

NJDOT Pavement Support Program: An Overview

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Center for Advanced Infrastructure and Transportation (CAIT)

Pavement Support Program (PSP)

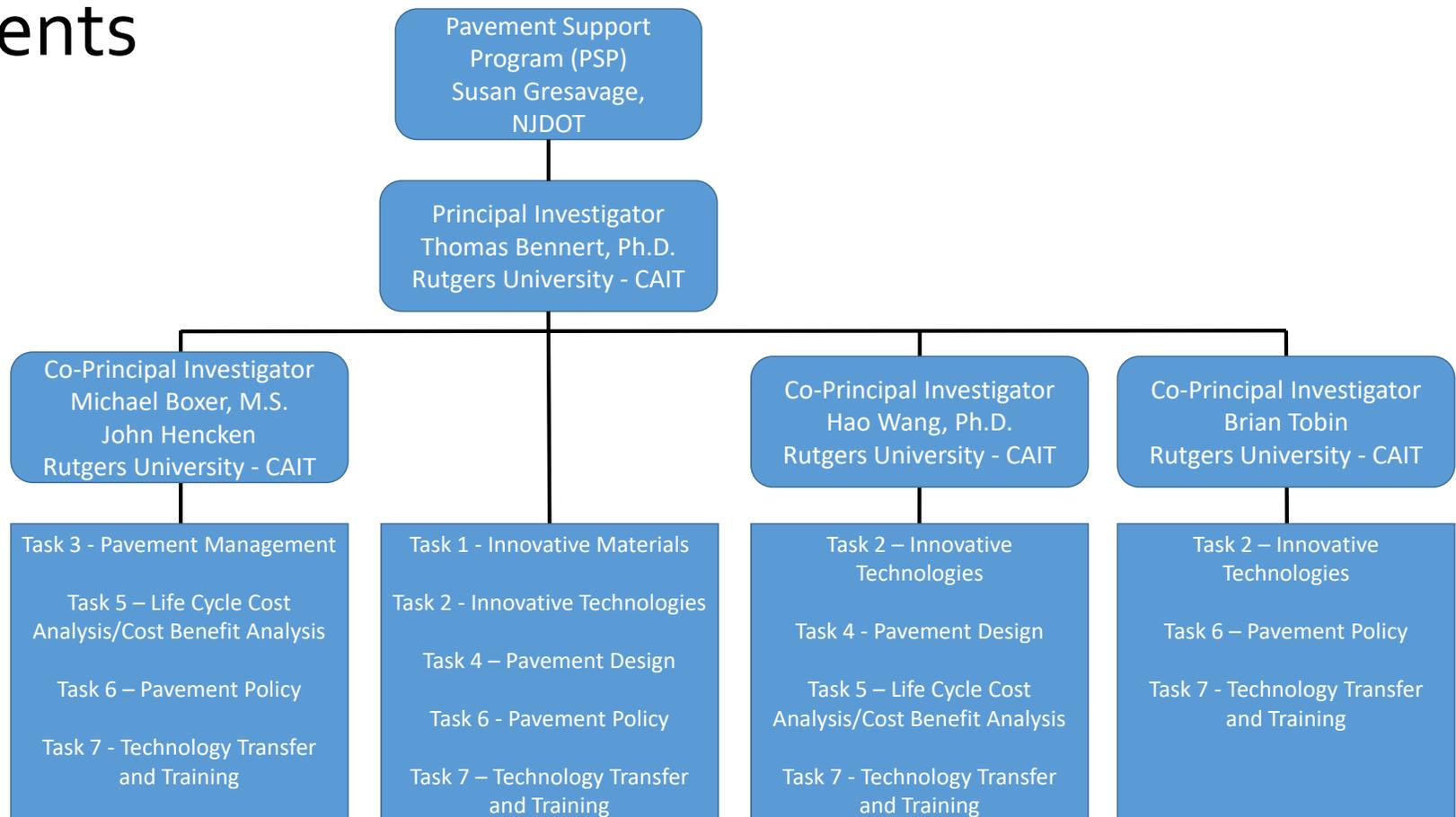
- Effort to support the activities of the Pavement & Drainage Management and Technology Unit
 - Manager: Susan Gresavage
- Research to implementation!
 - Pavement Management Group (Susan Gresavage)
 - Pavement Technology Group (Robert Blight)
 - Materials Bureau (Paul Hanczaryk)
 - Pavement materials a direct link to pavement performance!

Pavement Support Program (PSP)

- Focuses on 7 major support tasks
 - Innovative Materials
 - Innovative Technologies
 - Pavement Management System Development
 - Pavement Design Procedures
 - Life Cycle Cost Analysis/Cost Benefit Analysis
 - Pavement Policy Decisions
 - Technology Transfer & Training

Pavement Support Program (PSP)

- Work effort conducted using support of 10+ full time staff, graduate students and undergraduate students



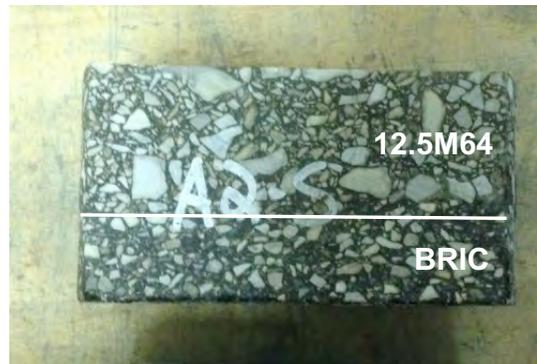
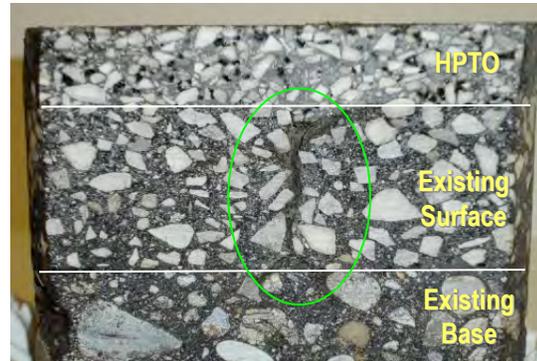
Examples of Activities

Task 1 – Innovative Materials

- Full Depth Reclamation Pilot Project
- Cold In-Place Recycling Pilot Projects
 - Two new specifications for NJDOT use
- NJDOT's Specialty Mixes
 - High Performance Thin-Overlays (HPTO)
 - Bituminous Rich Intermediate Course (BRIC)
- SMA Performance
- Recycled Asphalt Shingle (RAS) Mixtures
- High Friction Surface Treatments
- Repeatability Evaluation for Asphalt Pavement Analyzer
- Repeatability Evaluation for Overlay Tester

Task 1 – HPTO and BRIC

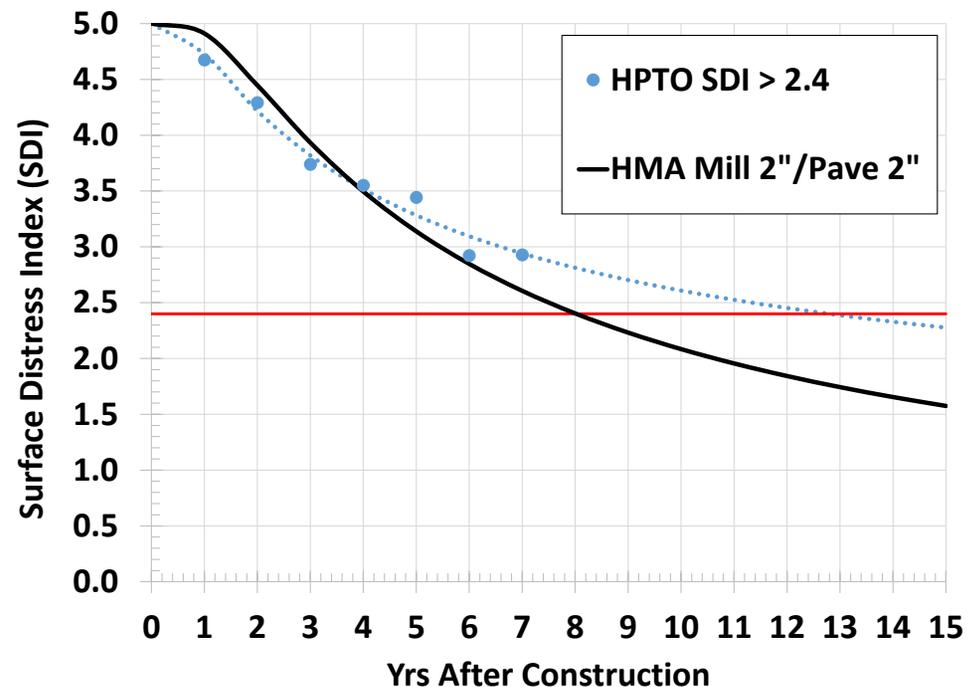
- NJDOT utilizes a series of “Specialty Mixes” that includes Performance Related Specifications to balance rutting and cracking
- Application specific for specific need
- Performance modeled using PMS data



$$SDI = SDI_0 - e \left(A - B \cdot C^{\ln \left(\frac{1}{Age} \right)} \right)$$

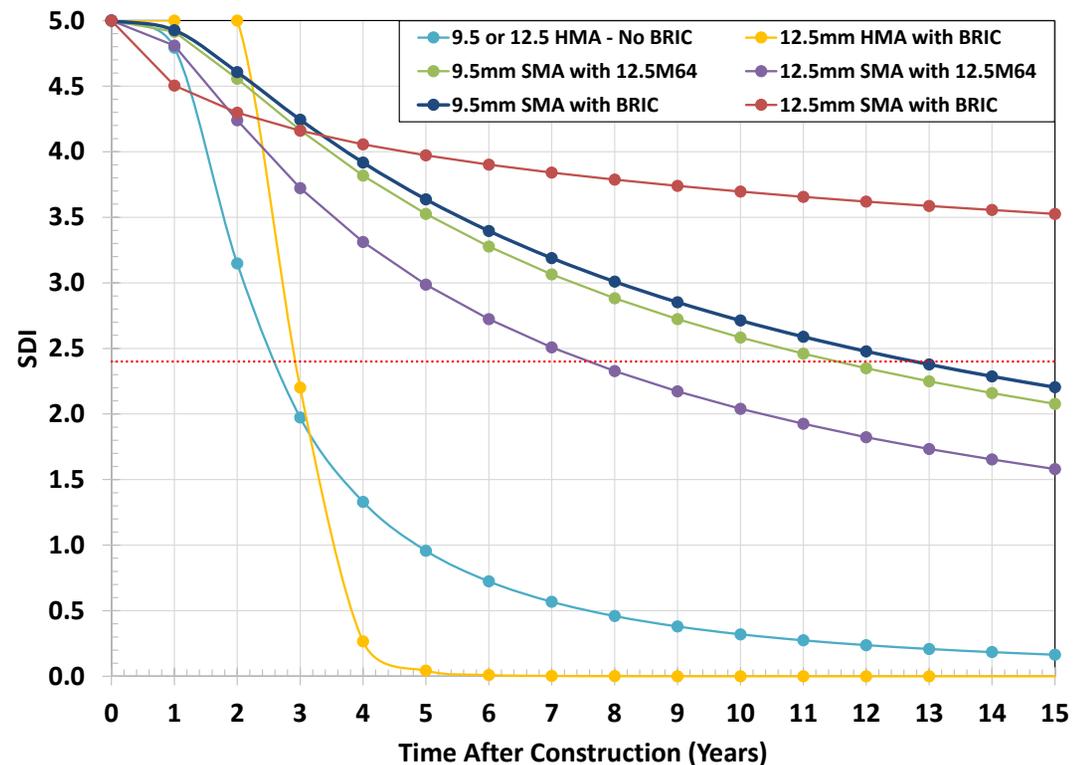
Task 1 – HPTO and BRIC

- HPTO used for pavement preservation
 - When applied to pavements in “Pavement Preservation” category, HPTO increases life 5+ years
 - Factors to watch for;
 - Binder content & grade
 - Aggregate selection
 - Diesel contamination from truck beds



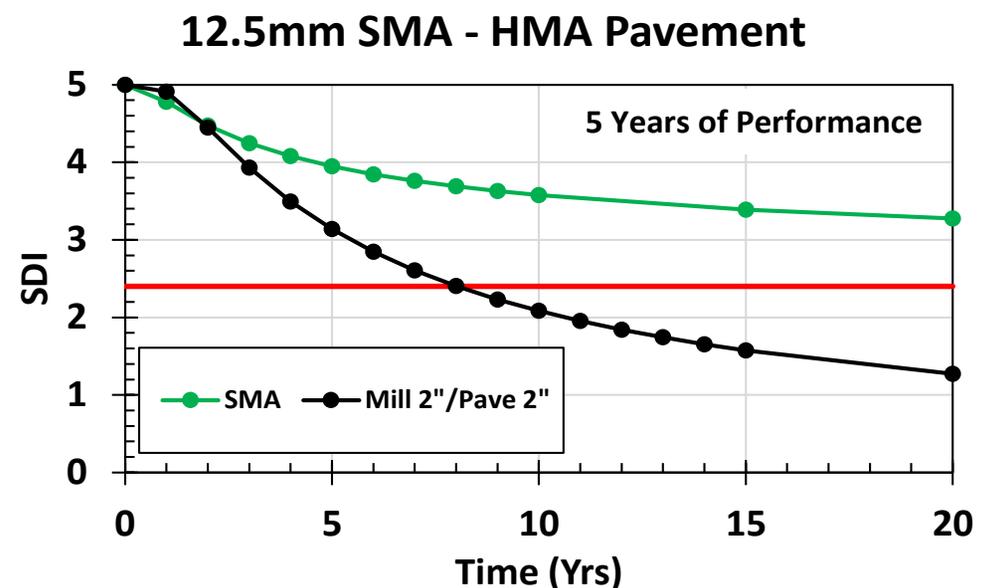
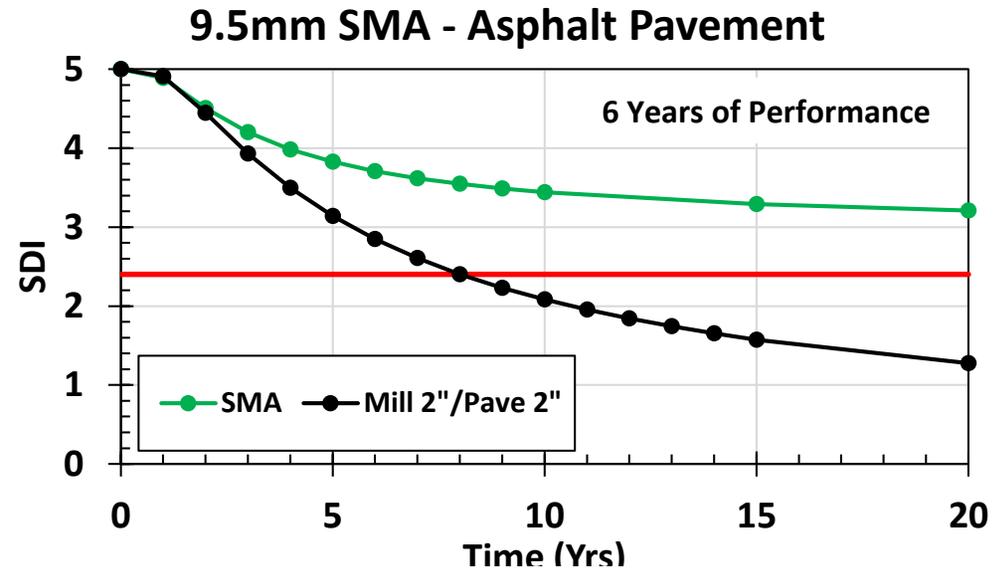
Task 1 – HPTO and BRIC

- BRIC improves asphalt overlay in mitigating reflective cracking in composite pavements
 - “System Approach”
 - BRIC reduces reflective cracking from horizontal deflection at joint
 - SMA reduces reflective cracking from vertical deflection at joint



Task 1 – SMA Performance

- SMA used in both flexible and composite pavements in NJ
 - Used sporadically until 2012
- Both 9.5 mm and 12.5 mm have been used
 - Currently only 12.5 mm



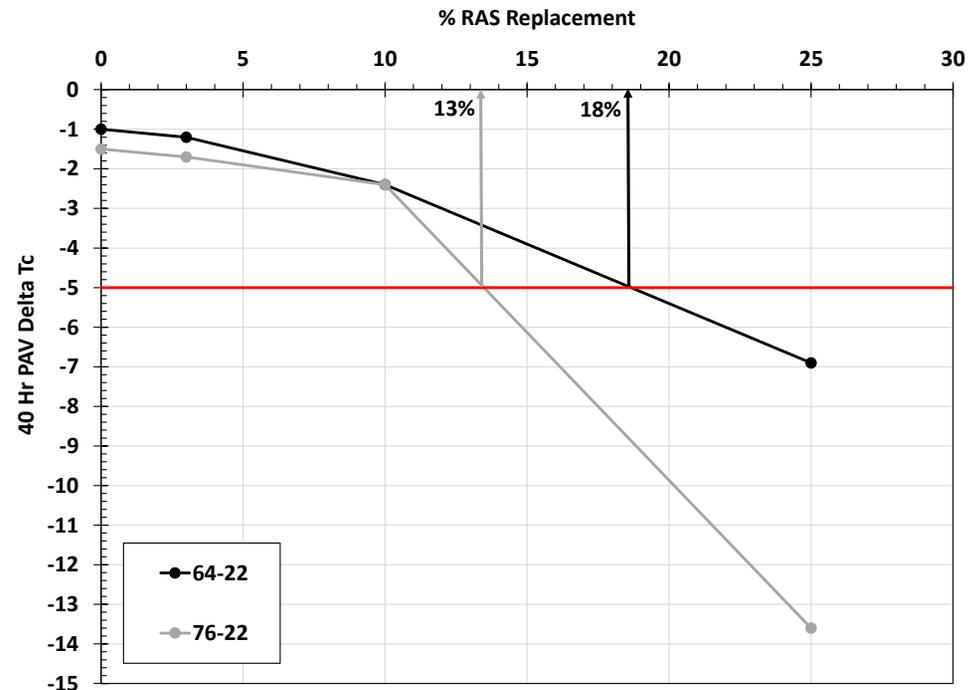
Task 1 – Recycled Asphalt Shingles

- Evaluated proposed AASHTO PP78 on developing RAS mixtures
 - *Standard Practice for Design Considerations When Using Reclaimed Asphalt Shingles (RAS) in Asphalt Mixtures*
 - Method looks at not amount of RAS (RBR or by weight), but what RAS binder does to total binder performance
 - Utilizes ΔT_c on either 40 hr PAV conditioned binder or recovered asphalt binder conditioned 25 hr loose at 135C
- Recommends to evaluate different levels of RBR and utilize RAS content where $\Delta T_c < -5C$

Task 1 – Recycled Asphalt Shingles

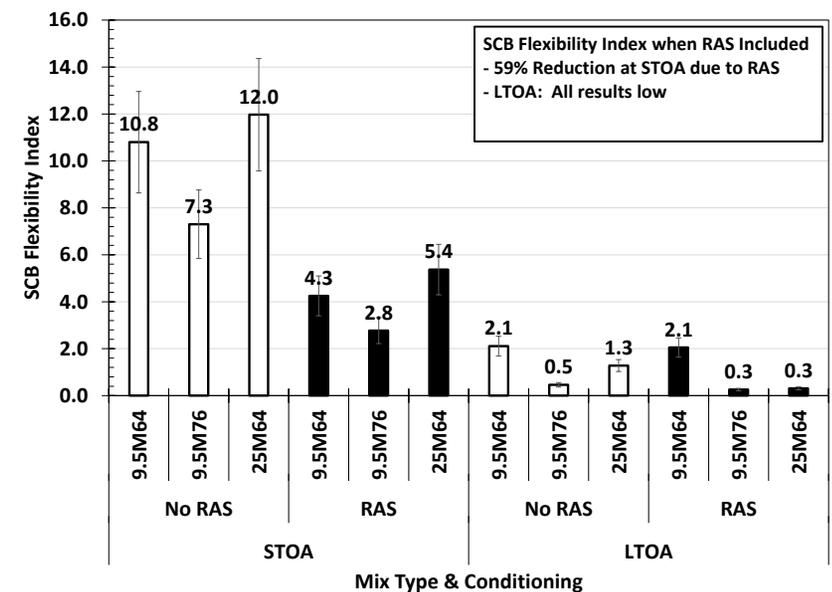
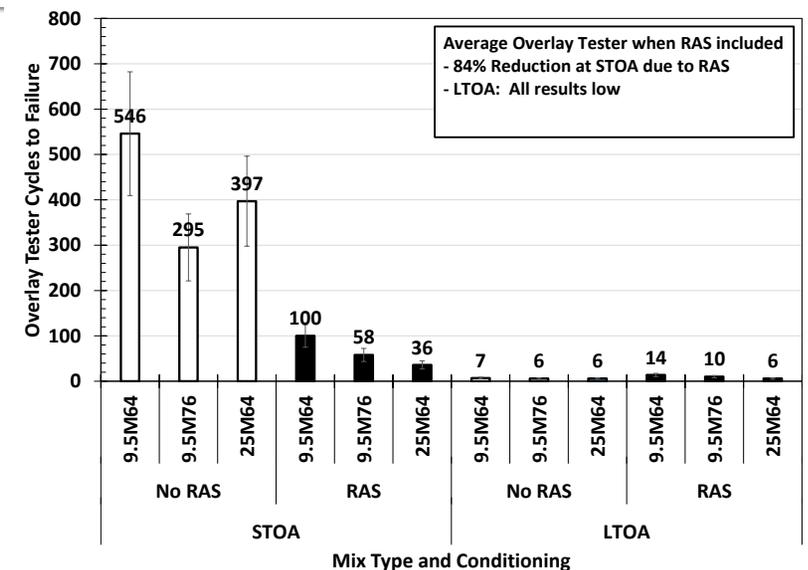
- 3 asphalt mixtures designed and evaluated;
 - 9.5M64, 9.5M76, 25M64
- Asphalt binder characterization
 - ΔT_c , Glover-Rowe, master curves, PG grading
- Asphalt mixture characterization
 - APA, Flow Number, E^* , Overlay Tester, SCB FI, Beam Fatigue

$$\Delta T_{cr} = T_{cr} (Stiffness) - T_{cr} (m-slope)$$



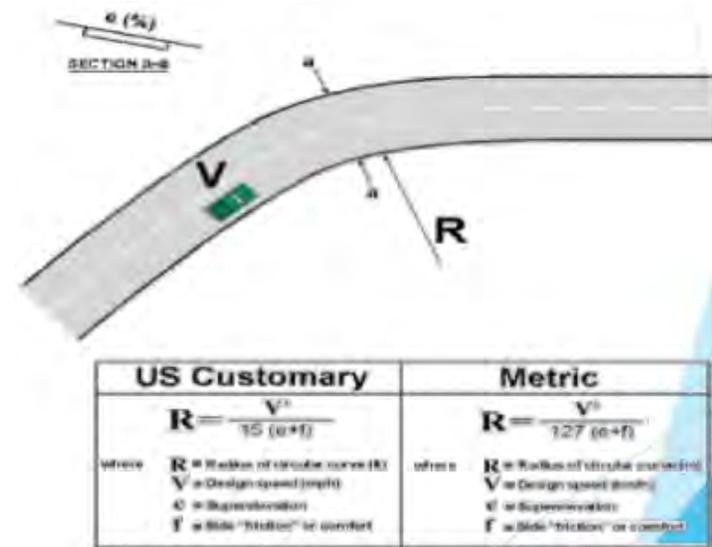
Task 1 – Recycled Asphalt Shingles

- AASHTO PP78 criteria may need to be further defined
 - RAS reduced Overlay Tester by 84%
 - RAS reduced SCB FI by 59%
- May need to also utilize
 - Softer binder (PG58-28)
 - Rejuvenators/WMA



Task 1 – High Friction Surface Treatment

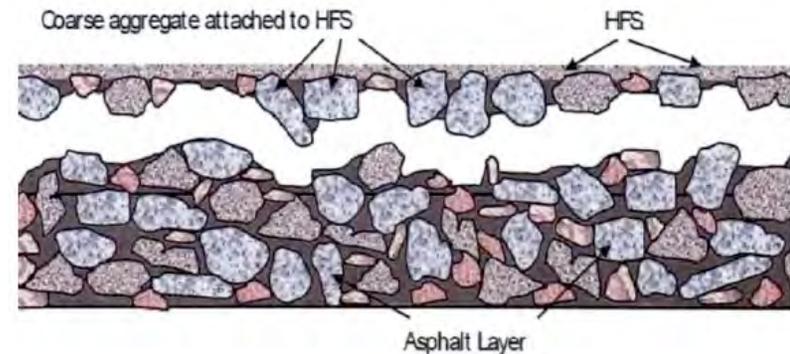
- High Friction Surface Treatment (HFST) is an initiative by FHWA to help improve driving safety
 - 5% Horizontal Curves on US Roads
 - Makes up 23% of all fatalities
 - 2016 – 336 fatalities and 517 serious injuries due to lane departures in NJ
- Calcined bauxite aggregate (high polish resistance) epoxied to pavement surface



Task 1 – High Friction Surface Treatment

■ Issue

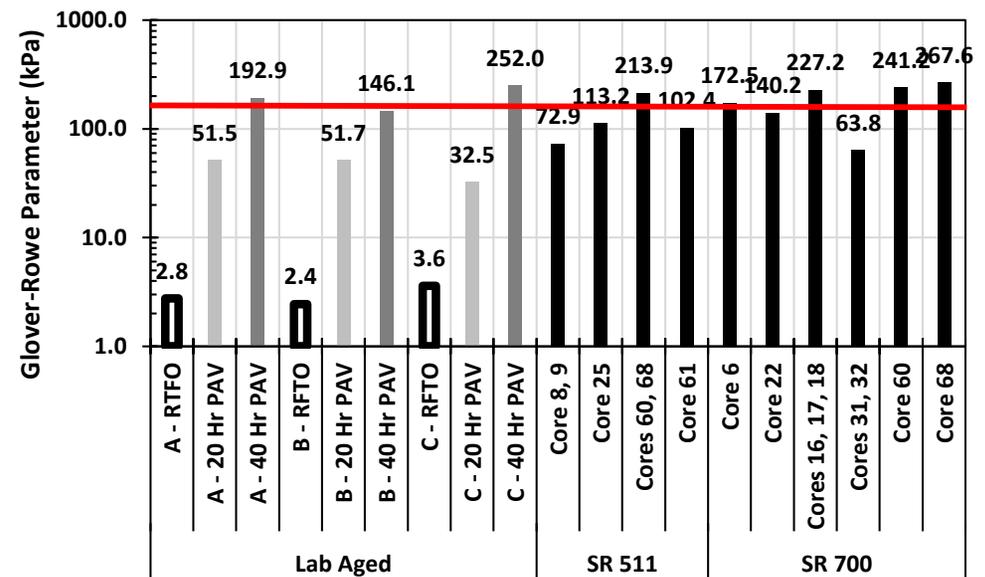
- NJ has a high occurrence of freeze-thaw cycles (large temperature swings in 24 hours)
- Epoxy resin used has a coefficient of thermal expansion 3 to 4 times that of HMA
- Can result in shallow delamination failures and induced edge cracking



Task 1 – High Friction Surface Treatment

■ Solution

- Developing screening method for evaluating substrate prior to application & acceptance after construction
- Utilizing pull-off strength (ASTM C1583) and binder testing (Glover-Rowe & ΔT_c) to identify aged/ravel-prone substrates



Task 1 – Innovative Materials

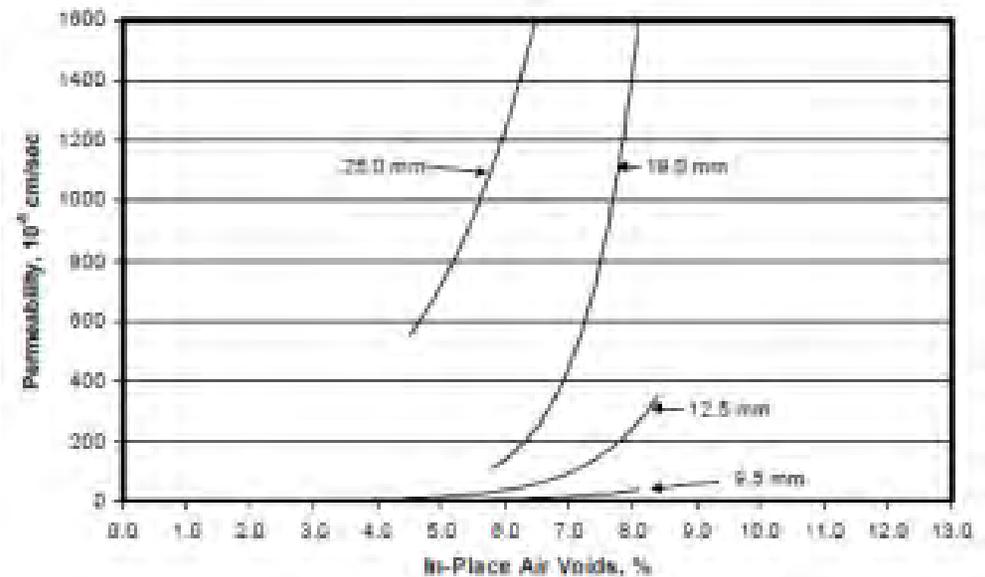
- Upcoming activities
 - High Friction Chip Seals
 - Criteria for Specialty Mixtures After Aging
 - Minimum Asphalt Contents to Maximize Performance

Task 2 – Innovative Technologies

- Intelligent Compaction Pilot Study
- Noise Generation of Different Pavement Surfaces
- Longitudinal Joint Specification
- Procedure for Evaluating Tack Coat Materials
- NJDOT SurPro Walking Profiler Test Method Specification
- Asphalt Core Delivery Process – National Survey

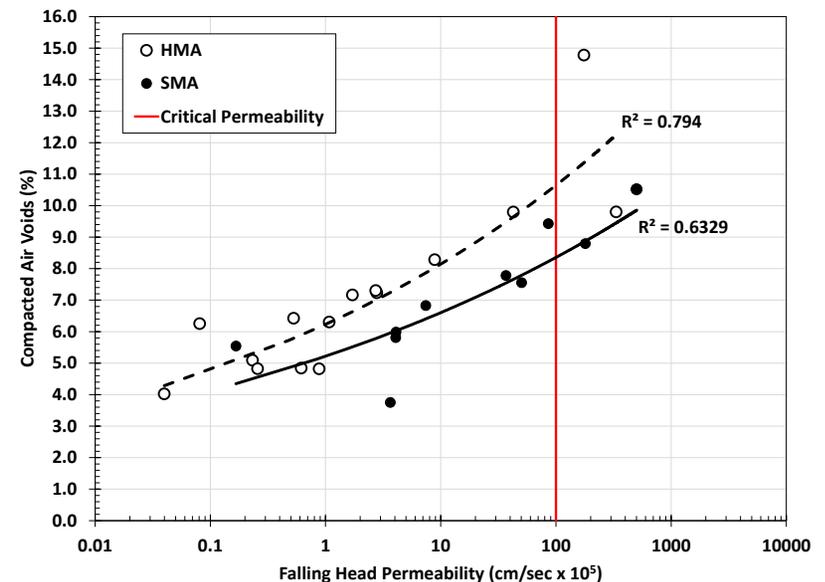
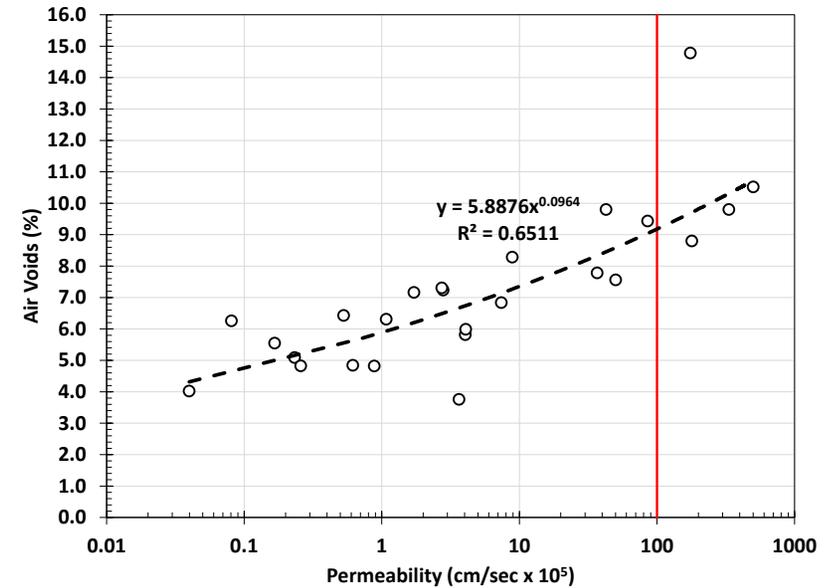
Task 2 – Longitudinal Joint Specification

- Pavement deterioration not always due to structural failure
- Longitudinal joint failure can significantly shorten pavement life
 - Function of permeability at joint – not simply air voids
- Utilized permeability of field cores to establish initial field density recommendations



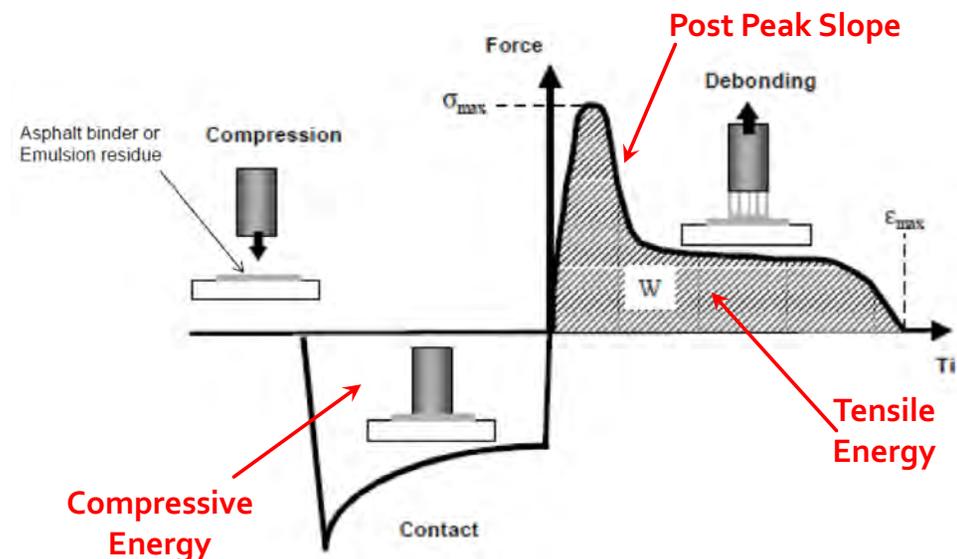
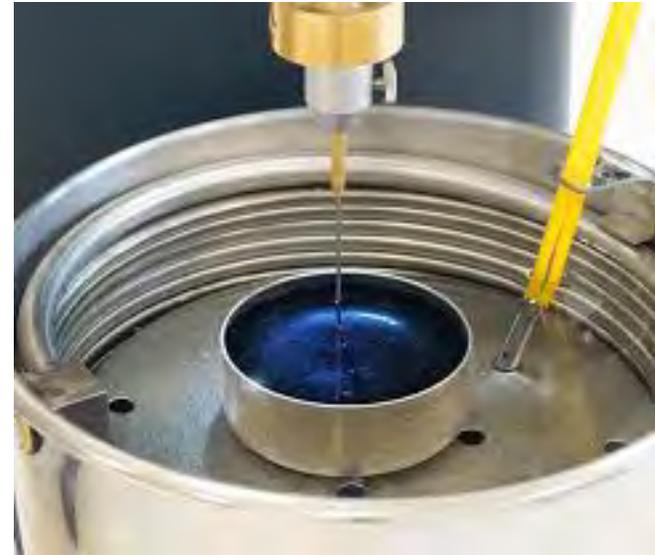
Task 2 – Longitudinal Joint Specification

- Evaluated falling head permeability for HMA and SMA field cores
 - Statistical analysis did not show difference between HMA mixes
 - Statistical difference between HMA and SMA
 - Initial Joint Density Criteria
 - HMA < 10% Air Voids
 - SMA < 9% Air Voids



Task 2 – Performance Test for Tack Coat Materials

- Looking at developing a performance based specification for Tack Coats
 - Current procedures use older test methods (Penetration)
- Test methods proposed will use existing equipment but procedures based on performance mechanism (for Tack Coats = Bonding Strength)

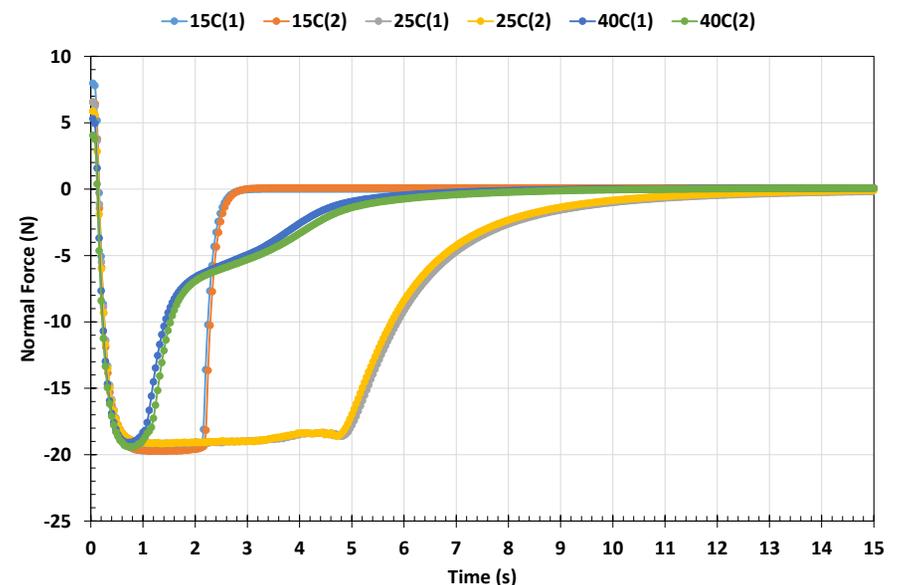


Task 2 – Performance Test for Tack Coat Materials

- Test method indicating sensitivity to different tack coat materials
- Repeatable when testing asphalt binder – some issues found with some emulsions
 - Sample preparation being closely examined
 - Potential separation in some samples

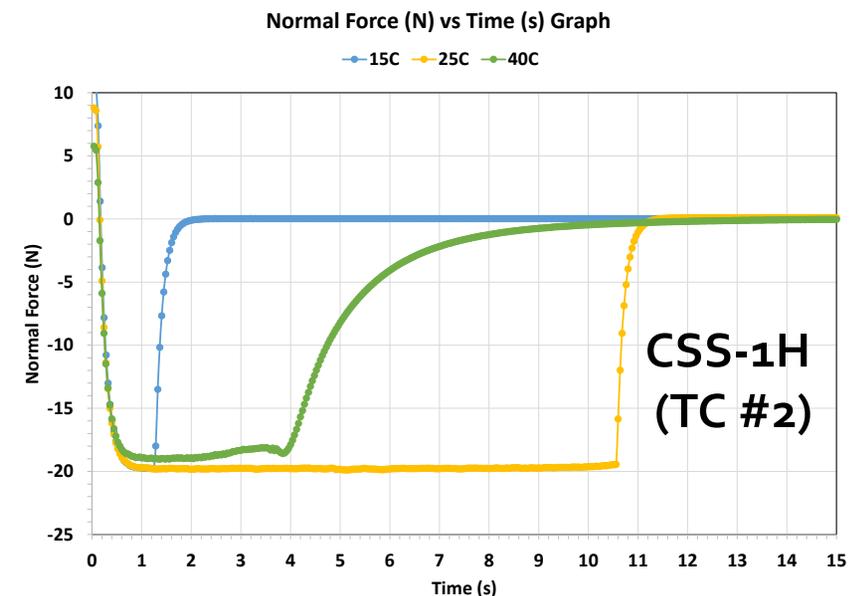
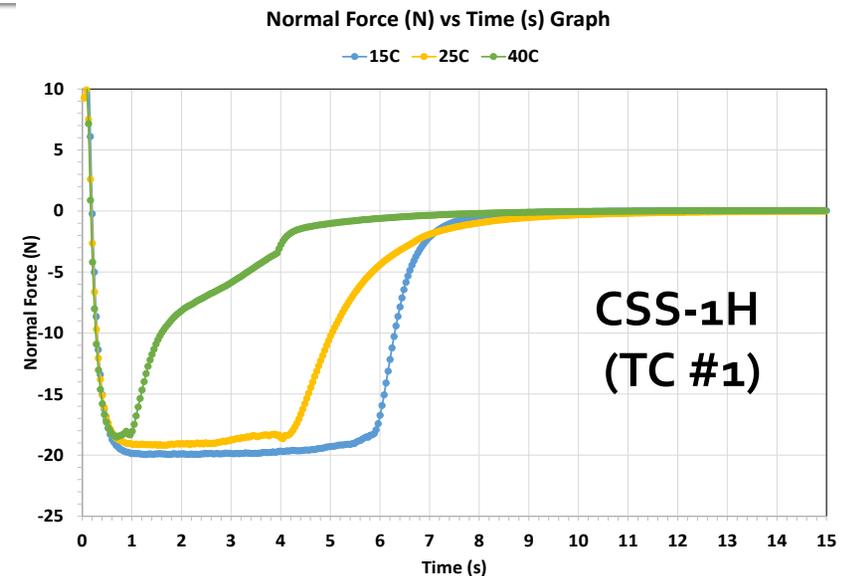


Normal Force (N) vs Time (s) Graph



Task 2 – Performance Test for Tack Coat Materials

- Working temperature has impact on adhesion
 - Looking at Tack Energy over a range of working temperatures that still provides repeatability
 - TC #1 “Softer” working range compared to TC #2
 - Eventually move to compare liquid test results to bond strength results with field cores



Task 2 – Innovative Technologies

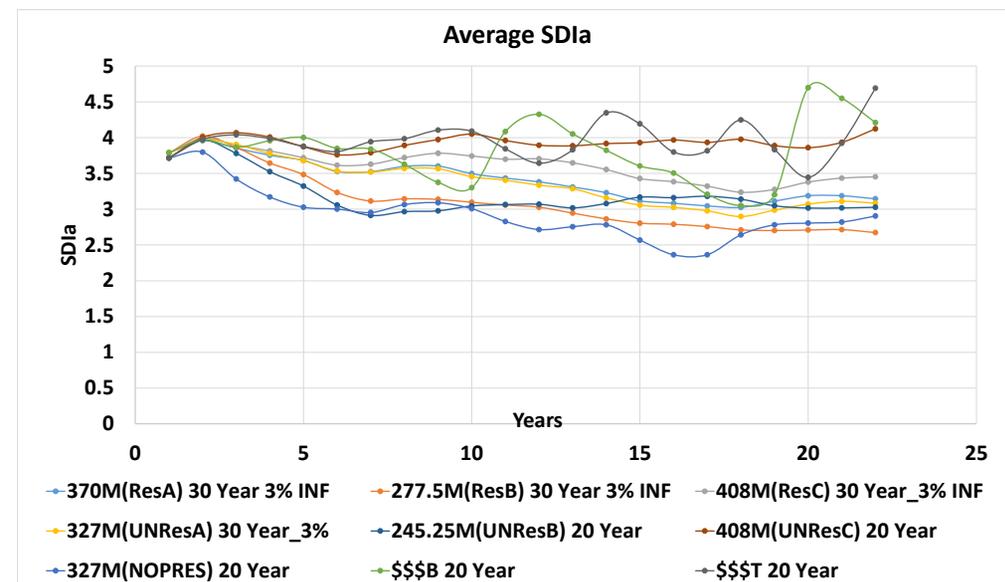
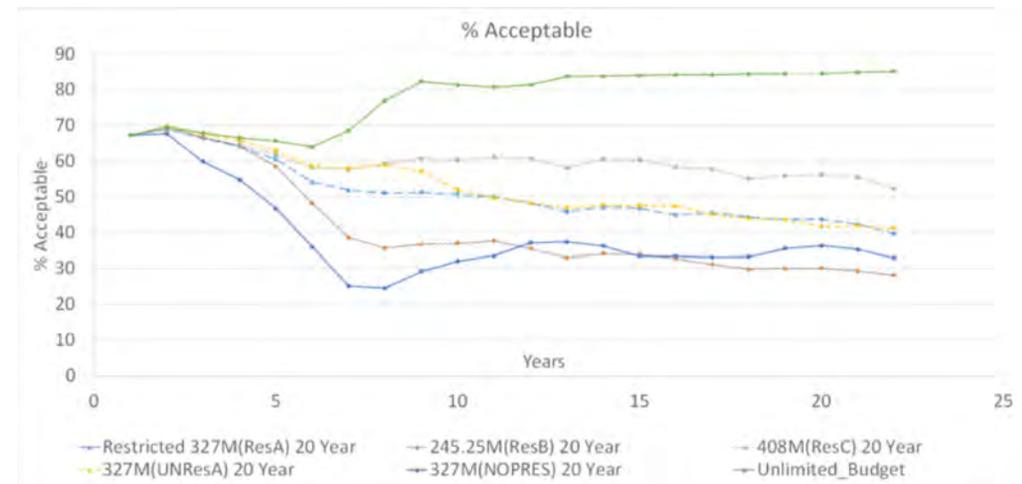
- Upcoming activities
 - Proficiency Sample Program for NJDOT's Approved Asphalt Plants
 - Repeatability of Indirect Tensile Test Procedures for Asphalt Plant QC Performance Testing
 - Evaluation of FHWA's Performance Engineered Mixture Design Using the AMPT

Task 3 – Pavement Management System Support

- Developing Analyses for Pavement Condition Data Collected on NJDOT Network
- Migration from Manual to Automated Distress Collection
- PMS Quality Assurance Manual and Procedures
- Enhancement of NJDOT Pavement History Software
- PMS Condition and Program Mapping
- Supporting NJDOT's Implementation of MAP-21 Data Collection and Reporting

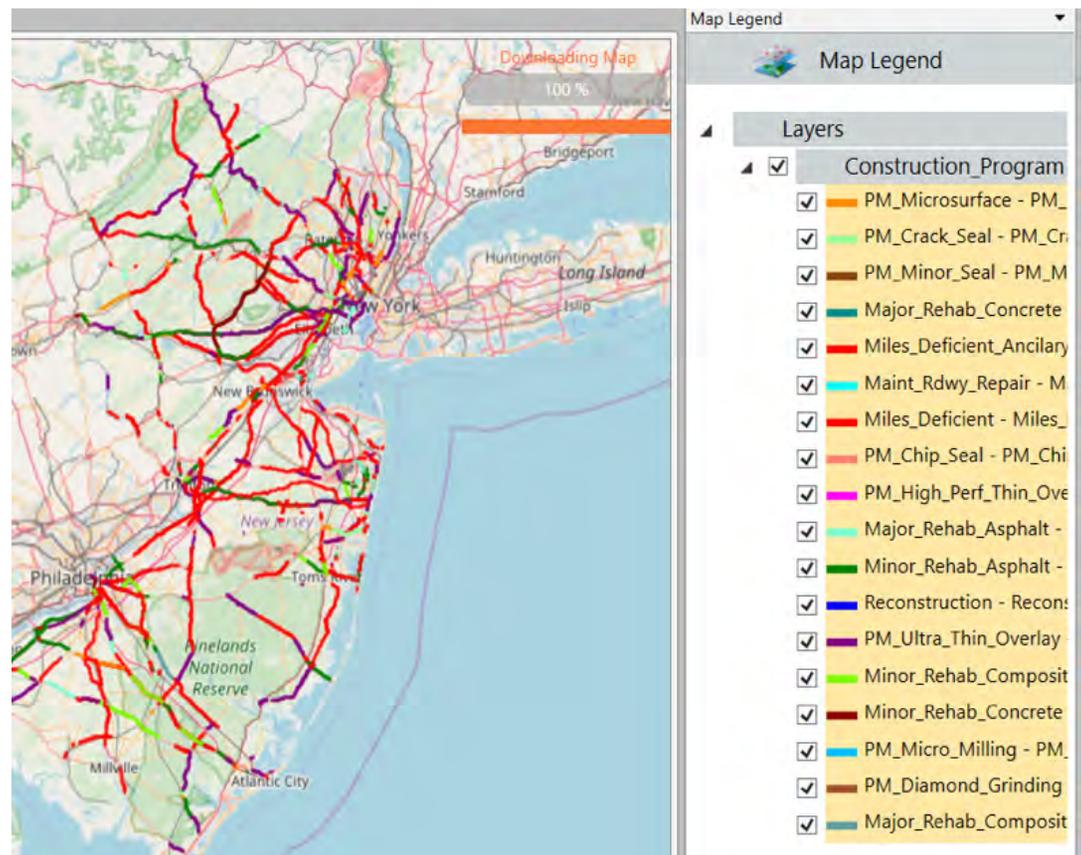
Task 3 – Condition Forecasting

- Developing analyses to help NJDOT forecast pavement condition
 - Based of various funding scenarios
 - +/- Current; Unlimited
 - Different programming type
 - With/without preservation
 - Configured to FHWA TAMP requirements



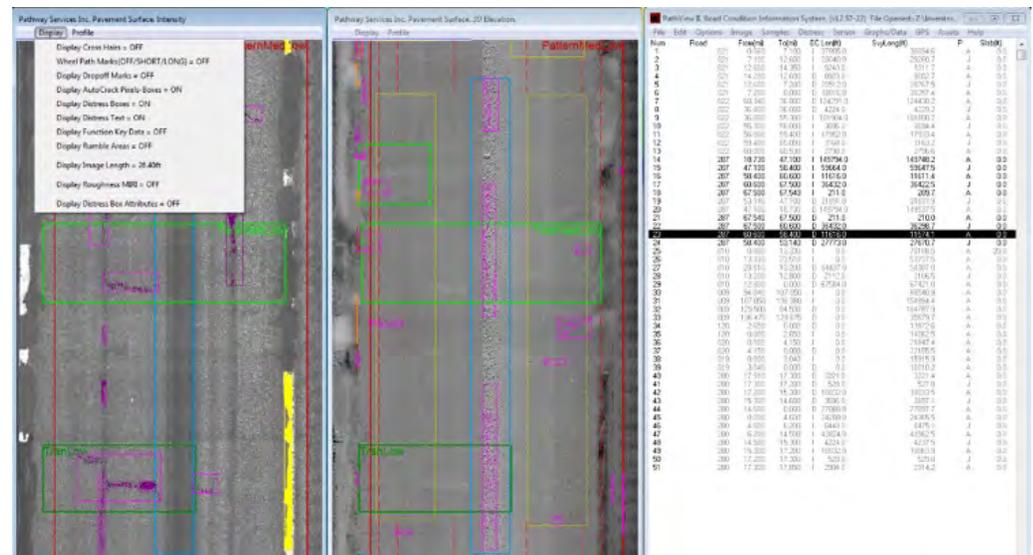
Task 3 – PMS Condition and Program Mapping

- Developing visual tools that NJDOT PMS can utilize for programming and reporting
 - Construction programming
 - Planning
 - Pavement Preservation
 - Rehab/Reconstruction



Task 3 – Migration to Automated Distress

- NJDOT previously utilized manual raters to provide condition assessment
- Over past 3 years, migration to automated distress
 - Updated Surface Distress Index (SDIa) for automated data collection



Task 3 – Pavement Management System Support

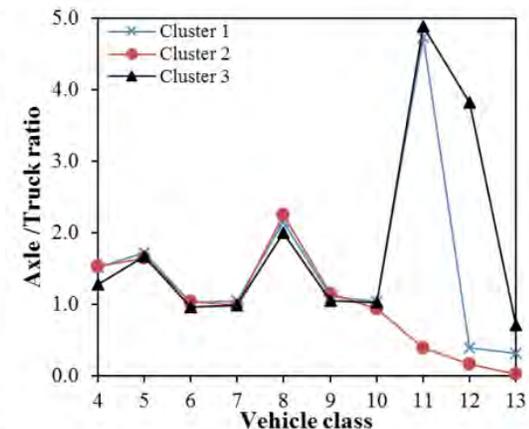
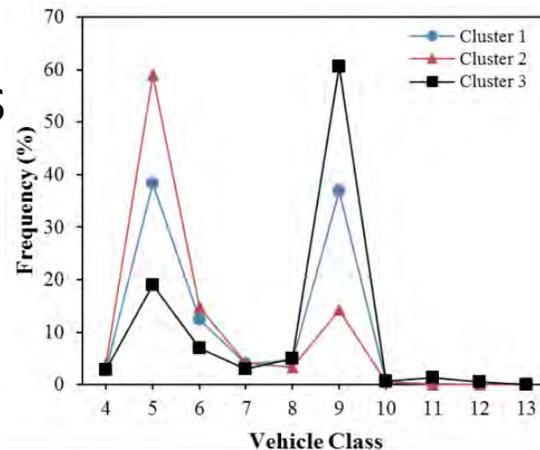
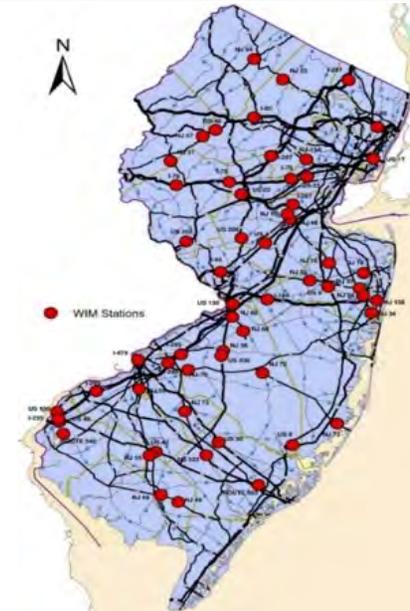
- Upcoming Activities
 - New mapping features to allow dual line work
 - Updating and maintaining analyses for FHWA TAMP
 - Incorporation of Life Cycle Cost Analysis
 - Customer Rated Pavement Condition
 - Automated Distress Profiler Verification for NJDOT and Its Consultants

Task 4 – Pavement Design

- Primarily focuses on supporting the NJDOT and its consultants moving to PAVEMENT-ME Adoption
 - Traffic Families (Clustering)
 - PAVEMENT-ME HMA Input Catalog
 - PAVEMENT-ME Model Calibration
 - Recommended Failure Thresholds for PAVEMENT-ME

Task 4 – Traffic Families (Clustering)

- Input for site specific traffic for PAVEMENT-ME is cumbersome and time consuming
 - Pavement distress sensitivity?
- Developed “families” of traffic loading conditions for easier inputting
 - Not sacrificing accuracy!
 - Based on NJDOT WIM sites
 - Generated HTML files NJDOT can use to directly upload traffic family data into PAVEMENT-ME



Task 4 – NJDOT Asphalt Materials Catalog

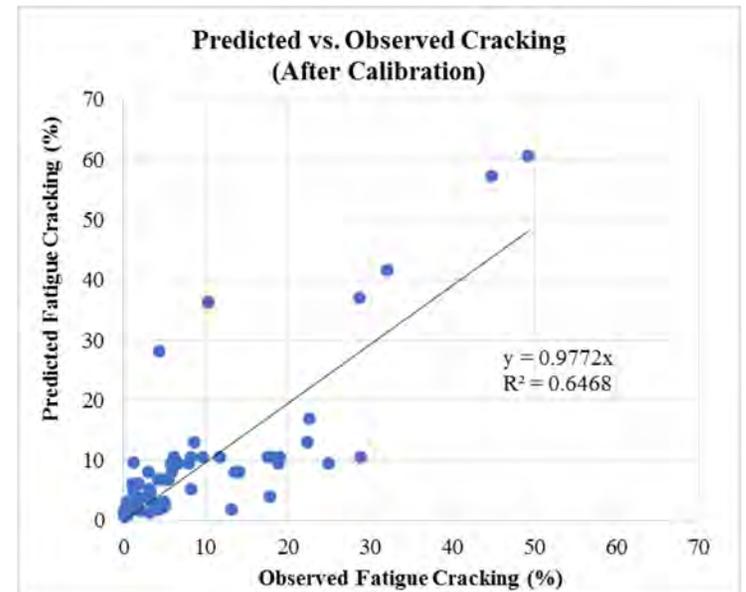
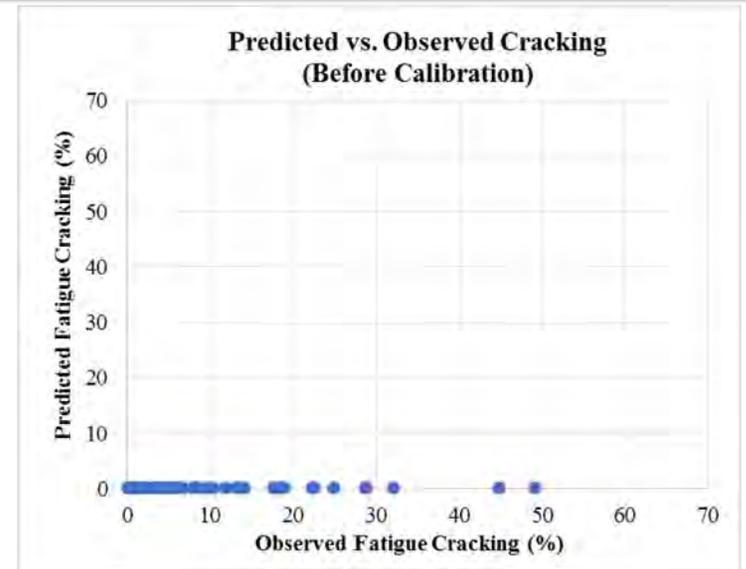
- Developed and updating HMA materials catalog for Level 1 type analysis
 - Based on plant produced HMA
 - Superpave, SMA, HPTO, BRIC
 - Aggregates and binder recovered from mixture and tested
 - Dynamic modulus and creep compliance directly measured
 - HTML files generated for direct uploading into PAVEMENT-ME



Material Information				
Mix Type: 12.5M64		NJDOT Region: North		
Producer: Stone Industries - Haledon				
General Information				
Unit Weight (pcf)		154.6		
Air Voids (%)		6.8		
Effective Binder Content (%)		12.0		
Thermal Conductivity (BTU/hr-ft ² -F)		0.67		
Heat Capacity (BTU/lb.-F)		0.23		
Asphalt Binder				
<i>(from recovered asphalt binder - results may differ due to RAP included)</i>				
Rotational Viscosity		Dynamic Shear Rheometer (10 rad/sec)		
Temperature (F)	Rotational Viscosity (cP)	Temp (F)	Shear Modulus, G* (Pa)	Phase Angle (degrees)
230	6,100	4.4	70380210	24.3
275	1,067	21.1	10401710	38.6
329	235	37.8	1297670	49.8
348.8	148	54.44	171080	58.2
Performance Grading				
Continuous		Final		
High Temperature	74.4	70		
Intermediate Temperature	21.9	22		
Low Temperature	-23.3	-22		
Aggregate Gradation				
Gradation		Percent Passing		
3/4 Inch Sieve		100		
3/8 Inch Sieve		84.7		
No. 4 Sieve		49.6		
No. 200 Sieve		6.2		
Asphalt Mixture - Dynamic Modulus				
<i>(from plant produced asphalt mixture; Reference Temperature = 70° F)</i>				
Temp (°F)	0.1 Hz	1 Hz	10 Hz	25 Hz
14	1,477,917	1,933,784	2,308,101	2,430,295
40	1,068,424	1,552,840	1,998,408	2,152,965
70	238,631	514,146	923,608	1,111,310
100	42,838	116,186	284,641	388,938
130	10,807	28,394	78,023	115,278

Task 4 – PAVEMENT-ME Model Calibration

- Model calibration being conducted using two large sets of data to observe differences between Level 1 and Level 3 inputs
 - NJ LTPP (Level 3)
 - NJDOT Automated Distress (Level 1)
- Model calibration also being conducted with Traffic Families (shown earlier)

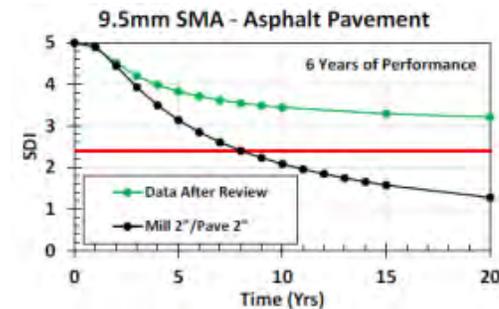
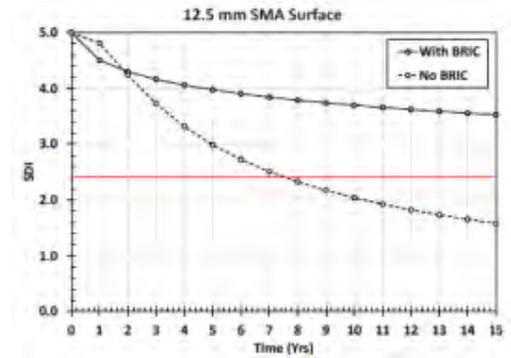
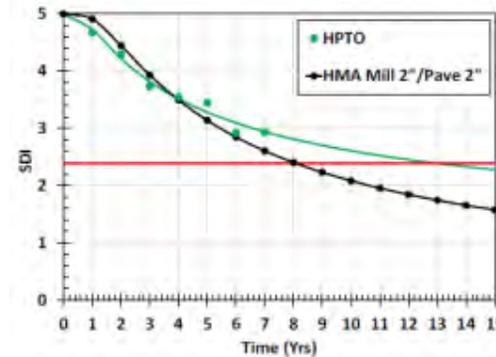


Task 4 – Pavement Design

- Upcoming activities
 - Characterizing Existing Pavement Conditions for Overlay Design (Level 1 vs Level 2/3)
 - Optimizing PCC Slab Length
 - Calibrating New PAVEMENT-ME Reflective Cracking Model

Task 5 – Life Cycle and Cost Benefits

- Working with NJDOT to develop Life Cycle Cost Analysis within PMS programming
- Developed Cost Benefit Ratio using PMS Surface Distress Index (SDI) and Construction Costs for NJDOT Specialty Mixes
 - Analysis indicates that even though some asphalt mixtures (SMA & HPTO) more expensive per ton than conventional HMA, Benefit to Cost Ratio better than HMA



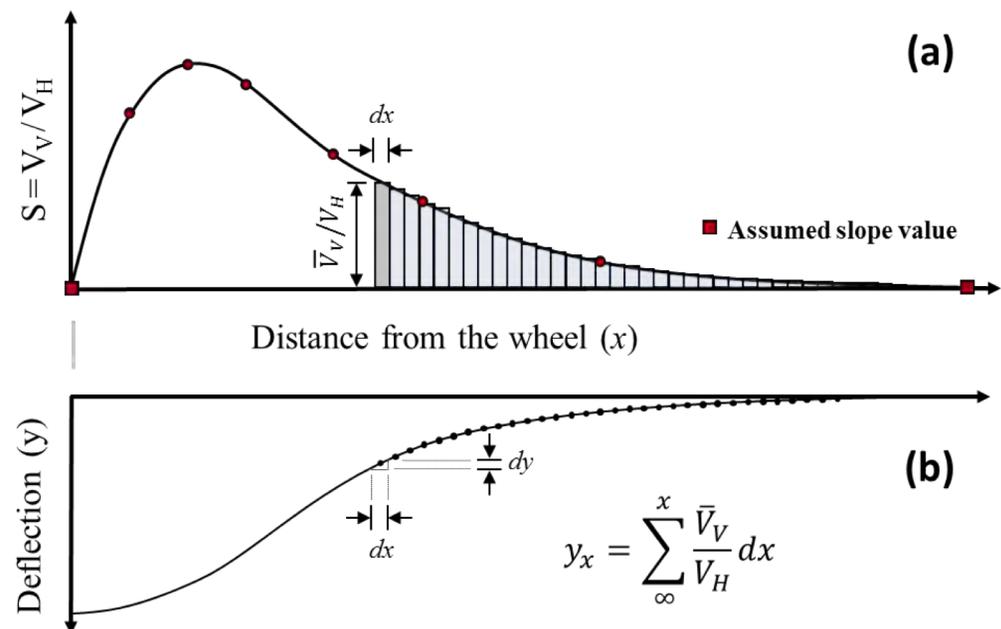
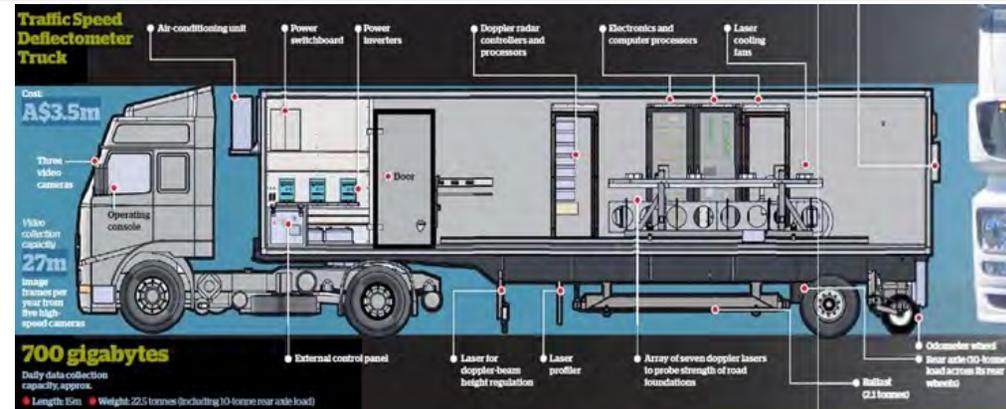
Mix Type	Compared to:	Performance Life Ratio	Cost Ratio (per Lane Mile)	Benefit/Cost Ratio [Performance Ratio/Cost Ratio]
HPTO	1.5" HMA	1.63	1.11	1.47
	2" HMA	1.63	0.83	1.96
12.5mm SMA Over HMA	2" HMA	1.88	1.84	1.02
12.5mm SMA Over PCC	2" HMA	2.67	1.84	1.45
12.5mm SMA + BRIC	3" HMA	5.00	1.75	2.85
12.5mm SMA + 12.5MGA	4" HMA	2.67	1.42	1.98

Task 6 – Pavement Policy

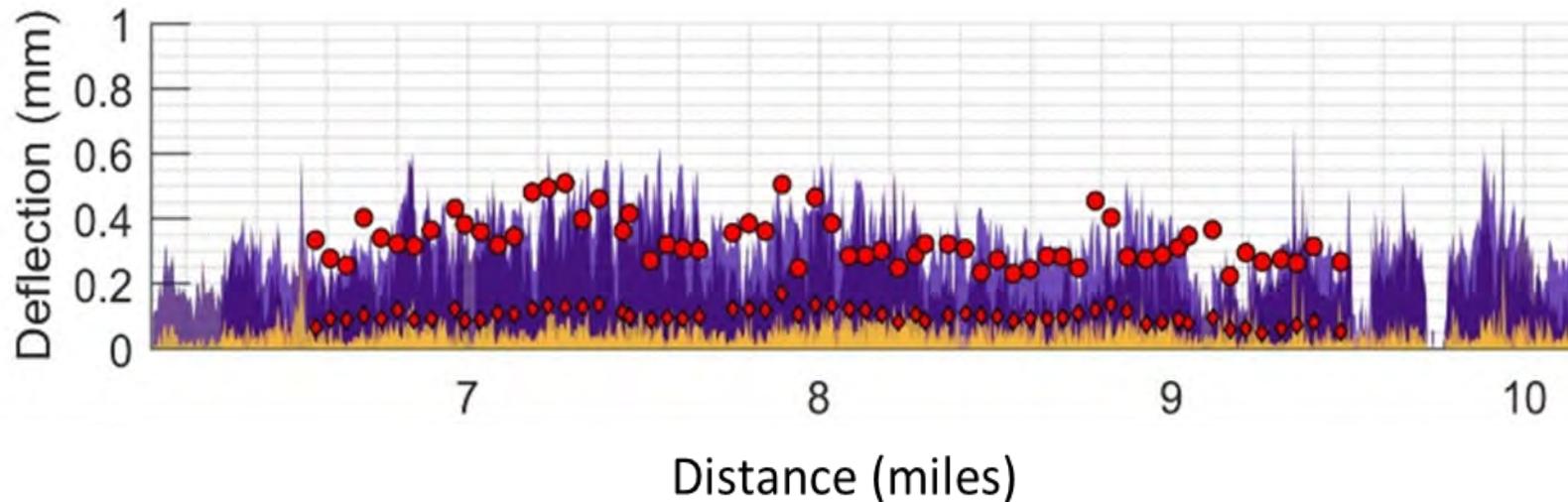
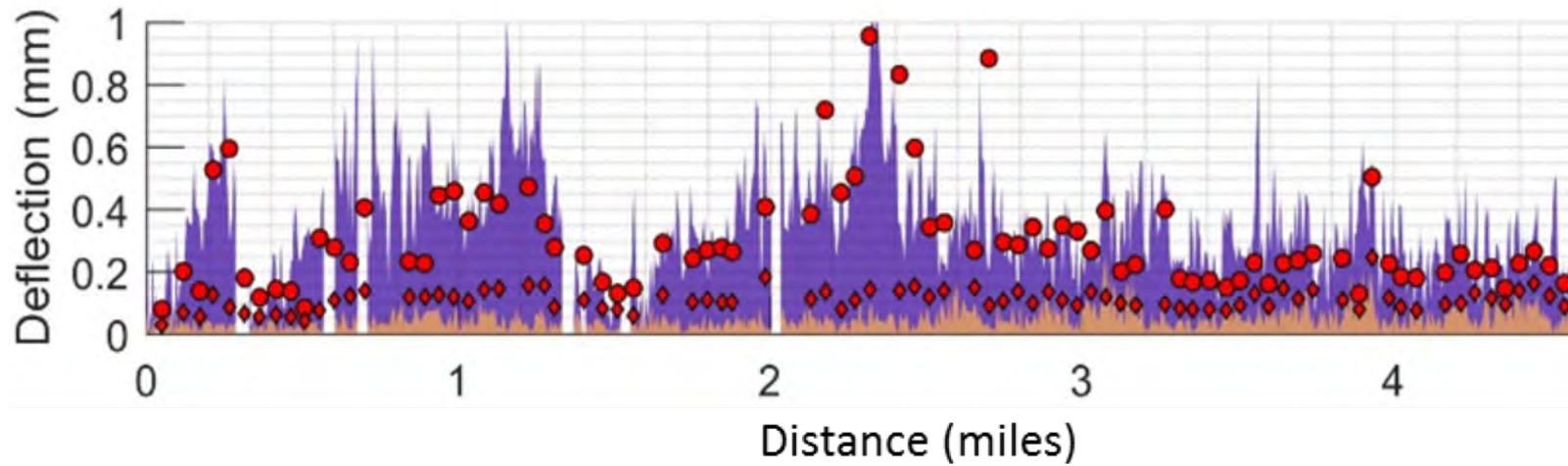
- Evaluating Traffic Speed Deflectometer (TSD) for Network Level
- NJDOT Profiler Certification Program
- Pavement Management Policy Initiatives

Task 6 – Traffic Speed Deflectometer

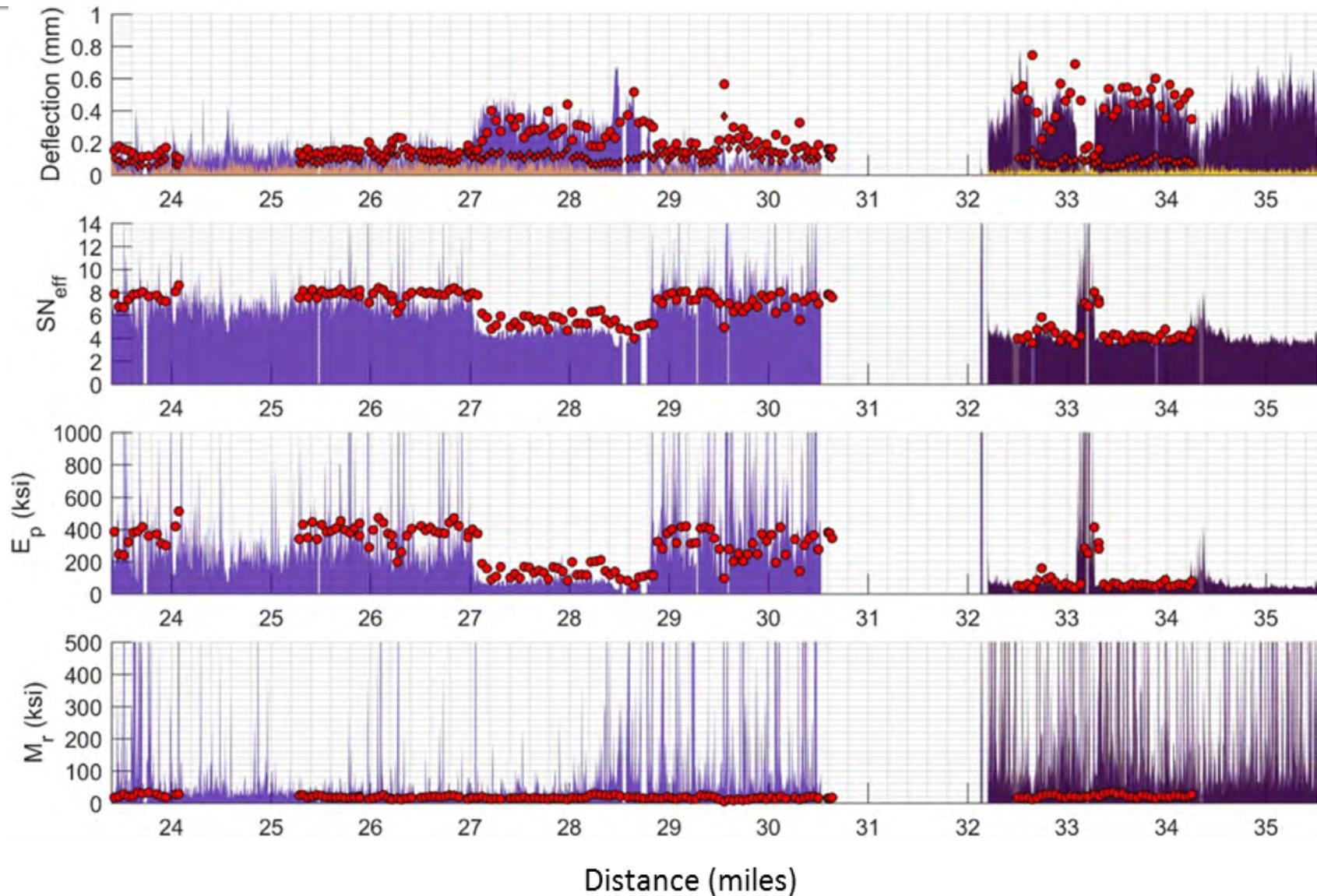
- Utilizing full scale truck loading to measure velocity of deflecting road surface
 - Integration of deflection velocity slope vs wheel offset provides deflection basin (similar to FWD)
- NJDOT evaluating if this measurement can provide guidance for network level decision making;
 - Pavement Preservation or Minor Rehab or Major Rehab



Task 6 – Traffic Speed Deflectometer

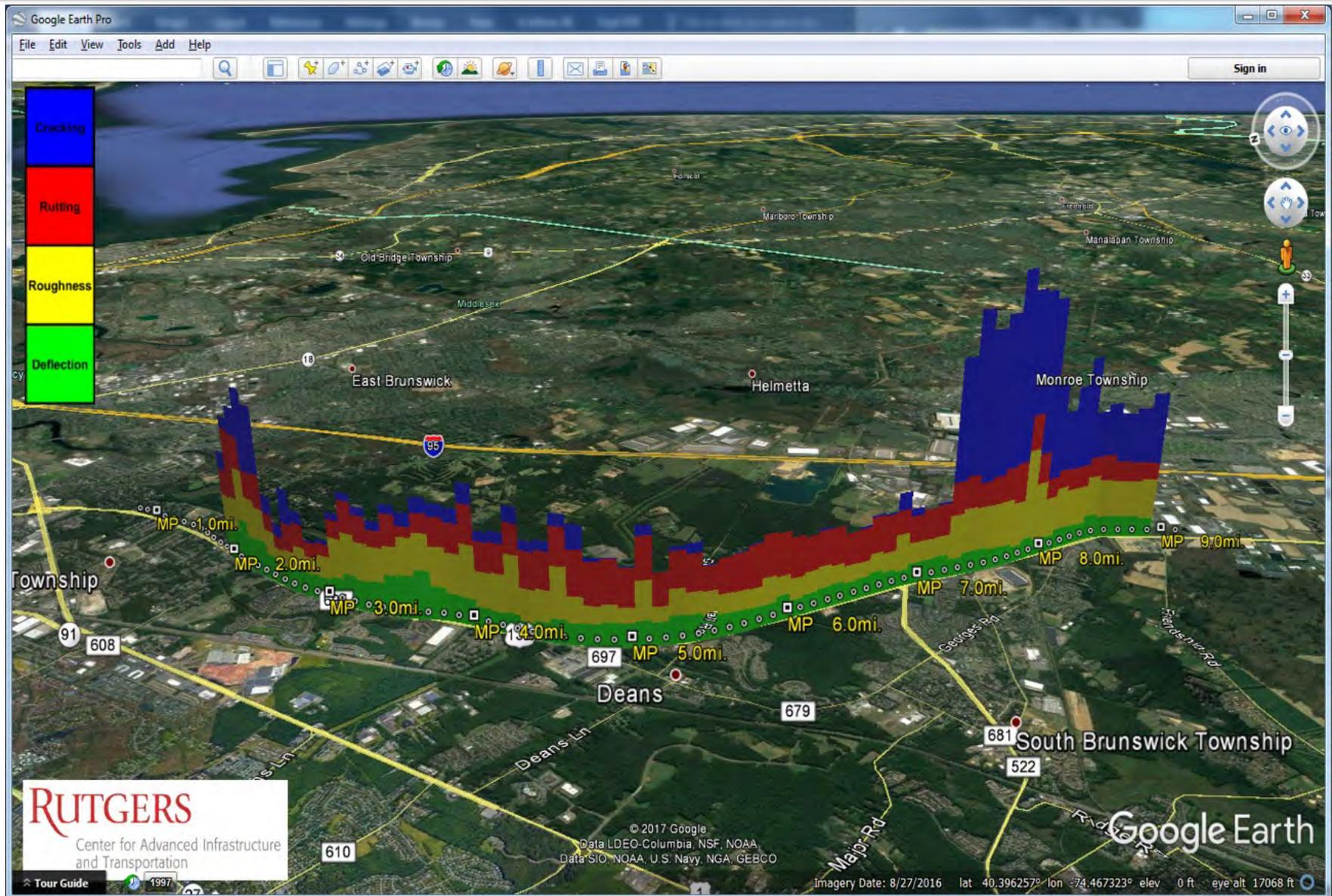


Task 6 – Traffic Speed Deflectometer



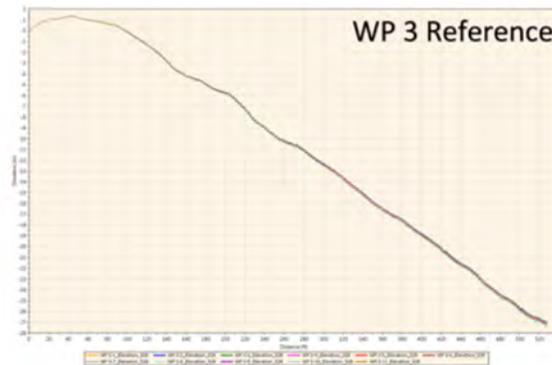
Legend: T9201706260014 (σ_{s1}) T9201706260017 (σ_{s2}) T9201707100010 (σ_{s3}) T9201706260014 (σ_{s4}) T9201706260017 (σ_{s5}) T9201707100010 (σ_{s6}) FWD (5/31/2015) (σ_{s7}) FWD (5/31/2015) (σ_{s8})

Task 6 – Traffic Speed Deflectometer



Task 6 – NJDOT Profiler Certification

- Established and maintain the NJDOT Profiler Certification site
 - Decommissioned weigh station area on I295
 - Conduct longitudinal reference profiles with SurPRO Walking Profiler
 - Used for NJDOT Region Walking Profilers and NJDOT High Speed Profiler



File	IRI (in/mi)
WP 3-1	94.50082
WP 3-2	96.2994
WP 3-3	96.26919
WP 3-4	93.45005
WP 3-5	93.42684
WP 3-6	93.56133
WP 3-7	94.73637
WP 3-8	92.9762
WP 3-9	96.21339
WP 3-10	94.68621
WP 3-11	95.24393

Year	Station	IRI (in/mi)								
1	0	100	95	90	85	80	75	70	65	60
2	100	95	90	85	80	75	70	65	60	55
3	200	90	85	80	75	70	65	60	55	50
4	300	85	80	75	70	65	60	55	50	45
5	400	80	75	70	65	60	55	50	45	40
6	500	75	70	65	60	55	50	45	40	35
7	600	70	65	60	55	50	45	40	35	30
8	700	65	60	55	50	45	40	35	30	25
9	800	60	55	50	45	40	35	30	25	20
10	900	55	50	45	40	35	30	25	20	15
11	1000	50	45	40	35	30	25	20	15	10

Task 6 – Pavement Policy

- Upcoming activities
 - Automated Distress Profiler Certification Site
 - Longitudinal Tining/Grinding Practices for Friction Increase in Horizontal Curves
 - Evaluating the Implementation of Warranties for NJDOT Asphalt Pavement Construction

Task 7 – NJDOT Training Activities

- A wide variety of training and technical presentations are conducted yearly for the NJDOT
 - Asphalt Materials and Construction – New Technologies
 - PAVEMENT-ME Use and Guidance
 - PMS Software Use and Guidance
 - SurPRO Walking Profiler Training
 - Development and Use of NJDOT's Performance Related Specifications
 - NJDOT High Speed Profiler Use and Guidance
 - NJDOT Pavement History Software Use and Guidance

Summary

- The NJDOT Pavement Support Program (PSP) is an initiative to support the immediate needs of the Pavement & Drainage Management and Technology Unit, as well as the Materials Bureau
- Emphasis on activities that can move to directly to implementation
 - Specifications; Procedural and Guidance Documents/Manuals; Training Activities/Programs

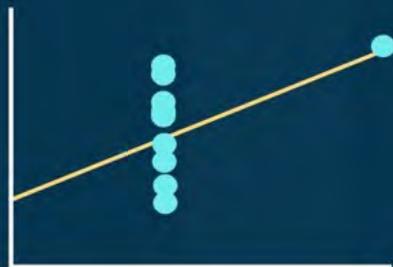
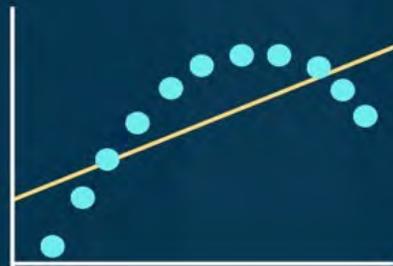
Thank you for your time!

Questions?

**BE CAREFUL WHEN YOU ONLY
READ CONCLUSIONS...**

Reference: The Anscombe's quartet, 1973

Designed by @YLMSportScience



**THESE FOUR DATASETS HAVE IDENTICAL MEANS,
VARIANCES & CORRELATION COEFFICIENTS**

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