Thin Mix HMA Overlays and Warm Mix Asphalt

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Northeast Pavement Preservation Partnership
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- NJDOT
  - Materials Bureau
    - Robert Sauber and Eileen Sheehy
  - Pavement Technologies
    - Susan Gresavage, Robert Blight, Joseph Beke

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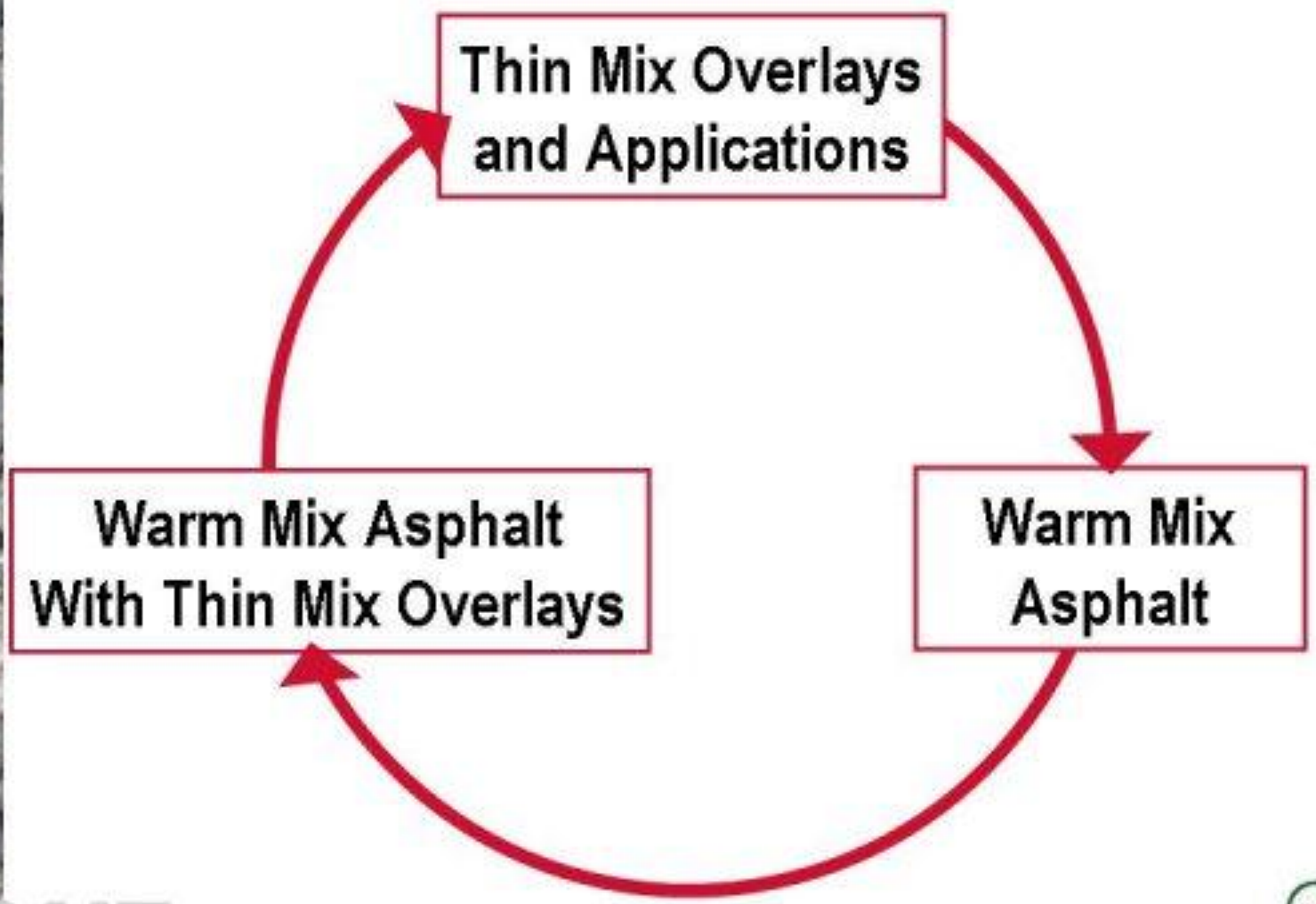
Presentation Outline



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Thin Lift HMA Mix

- What is a "thin lift HMA"
- New Jersey requirements
  - Thin-lift ≈ 25mm thick (Ideally)
    - Minimal change to existing infrastructure (bridge clearances, drainage, etc.)
  - Minimal Impact to Users (Coverage vs Unit Time)
  - Re-new and upgrade road surface
    - Improve Ride Quality (Smoothness), Noise and Minimal Distress
  - No "Cure-time" dependent materials (i.e. – cold applications)
    - Typical high ESAL's limit use

Thin Mix Asphalt Overlays

- Functional Overlays
  - Utilized to improve: Ride Quality, Noise Generation, Skid Resistance
  - Generally not associated with adding additional structure to pavement (i.e. – OGFC)
- Structural Overlays
  - Increased Rutting and Fatigue Resistance while utilizing a thin lift
  - Usually difficult rehabilitation situations (i.e. – bridge decks, deteriorating PCC)

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Thin Lift HMA

Functional Overlays Used in New Jersey

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Functional Overlays

- Typically placed on existing overlay
  - Thicker overlays can be placed directly on PCC
- What NJDOT is looking for:
  - Increase in Ride Quality (Pavement Smoothness)
  - Increase in Skid Resistance Properties
  - Decrease Tire/Pavement Generated Noise
  - 3/8 to 1.5 inches thick
- Adds some structure, but difficult to quantify

TRR 1929 (2005)

- Compare Functionality (Performance) of Thin-Lift Materials in Field
  - Ride Quality (IRI and RQI)
  - Tire/Pavement Noise Generation
  - Wet Weather Safety (Wet Skid Resistance)
- Assess "Non-Performance" Factors
  - Typical costs
  - Winter maintenance issues in NJ
  - Wet weather driving conditions

Surface Types in Study

- OGFC (5 sections)
- Novachip (2 sections)
- Micro-surfacing, Type 3 (2 sections)
- SMA, 9.5mm and 12.5mm (1 each)
- 12.5 mm Superpave (2 sections)
  - Typical re-surfacing mix for NJDOT
- PCC
  - No surface treatment (3 sections)
  - Diamond grind (1 section)
  - Transverse tining (2 sections)

Considered Baseline Sections

Measuring Tire/Pavement Noise

- 2 Microphones (8 inches from tire, 4 inches from ground)
- Acoustic foam insulation inside chamber
- Typical automobile tires

Close Proximity Method (CPX)

(ISO Standard 11819-2)

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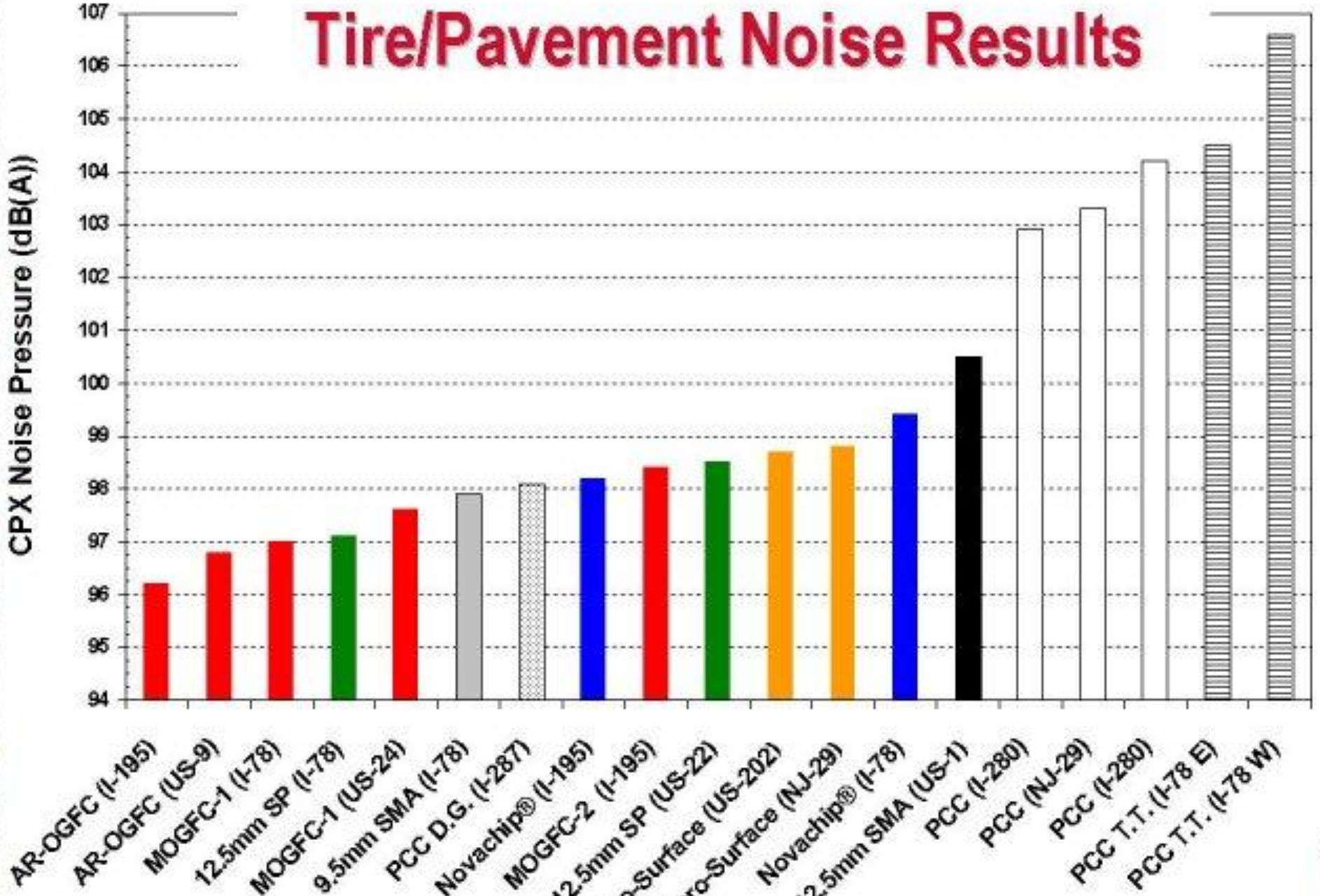
Tire/Pavement Noise Results



Average Tire/Pavement Noise

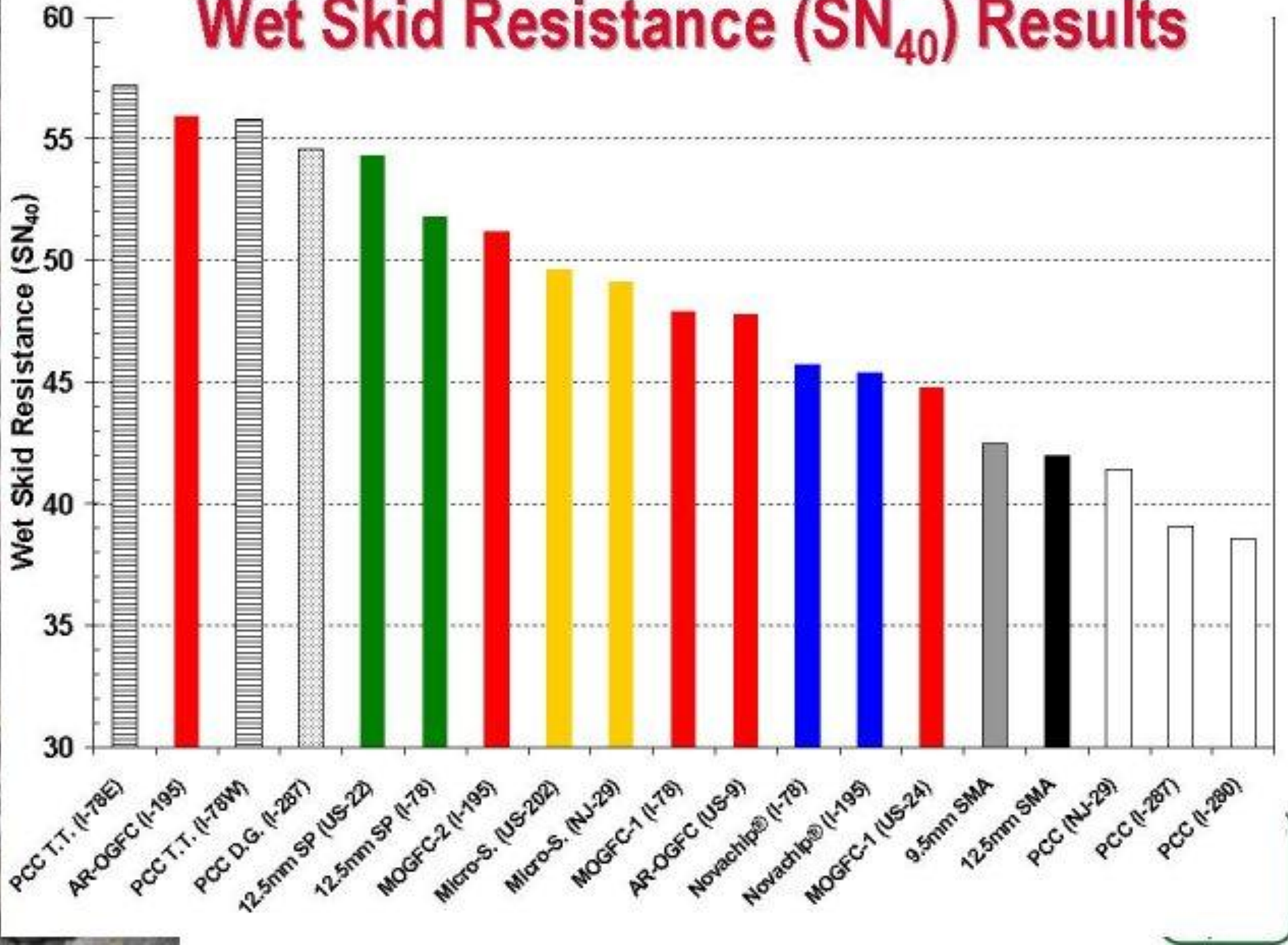
Surface Type	dB(A)
OGFC	97.20
Novachip®	98.80
9.5 mm SMA	98.00
12.5 mm SMA	100.50
Micro-Surfacing	98.78
12.5 mm SP	97.80
PCC	103.47
PCC (T.T.)	106.10
PCC (D.G.)	98.70

1 Week Old

* Each surface type averaged using all respective sections

Wet Skid Resistance (SN_{40})

Wet Skid Resistance (SN_{40}) Results



Average Wet Skid Resistance (SN_{40}) Results

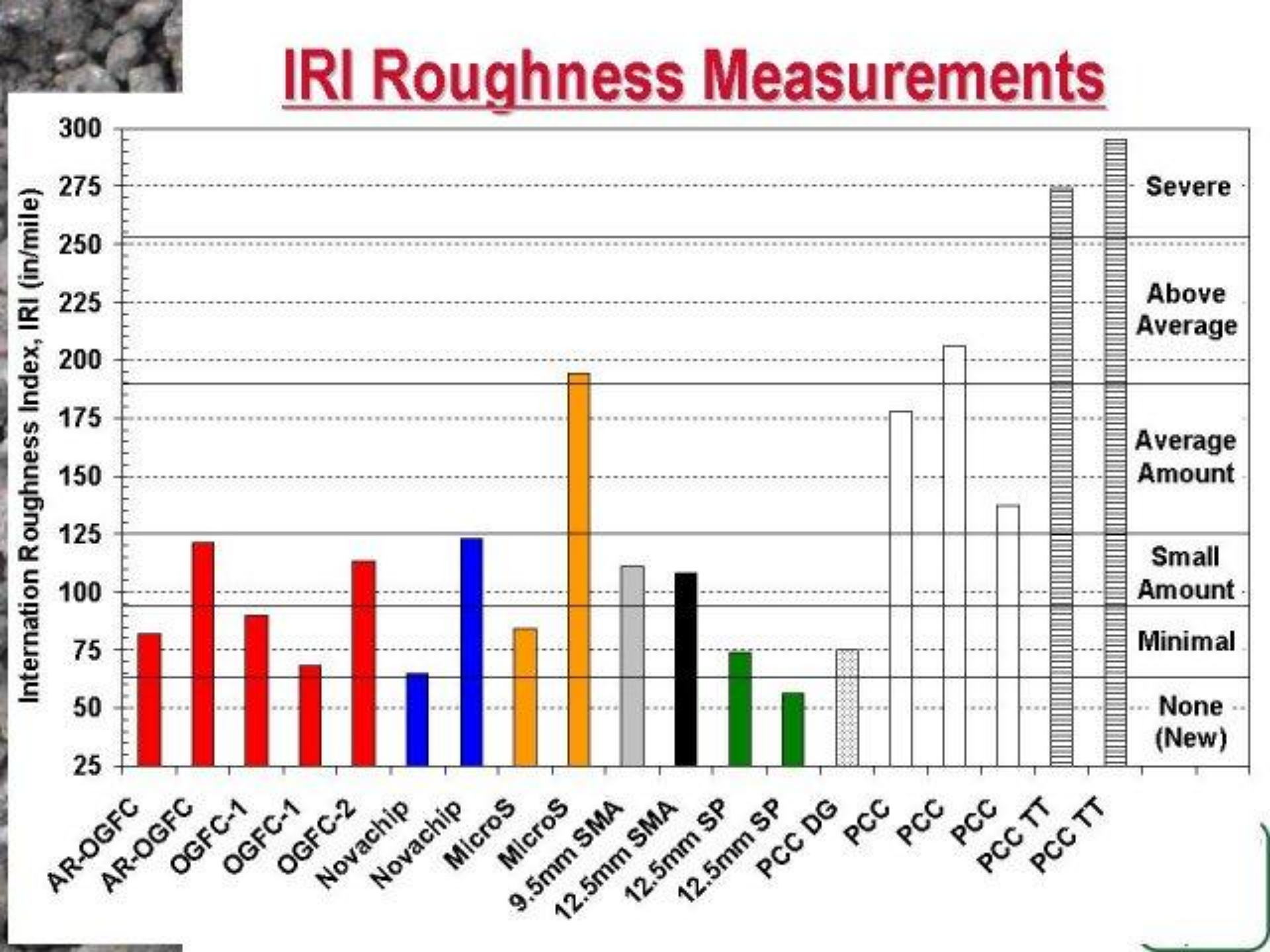
Surface Type	SN_{40}	
OGFC	49.5	
Novachip®	45.5	
9.5 mm SMA	42.5	
12.5 mm SMA	42	
Micro-Surfacing	49.3	
12.5 mm SP	53	1 Week Old
PCC	39.7	
PCC (T.T.)	56.5	
PCC (D.G.)	54.6	

* Each surface type averaged using all respective sections

Ride Quality Measurements - IRI

- International Roughness Index (IRI)
  - Two lasers, one in each wheel path, measure distance between body of vehicle and surface of pavement
  - 200 mm range, 0.4 mm accuracy
  - Final measurement provides a vertical movement change per travel distance
    - Developed and specified by World Bank
  - Signal passes through low and high pass filters to eliminate signal noise
- Final value averaged over total section distance

IRI Roughness Measurements



Average IRI Test Results

Surface Type	IRI (in/mile)
OGFC	94
Novachip®	94
9.5 mm SMA	84
12.5 mm SMA	194
Micro-Surfacing	110
12.5 mm SP	65
PCC	174
PCC (T.T.)	285
PCC (D.G.)	75

1 Week Old

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* Each surface type averaged using all respective sections

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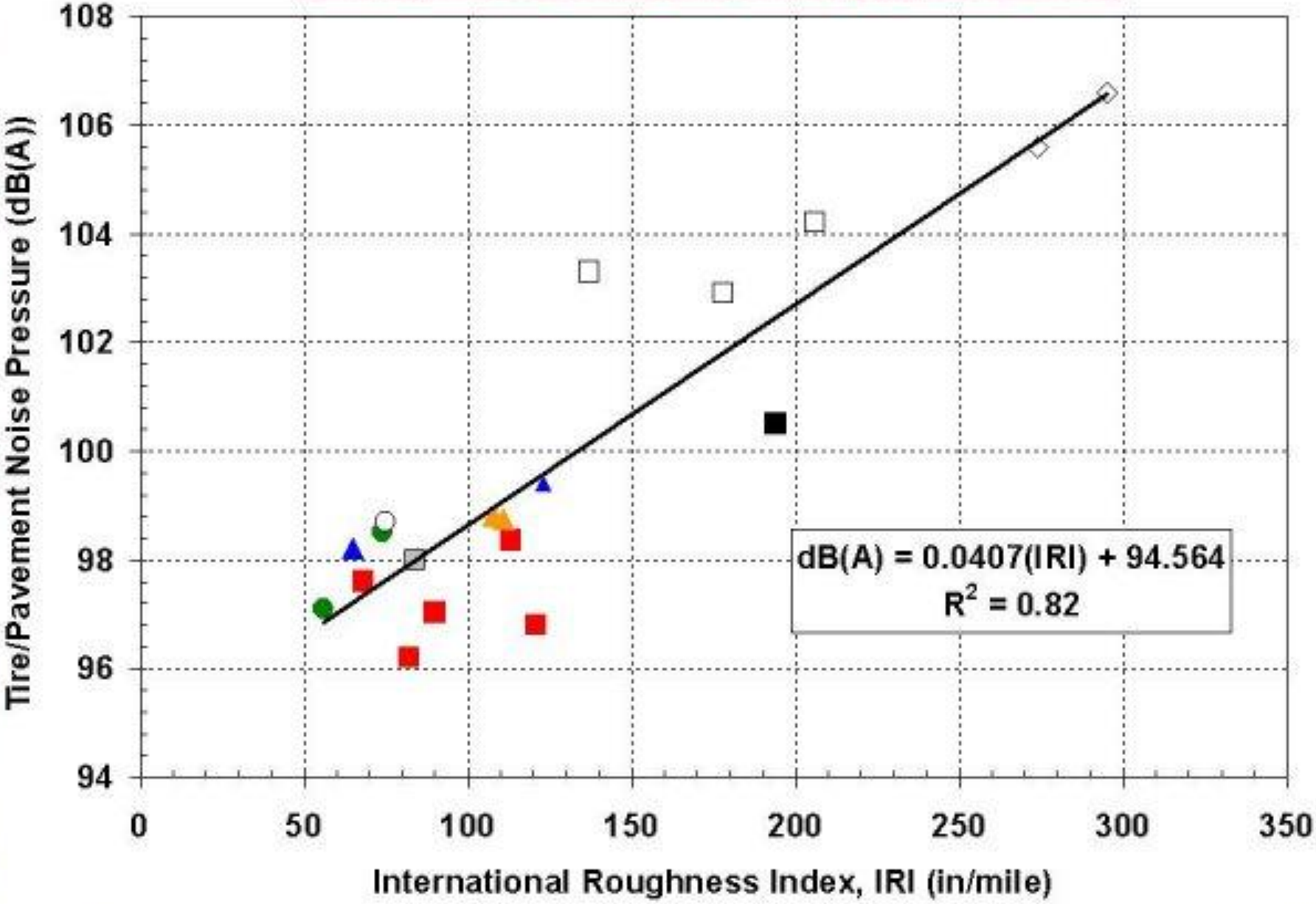
Tire/Pavement Noise vs IRI



Splash/Spray - Dense Graded Asphalt

Splash/Spray - Novachip

Splash/Spray - Open Graded Asphalt

AR-OGFC I-95 Splash/Spray Reduction

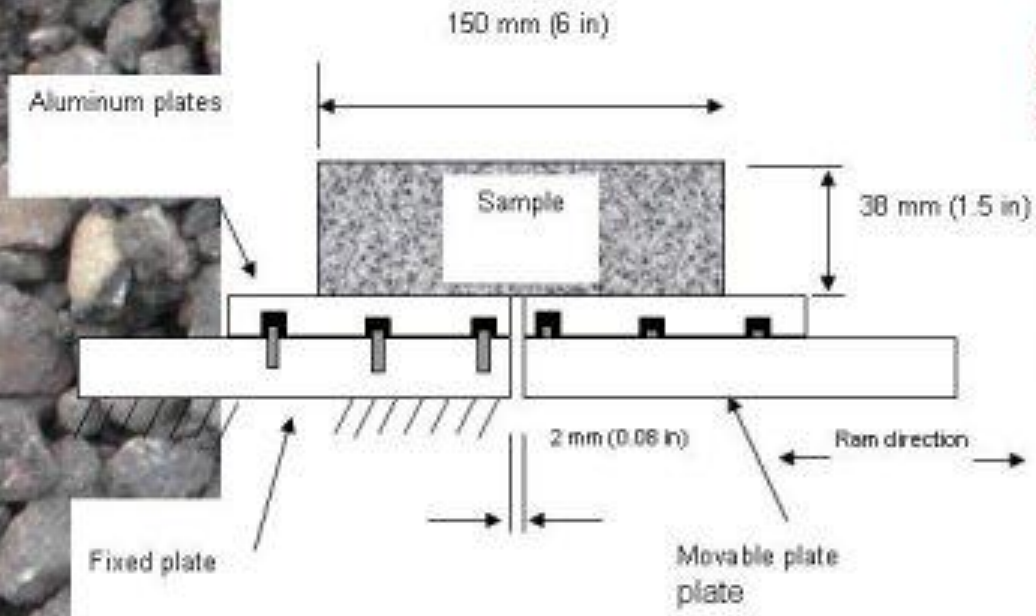
Wet Weather Accidents - TxDOT

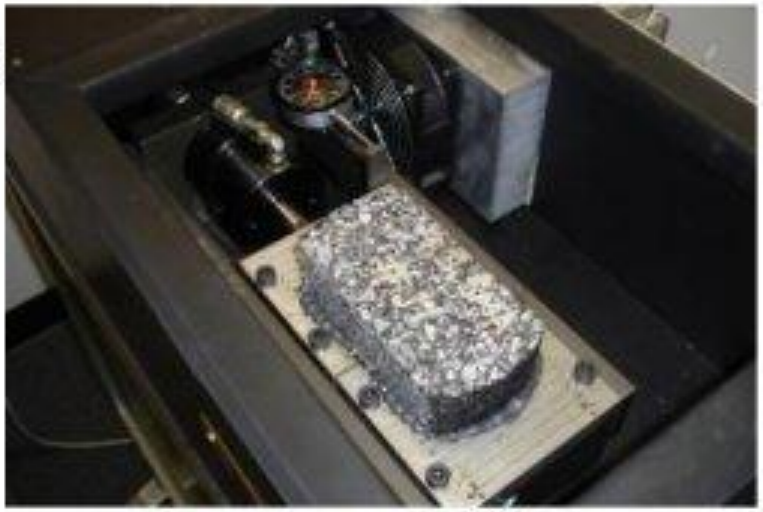
	Before OGFC			After	
Year	2001	2002	2003	**2004**	% Change
Total # Accidents	29	51	44	**17**	-58.9
Dry Weather Accidents	10	23	13	**15**	-2.2
Wet Weather Accidents	19	28	21	**2**	-91.2
Fatalities	0	1	5	**0**	-100
Total Injuries	25	16	21	**0**	-100
Annual Rainfall (in)	42.9	36.0	21.4	**52.0**	55.5
Total Rain Days	57	56	37	**70**	40.0

What NJDOT Learned Regarding Functional Overlays?

- Overall, OGFC had better functional performance than other thin-lift mixes evaluated
  - Since 2005, Pavement Technologies Unit began specifying OGFC on noise and wet weather problematic pavements
    - Asphalt rubber used in past 2 years (4 projects)
      - Laboratory testing showing superior fatigue resistance

Overlay Tester

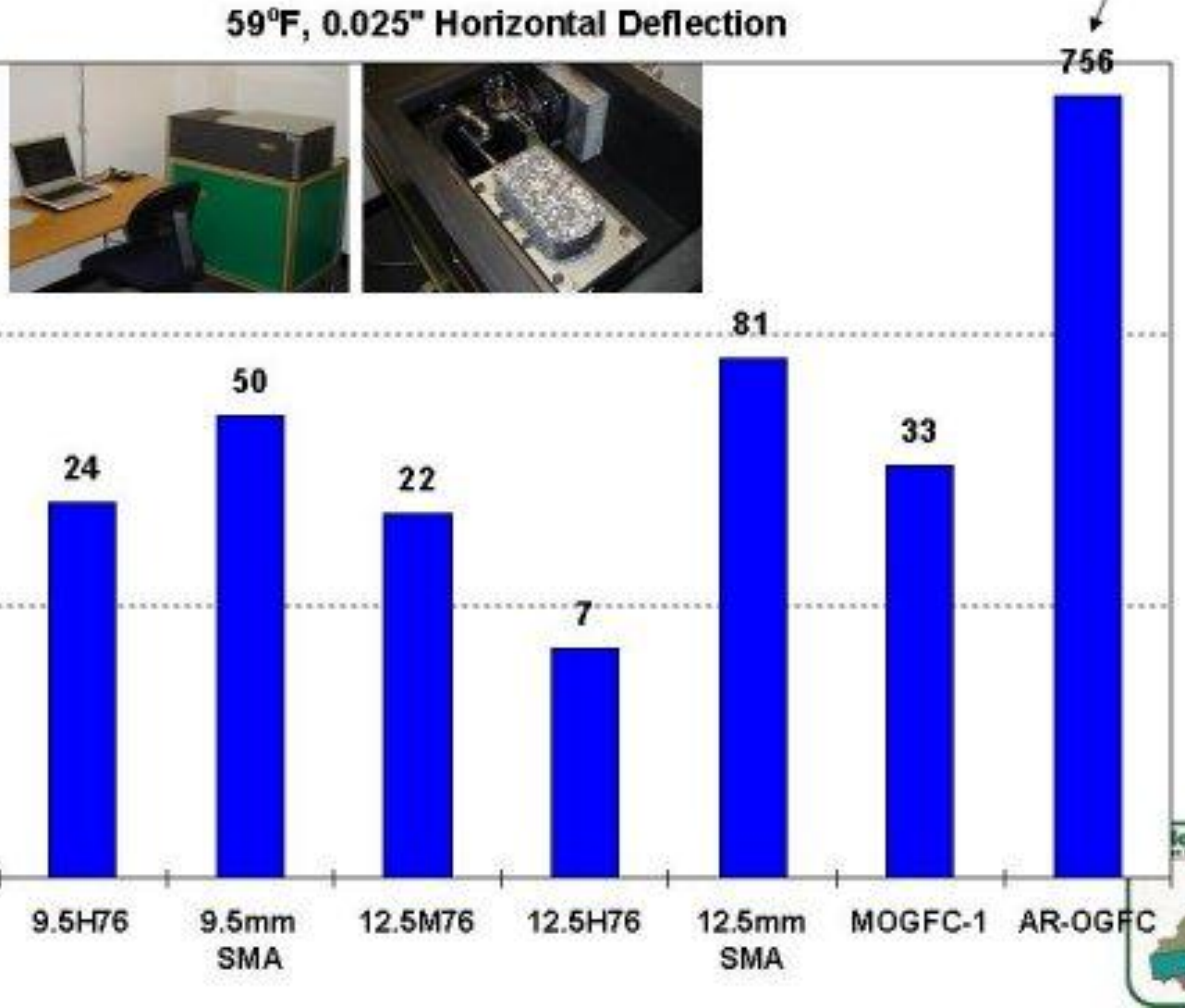




- Sample size: 6" long by 3" wide by 1.5" high
- Loading: Continuously triangular displacement 5 sec loading and 5 sec unloading
- Definition of failure
  - Discontinuity in Load vs Displacement curve

Typical NJDOT (Surface Course) Overlay Mixes

NJ I95 (2007)



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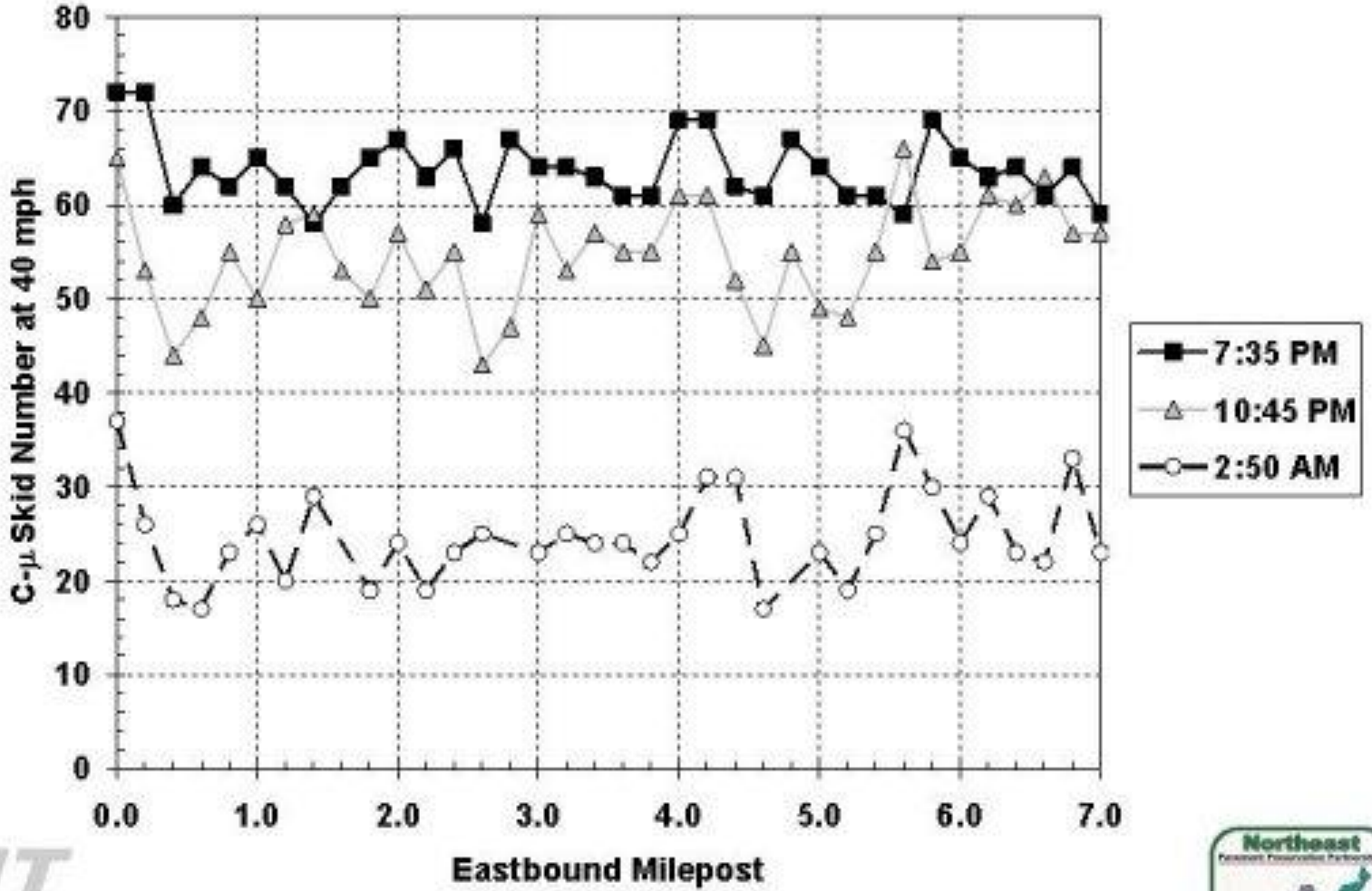
    - Asphalt rubber used in past 2 years (4 projects)
      - Laboratory testing showing superior fatigue resistance
    - Better IRI values generally found with OGFC surfaces
    - Winter maintenance perception still exists

NJ's Winter Maintenance Issues

- **NJDOT**
  - Rock salt is predominant method
  - Found OGFC significantly more difficult to maintain ice-free
    - More frequent applications and still tends to be icier
  - Began using a pre-wetted rock salt in 2005
- **NJ Garden State Parkway (NJGSP)**
  - 200 of 1,200 lane miles OGFC
  - Uses liquid magnesium-chloride for de-icing
  - Combines surface temperature measurements and weather forecasts to know when to treat
    - Pre-treats OGFC surfaces (If too late, magnesium-chloride washes off)
    - OGFC requires twice the total application as other DGA

Preliminary Winter Maintenance Data



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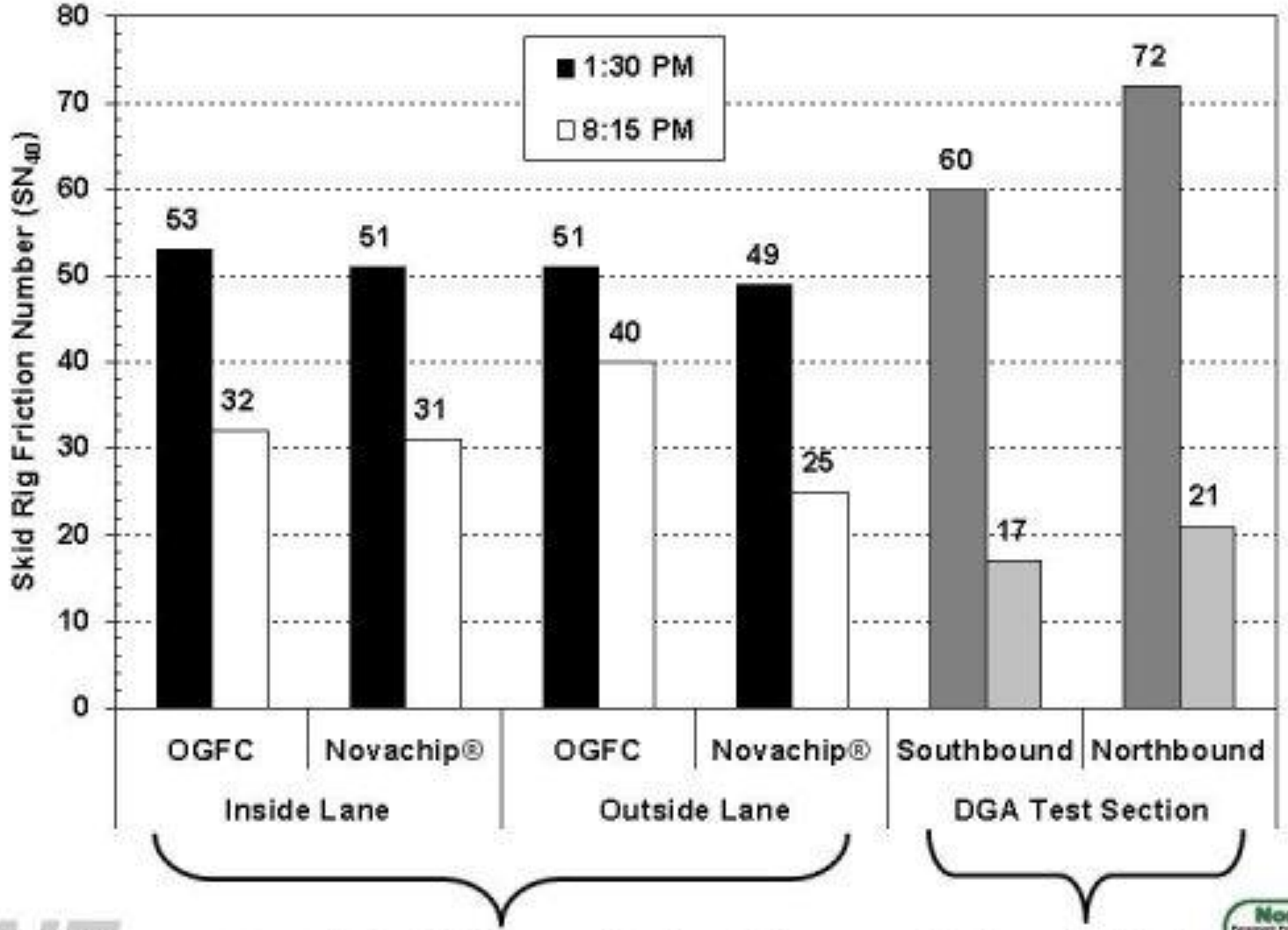
Skid Friction – Skid Trailer



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Thin Lift HMA

Structural Overlays Used in New Jersey

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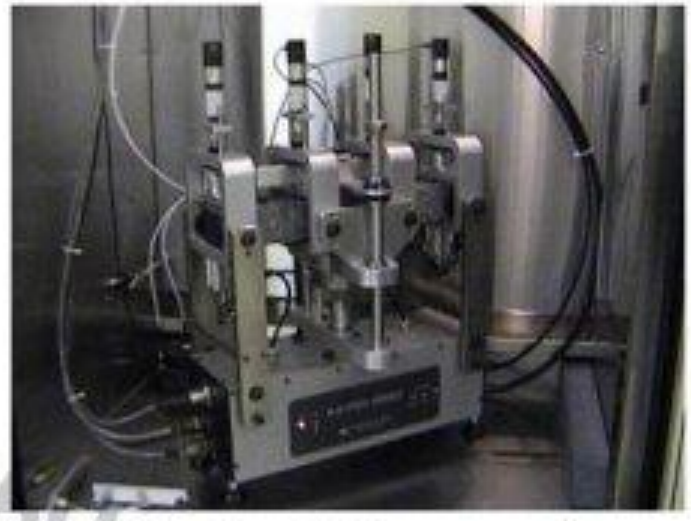
Structural Overlays

- What we are looking for:
  - Structural Wearing Course (Rutting and Fatigue)
    - Resist vertical and horizontal movements of bridge decks/PCC joints & cracks while maintaining rut resistance
  - Typically ¾ to 1.5 inches thick
  - Lower air voids to not allow infiltration of water (seal the pavement/bridge deck)
  - Maintaining skid resistance
  - May not always be as quiet as some other functional overlays

Mix Design and QC Evaluation Tools

Rutting & Stiffness

Horizontal Movement



Vertical Movement

Rutting

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Structural Thin Lift HMA

Bridge Deck Water-Proof Wearing Course (BDWC)

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Water Proof Wearing Course Mix

- Mix designed to provide a thin, rut and fatigue resistance mixture for bridge deck overlays
- Can be placed on bridge deck without vibratory rollers
- Asphalt mixture must also be "water proof" or low permeability
- "Sealing older bridge structures"

I-80 Bridge Deck

- Problems attributed to:
  - Potentially high air voids in 12H76 mix placed on bridge deck
    - No vibration on during rolling
    - Coarse, stiff mix with most likely low asphalt

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I-80 Lab Testing

- Cores taken from Bridge Deck and brought to Rutgers for forensics and permeability testing
- Air Voids:
  - Core #2 = 10.4%
  - Core #4 = 13.7%
  - Core #5 = 13.7%
  - Core #6 = 14.2%
- Only 2 cores in good enough shape for permeability testing (#2 and #5)

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Permeability Testing of Bridge Deck Core

Water Proof Wearing Course – Design Acceptance

1. Perform volumetric design and NJDOT verification – must have performance requirements verified
2. Produce mix through plant and pave test strip off site – supply Rutgers University loose mix for performance testing
3. Sample during production and supply Rutgers University loose mix for performance testing

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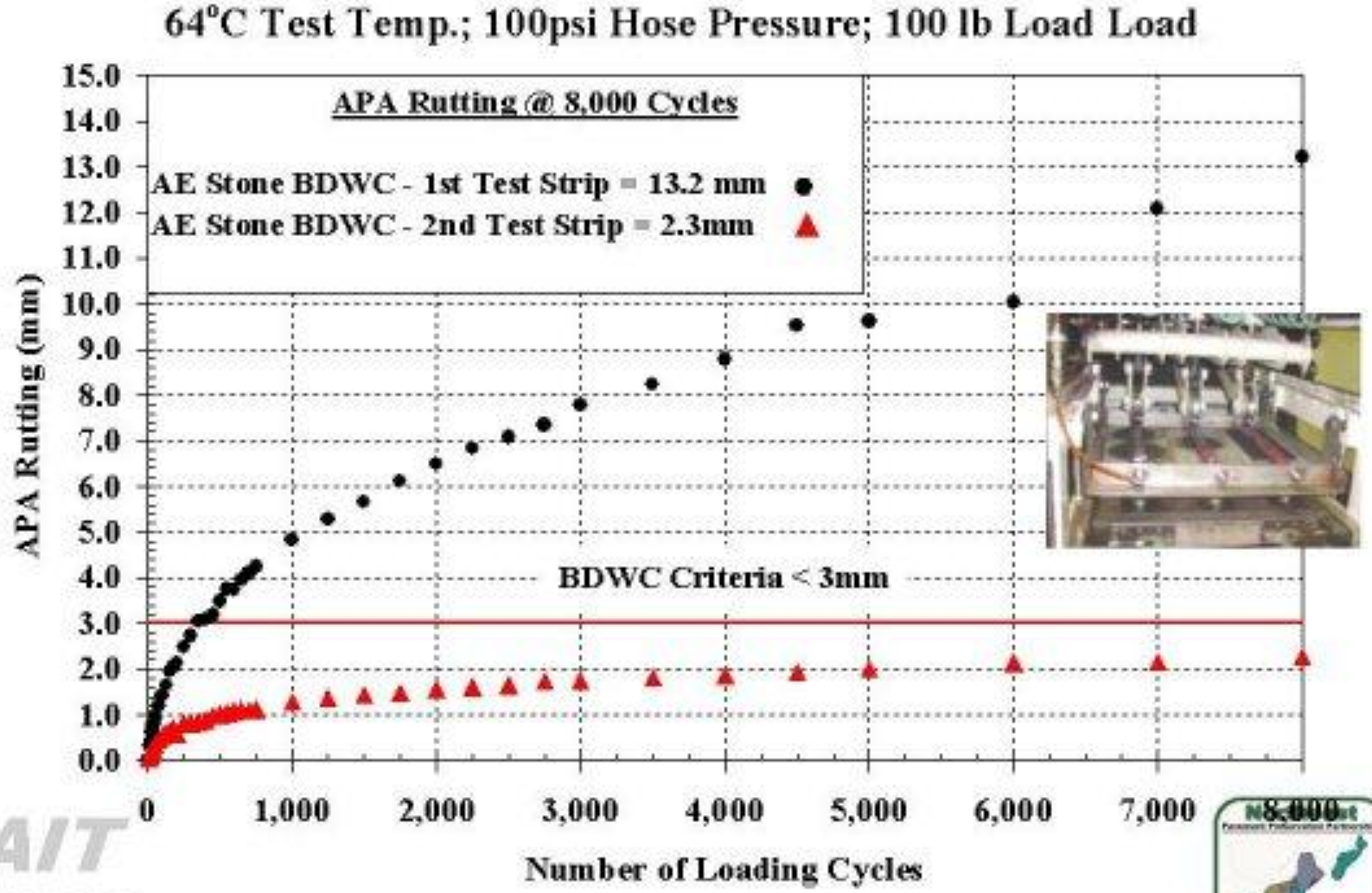
Why Do Performance Testing?

- Contractor's 1st (Right) and 2nd (Left) test strip
- Right lane flushed and did not set like as anticipated
- Performance testing showed poor results
- Why? Eventually found out Contractor did not switch over proper value on tank – used wrong asphalt binder!

1st vs 2nd Test Strip Material



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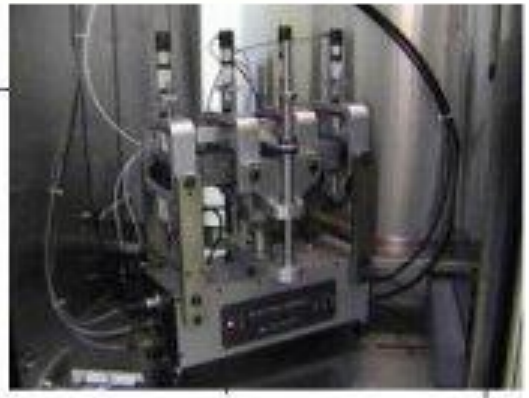

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1st Project – Rt 87 Absecon Inlet Bridge

- Contractor produced first BDWC mix
- 1900 tons placed and compacted to a 1.5-inch thickness in 2 days
- Core densities all between 2 to 4% air voids

Rt 87 Absecon Inlet Bridge – 2008 NAPA Quality in Construction Award Winner!

for Non-Typical Asphalt Project

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Structural Thin Lift HMA

High Performance Thin Overlay (HPTO)

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High Performance Thin-Overlay (HPTO)

- Focused Applications
  - Preventative Maintenance – NJDOT
    - Placed after signs of initial surface distress
    - Also potential use of "Shim" course on PCC prior to Wearing Course
  - Pavement Overlay – Locals/Municipalities
    - Place immediately on surface of pavements showing signs of surface distress with or without milling
      - Low severity wheelpath alligator cracking (base issues)
      - Surface cracking with minimal rutting

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Potential Areas of Application

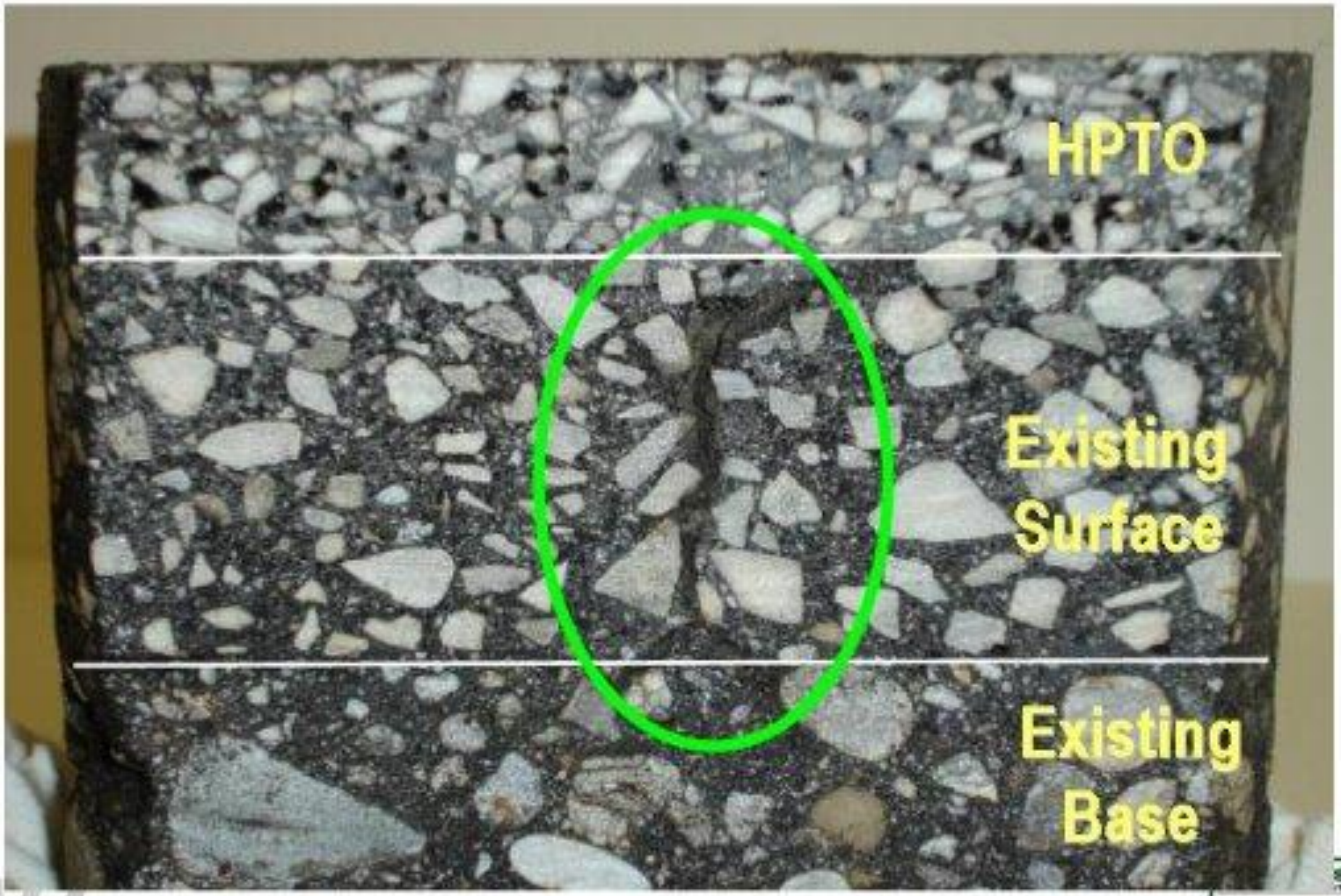
Minimal Rutting – low to moderate surface cracking
No Full Depth Cracking!

Low Severity Wheelpath

Low to Mod. Longitudinal Cracking

Low to Mod. Transverse Cracking

Direct Overlay – No Milling



High Performance Thin-Overlay

- **Binder**
  - Polymer-modified binder
    - PG76-22 (NJDOT Spec)
  - Minimum Asphalt Content = 6%
- **Performance Specification**
  - Utilize the Asphalt Pavement Analyzer (AASHTO TP 63) for stability (rutting) check
    - No check for fatigue – low air voids and higher asphalt content will control
    - Must supply for mix design verification and control (1st Lot and every other Lot after)

Surface (Skid) Friction, SN_{40}

Material Type	Skid Number
HPTO (New)	53
12.5mm SP (New)	51.6
12.5mm (4 Yrs)	54.3
19mm SP (4 Yrs)	55.7
19mm SP (5 Yrs)	47.7

Summary of Thin Lift HMA Mixes

- NJDOT utilizing thin lift HMA mixes for both functional and structural overlays
  - Functional
    - OGFC is main choice (AR-OGFC)
    - Primarily used for noise reduction and wet weather safety concerns
  - Structural
    - BDWC and HPTO mixtures being utilized
    - All structural thin lift mixes require laboratory performance testing to verify mix design and production

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Warm Mix Asphalt

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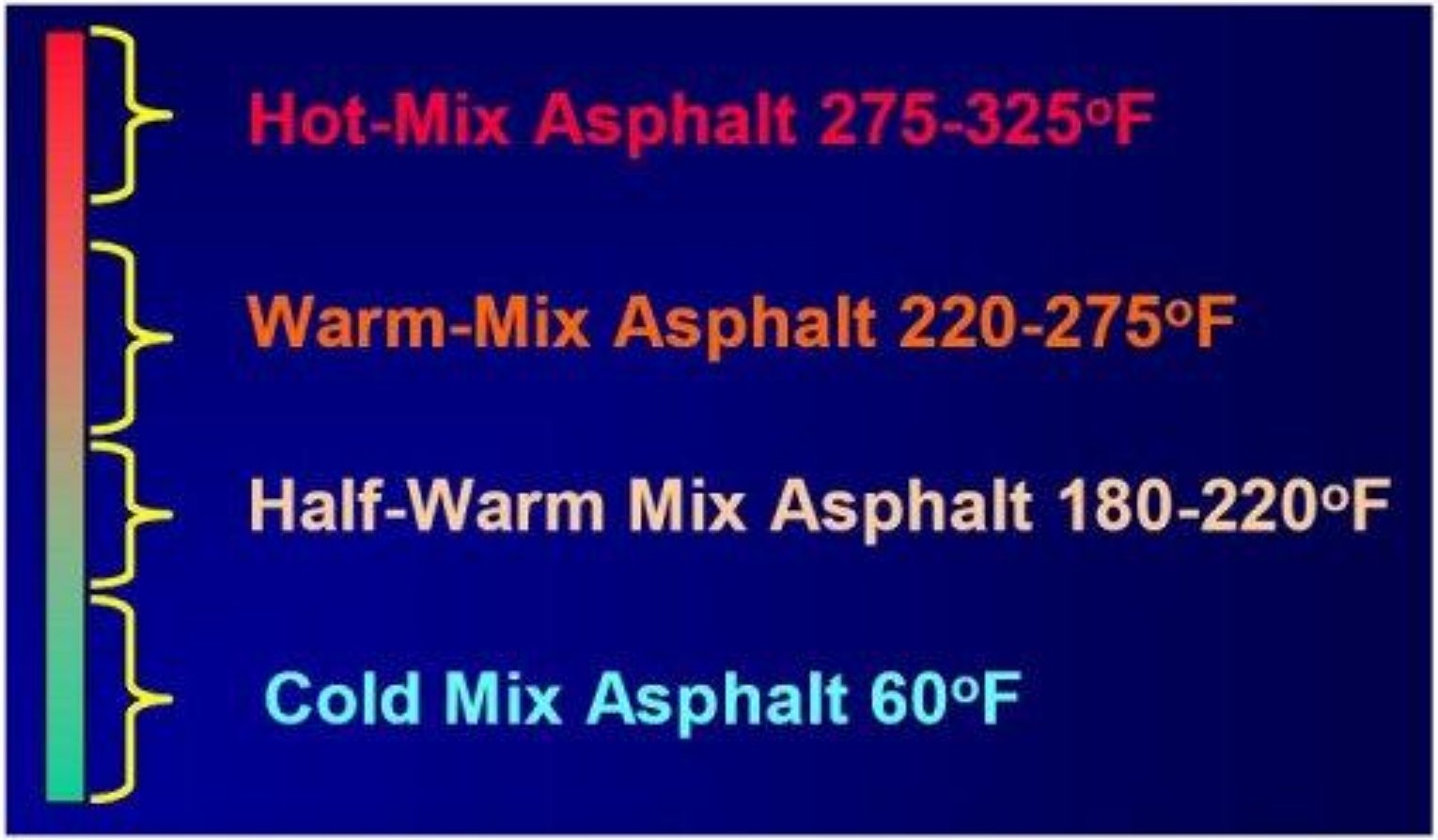
What is "Warm Mix Asphalt"



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Warm Mix Methods

Technology Overview**

- WAM-Foam
- Low Emission Asphalt
- Aspha-Min
- Advera
- Sasobit
- REVIX
- Evotherm
- Cecabase RT
- Thiopave
- Rediset WMX
- AquaFoam
- Ultrafoam GX
- Terex
- Accu•Shear
- Aquablack
- Double Barrel Green

Mathy Tech. & Eng. Services and Paragon Technical Services, Inc

**FHWA does not endorse any particular proprietary product or technology.

Warm Mix Methods – Four General Categories

- Introduction of moisture to create a foaming process to coat the binder
- Two stage process (hard and soft binder) or emulsion/chemical packages
- Viscosity reduction
- Surfactants to lubricate compaction process (Flow Enhancer)

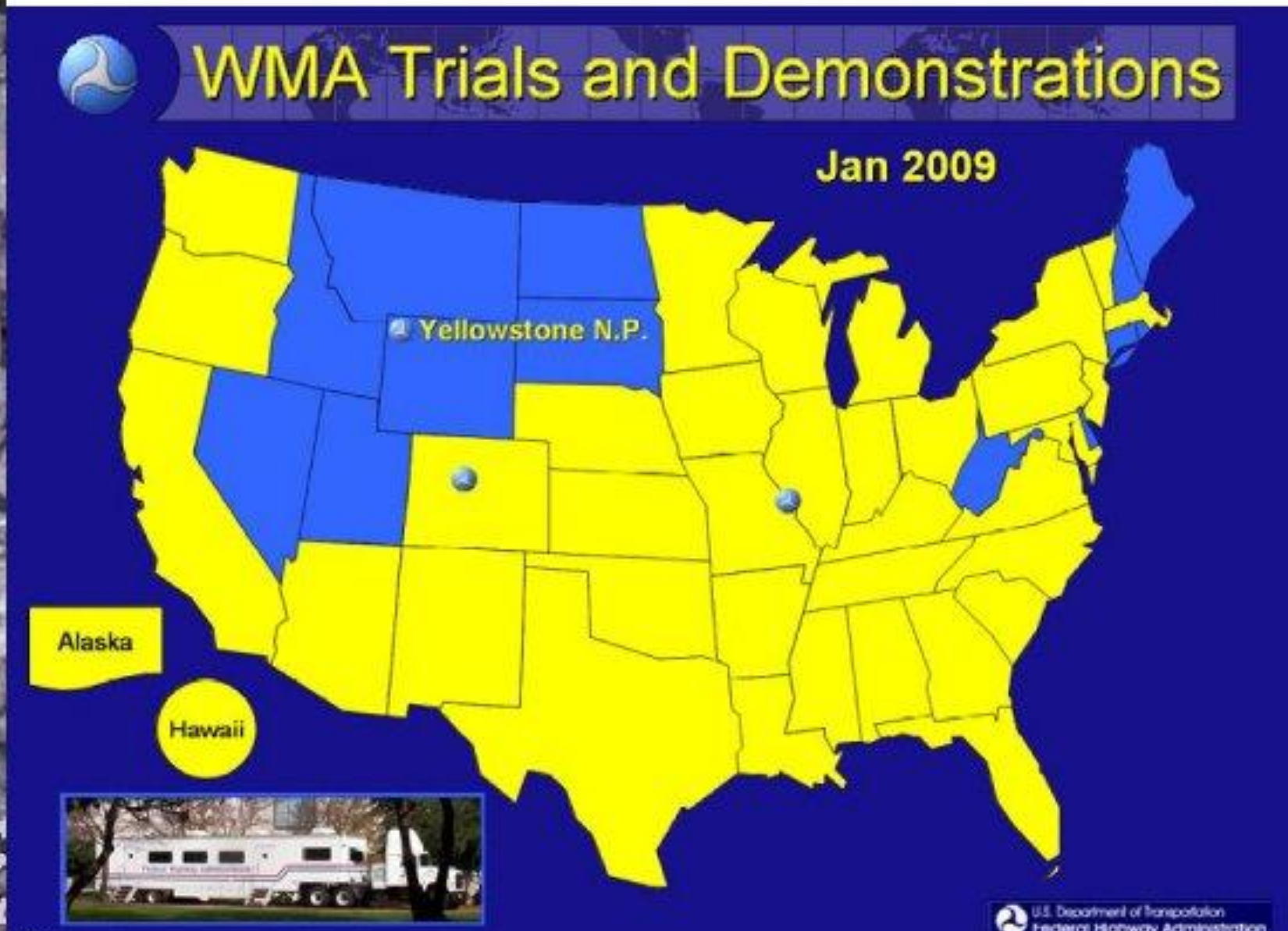
Growing Popularity of WMA

WMA Trials and Demonstrations

Jan 2007

U.S. Department of Transportation
Federal Highway Administration

Growing Popularity of WMA



General WMA Benefits

- Reduced Emissions and Fumes
- Reduced Energy Consumption
- Increased RAP Percentage
  - Specialized Applications
- Improved Workability
- Extending Paving Window
- Cold Weather Paving
- Compaction Aid/Improve Compaction Quality

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Application of WMA to Thin Lift HMA Overlays

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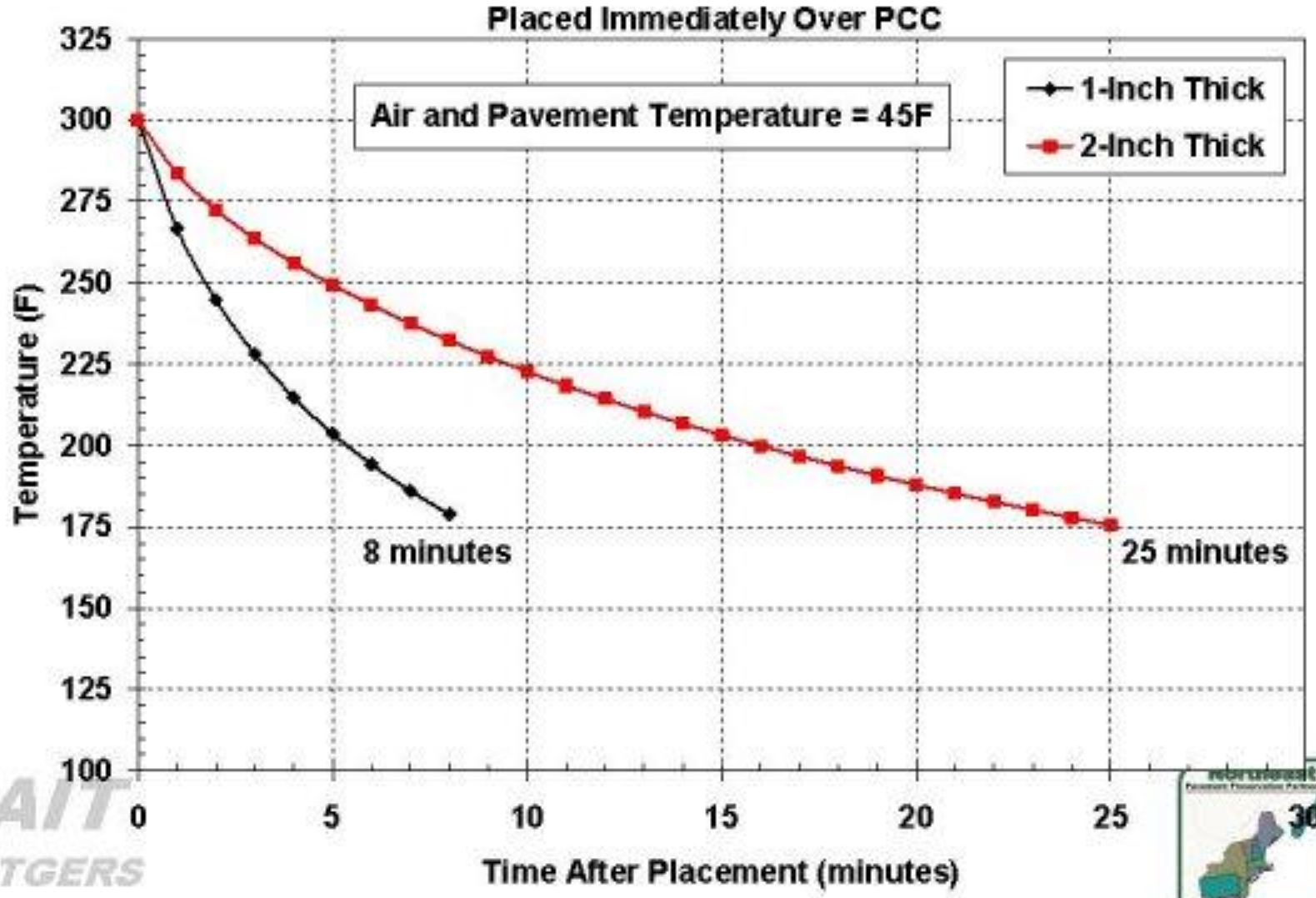
General Thin-Lift HMA Cooling (MultiCool 3.0)

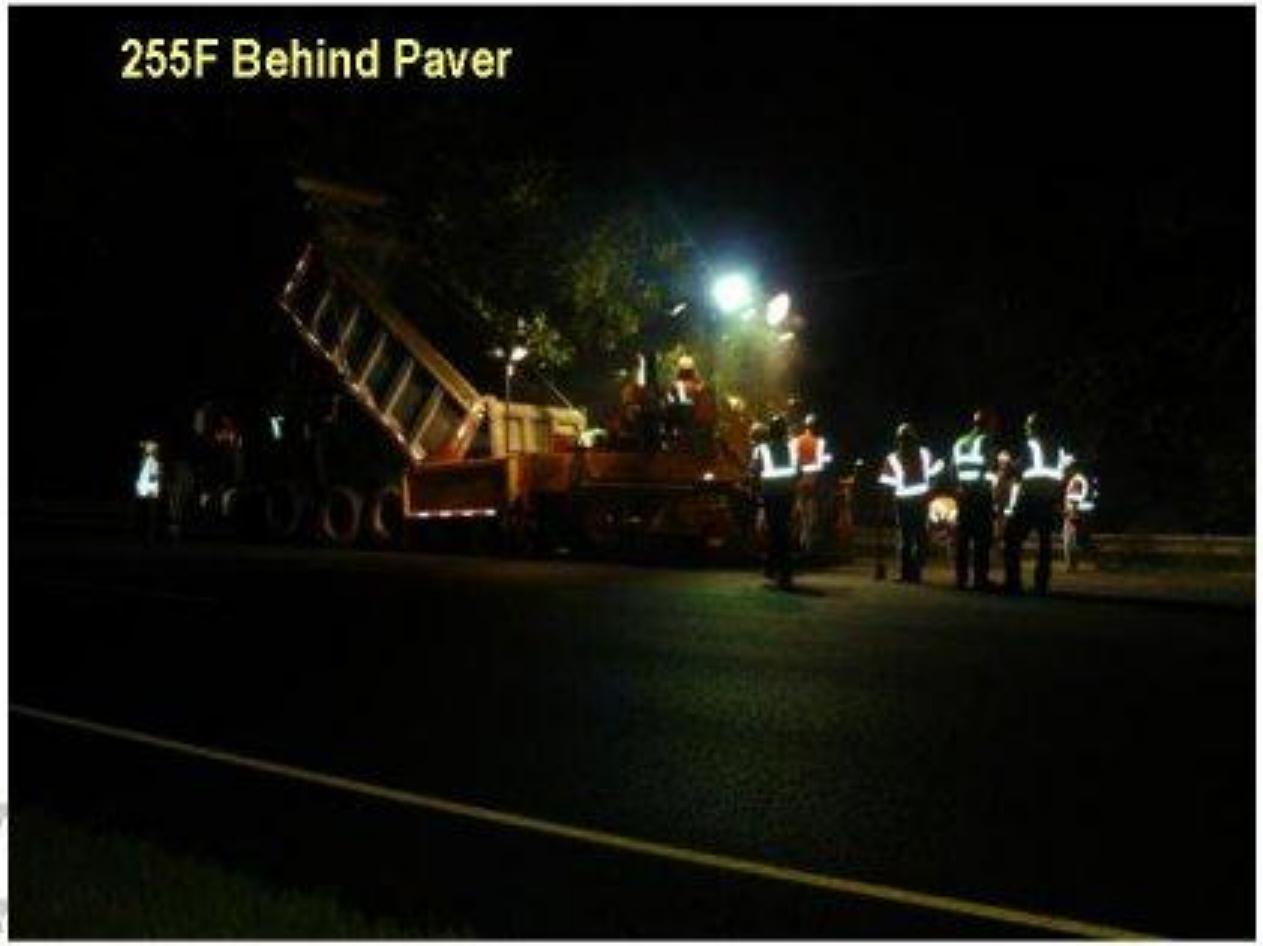


Reduced Emissions/Fumes

- NJ – I78 AR-OGFC (Normal Production Temperatures)

Reduced Emissions/Fumes

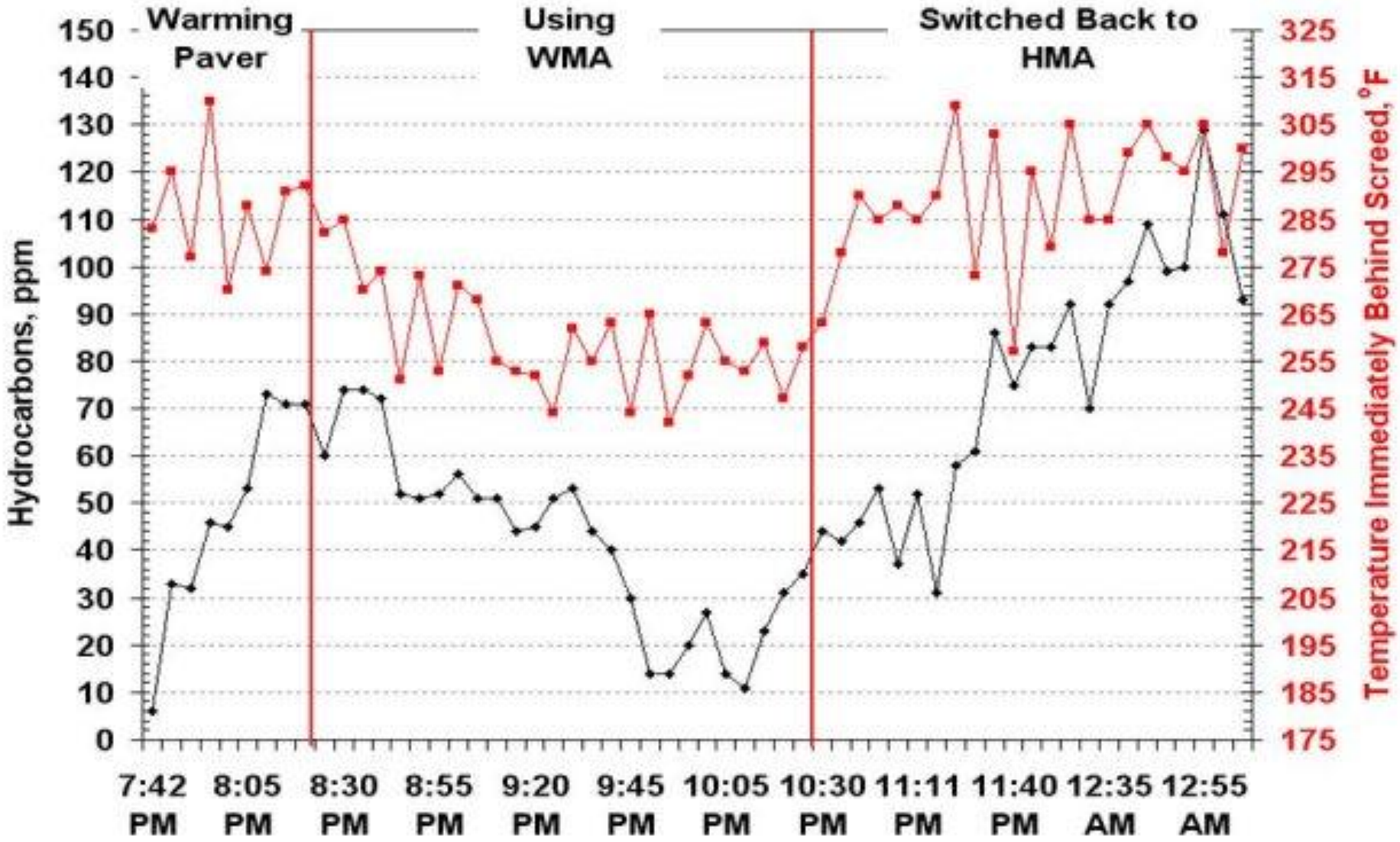
- NJ – I78 AR-OGFC (Reduced Production Temperature with WMA)



Emissions Testing

- Looked at quantifying emission reduction at paver with and without WMA
- Used portable emissions tester mounted to railing on back of paver (where workers would stand)

Example of Typical Emissions at Paver (AR-OGFC on I78)



Cooler Weather Paving – Thin Lift Applications

½ inch (12.5mm)Mix
PG 64-22
4.3% AC

Warm Mix Additives
Advera
Evotherm
Sasobit
AXKO-REDISET WMX

Average February Air Temperature in Texas = 48.7F

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Compaction of Stiff Mix (High RAP) – Thin Lift Applications

- **Wellesley, Massachusetts**

Latex + WM Additive
30% RAP
¾ inch (19.0mm)depth

Pavement Preservation Web-Site

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Improve Ride Quality – Thin Lift Applications

Missouri Department of Transportation

Single Lift
Thin Over-laid

Goal of WMA:

Reduce or Eliminate Bumps from Joint Sealant

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Improve Ride Quality – Thin Lift Applications

Missouri Department of Transportation

Normal Production Temperature

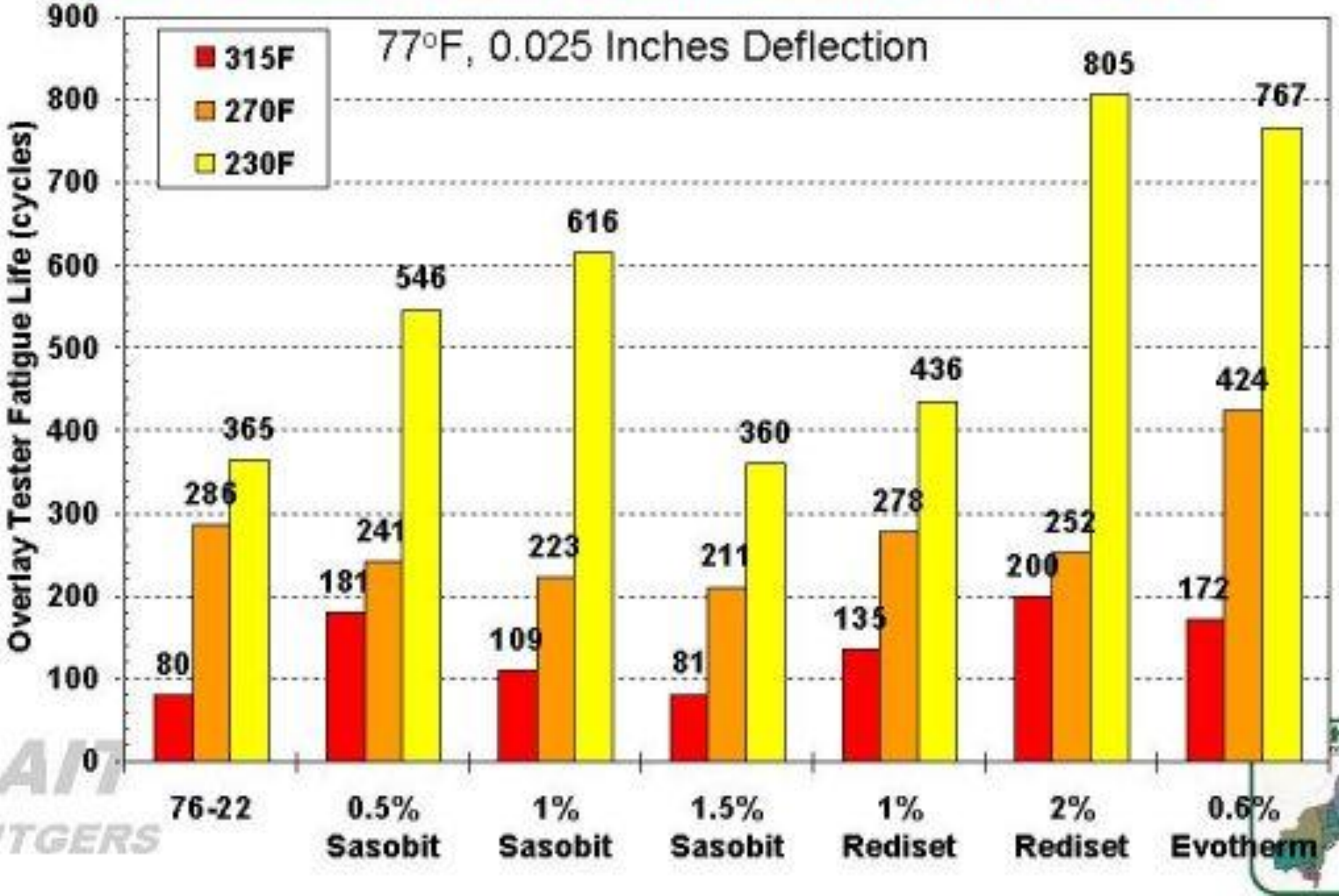
WMA – 60F Decrease in Temp

Improved Cracking Resistance with WMA?

- The use of warm mix asphalt may help in reducing cracking potential of asphalt mixtures
  - Reduces oxidation aging of base asphalt binder at higher temperatures
  - Reduces polymer degradation at higher temperatures
  - May reduce asphalt binder absorption when produced at lower temperature (results in higher effective asphalt contents)

Overlay Tester Results at Different Mixing Temperatures

Lab Produced 12.5mm Superpave Mixture with PG76-22



General Conclusions

- Thin Lift HMA applications have been found to be successful in both functional and structural overlays
  - OGFC preferred NJ choice for functional overlays
  - Structural overlays have performance testing
- WMA can increase successful use of Thin Lift HMA
  - Reduce emissions of asphalt rubber
  - Increase compaction/density
  - Potentially reduce "upward bleeding" of crack/joint sealants
  - Preserve the polymer!

Thank you for your time!

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