NATIONAL ACADEMIES Sciences Engineering Medicine

TRB TRANSPORTATION RESEARCH BOARD

# TRB Webinar: Laboratory Methods and Specifications for Testing Tack Coat Materials

*December 17, 2024*

*1:00 – 2:30 PM*

# PDH Certification Information

1.5 Professional Development Hours (PDH) – see follow-up email

You must attend the entire webinar.

Questions? Contact Andie Pitchford at TRBwebinar@nas.edu

***The Transportation Research Board has met the standards and requirements of the Registered Continuing Education Program. Credit earned on completion of this program will be reported to RCEP at RCEP.net. A certificate of completion will be issued to each participant. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the RCEP.***

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# Purpose Statement

This webinar will provide an overview of NCHRP Web-Only Document 381: Developing Laboratory Methods and Specification Language to Test Tack Coat Materials, highlighting key findings from the study, including recommended changes to tack coat material specifications. Presenters will cover the evaluation plan for tack coat materials and a field experiment designed to validate the proposed specifications.

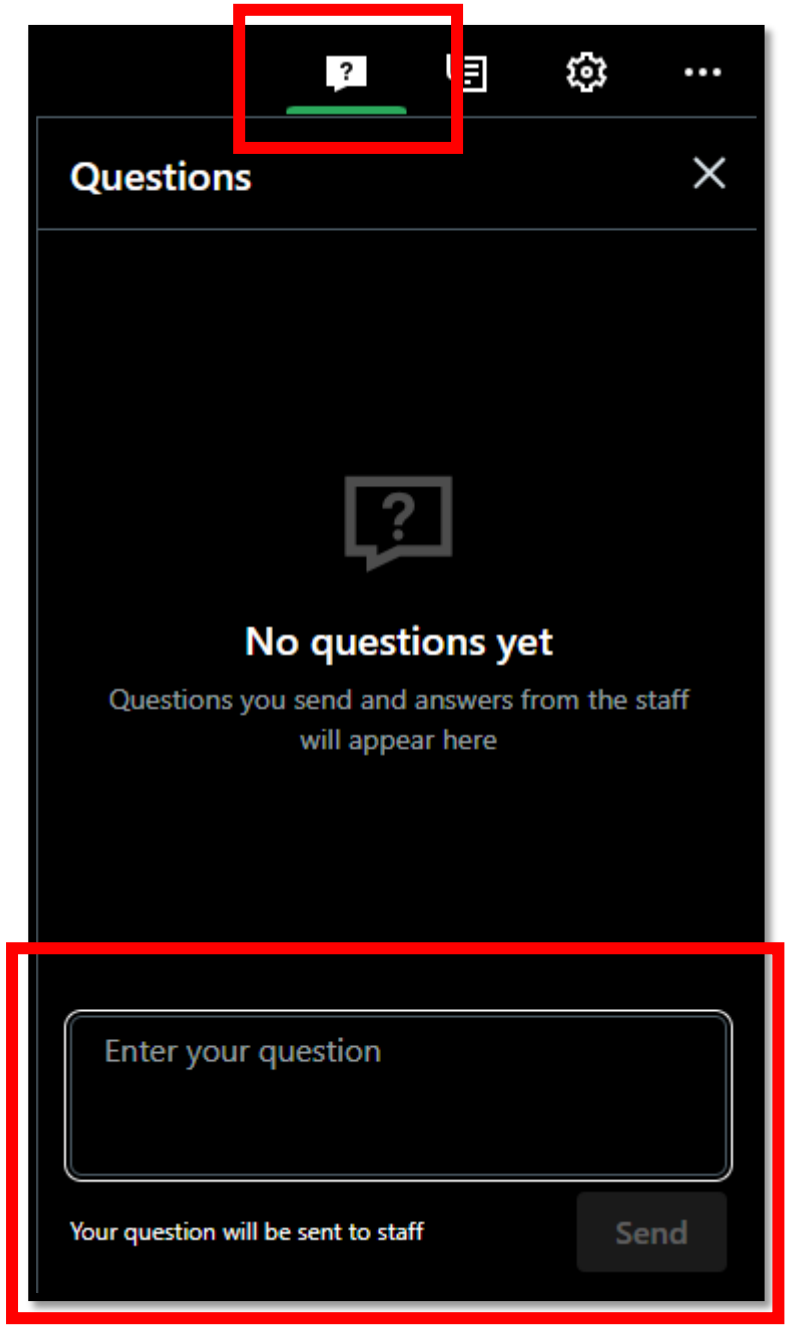
# Learning Objectives

At the end of this webinar, you will be able to:

- Understand the basis and the proposed language changes for the tack coat material specifications
- Evaluate the newly proposed changes for tack coat specifications

# Questions and Answers

- Please type your questions into your webinar control panel
- We will read your questions out loud, and answer as many as time allows



# Today's presenters

Rita Nasr
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*CRAFCO INC*

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*Louisiana Department of Transportation*



# *Developing Laboratory Methods and Specification Language to Test Tack Coat Materials*

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Rita Nasr, Ph.D. (Speaker)

Elie Y. Hajj, Ph.D.

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**Reno, NV**

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Gaylon L. Baumgardner, Ph.D.

Shelly Cowley

**Paragon Technical Services**
**Richland, MS**

**NCHRP Project 09-64**

**Tuesday, December 17 2024**

NEVADA

NCHRP NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

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# List of Content

## Outline

Objective and Motivation

Experimental Plan

Test Results

- Bonding Performance
- Tracking Performance
- Durability Performance

Conclusions and Recommendations: AASHTO Specification, NTPEP Work Plan, Field Validation Work Plan

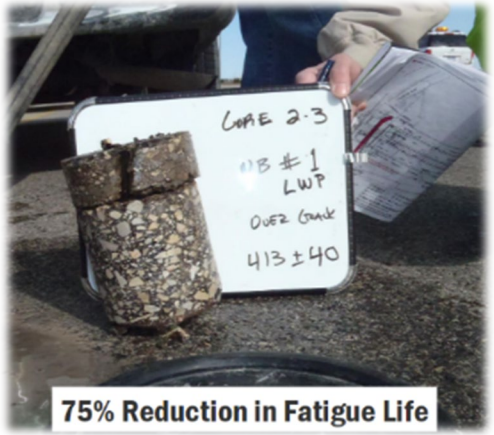
# Objective and Motivation

***Non-Bonded***

***½" Deflection***
***60 lbs. Load***

***Fully Bonded***

***¼" Deflection***
***160 lbs. Load***



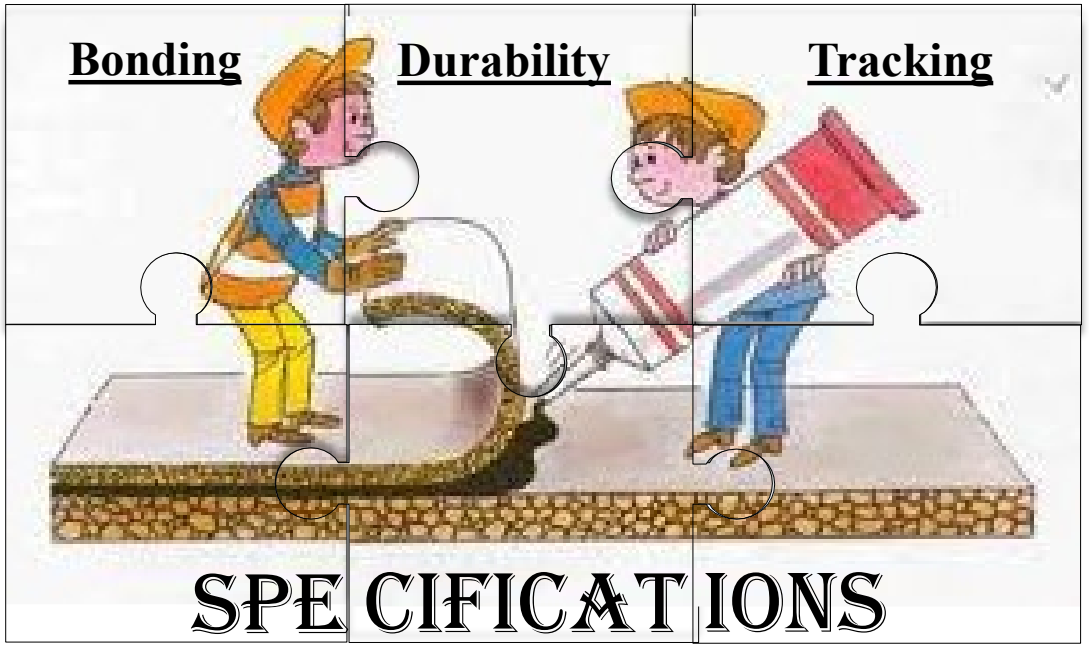

**75% Reduction in Fatigue Life**

**Spray a thin layer of tack coat →** proper bonding between two pavement layers

**Monolithic structures →** efficiently transfer the traffic loads

**Prevent premature pavement failure** (delamination, slippage, fatigue, etc.)

# Objective and Motivation

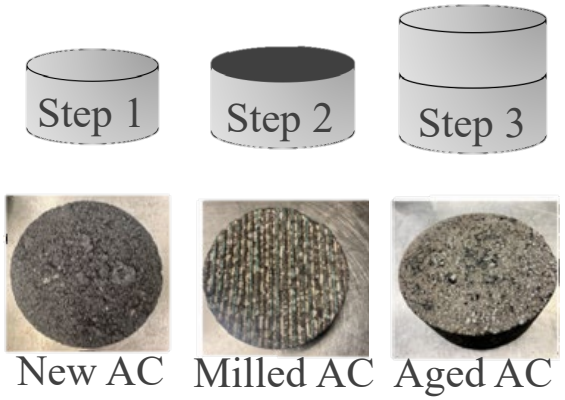



→ Over a range of environments, construction conditions

→ Taking into consideration tack coat material bonding, durability, and tracking

# Experimental Plan

## I. AC Sample Preparation
*(OBC per Superpave Mix Design)*




Condition samples (0°C, 5°C, 25°C, Moisture conditioned)

↓

Perform Interlayer Shear Strength (**ISS**) testing AASHTO TP 114

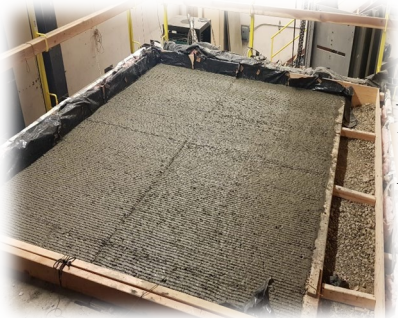
↓

Correlate **ISS** with fundamental rheological properties

## Experimental Matrix

- **5 Surface Types** (New AC, Milled AC, Aged AC, New PCC, Aged PCC)
- **14 Tack Coat Materials** (including emulsions and hot applied binders)
- **3 Asphalt Binders in the Mixture** (PG 64-22(1), PG64-22(2), PG 58-28)
- **3 Application Rate Levels** (Low: L-, Medium: M, and High: H+)
- **2 Mixture Types** (Fine-graded: ½ NMAS and Coarse-graded: ¾ NMAS mixtures)

## II. Large Scale AC over PCC Slabs
*(using UNR PAVEBOX)*



New PCC
Aged PCC

# Experimental Plan

## *Asphalt Materials*

**Residue/Binder Performance Tests**

- Performance Grading
- Multiple Stress Creep & Recovery (MSCR)
- Crossover Temperature
- Viscosity
- Penetration
- Softening point
- Tackiness Test
- 4 mm DSR on original and RTFO aged residue/binder materials

- All tack coat emulsion and asphalt binder materials

- Residue Recovered using:

- Distillation Recovery Method
- LTE Recovery Method
- Vacuum Recovery Method

# Experimental Plan

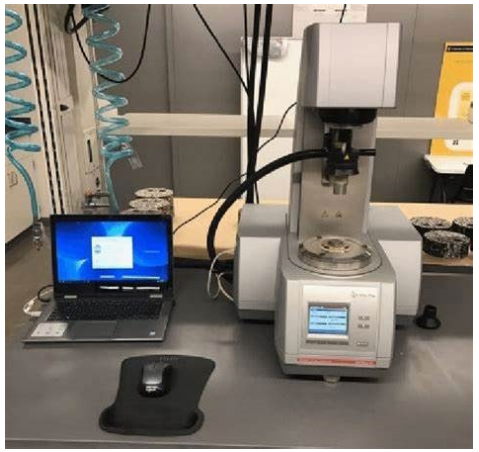
## *Asphalt Materials*

### Tack Coat Materials

- SS1(1)_In spec
- SS1(2)_In spec
- SS1(OS)_Off spec
- SS1h(1)_In spec
- SS1h(2)_In spec
- SS1h(OS)_Off spec
- HP NT(1)_In spec
- HP NT(2)_In spec
- HP NT(OS)_Off spec
- PM NT_In spec
- HPM_In spec
- PG 67-22_In spec
- HP NT(HA)_In spec

### Binders Used in the Mixture

- PG 64-22(1)
- PG 64-22(2)
- PG 58-22



### Residue/Binder Performance Tests

- Performance Grading
- Multiple Stress Creep & Recovery (MSCR)
- Crossover Temperature
- Viscosity
- Penetration
- Softening point
- Tackiness Test
- 4 mm DSR on original and RTFO aged residue/binder materials

# Test Results

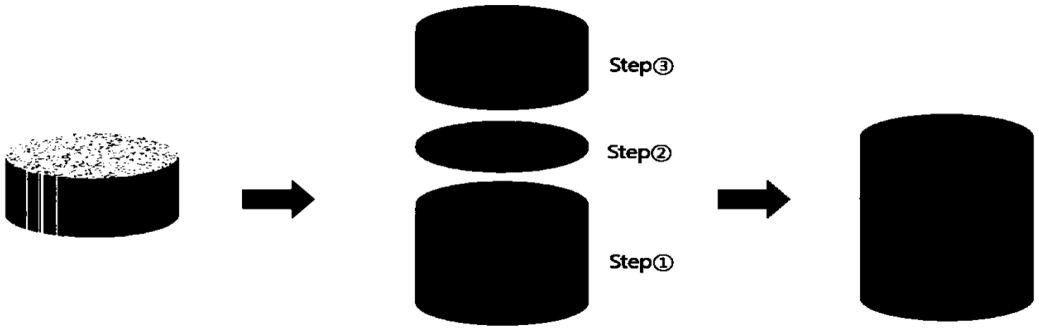
| Test Results 10 | Test Results 38 | Test Results 43 |
| --- | --- | --- |
| *Bonding Performance* | *Tracking Performance* | *Durability Performance* |

# Test Results

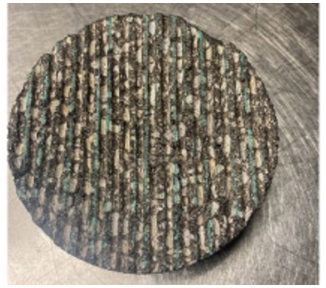
***Bonding Performance***

# AC Sample Preparation

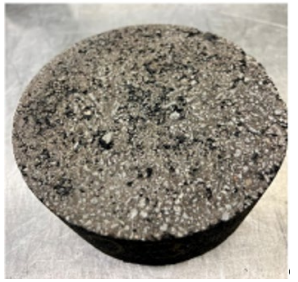
- **Surface mixture preparation (produced in 2 separate layers):**
  - *Bottom layers:*
    - Compacted to a height of 3 in at 135°C using SGC with a target AV of 7% ± 1%.
    - Allowed to cool to laboratory temperature
    - Surface preparation (New AC, Milled AC, Aged AC)




New AC



Milled AC



Aged AC

- Apply the correct amount of tack coat (application rate x area of the specimen) using a lab balance and allow the material to cure for 30 minutes
- *Top layers:*
  - Bottom half is placed in a preheated SGC
  - Loose mixture is compacted on top of the tack-coated bottom half (targeting 2 in height and 7% ± 1% AV).

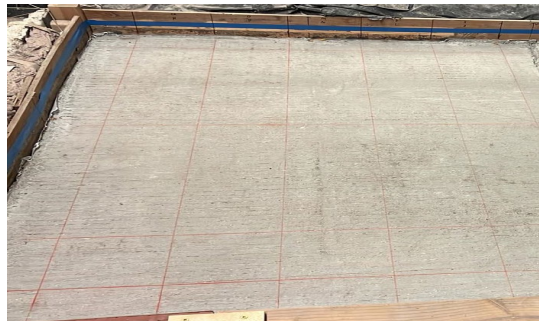
# PCC Slab Preparation

Leveling Aggregate
Base Course Surface

Tining the PCC Surface
≈ New PCC Field Condition

or

Tining + Sandpaper
≈ Aged PCC Surface



Apply Tack Coat
(7 TC, M and H+)

Compact New AC Layer and Mark the
Tining Direction

# Tack Coat Application

$$\textbf{Weight of Tack Coat} = 2.9205 \times \frac{Targeted\ residual\ application\ rate \times Area \times Specific\ gravity}{\%\ Asphalt\ Residue}$$


For Emulsions Application

For Hot Applied Binders Application

*Recommended by NCHRP Project 09-40*

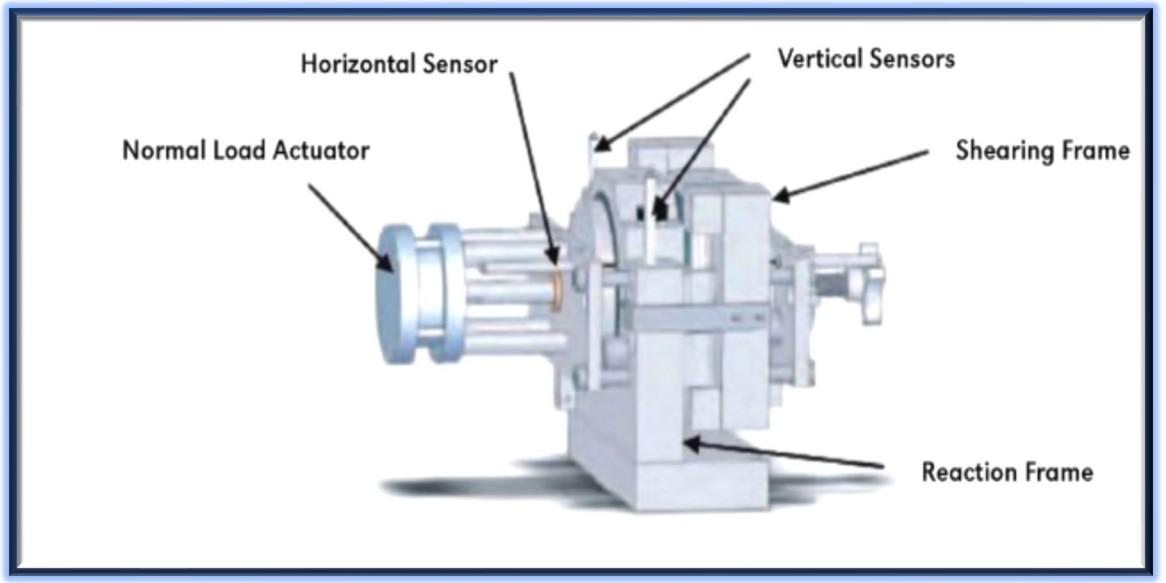
| Surface Type | Residual Application Rate (gsy) |
|---|---|
| New AC | 0.035 |
| Milled AC | 0.055 |
| Aged AC | 0.055 |
| PCC | 0.045 |

As well as lower (L-) and higher (H+) application rate levels

# Bond Strength Test (AASHTO TP 114)

- Asphalt overlay is 2 ± 0.2 in
- Substrate is 3 ± 0.2 in
- Substrates: New AC, Milled AC, Aged AC, New PCC, Aged PCC
- Mix types:
  - Fine (½ NMAS gradation) vs. Coarse (¾ NMAS gradation)
- Testing Temperature Conditions:
  - 25°C
  - Moisture Conditioning (AASHTO T 283)
  - Low Temperatures: 0°C and 5°C
- Loading Rate: 0.1 in/min for testing at 25C and MC
  0.05 in/min for testing at low temperatures

- ISS = Maximum shear strength measured to shear the sample.




# Bond Strength Test (AASHTO TP 114)

## *Sample Combinations*

### AC Samples

½” New AC

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**½” New AC**

¾” New AC

---

**¾” New AC**

½” New AC

---

**½” Milled AC**

¾” New AC

---

**¾” Milled AC**

½” New AC

---

**½” Aged AC**

### PCC Samples

½” New AC

---

**New PCC**

¾” New AC

---

**Aged PCC**

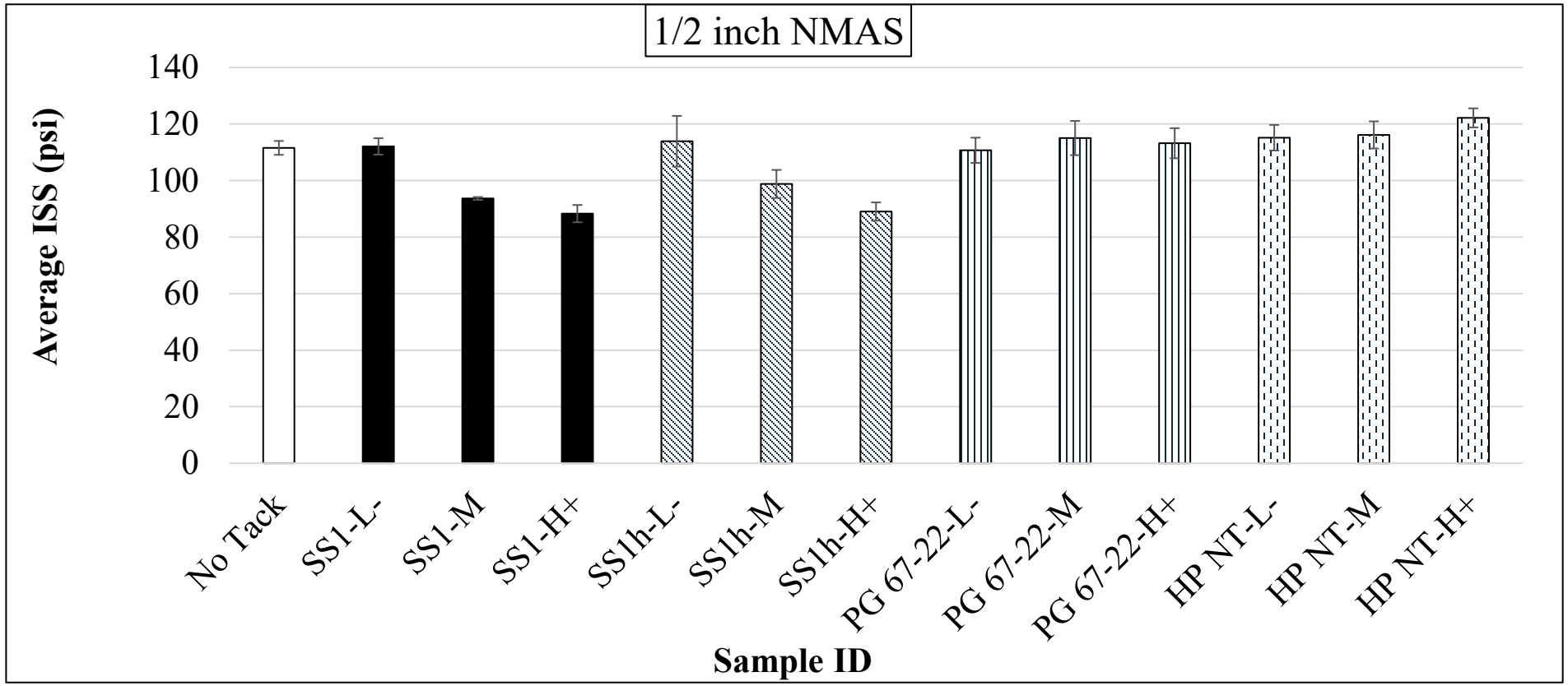
½ New AC

---

**Aged PCC**

# ISS Test Results of HMA/HMA Samples

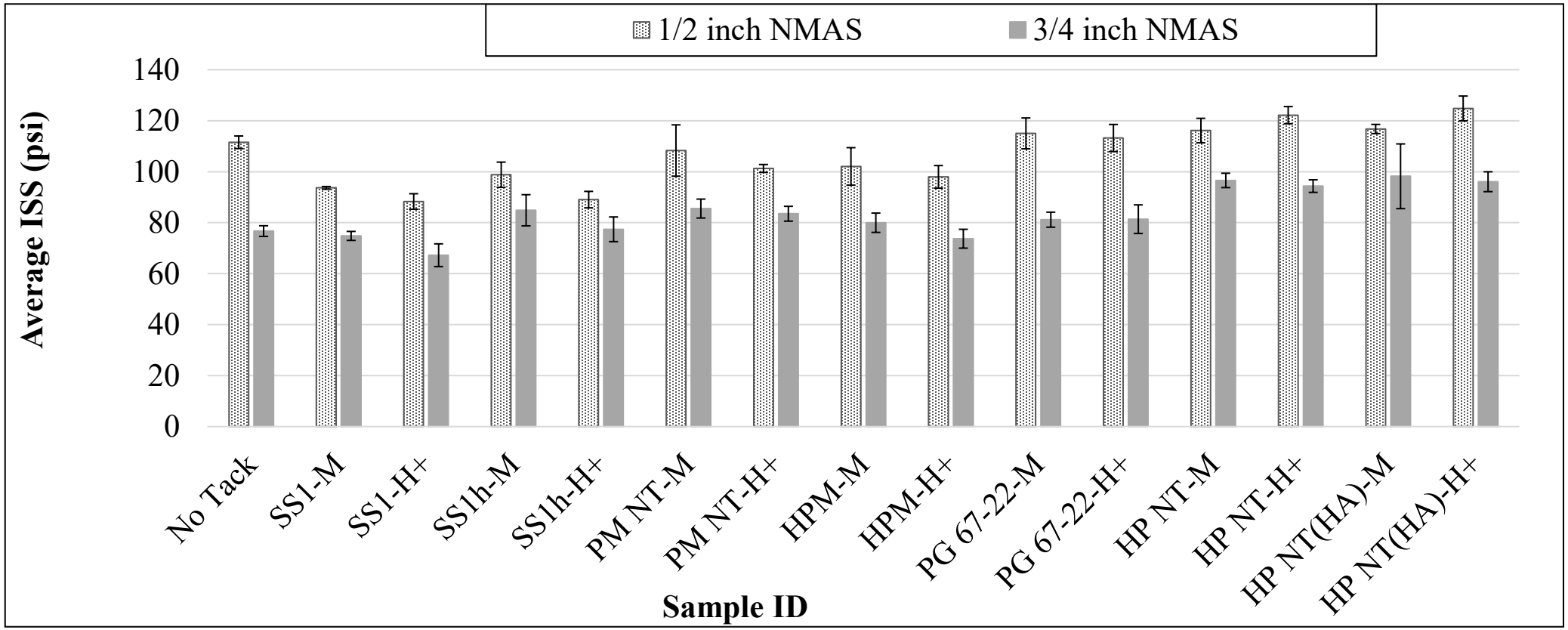
- ISS test results using ½" New AC and different tack coat types at different application rates
- Test conducted at 25°C




½" New AC

# ISS Test Results of HMA/HMA Samples

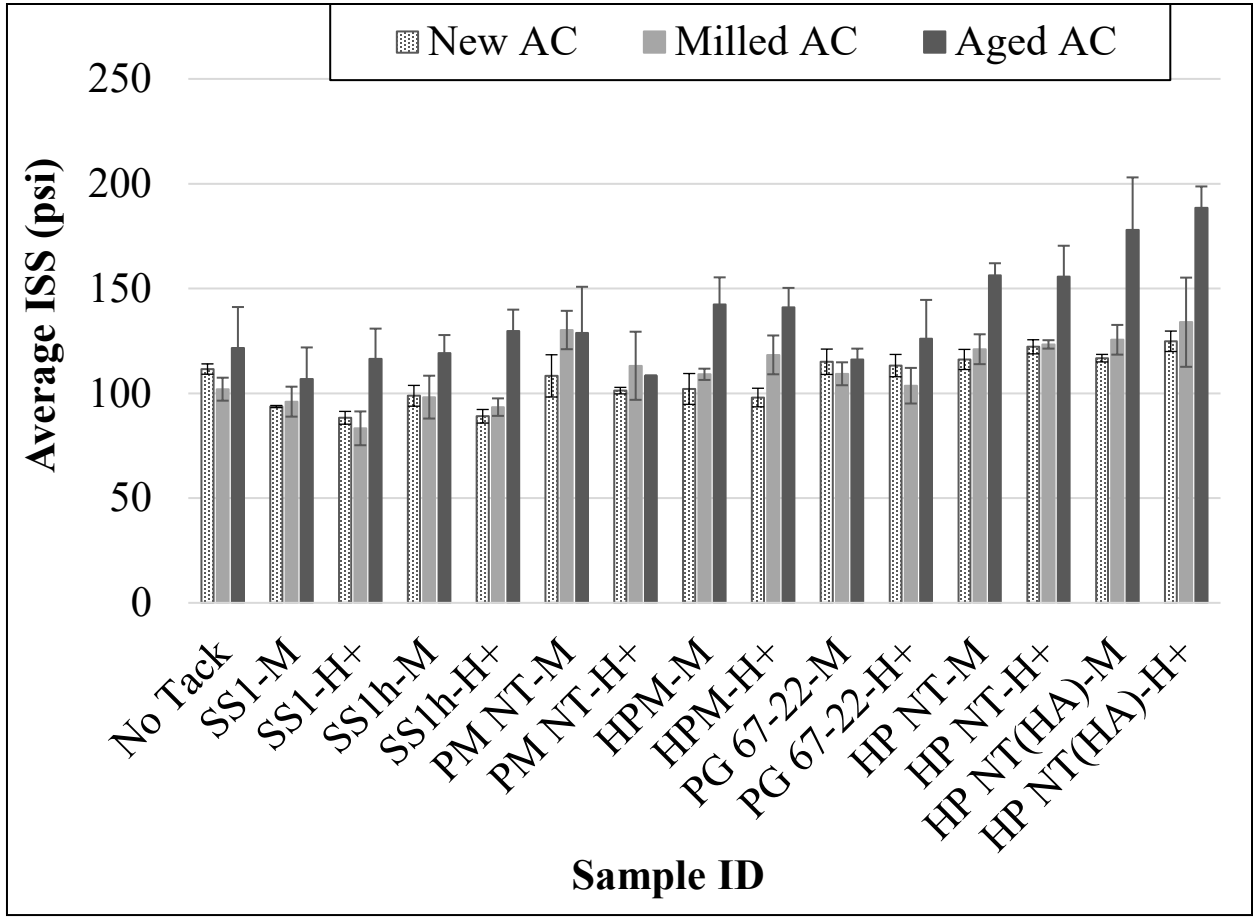
- ISS test results using ½" and ¾" New AC and different tack coat types at different application rates
- Test conducted at 25°C



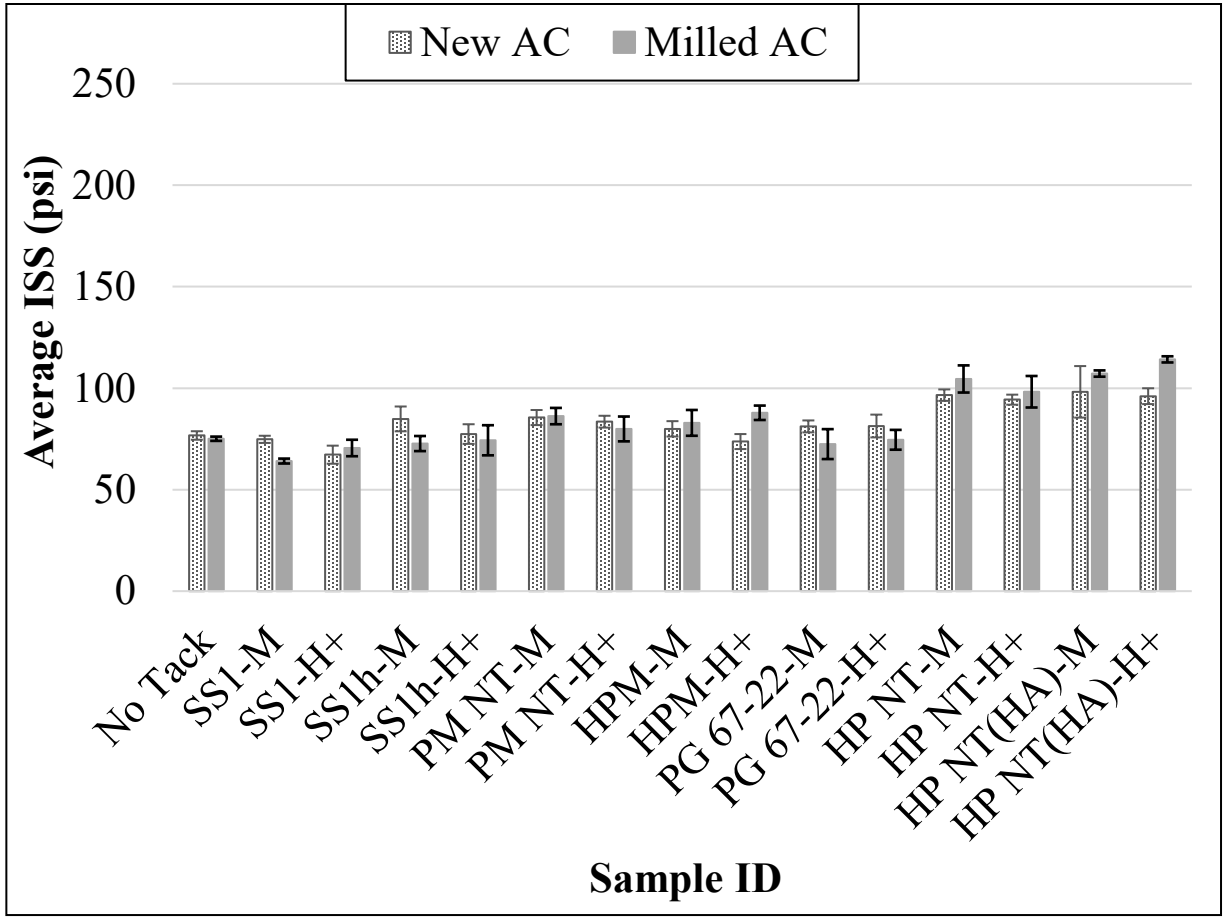

½" New AC and ¾" New AC

# ISS Test Results of HMA/HMA Samples

- ISS test results using different mixture types, surface conditions and tack coat types at different application rates
- Test conducted at 25°C

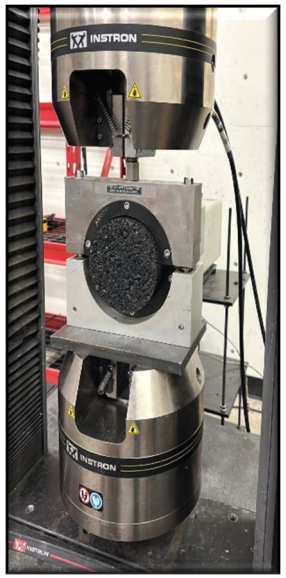


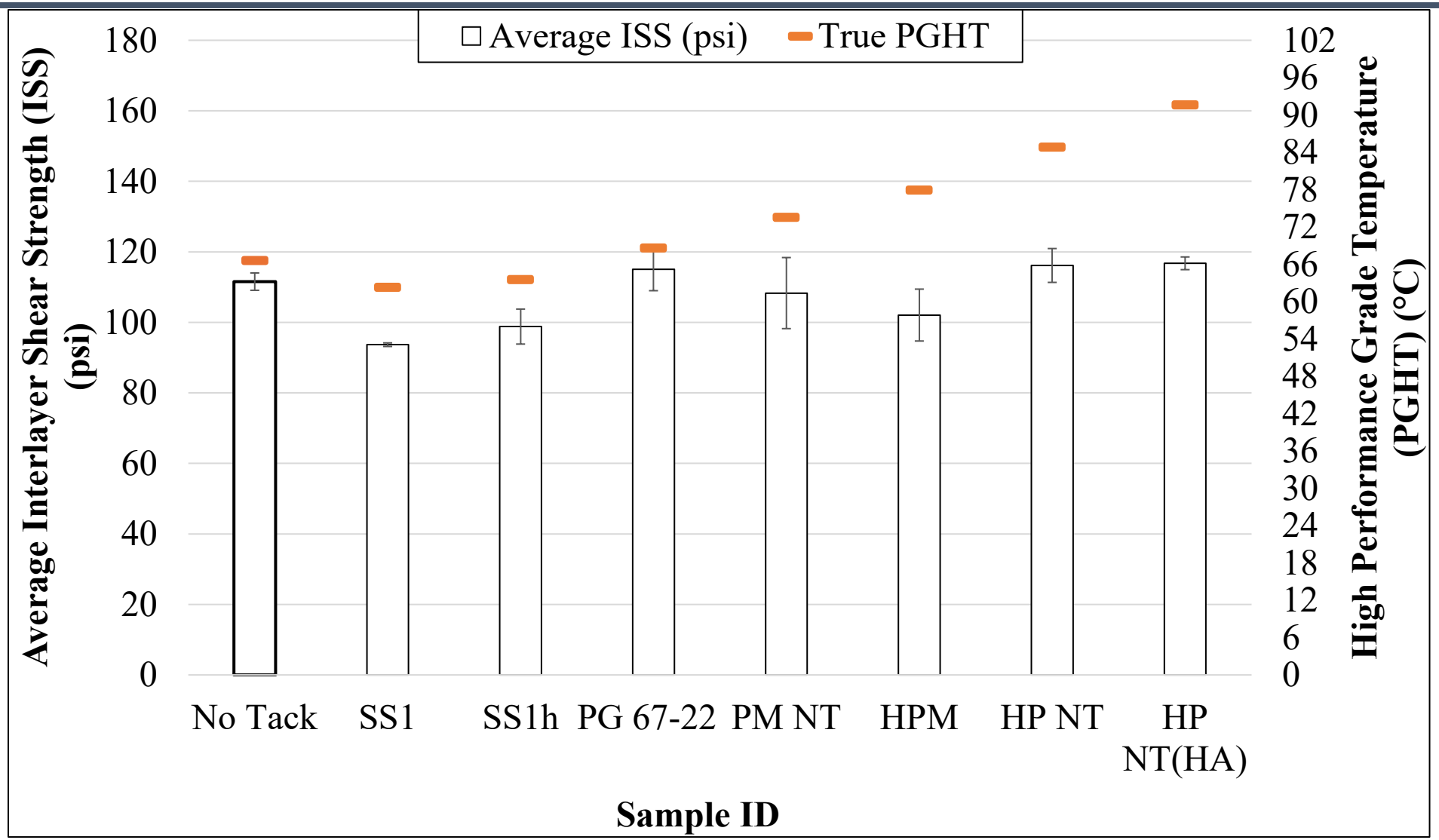

½" NMAS Mixture




¾" NMAS Mixture

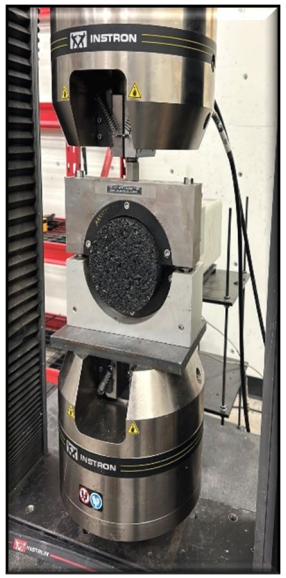
# Shear Strength of ½” NMAS Mixtures vs. Binder/Residue PGHT

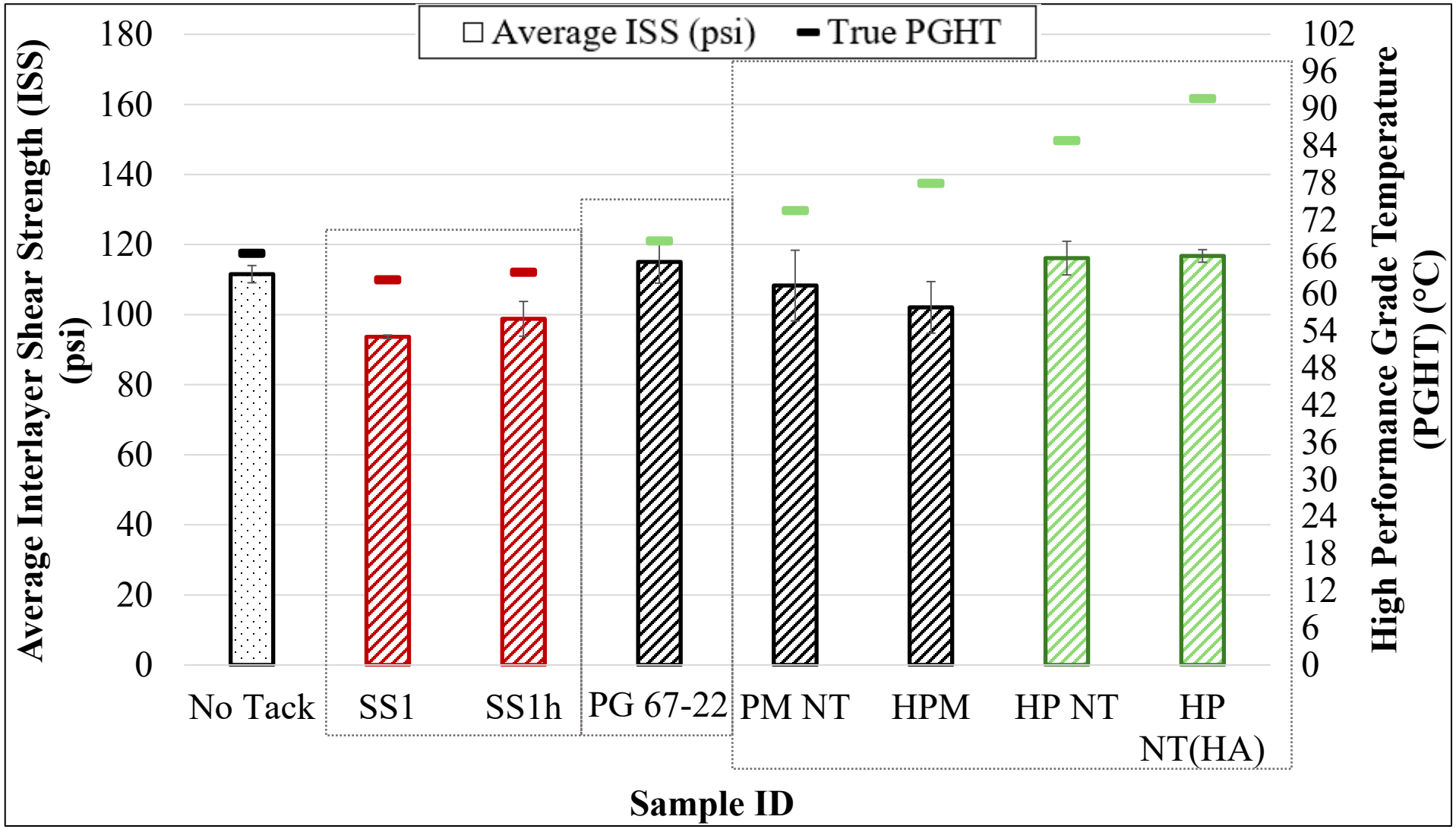


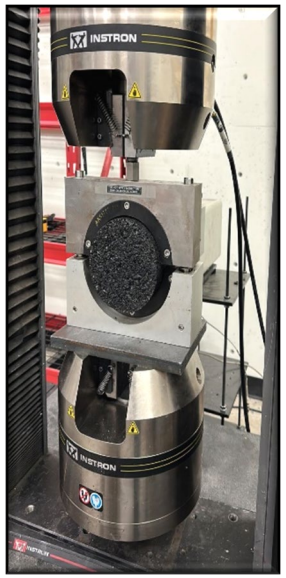

½” NMAS Mixture

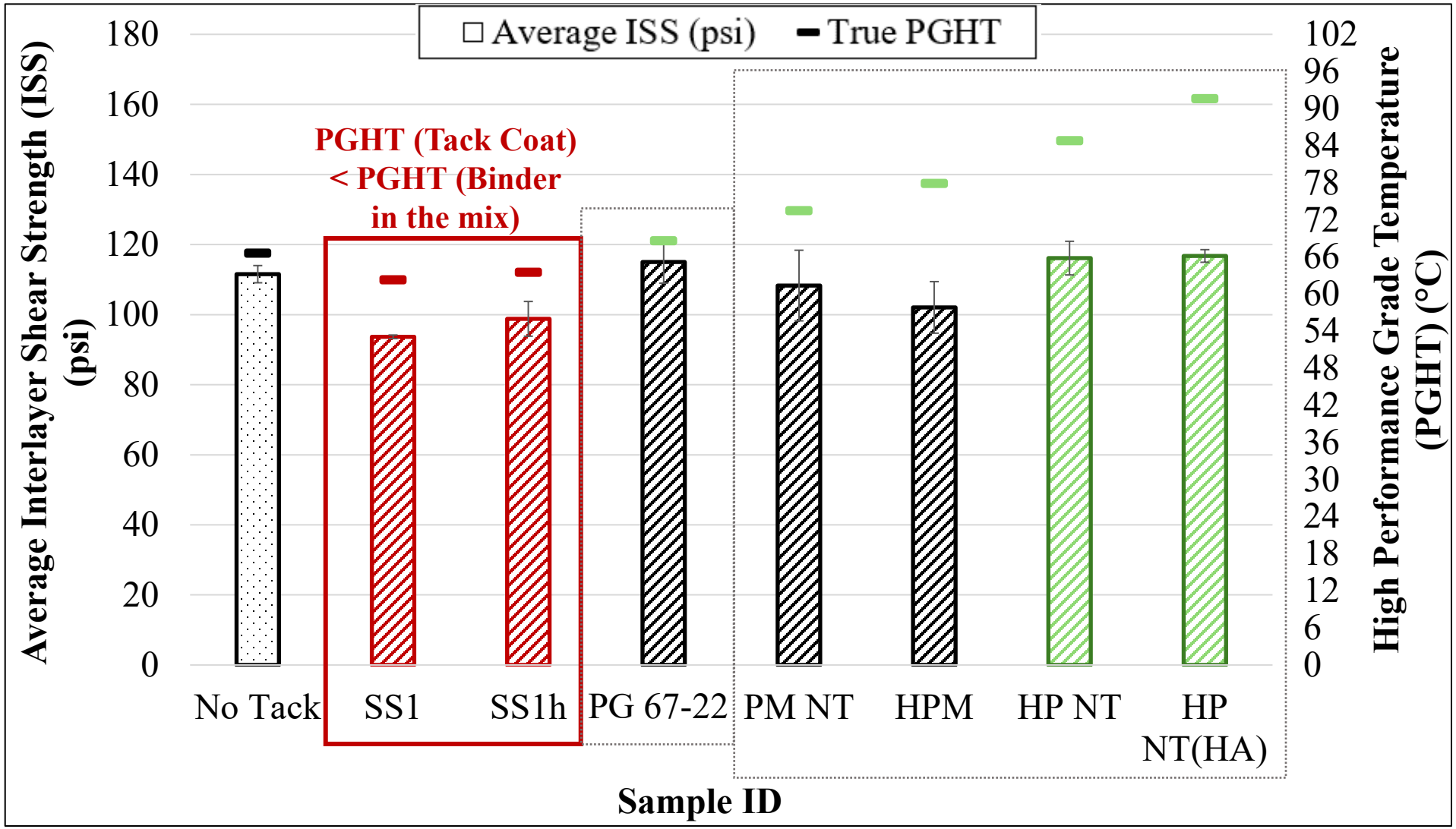
# Shear Strength of ½” NMAS Mixtures vs. Binder/Residue PGHT



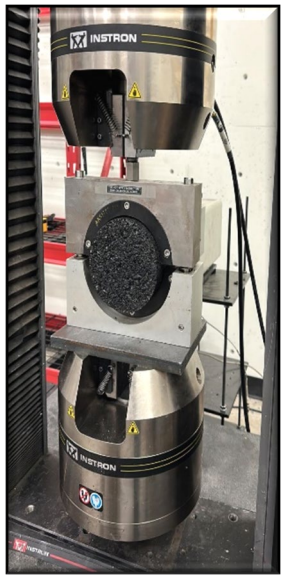



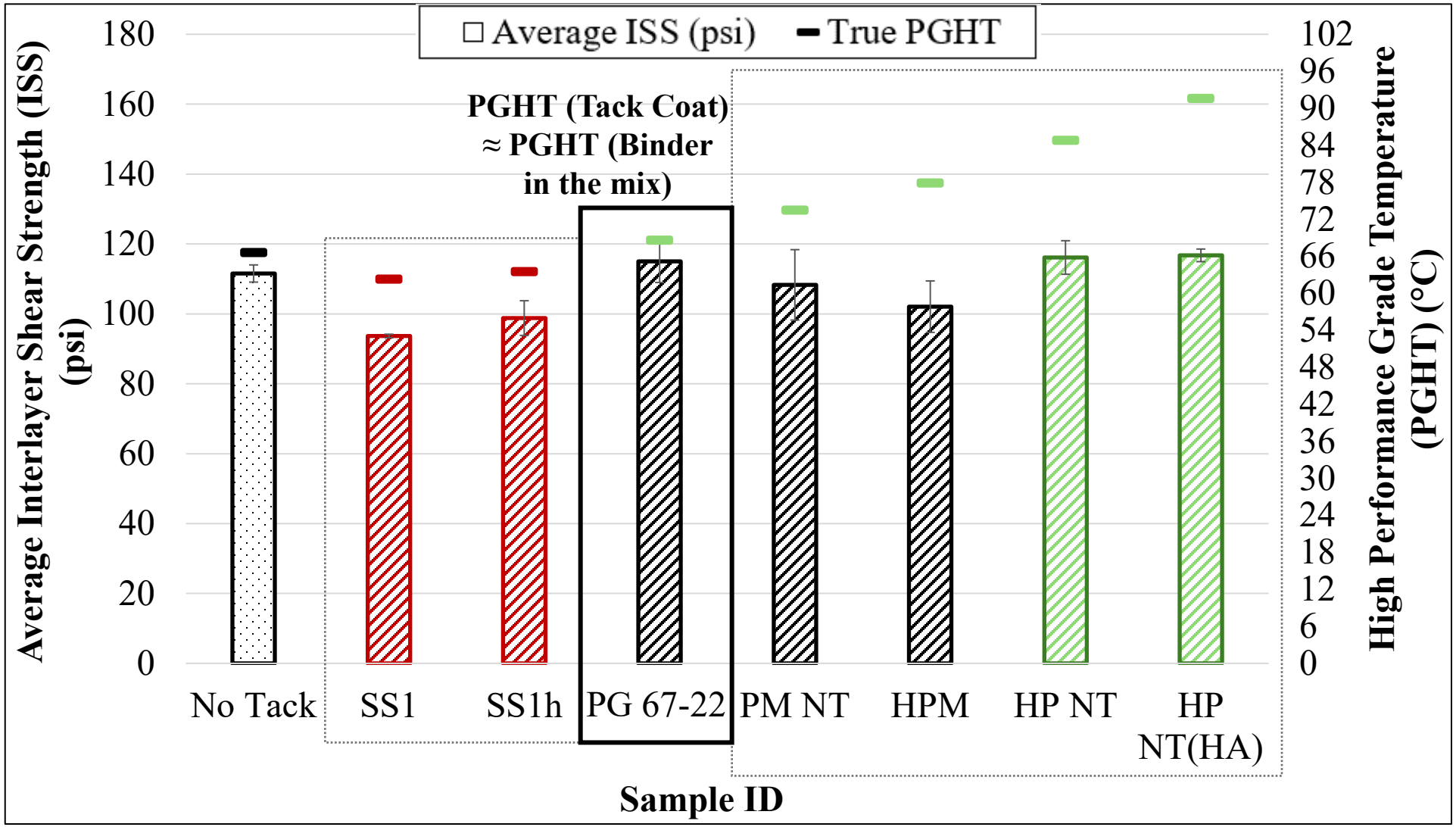

# Shear Strength of ½” NMAS Mixtures vs. Binder/Residue PGHT



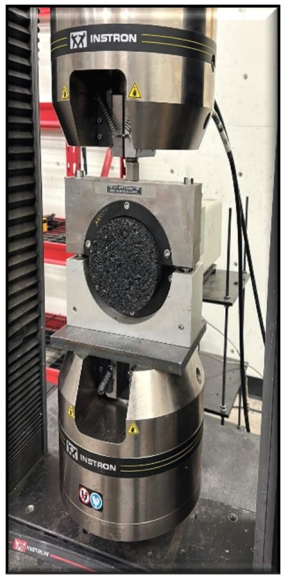



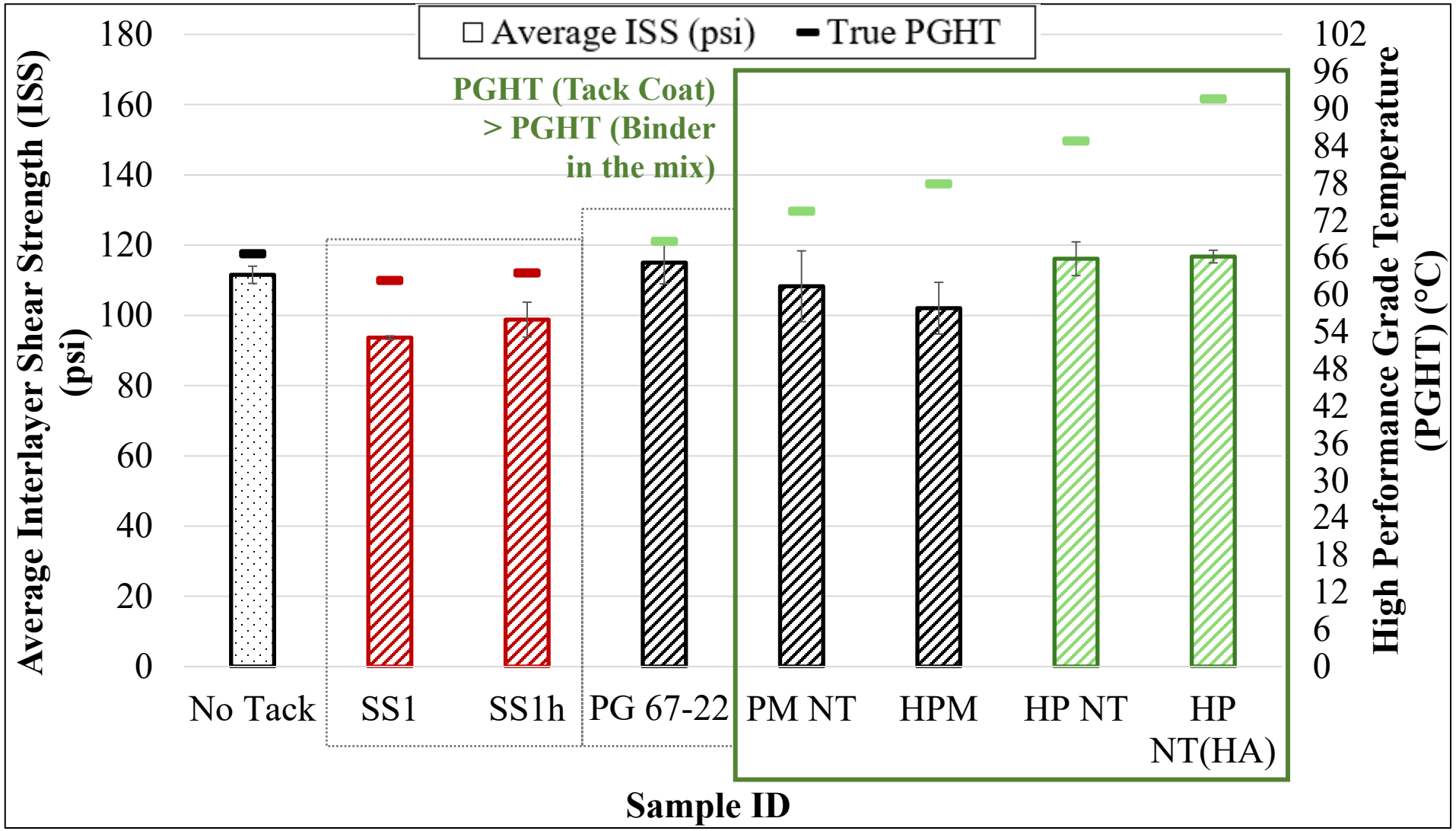

# Shear Strength of ½” NMAS Mixtures vs. Binder/Residue PGHT



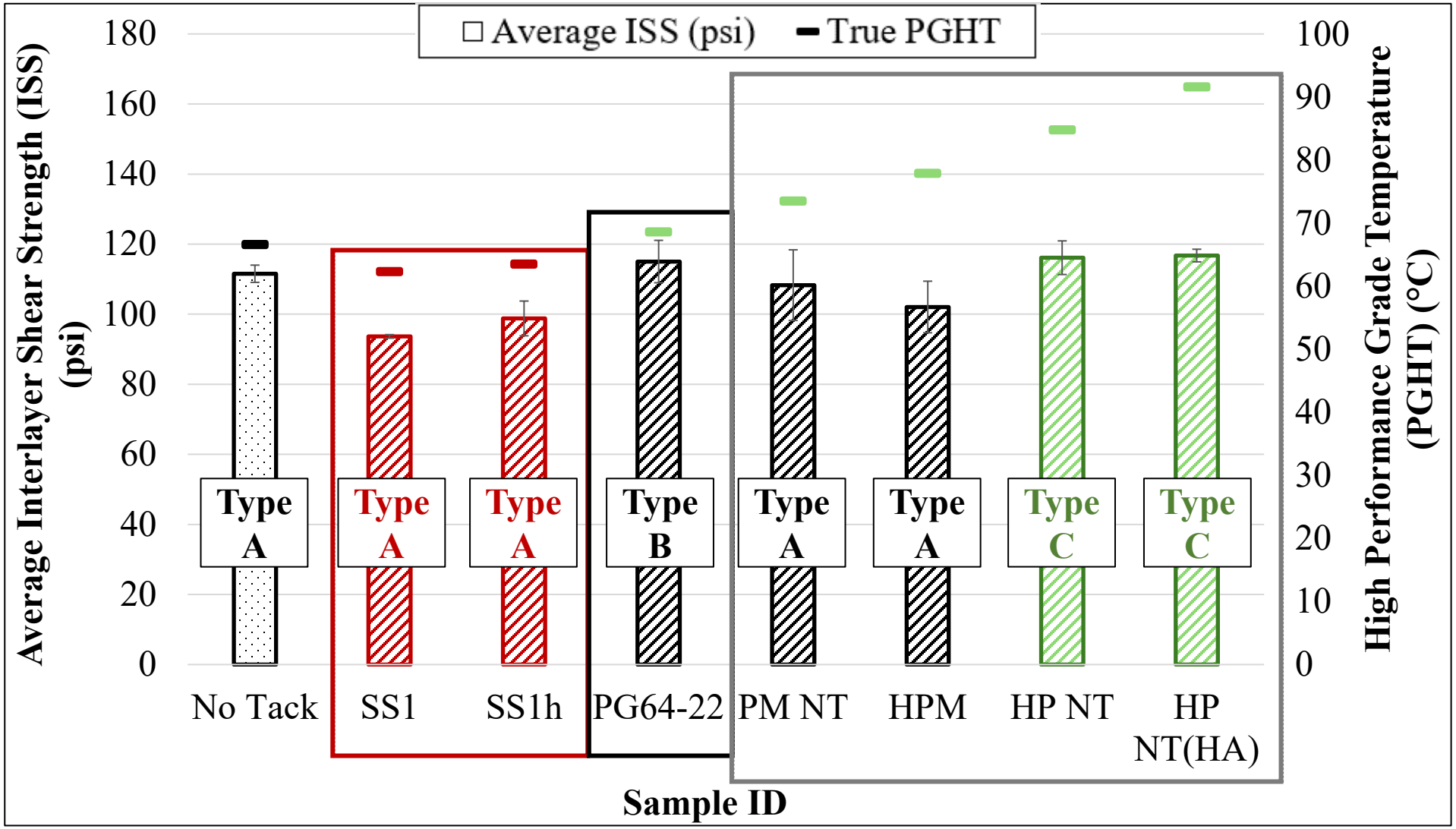




# Shear Strength of ½” NMAS Mixtures vs. Binder/Residue PGHT

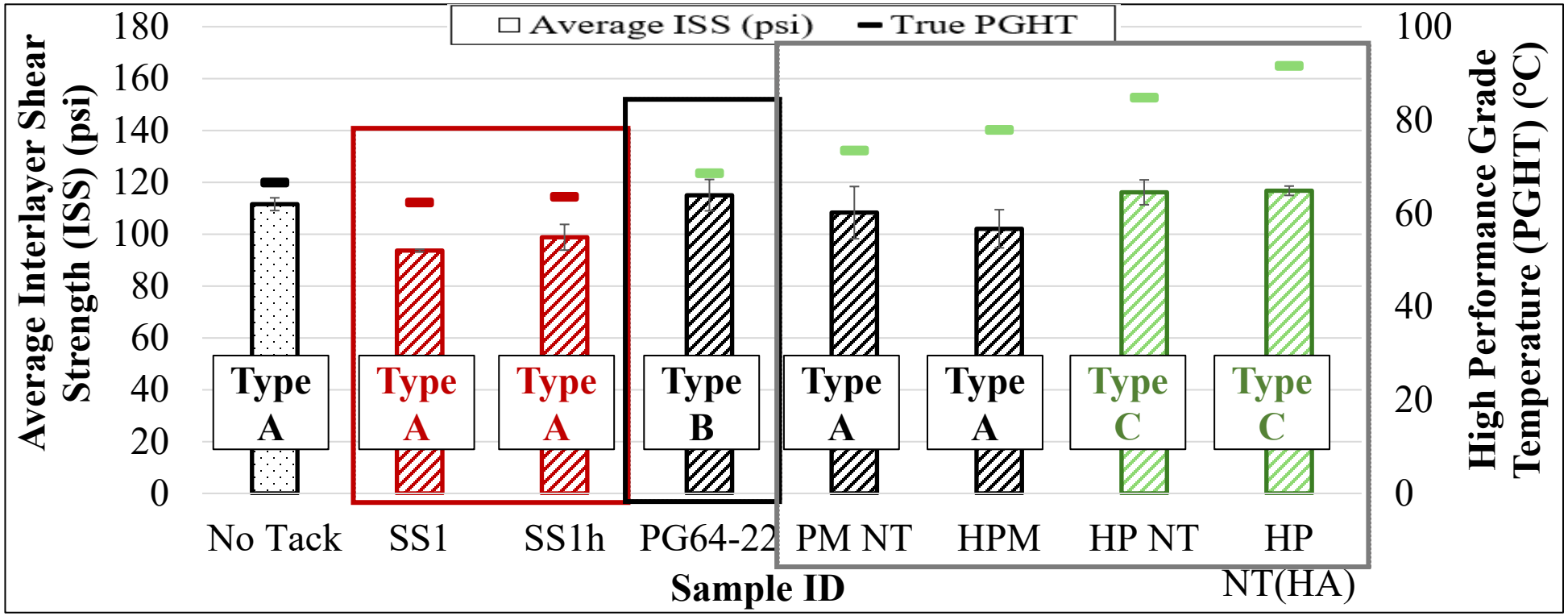


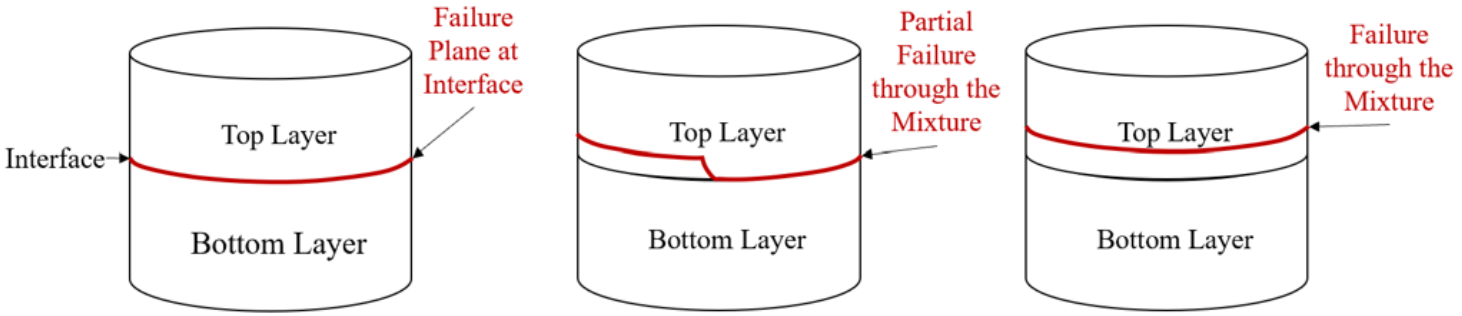




# Shear Strength of ½” NMAS Mixtures vs. Binder/Residue PGHT

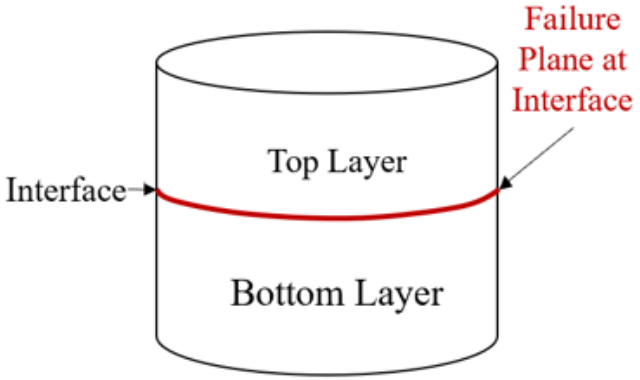


# Shear Strength of ½” NMAS Mixtures vs. Binder/Residue PGHT

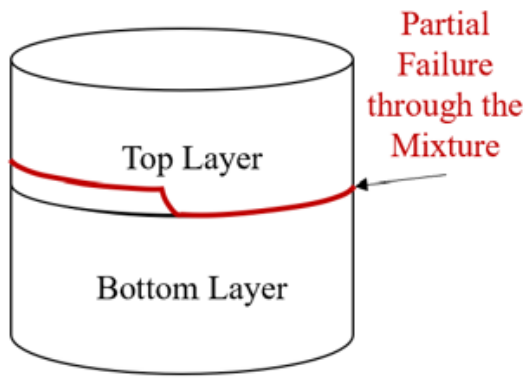


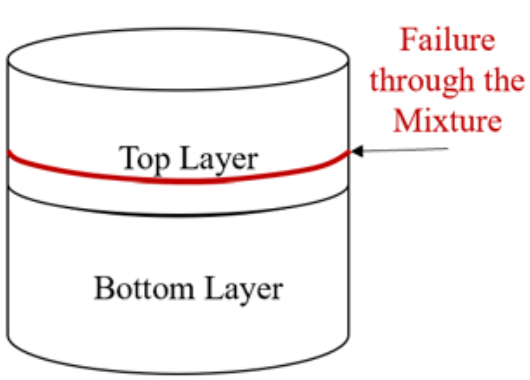
# Failure Types




**Type A**




**Type B**




**Type C**

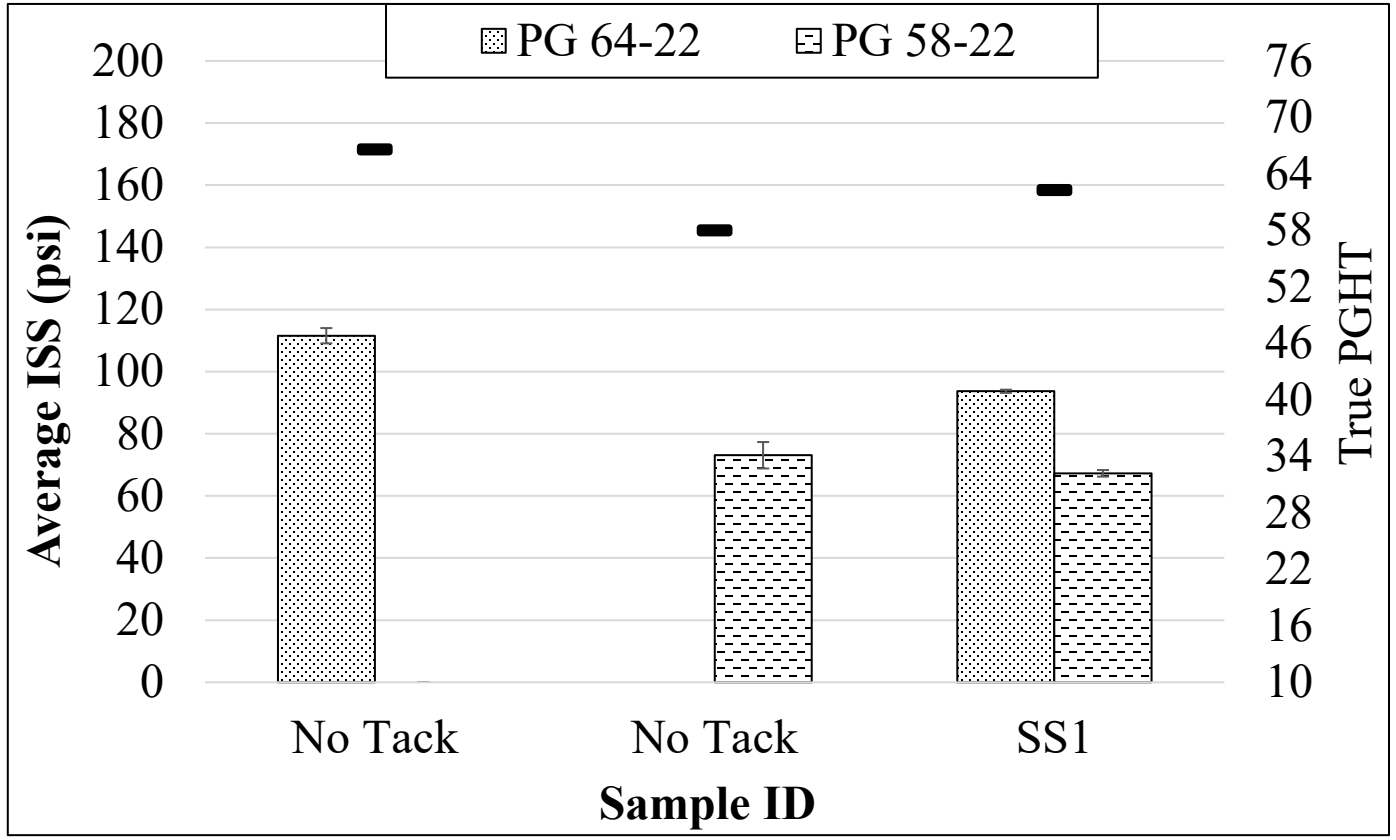
**Type A**

**Type B**

**Type C**

# ISS Test Results of HMA/HMA Samples

**Comparison between ISS Test Results of Mixtures Prepared with PG 64-22(1) and PG 58-22**



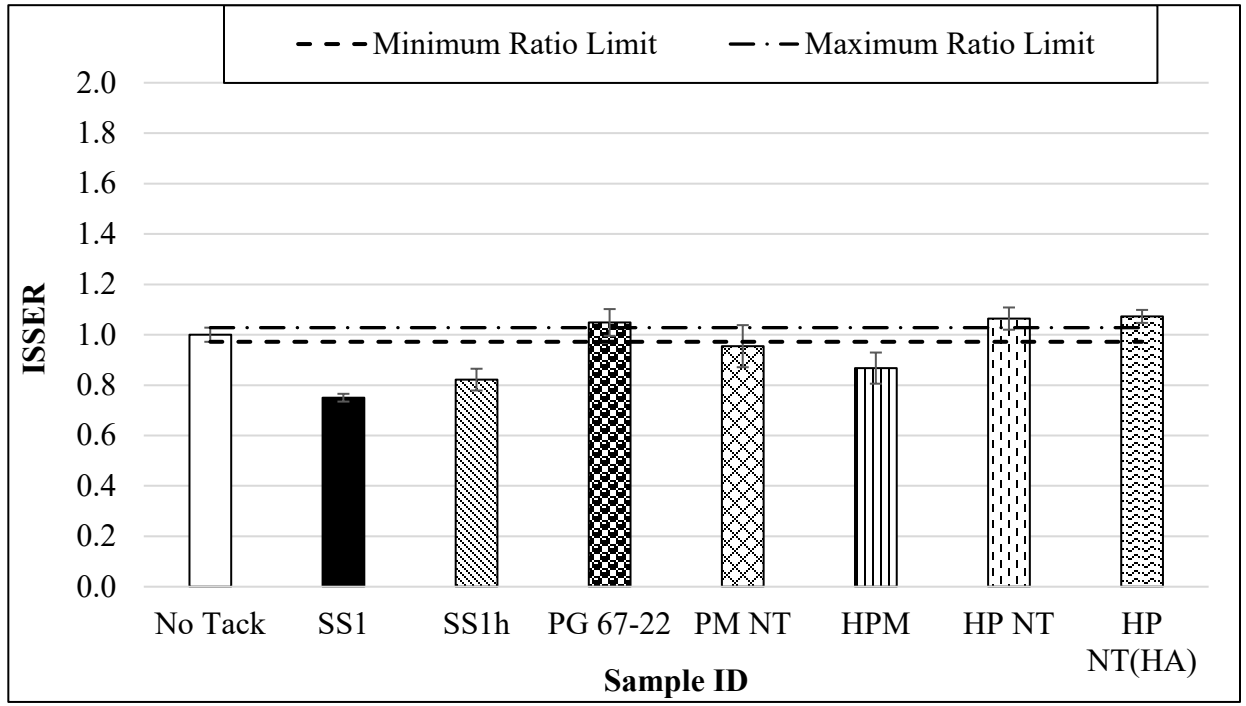

| Mix ID | Recovery Method | PGHT (°C) |
|---|---|---|
| SS1(1) | Distillation | 60.6 |
| PG 64-22 | N/A (hot applied) | 66.7 |
| PG 58-22 | N/A (hot applied) | 60.7 |

½” NMAS Mixture

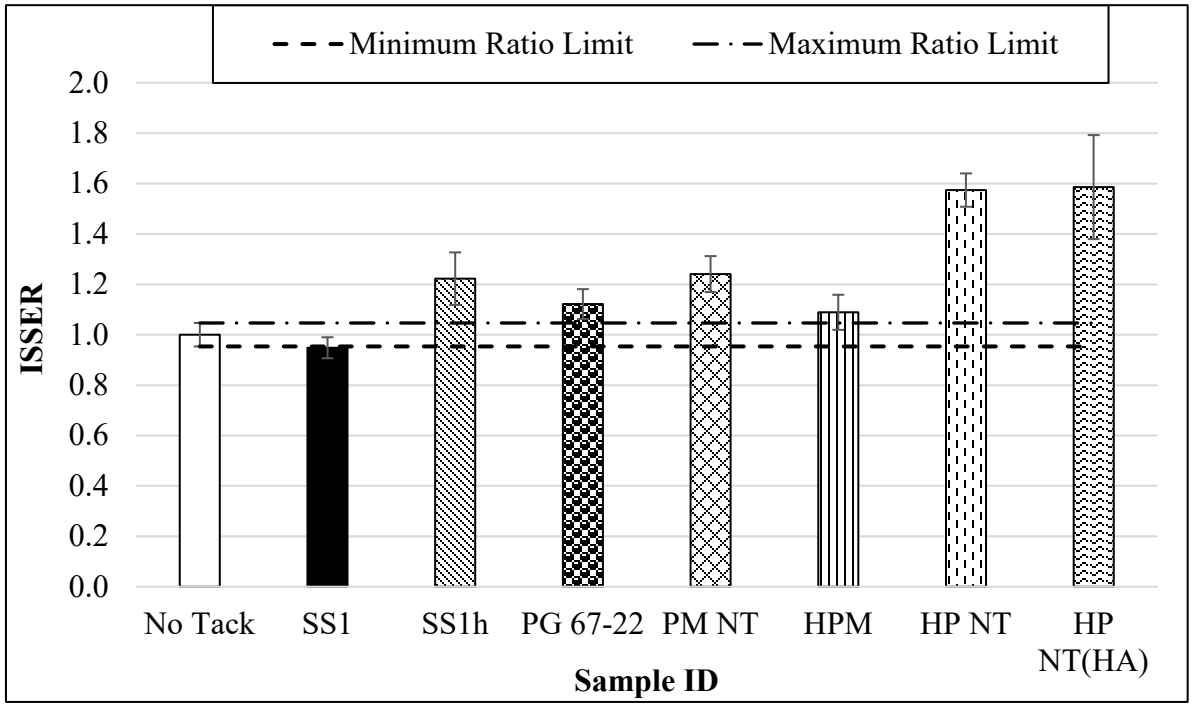
# ISS Test Results of HMA/HMA Samples

$$Interlayer\ Shear\ Strength\ Effectiveness\ Ratio\ (ISSER) = \frac{ISS - ISS_{min}}{ISS_{No\ Tack} - ISS_{min}}$$

$ISS_{min} = 40$ psi

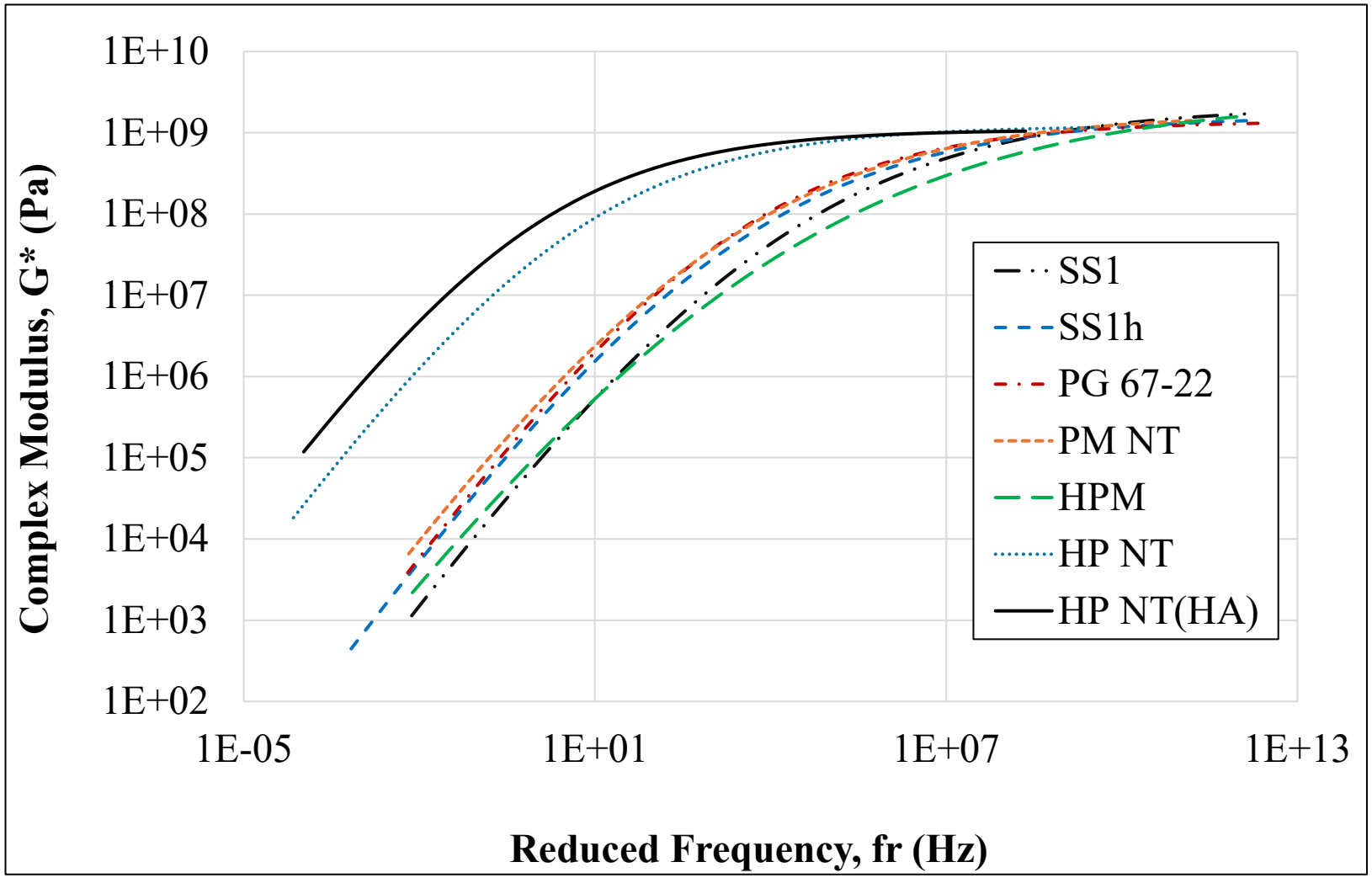



½" NMAS Mixture

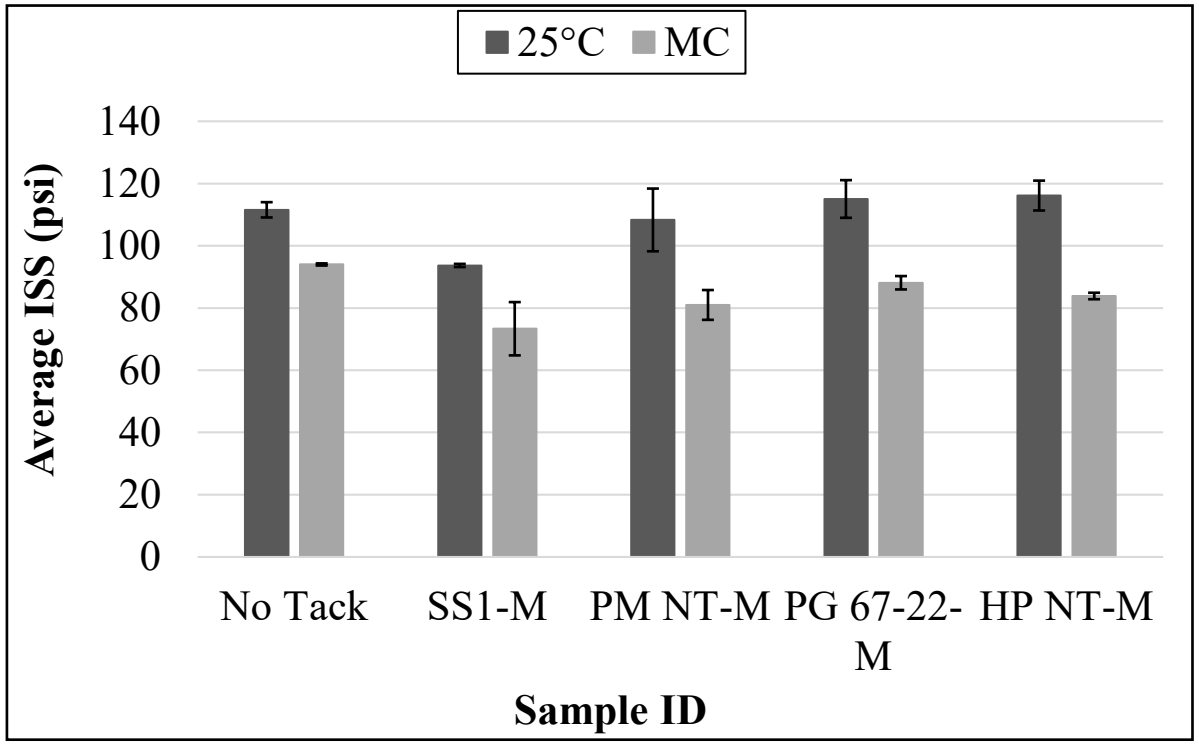



¾" NMAS Mixture

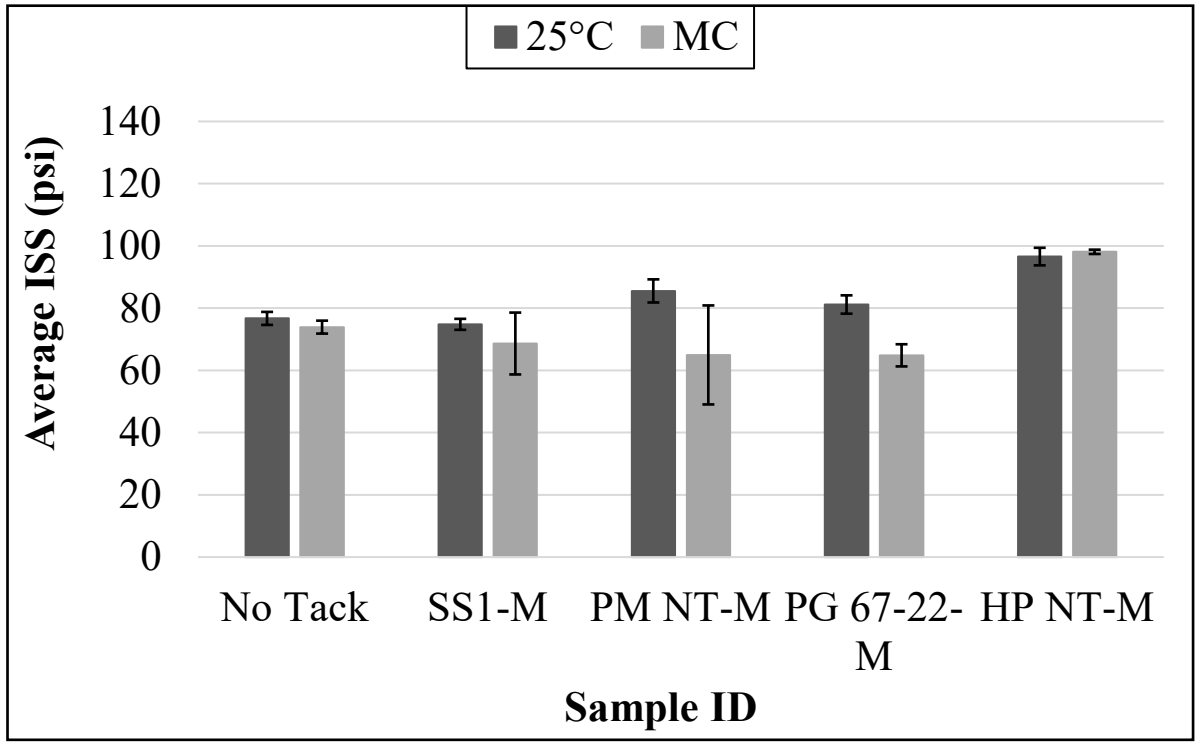
# Complex Modulus of Tack Coat Materials



# ISS Test Results of HMA/HMA Samples

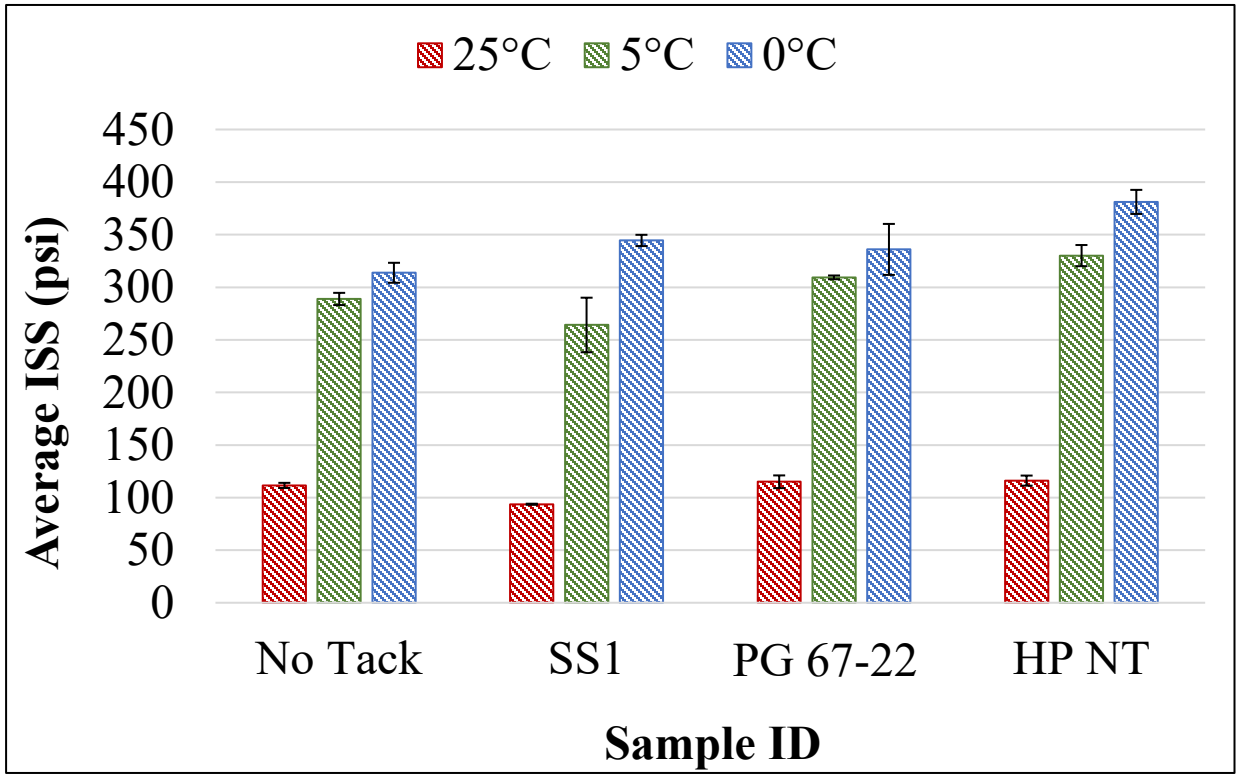



½" NMAS Mixture

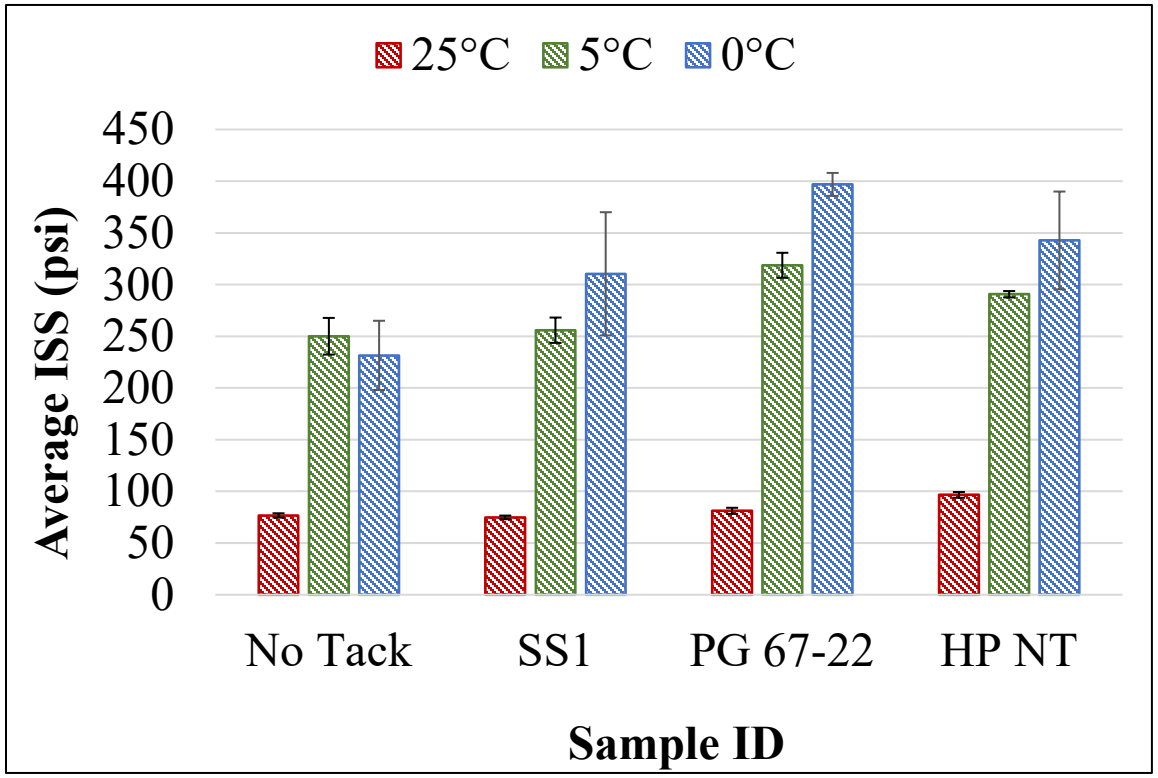



¾" NMAS Mixture

# ISS Test Results of HMA/HMA Samples




½" NMAS Mixture




¾" NMAS Mixture

# Results and Findings on ISS Test Results of New AC/PCC Samples

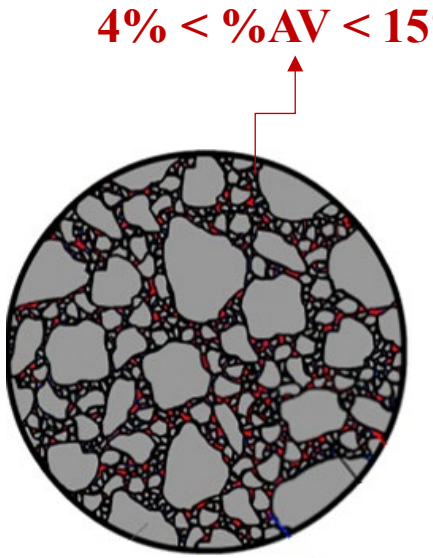


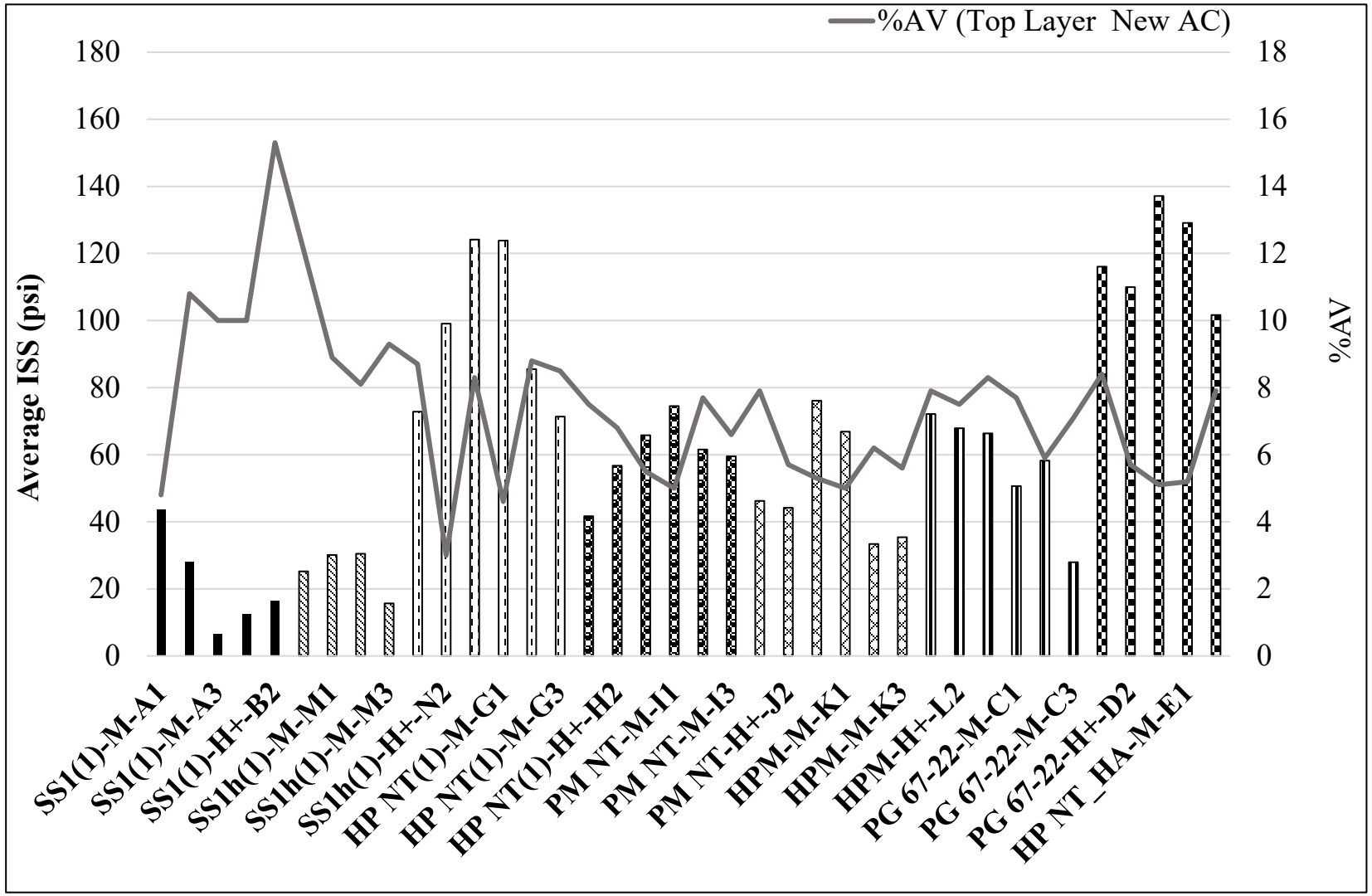
- ½ NMAS New AC/New PCC
- ¾ NMAS New AC/Aged PCC
- ½ NMAS New AC/Aged PCC
- 7 Tack Coats Materials Used
- Medium Application Rate (0.045 gsy)
- High Application Rate (0.074 gsy)
- Cored Samples
- No Tack Coat = No ISS


**Cored AC/PCC Sample**

**Top Layer Debonding During Coring Process**

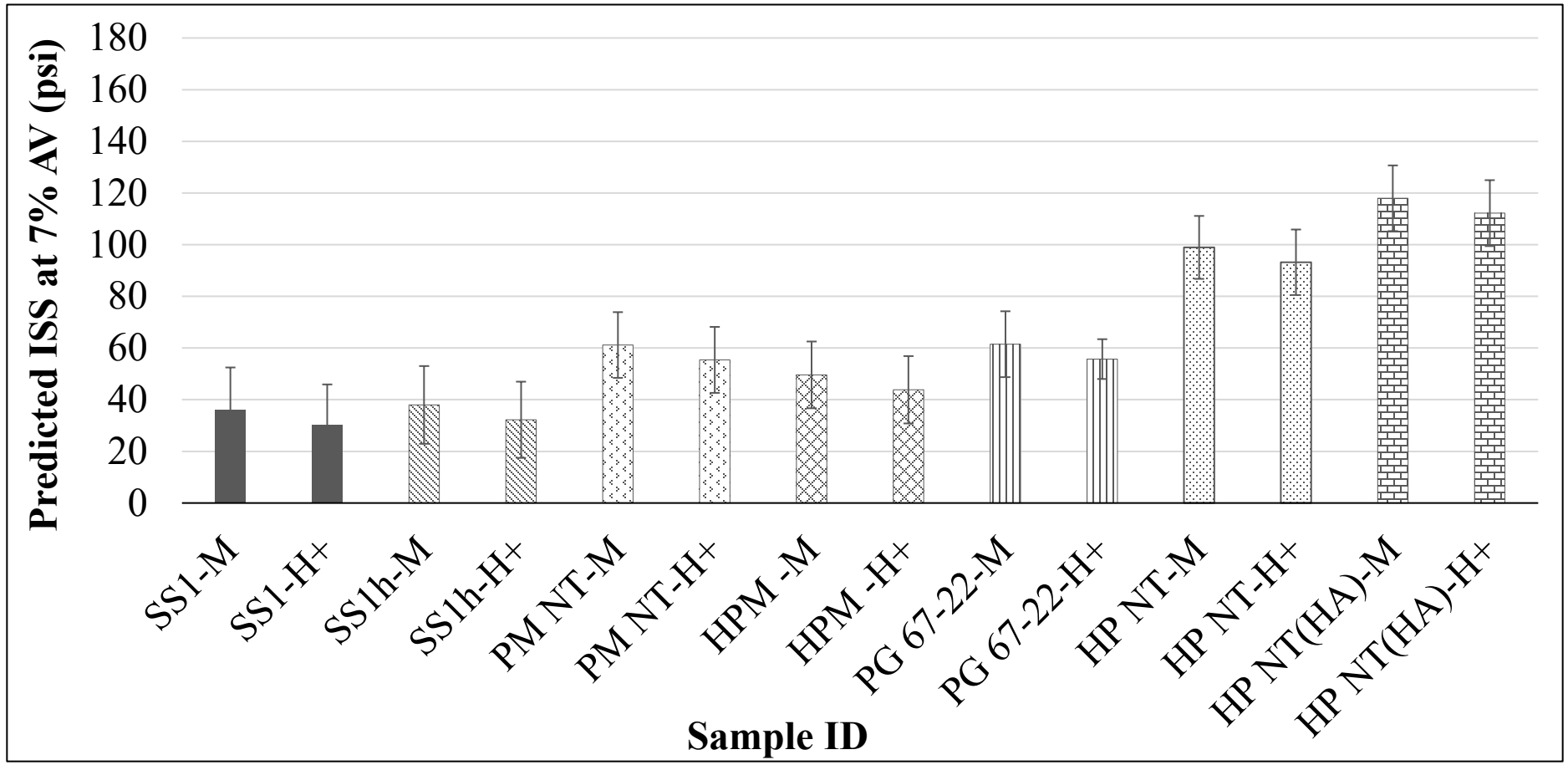
# ISS Test Results of New AC/New PCC Samples




½” NMAS Mixture

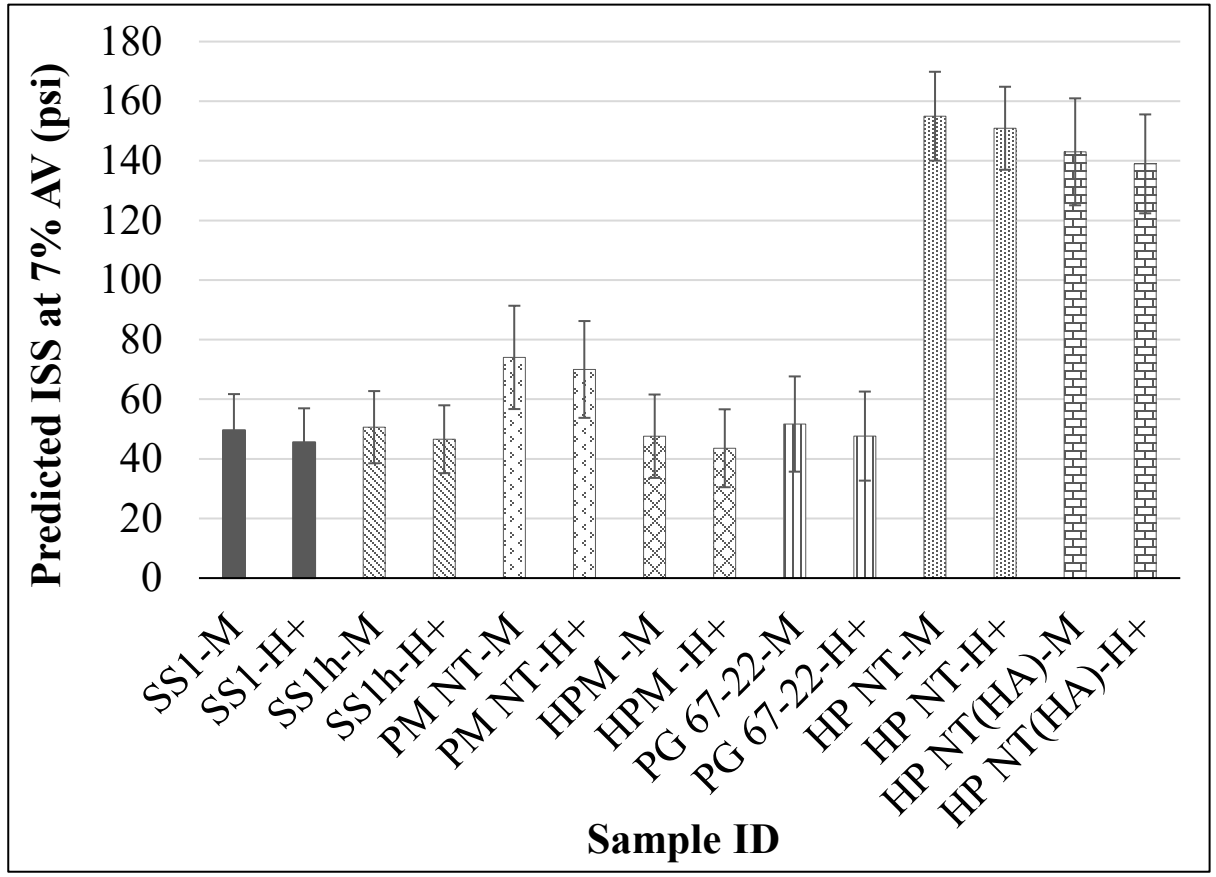
# ISS Test Results of New AC/New PCC Samples



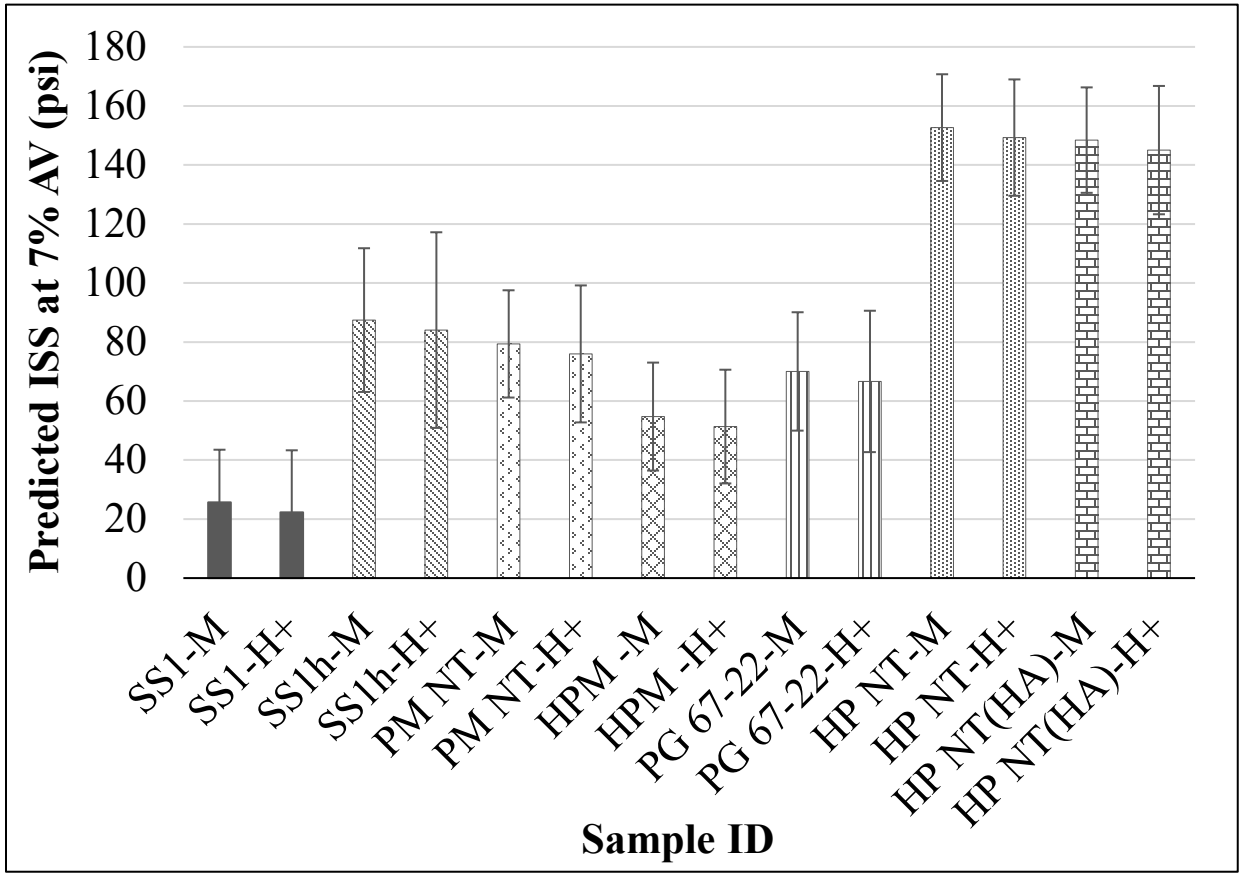

½" NMAS Mixture

# ISS Test Results of New AC/Aged PCC Samples

**Prediction of ISS Values at 7% Air Voids for New AC/Aged PCC Samples**

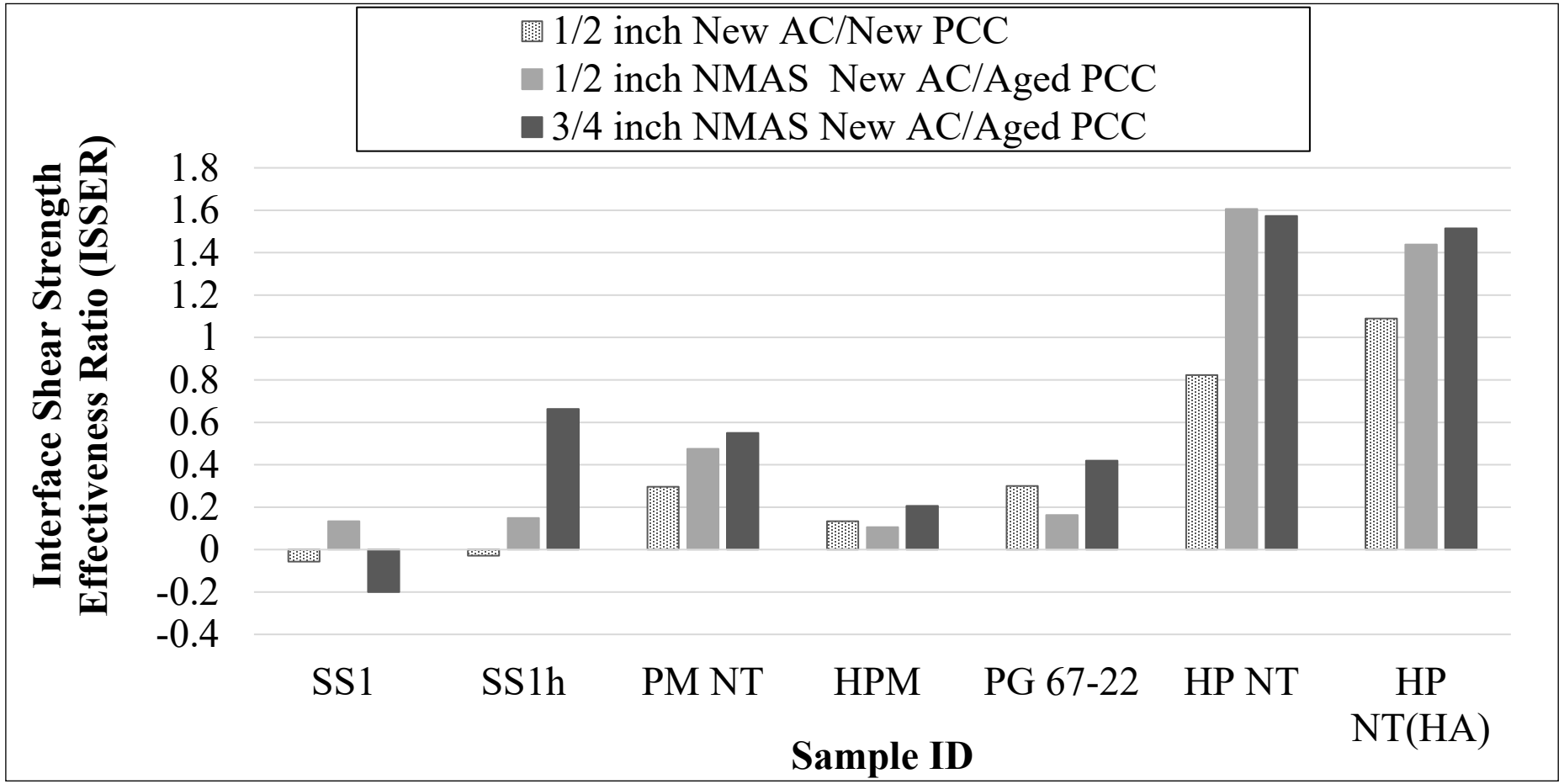



½” NMAS Mixture




¾” NMAS Mixture

# Interface Shear Strength Effectiveness Ratio

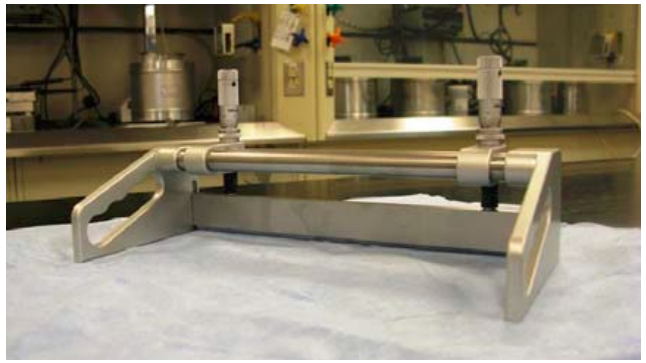


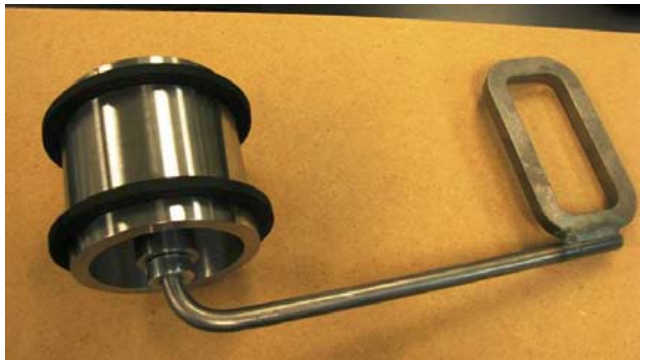
# Test Results

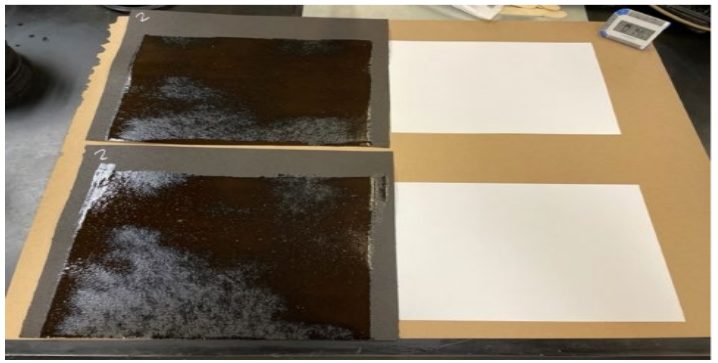
***Tracking Performance***

# Tracking Test

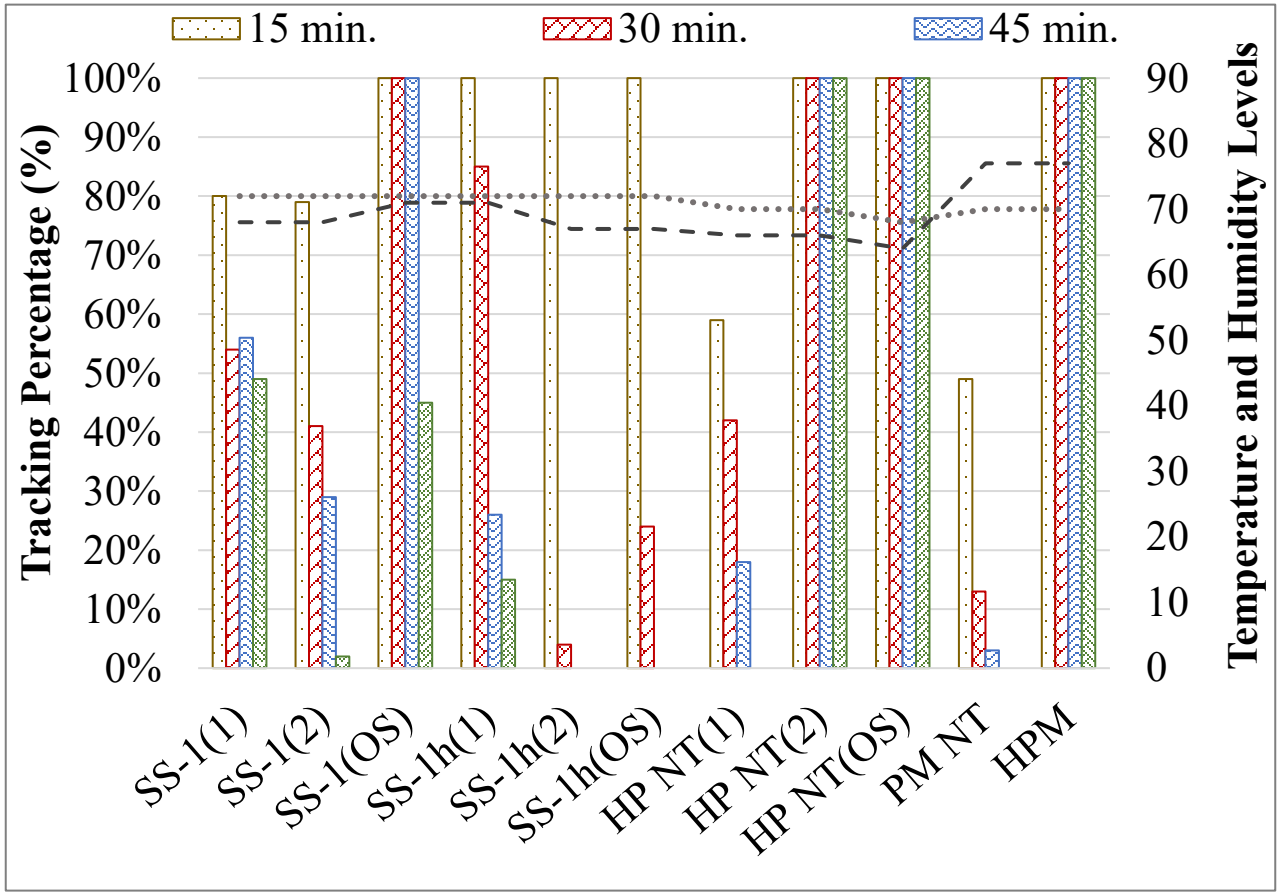
- Measure the time required for each emulsion material used in this research to set before opening to traffic.
- Based on both ASTM D711-20 Standard Test Method for No-Pick-Up Time of Traffic Paint and BASF Tack/Bond Coat Tracking Test Procedure for Asphalt Paving Application
- Uses a ten-pound stainless steel wheel with quarter-inch wide grooves that are fitted with two square-cut O-rings
- The wheel is rolled through a 15-mil emulsion mat every 15 minutes onto white card stock until no further tracking is noted
- The emulsion mat, wheel, and O-rings were used at room temperature (70-75°F)
- The BASF procedure rates the thickness of the track and includes measuring the length of the track itself

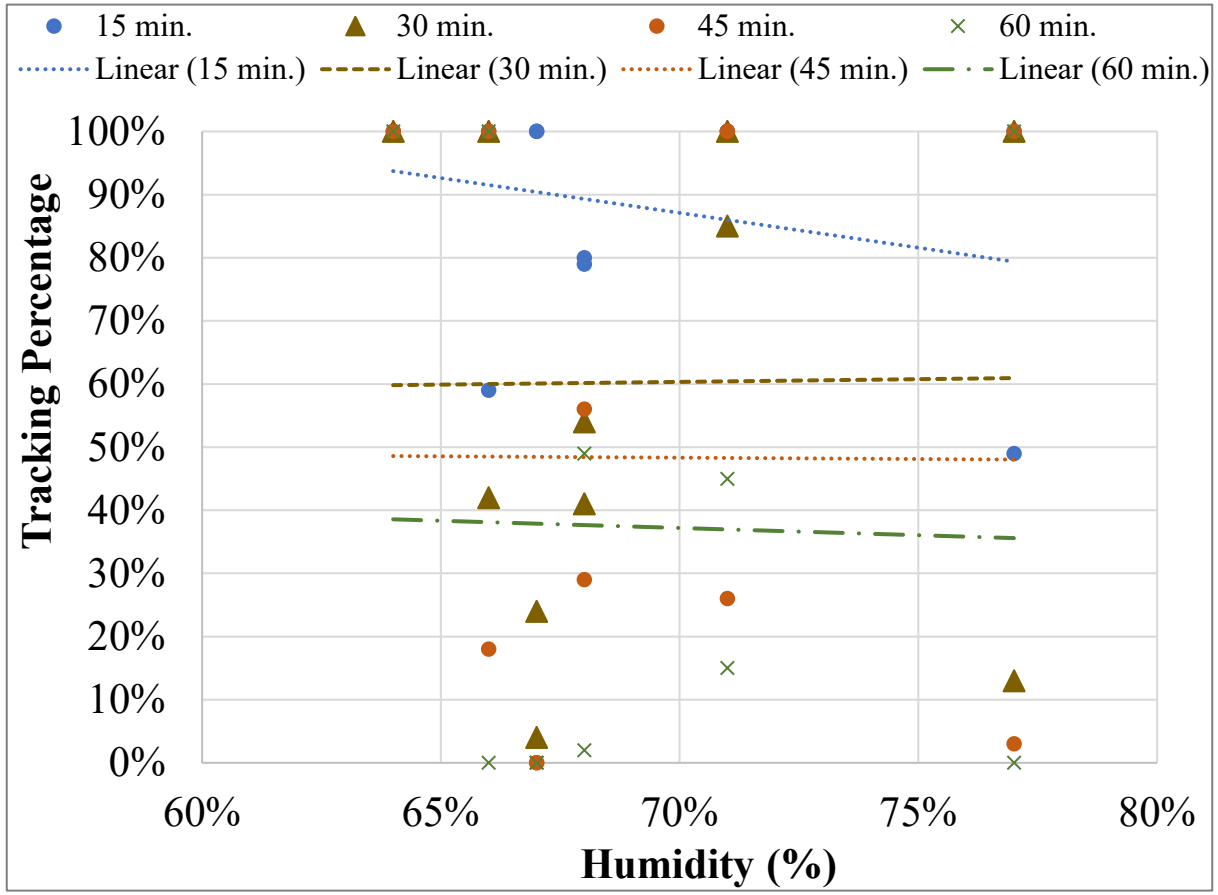






# Tracking Test Results

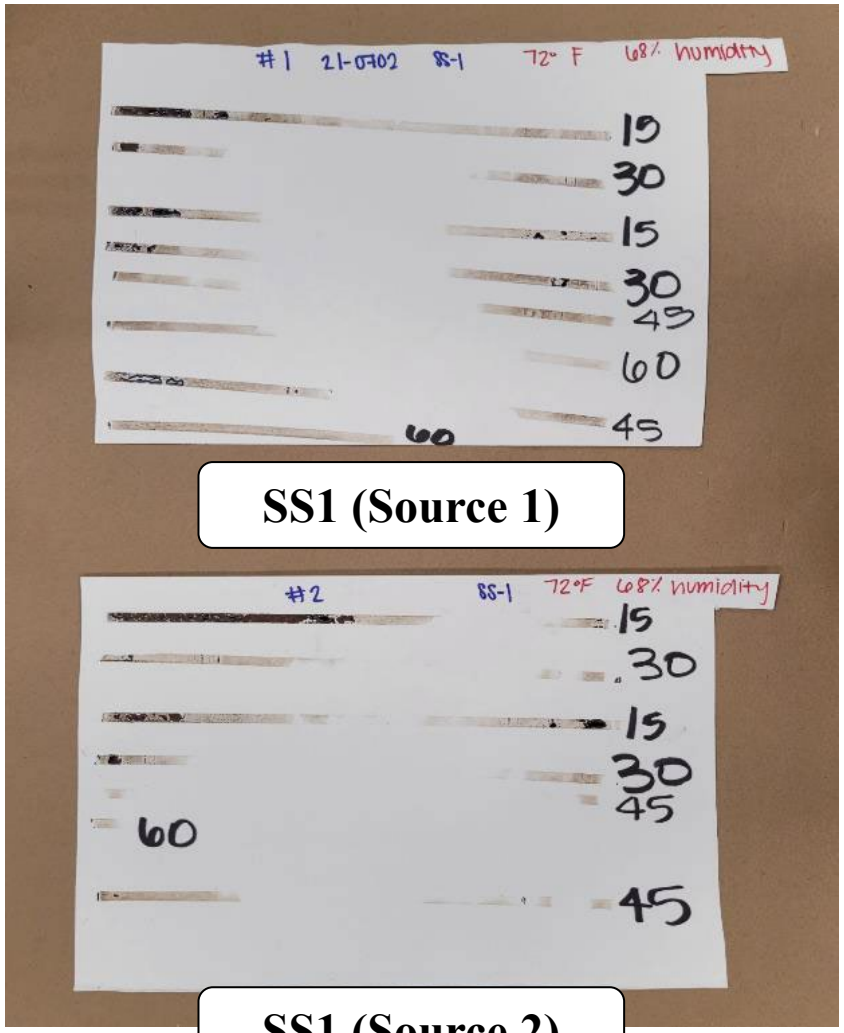



**No trend was observed between tracking percentage, temperature and humidity ➔ Tracking performance is material related**

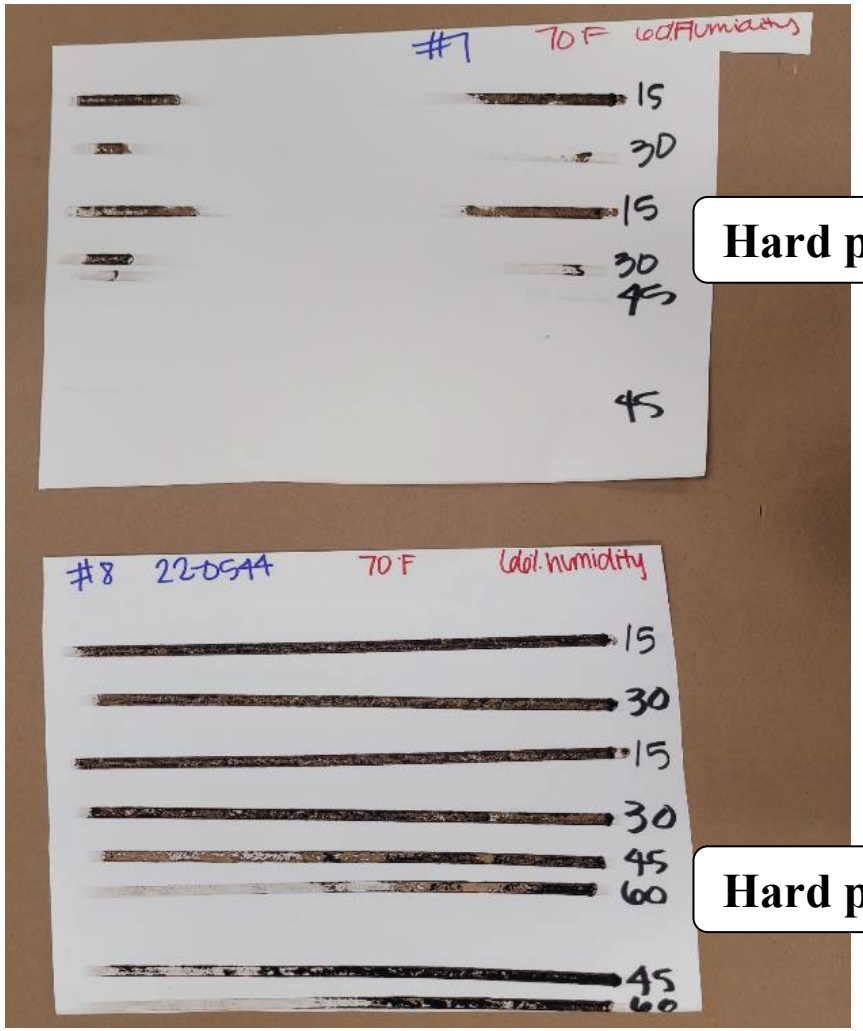
**➔ Temperature and humidity levels did not have a significant impact on setting time and tracking performance.**

# Tracking Test Results




SS1 (Source 1)

SS1 (Source 2)




Hard pen Non-Tracking (Source 1)

Hard pen Non-Tracking (Source 2)

# Tracking Test Results

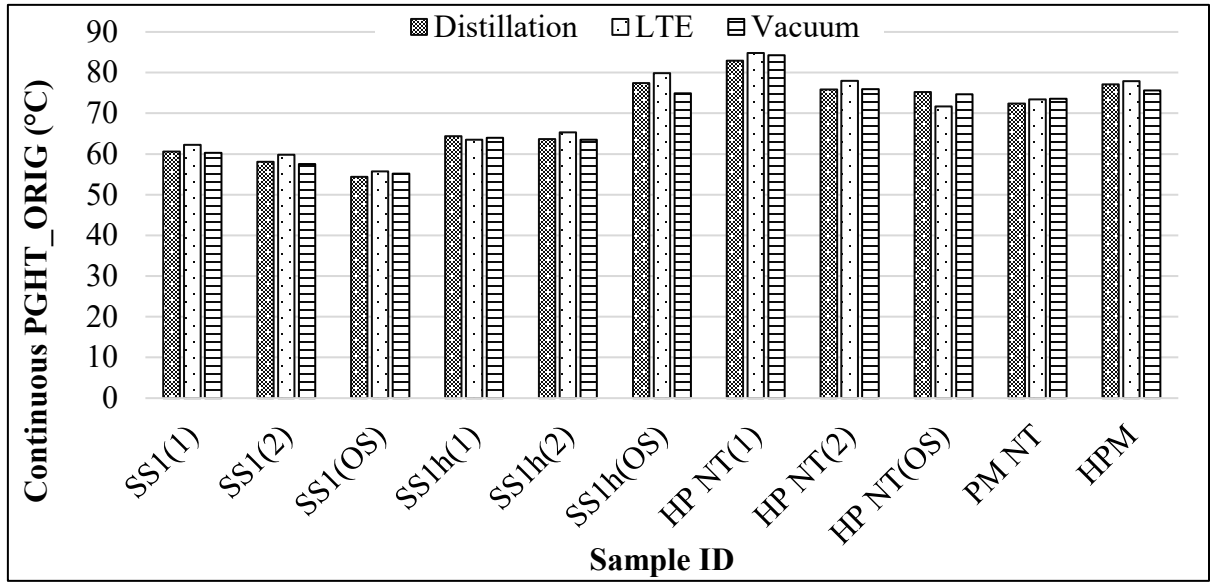

➔ A basic assumption is that the temperature difference between crossover temperature and the temperature at which tracking begins is material-dependent. Field observations suggest that the offset is about 25°C.

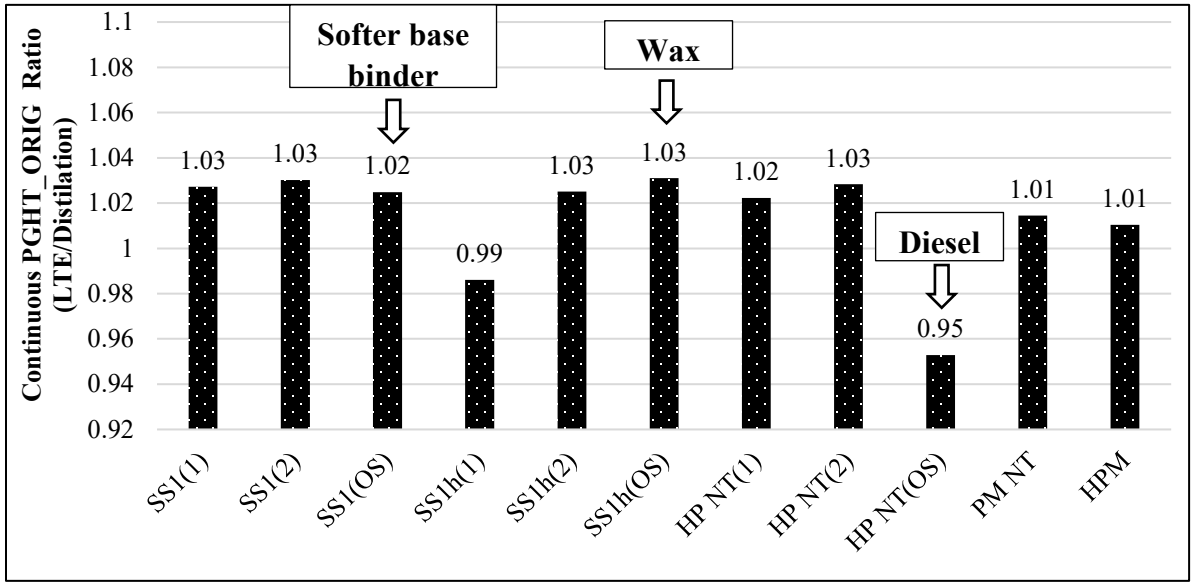
# Test Results

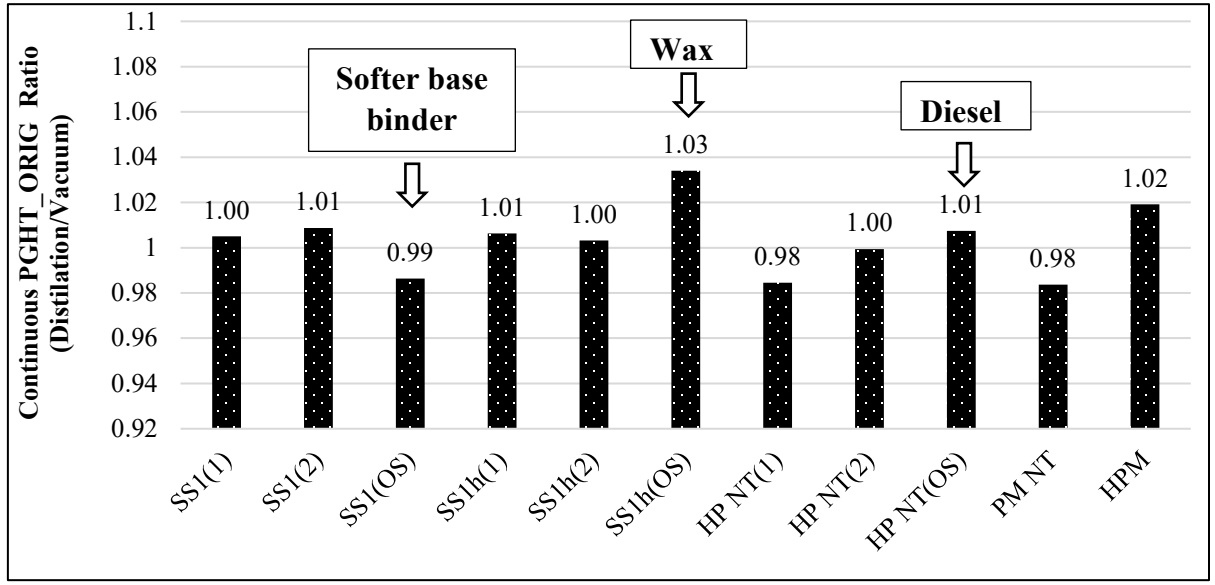
***Durability Performance***

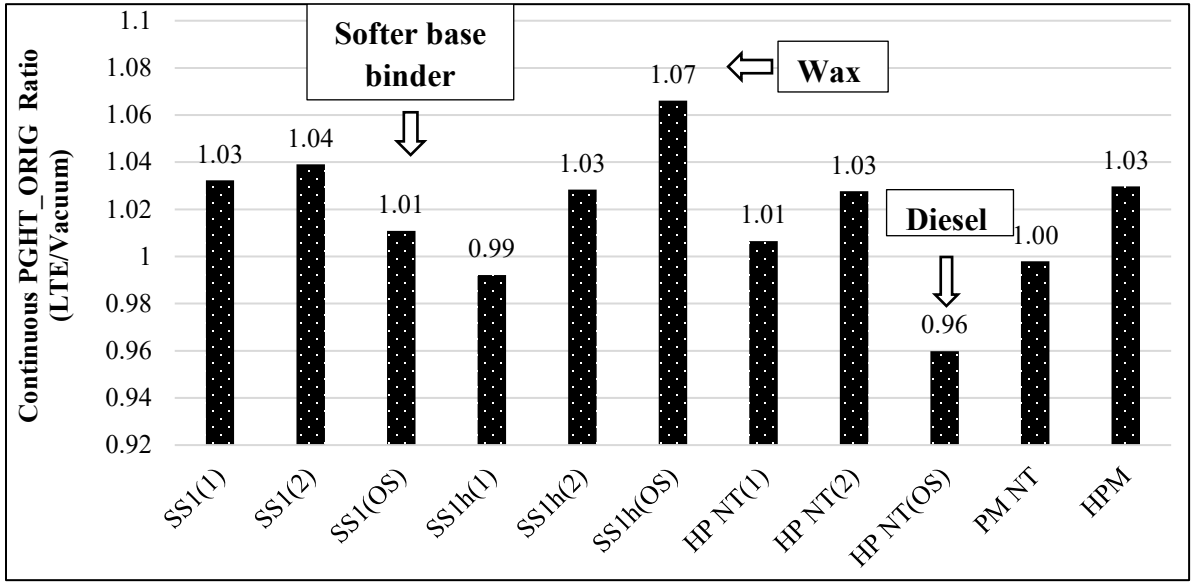
# Comparison between Residue Recovery Methods

## *PGHT*



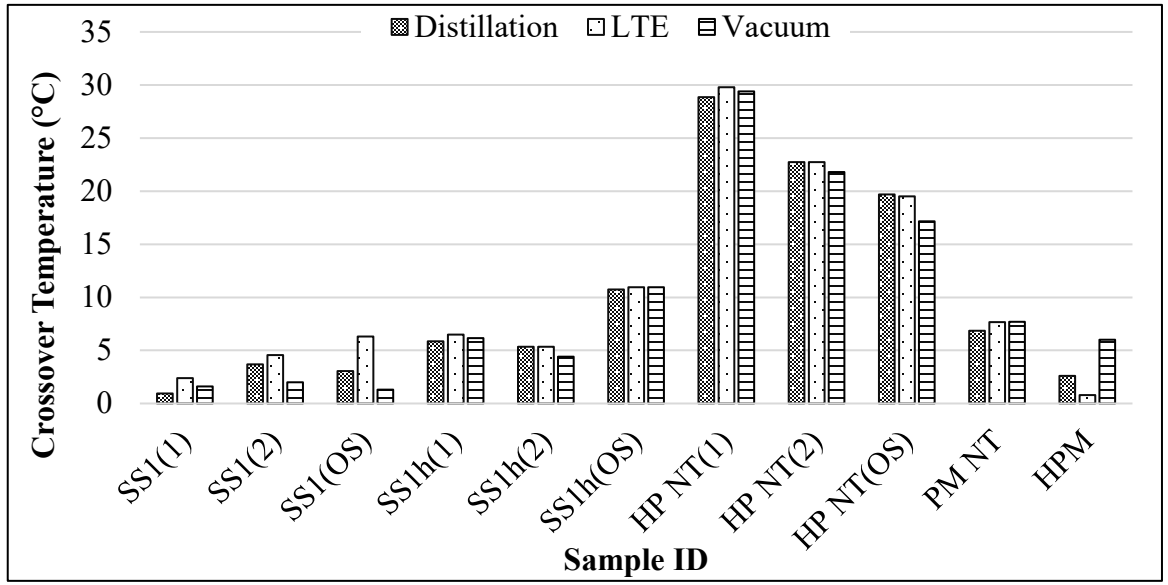



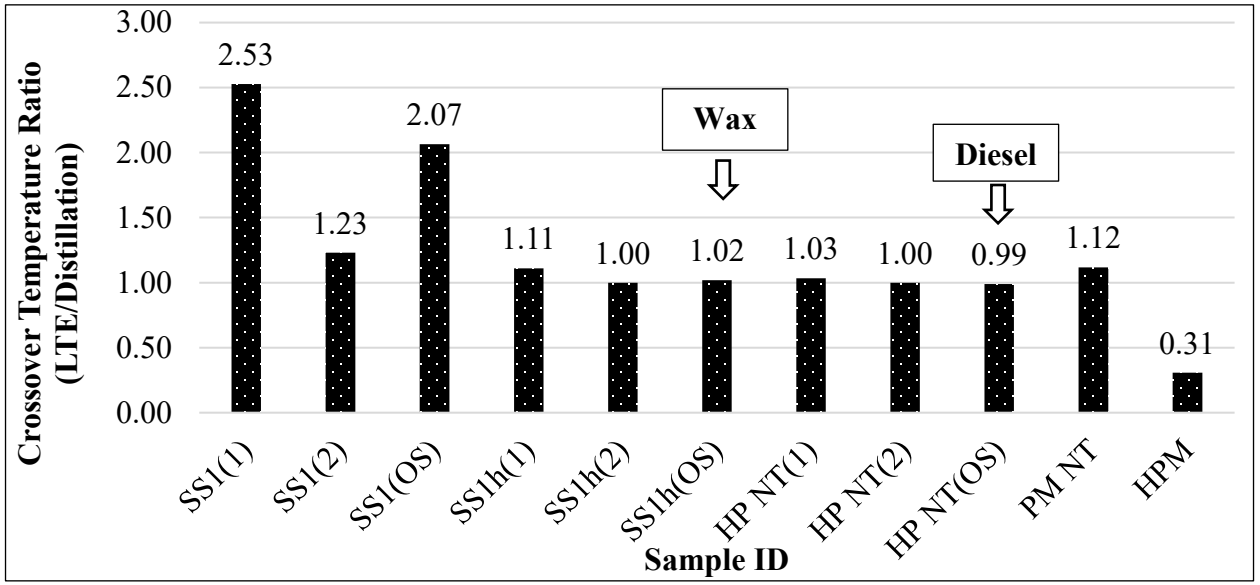



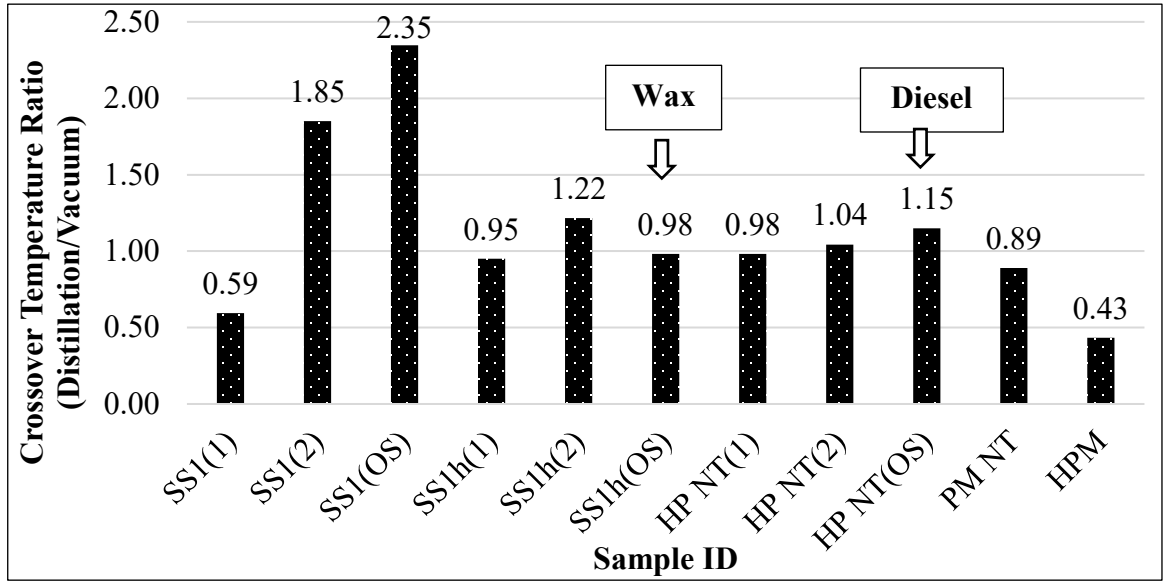
# Comparison between Residue Recovery Methods

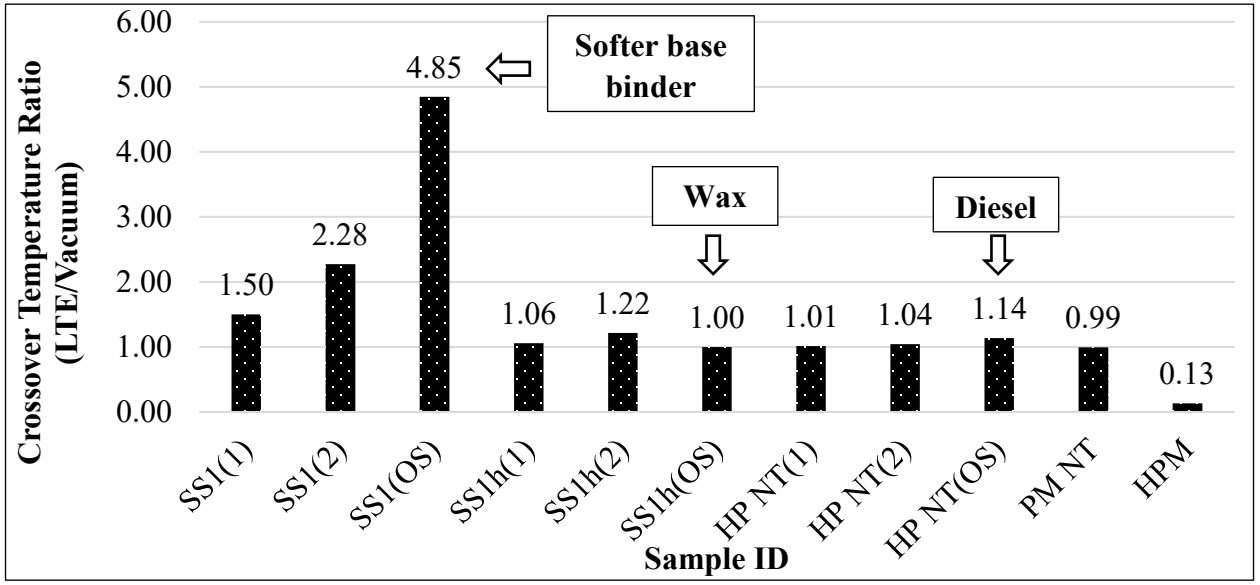


## *Crossover Temperature*

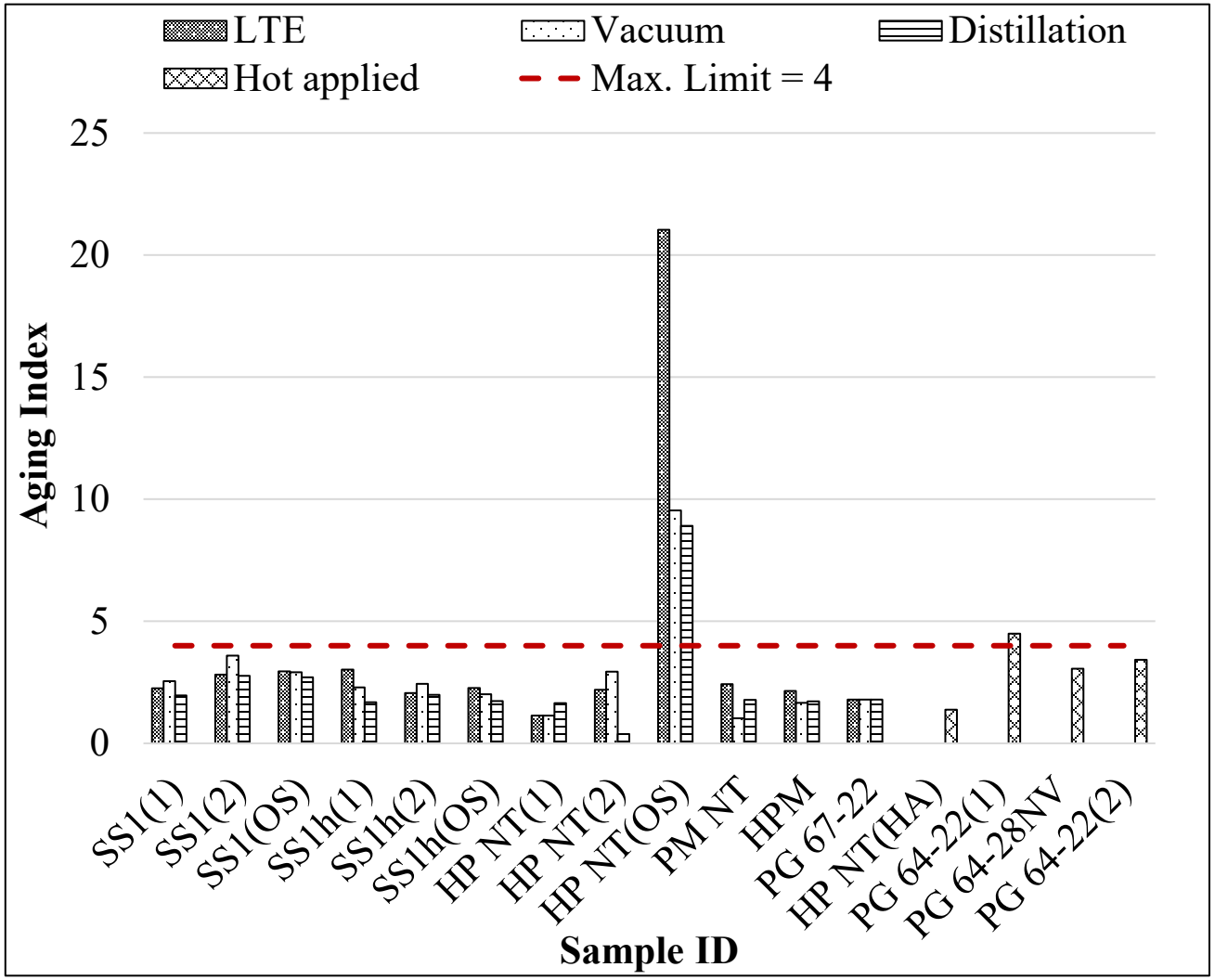


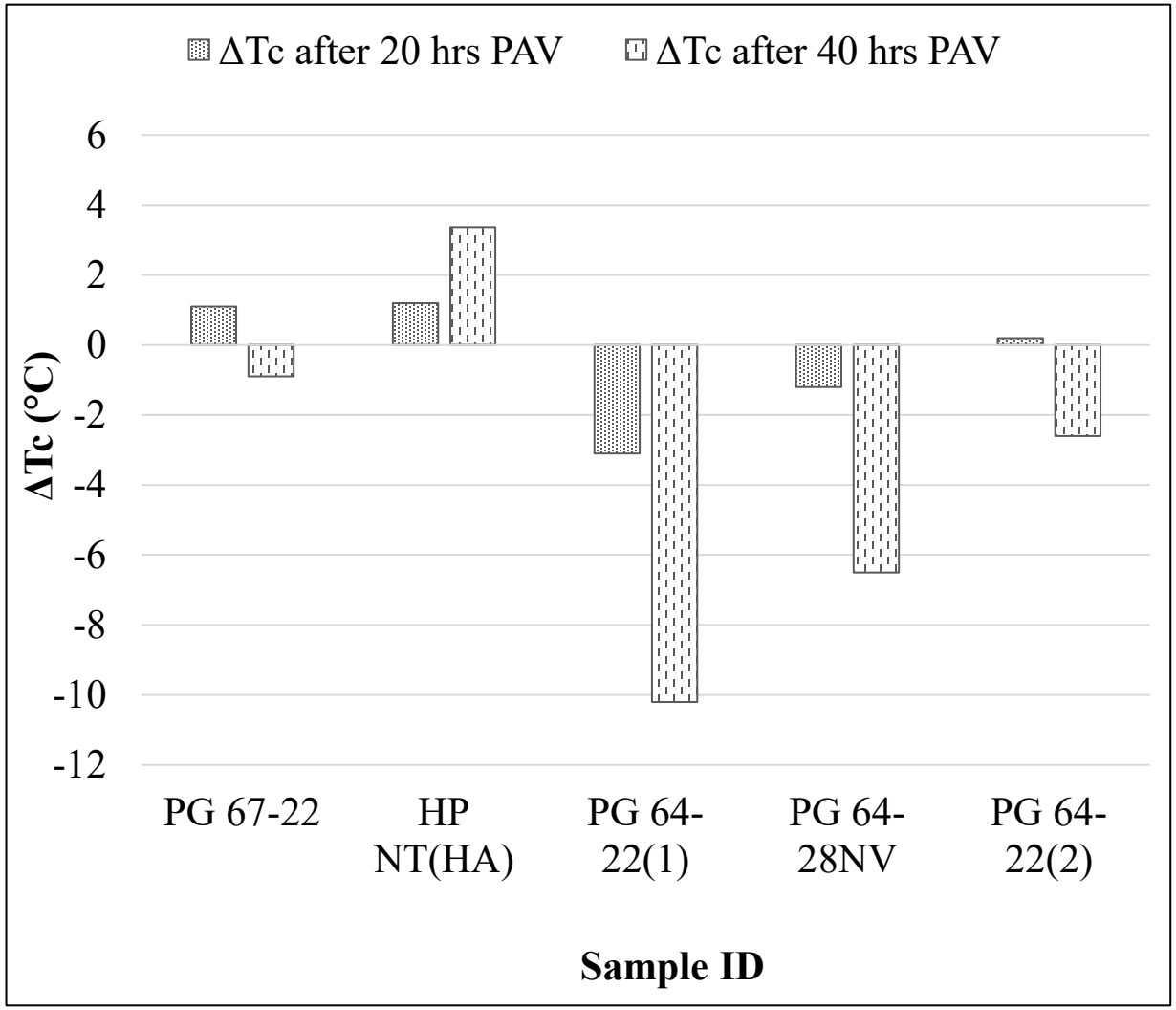



# Durability


LTE
Vacuum
Distillation
Hot applied
Max. Limit = 4
Aging Index
25
20
15
10
5
0
SS1(1)
SS1(2)
SS1(OS)
SS1h(1)
SS1h(2)
SS1h(OS)
HP NT(1)
HP NT(2)
HP NT(OS)
PM NT
HPM
PG 67-22
HP NT(HA)
PG 64-22(1)
PG 64-28NV
PG 64-22(2)
Sample ID


ΔTc after 20 hrs PAV
ΔTc after 40 hrs PAV
ΔTc (°C)
6
4
2
0
-2
-4
-6
-8
-10
-12
PG 67-22
HP NT(HA)
PG 64-22(1)
PG 64-28NV
PG 64-22(2)
Sample ID

# Conclusions and Recommendations

Decrease Neutral Increase

- **Effect on Shear Strength**
  - Application rate
  - Gradation: Fine Gradation
  - Surface Condition: Aged (polished) surface
  - Testing Temperature: Low-Temperature
  - Moisture Conditioning: Fine-graded mixture, Coarse-graded mixture
- **The addition of tack coat improved bond strength in all cases in the composite pavement**
- **AASHTO Specification**

**Bonding** – Tack Coat PGHT > Top AC Layer PGHT.

**Tracking** – Crossover Temperature > Pavement Temperature - 25°C.

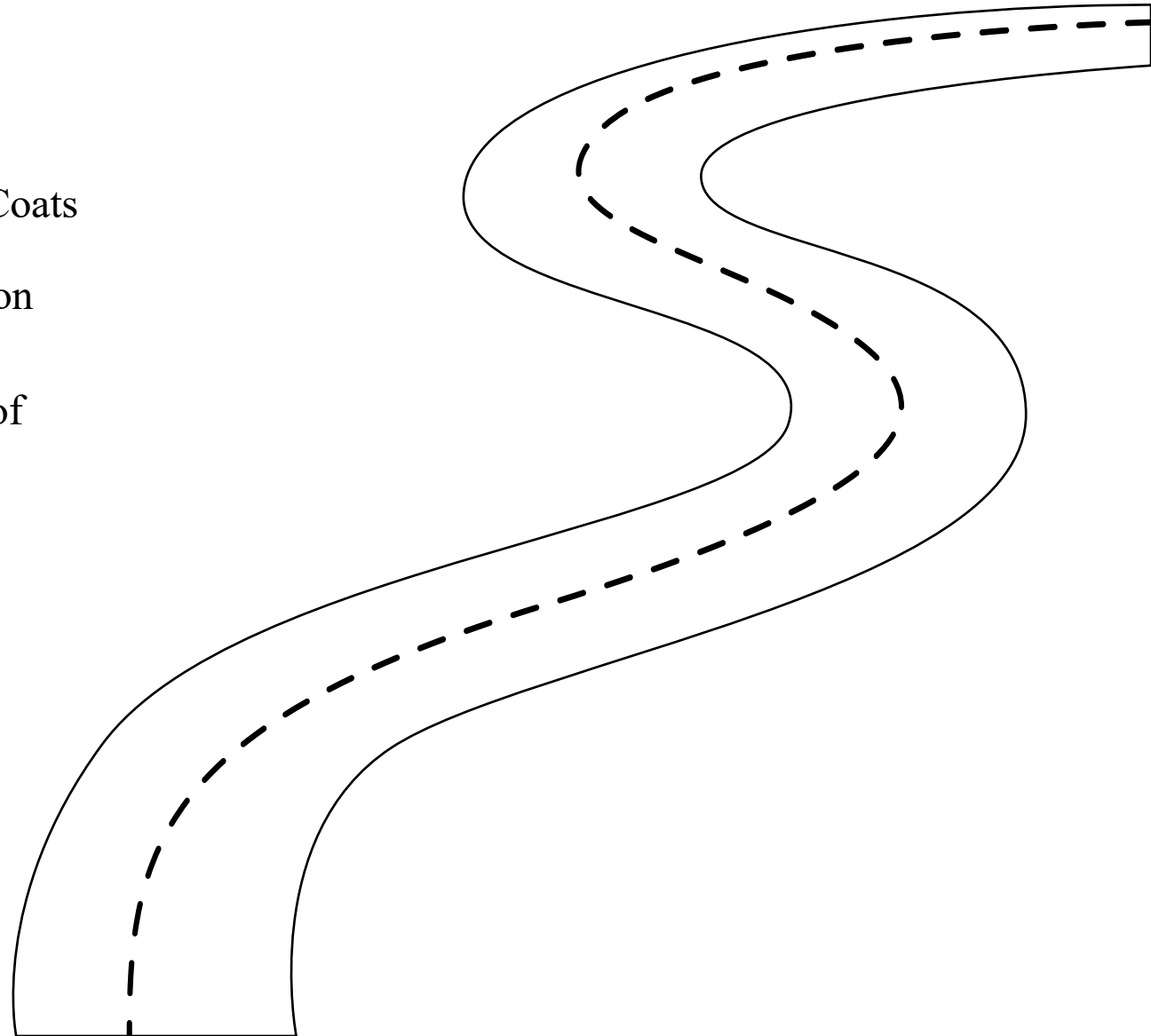
**Durability** – Aging Index (RTFO DSR/Original DSR at high grade temperature) < 4.0.

# Conclusions and Recommendations

## NTPEP Work Plan

- Defines the evaluation procedures for Asphalt Tack Coats which will serve as the standard testing protocol for AASHTO's National Transportation Product Evaluation Program for these products.
- Develops laboratory testing to determine properties of Asphalt Tack Coats.

NTPEP
AASHTO THE VOICE OF TRANSPORTATION | NATIONAL TRANSPORTATION PRODUCT EVALUATION PROGRAM



# Conclusions and Recommendations

## Field Validation Work Plan

- Transition from controlled laboratory conditions to field conditions:
  - Field Experiment Projects.
  - Tack Coat Material Specification and Test Method.
  - Tack Coat Construction Specifications.
  - Pavement Bond Strength Sampling and Testing.
  - Participating Agencies and Contractors/Material Suppliers.
  - Documentation, Communications and Reporting.
  - Analysis and Specification Validation or Refinement.

# Questions?


NEVADA

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paragon technical services, inc.

# Today's presenters

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Rnasr.unr@gmail.com
*CRAFCO INC*

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*Louisiana Department of Transportation*

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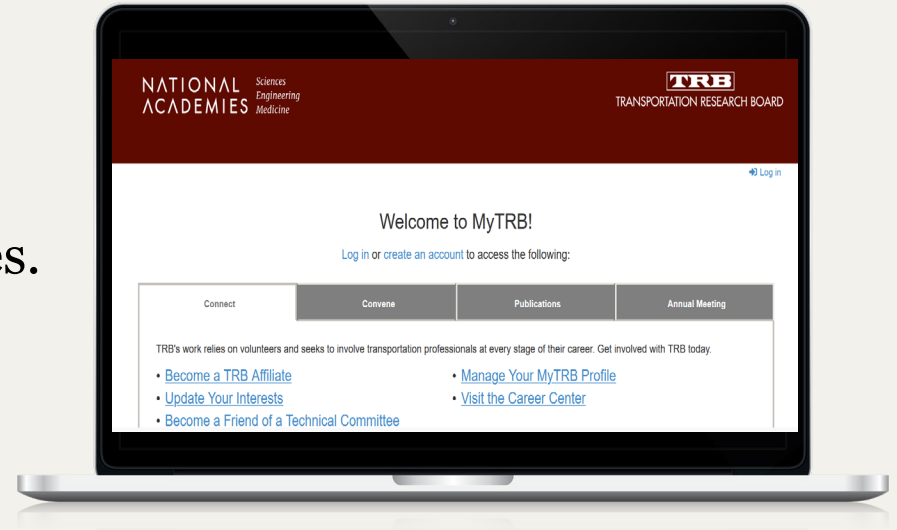


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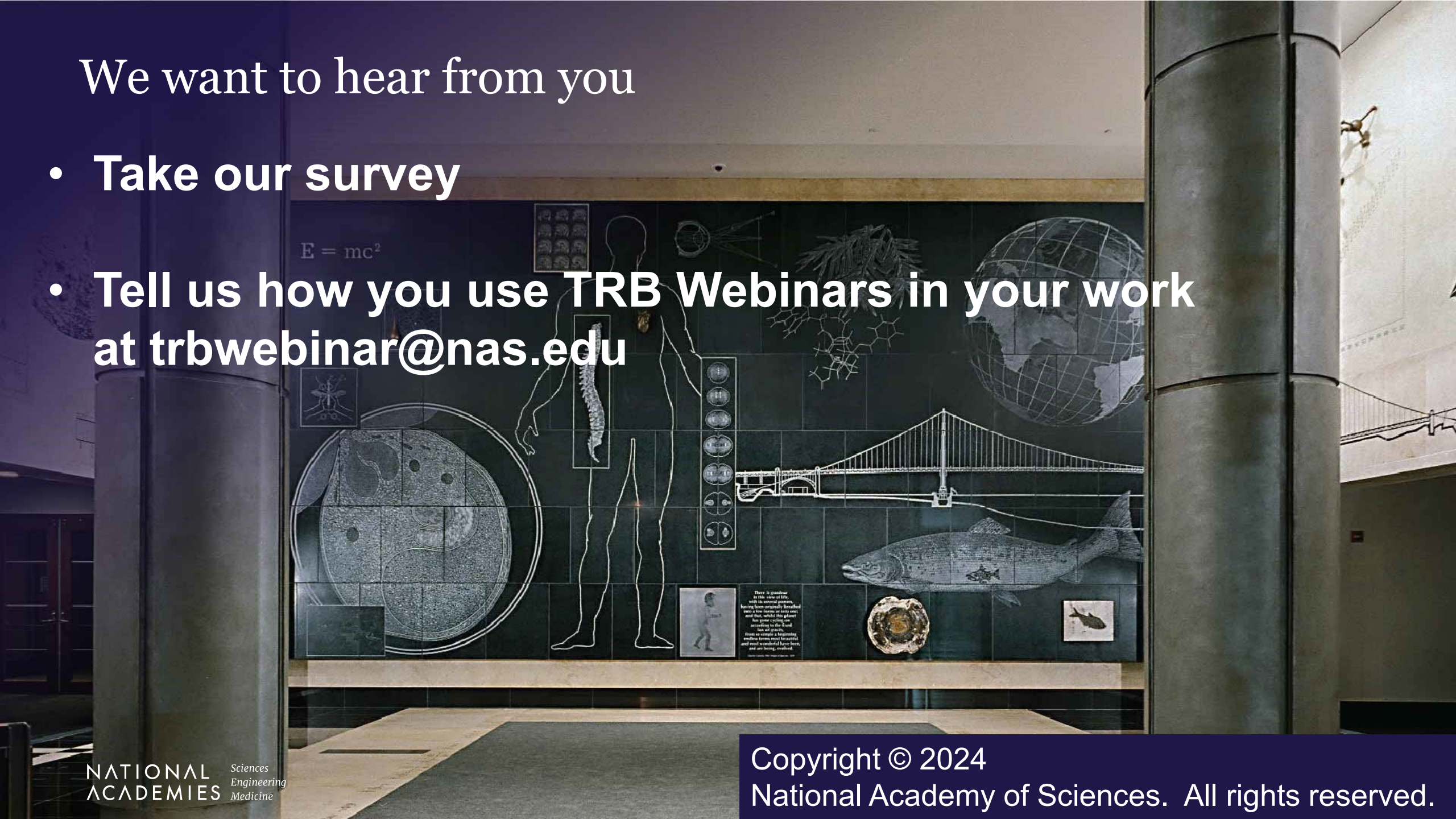


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