Tack Coat Best Practices

FHWA Cooperative Agreement Subtask

Intelligent Compaction
Far too frequent practices
Days later!

Courtesy of Road Science
Tack Coat Best Practices Outline

- Terminology
- Purpose of Tack Coats
- Consequences of Poor Bond
- Relative Cost for Tack Coat
- Tack Coat Difficulties
  - Contractor
  - Agency
- Materials
  - Traditional
  - New Materials
  - Selection
Tack Coat Best Practices Outline

• Handling and Storage of Tack
• Tack Coat Field Operations
  • Manuals of Practice
  • Research / Bond Strength Testing
  • Best Practices
    • Surface Preparation
    • Truck Setup
• Tack Coat Application Calculations
• Spray Pavers
• Review and Summary
  • Common Tack Coat Questions
  • Areas of Known Agreement
• **Tack Coat**—sprayed application of asphalt cement upon an existing asphalt or Portland cement concrete pavement which may or may not have been milled before an overlay, or between layers of fresh asphalt concrete.

• **Original Emulsion**—an undiluted emulsion which consists of a paving grade binder, water, and an emulsifying agent.

• **Diluted Emulsion**—an emulsion that has been diluted with additional water.
  • Critical to control
  • 1:1 typical (Original Emulsion:Added Water)
• **Residual Asphalt**—the remaining asphalt after an emulsion has set typically 57-70 percent.

• **Tack Coat Break**—the moment when water separates enough from the asphalt showing a color change from brown to black.

• **Tack Coat Set**—when all the water has evaporated, leaving only the residual asphalt. Some refer to this as completely broken.
Importance of Tack Coats

Why do we use Tack Coats?
Importance of Tack Coats

- To promote the bond between pavement layers.
  - To prevent slippage between pavement layers.
  - Vital for structural performance of the pavement.
  - All layers working together.
  - Apply along all transverse and longitudinal vertical surfaces.
Pavement Behavior

Shear Transfer?

- Stress Distribution
- Tension
- Compression
- Aggregate Base
- Soil Subgrade

Courtesy of Rich May
Consequences of Debonding

Courtesy of NCAT
Bonded Strength Demonstration

½” Deflection, 60# Load

¼” Deflection, 160# Load

Unbonded

Fully Bonded
• **Highlights**

- 5 unbonded layers deflected **4x more** than 5 bonded with the same loading.
- 2 bonded layers had less deflection than 5 unbonded with the same loading.
- **5 bonded layers with over 2½x the load deflected half as much as 5 unbonded.**
Consequences of Poor Bond

- Layer independence
  - Reduced fatigue life
  - Increased rutting
  - Slippage
  - Shoving
- Compaction difficulty

Direction of traffic?
May & King:
  • 10% bond loss = 50% less fatigue life

Roffe & Chaignon
  • No bond = 60% loss of life

Brown & Brunton
  • No Bond = 75% loss of life
  • 30% bond loss = 70% loss of life
8 – 10 years (est.) Interstate Pavement

Courtesy of MODOT
So is it worth it to apply a tack coat?

Cost of Tack Coat

• New or Reconstruction
  • About 0.1-0.2% of Project Total
  • About 1.0-1.5% of Pavement Total Cost

• Mill and Overlay
  • About 1.0-2.0% of Project Total
  • About 1.0-2.5% of Pavement Total Cost
• Assume no inflation for materials
• Estimated traffic control
• Used project plans for thicknesses
• Used bid tabs for:
  • Milling
  • Material costs
  • Replaced pavement markings

30-100% of Original Pavement Costs
Common Tack Coat Materials

- Emulsified Asphalt
  - Most common option
    - SS-1, SS-1H
    - CSS-1, CSS-1H
    - RS-1, RS-1H, RS-2
    - CRS-1, CRS-2
    - PMAE

- PG Graded Binders
  - Neat Binders
    - PG 58-28
    - PG 64-22
    - PG 67-22
  - Polymer Modified

- Reduced or Non-Tracking Tack Coat Emulsions
23 States Known to Allow Non-Tracking Tack Materials
Tack Coat
Field Operations
Tack Coat Challenges

- Contractor
  - Application Rate
  - Consistency of Application
  - Tack Coat Pickup or Tracking By Vehicles
  - Traction for Construction Equipment
  - Breaking/Setting Time

- Agency
  - Acceptance
  - Dilution?
  - Application Measurement
  - Bond Quality
  - Tort Claims
  - Pulling Up of Pavement
Manuals of Practice

• Asphalt Institute
  • MS-22 *Construction of Hot Mix Asphalt Pavements, 2nd Edition*

• Comments
  • AI has a long history of promoting the proper use of tack coats.
Testing Methods

- Materials
  - Emulsion
  - Paving grade asphalt
- Field/Laboratory Bond Testing
  - Shear Testing
  - Torsion Testing
  - Pull-Off Testing (tension)
  - Cyclic
Best Practices

• Surfaces need to be clean and dry.
• Uniform application.
• All surfaces are tacked.
• Tack should not be tracked off the road.
Best Practices

• Match application to conditions.
  • Materials
  • Residual rate
• Verify application rate.
• Resist tacking too far ahead of paver.
Distributor Truck Setup
Spray Bar/Nozzles

- Single Coverage
- Double Coverage
- Triple Coverage

Nozzle Angle Setting: 15 to 30 Degrees

Spray Bar Axis
Effect of Nozzle Orientation
Nozzles are clogged, but triple overlap covering the gap.

Note: not a tack coat, but principle applies.
Nozzle Selection
Application Calculations
• Dilution rates are **critical** in determining final application rates.

• Temperature is important in determining accurate volumetric calculated rates.
• Asphalt and water expands and contracts when temperatures deviate from 60°F.

• As temperatures rise above 60°F expansion occurs and the resulting density (kg/L) decreases.

• As temperatures cool below 60°F contraction occurs and the density increases.

• A Temperature–Volume correction table for asphalt emulsion is available in MS-19, page 91.
Table 13. Temperature - volume corrections for asphalt emulsions\(^{(6)}\).

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\( M = \text{multiplier for converting oil volumes to the \°C (60°F)} \)

\[ \text{Volume}_{@ \°F} \times M_{\text{value}} = 60°F \text{ Vol.} \]

\[ \text{Volume}_{@ \°C} \times M_{\text{value}} = 15.6°C \text{ Vol.} \]
There are three primary methods of determining field application rates.

- Determination by volume.
- Determination by weight or mass.
- Determination by direct measurement, ASTM D2995
Longitudinal Joint Tacked

Dirty Surface

No Tack

Light Application
Review and Summary
Common Tack Coat Questions

• Experts commonly disagree
• “Do I still need to tack...”
  • Milled Surface
  • “Fresh” Pavement
  • Late season/cooler days
• Asphalt Institute recommends tacking all surfaces
Common Tack Coat Questions

• “When can I pave on the emulsion?”
  • Has it Broken?
  • Does it need to be Set?
  • Fresh—spray pavers

• Asphalt Institute recommends paving begin after the emulsion has broken.

• Spray pavers are an engineered system that are designed to perform without emulsion break.
Can I speed up the set?
• **What is the Optimal Application Rate?**
  • Surface Type
  • Surface Condition

• **Workshop Recommended Ranges**

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<th>Surface Type</th>
<th>Residual Rate (L/m²)</th>
<th>Approx. Bar Rate Undiluted* (L/m²)</th>
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*Assume emulsion is 40% water and 60% asphalt.
Key Items for Inspectors

• Check truck setup.
  • Spray bar height (~300 mm)
  • Appropriate nozzles
  • Nozzle orientation (15-30°)
  • Check application rate gauge in truck
  • Check application temperature
• Collect samples.

• Know the desired application and residual rates.
• Visually inspect application
• Verify application.
  • Volume
  • Mass
  • ASTM D2995
Generally Uniform Application

Missed Line
Common Tack Coat Questions

• When to Re-Tack?
  • Tracking
  • Contamination

**Re-Tack when in doubt.**

• Is Dilution okay?
  • Follow state specs
  • Verify dilution amount
  • Can not be used to “stretch” tack as residual value is key.

**Limit dilution to supplier.**
Areas of Known Agreement

• Layer Bonding is Vital
• Surface Preparation
  • Clean
  • Dry
• Millings Improves Field Performance
  • Shear
  • Cleaning
Areas of Known Agreement

- Application Quality Vital
  - Proper Rate
  - Consistency
- Distributor Truck
  - Setup
  - Calibration/Verification
  - Maintenance
- Tacking of Longitudinal Joints
  - Bonding
  - Confinement
- Excessive Tack is Bad
Areas of Known Agreement

• Tack Coat Rate Depends on Surface Condition
  • Fresh
  • Weathered
  • Raveled
  • Milled

• Need for Research
  • Field Performance
  • Field Testing
    • Bond strength and application amount

• Treat Tack as **Separate Pay Item** vs. Incidental Item
Questions?

4-hour workshop by Asphalt Institute