Effect of Tack Coat Materials and Application Rates on the Interface Bond Strength

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What is a Tack Coat?

- A light application of asphalt onto an existing pavement surface
  - Asphalt emulsion diluted with water
- Used to ensure a *bond* between the surface being paved and the underlying course
Why is Tack Coat Used?

- Monolithic structure
  - withstand/transfer shear stresses from traffic loading

- Lack of bond between the wearing and binding layers
  - Cause slippage
  - activate distress mechanisms and rapidly lead to total failure
**Background**

- **Experience and empirical judgment**
  - Selection of tack coat material type, application rate, and placement

- **Quality control and quality assurance testing**
  - rarely conducted
  - resulting in the possibility of unacceptable performance at the interface,
  - premature failure.

- **NCHRP Project 9-40**
  - Optimization of Tack Coat for HMA Placement
  - develop a procedure to evaluate the tack coat quality in the field
  - bonding characteristics testing
Background
Characterization of Interface Bond Strength

- Interlayer Bond Strength

Direct Shear

Torsion
Background
Characterization of Interface Bond Strength

- Interlayer Bond Strength
Background
Characterization of Interface Bond Strength

- Developed equipment
  - Louisiana Interlayer Shear Strength Tester (LISST)
  - Interface Bond Strength
  - Shear
- Easy to use
- Portable
- Adoptable to exiting load frames
- Reasonable cost
- accommodate both 100 and 150-mm sample diameter
- Draft test method in AASHTO format
Objective

- Examine Effect of Tack Coat Materials and Application Rates on the Interface Bond Strength
Scope

- Pavement surface types:
  - existing HMA

- Construction Condition
  - Pavement Surface
    » clean and dirty
    » wet and dry

- Tack coat material types
  - Emulsion
    » CRS-1, Trackless, SS-1h

- Application rates (residual):
  - high (0.031 gsy), medium (0.062 gsy), and low (0.15 gsy)

- Surface coverage by tack coat:
  - 100%
Methodology

- Full-scale test site at the PRF
  - designed and constructed
    » conventional tack coat application
    » paving equipment.
Existing HMA Surface

- Survey of the condition of the surface of the test lanes at the LTRC pavement research facility.
  - identify and document surface irregularities
  - avoid them during the coring processes

- Surface texture measurement
  - ASTM E1845
  - 1.07 mm
Test Lane Surface Layout
Construction Condition -- Dirt

RATE = 0.34 kg/m²
Spray Application of Tack Coat

- Equipments
  - Asphalt Products Unlimited, Inc
  - Computerized tack coat distributor truck
  - Etnyre, Model 2000
Spray Application of Tack Coat
Verification of Spray Rates

- Geotextile Pad layout
  - ASTM 2995
  - One transverse direction
Construction Condition -- Wet

Rate = 0.27 L/m²
Overlay Construction

Material Transfer Vehicle
Completion of Overlay Construction
Interface Shear Strength (ISS) Tests -- LISST
Louisiana Interface Shear Strength Tester

- Horizontal Sensor
- Vertical Sensors
- Normal Load Actuator
- Shearing Frame
- Reaction Frame

Graph: Interface Shear Load (kN) vs. Displacement (mm)

- Interface Shear Load (kN):
  - 0.0
  - 0.5
  - 1.0
  - 1.5
  - 2.0
  - 2.5
  - 3.0
  - 3.5

- Displacement (mm):
  - 0
  - 1
  - 2
  - 3
  - 4
  - 5
  - 6
  - 7
Effect of Tack Coat Materials & Application Rate -- Clean & Dry Condition

![Graph showing the interface shear strength in psi vs. the residual application rate in gsy for SS-1h, CRS-1, and Trackless materials. The graph shows a positive correlation between the application rate and interface shear strength.]
Effect of Dirt on the ISS

- **Interface Shear Strength (psi)**
  - Clean/Dry
  - Dirty/Dry

- **Residual Application Rate (gsy)**: 0.031, 0.062, 0.155

- **Tracks**:
  - SS-1h
  - CRS-1
  - Trackless

- **Notable Points**:
  - * indicates significant difference

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*Image Description:*
- The graph shows the effect of dirt on the ISS interface shear strength for different residual application rates and tracks (SS-1h, CRS-1, Trackless).
- Clean/Dry and Dirty/Dry conditions are compared.
- Significant differences are marked with asterisks (*) for each condition and rate.

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*Legend:*
- Clean/Dry
- Dirty/Dry

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*Conclusion:*
- The presence of dirt significantly affects the interface shear strength for all conditions and application rates.
- Differences are most pronounced in the Trackless track with higher residual rates.
Effect of Wetness on ISS: SS-1h Clean Surface

![Bar Chart](chart.png)

- **Interface Shear Strength (psi)**
- **Residual Application Rate (gsy)**

- **Dry / Clean**
- **Wet / Clean**

- Bars represent values:
  - 0.031
  - 0.062
  - 0.155
Effect of Wetness on ISS: SS-1h
Dirty Surface

Residual Application Rate (gsy)

Interface Shear Strength (psi)

Dry / Dirty
Wet / Dirty

0.031 0.062 0.155
Summary

- **Effect of Emulsified Tack Coat Material on Interface Shear Strength**
  - Trackless exhibited the highest ISS followed by SS-1h and CRS-1
  - All residual application rates
  - These results relate directly to the consistency of the residual binders
    - RV, G*S

- **Effect of Application Rate on Interface Shear Strength**
  - Highest ISS was observed at high rate
    - All materials

- **Effect of Dirtiness on Interface Shear Strength**
  - Dirt present exhibits greater interface strength than clean conditions
  - Some cases, no difference statistically
Summary

● **Effect of Emulsified Tack Coat Material on Interface Shear Strength**
  - Trackless exhibited the highest ISS followed by SS-1h and CRS-1
    » All residual application rates
  - Relate directly to the consistency of the residual binders
    » RV, G*Sin δ, softening point

● **Effect of Application Rate on Interface Shear Strength**
  - Highest ISS was observed at high rate
    » All materials
    » difficult to determine the optimum residual application rate.
      ● Highly-oxidized HMA surface
      ● Required greater tack coat rates
    » Excessive tack coat may migrate into the HMA mat during compaction causing a decrease in the air void content of the mix.
Summary

● Effect of **Dirtiness** on Interface Shear Strength
  - Majority of the cases showed a statistically significant difference between clean and dusty conditions.
  - Dust combined with the asphalt formed a mastic
    - resultant viscosity higher than the neat residual asphalt.

● Effect of **Wetness** on Interface Shear Strength
  - majority of the cases
  - No statistically significant difference between dry and wet conditions.
  - Small amount of water can be flashed away by the hot HMA mat and have inconsequential effects on the quality of the tack coat.
Acknowledgement

- **APU**
  - Distributor Truck
  - SS-1h, CRS-1

- **Costal**
  - HMA Overlay

- **Blacklidge**
  - Trackless