Pennsylvania's Experience with Thin Asphalt Overlays

Northeast Asphalt User Producer Group
Annual Meeting
Newark, DE
October 20, 2016

Mansour Solaimanian, PhD, PE
Penn State University

Outline

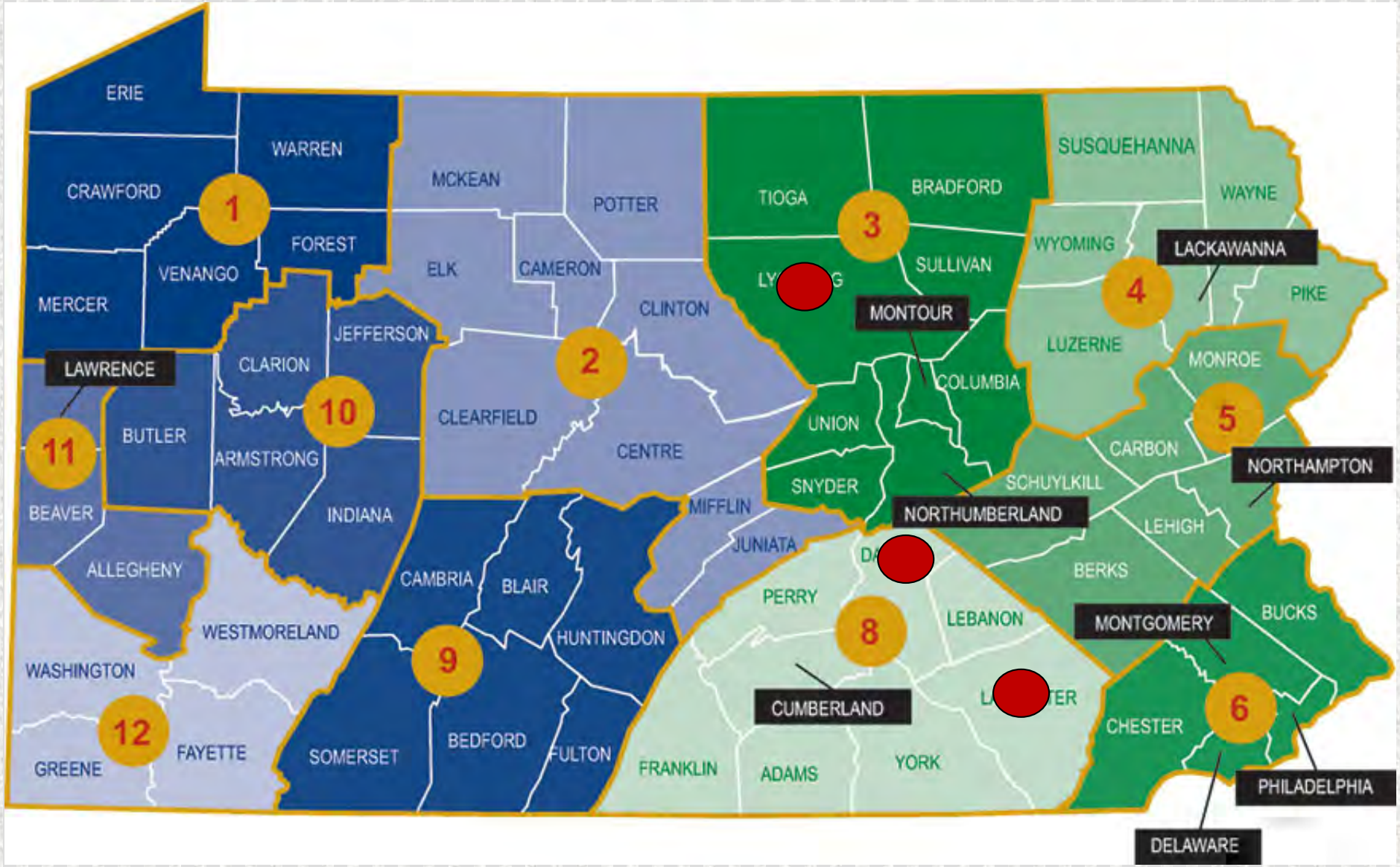
1. THMAO As A Pavement Preservation Strategy
2. Mix Design and Evaluation
3. Construction
4. Quality Control
5. Performance Evaluation

THIN OVERLAYS FOR PAVEMENT PRESERVATION

PennDOT Research Project on THMAO

- Four Year Project: June 2012 – June 2016
- Initiated by PAPA/PennDOT
- Included Three Demonstration Projects
- Research Team:
  - Penn State (Prime Contractor)
  - Advanced Infrastructure Design
  - Quality Engineering Solutions, Inc.
  - Penetradar Corporation

Pilot Projects



Roadway Improvement Activities

			Pavement Preservation		
Activity	**Reconstruction**	**Major Rehabilitation**	**Minor Rehabilitation**	**Preventive Maintenance**	**Routine Maintenance**
Increase Capacity	●	●			
Increase Structural Strength	●	●	? Depends		
Improve Pavement Condition	●	●	●	●	●
Restore Serviceability	●	●	●	●	●
Extend Service Life	●	●	●	●	●

How Thick is Thin Asphalt?

- **Placed up to 1.25 inches in thickness**

- **Ultrathin layers: between 0.5” and 1.0”**

Practice in Other States

State	Term	Type	Sieve mm	%Pass	Thick-ness, in
IN	Ultrathin Bonded Wearing Course	4.75mm	9.5 4.75	100 40-55	3/4 - 1
		9.5mm	12.5 9.5	100 85-100	
MI	HMA Ultra-Thin		12.5 9.5 4.75	100 99-100 75-95	3/4
NC	Ultrathin Bonded Wearing Course		12.5 9.5 4.75	100 85-100 28-44	1/2 – 1 Mostly 5/8

Practice in Other States

State	Term	Type	Sieve mm	%Pass	Thick-ness, in
NY	6.3 mm Polymer Modified HMA		9.5 6.3 4.75	100 90-100 90 (Max)	3/4 - 1
OH	Smoothseal	Type A	9.5 4.75 2.36	100 95-100 90-100	5/8 – 3/4
		Type B	12.5 9.5 4.75	100 95-100 85-95	3/4 - 1
TX	Crack Attenuating Mix (CAM)		12.5 9.5 4.75	100 95-100 70-90	

Mat Thickness/NMAS Ratio

NMAS: Nominal Max. Aggregate Size

Aggregate
NMAS

Mat Thickness
0.5 to 1.25 in

3 ≤ Ratio of Thickness to NMAS ≤ 5

Importance of NMAS in Thickness

Table shown with:

Mat Thickness:
from 1.5 inches to 0.50 inches,

and

NMAS:
from 12.5 mm to 4.75 mm

- **Good**
- **Ok**
- **Avoid**

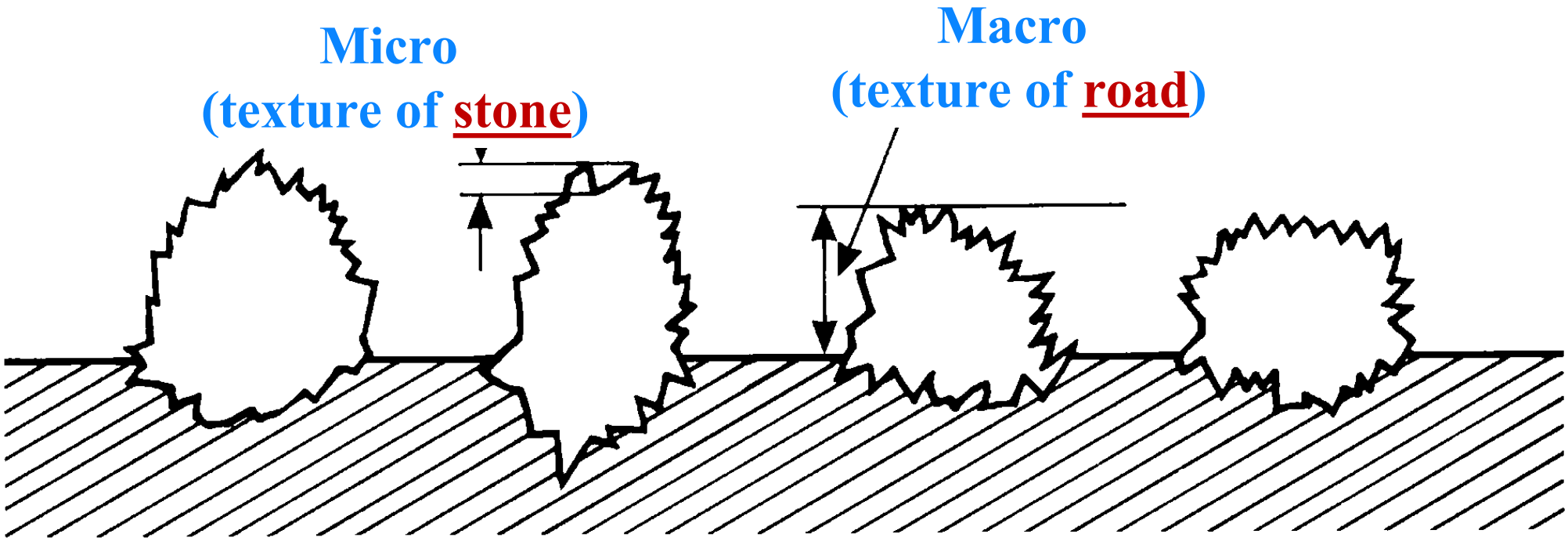
Mat Thickness			
In	mm	NMAS	Ratio
1.50	38.1	12.5	3.0
		9.5	4.0
		6.3	6.0
1.25	31.8	9.5	3.3
		6.3	5.0
		4.75	6.7
1.00	25.4	9.5	2.7
		6.3	4.0
		4.75	5.3
0.75	19.1	6.3	3.0
		4.75	4.0
0.50	12.7	6.3	2.0
		4.75	2.7

Significance of Aggregate Skid Resistance Level in Thin Asphalt

Two of the Most Important Properties Affecting Friction (Skid Resistance) Are:

1. Aggregate Microtexture
2. Pavement Macrotexture

Significance of SRL in Thin Asphalt



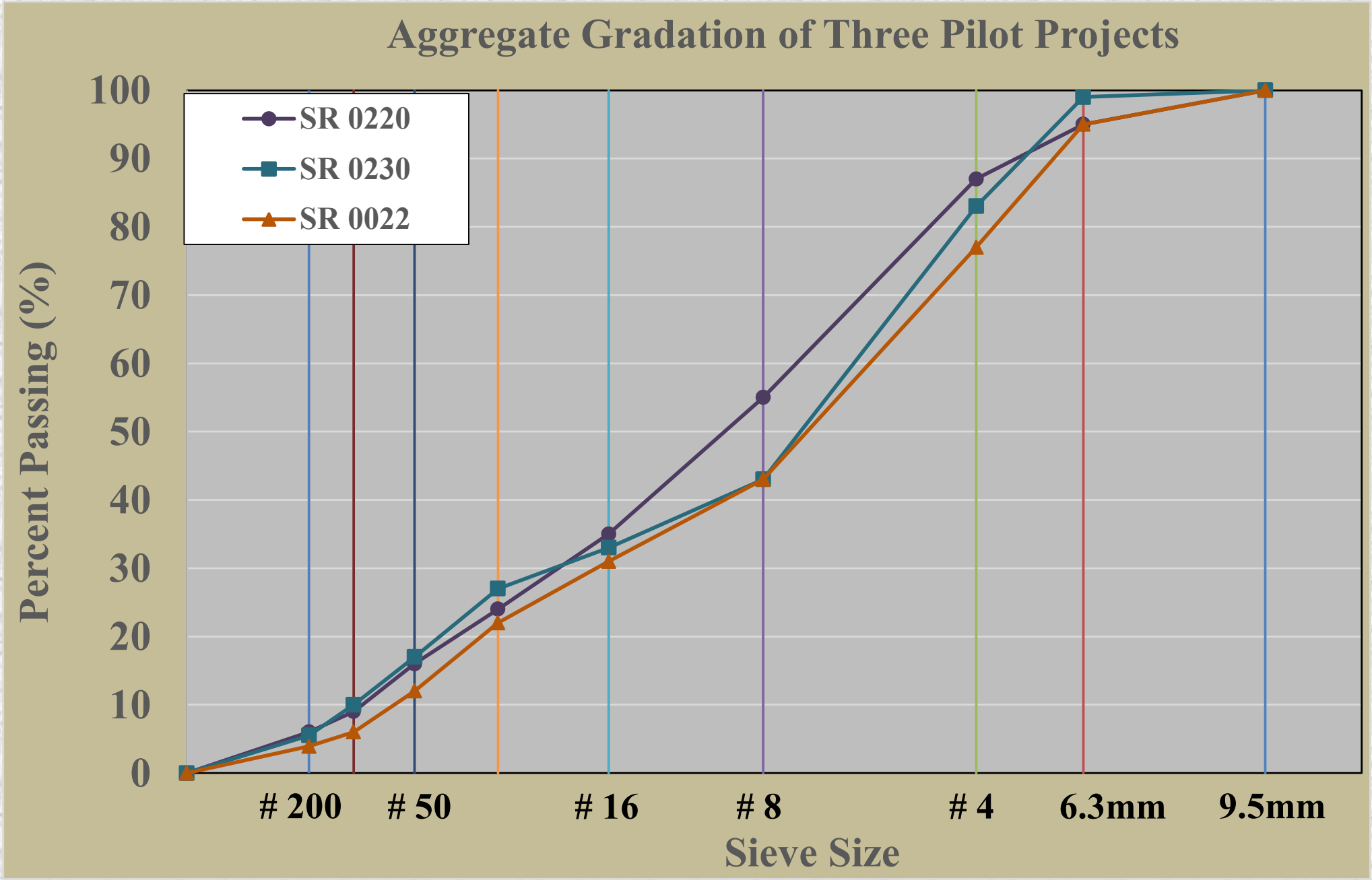
As thickness gets smaller, harder to develop macro and more demand on micro.

MIX DESIGN AND EVALUATION

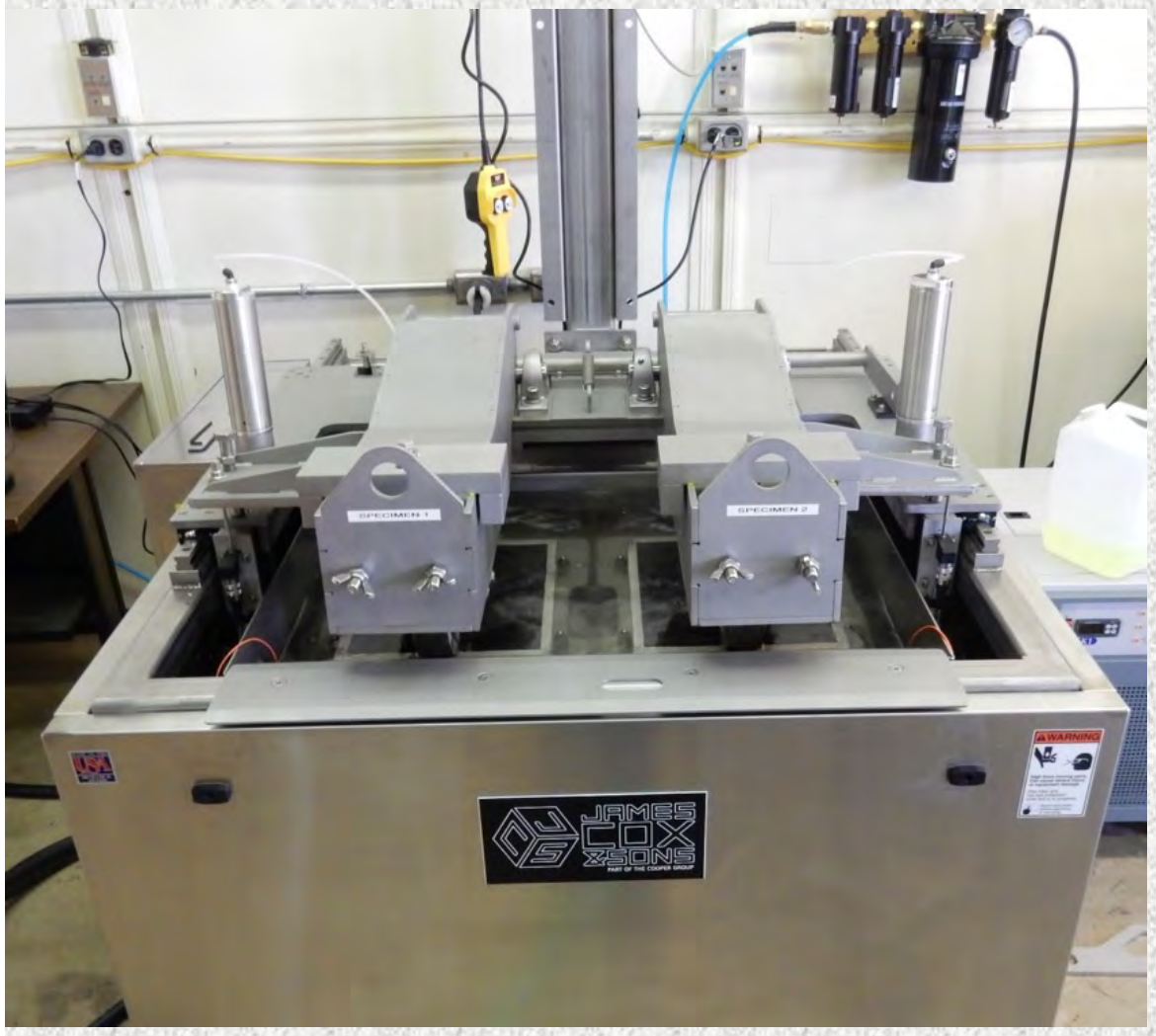
6.3 mm NMAS Mix
Placed at 1 inch thickness

Aggregate: Skid Resistance Level (SRL): E
Polymer Modified Binder: PG 76-22 (for heavier traffic)
Gyration Level: 75
Design Air Void: 4%, Min. Design VMA: 16.5%
Design Binder Content: 6.7%; 7.0%; 6.9%
NO RAP/RAS

6.3 mm NMAS Mix

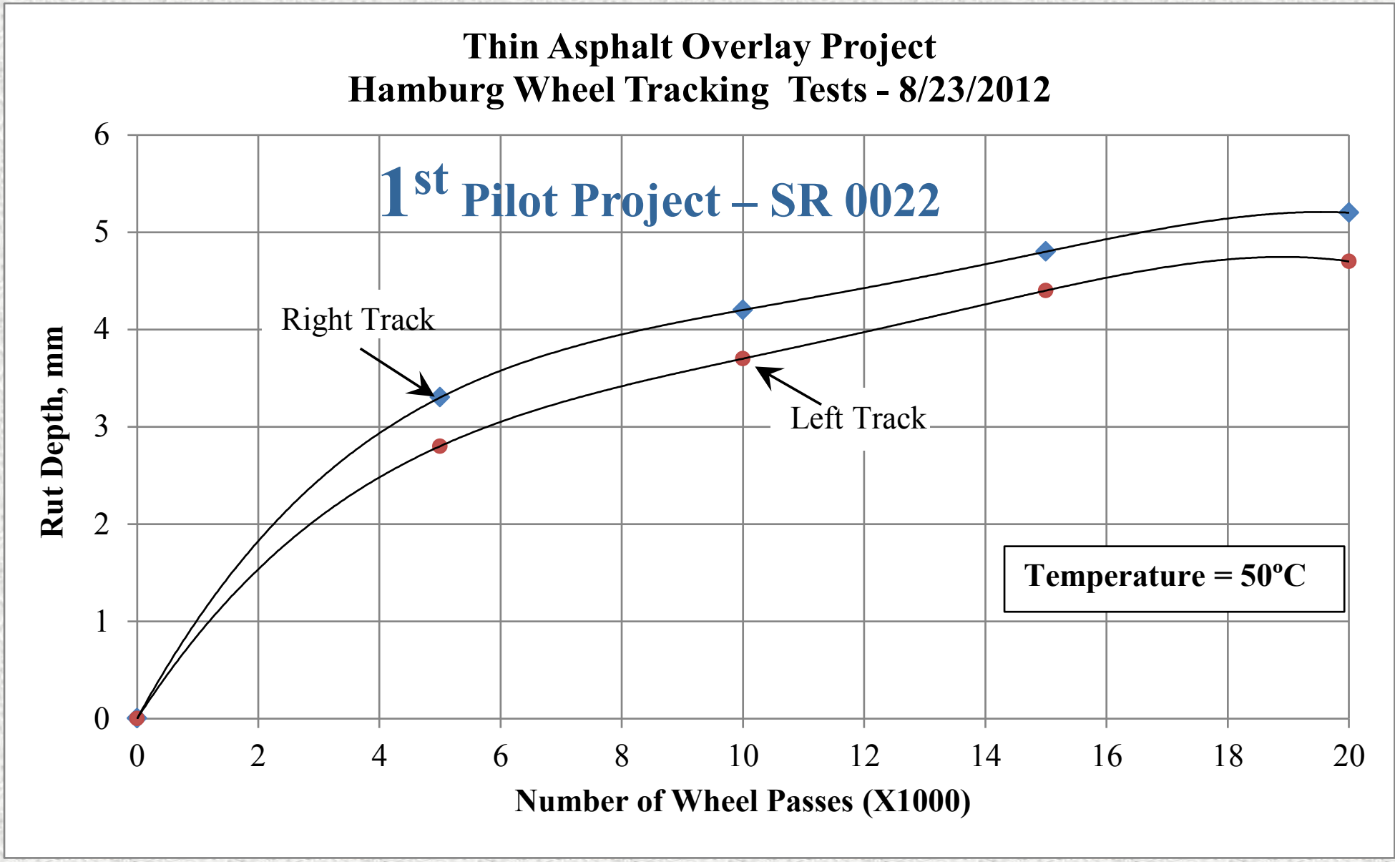


Performance Evaluation - HWTD



Specimens under water
Test Temperature: 50ºC
20,000 Passes
50 Passes per minute
158-lb load

Performance Evaluation - HWTD



Performance Evaluation – Texas Overlay Tester

Performance Evaluation – Overlay Tester

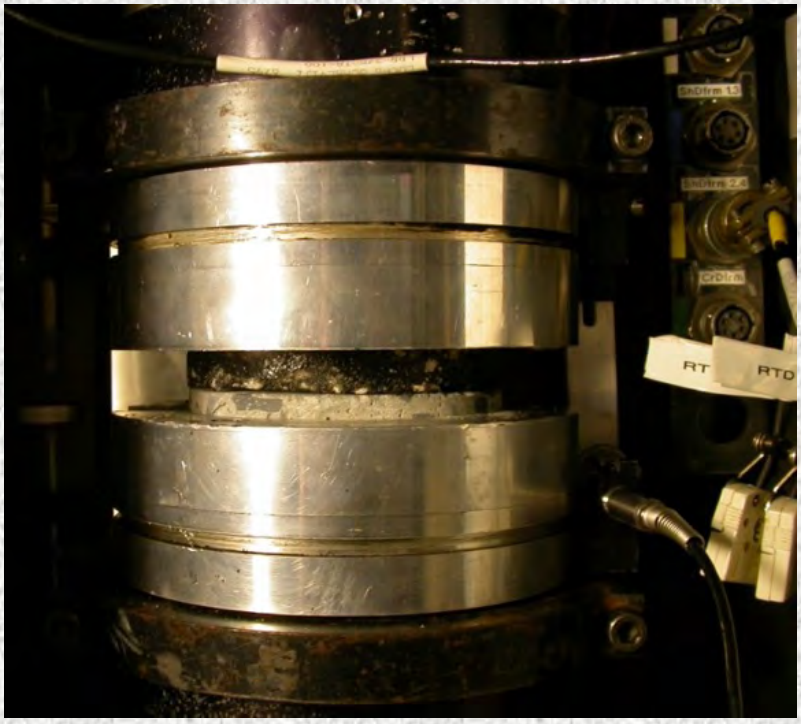
Test Temperature: 25ºC
# of load cycles: 1000
Or until load reduced to 93% of original

- **Repeated loading (triangular form) under constant deformation**
- **Deformation magnitude per load cycle: 0.025 inches (0.6 mm)**
- **Duration of each load cycle: 10 seconds**

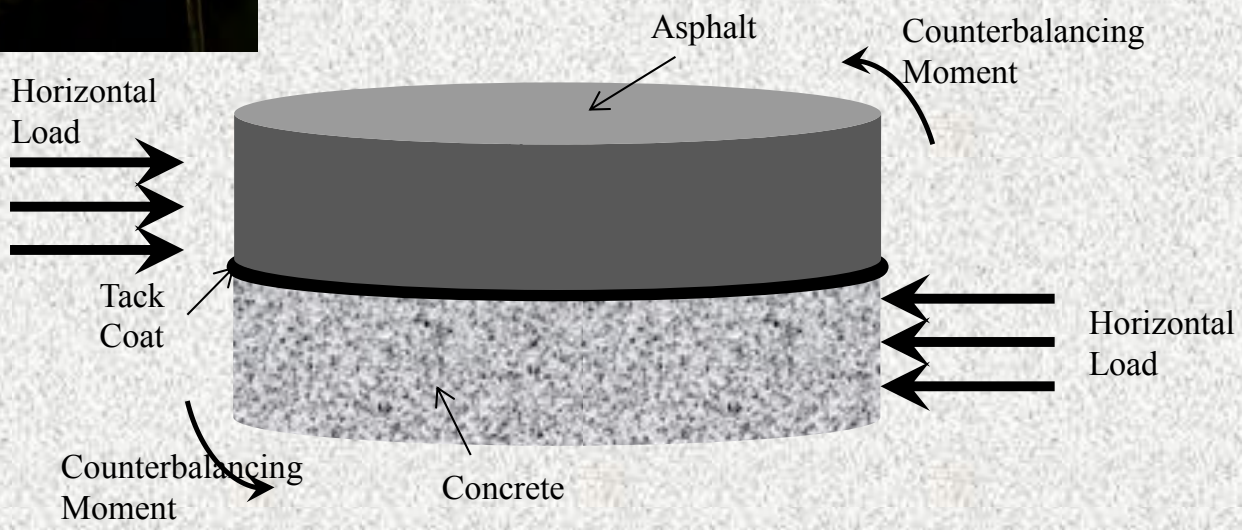
Cycles to failure > 500

Good Performance

Tack Coat Evaluation



Direct Shear Applied at the Asphalt-Concrete Interface



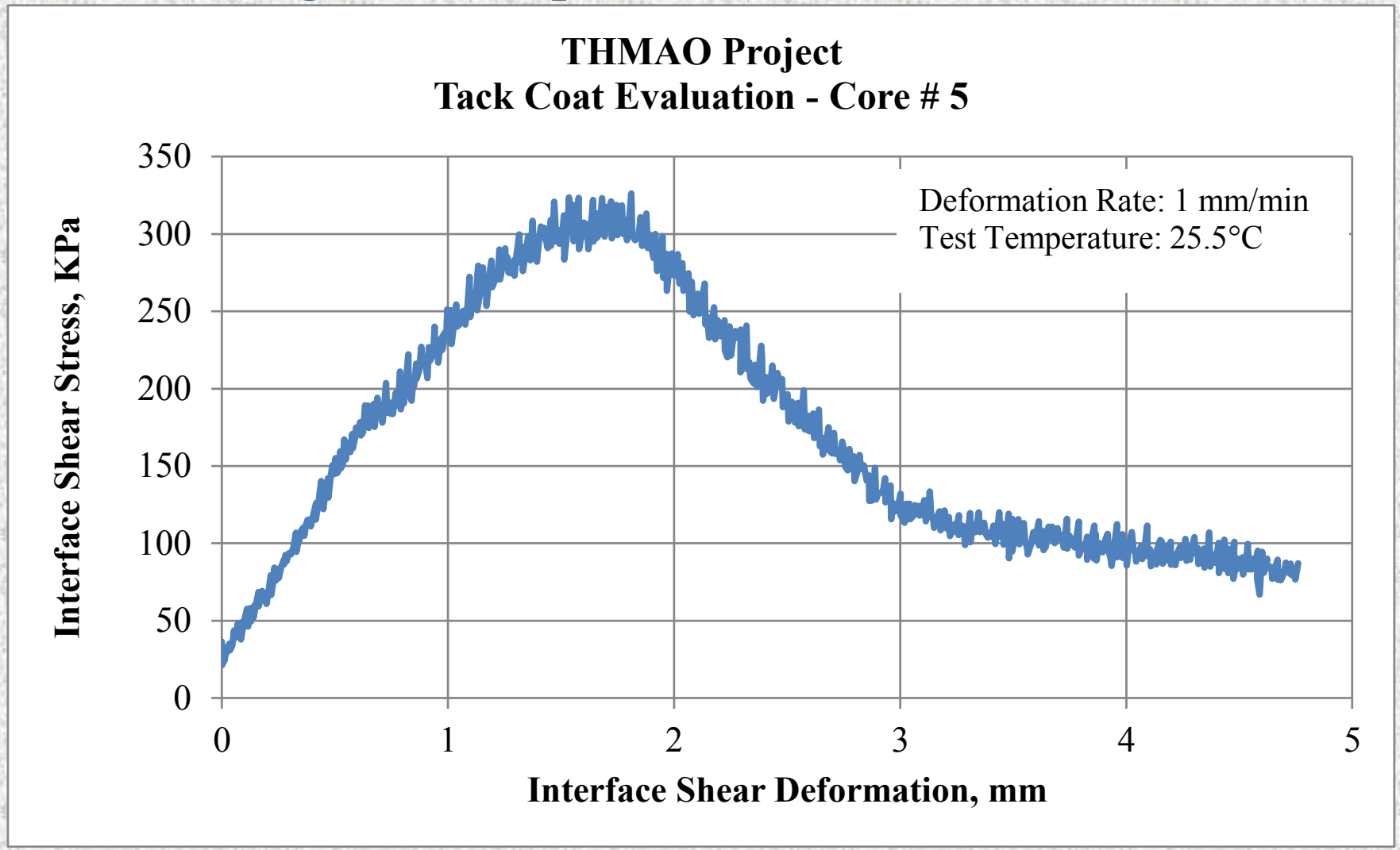
Tack Coat Evaluation

Trimmed Core

Tested Specimen in Direct Shear

Tack Coat Evaluation

Shear Strength = 44.5 psi (307 KPa) - Good Performance



Recommended Requirements for Design of Asphalt Mix for Thin Lifts

Asphalt Binder

- PG 76-22 or PG 64E-22 if ESALs > 3M
- PG 64-22 if ESALS ≤ 3M
- PG 76-22 or PG 64E-22 if grade≥ 5% regardless of traffic level.

Mix Design

- 75 Gyrations
- Air Void: 4.0%
- VMA: 16.5%

Recommended Requirements for Design of Asphalt Mix for Thin Lifts

Aggregate, SRL E

AGGREGATE GRADATION REQUIREMENTS, PERCENT PASSING	
Sieve Size	Min. – Max.
3/8”	100 Min.
1/4”	90-100
No. 4	85 Max
No. 8	37-55
No. 50	8-25
No. 200	3-10

Pilot Projects %Pass#4

87

83

77

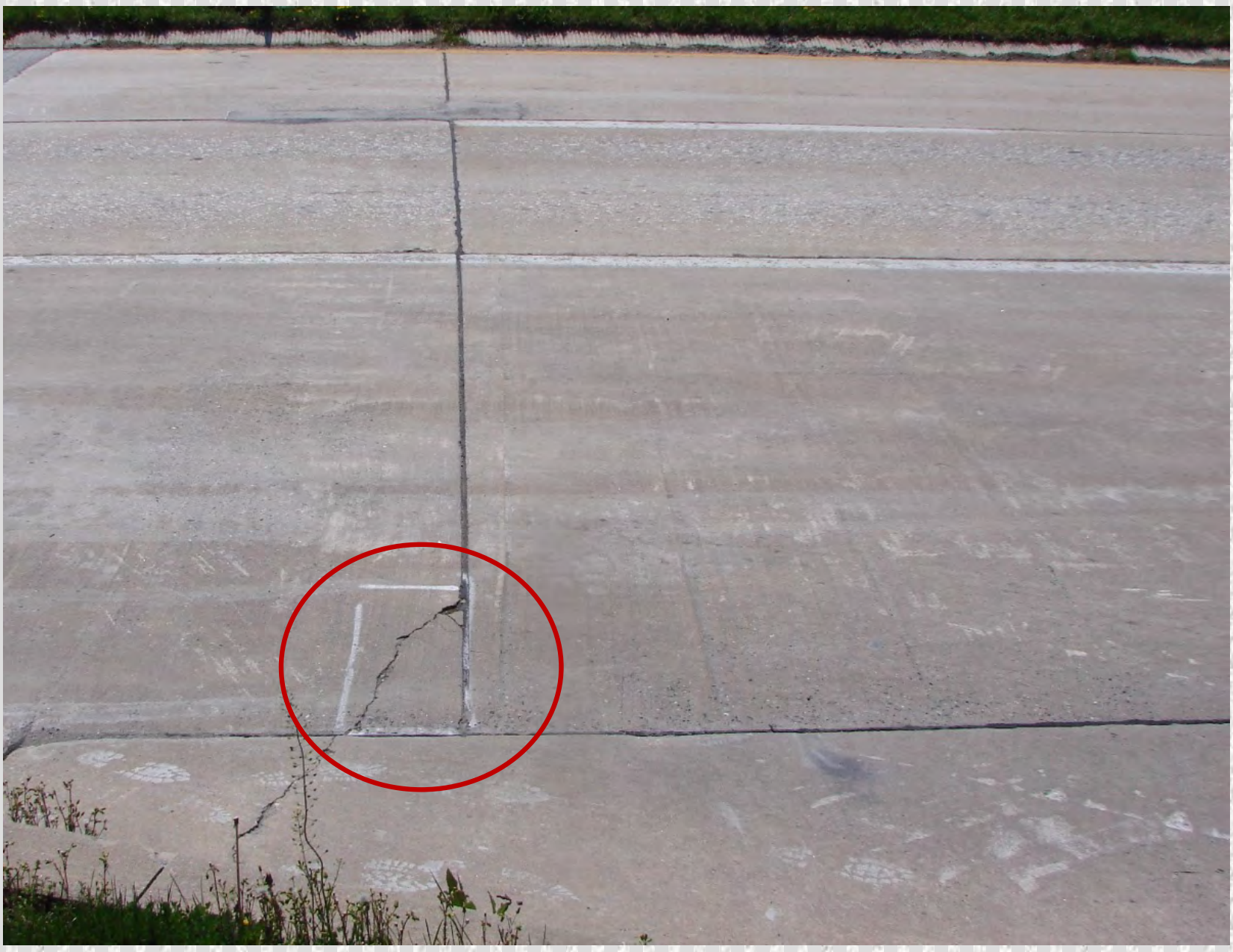
Recommended Requirements for Design of Asphalt Mix for Thin Lifts

Tack Coat, CSS-1h

Surface Type	Residual Application Rate (Gallons/Square Yard)
New Asphalt Mixture	0.03 to 0.04
Oxidized Asphalt Mixture	0.04 to 0.06
Milled Asphalt Mixture	0.05 to 0.07
Milled PCC	0.05 to 0.07
Portland Cement Concrete	0.05 to 0.07

CONSTRUCTION OF THIN OVERLAYS

Repair/Prepare the Base



Repair/Prepare the Base

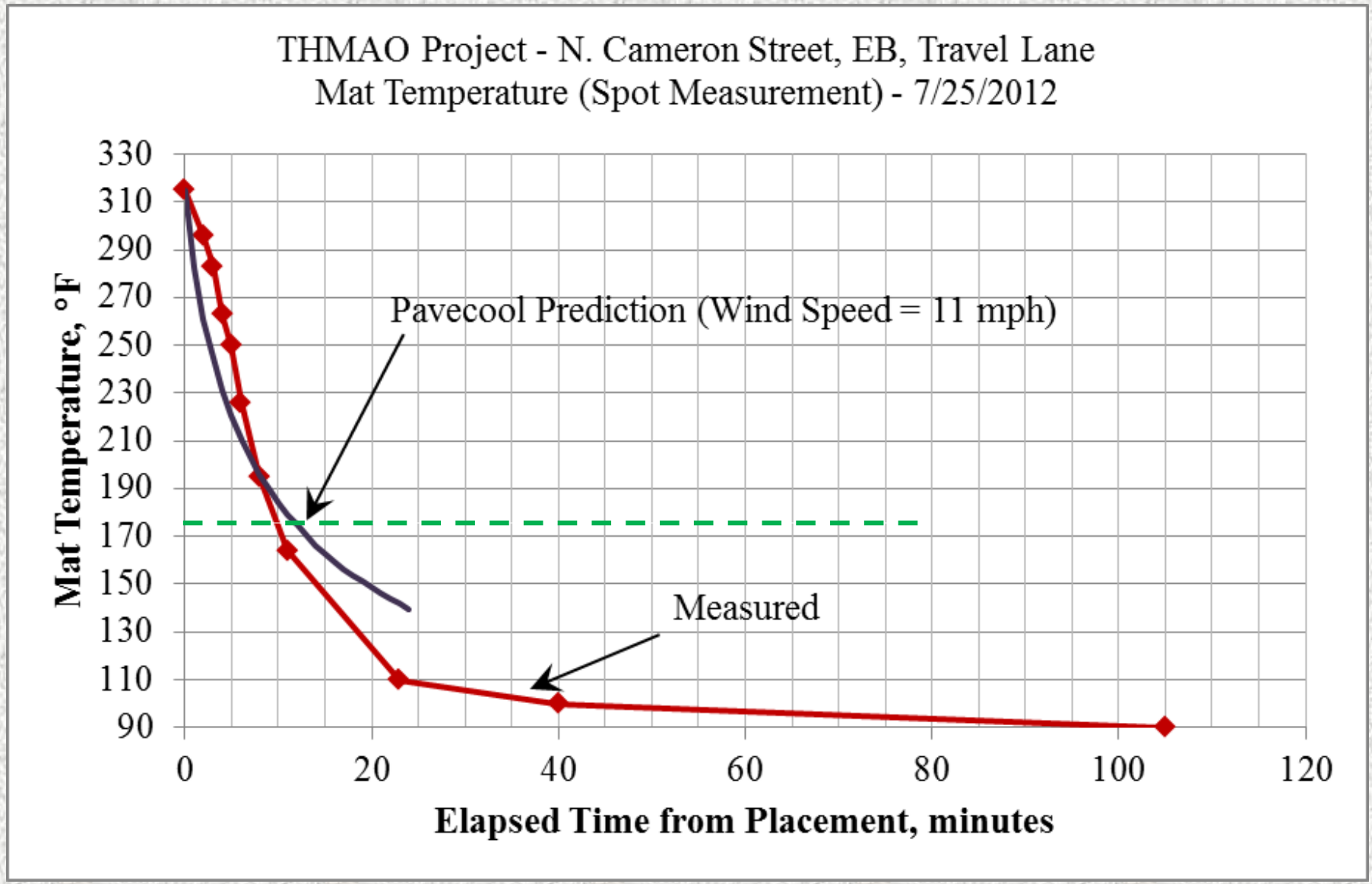
Repair/Clean before Tacking

Emulsion Tack Coat Application

Rollers Follow Paver Closely

Concern with Mat Temperature

Mat Temperature



Finished Overlay – SR 0022

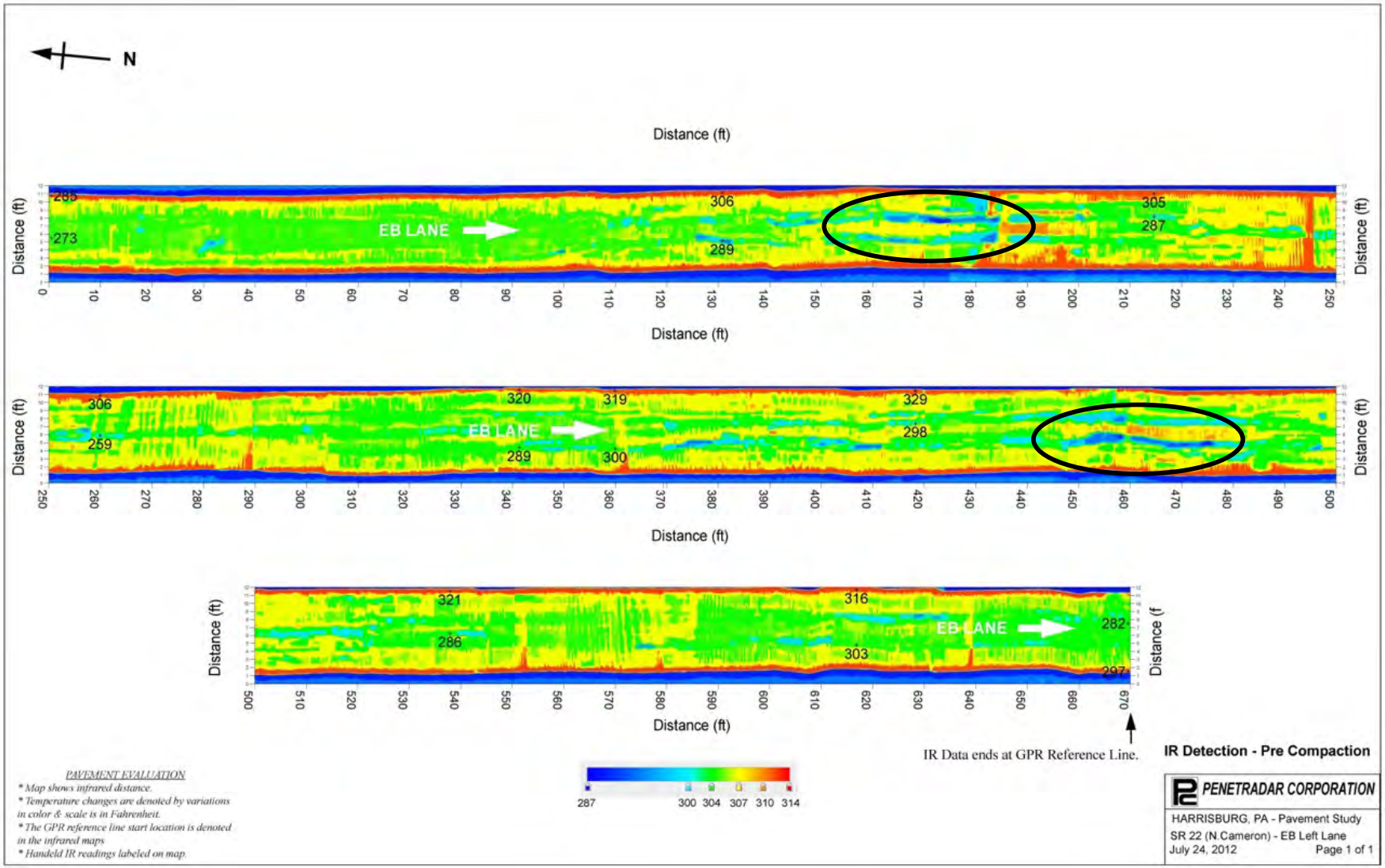
SR 230 – Finished Overlay

SR 220 – Finished Overlay

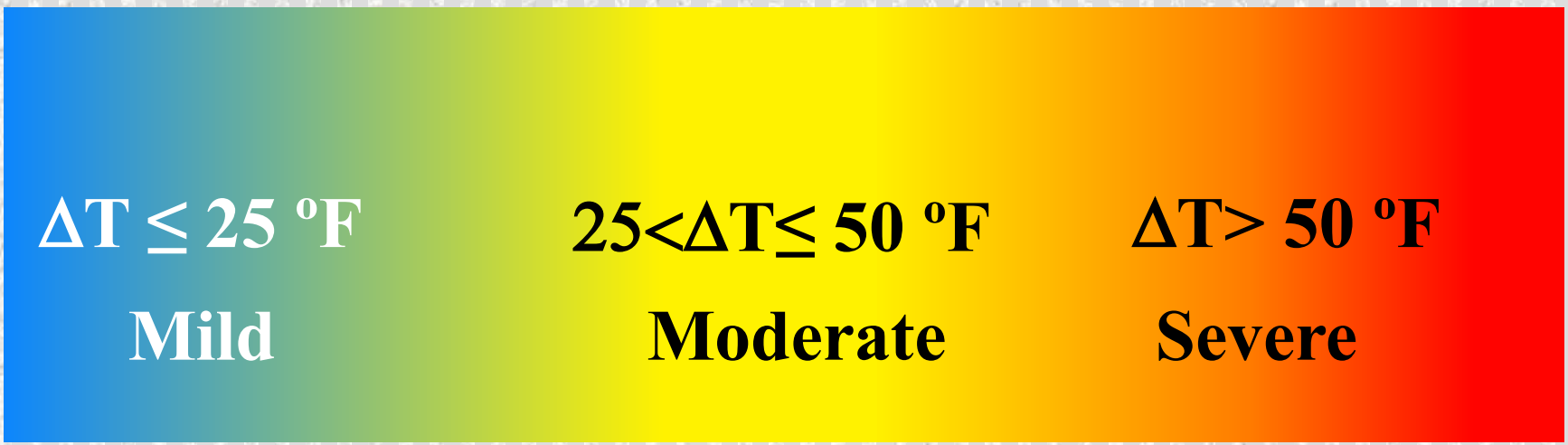
QUALITY CONTROL OF THIN OVERLAYS

Mat Temperature

Infrared Measurements



Thermal Segregation



Less Temp. Variation ⟷ More Temp. Variation

More Uniformity ⟷ More Variability

Pave-IR™ for thermal profiling

- Continuous Temperature Measurement Using Infrared Sensor Bars

- Gives Paver Speed, Idle Time, Position


Pave-IR™
for thermal profiling
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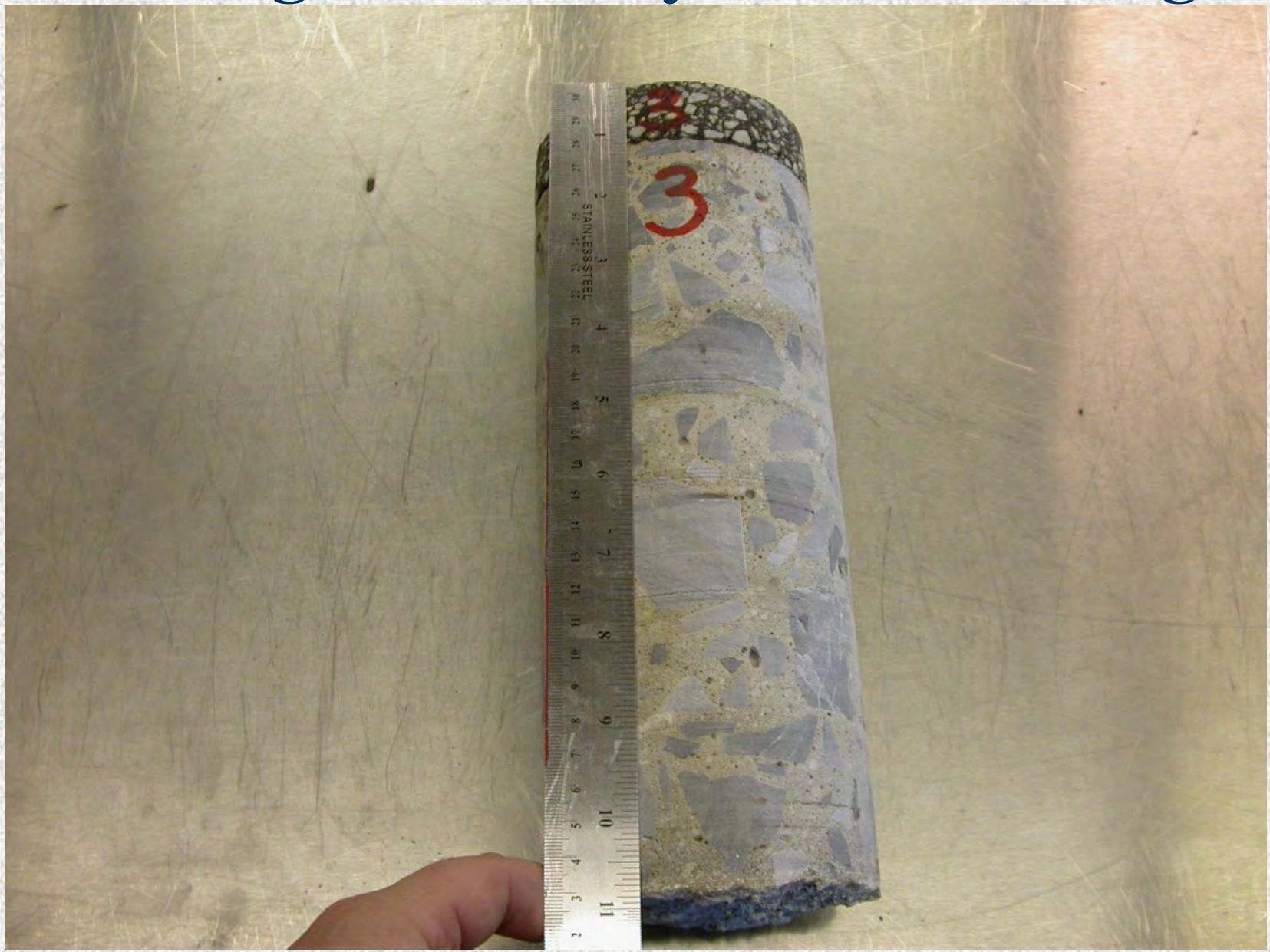
Coring for Density & Lab Testing



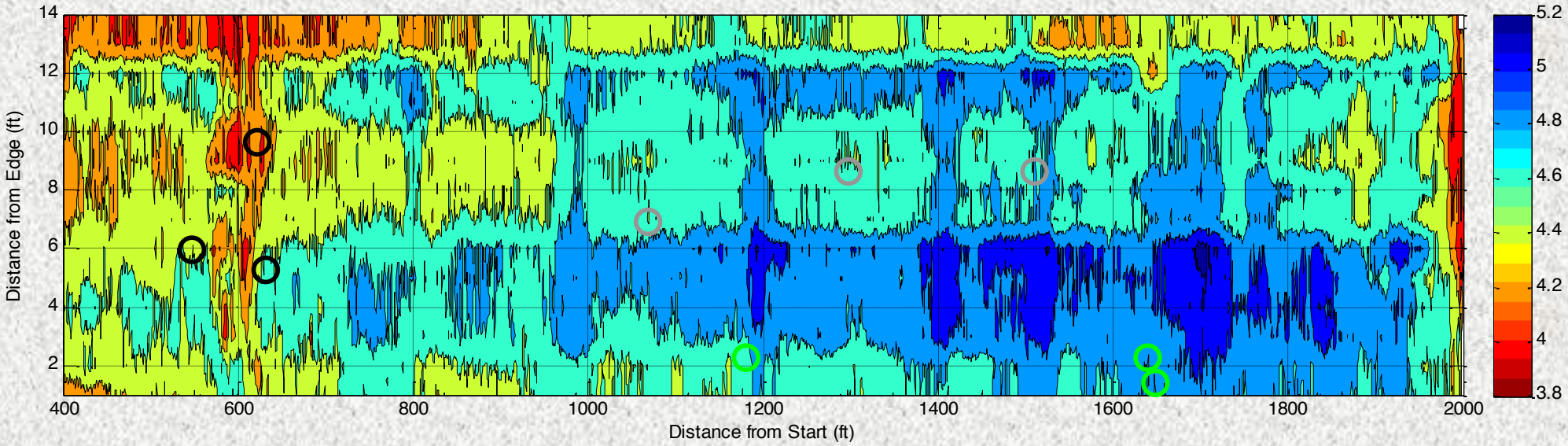
Ground Penetrating Radar

AID Integrated Testing Vehicle
Courtesy of Advanced Infrastructure Design, Inc.

Can GPR provide a reliable estimate of mat density?

Air Coupled GPR

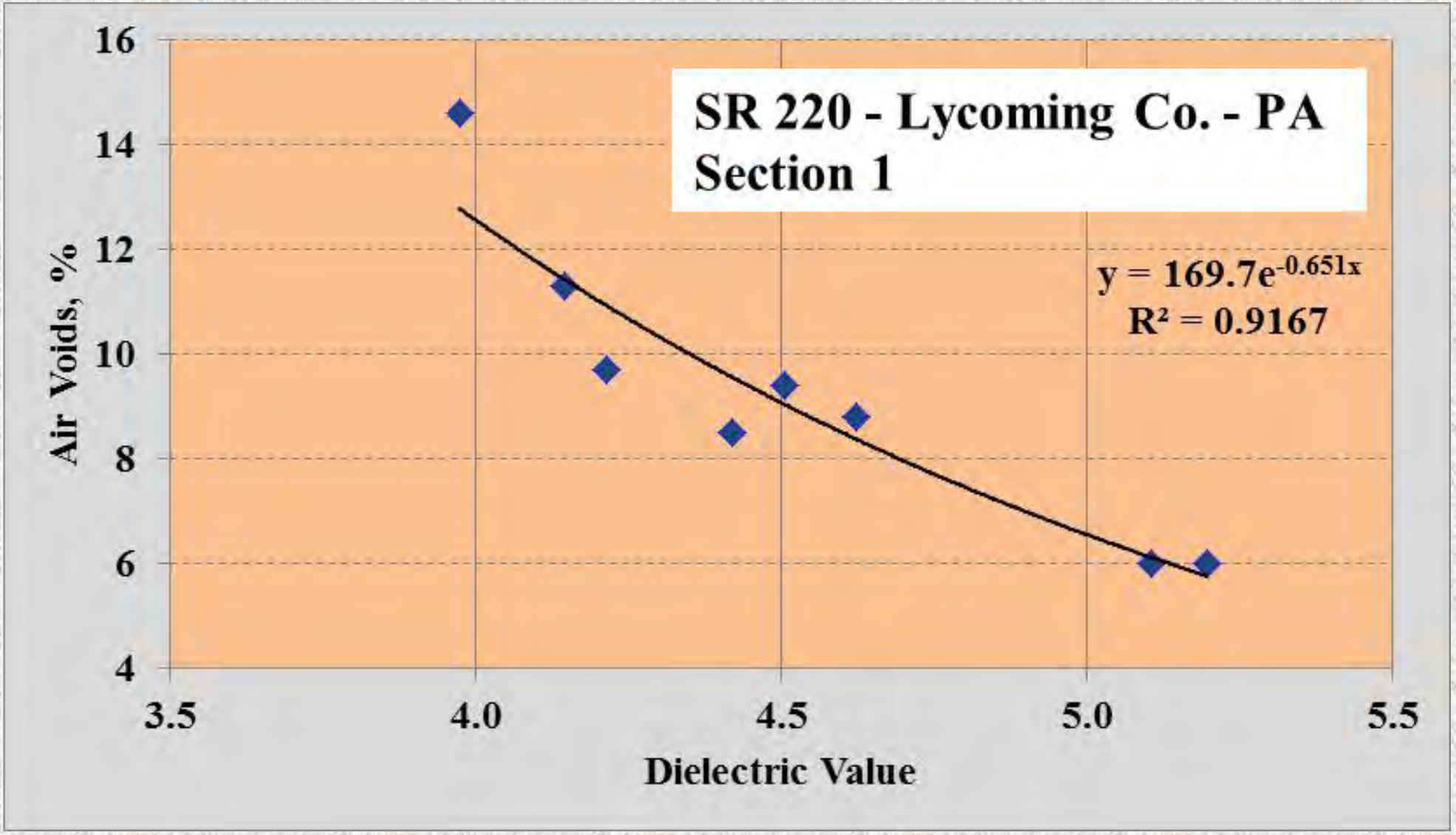
Dielectric Distribution Map



LOW dielectric area (estimated HIGH air voids)

HIGH dielectric area (estimated LOW air voids)

GPR Dielectric-Air Void Relationship



PERFORMANCE OF THIN OVERLAYS

Performance – SR 0022

Before paving

Nov. , 2013
≈ 15 months
afer paving

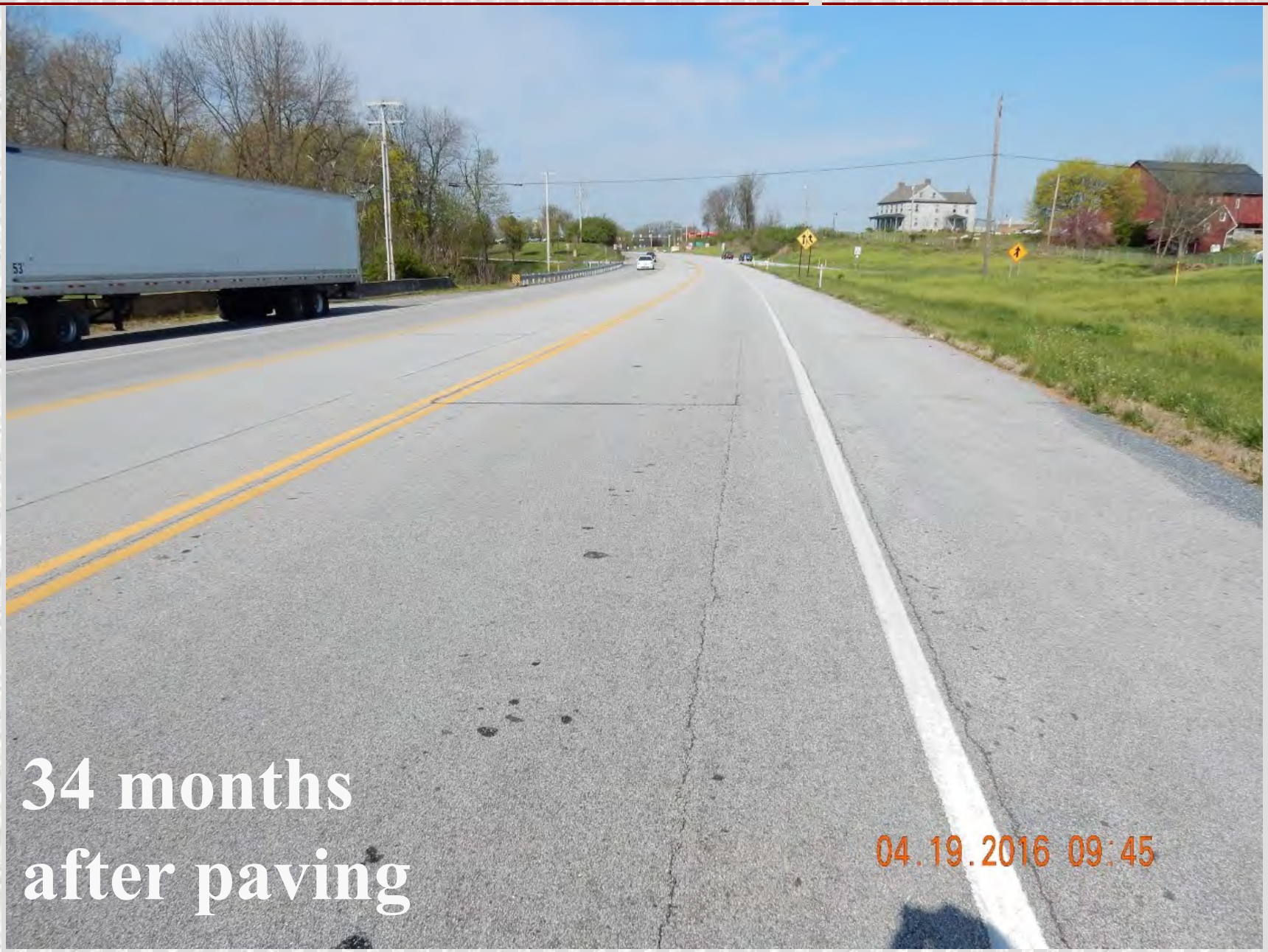
Performance – SR 0022

Performance – SR 0022

Performance – SR 0022

SR 230 – Before THMAO

SR 230 – Performance



SR 230 – Performance

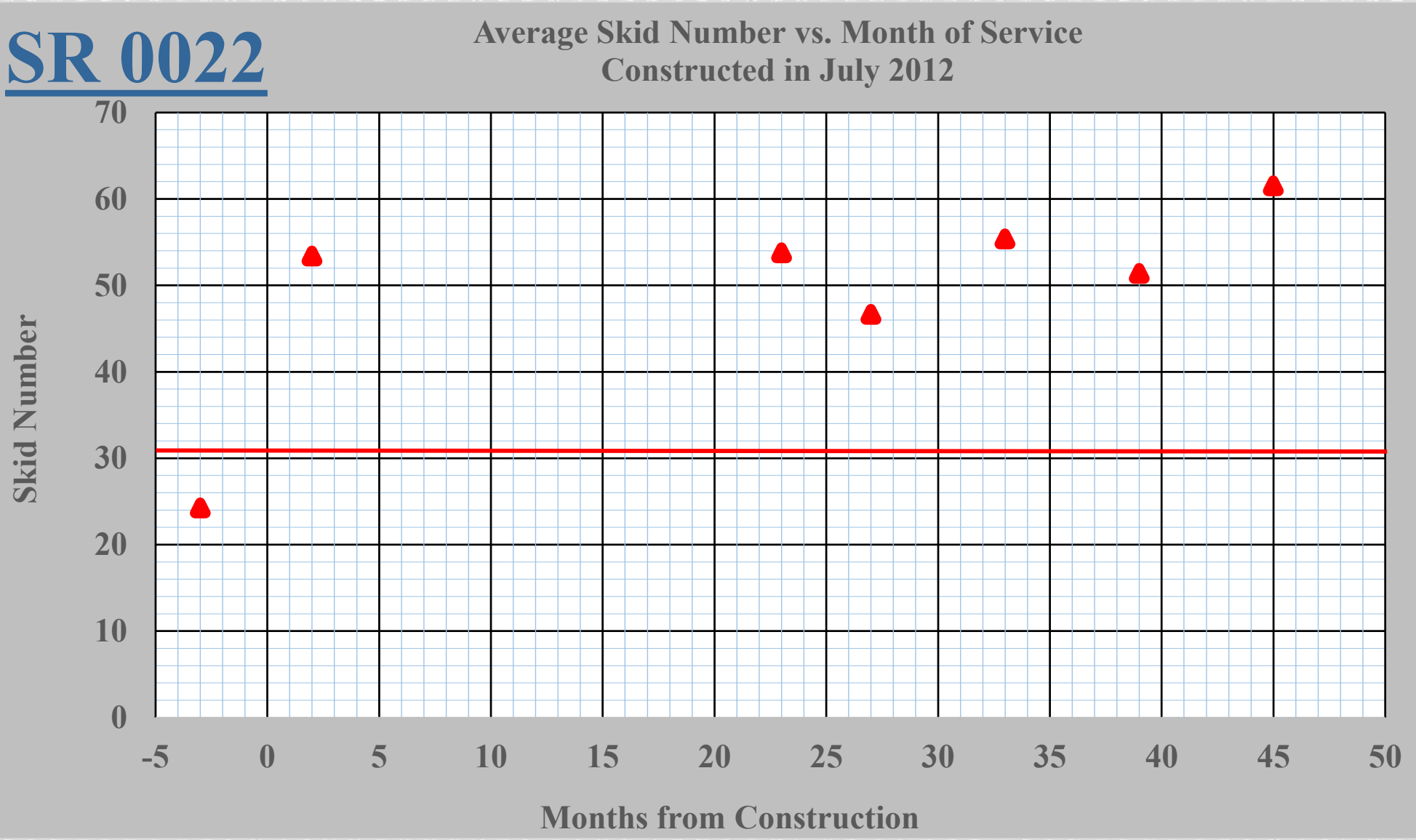
SR 220 – Performance

SR 220 – Performance

Skid Resistance Results

Friction Improvement

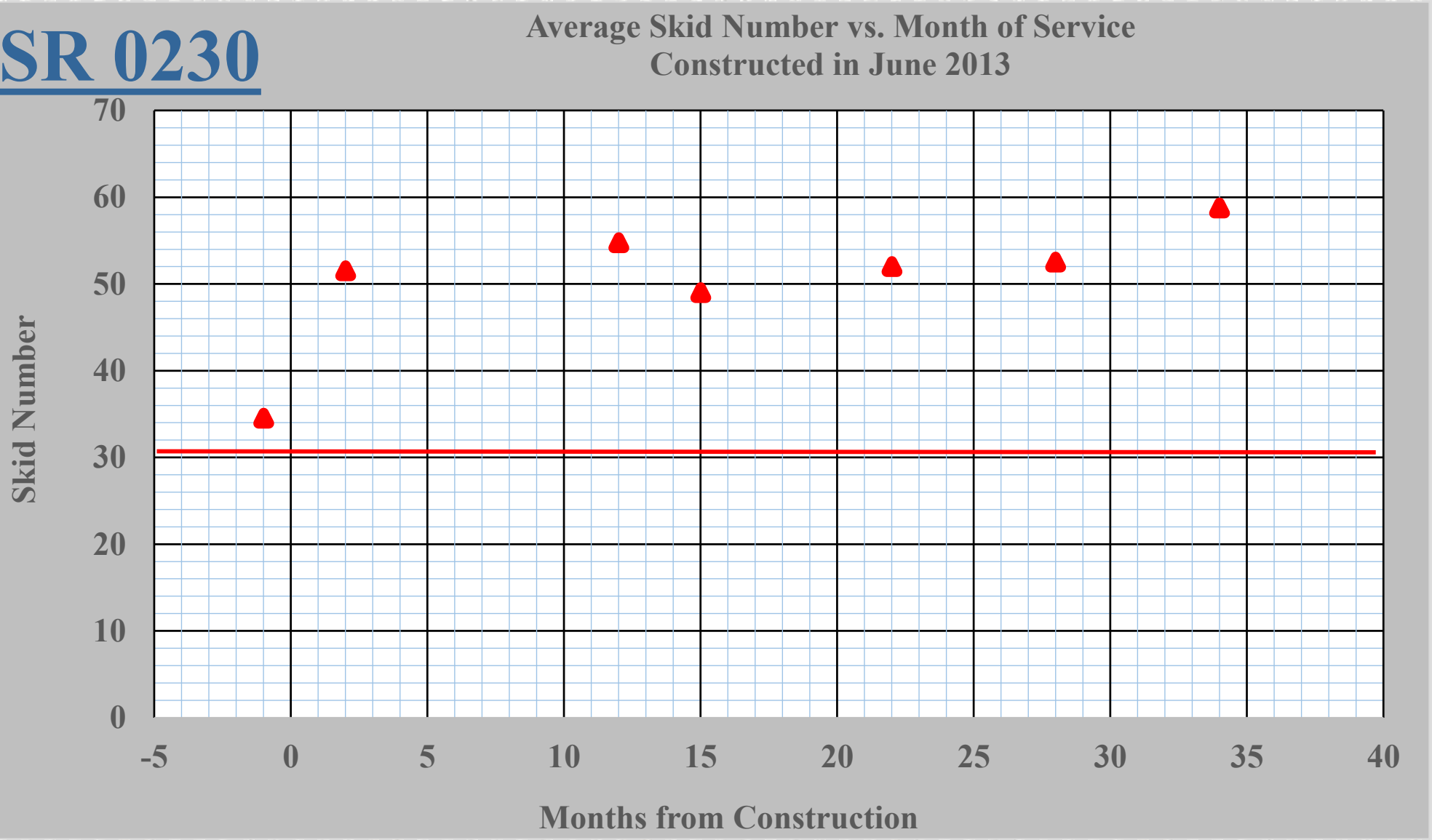
SR 0022



Data: Courtesy of PennDOT BOMO

Friction Improvement

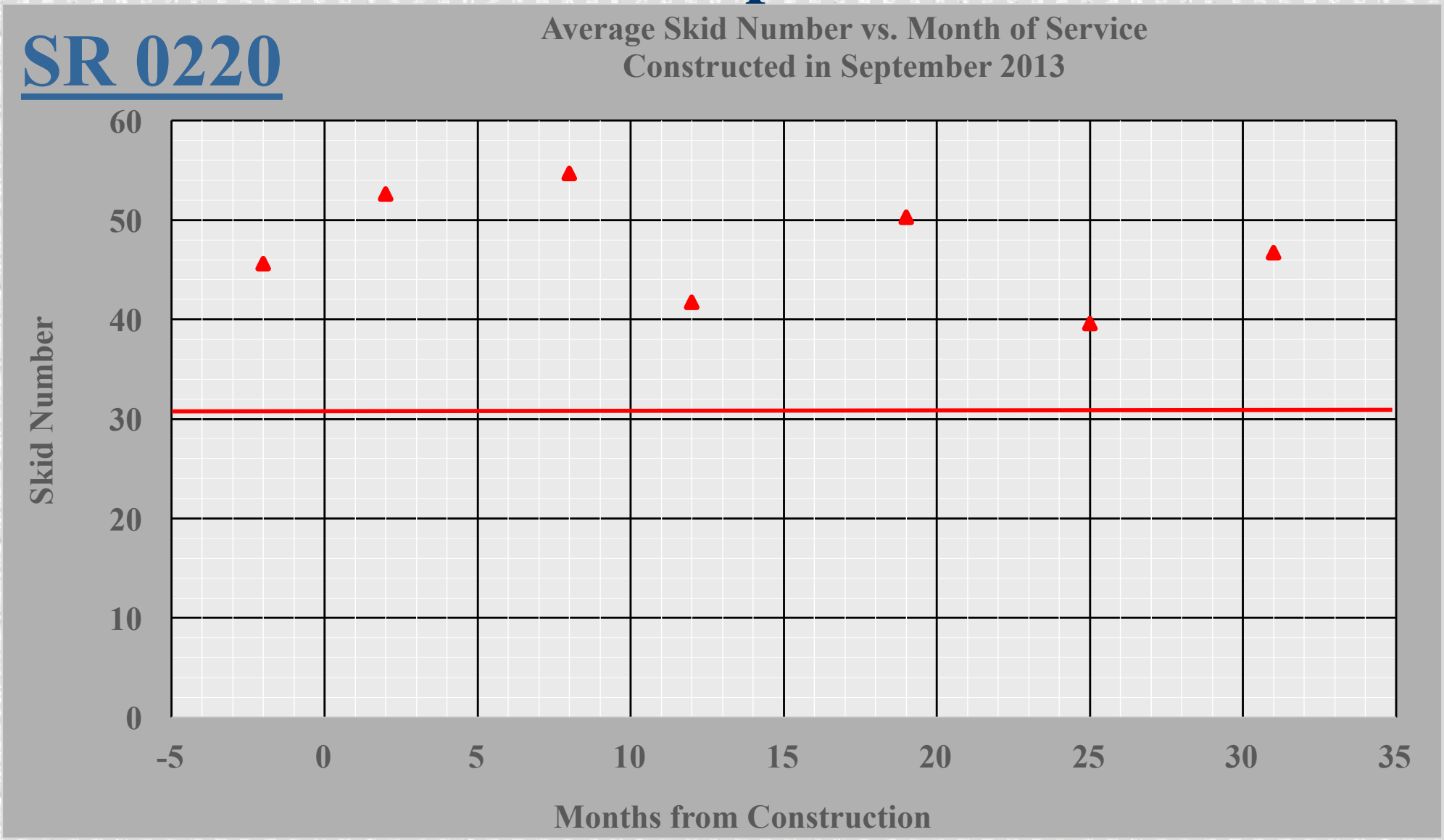
SR 0230



Data: Courtesy of PennDOT BOMO

Friction Improvement

SR 0220

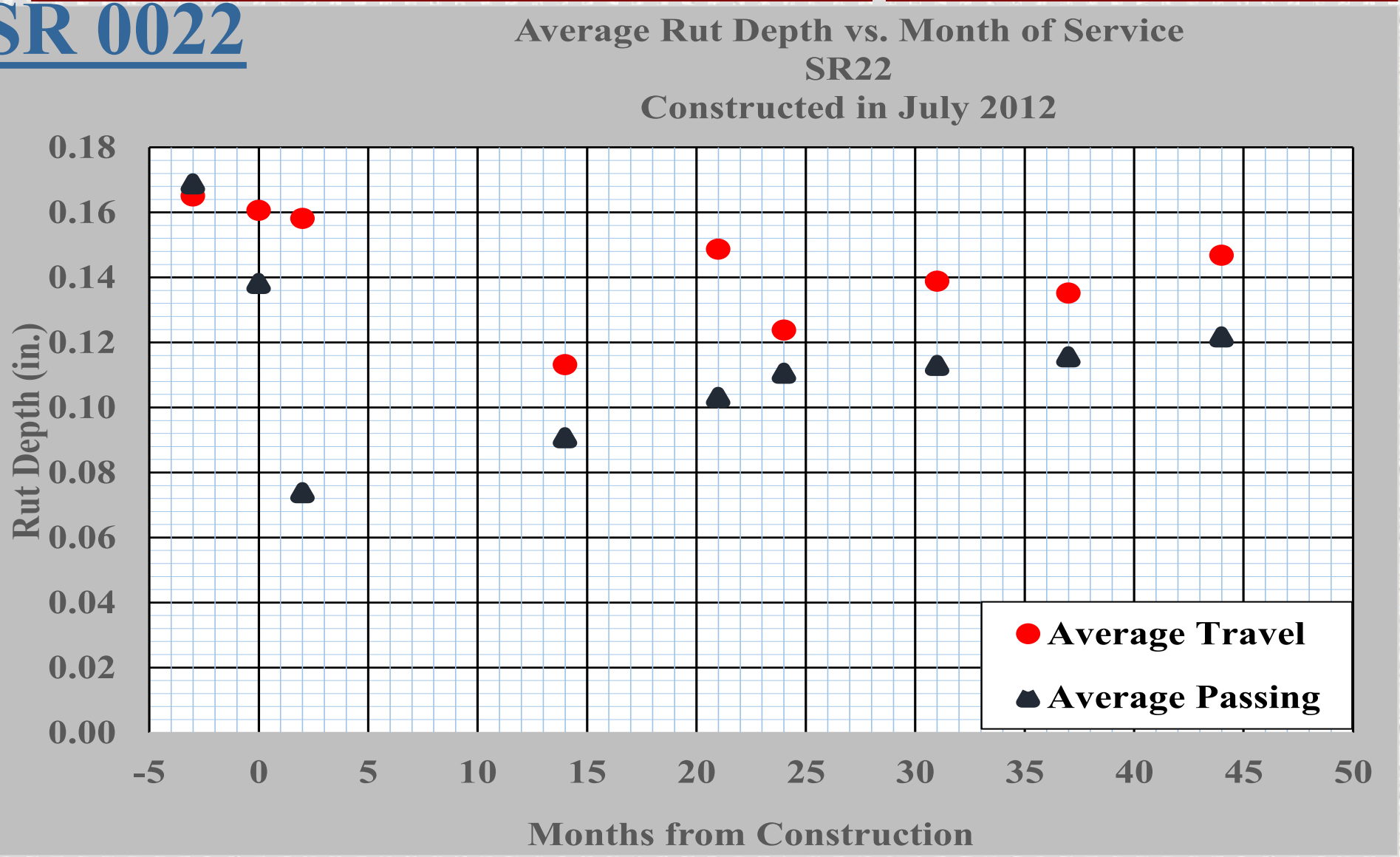


Data: Courtesy of PennDOT BOMO

Rutting

Rutting

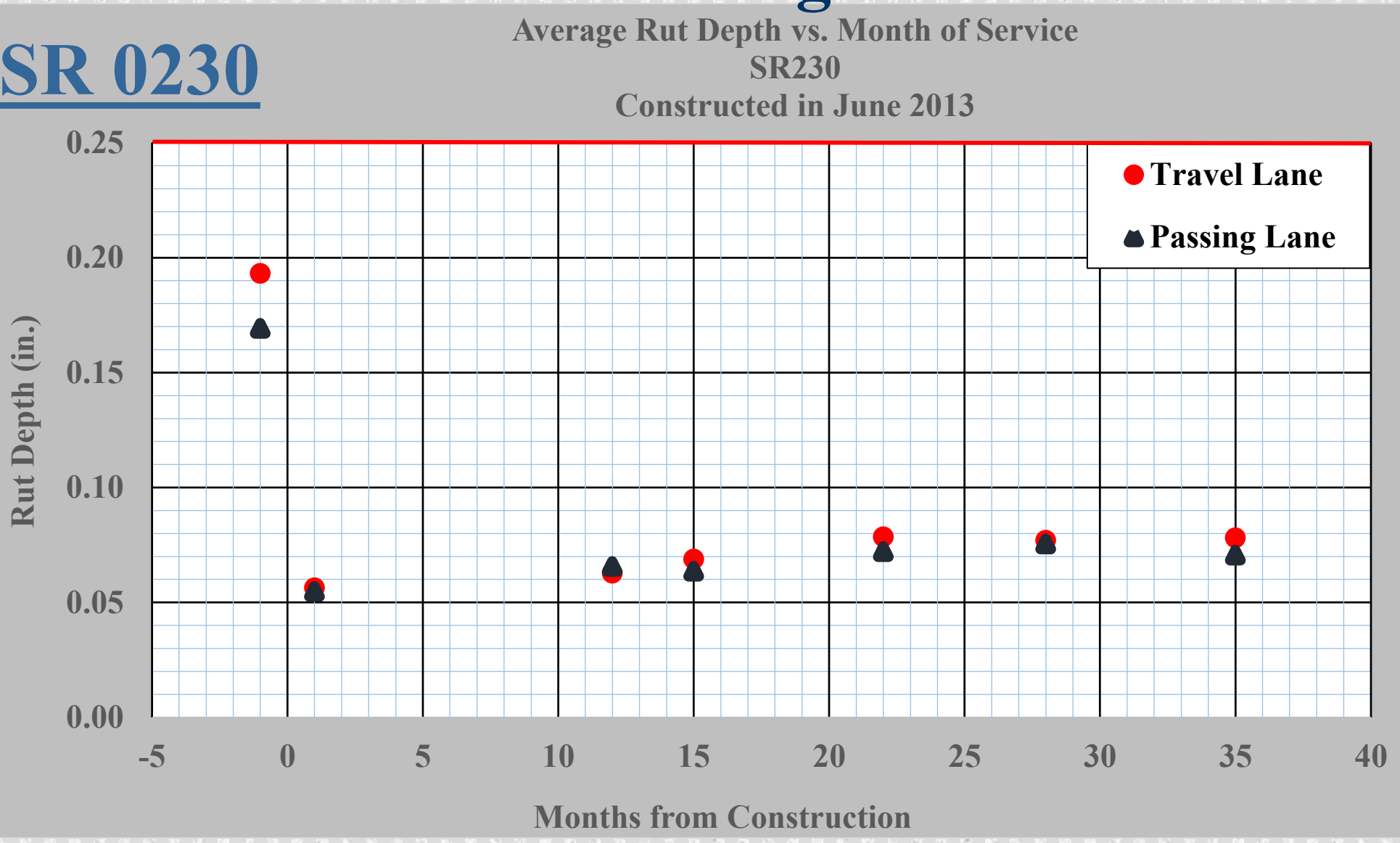
SR 0022



Data: Courtesy of PennDOT BOMO

Rutting

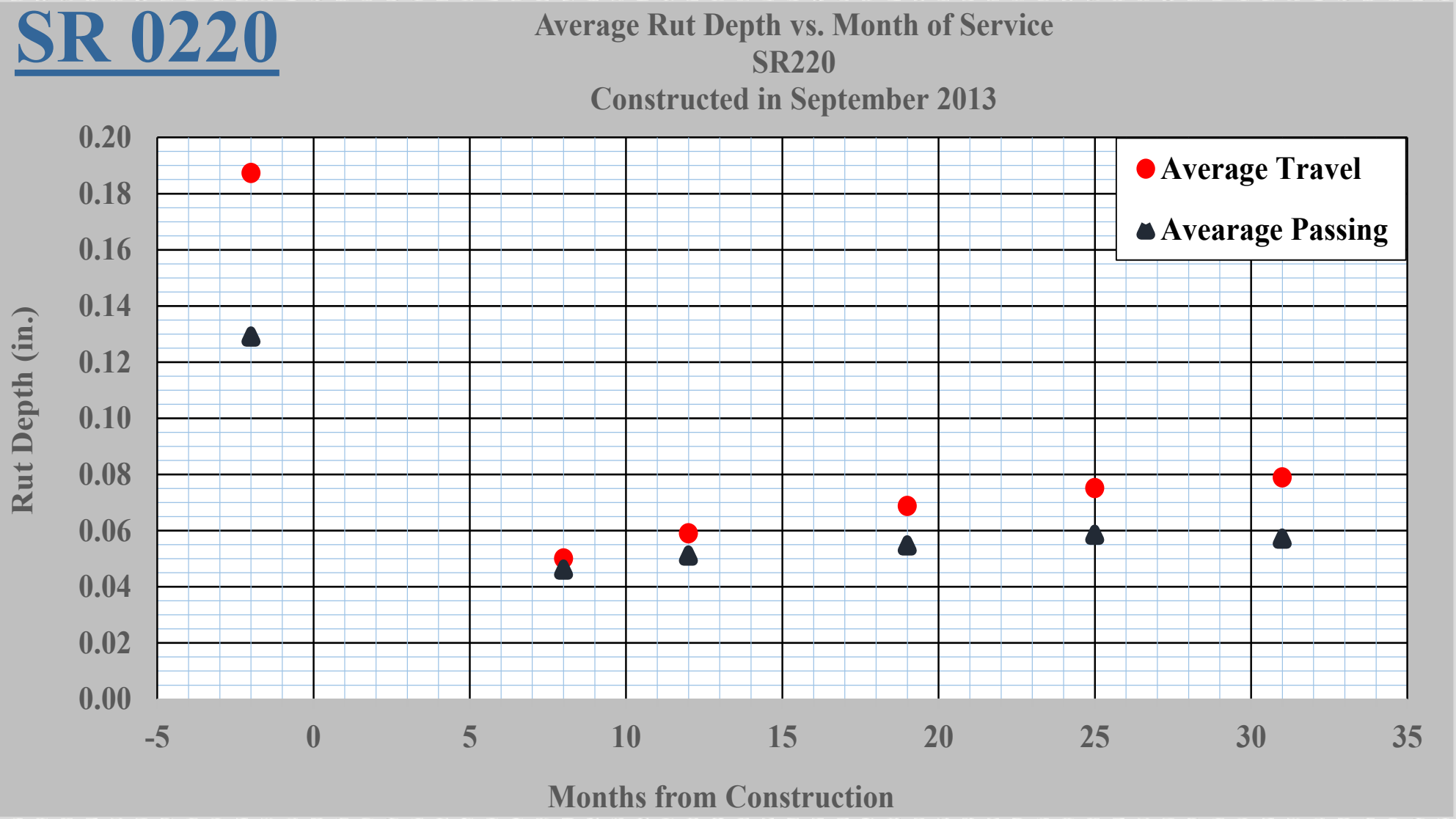
SR 0230



Data: Courtesy of PennDOT BOMO

Rutting

SR 0220

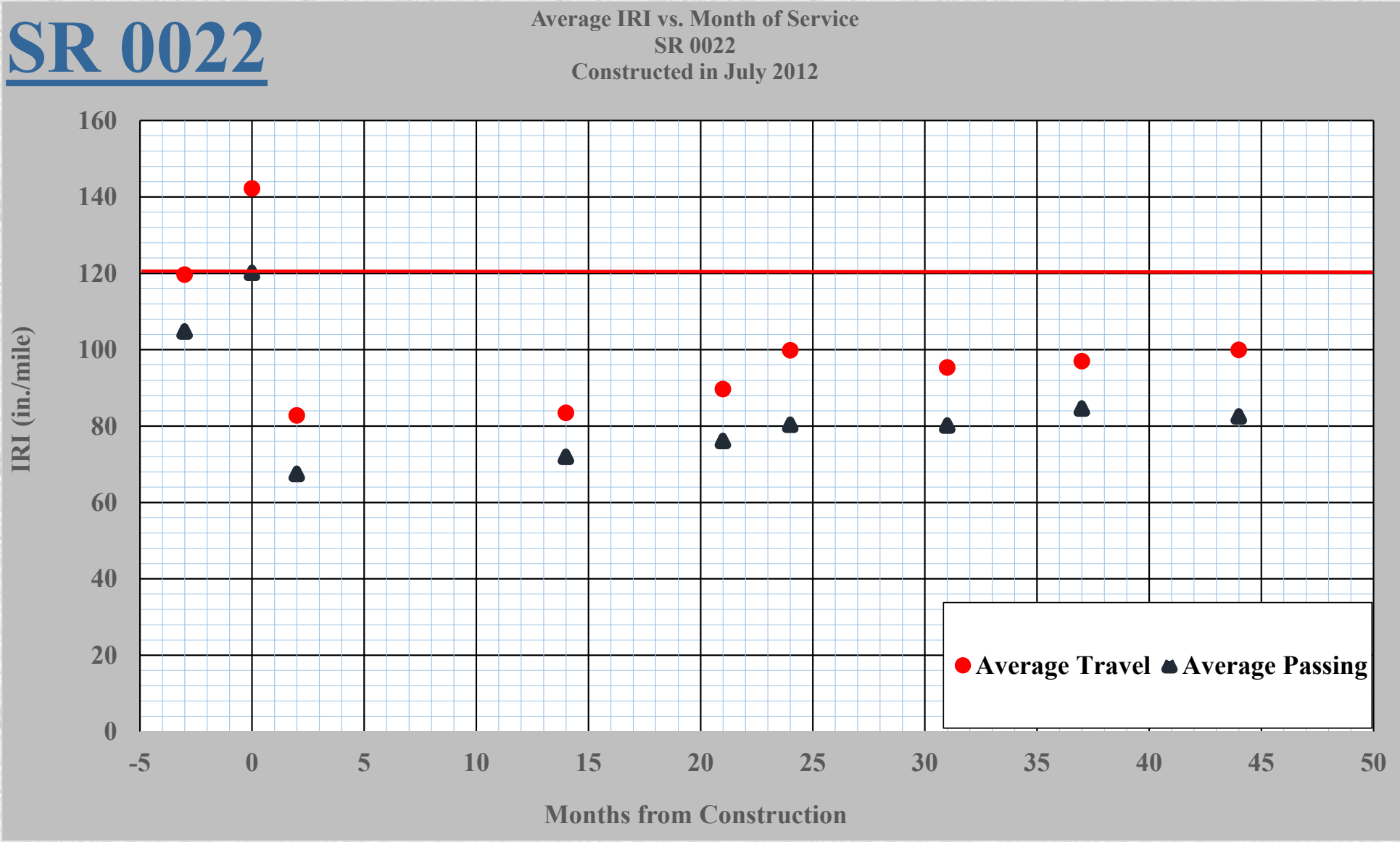


Data: Courtesy of PennDOT BOMO

Ride Quality & Smoothness

Ride Quality (Smoothness) Improvement

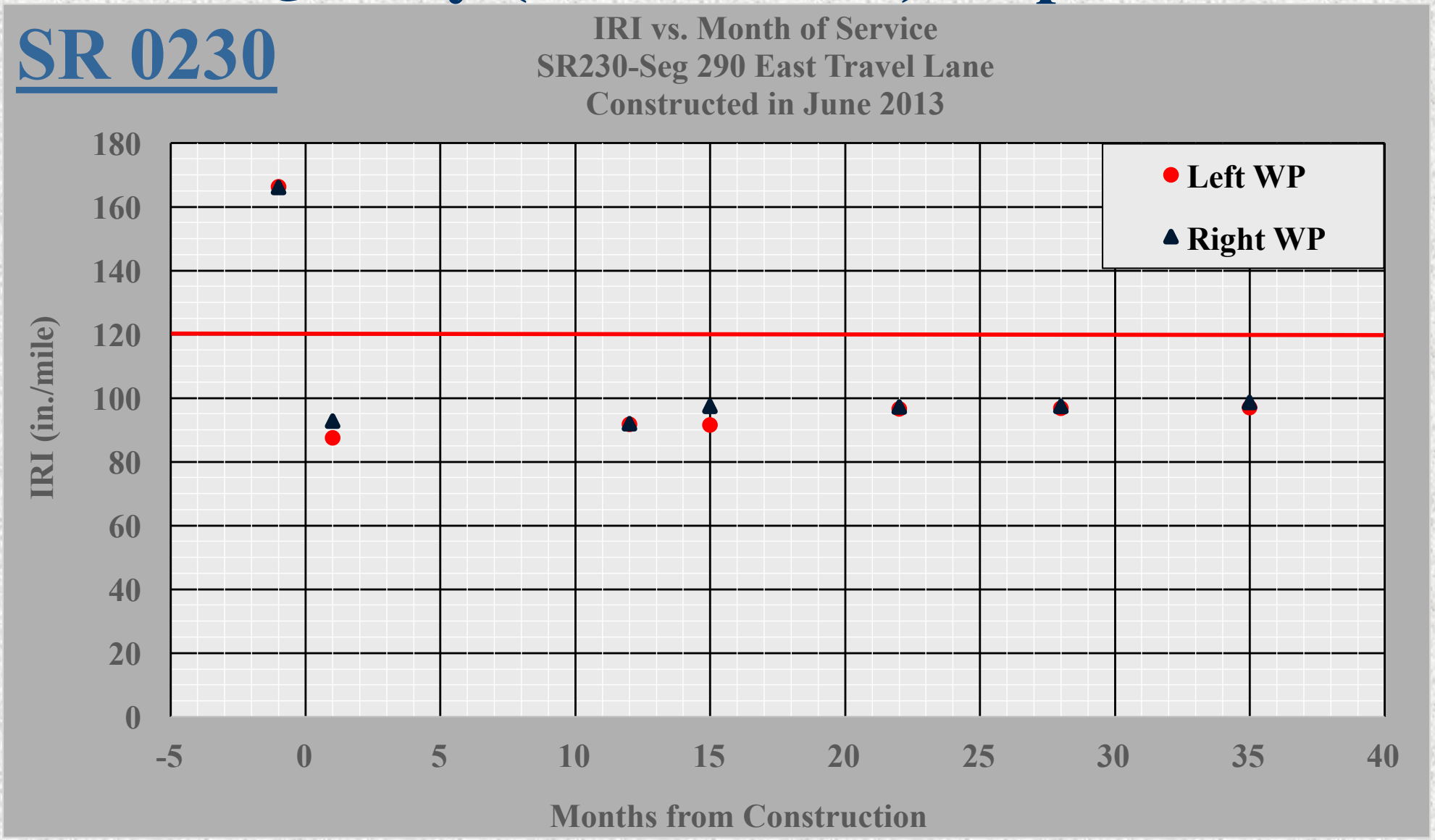
SR 0022



Data: Courtesy of PennDOT BOMO

Ride Quality (Smoothness) Improvement

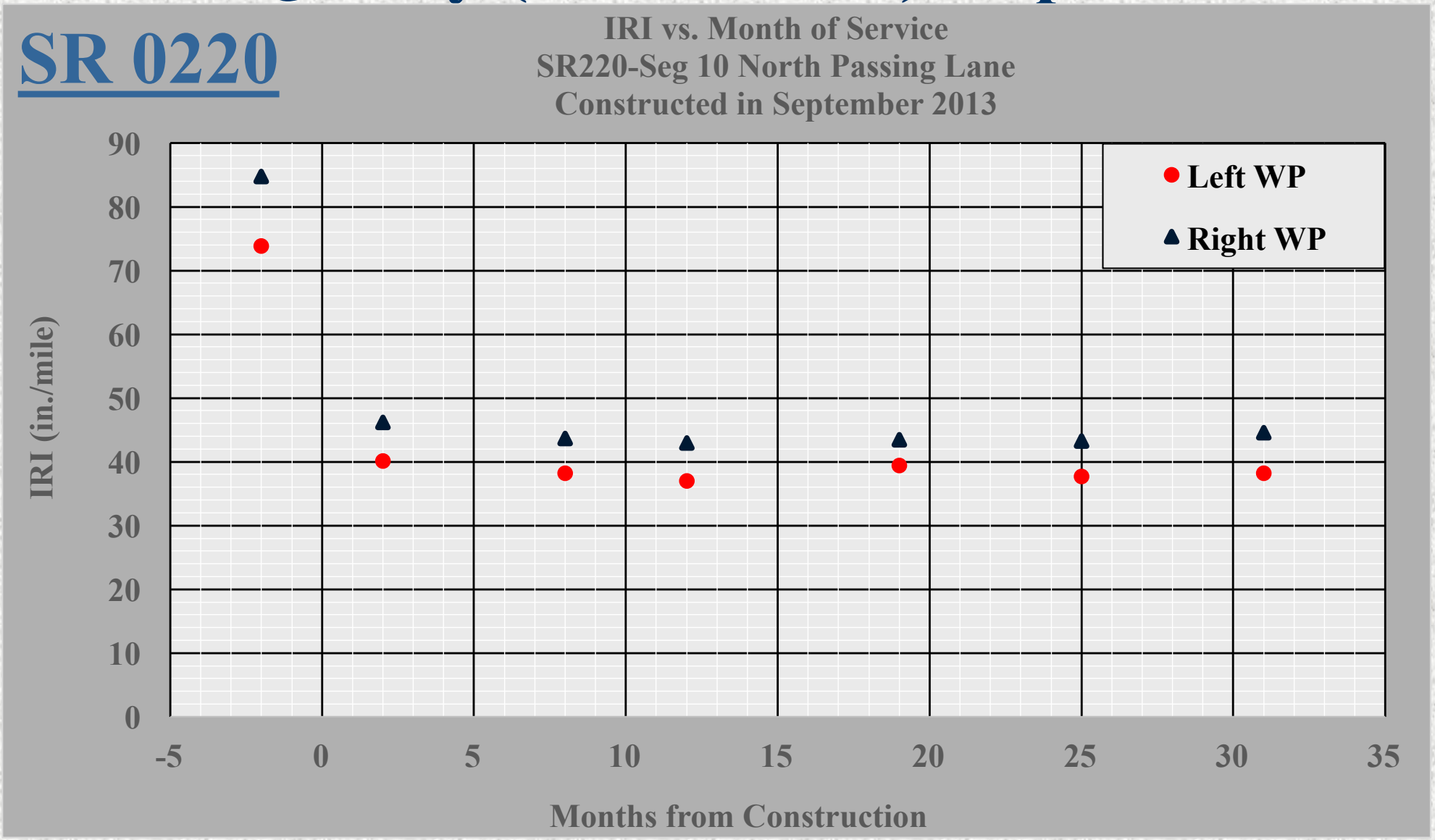
SR 0230



Data: Courtesy of PennDOT BOMO

Ride Quality (Smoothness) Improvement

SR 0220



Data: Courtesy of PennDOT BOMO

Summary

- Thin Asphalt A Good Tool for Surface Treatment
- Proper Base Repair is a MUST
- Improved Ride and Friction
- Improved Ride and Friction Maintained
- Minimal Rutting Observed

Summary

- **Concerns:**
  - Rapid Mat Cooling
  - Reflection of cracks is a challenge on jointed or cracked pavement
- **Advanced Tech for Quality Control:**
  - GPR-Density results are promising
  - Thermal Imaging
- **Good Mix Lab Performance:**
  - Rutting and Moisture Resistance (HWTD)
  - Crack Resistance (Texas Overly Test)

Thank You!