DEPARTMENT OF TRANSPORTATION

Paver Thermal Profiling, Intelligent Compaction and Rolling Density Meter (GPR)

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B1G

2017 BOWL GAME RESULTS 7-1

SEVEN WINNERS

ONE LOSER

Everything you need to know

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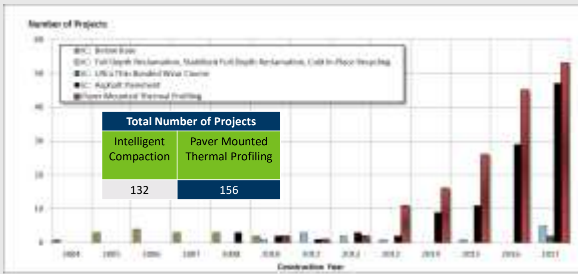
Presentation Breakdown

- Paver Mounted Thermal Profiling – SHRP2 25%
  - AASHTO PP-80
- Intelligent Compaction of Asphalt Pavements 25%
  - AASHTO PP-81
- Rolling Density Meter - SHRP2 50%
  - Draft AASHTO PP (2019?)

Draft AASHTO Standard for Data Files (2019?)

MN Intelligent Compaction and Thermal Profiling History



Paver Mounted Thermal Imaging Equipment

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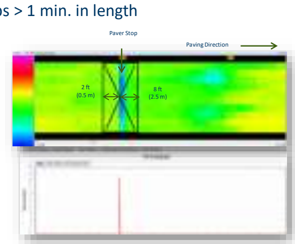
Monetary Price Adjustment Thermal Segregation

S-xx.3.J.1.a Surface Temperature Readings

- Exclude following surface temp. readings:
  - < 180 °F
  - Paver stops > 1 min. in length

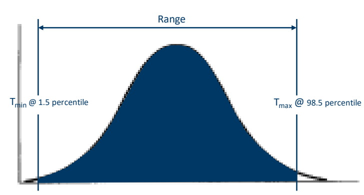


VETA

Monetary Price Adjustment Thermal Segregation – Range

Equation 2016-11 (PMTP)

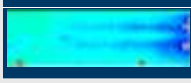
- Range = Tmax - Tmin

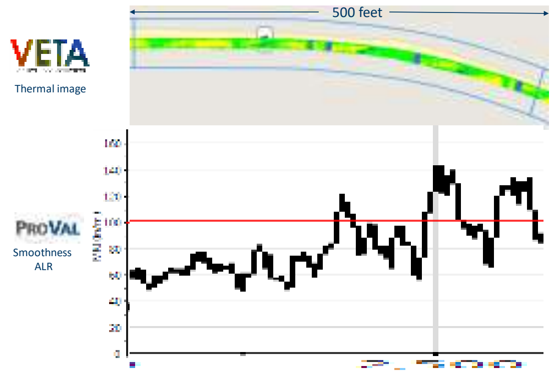


Monetary Price Adjustment
Thermal Segregation - Severity Level

Table 2016-8 (PMTP)

Sublot Temperature Differential

Range		Thermal Segregation Category
	Range ≤ 25.0°F	Low
	25°F < Range ≤ 50°F	Moderate
	50 °F < Range	High



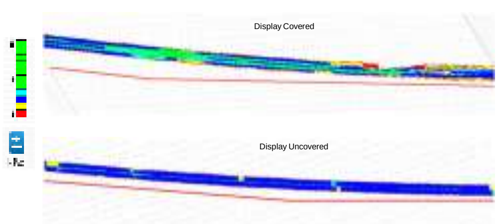
Not all paver stops create roughness, not all roughness is from paver stops.
Fewer paver stops equals fewer opportunities to create roughness.

Intelligent Compaction

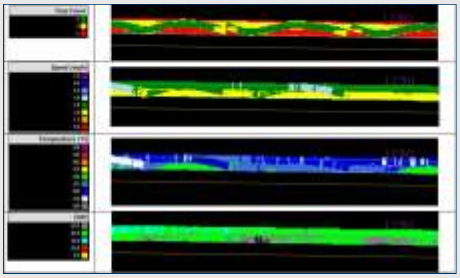
Figure Courtesy of Trimble

Intelligent Compaction - Rolling Patterns

Kandiyohi County



Observe Rolling Operations



Thermal and IC Synopsis

- Thermal
  - Real time in field and anywhere online
  - Easy to interpret or diagnose
  - Follow proper practices = success
- Intelligent Compaction
  - Real time for roller operators
  - Multiple rollers and parameters
  - Currently limited to after the fact diagnosis. (one to two day delay depending upon complexity)
  - Real time field analysis coming soon

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Effects of Technology on Process Control

RDM Theory

Material	Dielectric Value	Note
Air	1	Radar travels very fast (fastest)
Water	81	Radar travels very slowly (slowest)
Asphalt Mix	4 – 8	Not as fast as through air

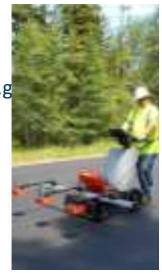
Asphalt Mix composition

- Aggregates 4-9
- Asphalt binder 2
- Air 1

Lower Air Content →	**Higher Dielectric**
Higher Dielectric →	**Higher Density**

Rolling Density Meter (RDM)

- RDM is an air-coupled GPR with 2.0 GHz sensor(s)
- 3 antennas can be spaced from 1 to 2.5 ft apart
- RDM operates in passes in regions of interest (e.g. near longitudinal joint)
- Data acquisition relatively quick
  - 10 dielectric reading per foot of travel
  - 1584 tests per minute walking at 3 mph



RDM vs other GPR-based Tools

- Strict Performance Specification

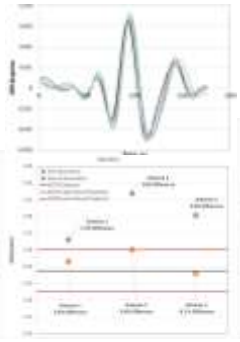
Measure Description
Short Term Dielectric Stability
Mid Term Dielectric Stability
Long Term Dielectric Stability
Inter-Antenna Dielectric Variation*
Inter-Antenna Amplitude Variation*
*Multi-channel systems only

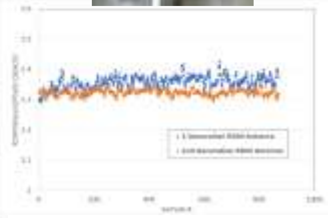

Asphalt Surface Dielectric Profiling System using Ground Penetrating Radar

AASHTO

RDM Performance Improvement

➢Measurement difference among the antennas?





Field Testing – SHRP 2

- Objectives
  - DOT personnel training
  - RDM technology evaluation/refinement
  - Test protocols and specifications development
- Projects
  - US-52 near Zumbrota, Minnesota
  - HWY 2 in Lincoln, Nebraska
  - US-1 near Cherryfield, Maine
  - State Rte 9 near Clifton, Maine
  - I-95 near Pittsfield, Maine
  - US-14 near Eyota, Minnesota

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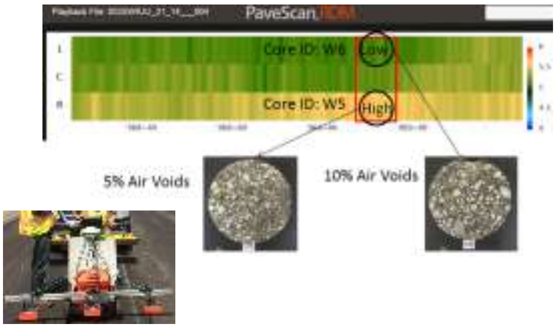
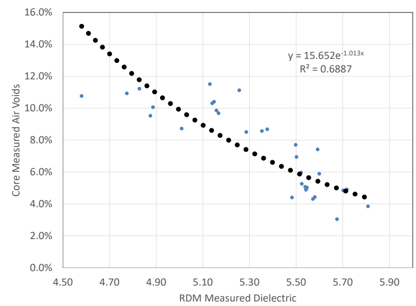
Rolling Density Meter



Relating Dielectric Measurements to Air Void Content

TH52: 32 cores



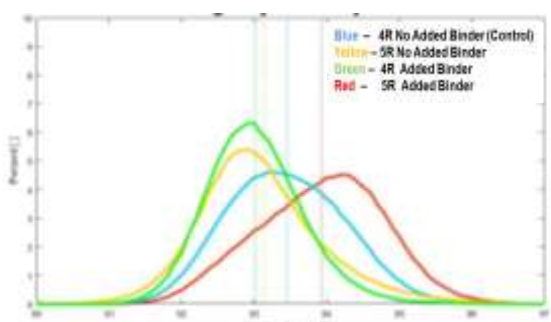
Effect of Roller Number and Binder Content

Median Density

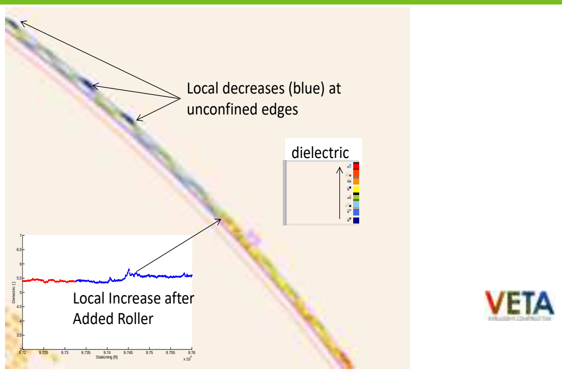
- 4 rollers, no added binder (control): 93.4% MTD
- 5 rollers, no added binder: 93.1% MTD
- 4 roller, added binder : 93.0% MTD
- 5 roller, added binder: 94.0% MTD

Effect of Roller Number and Binder Content

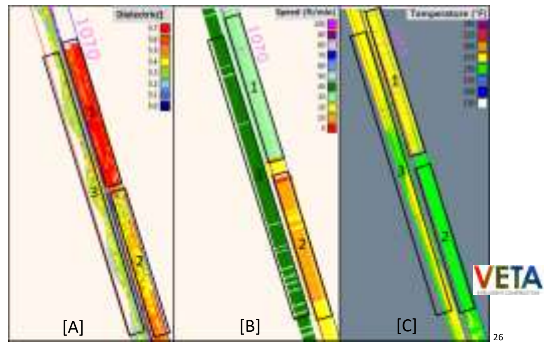
Section with added binder + 5 rollers has the highest density



TH 52: Comparison with Other Factors



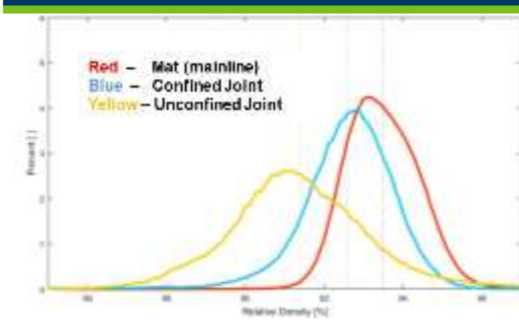
TH 52: Comparison with Other Factors



Evaluation of Compaction at Longitudinal Joint

Location	Relative Density	
	Mean	Std Deviation
Mainline	93.5%	0.94%
Unconfined side of the joint	91.4%	1.22%
Confined side of the joint	92.5%	1.8%

TH 52 – Longitudinal Joint



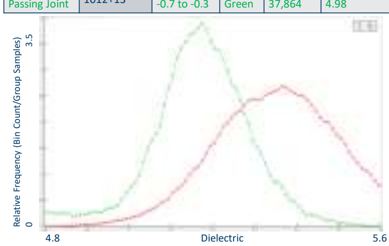
Rolling Density Meter - 2017

I-35 Echelon Paving

- Best way to compact the joint?
  - First pass roller offset of joint?
  - First pass roller overlap joint?

Interstate 35 – OFFSET OF JOINT Passing Lane Mat vs Joint Histogram

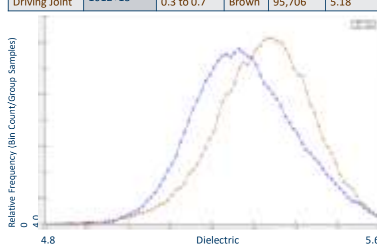
Group Name	Stationing range, ft.	Offset range, ft.	Color	Samples	10th Percentile Dielectric	50th Percentile Dielectric	Dielectric Range (50th-10th)
Passing Mat	507+24 to 1012+13	-10 to -2	Red	137,309	5.17	5.36	0.19
Passing Joint		-0.7 to -0.3	Green	37,864	4.98	5.17	0.19



- Increased compaction in mat vs joint can be observed on-site by increase in dielectric
- Mat and Joint had similar consistency with dielectric ranges of 0.19

Interstate 35 – OVERLAP OF JOINT Driving Lane Mat vs Joint Histogram

Group Name	Stationing range, ft.	Offset range, ft.	Color	Samples	10th Percentile Dielectric	50th Percentile Dielectric	Dielectric Range (50th-10th)
Driving Mat	507+24 to 1012+13	2 to 10	Blue	257,817	5.13	5.27	0.14
Driving Joint		0.3 to 0.7	Brown	95,706	5.18	5.33	0.15

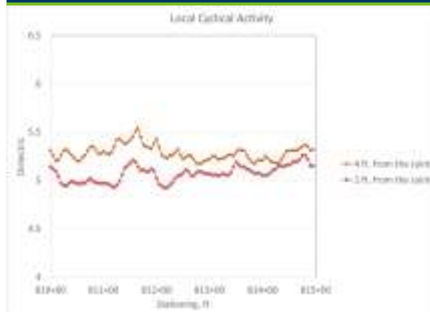


- No statistically significant decrease in joint compared to mat
- No statistically significant increase in variability at the joint

Interstate 35 –Passing Lane Offset Comparison

- First ½ mile stretch
  - Most of the increase occurs in the first 500 ft when 4 ft. away from the joint
  - Gradual increase over 2500 ft occurs at 2 ft. from the joint

Interstate 35 –Local Variation Offset Comparison



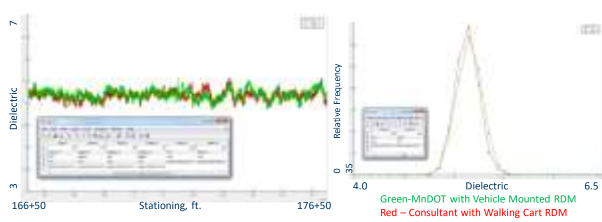
- First 500 ft local comparison
  - Can observe cyclical variation in the mat at different compaction levels
  - Both offsets show similar variations in compaction

Interstate 35 –Local Variation Offset Comparison

- 1000 ft comparison after increase in compaction
  - Can observe cyclical variation in the mat at similar compaction levels
  - Variability within offsets are lower

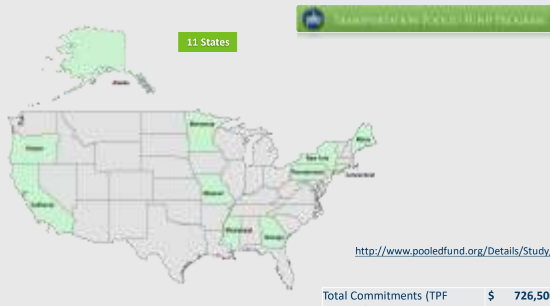
County Road 86 – Consultant vs MnDOT Repeatability

- Increased compaction in mat vs joint can be observed on-site by increase in dielectric
- Mat had slightly better consistency than joint (0.21 range vs 0.28 range)



Intelligent Construction Data Management

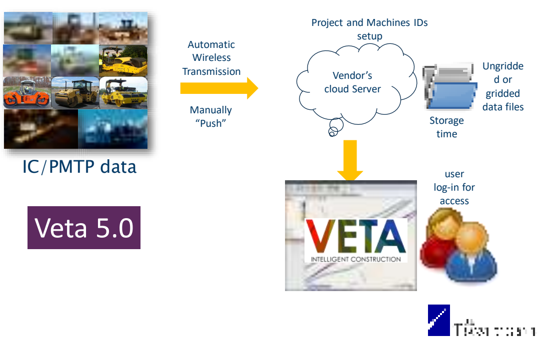
Current Pooled Fund Participants



http://www.pooledfund.org/Details/Study/583

Total Commitments (TPF Website)	$	726,500
Total Funds Received	**$**	**396,500**

Direct Download to Veta from Cloud



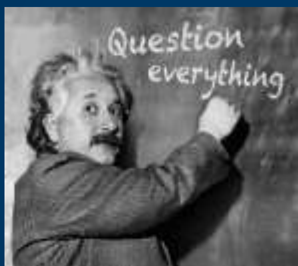
IC/PMTP data

Veta 5.0

NRRA
National Road Research Alliance

Strategic Implementation Through Cooperative Pavement Resea

QUESTIONS ?



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