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



Mean Profile Depth (MPD) Measurements SR-19 near Eustis, FL



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

MATC MOBILE ASPHALT TECHNOLOGY CENTER

U.S. Department of Transportation Federal Highway Administration

Laser Texture Scanning

Benefits

+ Easy to use & nondestructive
+ High accuracy
+ Takes 90 seconds to run
+ Good for QC use
+ Can be used in lab during mix design & production

Current Limitations

- Standards still under development
- Surface must be dry, if used on field mat
- Sensitive to shiny mixes so spray needed to dull reflectance
- Not a direct correlation to friction

Current under consideration for implementation

- California, Illinois, Kentucky, North Carolina, Ohio, Washington

In-Place Asphalt 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 Federal requirements*

Step 1

Place the target

Step 2

Pave over it

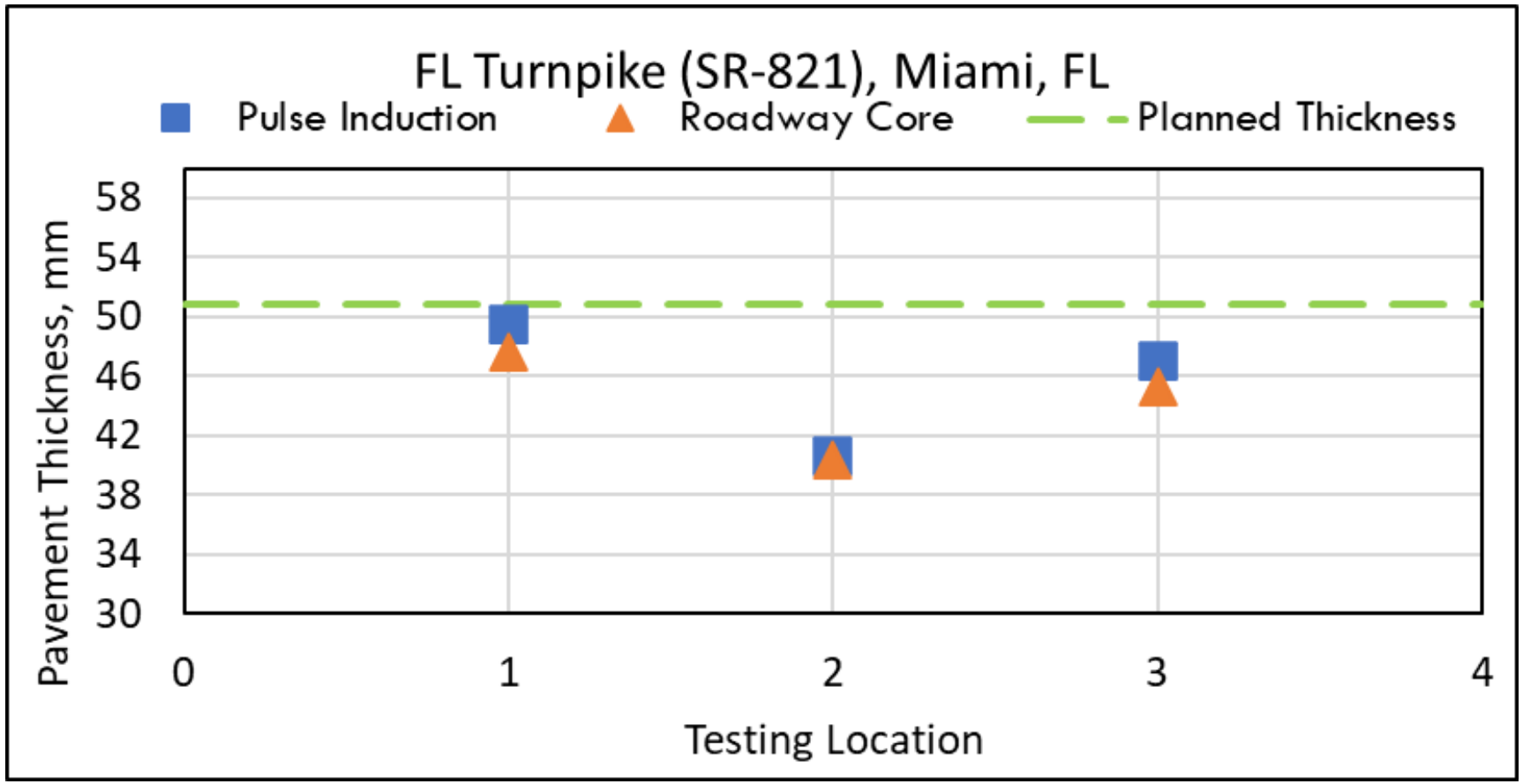
Step 3

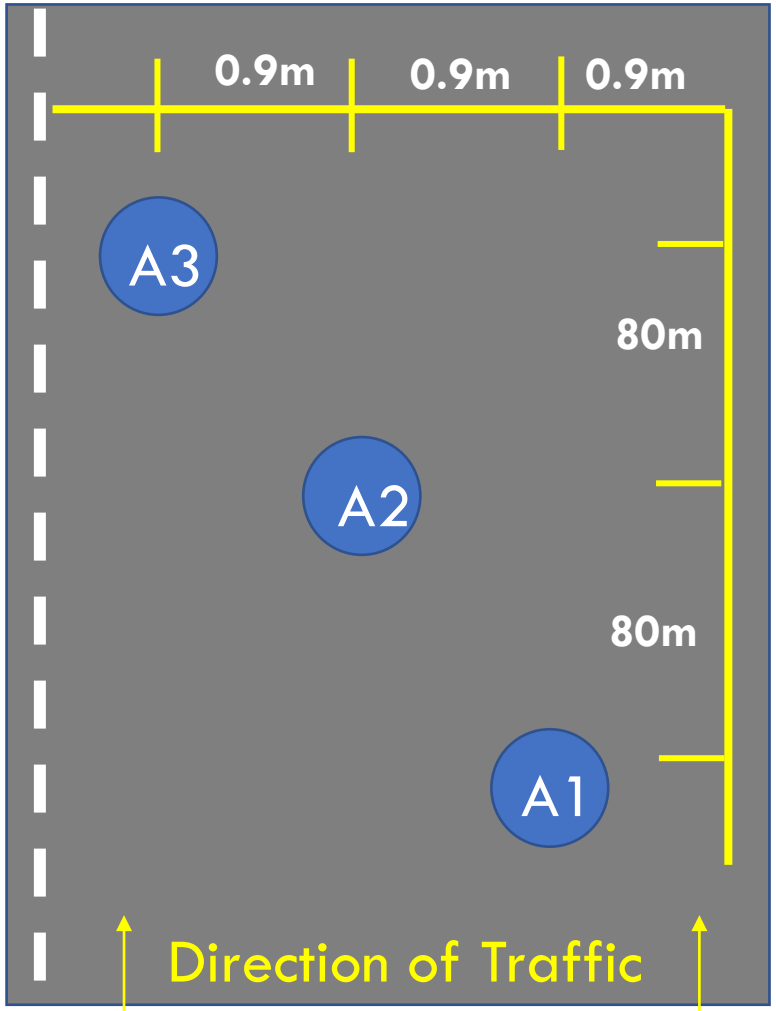
Find targets; measure thickness

Optional Step

Core & confirm thickness

Pulse Induction Technology - FL Turnpike (SR-821), Miami FL

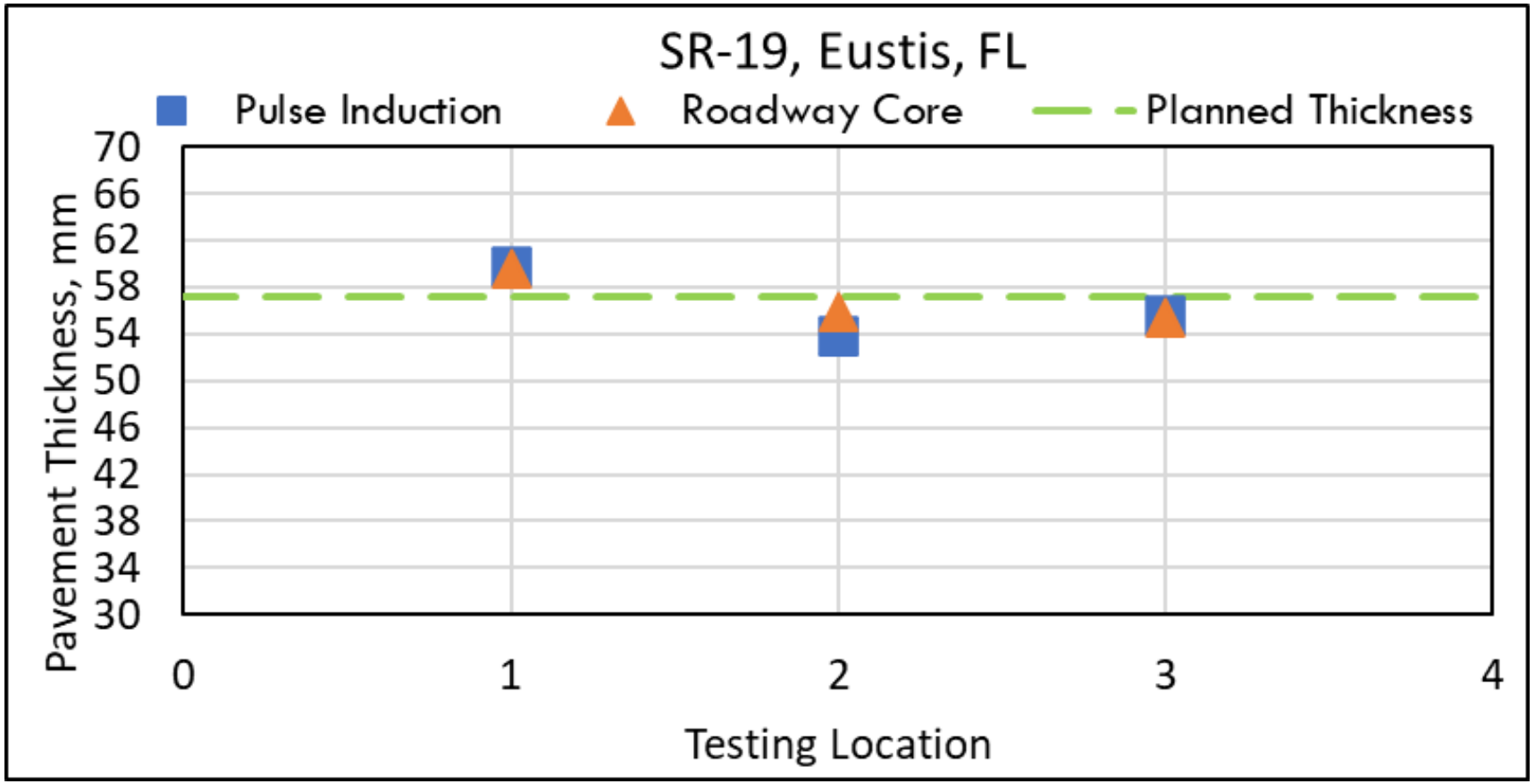


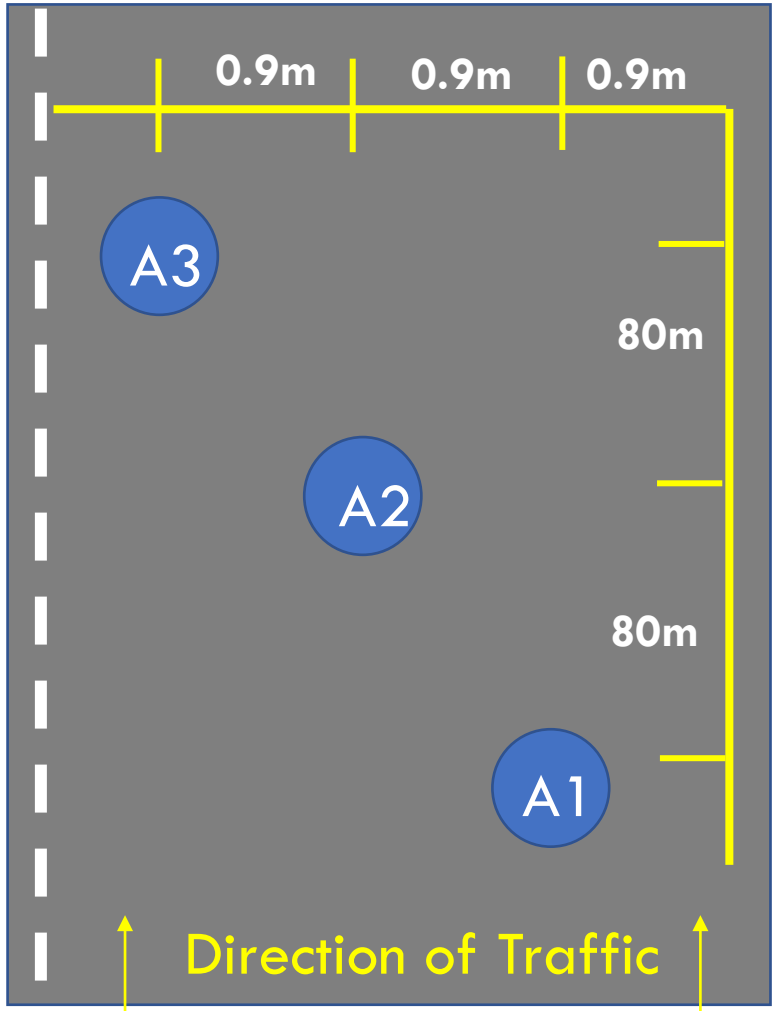


MATC MOBILE ASPHALT TECHNOLOGY CENTER

U.S. Department of Transportation Federal Highway Administration

Pulse Induction Technology - SR-19 near Eustis, FL





MATC MOBILE ASPHALT TECHNOLOGY CENTER
U.S. Department of Transportation Federal Highway Administration

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

Current Limitations

- Presence of existing rebar in existing layers
- Presence of excessive moisture on surface
- Windrow paving
- Surface irregularities (inadequate removal of scabs, unlevel existing surface)

Current practice

- Iowa, Minnesota, Pennsylvania, Washington, Wisconsin

In-Place Asphalt Density & Mat Uniformity Testing

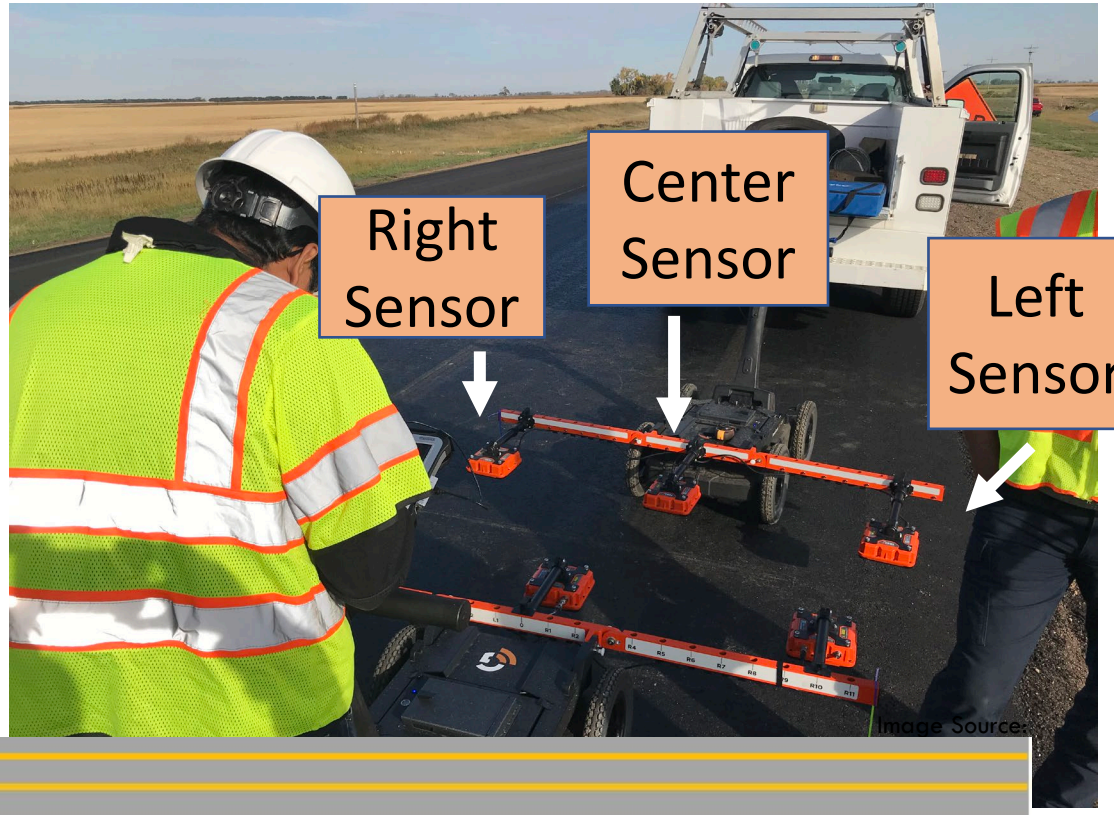
Existing Density Measurement Techniques

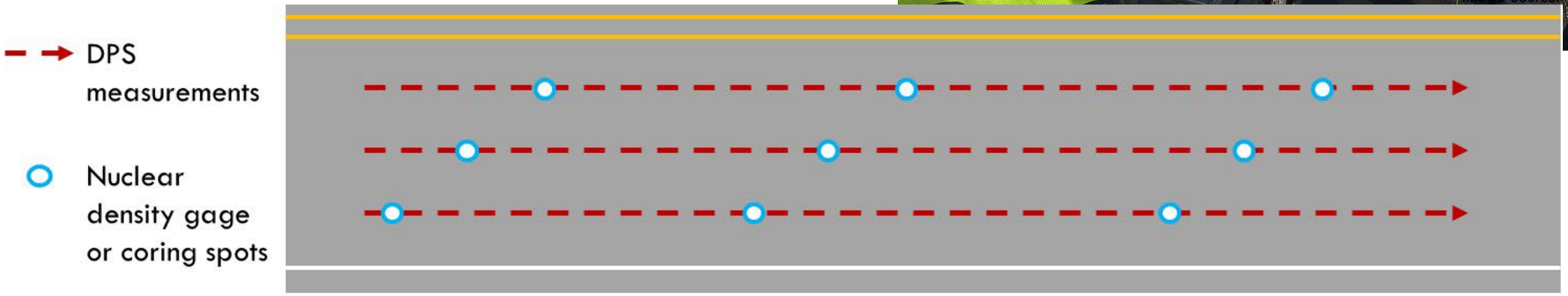
- Coring:
  - Labor intensive, destructive, long turnaround time
    - 1to 2 days
- Nuclear density gauge:
  - Involves calibration, special handling, training, and certification

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

Dielectric Profiling Systems (DPS)

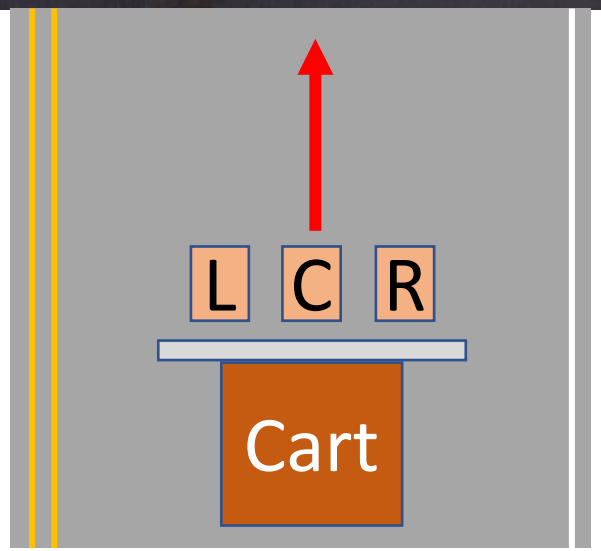
- Coring and nuclear density gauge only used for spot checks on predetermined, random locations
- DPS provides continuous density profile along testing path
- Reduce turnaround times



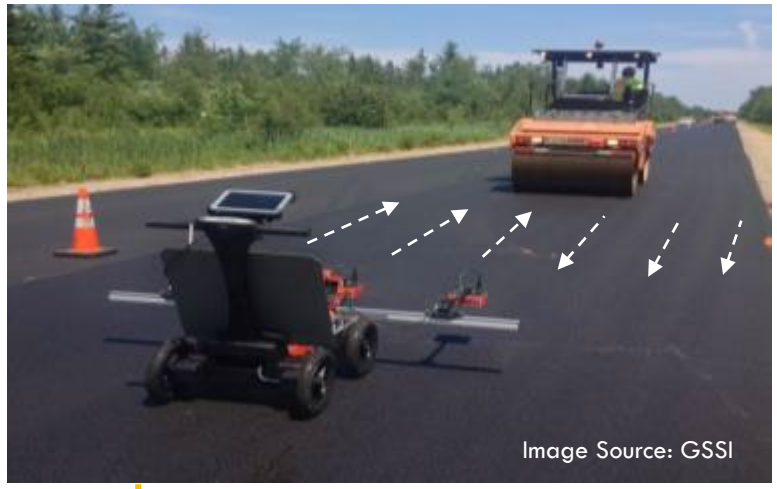


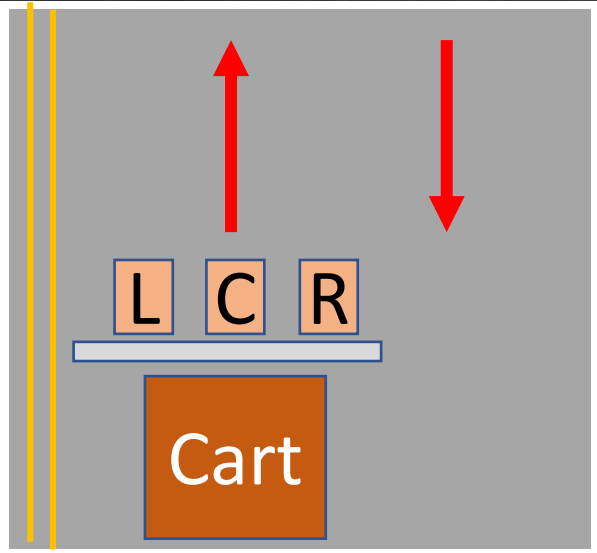
Data Collection Patterns

1-Pass Pattern



2-Pass Pattern





MATC MOBILE ASPHALT TECHNOLOGY CENTER

U.S. Department of Transportation
Federal Highway Administration

DPS Output: Relating Dielectrics to Density

Low Dielectric Value → Higher Air Void Content → Lower Density

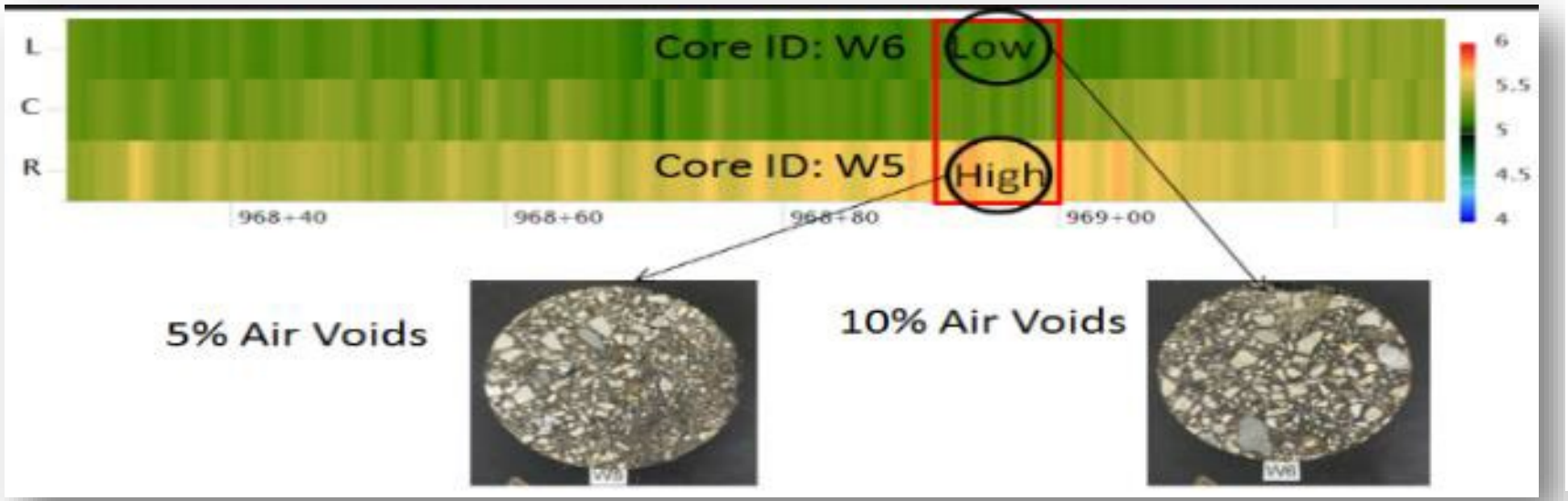


Image Source: GSSI

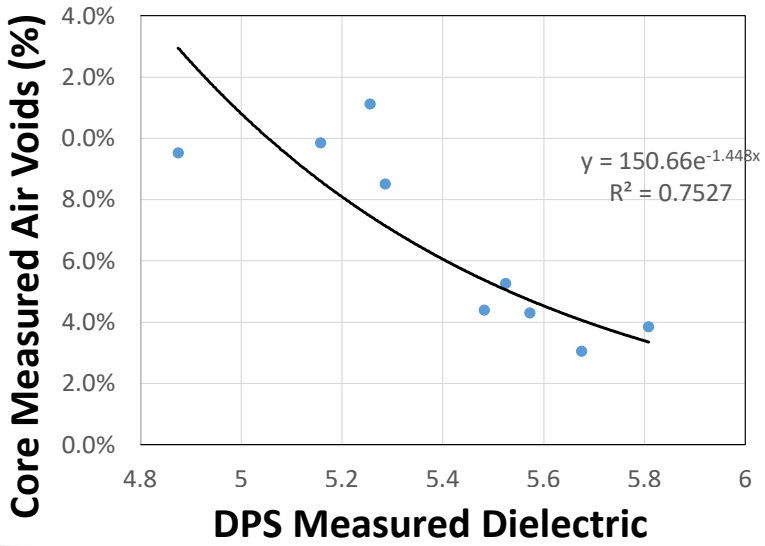


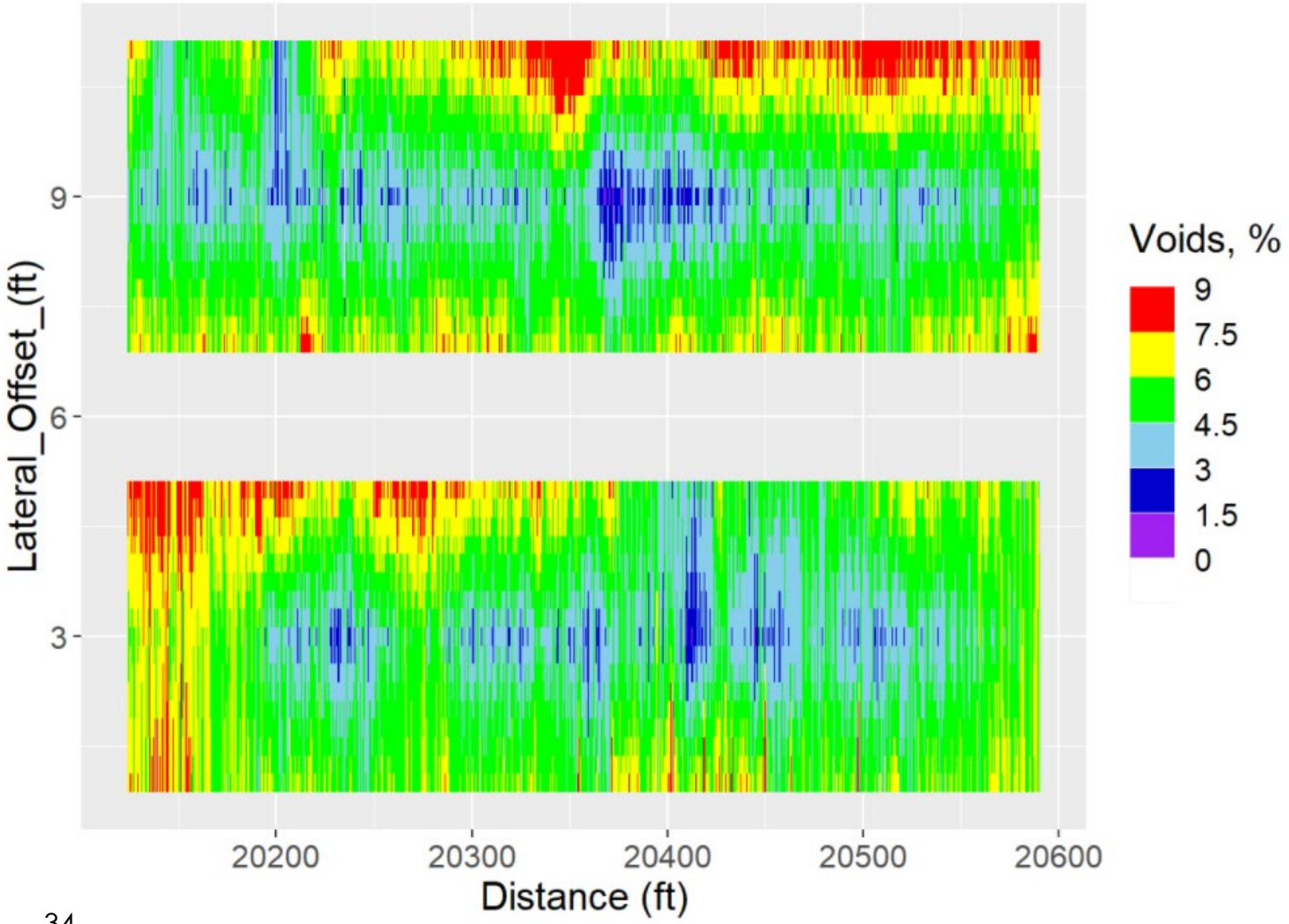
Image Source: FHWA

High Dielectric Value → Lower Air Void Content → Higher Density

MATC MOBILE ASPHALT TECHNOLOGY CENTER

U.S. Department of Transportation
Federal Highway Administration

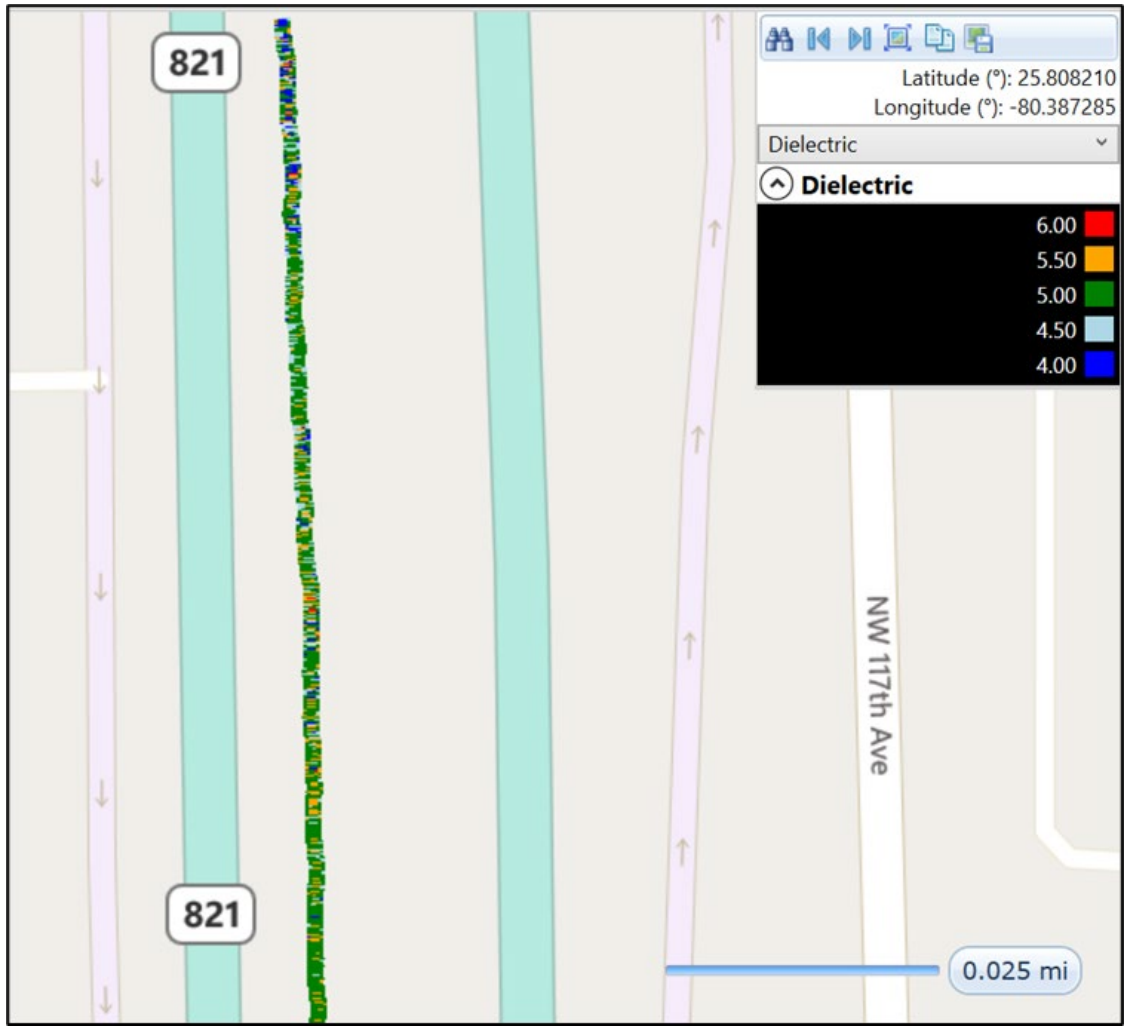
Dielectric Mapping or "Heat Maps" for density

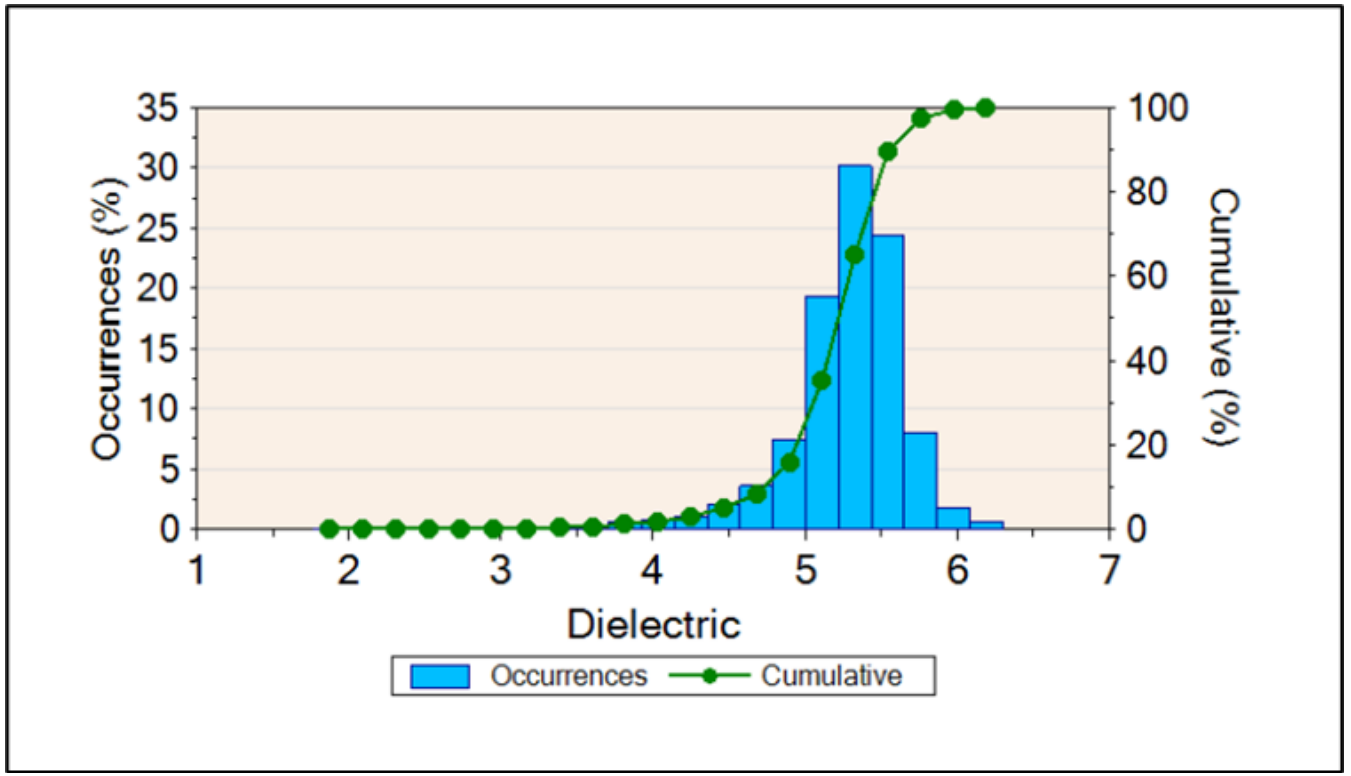


- Helps identify potential areas of low density areas - e.g., at start of pass, along paving joints, etc.)
- View heat maps in real time

Source: FHWA

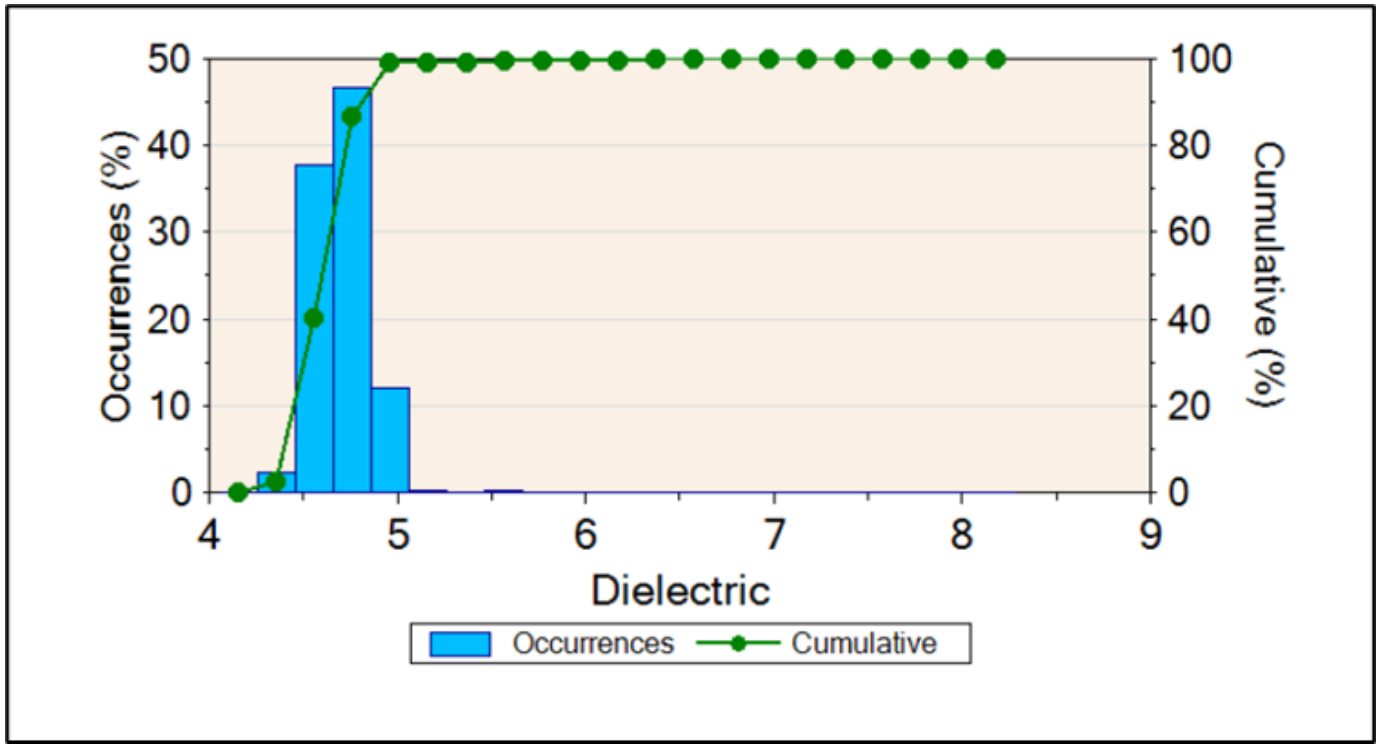
DPS Mapping & Dielectric Distribution - FL Turnpike (SR-821), Miami FL





MATC MOBILE ASPHALT TECHNOLOGY CENTER
U.S. Department of Transportation Federal Highway Administration

DPS Mapping & Dielectric Distribution - SR-19 near Eustis, FL



MATC MOBILE ASPHALT TECHNOLOGY CENTER
U.S. Department of Transportation Federal Highway Administration

Benefits and Challenges of DPS

Benefits

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

Current 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
- Device is run manually

Current Activities Related to DPS Nationally

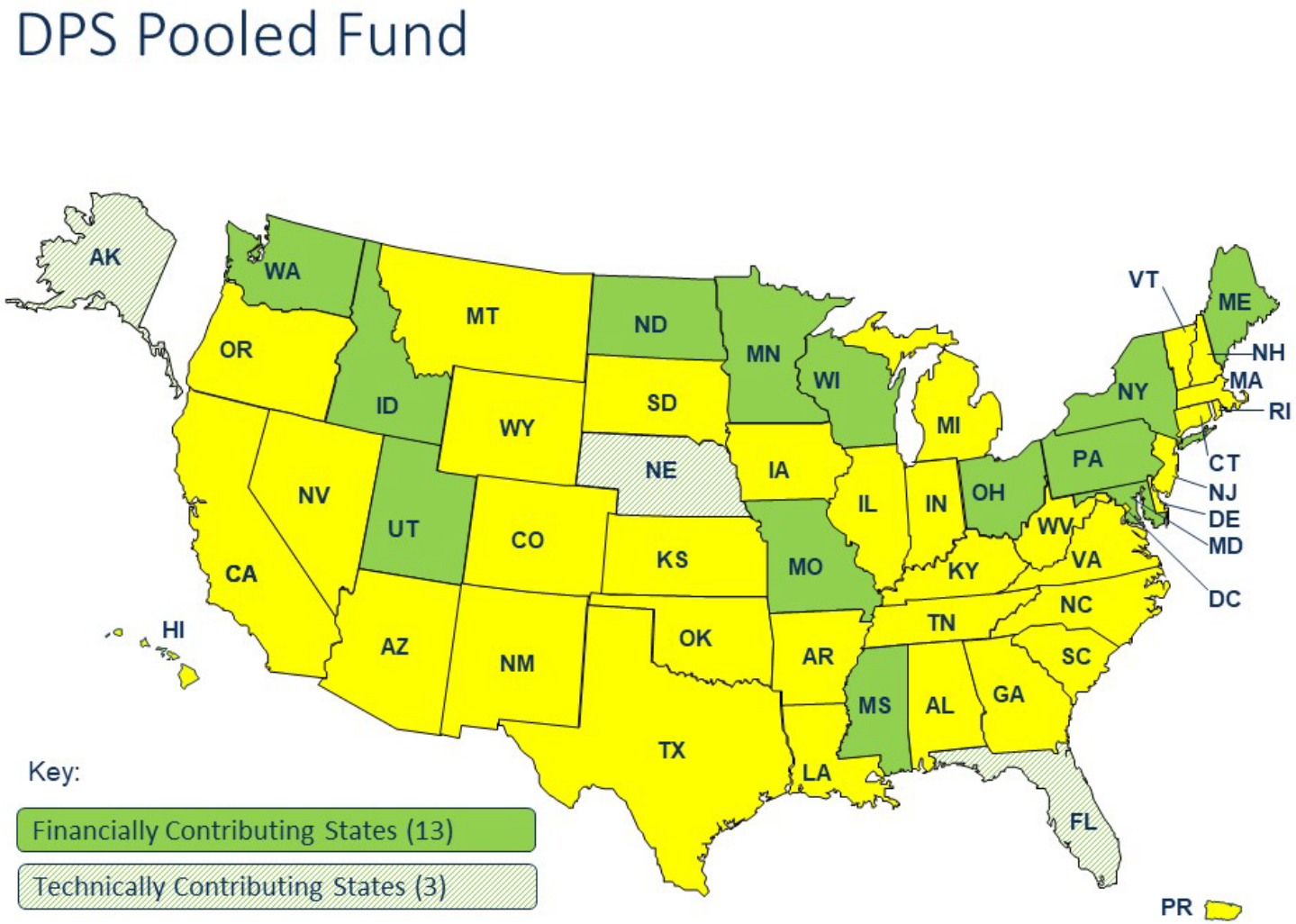
- FHWA and multiple State DOTs participating in a pooled fund study to evaluate use of DPS

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

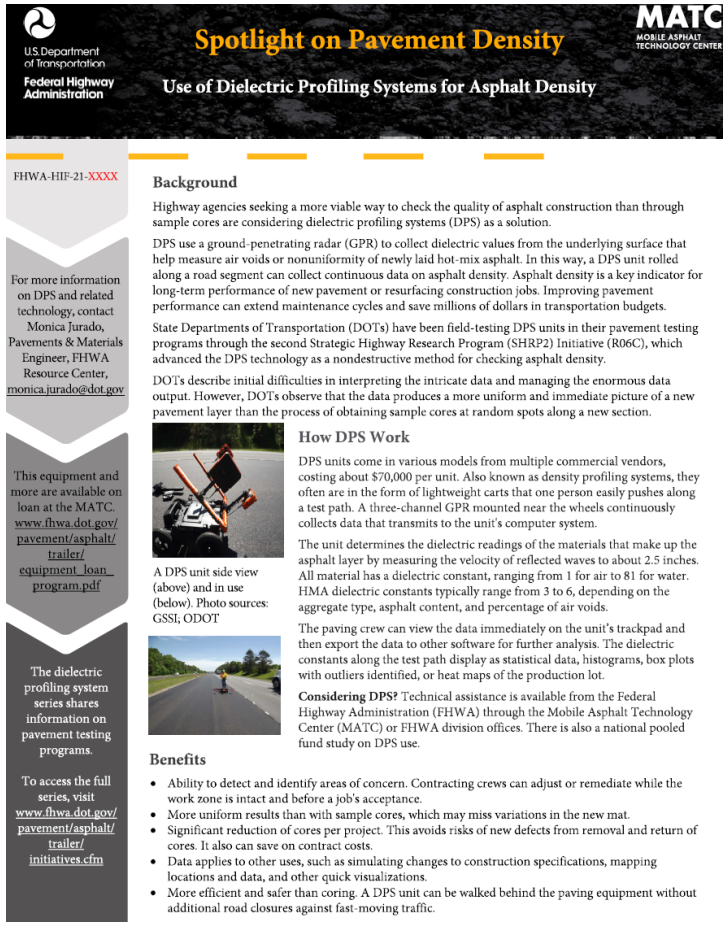
- **Objectives:**
  - Further advance and improve system based on experience and needs to effectively and efficiently support QA programs
  - Support communication
  - Provide training and technical assistance
  - Conduct technology promotion and marketing

DPS Pooled Fund Recommendations

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



Technology Transfer



U.S. Department of Transportation
Federal Highway Administration

MATC
MOBILE ASPHALT TECHNOLOGY CENTER

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.

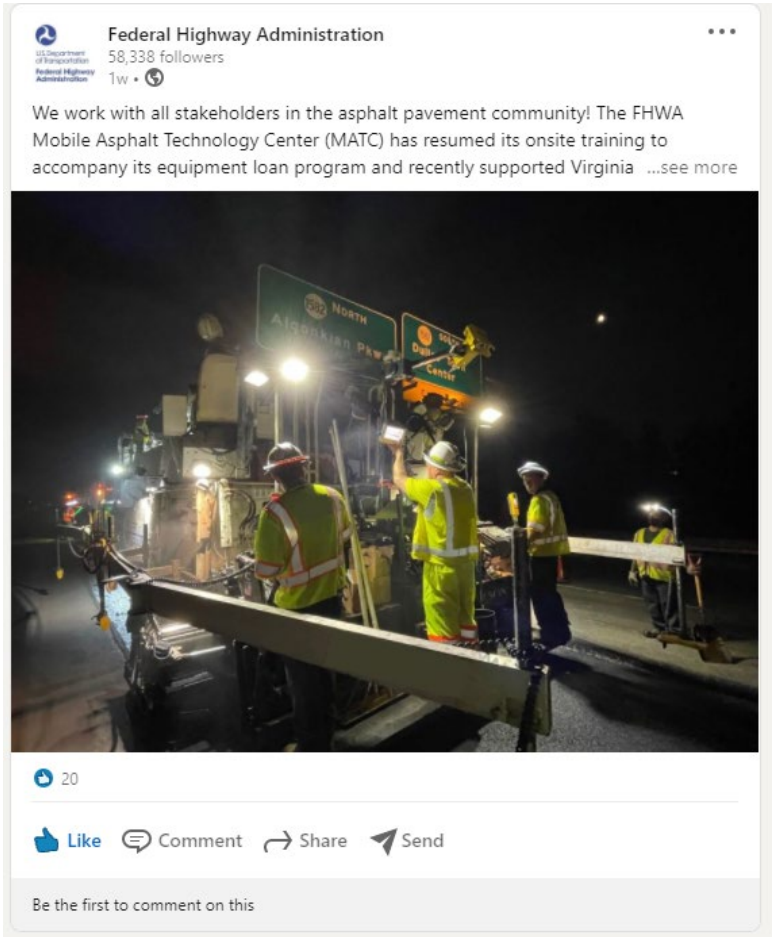
The unit determines the dielectric readings of the materials that make up the asphalt layer by measuring the velocity of reflected waves to about 2.5 inches. All material has a dielectric constant, ranging from 1 for air to 81 for water. HMA dielectric constants typically range from 3 to 6, depending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



- Communication bursts to raise awareness on FHWA efforts

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

Equipment Loan Program

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 (for BMD)
- Laser texture scanner
- Handheld XRF binder device
  - Detects limestone, titanium dioxide, REOB

Equipment loan includes on-site training by FHWA, 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 & Warm Mix Usage
- Resilience

MATC

MOBILE ASPHALT TECHNOLOGY CENTER

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

Leslie Myers, PhD, PE
MATC Program Manager
leslie.myers@dot.gov