Balanced Mix Design

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Balanced Mix Design: Why should I care?

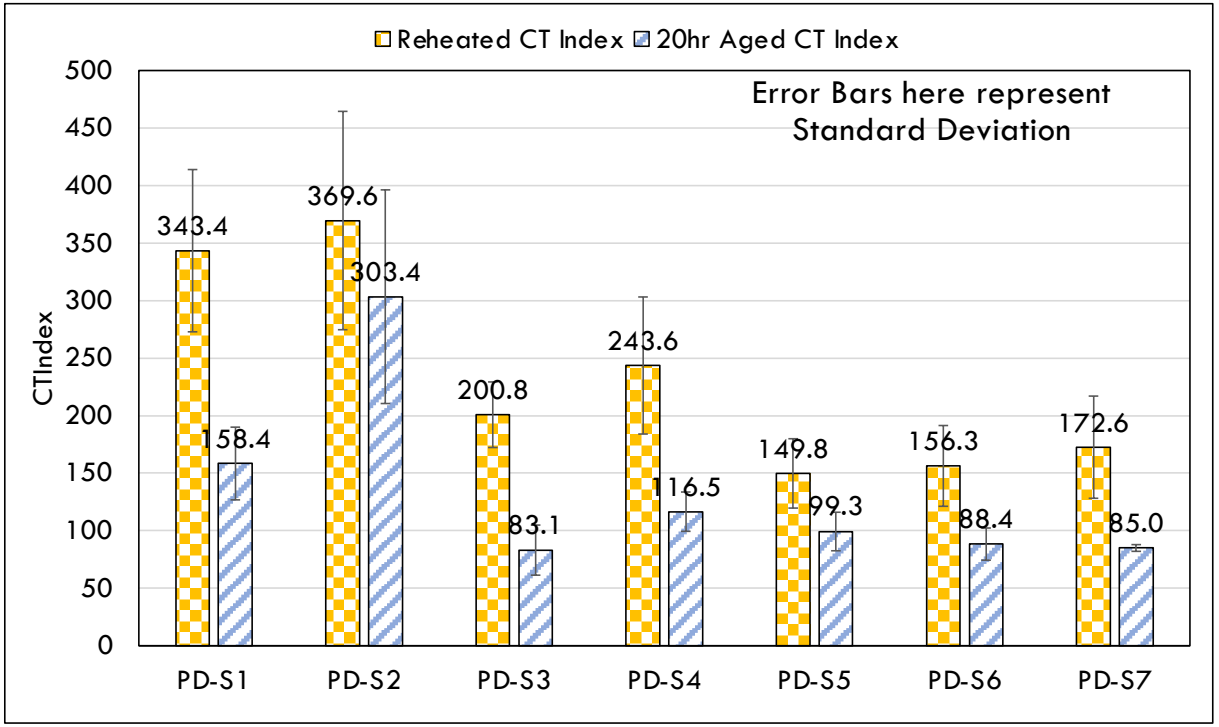
- Do all your mixtures last as long as you design them for?
- Do all your mixtures in a given category perform equally?
- Do you have confidence that Superpave can handle all the different mixture and materials you use?

What has changed?

The advent and popularization of mechanical tests for the asphalt mixture related to common distresses.

BMD

- Variability in production still largely an unknown.
- Impact of aging on cracking tests.



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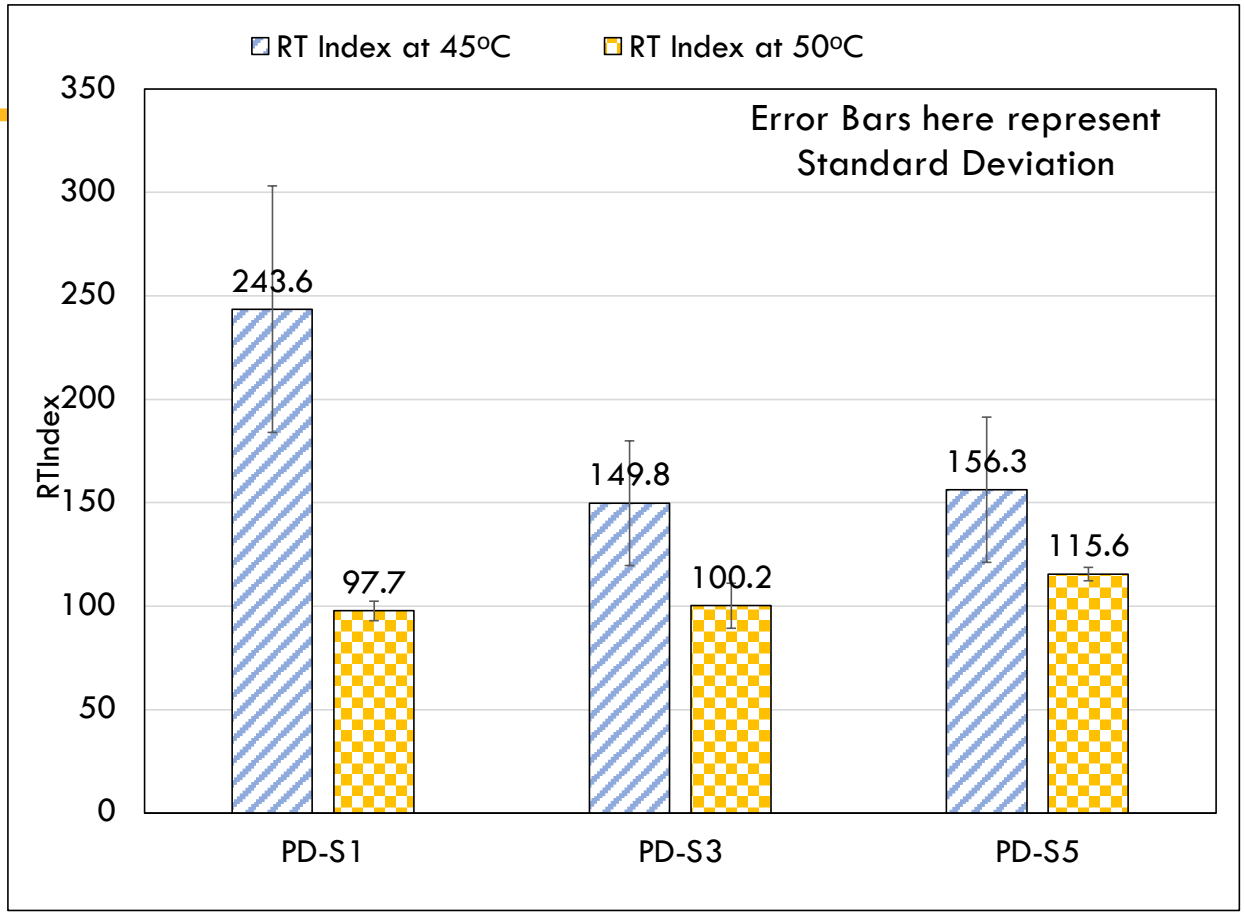
BMD

- Selection of test temperature is critical – especially for rutting tests.



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Macrotexture for Safety
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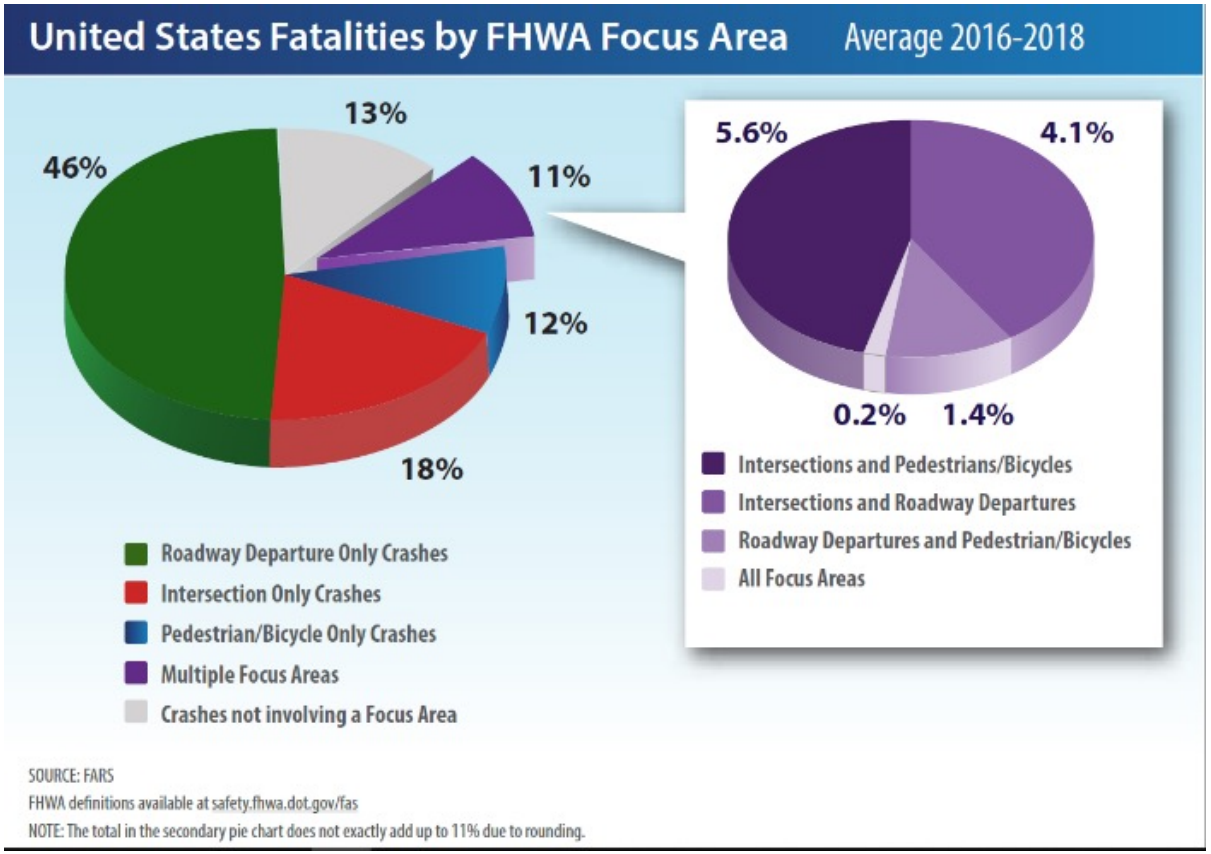
U.S. Fatalities



- Roadway departure crashes overrepresented in annual fatalities

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Technical Advisory on Surface Texture

Surface Texture for Asphalt and Concrete Pavements T-5040.36

Issued June 17, 2005

- Technical Advisory
  - (1) issues information on state-of-the-practice for providing surface texture/friction on pavements and
  - (2) issues guidance for selecting techniques that will provide adequate wet pavement friction
- Not aware of any State DOT with dense graded asphalt mix specification requirements for macrotexture

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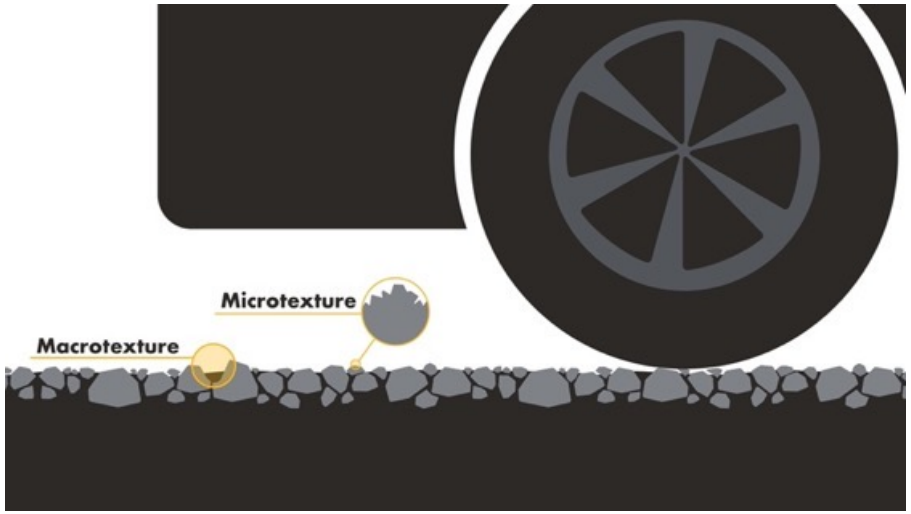
Asphalt Pavement Macrotexture

- **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, driven by aggregate gradation**
  - Provides voids/channel to evacuate water – more critical at higher speeds
  - Provides friction from hysteresis – hysteresis increases with speed – more critical at higher speeds
  - FHWA is investigating macrotexture testing procedures that could be used in mix design, mix verification, and field verification



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Sand Patch Method

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Circular Texture Meter (CTM)

- Changes in Pavement Macrotexture
- Have Been Used to Identify Segregation, Skid Resistance, Pavement Noise
- CTM – Laser-Based Device to Measure Mean Profile Depth (MPD) of a Pavement
- Displacement Sensor mounted on an Arm Rotates Clockwise at a Fixed Elevation from Surface to Measure Vertical Macrotexture Depth
- Does Not Account for Concave Recesses in the Pavement Surface
- Correlates Well with Sand Patch Test

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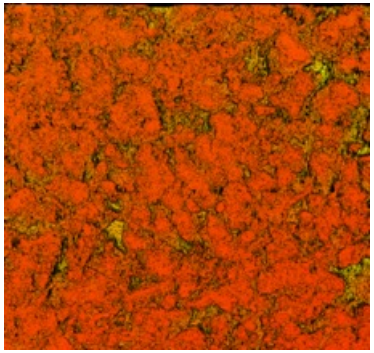
Laser Texture Scanner (LTS) in Lab or Field

- 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



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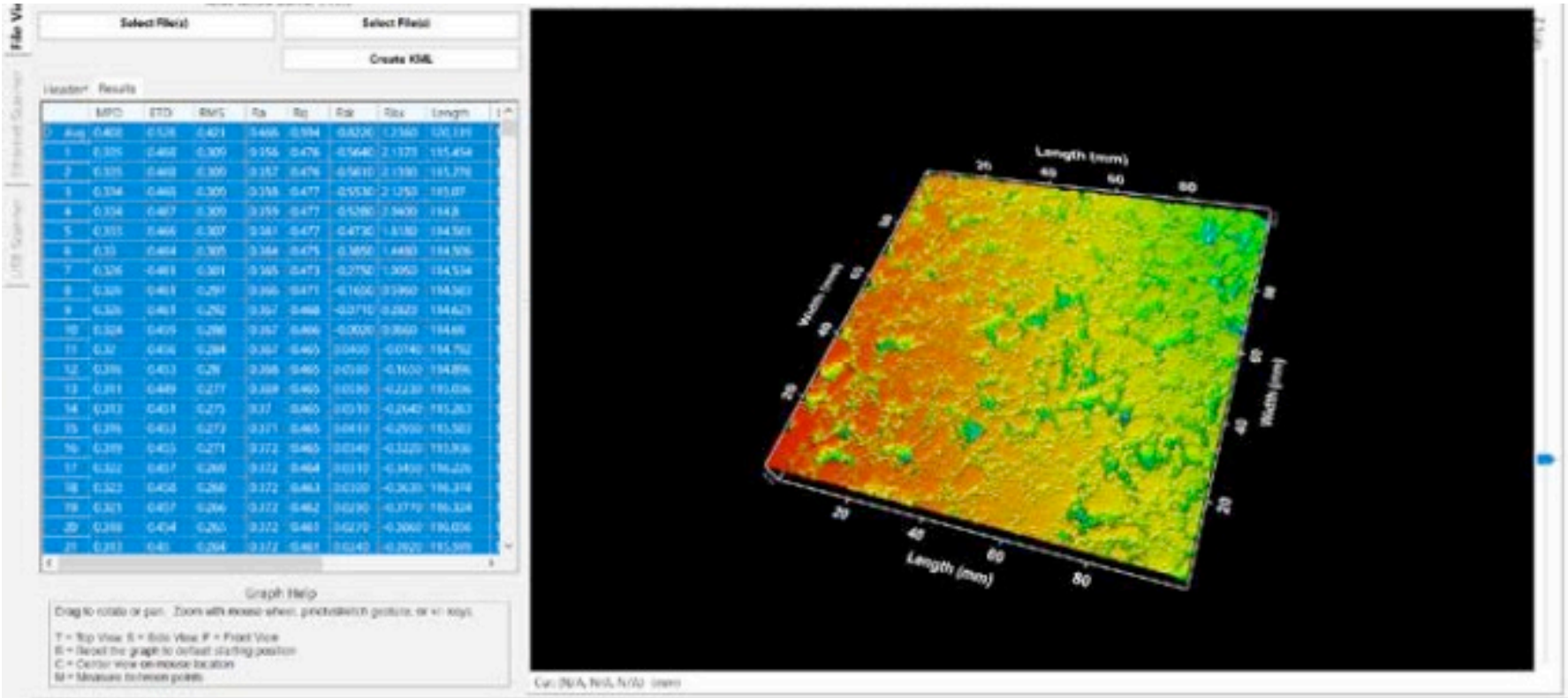
Typical Gyratory Scanned Surface



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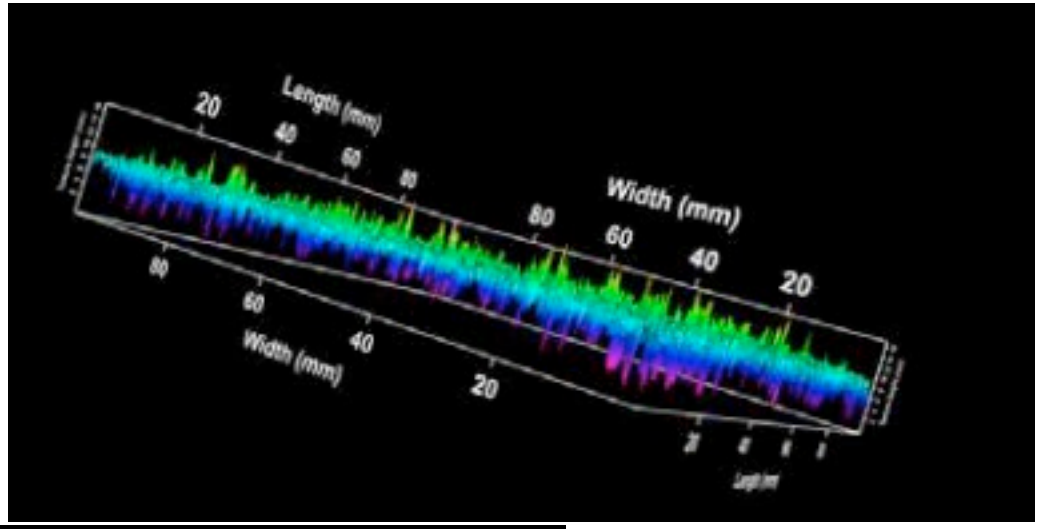
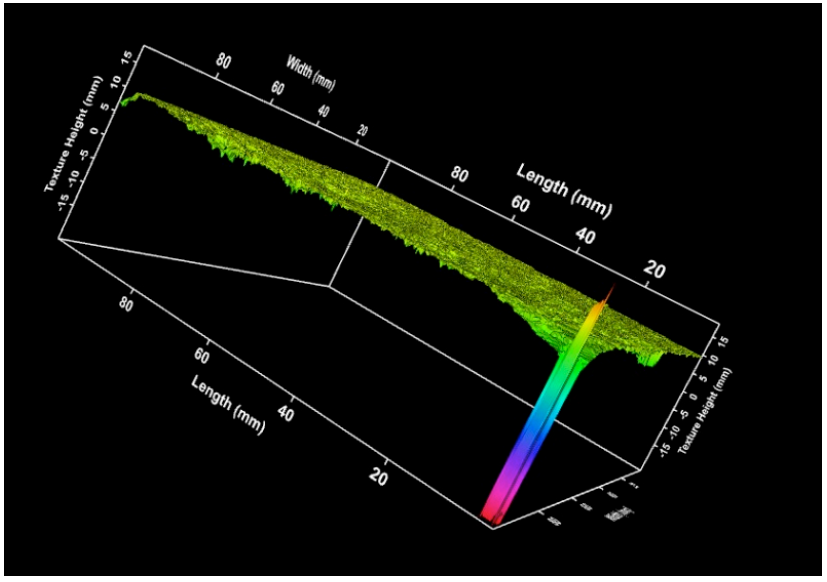
Challenges

- Reflectance resulting in data outliers.
  - Dulling spray used.
- Edge effects when using smaller specimens or misaligned cores.
- Current work on AASHTO method and interlab study.





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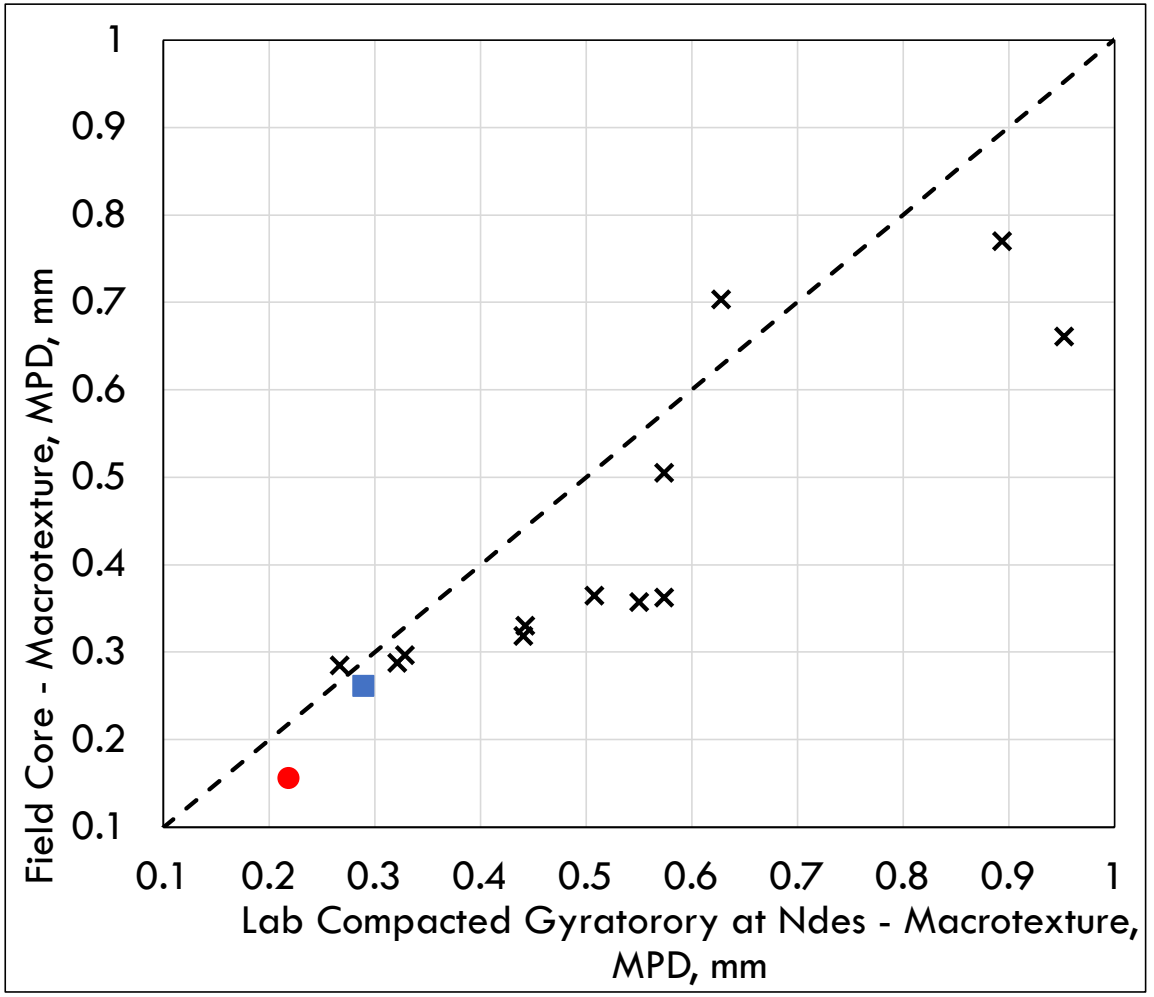
Mean Profile Depth

Different sample measurements



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Tools for QC of Mix Placement

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Tools for QC of Mix Placement

- MATC currently deploying two tools ready now for effective quality control of mix placement:
  - Dielectric Profiling System (DPS)
  - Paver-Mounted Thermal Profiler (PMTP)

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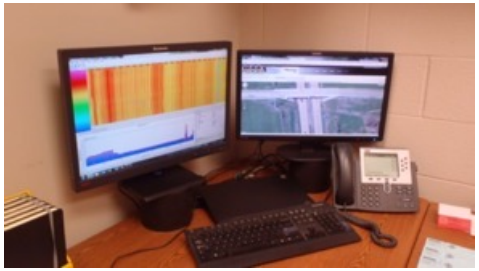
Paver-Mounted Thermal Profiler (PMTP)

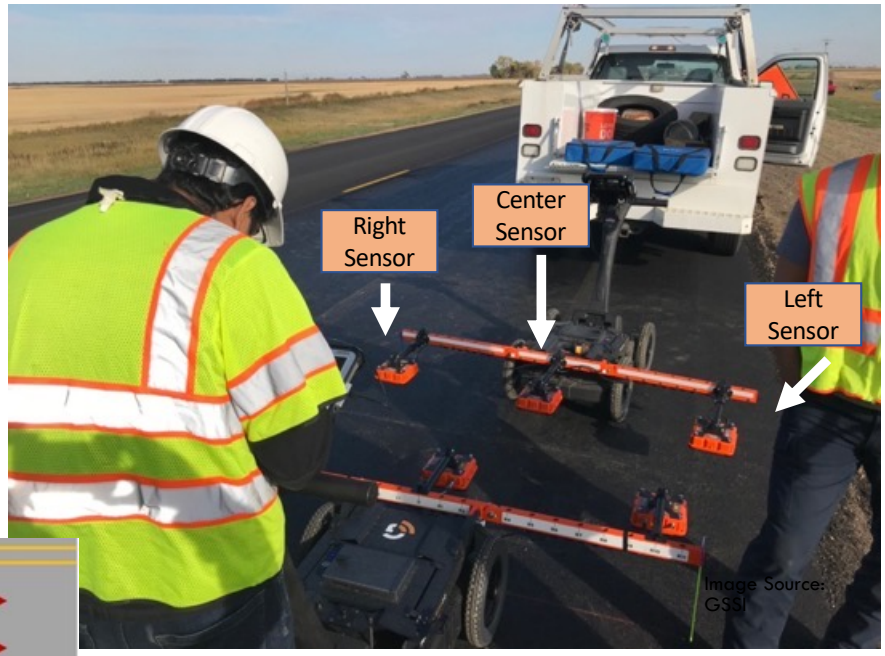
Imaging of Mat Surface: 2 to 3 meters behind screed

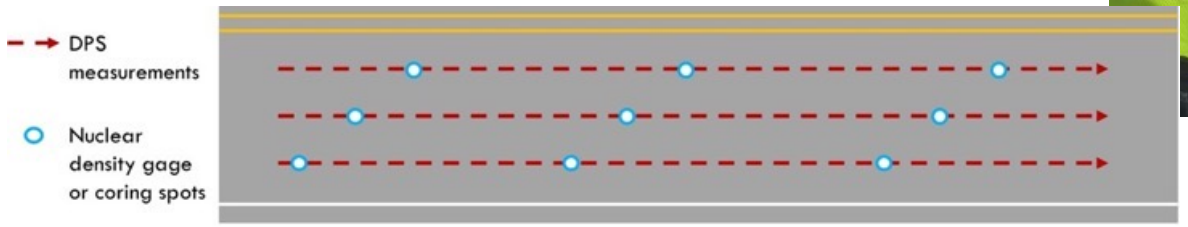


All images source: Travis Walbeck

Dielectric Profiling System (DPS)

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





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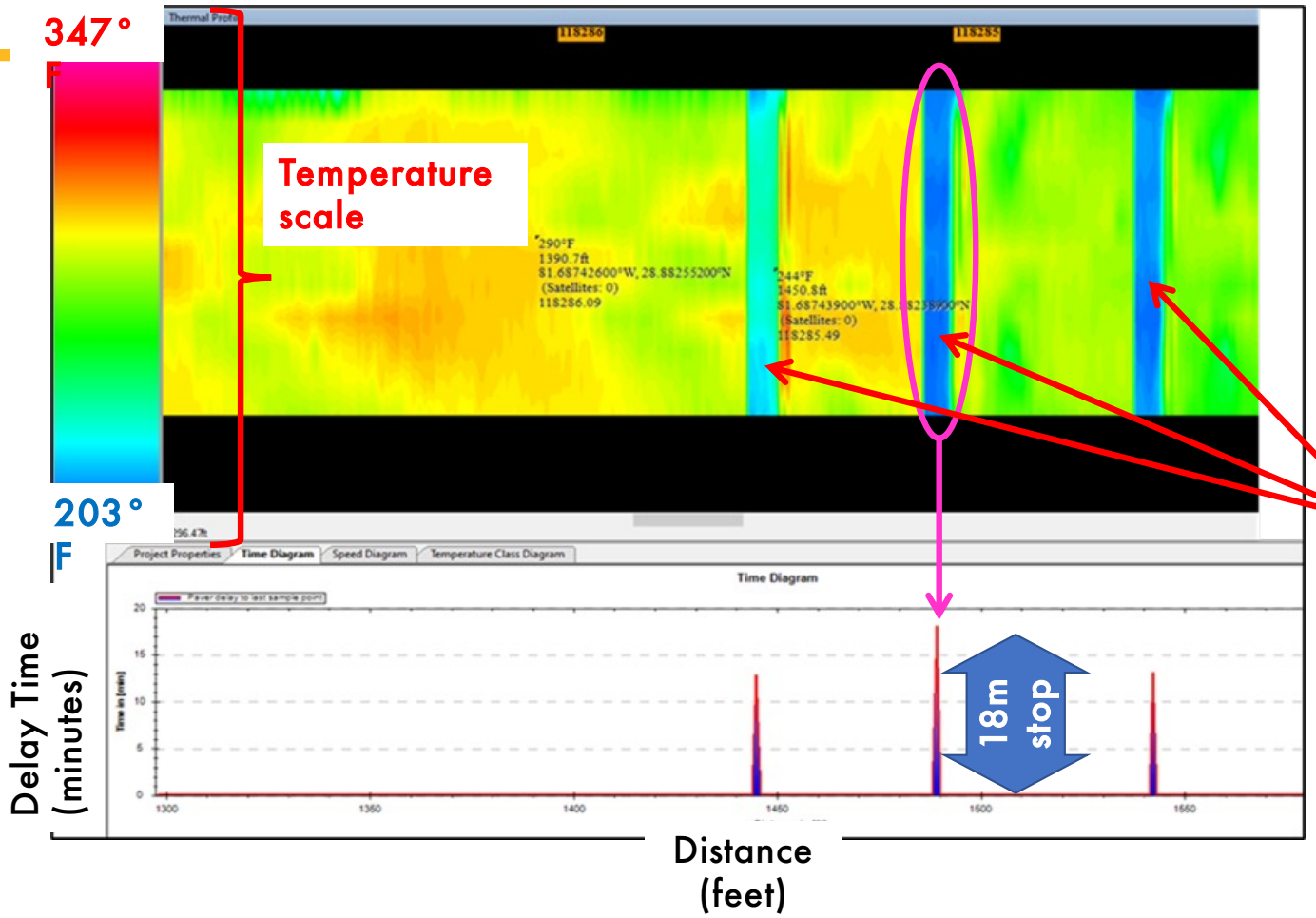
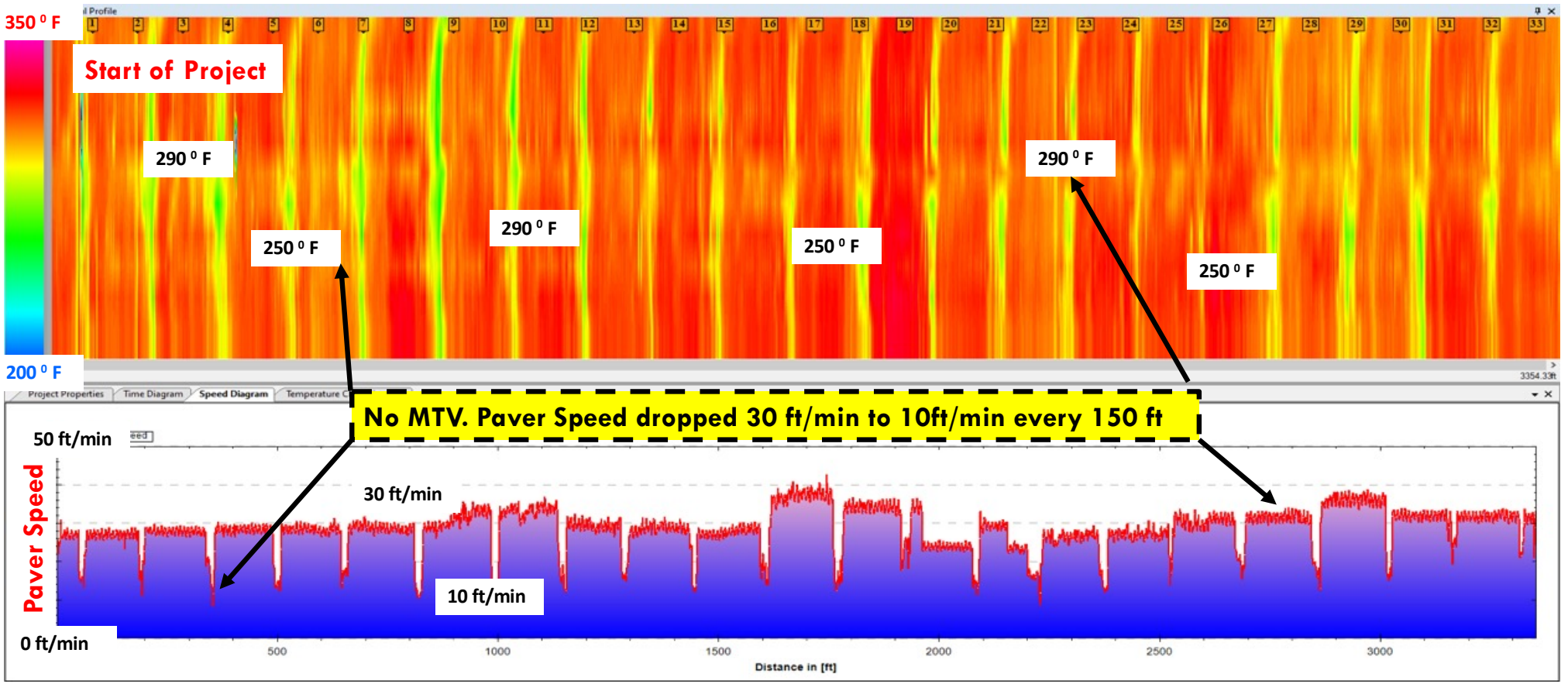
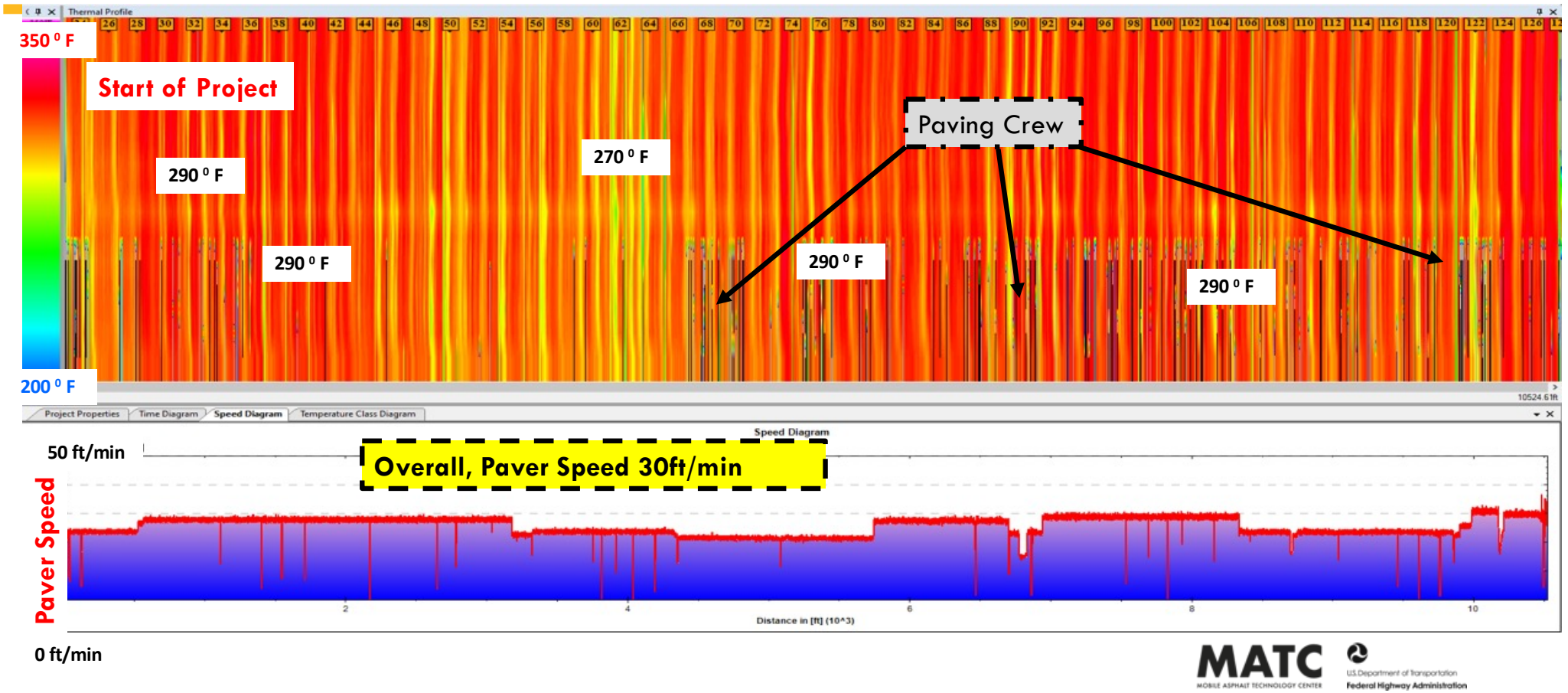
PMTP Thermal Map: Example 1



Example 1: Paver-Mounted Thermal Profiler (PMTP)



Example 2 – Day 1: PMTP



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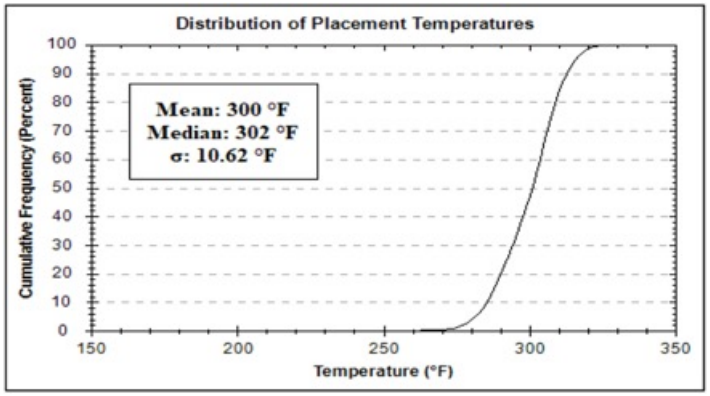
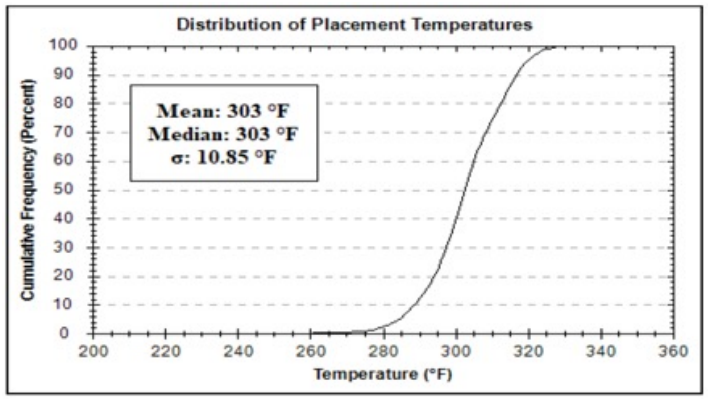
Example 2 – Day 2: Data from PMTP



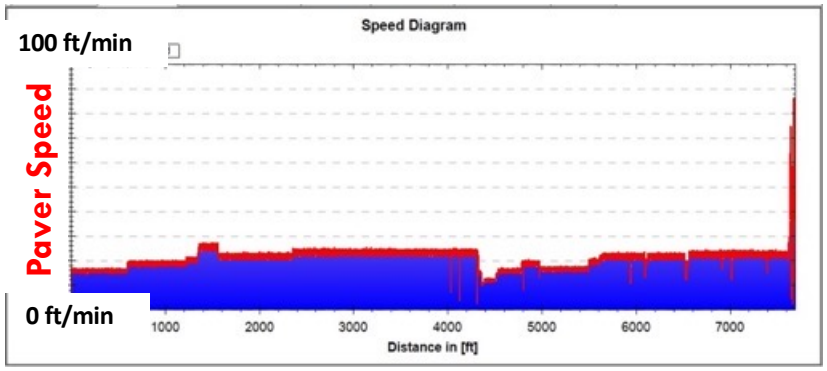
Date: 6 - 24 - 21



Date: 6 - 29 - 21

Cumulative Distribution of Mat Temperature

Distribution of Paver Speed



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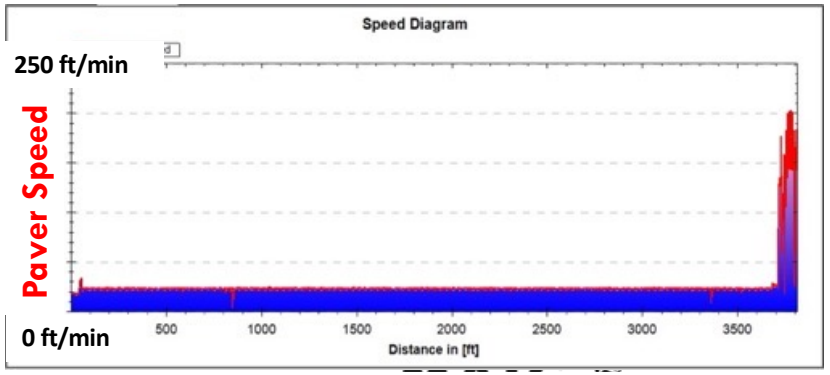
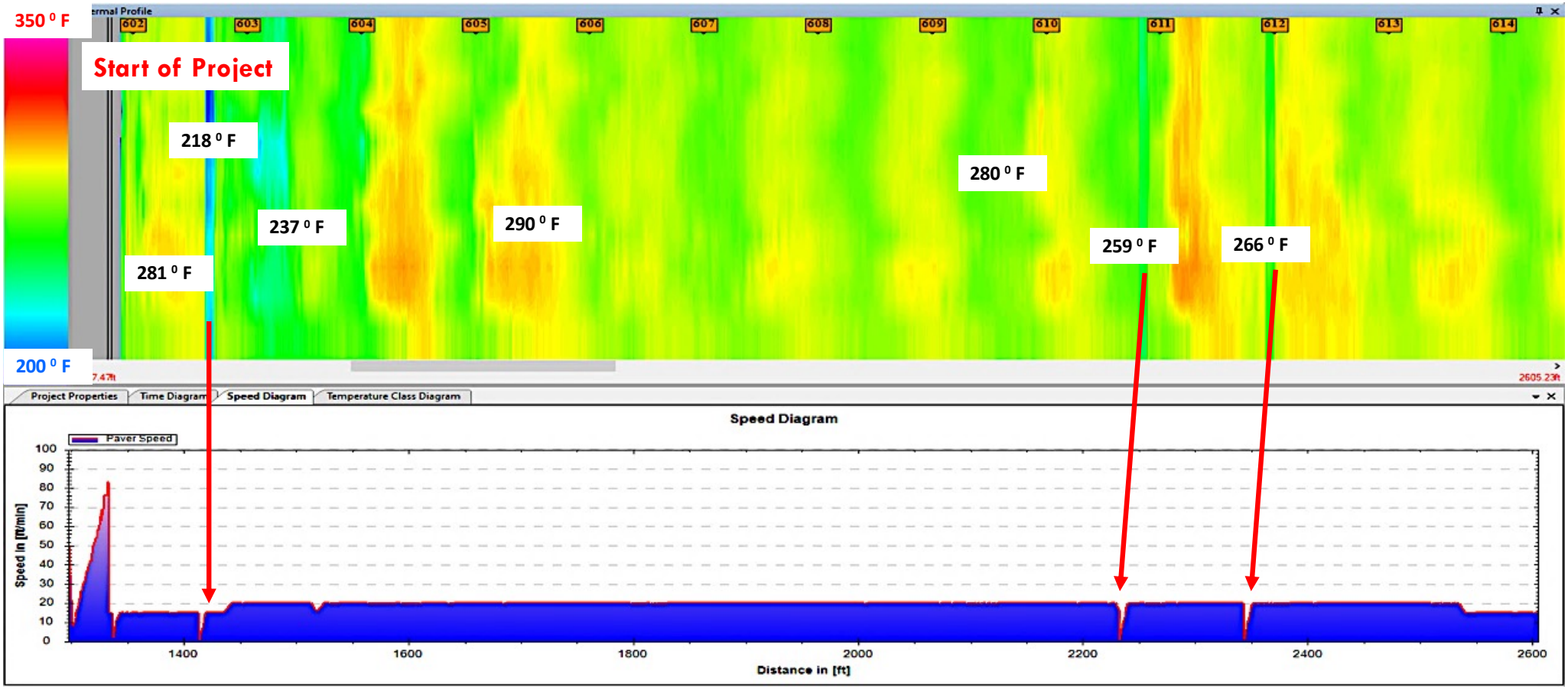
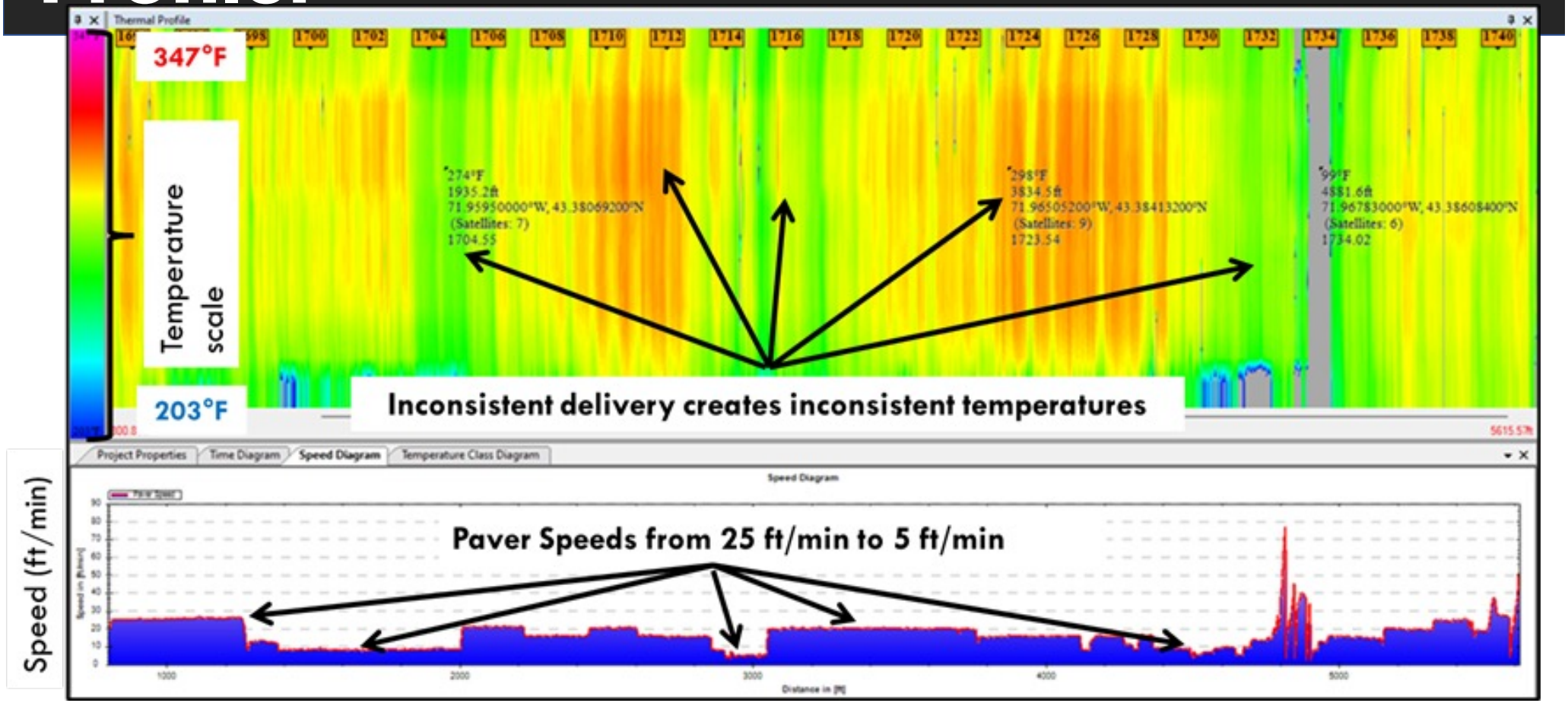


Date: 6 - 29 - 21

Example 3: Paver-Mounted Thermal Profiler

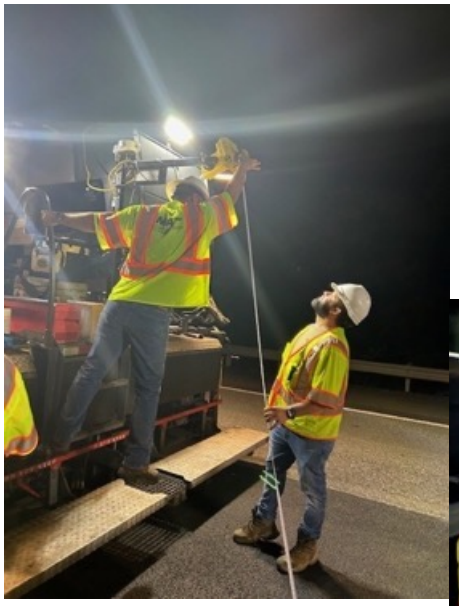


Example 4: Paver-Mounted Thermal Profiler



An ideal match?

Paver-Mounted Thermal Profiler (PMTP) + Dielectric Profiling System (DPS)



Example 3: DPS and PMTP – as viewed in VETA

Final Thoughts

Technology Transfer

Spotlight on Pavement Density

Use of Dielectric Profiling Systems for Asphalt Density

FHWA-HIF-21-XXXX

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.

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

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.

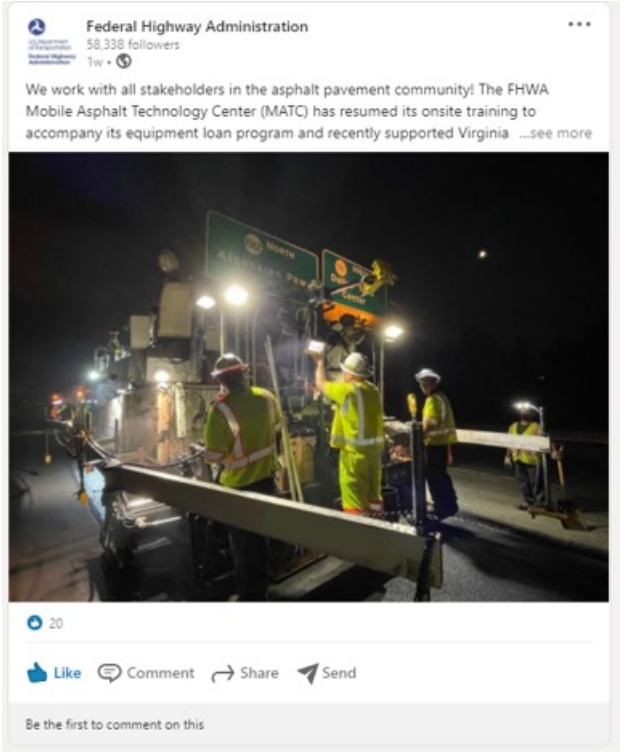
A DPS unit side view (above) and in use (below). Photo sources: GSSI, ODOT

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.

- Join **social media** (LinkedIn, Facebook) to follow FHWA MATC efforts
- **1-pagers on Asphalt Construction:**
  - Enhancing in-place density
  - Spotlight on Pavement Density: Dielectric Profiling System Series
  - Spotlight on Constructability: Paver-Mounted Thermal Profiler Series
  - Spotlight on Pavement Safety



Technical Documents - Mobile Asphalt Technology Center - Asphalt - Pavement & Materials - Pavements - Federal Highway Administration (dot.gov)

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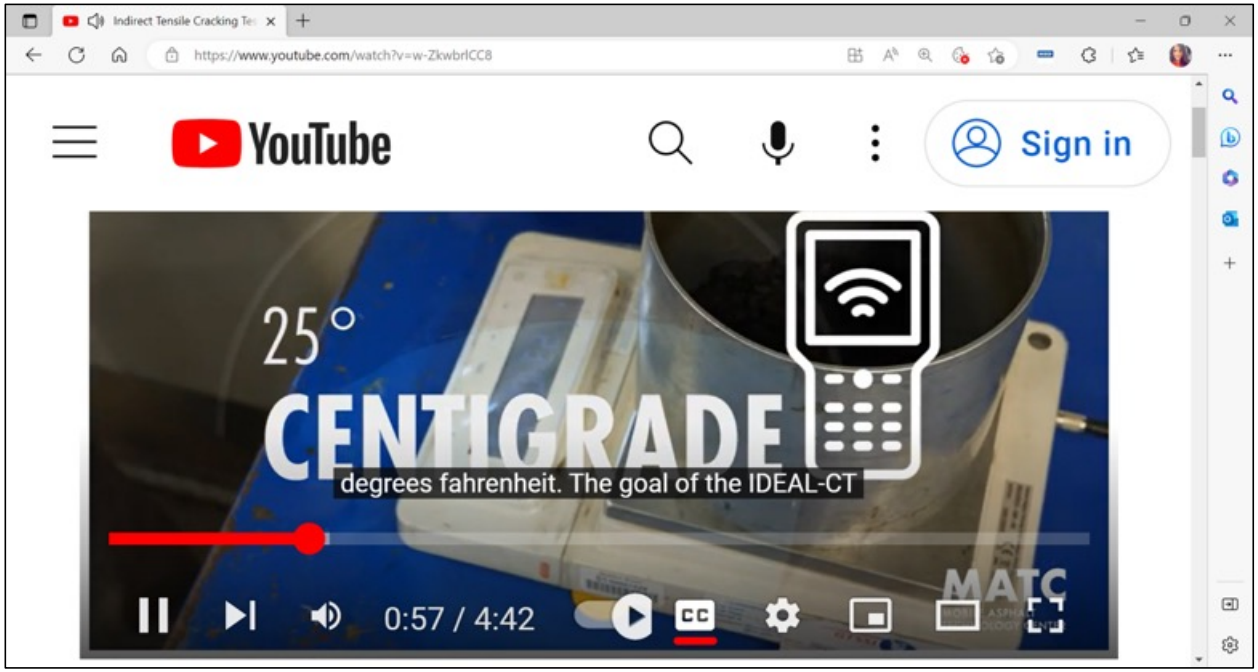
1-pagers & “Technician’s Tips and Tricks” Videos

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TECHNOLOGY DEPLOYED IN MATC

FHWA-HIF-23-030

RAPID SHEAR RUTTING TEST (IDEAL-RT)

Determine the rutting potential of your asphalt mixtures

HOW IT WORKS

The IDEAL-RT is a rapid compressive test that determines the rutting potential of asphalt mixtures during design and production phases through a shear strength-based parameter: Rutting Tolerance Index (RT_{Index}). Asphalt mixture specimens are conditioned and fabricated to 150 mm in diameter and 62 mm in height, with 7.0±0.5 percent air voids. There is no notching or cutting of specimens needed. The specimen is placed into a cradle jig and is loaded at three points, creating two shear planes within the specimen. The test is run on specimens conditioned at an elevated temperature (typically 50°C) with a monotonic loading rate of 50 mm/minute of cross-headed displacement.

The larger the RT_{Index} value, the better the rutting resistance.

Image Source: FHWA
Load Frame performing Ideal-RT

IDEAL-RT FEATURES

Highly **VERSATILE**

Quick Preparation and **OPERATION**

Field Laboratory **ACCESSIBLE**

Retrofit for existing load frame **COSTS ~$4,000**

New load frame and equipment **COSTS ~$12,000**

Tests at least **3 REPLICATES** for each sample

Generates a RT_{Index} for each sample in **<5 MINUTES**

Meets **ASTM D8360** standards and specifications

Current Performance Testing Program Evaluations of IDEAL-RT in: Texas, Maine, Missouri, Kansas, and National Center for Asphalt Technology (NCAT).

LEARN MORE AT HTTPS://WWW.FHWA.DOT.GOV/MATC

Except for the statutes and regulations cited, the contents of this document do not have the force and effect of law and are not meant to bind the States or the public in any way. This document is intended only to provide information regarding existing requirements under the law or agency policies.

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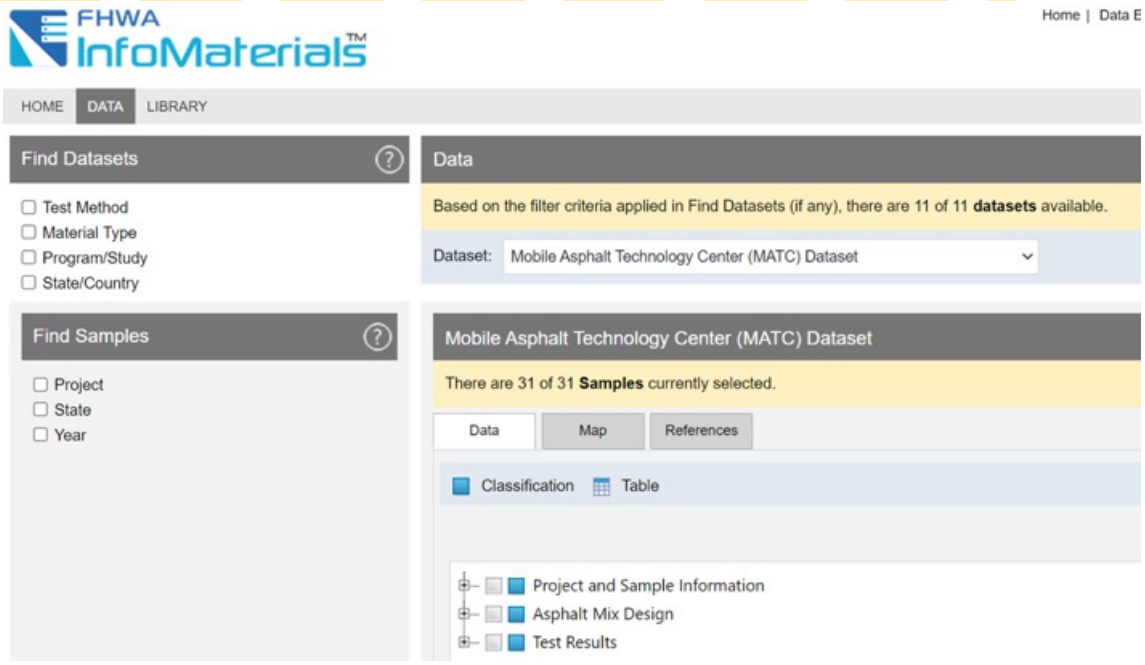
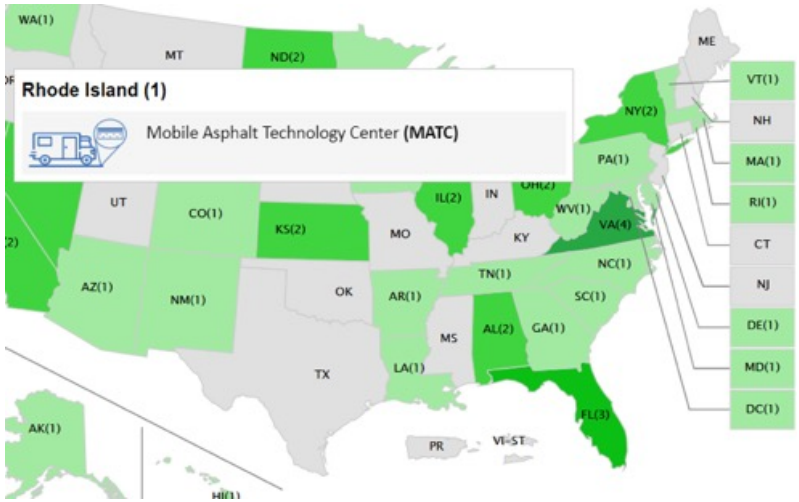
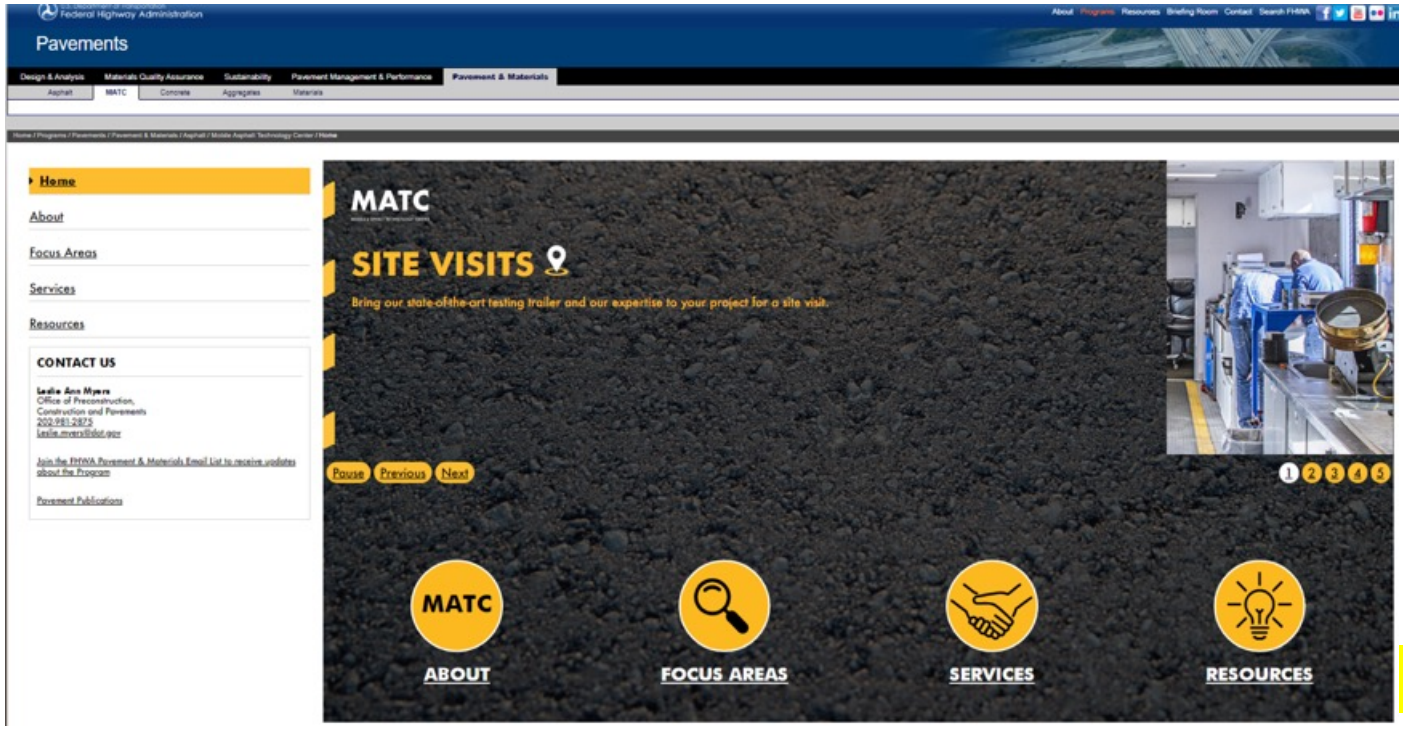
FHWA InfoMaterials: MATC Data from Past Site Visits





https://infomaterials.fhwa.dot.gov/Dataset/DatasetDetails

MATC Website



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