WORKSHOP ON BITUMEN EMULSION TECHNOLOGY

10TH JUNE 2026
VIENNA, AUSTRIA

Beyond the Surface: Tack Coat Strategies for Durable Asphalt Pavements

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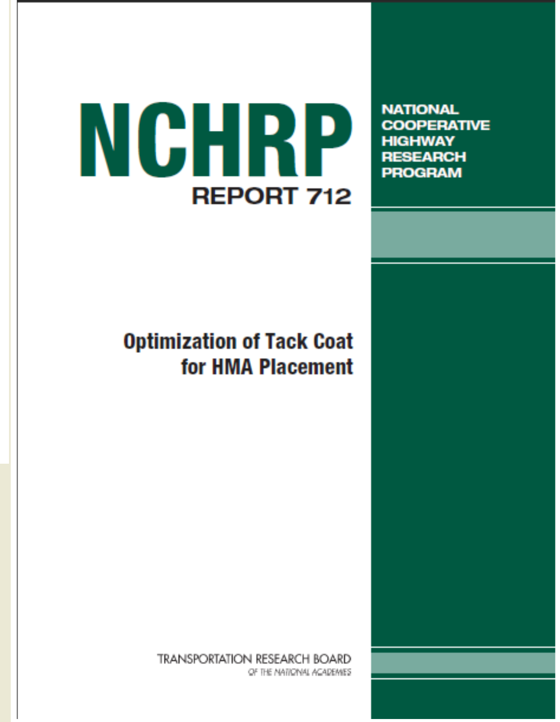
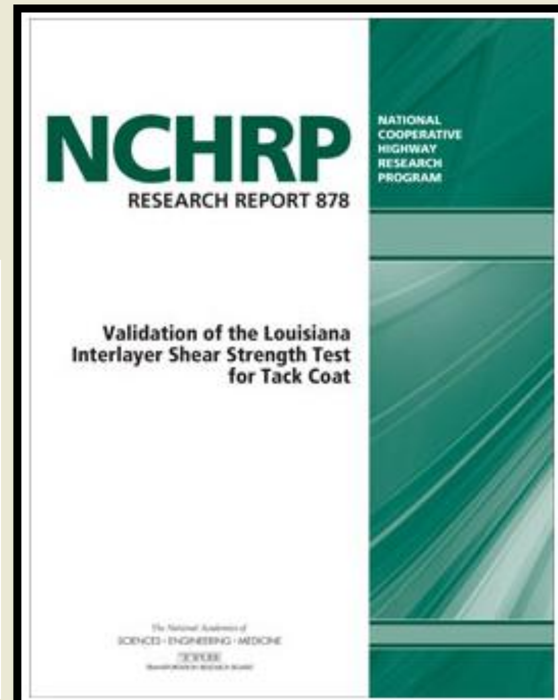
International Bitumen Emulsion Federation

Key Topics

- Durability
  - Pavement Performance
  - Bonding
- Tack Coat Research
  - NCHRP Project 9-40
    - » Report No. 712
  - NCHRP Project 9-40A
    - » Report No. 878
- Summary and Conclusions



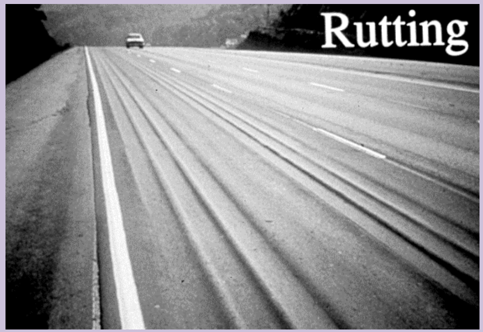


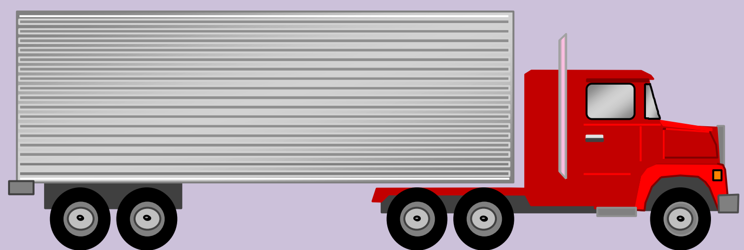
Acknowledgement

- **NCHRP**
  - Technical Review Panel
  - State DOTs
- **LTRC Asphalt Lab**
- **State DOTs**
  - **Missouri; Louisiana; Florida; Tennessee; Nevada; Oklahoma**
- **Material Suppliers and Contractors**
  - Asphalt Products Unlimited
  - Ergon Asphalts
  - Blacklidge
  - Coastal Bridge
  - …

Durable Flexible Pavement

- Permanent deformation
- Fatigue cracking – repeated load
- Low temperature cracking
- Moisture induced damage
- Raveling
- etc …





Durable Flexible Pavements

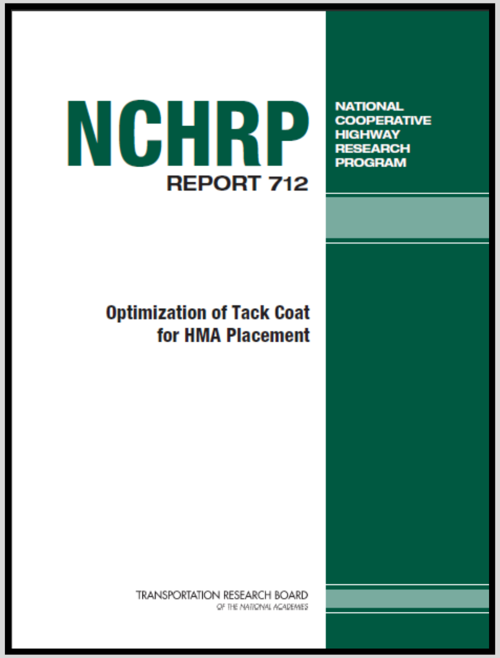
- **Mixture Design**
  - Components Materials
  - BMD
  - Sustainable Development
- **Construction**
  - Tack Coat Practices
  - Thermal segregation
  - Warm Mix Asphalt
  - Increased density
  - …

Laboratory Design

Field Construction

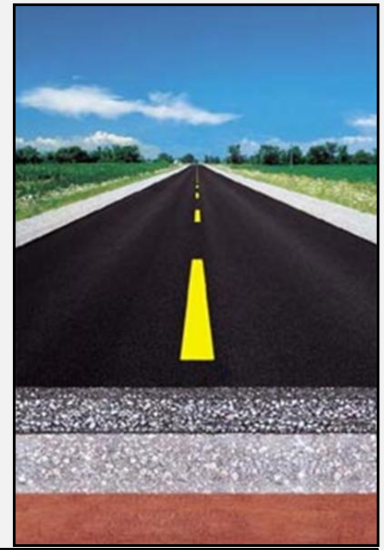
Durable Flexible Pavements

- Mixture Design
  - Components Materials
  - Engineered Performance /
  - Sustainable Development
- **Construction**
  - Tack Coat Practices
  - Thermal segregation
  - Warm Mi
  - Increased



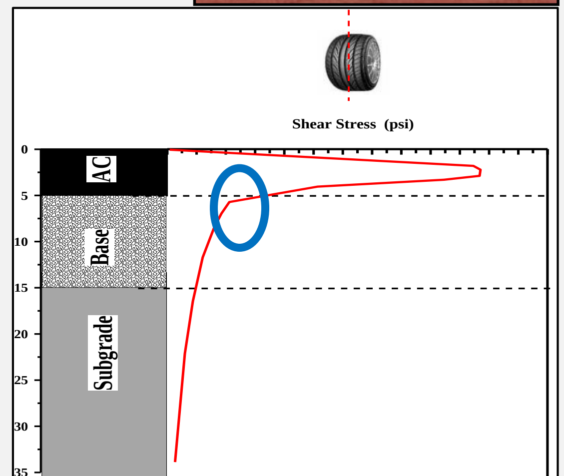
Field Construction

Durable Pavement – Construction Tack Coat

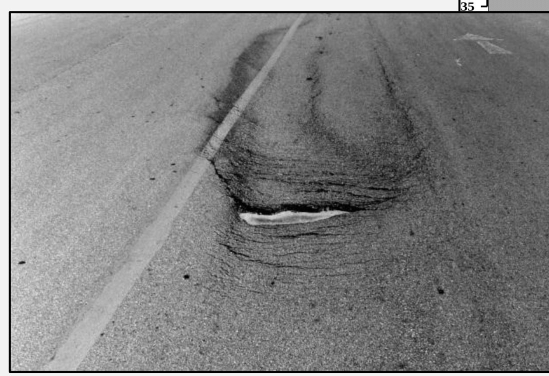


- **Purpose of tack coat application**
  - To ensure adequate bond between pavement layers
  - To transmit traffic loads down through the whole pavement structure
- **Not properly bonded, increase tendency for**
  - Debonding (delamination/slippage/sliding), and/or
  - Fatigue cracking
  - Permanent deformation

  …and thus failure in the surface overlay

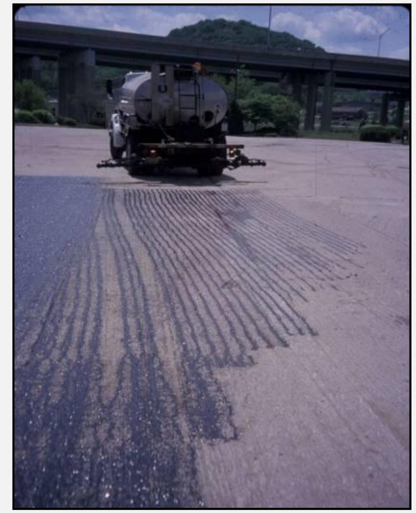


- **Tack coat material is relatively inexpensive portion compared to overall pavement construction cost**
  - Bonding failure is extremely $$$!!!



Improper Tack Coat Application






Courtesy of James A. Scherocman

Proper Tack Coat Application
Uniform Coverage

0.031 gsy

Low

0.062 gsy

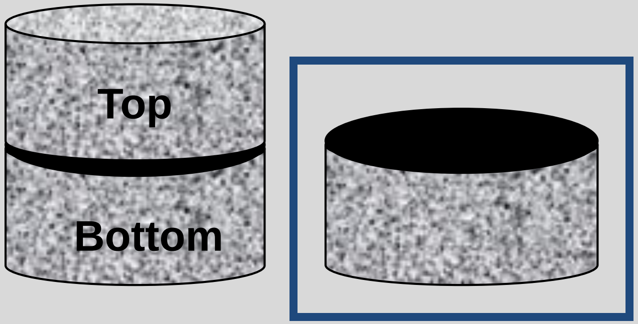
Medium

0.155 gsy

High

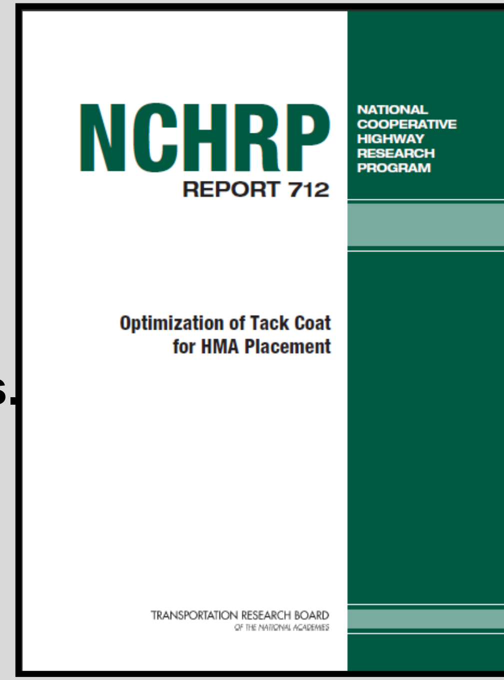
Objectives – NCHRP Project 9-40

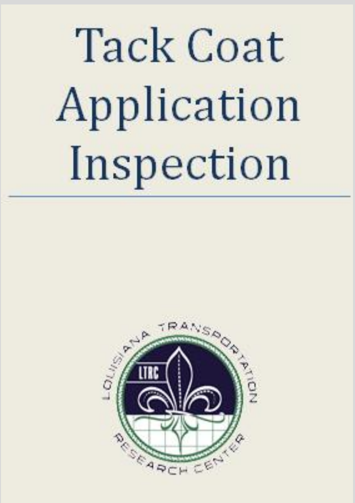
- **Evaluate factors that affect interlayer bonding**
  - Tack coat material type and application rate
  - Pavement surface type
  - Temperature
  - Construction condition
- **Develop AASHTO test methods and practices related to tack coats**
  - Tack Coat Quality
    - spray application
  - Interlayer Bond Strength

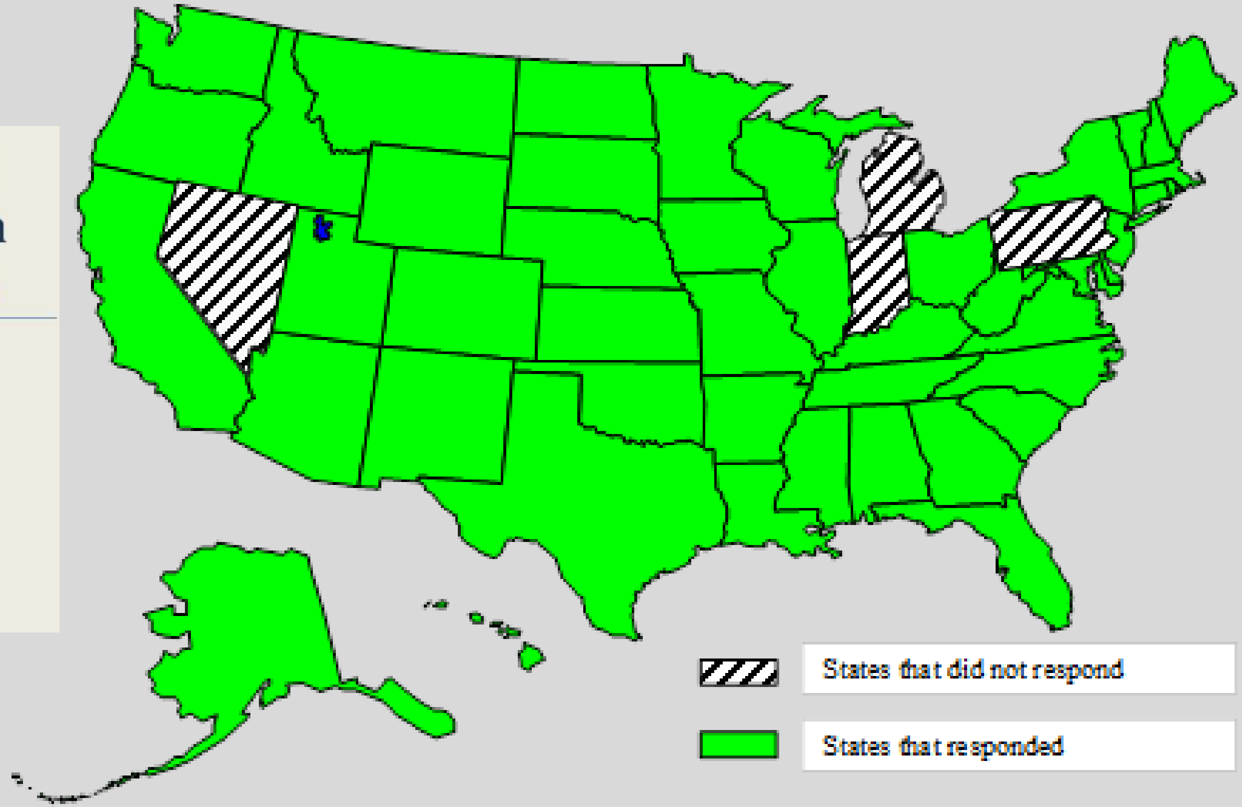


Outcome – NCHRP Project 9-40

- Worldwide Survey on Tack Coat Practices
  - 92% return
  - Canada, Denmark, Finland, South Africa, and the Netherlands.
- Best Practices and Training Manual
  - recommended construction and testing procedures





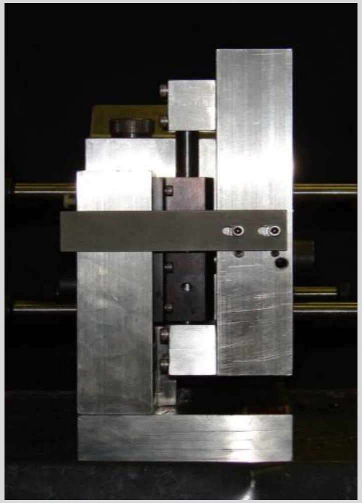


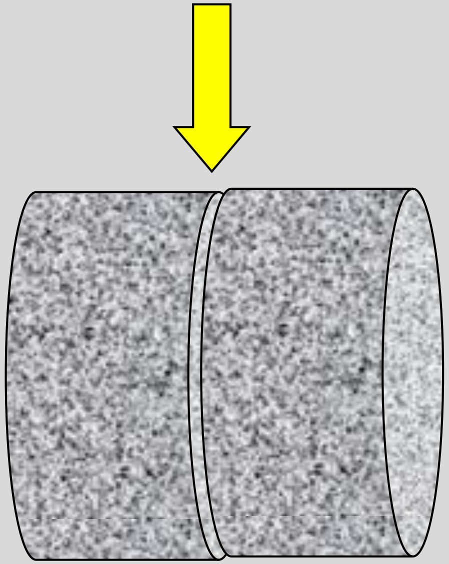
Outcome – NCHRP Project 9-40

- **Recommended tack coat residual application rates**
- **AASHTO T 407 and AASHTO T 408 test method was developed to characterize Bond Strength and spray quality of tack coats**
- **Recommended threshold Interface Shear Strength criterion**
  - **Minimum 40 psi – from AASHTO T 407**

Surface Type	Residual Application rate, gsy
New HMA	0.035
Existing HMA	0.055
Milled HMA	0.055
PCC	0.045

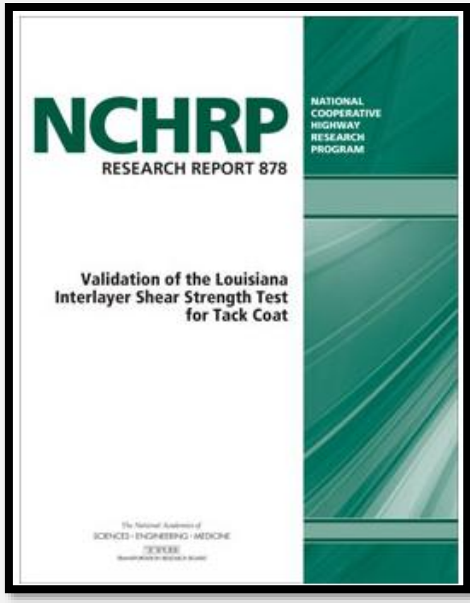
AASHTO T 407





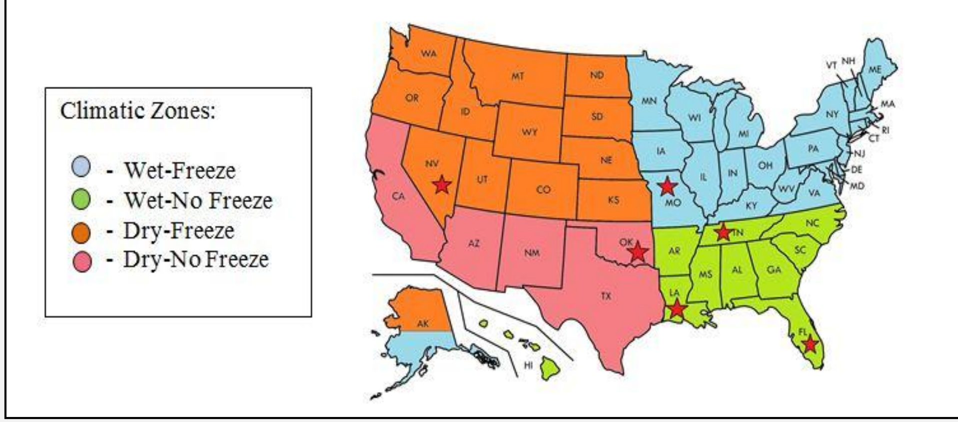
Objective – NCHRP Project 9-40A

- **Validate AASHTO T 407 test method and minimum recommended ISS threshold (40 psi) criterion**
- **Evaluate factors that affects interface bonding**
  - Pavement Surface Type
  - Tack Coat Material Type
  - Residual Application Rate
  - Service Time – 12 months
- **Investigate effect of bonding on short-term pavement performance**


NCHRP
NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
RESEARCH REPORT 878
Validation of the Louisiana Interlayer Shear Strength Test for Tack Coat

Scope

- **Six field projects**
  - Missouri; Louisiana; Florida; Tennessee; Nevada; Oklahoma
- **Four Pavement surface types:**
  - New HMA; Existing HMA; Milled HMA; PCC
- **Tack coat material types:**
  - Slow setting
    - SS-1H, CSS-1H, SS-1
  - Non-tracking rapid setting
    - NTSS-1HM, CBC-1H, CRS-1 HBC
- **Tack coat residual application rates:**
  - specified by state DOTs
  - recommended by NCHRP Project 9-40



Surface Type	Residual Application rate, gsy
New HMA	0.035
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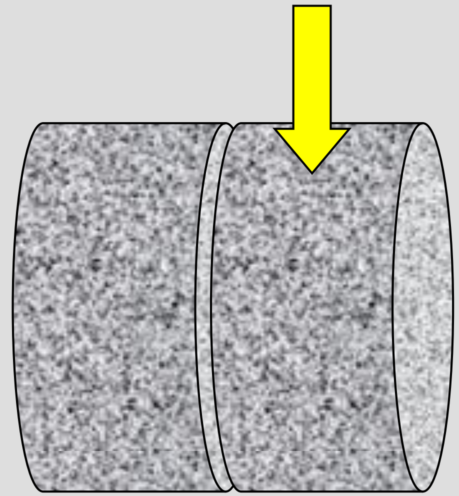
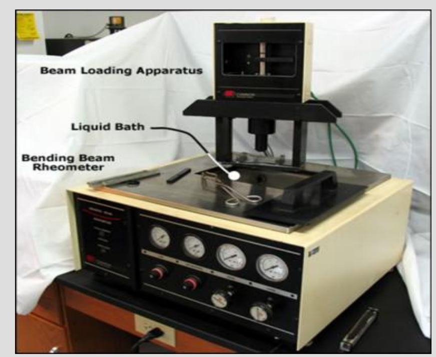
Milled HMA	0.055
PCC	0.045

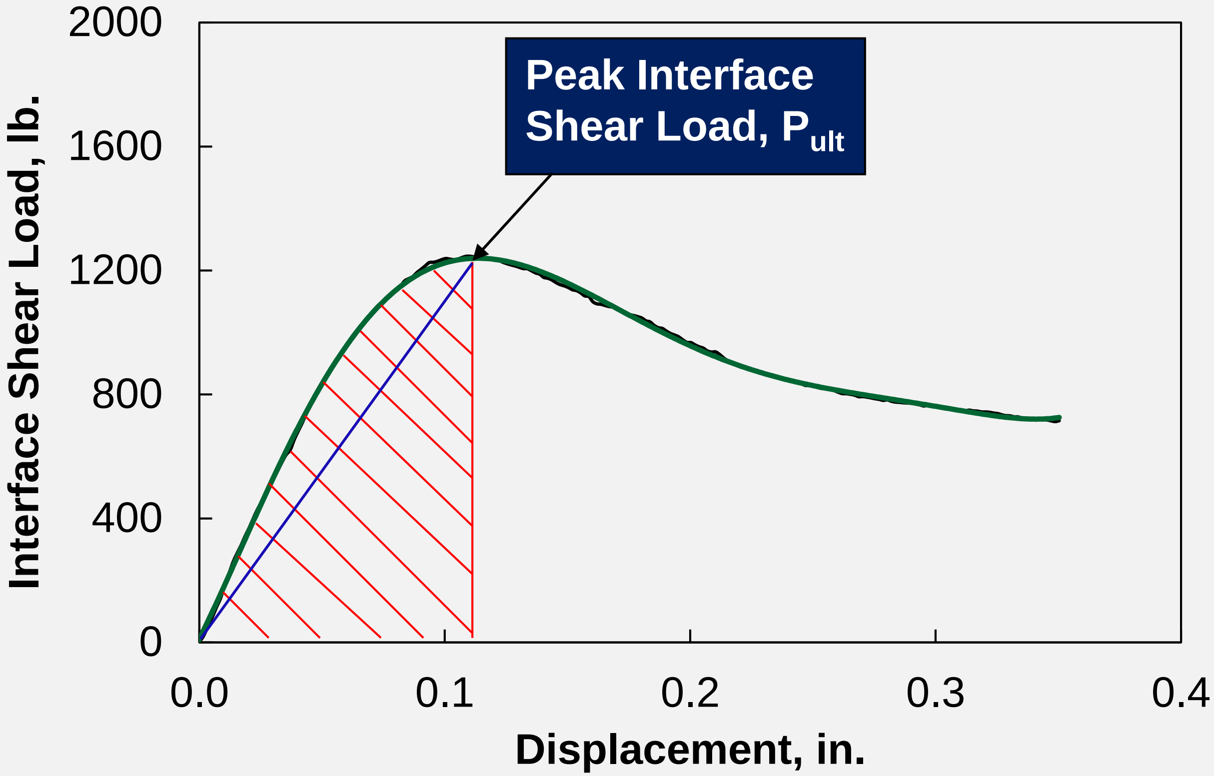
Experimental Program

- **Field Measurements**
  - Distributor Truck Calibration (ASTM D 2995)
  - Pavement Surface Texture Measurement (ASTM E 965)
  - Measured Field Application Rate (ASTM D 2995)
  - Distress Survey (LTPP Manual)
  - FWD (Structural Capacity)
- **Laboratory Measurements**
  - Interface Shear Strength Test (AASHTO T 407)
  - Tack Coat Material Rheological Characterization (AASHTO M 320)





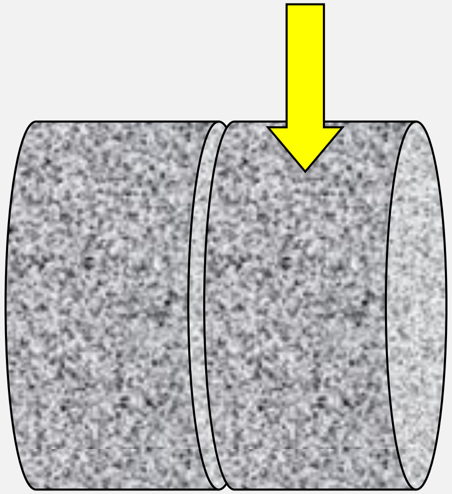
Laboratory Measurement – AASHTO T 407
Tack Coat Materials Bond Quality



$$\text{ISS} = \frac{P_{ult}}{\frac{\pi D^2}{4}}$$

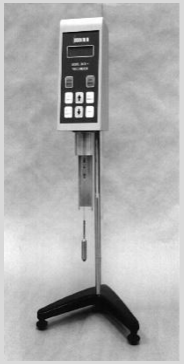
$$\text{IBE} = \frac{\textit{Area Under the Curve upto } P_{ult}}{\frac{\pi D^2}{4}}$$

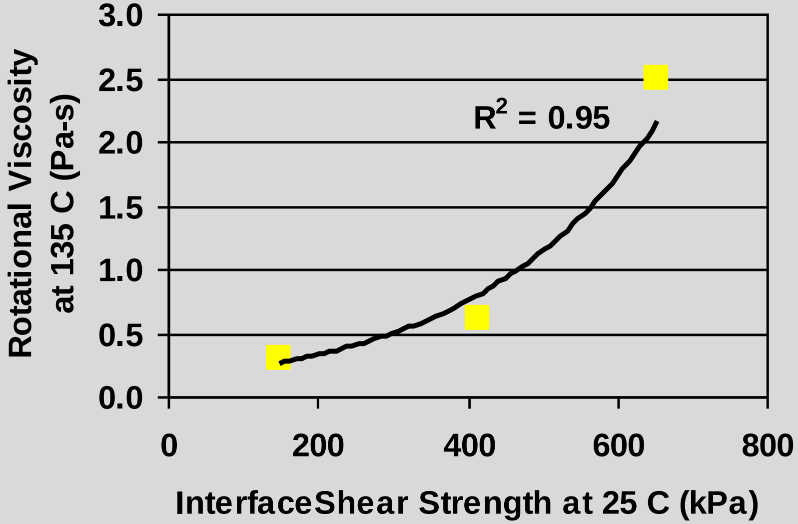
$$\text{K} - \text{modulus} = \frac{ISS}{\textit{Displacement at } P_{ult}}$$

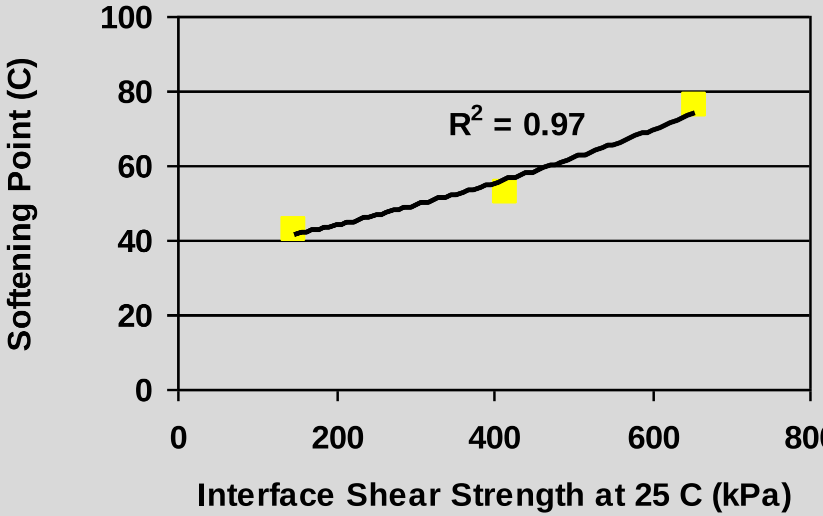


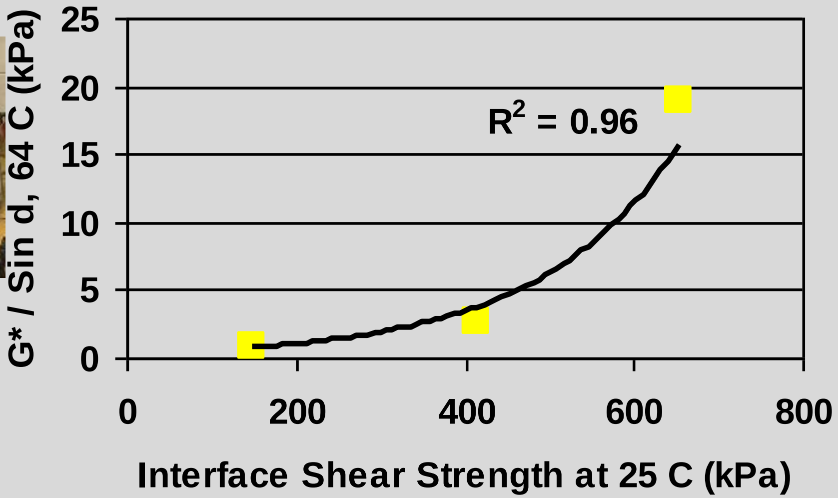
- **Loading rate: 2.54 mm (0.1 in.) per minute**
- **Interface Shear Strength (ISS, psi) : COV < 15%**
- **Interface Bond Energy (IBE, lb.-in/in²)**
- **Interface Shear Stiffness (k-modulus, psi/in)**

Relationship between ISS vs. Rheology Test Results

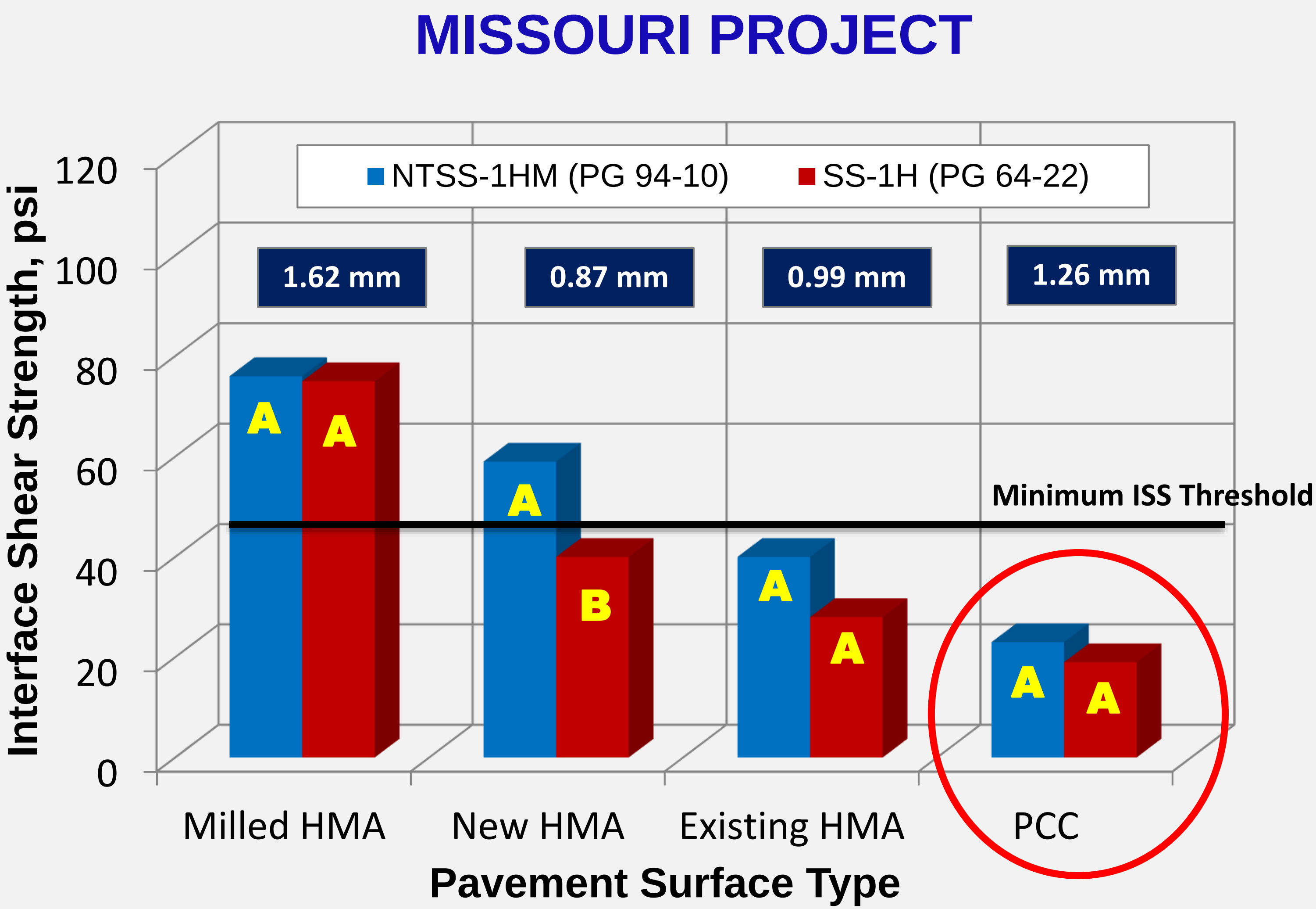








Effect of Pavement Surface Type on ISS



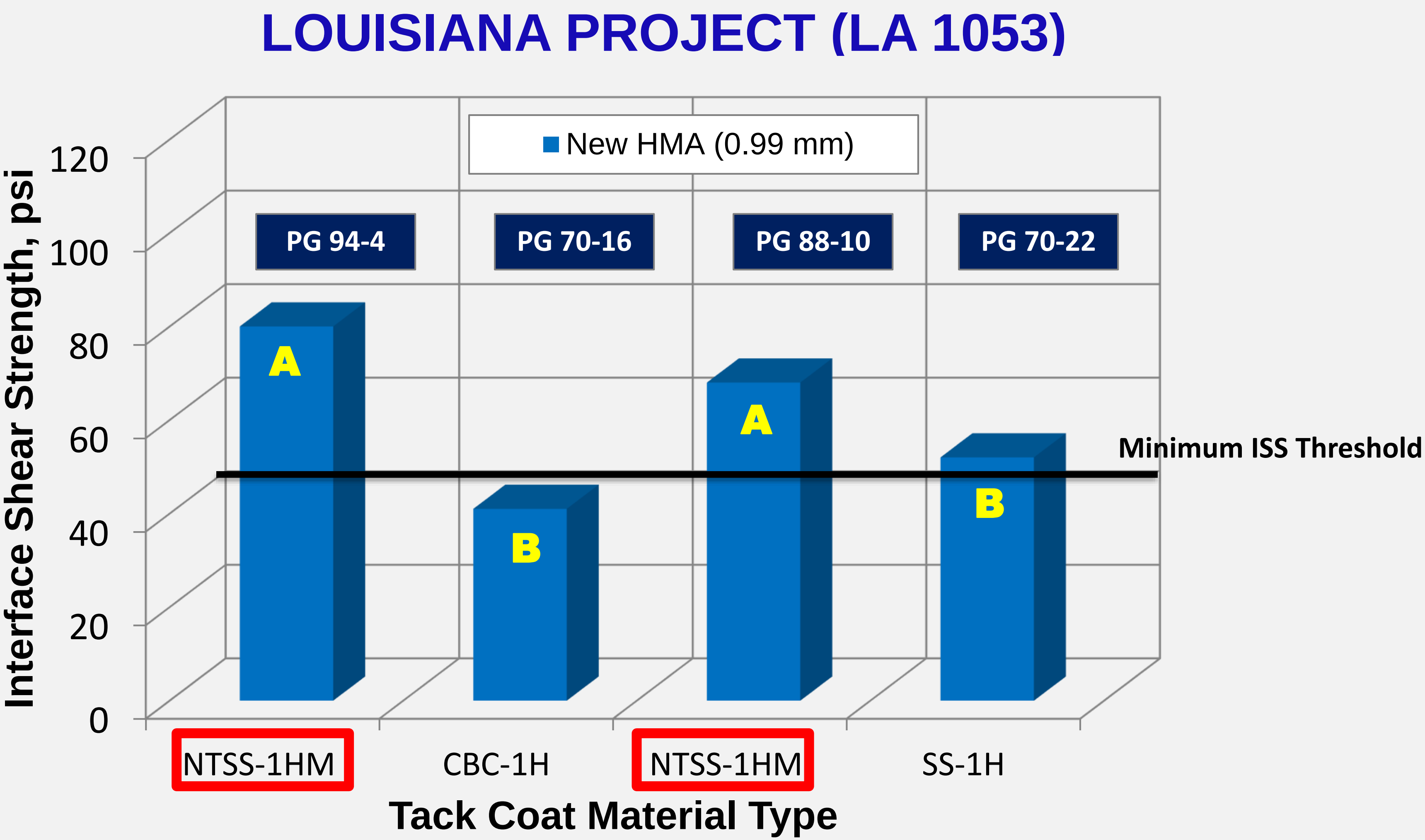
- All tack coat material were compared at 0.05 gsy residual application rate

Effect of Pavement Surface Type on ISS

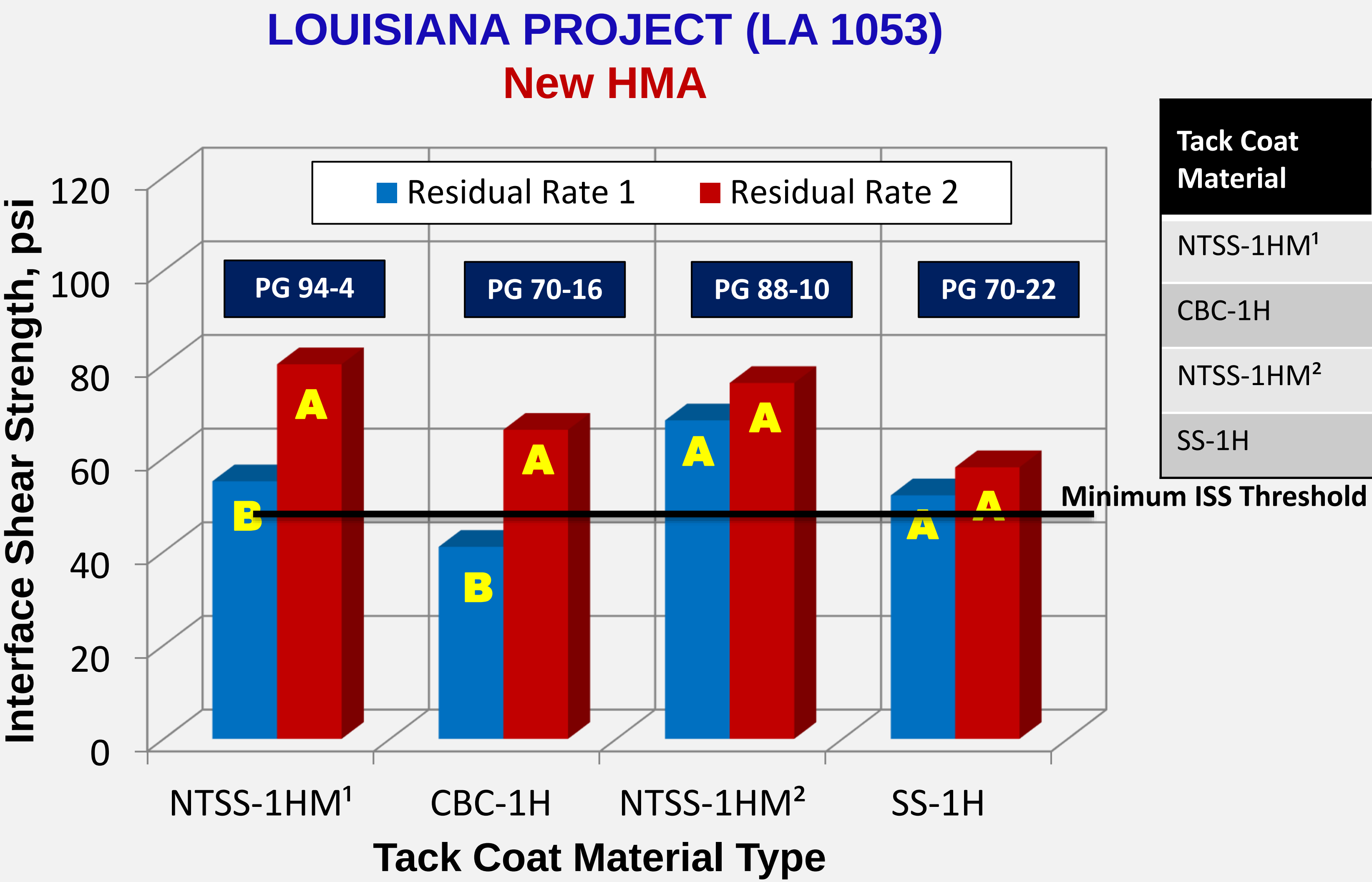
MISSOURI PROJECT

Pavement Surface Type

Effect of Tack Coat Type on ISS

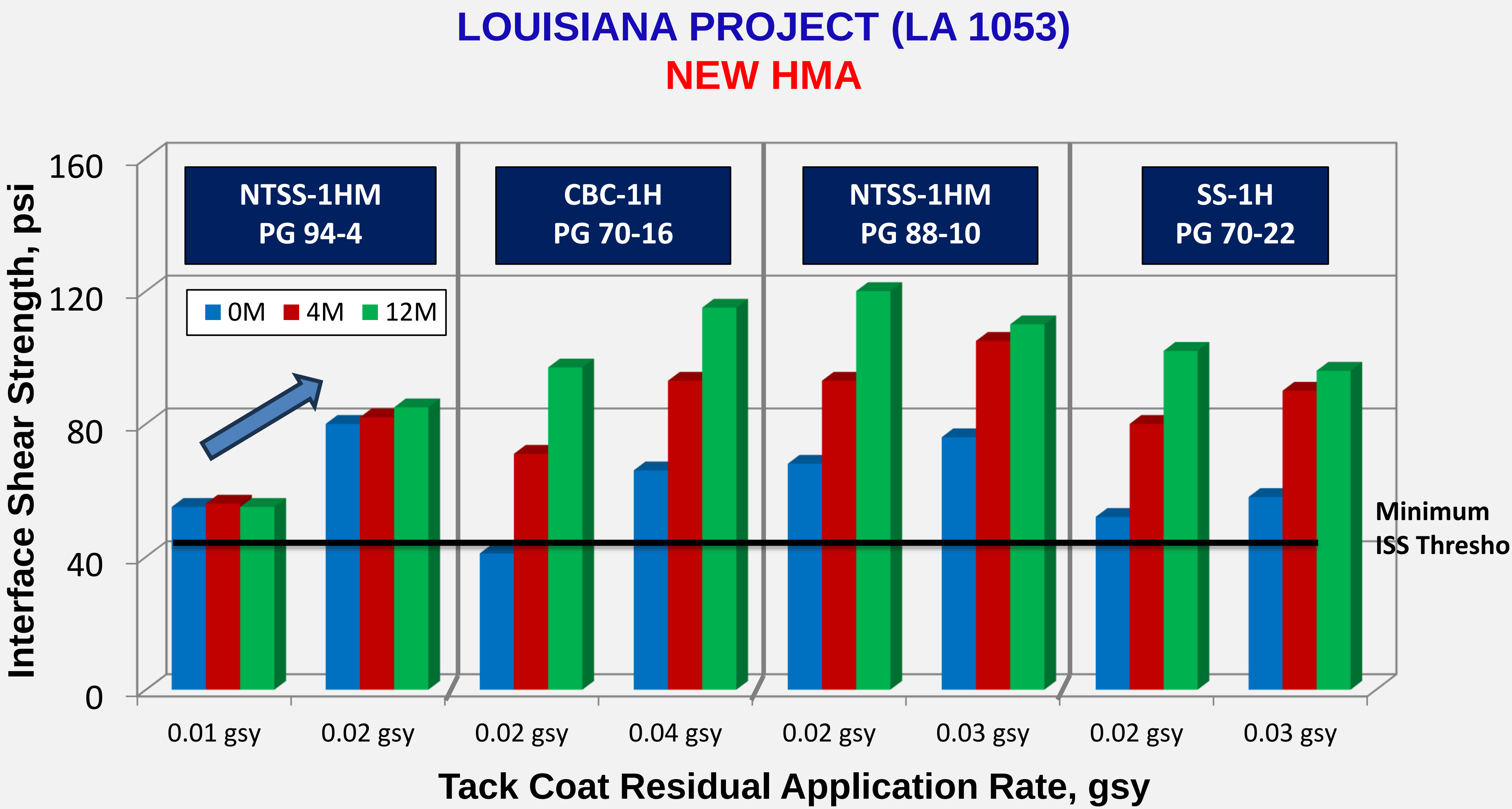


Effect of Residual Application Rate on ISS

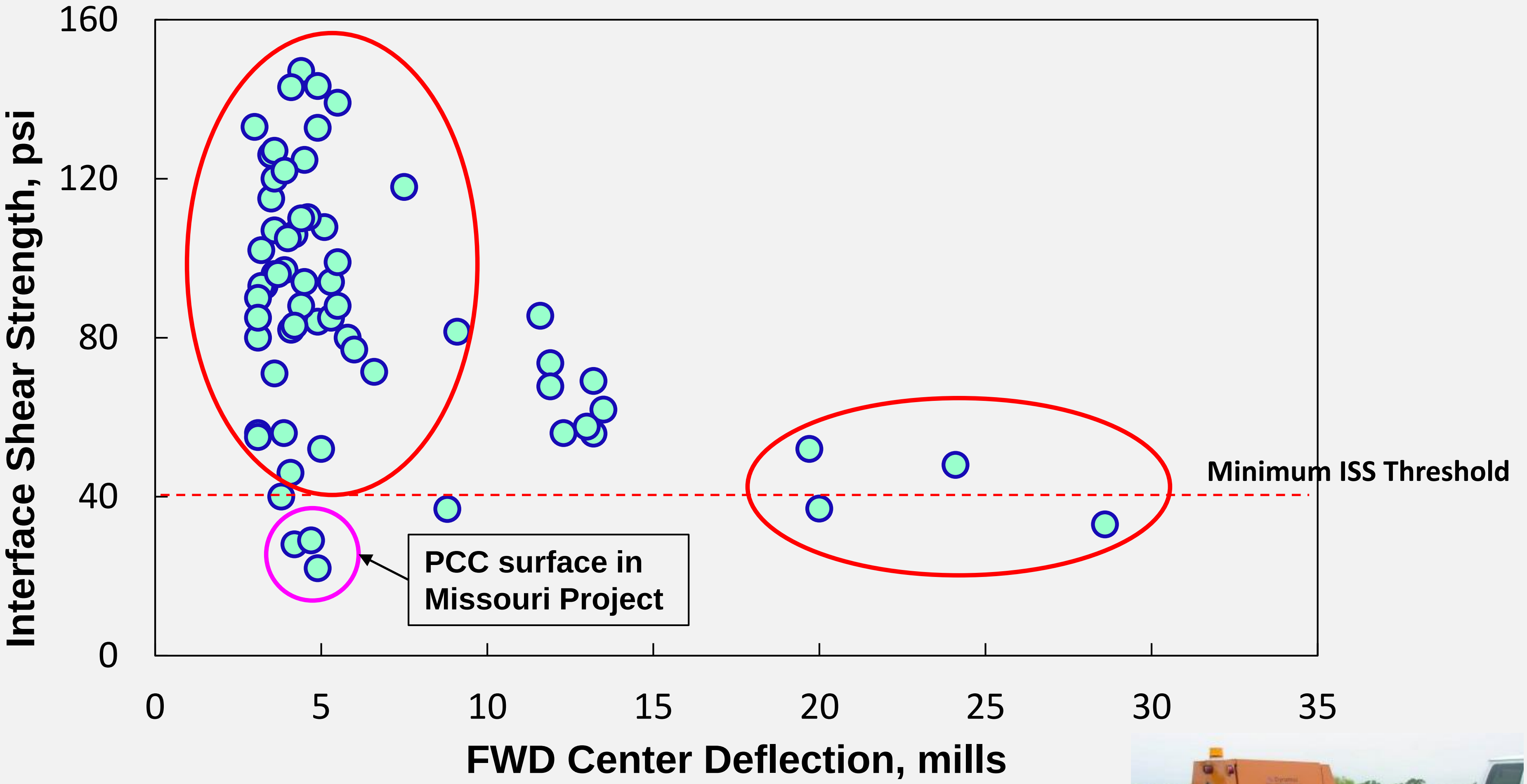


Tack Coat Material	Residual Rate, gsy	
	1	2
NTSS-1HM[1]	0.01	0.02
CBC-1H	0.02	0.04
NTSS-1HM[2]	0.02	0.03
SS-1H	0.02	0.03

Effect of Service Time on ISS

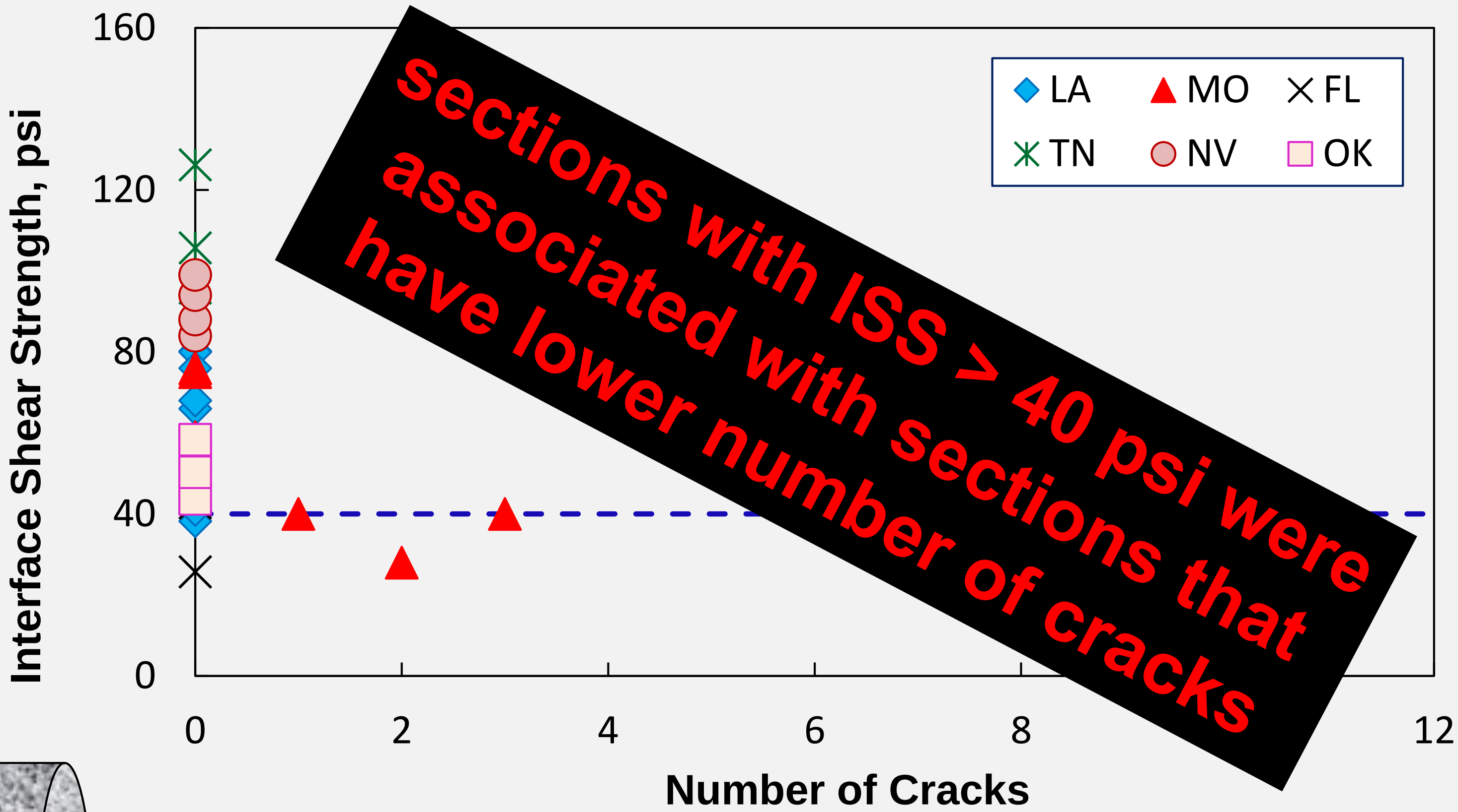


Structural Capacity (FWD) vs ISS

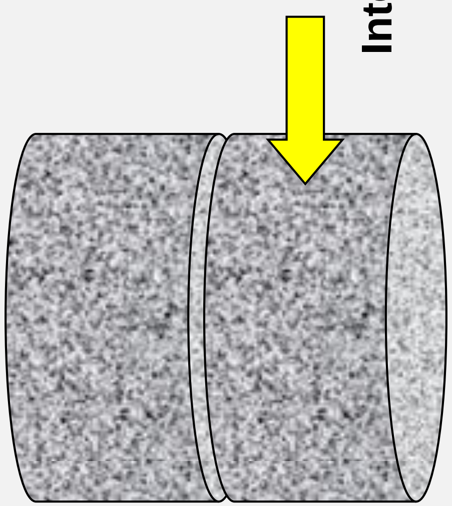


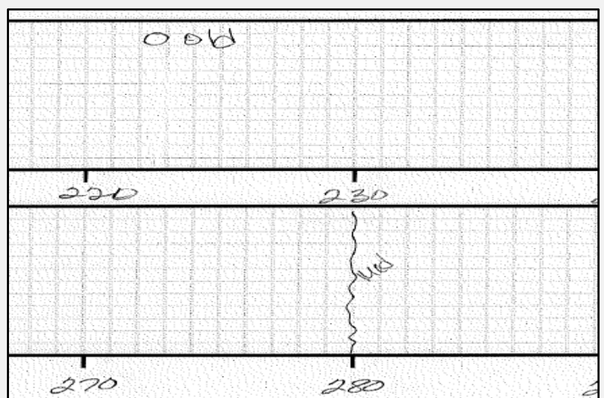
- ❑ **Indicates surface deflection depends on**
  - — the interface bonding between pavement layers

Pavement Cracking vs Bond Strength (ISS)



Sections with ISS > 40 psi were associated with sections that have lower number of cracks





Key Takeaways

- **Effect of tack coat type on ISS**
  - Non-tracking rapid setting tack coats with stiff base asphalt (NTSS-1HM) exhibited the highest ISS, and slow setting resulted in the lowest

- **Effect of pavement surface type on ISS**
  - ISS was largely dependent on
    - Type of pavement surface (HMA versus PCC)
    - Type of pavement surface texture (milled versus non-milled)
  - Milled surface yielded highest ISS, followed by new HMA, existing HMA, and PCC surface types
    - Higher surface roughness provided greater shear resistance

- **Effect of residual application rate on ISS**
  - ISS improved with increase in residual application rate for all tack coat types and pavement surface types

Key Takeaways

- **Effect of service time on ISS**
  - In general, ISS increased with increase in service time
    - tack coat curing
- **Pavement Structural Capacity (FWD test results)**
  - Mean center deflection decreased with service time
  - Densification of overlays was attributed to
    - in-service trafficking
    - improved ISS
- **Short-term pavement performance**
  - ISS values correlated well with short-term performance
  - test sections with ISS < 40 psi showed low to moderate cracking

Recommendations

- **AASHTO T 407 test**
  - — Quality control and quality assurance testing of tack coat construction
  - — Evaluation of interface-bonding condition of in-service pavements
- **Use of minimum ISS threshold criterion (40 psi)**
  - — As the specification for satisfactory pavement performance

Thank you
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