

Research Innovation at Rutgers University

Presented By:

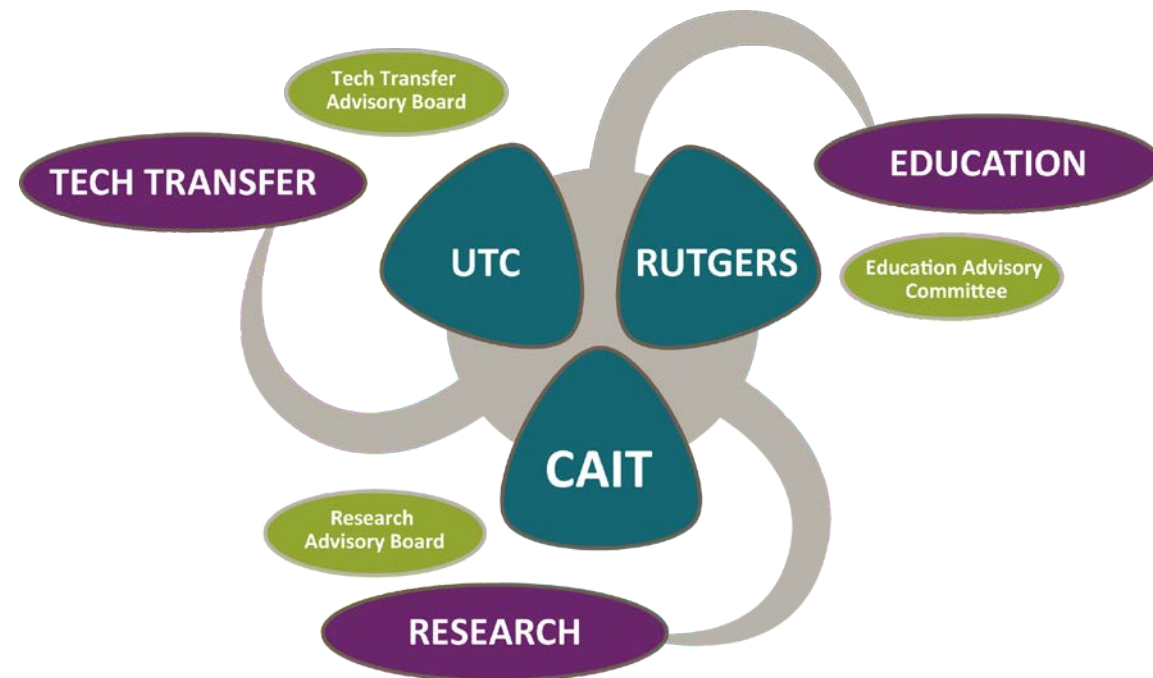
Thomas Bennert, Ph.D.
Center for Advanced Infrastructure and Transportation (CAIT)
Rutgers University



Center for Advanced Infrastructure and Transportation (CAIT)

CAIT's Mission

Solving complex, interrelated transportation and infrastructure problems, specifically in high-volume, multimodal corridor environments.

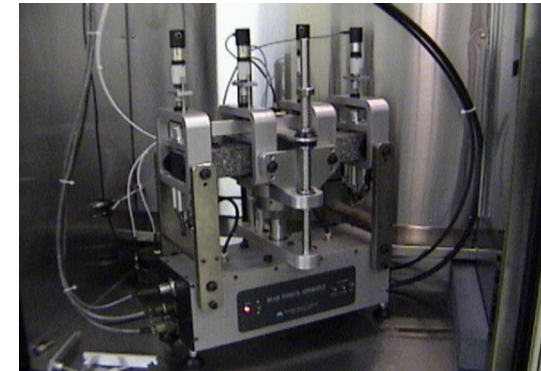
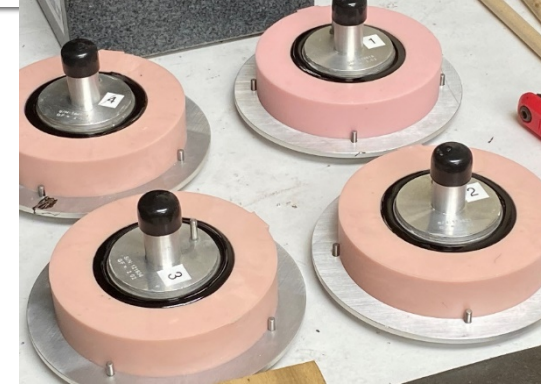
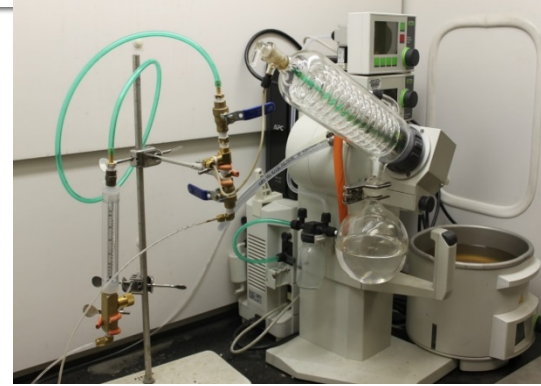




don't be afraid to
get your hands dirty

Rutgers Asphalt Pavement Laboratory (RAPL)

- 20,000 ft² facility
- AASHTO AMRL accredited for Asphalt Mixture, Asphalt Binder, Aggregate
- 10 full-time staff
 - 4 to 8 undergrad/grad students
- Activities;
 - Innovative Materials & Technologies
 - Pavement Management & Design
 - Technology Transfer & Training

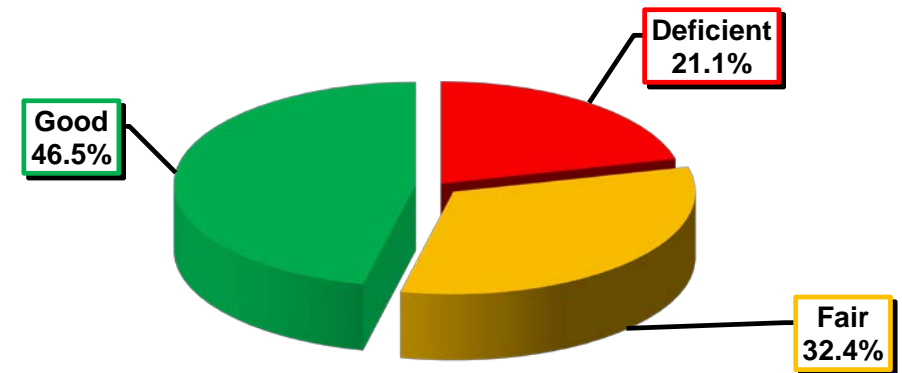


RAPL Involvement with Pavement Preservation Activities

RAPL Pavement Preservation Activities

- Significant work conducted for NJDOT
 - Annual Pavement Preservation goal ≈ \$50M to \$100M per year
 - NJDOT looking for RAPL to provide technical support
 - Better material characterization
 - Current, new and recycled materials
 - Validating performance and use
 - Material & Spec Development
 - Lab Simulation of Construction & Field Performance
 - Improving Construction Practices

NJDOT Maintained Pavement Status Based on IRI & SDI
(Based on 2021 Data)



Source: NJDOT Pavement Management System, 2021 Data

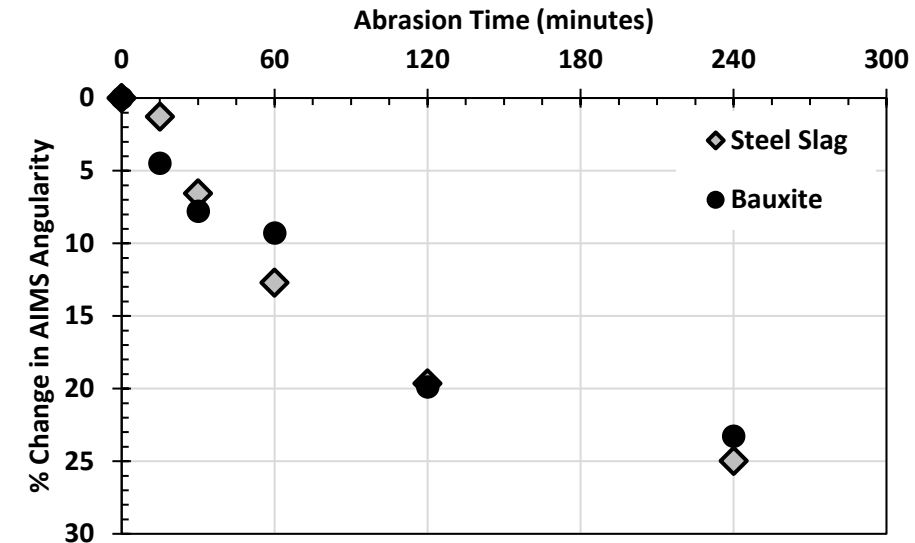
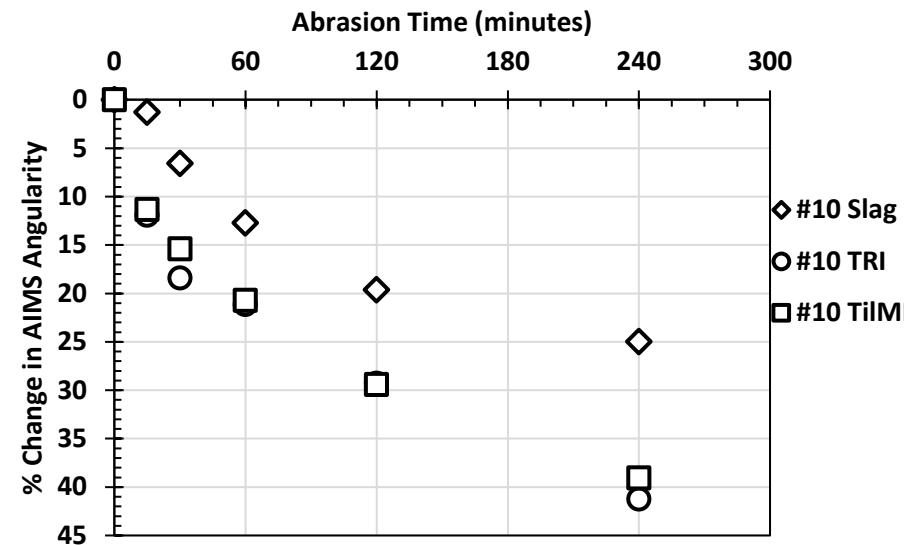
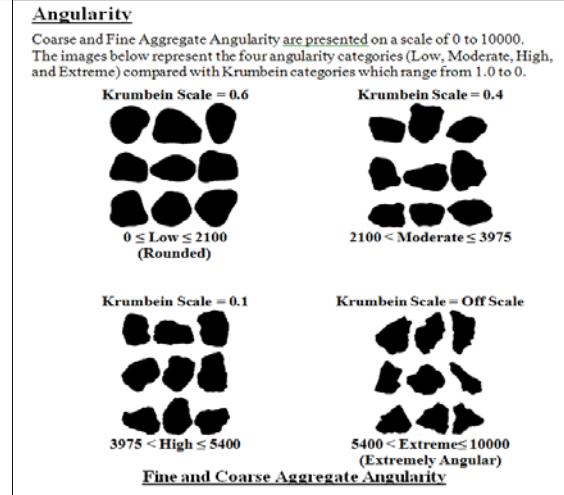
Characterization of Materials

- Exploring methods to evaluate materials in lab prior to field application
 - Ex. Steel slag for aggregates for high friction applications
 - By-product of steel production
 - High friction
 - Low abrasion
 - High density/moderate absorption



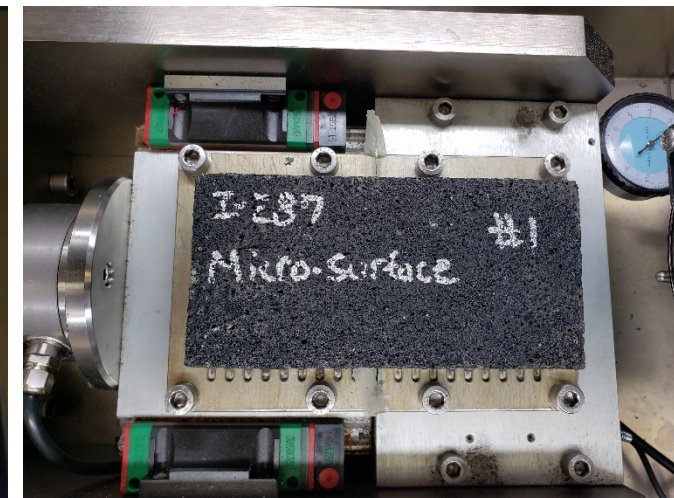
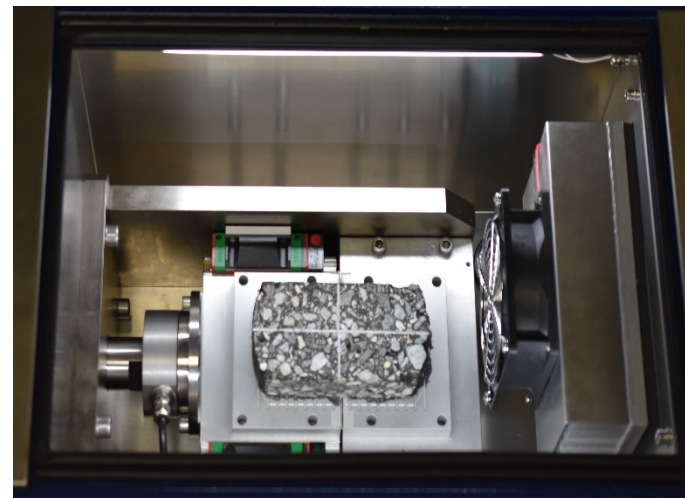
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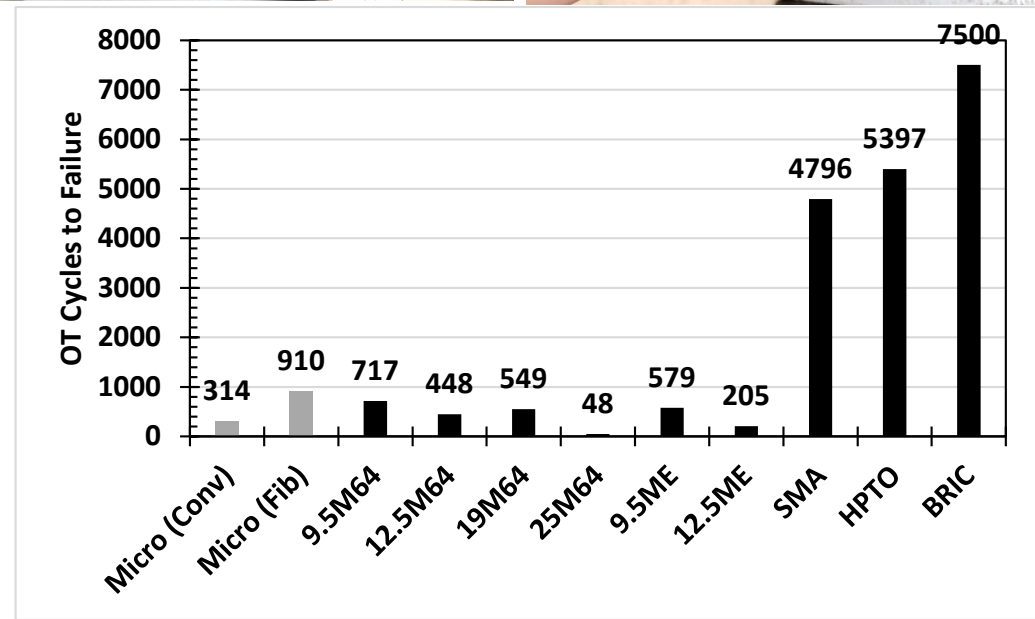
Validating Cracking Resistance

- Question:
 - Are pavement preservation technologies as crack resistant as conventional HMA?
 - Can we evaluate the impact of additives?
 - Ex. – Comparing Micro to HMA;
Micro with & without Fibers



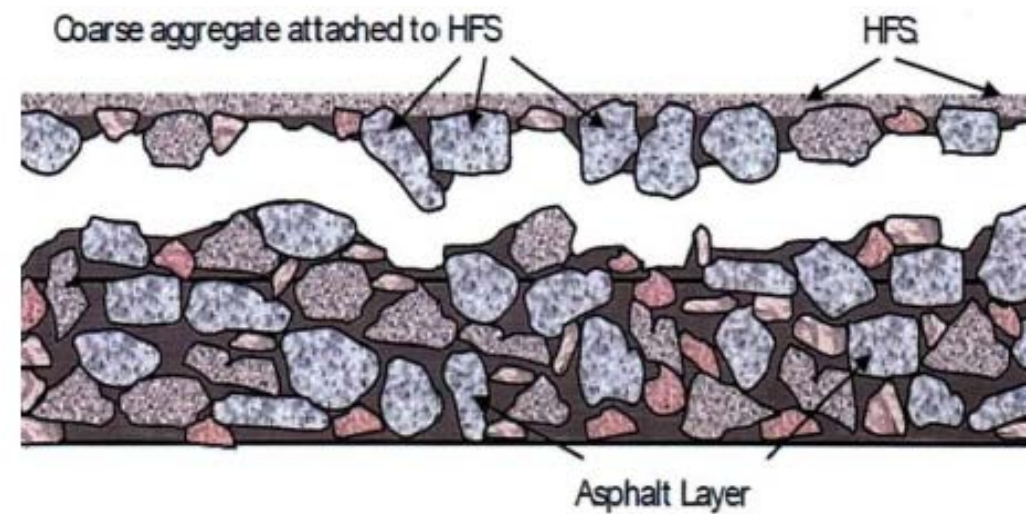
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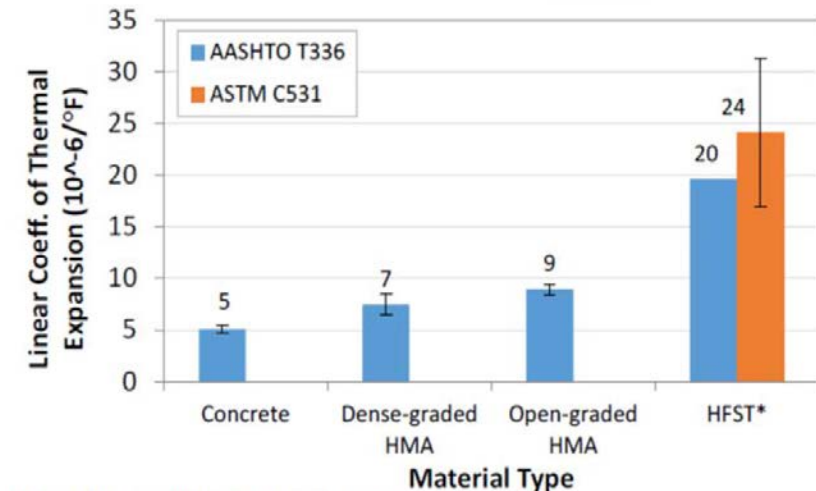
Developing New Applications/Project Screening Tools

- High Friction Surface Treatment (HFST)
 - Substrate Failure – Top-down & Shallow Horizontal Cracking
 - Due to weak substrate
 - Areas of extreme stopping & slow turning
 - Thermally induced stress
 - Excessively thick & stiff HFST layer (epoxy)



Developing New Applications/Project Screening Tools

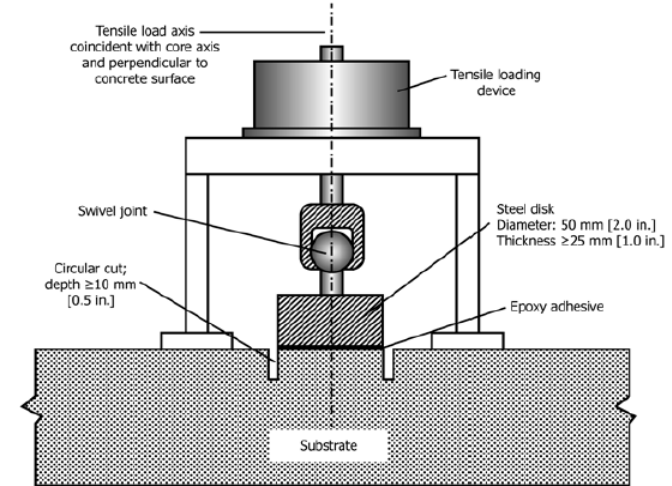
- Substrate Failure – Top-down & Shallow Horizontal Cracking
 - Typically $\frac{1}{4}$ " to $\frac{1}{2}$ " deep
 - Epoxy and asphalt mixtures are thermally incompatible
 - Epoxy has an expansion/contraction rate 3 to 4 times greater than asphalt mixtures
 - Worst situation – cool/cold temperatures with a quick, large temperature decrease



*From designs with different resin binders

Developing New Applications/Project Screening Tools

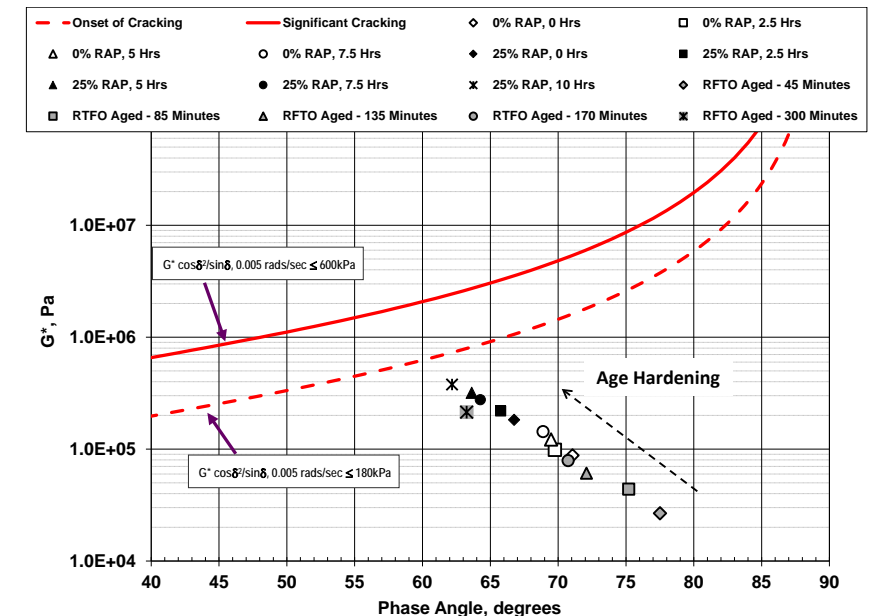
- Test methods selected;
 - ASTM C1583 – testing pull-off strength of existing substrate tested at 25°C
 - 6 inch field cores work well
 - Asphalt binder characterization from upper 1/2" to 3/4" of existing asphalt pavement for “durability”
 - Glover-Rowe Parameter



Developing New Applications/Project Screening Tools

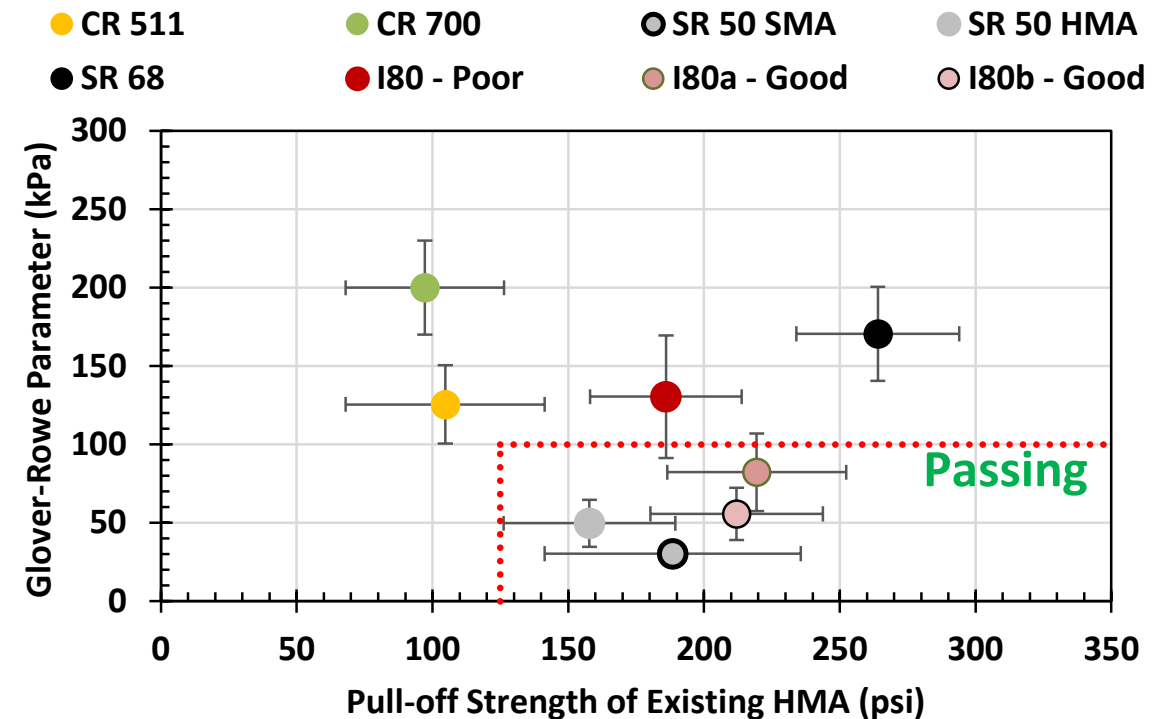
- Rowe (AAPT, 2011) proposed the DSR master curve analysis to calculate the “Glover-Rowe” parameter
 - As G-R parameter increases, the binder is more prone to fatigue cracking
 - Correlates very well to ductility of asphalt binder
 - G^* = shear modulus (stiffness of asphalt binder)
 - δ = phase angle (relaxation of asphalt binder)

$$\frac{|G^*|(\cos \delta)^2}{\sin \delta}$$



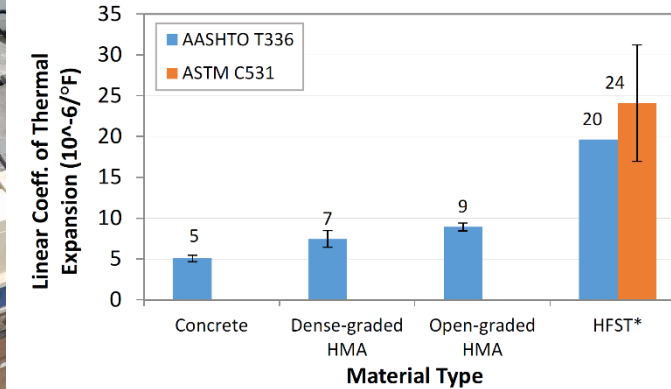
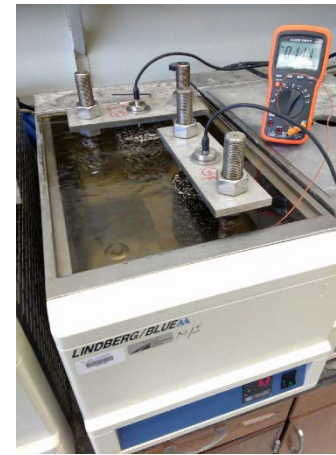
Developing New Applications/Project Screening Tools

- Even though a pavement is visually in “good condition”, asphalt may still be prone to raveling/durability issues of “aged” asphalt
 - Binder testing to address quality of asphalt binder in existing pavement surface
 - Mix testing to address quality of mix strength properties in existing pavement surface

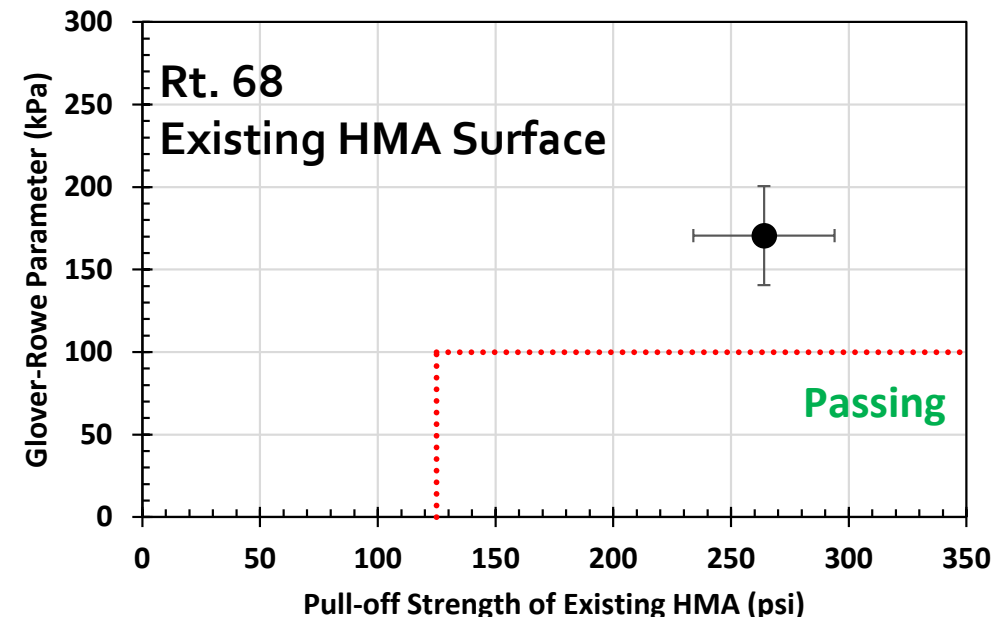


Developing New Applications/Project Screening Tools

- What if we tried high friction aggregate with a highly modified asphalt binder?
 - Asphalt-based binding system more thermally compatible than epoxy resin
 - High PG to maintain stiffness in hot temperatures
 - Low PG properties to aid in thermal contraction movements



*From designs with different resin binders



Developing New Applications/Project Screening Tools

- Asphalt binder met the requirements for FAA P₄₀₄, *Fuel Resistant (FR) Asphalt Mixture*
 - PG88-22 with Evotherm applied hot 0.3 to 0.38 gal/yd²
- Aggregate “chips” spread at 14 to 18 lb/yd²
- Rubber wheel rollers to seat aggregate & loose aggregate swept



Developing New Applications/Project Screening Tools



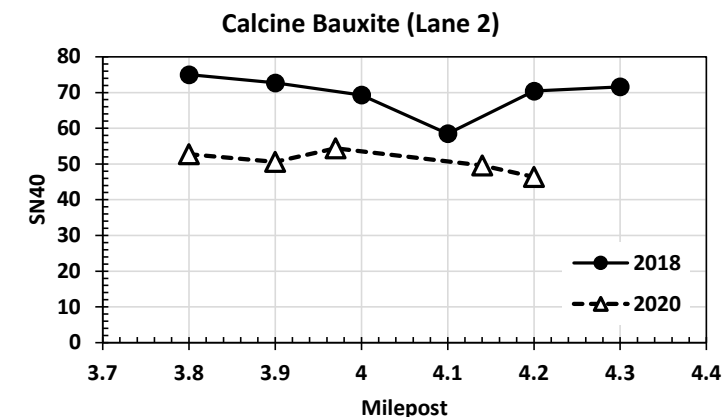
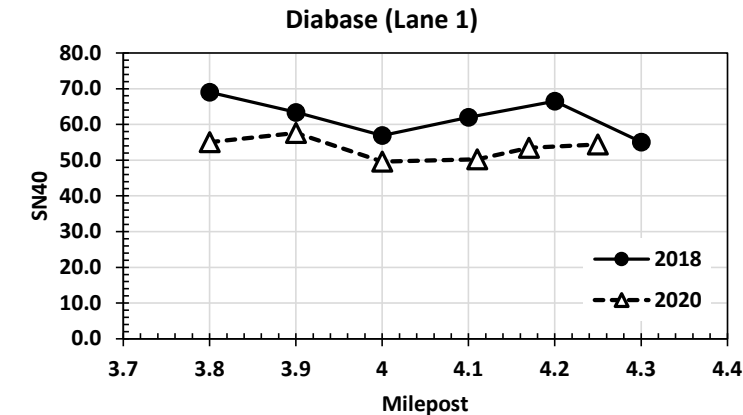
Diabase Aggregate



Calcine Bauxite

Developing New Applications/Project Screening Tools

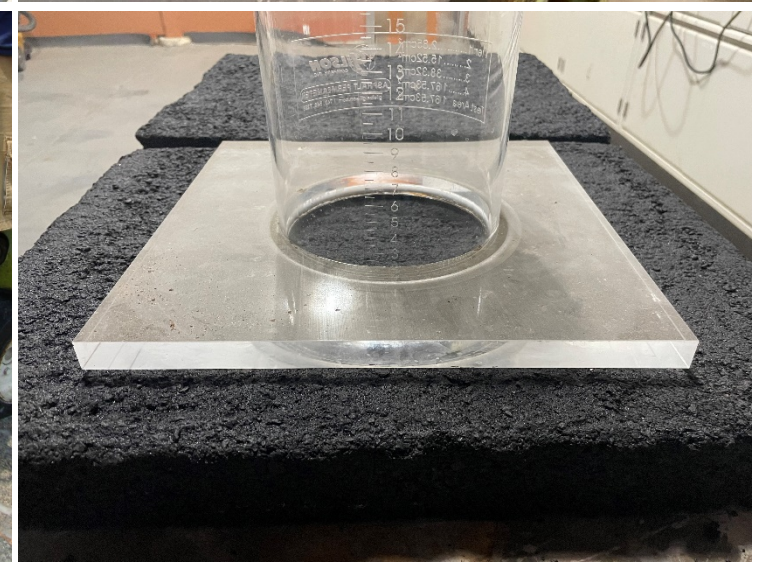
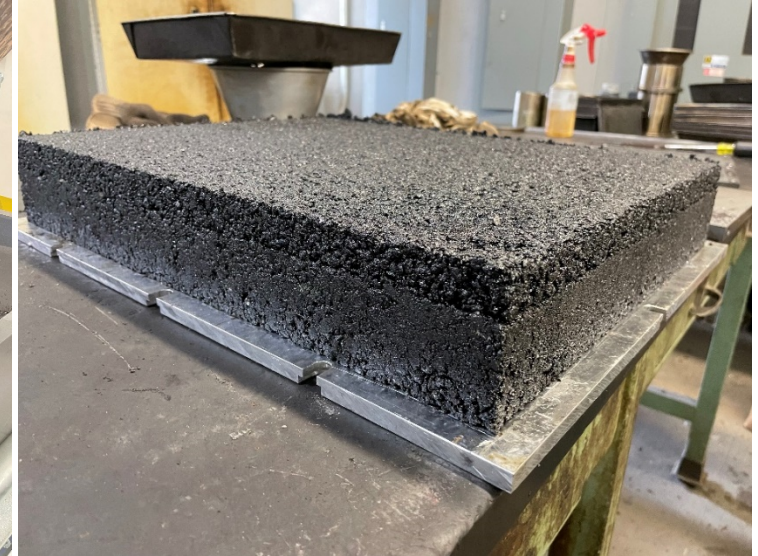
- Skid Testing was conducted in accordance to ASTM E274
 - Initial results looked good (SN₄₀ Ave > 60)
 - After 2 years, values dropped around 10 to 20%
 - Skid friction influenced by bleeding of adjacent asphalt rubber chip seal major issue



Simulating Wear and Bonding

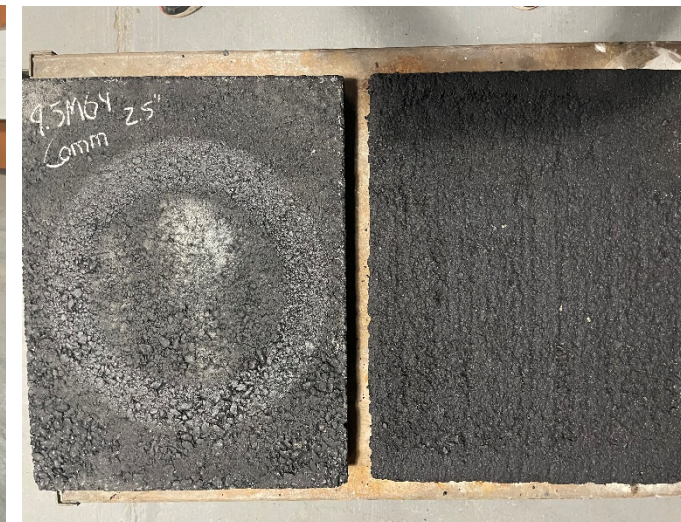
Simulating Wear and Bonding

- Question:
 - Can we evaluate which materials best provide friction over time?
 - Can we evaluate resistance to abrasion prior to field placement?
 - Impact of tack coat materials/surface preparation on bond strength?



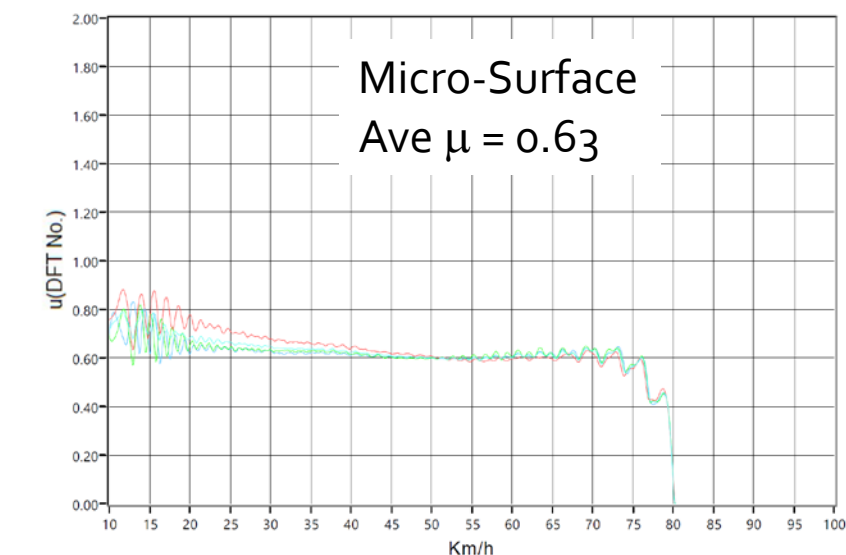
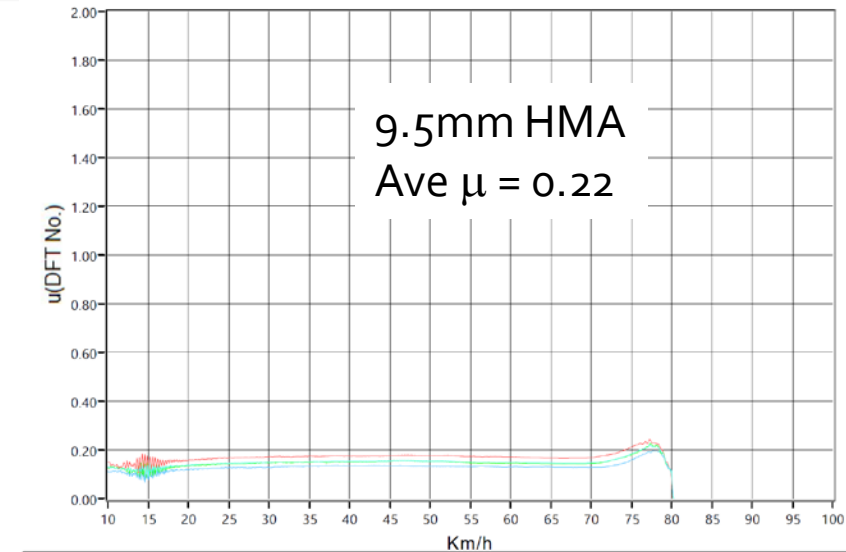
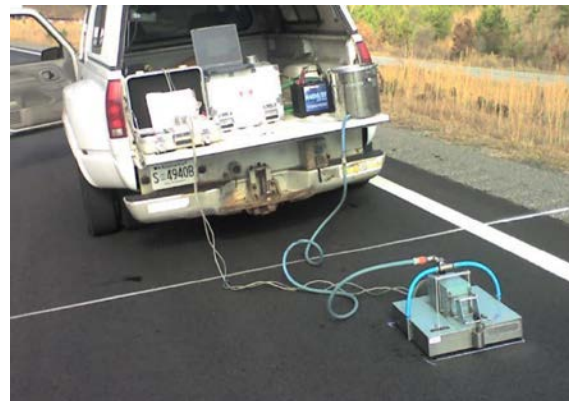
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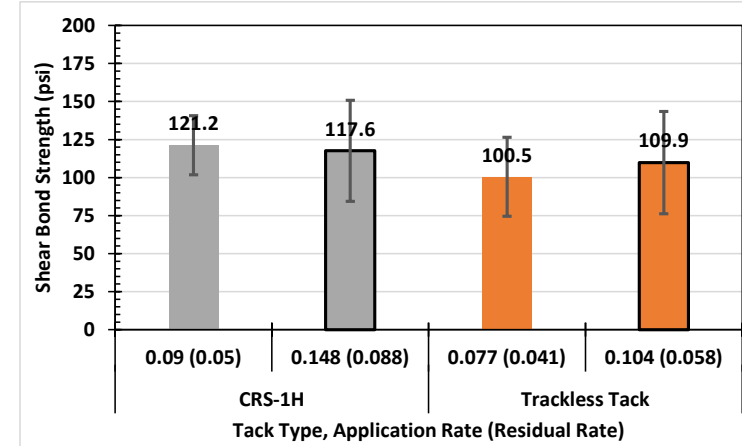
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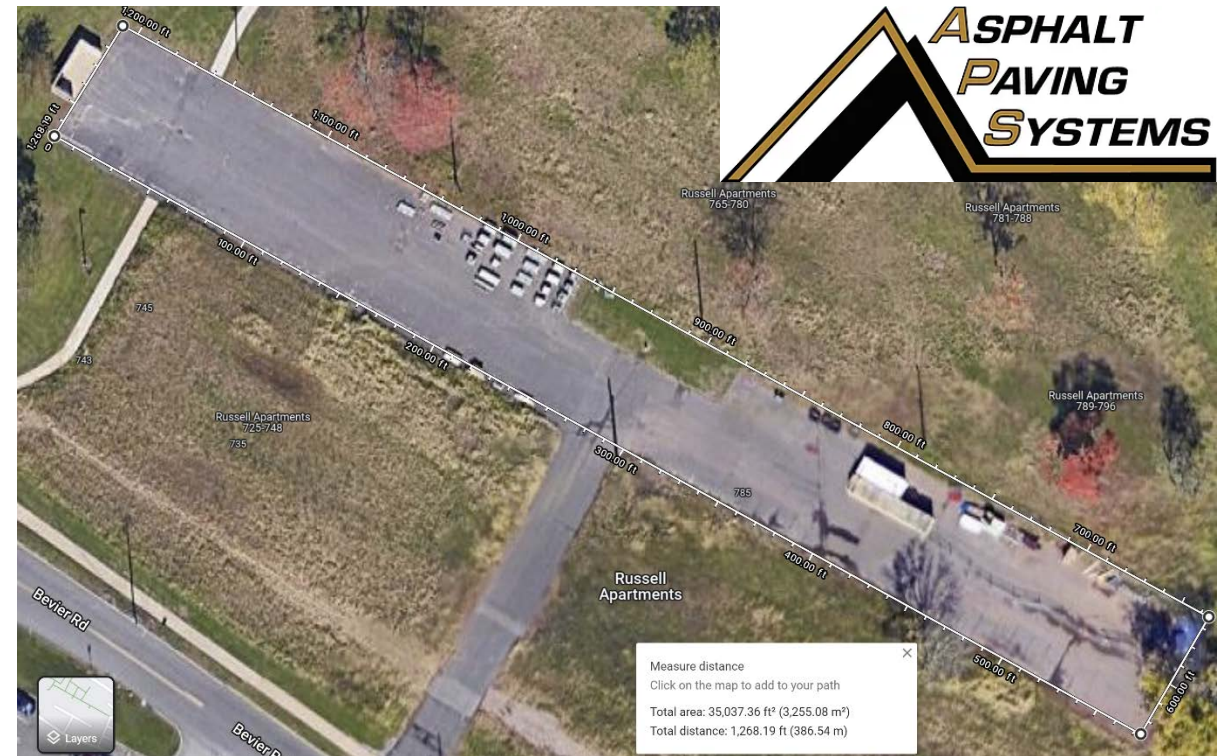


Rutgers Living Laboratory (Coming 2023)

Rutgers Living Laboratory

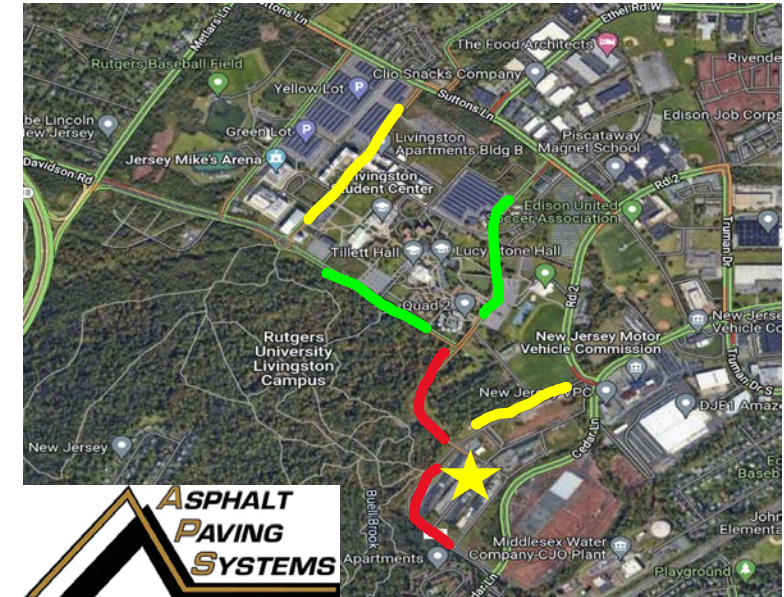
■ Construction Practices

- Approximately 570 ft x 70 ft
- Impact of construction practices
 - Milling; surface prep; tack coat/VRAM application
 - Bond strength; permeability; density
- Cold In-Place Recycling
- Classroom and Field Training



Rutgers Living Laboratory

- Field Sections at Rutgers
 - Utilizing the some of the Livingston campus network to evaluate different applications
 - Test sections close to laboratory for material collection and evaluation
 - High friction chip seals (HFCS)
 - Chip seals with RAP
 - Micro-surface Treatments



As Ted Lasso reminded us..
“Be curious, not judgmental...”



Thank you for your time!

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