60th Annual New Jersey
Asphalt Paving Conference

Center for Advanced Infrastructure and Transportation

New Jersey Asphalt Pavement Association

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Center for Advanced Infrastructure and Transportation

NJAPA

Lab Performance Testing Procedures for Asphalt Plants

Thomas Bennert, Ph.D.
Rutgers University
Center for Advanced Infrastructure and Transportation (CAIT)

Performance Testing for the Suppliers

- Rutgers University working on putting together a set of performance tests (rutting and cracking) that can be used by asphalt plants
  - Time for testing and analysis
  - Relationship to current test methods/field performance
  - Cost (equipment, supplies)

Who Remembers This?

- Most plants still have Marshall equipment
  - TSR's
  - FAA work
- Proposing the use of Marshall equipment as the loading frame for new tests
- Rutting and cracking performance can be assessed with minor investments

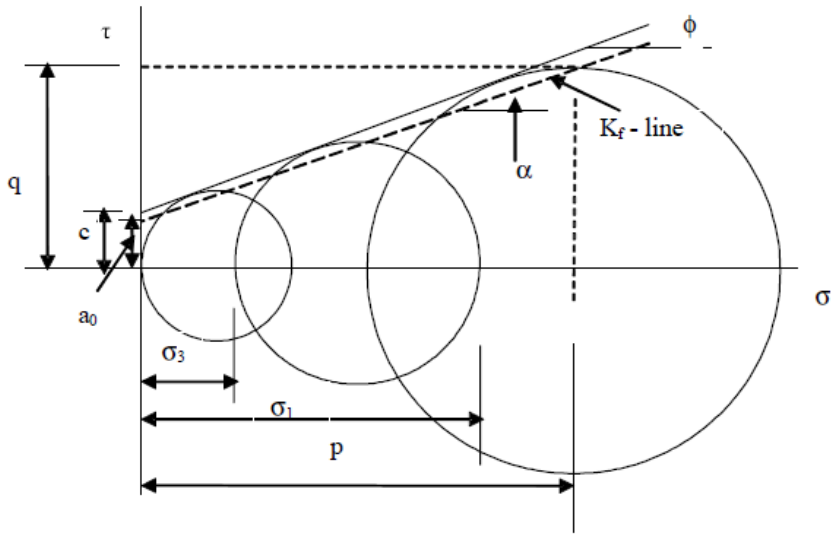
Rutting (Permanent Deformation)

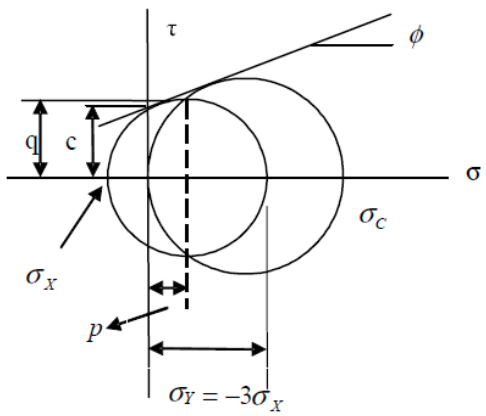
QC Lab Testing – Rutting – High Temperature IDT (HT-IDT)

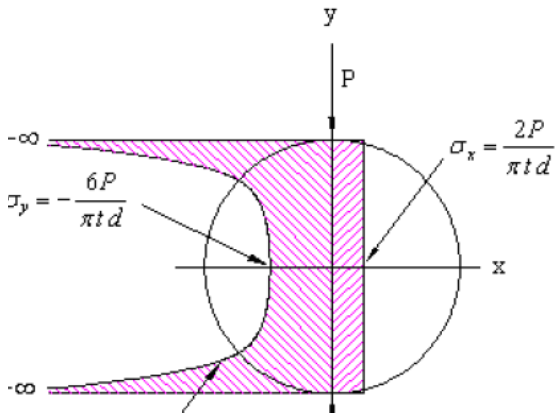
- High temperature IDT
  - Uses TSR IDT frame with Lottman head (used for TSR; AASHTO T283)
  - Gyratory compacted samples (set air void level to specified)
  - Condition in oven for >4 hours; water for >2 hours (place in bag to keep dry)
  - 50 mm/min (2 inch/min) deformation rate
  - Test temperature is 10°C lower than local climate (LTPPBind 3.1, 98% Reliability, 20 mm below surface, not corrected for traffic or vehicle speed)
    - For NJ = 44°C

History of HT-IDT

- Indirect tensile strength (IDT) is related to the shear strength of materials
  - Mohr-Coulomb
- Rutting a function of the shear strength
  - Cohesion (C) ≈ binder properties
  - Friction (ϕ) ≈ aggregate properties

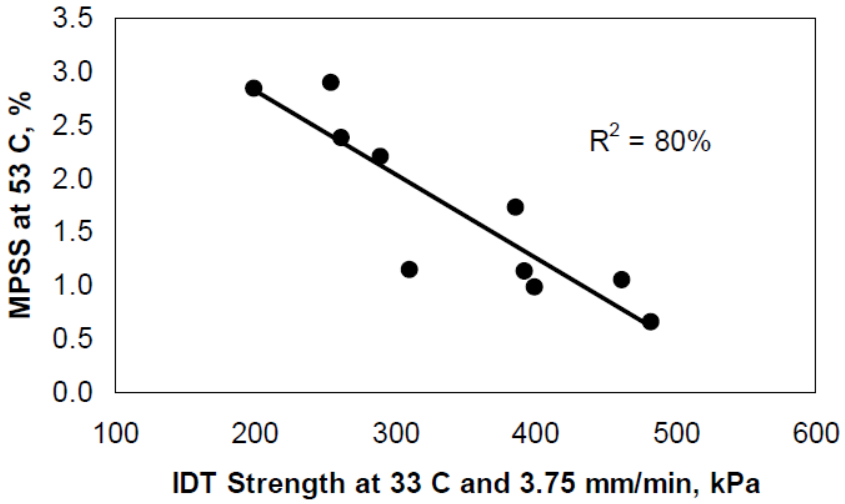


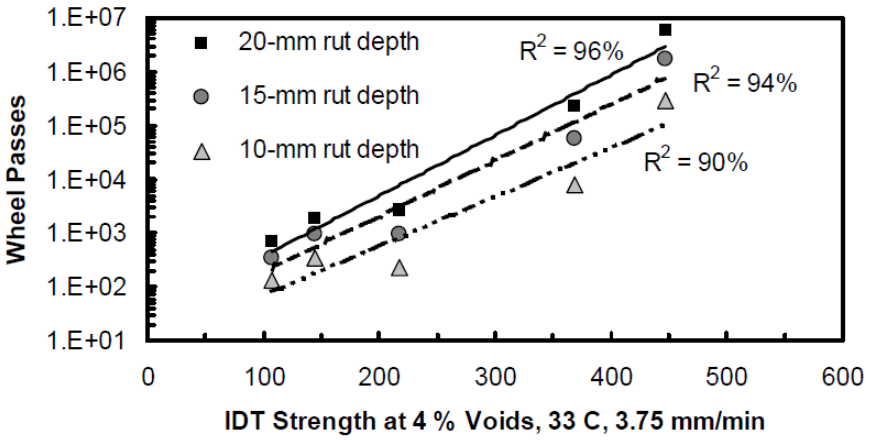




History of HT-IDT

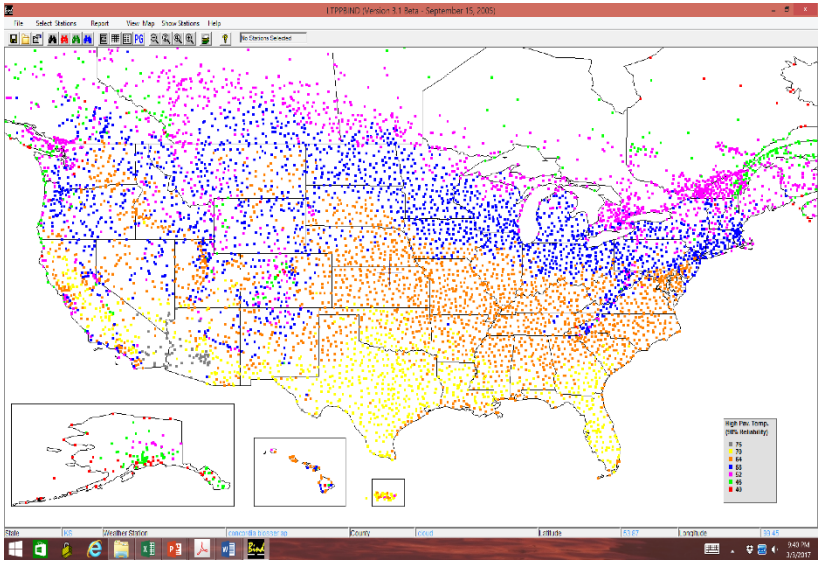
- Gokhale (2001) compared HT-IDT to Superpave Shear Tester (SST) Repeated Shear test maximum permanent shear strain (MPSS)
- Found good relationship for lab test (HT-IDT vs MPSS) and related to field rutting at FHWA ALF
  - Issue – test conducted at 7.5 mm/min & 33°C





History of HT-IDT

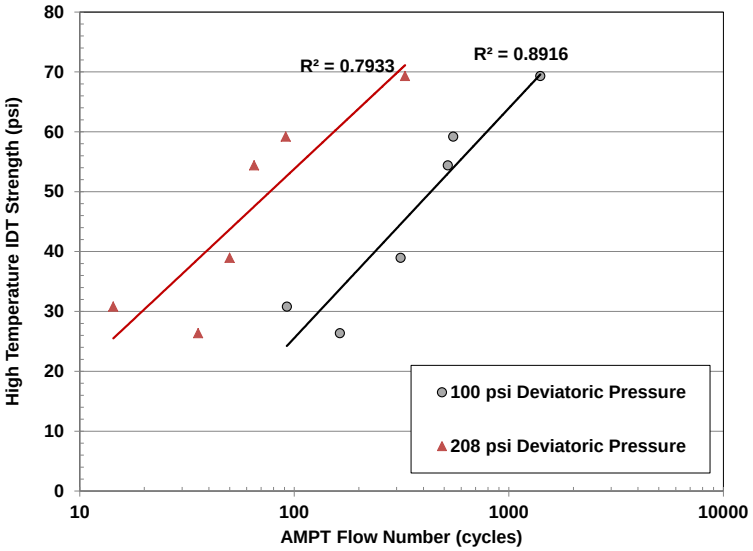
- NCHRP 9-33 (AAT, 2010) proposed using test method at faster loading speeds (50 mm/min) & warmer test temperature
  - Temps based on LTPPBind software
  - For NJ, temp = 44°C
- Also proposed limits, but not verified with actual field performance

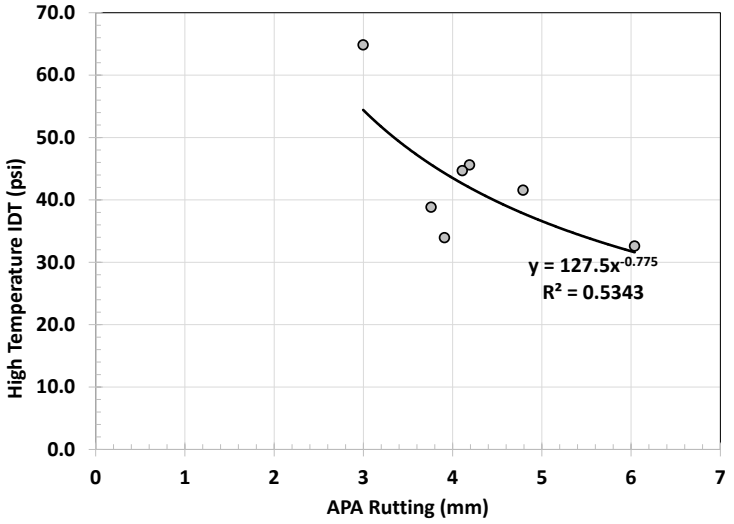


Traffic Level *Million ESAL's*	Minimum HT-IDT Strength *psi*
< 3	---
3 to < 10	29
10 to < 30	49
≥ 30	67

History of HT-IDT

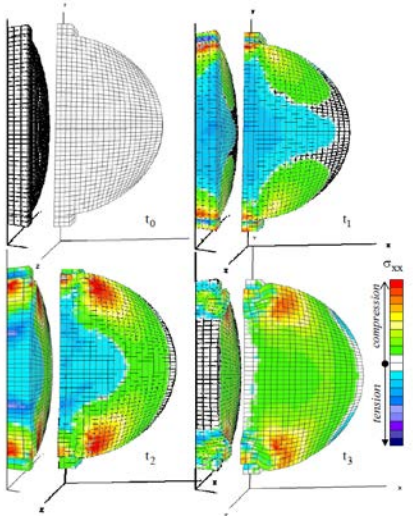
- Bennert (2013) conducted study for FAA showing strong relationship between HT-IDT & Flow Number (Repeated Load)
- Bennert (2015) evaluated 8 different PANYNJ mixes and showed strong relationship between HT-IDT & APA rutting

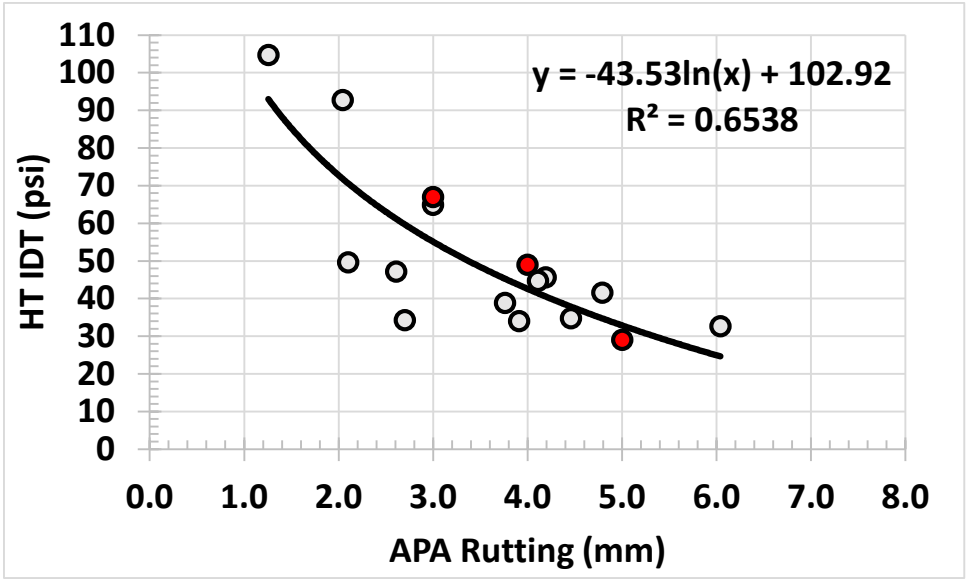




History of HT-IDT

- Since 2015, Rutgers continuing to develop database of APA vs HT-IDT
  - Red symbols represent NCHRP 9-33 relationships
- Almost 20 different HMA mixes (P401, Superpave, SMA, polymer & neat binders included)

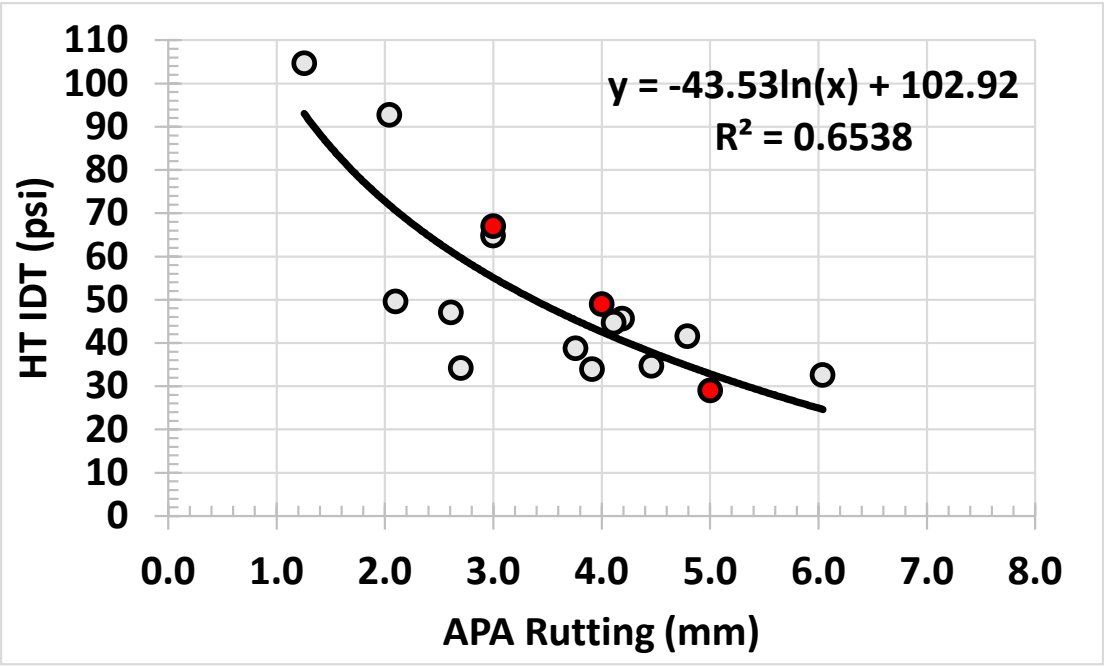




How Can Asphalt Suppliers Use Information?

- HPTO, BDWSC, BRIC & HRAP all require APA testing but equipment not readily available for everyone
- Suppliers can use relationship to provide guidance whether or not mixture will pass rutting requirement
- Test quick enough to be used during daily QC
- **NOT** to be used for acceptance – NJDOT still using and requiring APA – solely used for **GUIDANCE**
  - Test method allows asphalt suppliers to evaluate mixes on their own (i.e. – impact of RAP%, WMA, rejuvenators, binder grade/type)

HT-IDT vs APA Rutting – Preliminary Guidance Values



Mix Type	APA (mm)	HT-IDT (psi)
BRIC/HRAP	< 6	> 25 psi
HPTO/HRAP	< 4	> 45 psi
BDWSC	< 3	> 60 psi

Fatigue Cracking

Asphalt Mixture Fatigue Cracking

- Over the past 5 years, Rutgers has been evaluating a number of fatigue cracking/durability tests for asphalt mixtures and binders
  - Mixture to field performance
  - Binder to field performance
  - Mixture to binder relationships
- Looking for "simplified" method that is related to field performance and sensitive to volumetrics and aging
- On-going/Initiating research with both NJDOT & FAA

QC Lab Testing – Fatigue – SCB Flexibility Index

- Semi-circular Bend Flexibility Index Test
  - Can use Marshall equipment
  - Modification to Lottman Head fixture required or
  - 3 point bending fixture required (≈ $750)
  - 25°C
  - 50 mm/min deformation rate
- Sample prep, testing speed, and analysis fast enough to be used during daily QC testing

SCB Flexibility Index

Standard Method of Test for Determining the Fracture Potential of Asphalt Mixtures Using Semicircular Bend Geometry (SCB) at Intermediate Temperature

AASHTO Designation: TP 124-16[1]

AASHTO

Release: Group 3 (August 2016)

1. SCOPE

1.1. This test method covers the determination of the fracture energy (G_f) of asphalt mixtures using the semicircular bend (SCB) geometry at an intermediate test temperature. The method also includes procedures for calculating other relevant parameters derived from the load-displacement curve. These parameters, in conjunction with field performance, can be used to develop a Flexibility Index (FI) to predict an asphalt mixtures' damage resistance. The index can be used as part of the asphalt mixture approval process.

1.2. These procedures apply to test specimens having a nominal maximum aggregate size (NMAS) of 19 mm or less. Lab compacted and field core specimens can be used. Lab compacted specimens shall be 150 ± 1 mm in diameter and 50 ± 1 mm thick. When field cores are used, specimens shall be 150 ± 8 mm in diameter and 25 to 50 mm thick. A thickness correction factor may be applied for field cores tested at thickness less than 45 mm.

1.3. A vertical notch parallel to the loading axis shall be cut on the SCB specimen. The SCB specimen is a half disc with a notch parallel to the loading and the vertical axis of the semicircular disc.

1.4. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish and follow appropriate health and safety practices and determine the applicability of regulatory limitations prior to use.*

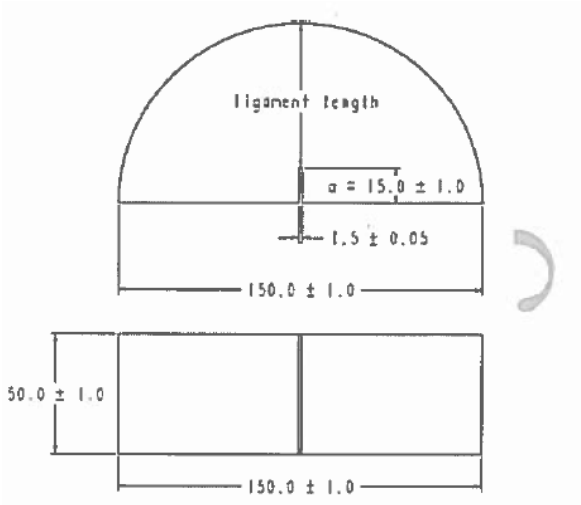
2. REFERENCED DOCUMENTS

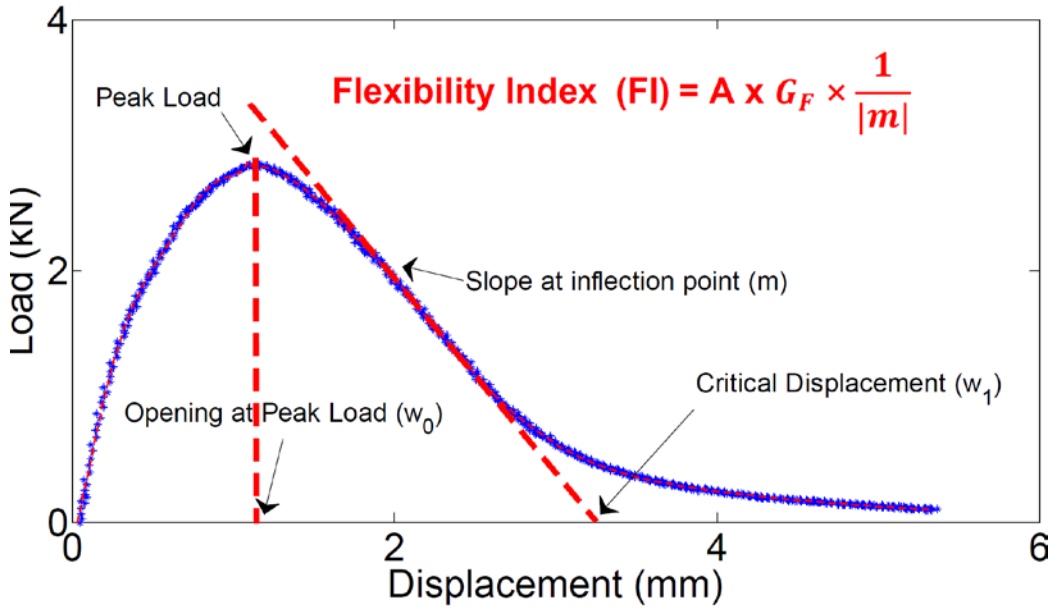
2.1. *AASHTO Standards:*

- T 166, Bulk Specific Gravity (G_{mb}) of Compacted Hot Mix Asphalt (HMA) Using Saturated Surface-Dry Specimens
- T 209, Theoretical Maximum Specific Gravity (G_{mm}) and Density of Hot Mix Asphalt (HMA)
- T 269, Percent Air Voids in Compacted Dense and Open Asphalt Mixtures
- T 283, Resistance of Compacted Asphalt Mixtures to Moisture-Induced Damage
- T 312, Preparing and Determining the Density of Asphalt Mixture Specimens by Means of the Superpave Gyratory Compactor
- TP 105, Determining the Fracture Energy of Asphalt Mixtures using Semicircular Bend Geometry (SCB)

2.2. *ASTM Standards:*

- D3549/D3549M, Standard Test Method for Thickness or Height of Compacted Bituminous Paving Mixture Specimens





History of SCB Flexibility Index

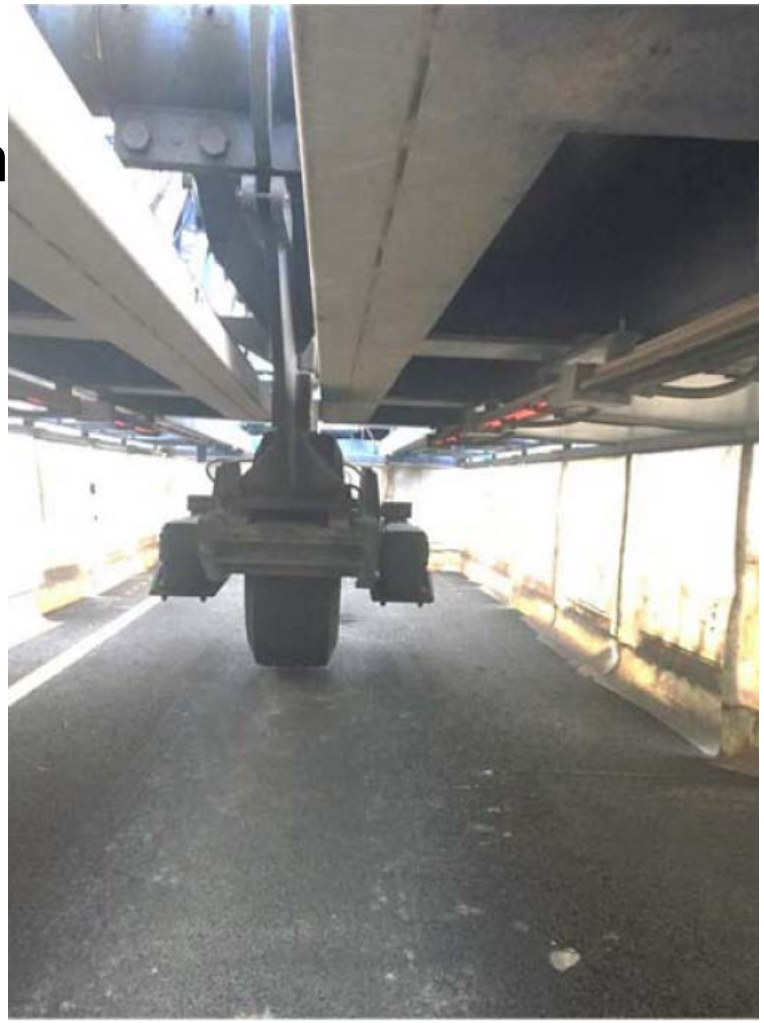
- Developed at University of Illinois in 2014 combining the concept of fracture energy and post-peak strength
- Early testing showed:
  - Sensitive to volumetrics
  - Sensitive to recycled AC (RAP & RAS)
  - Correlated to field performance

History of SCB Flexibility Index – Rutgers Experience

- Examples of some of the work to date
  - FHWA ALF Experiment on Recycled Asphalt
  - PANYNJ's Airfield Durability
  - SCB Flexibility Index to Overlay Tester Correlation
    - Resultant Proposed Criteria

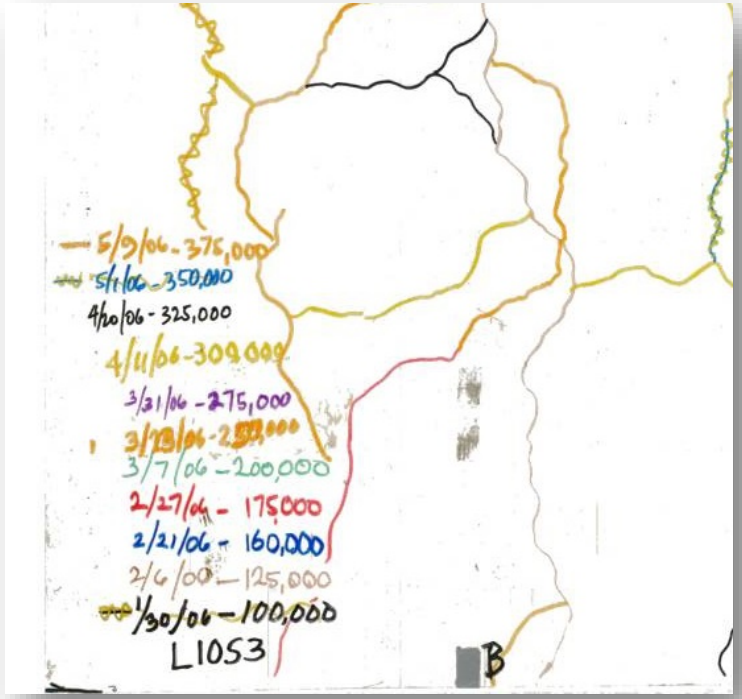
FHWA Accelerated Loading Facility (ALF)

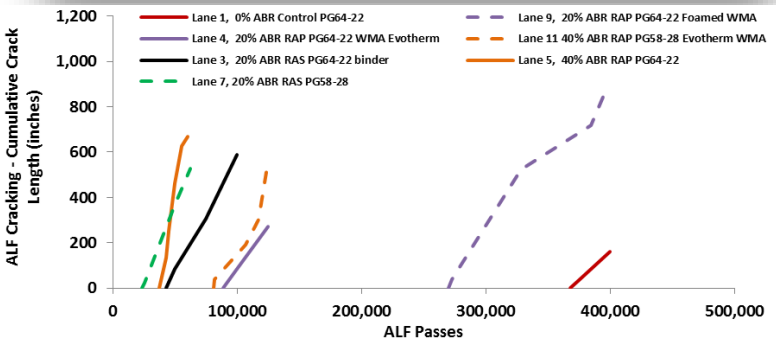
- ALF Loading Conditions
  - Controlled 20°C @ 20mm depth
  - Loading only in one direction
  - Lateral wander
  - 425 Super Single Tire
  - 100 psi inflation
  - 14,200 lb load

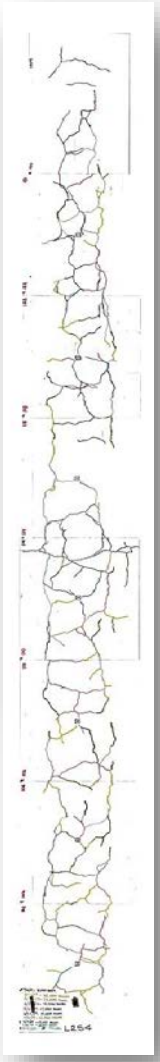


FHWA Accelerated Loading Facility (ALF)

- Cracking performance measured and quantified in two indices
  - Number of cycles until 1st Crack observed
  - Cracking Rate



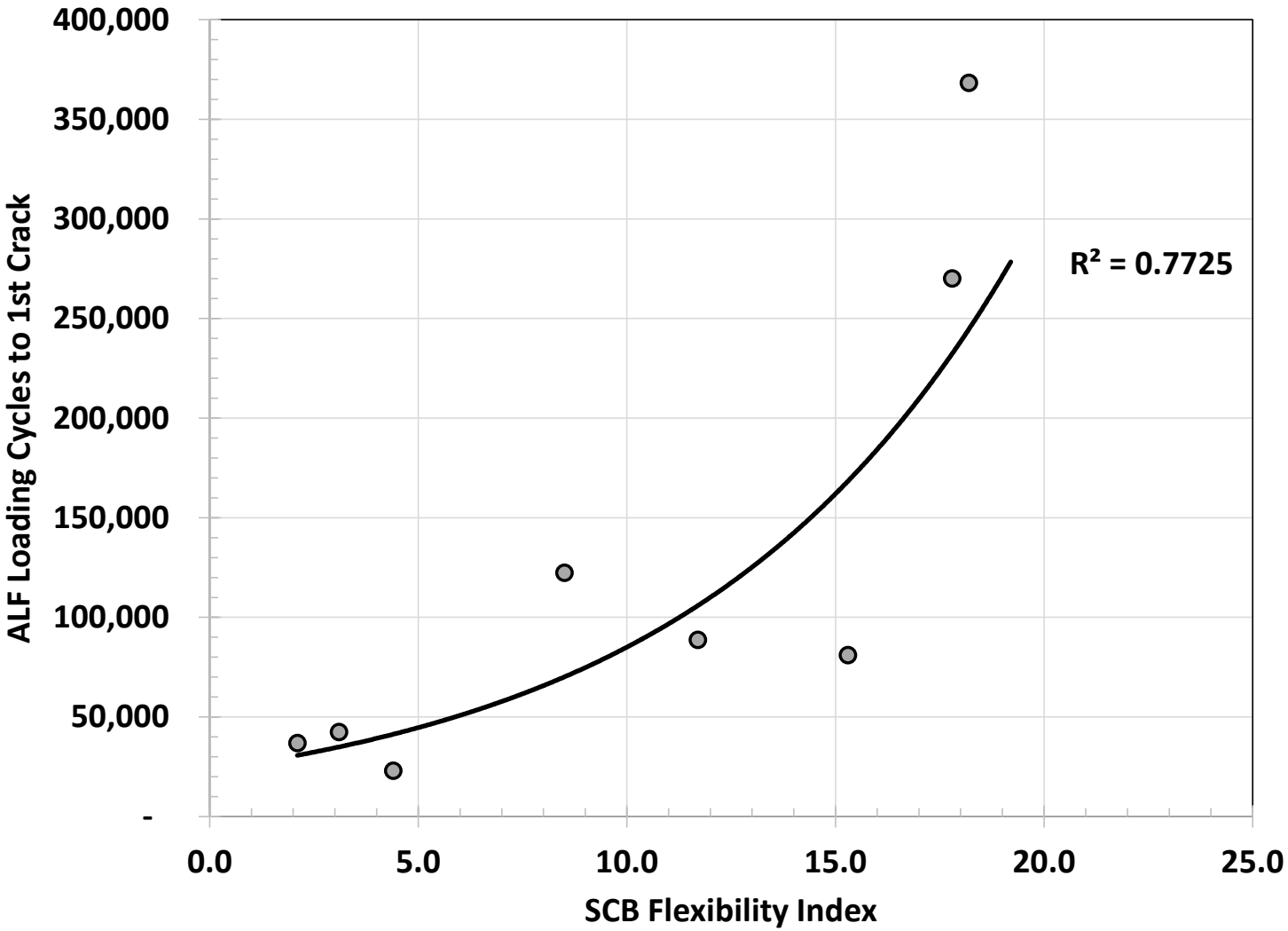




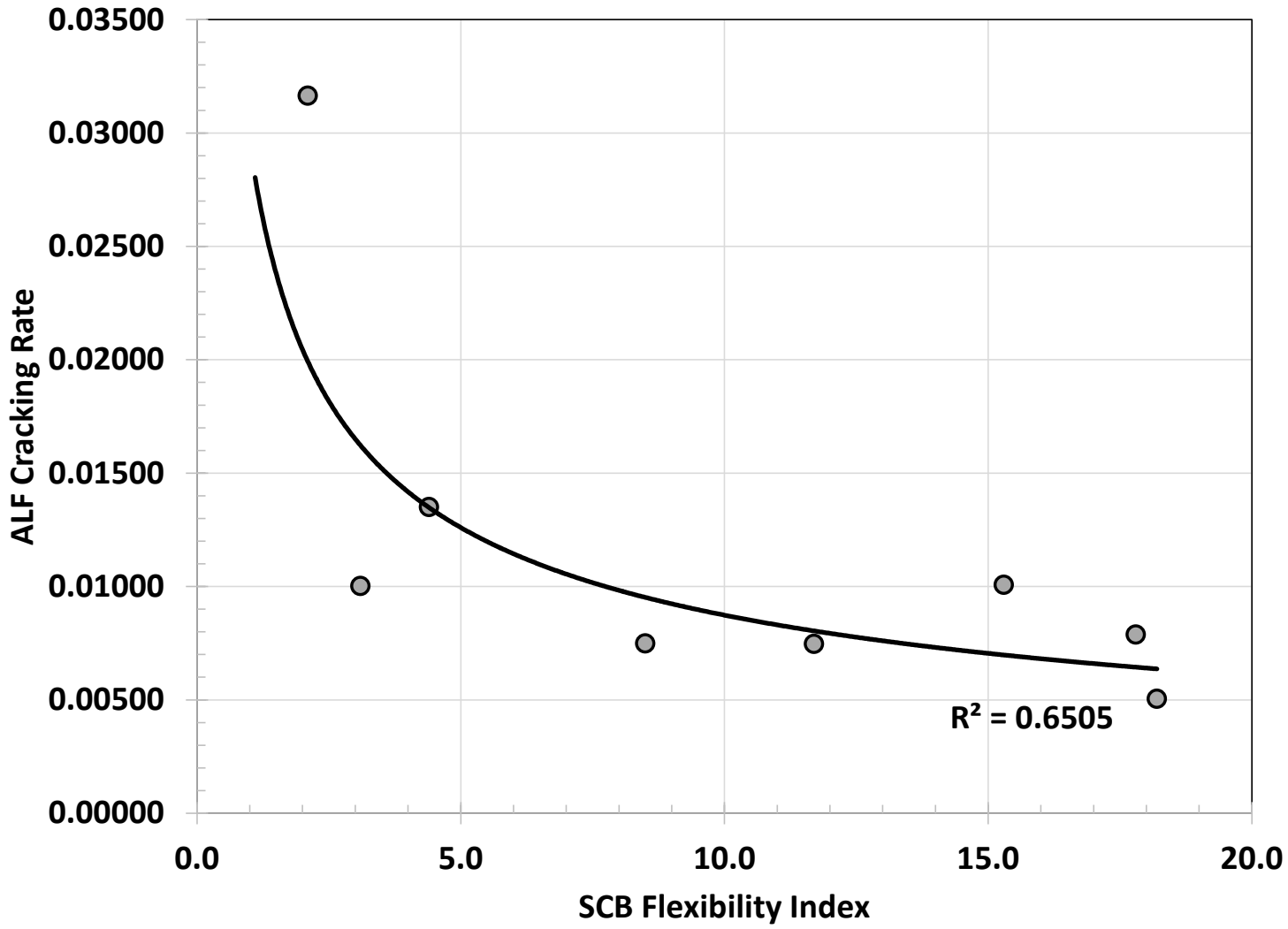
FHWA Accelerated Loading Facility (ALF)

- Question: How well do asphalt mixture and binder tests correlate to field measured fatigue performance?
  - RAP, RAS, WMA
- 10 cores taken from each lane
- Mixture and binder testing conducted on bottom 2 inches of field core to minimize surface aging

SCB FI vs Cycles to 1st Crack



SCB FI vs Cracking Rate



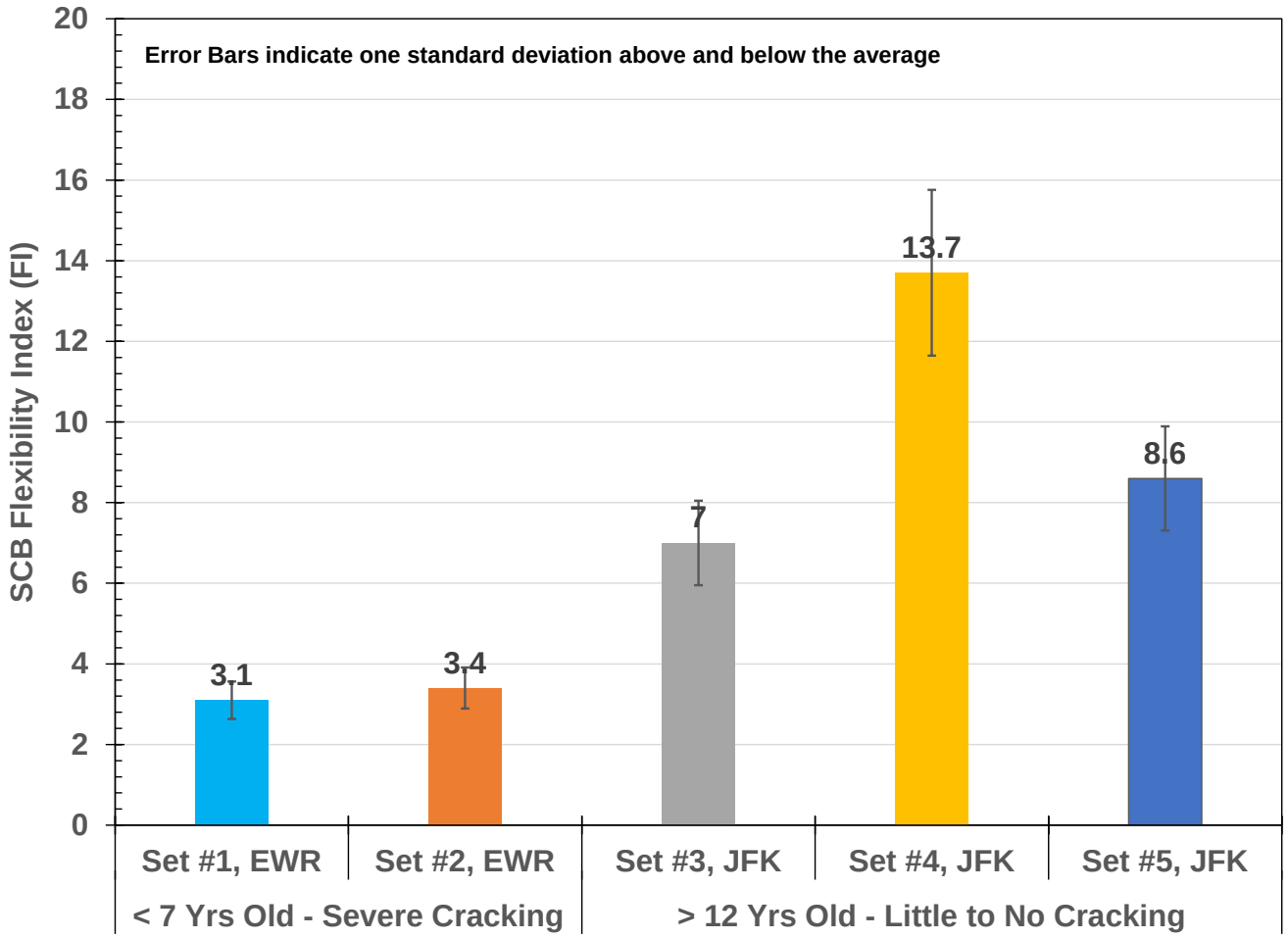
PANYNJ – Newark and JFK Runway Fatigue Cracking

- Evaluate different runway P401 mixtures for their respective fatigue cracking performance
  - 6 different mixes (1 seal coated so eliminated from analysis)
  - Different asphalt binders
  - Different field performance
    - 3 years – performing poorly
    - 15 years – performing well
- "Fatigue" asphalt binder testing
- Mixture fatigue cracking tests
- Ultimately – can we find a binder parameter for purchase specification and mixture specification for Quality Control to promote durable asphalt mixtures

PANYNJ Field Observations

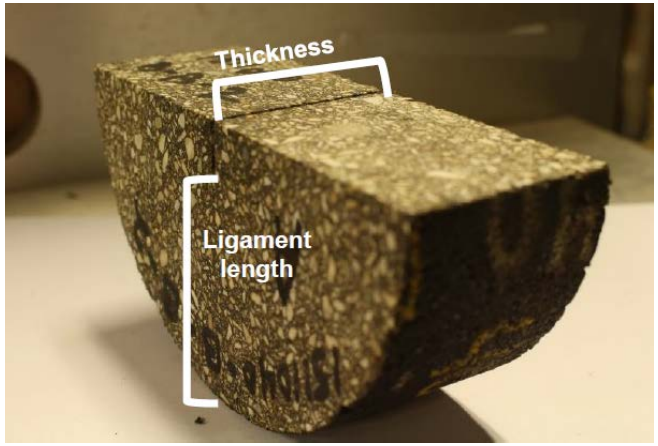
- No rutting
- Longitudinal and transverse cracking observed
- Cracking top-down
  - Stops approximately 0.5" to 0.75" below surface

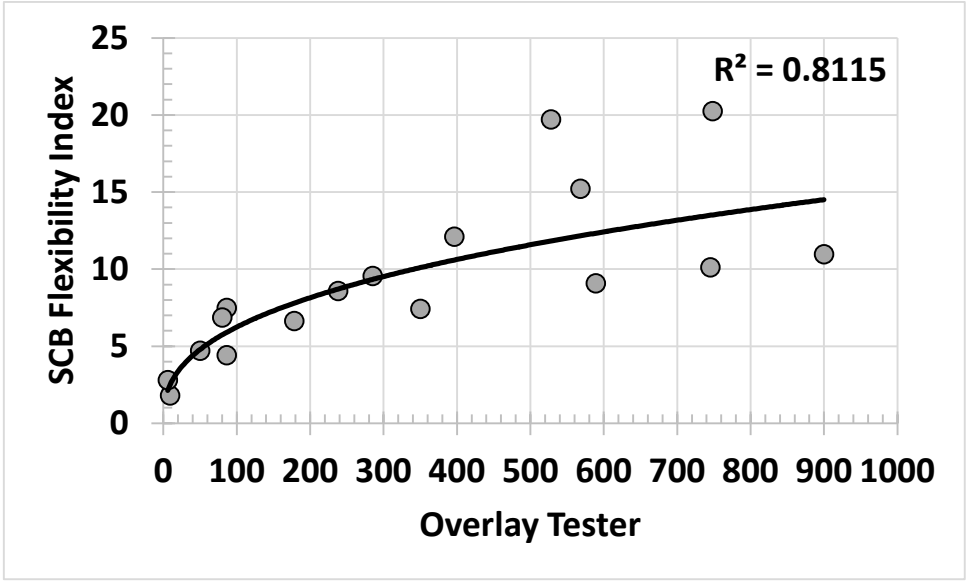
Semi-circular Bend (SCB) Flexibility Index (FI) – Corrected for Thickness



Preliminary Relationship with Overlay Tester

- Initial testing shows possible relationship between SCB Flexibility Index and Overlay Tester
  - Further evaluating in NJDOT Research Study
- With NJ's work showing good relationship between field performance & Overlay Tester, SCB Flexibility Index may be used for GUIDANCE





Specimen Prep – Initial Cut

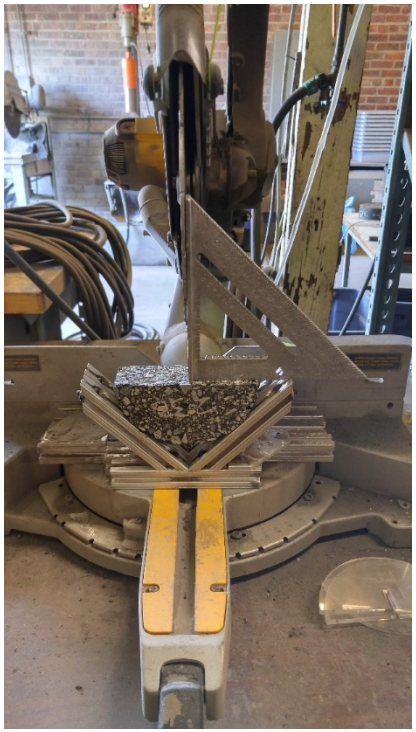
(1)

(2)

(3)

Specimen Prep – Cutting Notch

(1)



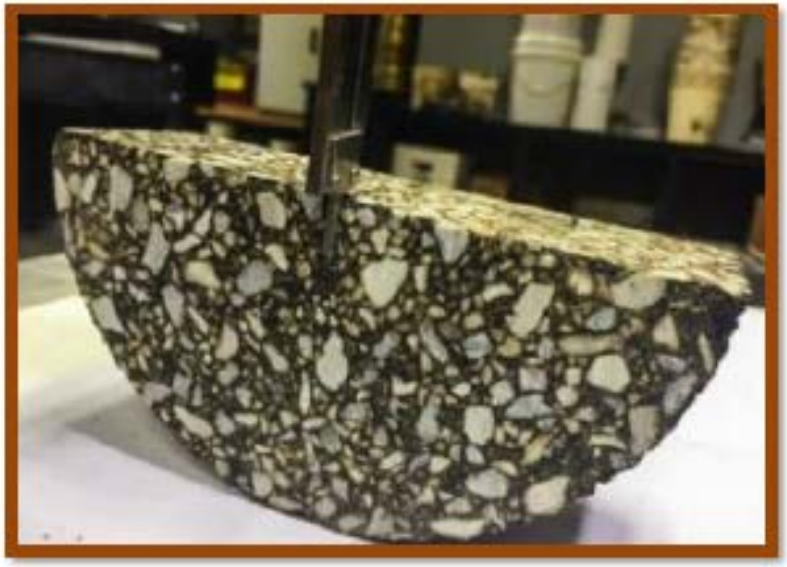
(2)

(3)

Specimen Prep - Dimensions

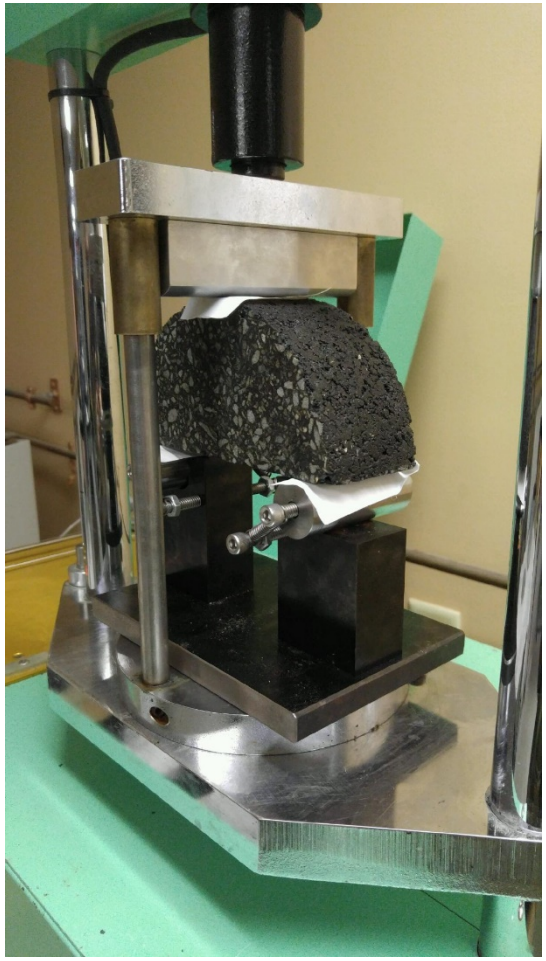
(1)

(2)



(3)

SCB Using Marshall Machine



SCB Using Marshall Machine - Fixture

https://www.globalgilson.com/semi-circular-b... Identified by DigiC... Mail - bennert@soe.rutgers.edu Semi-Circular Bend (SCB) Te...

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NEED SIEVES?

Semi-Circular Bend (SCB) Test Fixture

Home « Asphalt « Asphalt Mix Design « Marshall Testing « Semi-Circular Bend (SCB) Test Fixture

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MS-45 pictured with asphalt specimen

Model: MS-45

Price: $680.00

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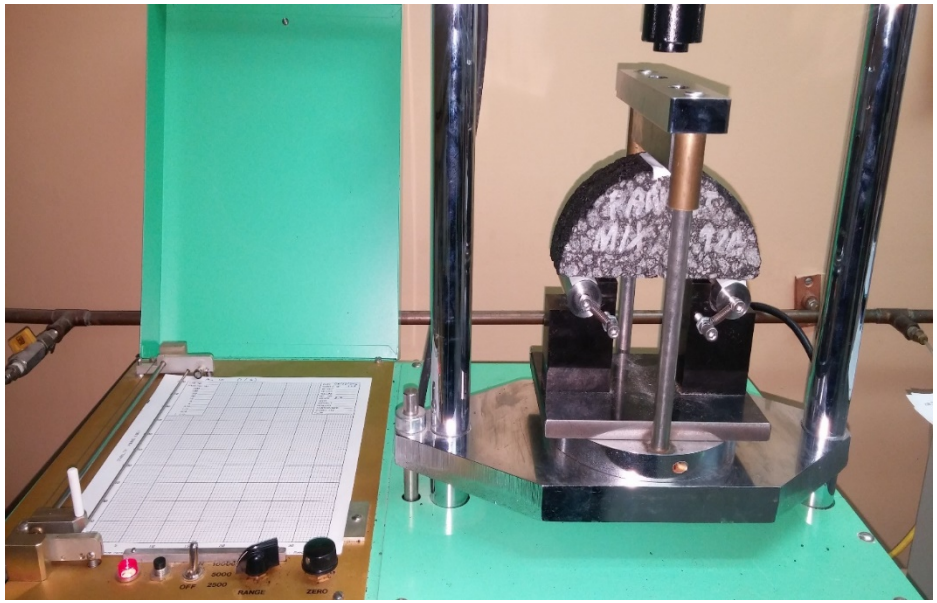
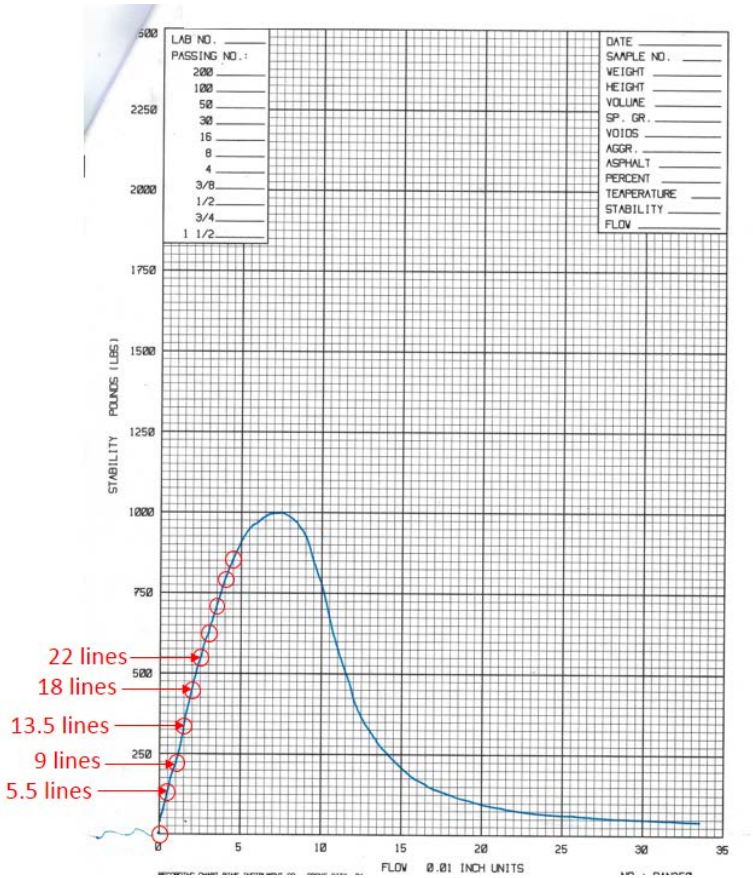
SCB Flexibility Index



Potential SCB Implementation – Analysis



Rutgers University SCB Analysis Using Marshall Press

Sheet Preparation

1) Make sure the following "Add-Ins" are enabled in Excel. You can get to Figure 1 by clicking "File -> Options -> Add-Ins". Click "Go..." for Manage: Excel Add-ins and ensure the three Add-Ins in Figure 2 are selected on your machine.
2) Copy the tab as needed for the amount of samples you would like to analyze in a single Excel Workbook.

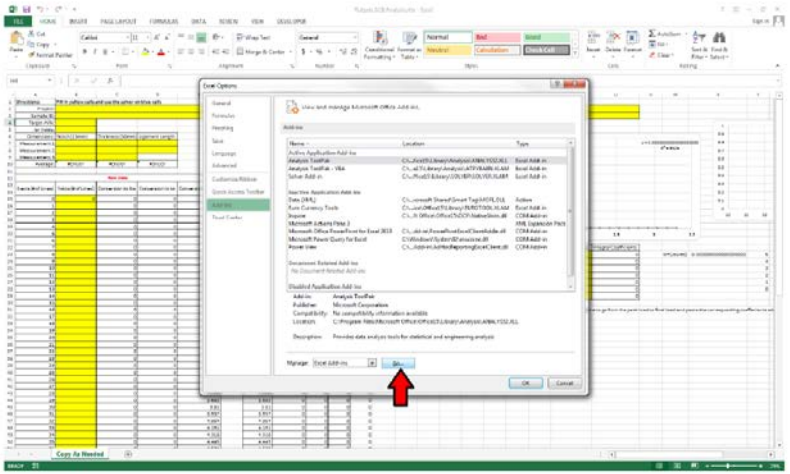
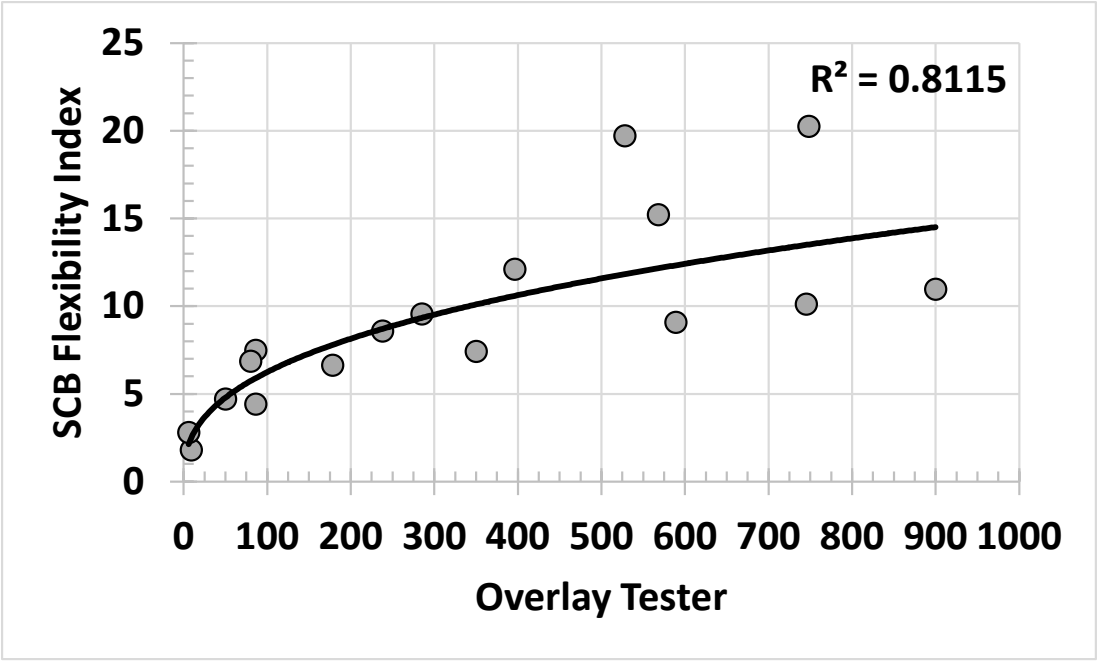


Figure 1 "Accessing Settings"

How Can Asphalt Suppliers Use Information?

- BRIC, HRAP & HPTO (2017) all require Overlay Tester testing but equipment not readily available for everyone
- Suppliers can use relationship to provide guidance whether or not mixture will pass cracking requirement
- Test quick enough to be used during daily QC
- **NOT** to be used for acceptance – NJDOT still using and requiring Overlay Tester – solely used for **GUIDANCE**
  - Test method allows asphalt suppliers to evaluate mixes on their own (i.e. – impact of RAP%, WMA, rejuvenators, binder grade/type)

Overlay Tester vs SCB Flexibility Index – Preliminary Guidance Values



Mix Type	OT (cycles)	SCB FI
HRAP	> 175	> 8
BRIC/HPTO	> 700/750	> 14

QC Lab Performance Testing

- Laboratory tests available for asphalt suppliers to provide help in design and material evaluation
  - Not intended for acceptance – **ONLY GUIDANCE**
- Ultimately acceptance would continue to be conducted with APA (rutting) and Overlay Tester (fatigue) until more experience gained
- These proposed methods will allow:
  - Asphalt suppliers to evaluate mixtures prior to design submittal
  - Possible use during QC testing
  - With more research/experience, potential use as QA tests that can be conducted by both agency and industry with little dollar investment


Thank you for your time!
Questions?
Thomas Bennert, Ph.D.
Rutgers University
609-213-3312
bennert@soe.rutgers.edu