Importance of Tack Coat

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Denver, CO
Outcomes From 47 Workshops

- FHWA Best Practices Tech Brief
- AASHTO SOM Specification Was Submitted
- NCHRP 20-05 Synthesis - Tack Coat Study
- Increasing Application Rates
- DOTs Specification Revisions
Outcomes From 47 Workshops

- Going to Stiffer Base Asphalts (SS-1h CSS-1h)
- Verifying Calibration of Distributor
- Treat Tack as Separate Pay Item vs. Incidental Item
- **Tack Coat Pocket Guide** (August 2019)
Survey - excellent response rate

41 Questions

• Tack Coat Payment Specs
  – 2 questions
• Tack Coat Materials
  – 4 questions
• Tack Coat Application
  – 28 questions
• Tack Coat Evaluation
  – 7 questions

Survey results courtesy of Dave Johnson and Danny Gierhart of the Asphalt Institute
Far too frequent practices.
Successful Tack Coat
Uniform, complete, and adequate coverage
Tack Coat Best Practices Outline

- Terminology
- Purpose of Tack Coats
- Specifications
- Materials/Products
- Construction Practices
- Testing and Acceptance
What we are talking about:

- **Undiluted Emulsion**—an emulsion which consists of a paving grade asphalt binder, water, and an emulsifying agent.

- **Diluted Emulsion**—an emulsion with additional water added to it. The most common dilution rate is 1:1 (one part undiluted emulsion and one part additional water).

- **Residual Asphalt**—the remaining asphalt after an emulsion has set, typically 57–70 percent of the undiluted emulsion.
More Terminology

- **Tack Coat Break**—the moment when water separates enough from the asphalt to show 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.
So who was listening?

- T/F   A Broken Emulsion is the remaining asphalt after an emulsion has set.
What’s wrong (if anything) with the following specification regarding application rate?:

“Apply the tack coat at a rate of 0.05 gallons/yd^2”
If the example spec intended 0.05 gal/yd\(^2\) of residual asphalt:

Undiluted emulsion applied at 0.05 gal/yd\(^2\) using an emulsion with 60% residual asphalt, leaves 0.03 gal/yd\(^2\) on the roadway?

40% less than intended
If the example spec intended 0.05 \( \text{gal/yd}^2 \) of residual asphalt:

\textit{Diluted Emulsion} using the same emulsion diluted 1:1 with water and applied at 0.05 \( \text{gal/yd}^2 \) leaves 0.015 \( \text{gal/yd}^2 \) on the roadway?

70% less than intended
What difference does it make?

If the example spec intended 0.05 gal/yd$^2$ of residual asphalt:

To receive Residual Asphalt at 0.05 gal/yd$^2$ using an emulsion with 60% residual asphalt, the contractor would need to apply:

0.083 gal/yd$^2$ of Original Emulsion or 0.167 gal/yd$^2$ of 1:1 Diluted Emulsion
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.

Why do we use Tack Coats?
Consequences of Poor Bonding

- Poor pavement performance
  - Early fatigue life
    - Bottom up
    - Top down
  - Slippage cracks
  - Shoving

- Costly pavement repairs
  - Shorter than expected pavement life can be devastating for agency budgets
  - Removal and replacement of a portion or the entire pavement structure is very expensive
Pavement failure types cited by agencies as potentially caused by poor bond strength

- Slippage of the surface layer
- Delamination of pavement layer
- Fatigue cracking
- Top-down cracking
- Rutting of the pavement
- Other distress(es)

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Days later – significant slippage

Shoving

Surface Core

Courtesy of Road Science™
Early Fatigue - 8–10 years est. Interstate Pavement

Attributed to Bond Failure

Courtesy of MoDOT
Tack Coat Specifications

Most agencies specify tack coat materials using the following AASHTO specifications or some form of them:

- **Asphalt Emulsions**
  - M140 anionic emulsions
  - M208 cationic emulsions
  - M316 polymer-modified cationic emulsions

- **Straight Binders**
  - M320 Performance Graded Asphalt Binder
  - M322 Performance–Graded Asphalt Binder Using Multiple Stress Creep Recovery (MSRCR) Test
Percentage of Materials Used

- Straight Binders: 0.4%
- Emulsions: 79.4%
- Cutbacks: 0.0%
- Reduced-Tracking: 20.2%

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Top 5 Emulsions Used

1. CSS–1h (52%)
2. Non-standard* (48%)
3. SS–1h (46%)
4. SS–1 (36%)
5. CSS–1 (28%)

- Non-standard means that a state has come up with its own nomenclature for an emulsion, outside those specified in AASHTO M 140 (Anionic Emulsions), M 208 (Cationic Emulsions), or M 316 (Polymer-Modified Cationic Emulsions).

Examples: SS1hp, CRS-2h, EBL
### Top Reduced Tracking Emulsion Used

1. **NTSS–1hm** (24%)

Others specified (all by less than 3% of the states)

<table>
<thead>
<tr>
<th>Species</th>
<th>Species</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBC–1H</td>
<td>CBC–1HT</td>
<td>EM–50–TT</td>
</tr>
<tr>
<td>E–Tac</td>
<td>NTCQS–HH</td>
<td>NTCQS–1HM</td>
</tr>
<tr>
<td>NTCRS–1HM</td>
<td>NTCRS–1HSP</td>
<td>NTHAP</td>
</tr>
<tr>
<td>NTT</td>
<td>PATT</td>
<td>UltraFuse</td>
</tr>
<tr>
<td>UltraTack</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

“Non-tracking tacks are designed to improve the pavement performance by avoiding the tracking problems associated with traditional tacks. This material is typically manufactured to harden quickly and adhere minimally to tires. When a hot lift of asphalt is subsequently placed over the tack, the hardened tack is reactivated by the heat, and bonds the new overlay with the existing surface.” (Seo, 2016)
**Material Acceptance**

Most agencies accept material using one or more of the following methods:

- **Approved Source List**
  - Specifies pre-approved products and sources
  - Typically maintained on the agency’s website

- **Supplier Certification**
  - Agency relies on supplier testing
  - Requires document certifying material meets agency specs

- **Testing of Samples**
  - Samples from supplier or field project
  - Verify product meets AASHTO specs, some agencies also verify performance via some form of bond strength test
How is tack paid for?

Why is this important?

Little incentive for sufficient tack application if not a direct pay item
How is tack measured for pay?

- Volume of undiluted emulsion
- Mass of undiluted emulsion
- Volume or mass of diluted emulsion
- Volume or mass of residual asphalt
- Area (square yards)

* Some states pay by more than one method, so %’s do not add up to 100
Emulsion Storage and Handling

- Emulsion are the most commonly used materials for tack coats
- Care needs to be taken to make sure material doesn’t separate
  - Insulated storage tanks
  - Gentle agitation
  - Proper temperature range
  - Avoid contamination
  - Consult supplier for compatibility information
Tack Coat Construction Practices

- Provides detailed findings on agencies’ and contractors’ best practices
- Discusses:
  - Training and communication
  - Tack coat application rates
  - Dilution issues
  - Surface preparation
  - Application best practices
  - Asphalt distributors
  - Vehicle tracking of tack coat
Agencies in the US are fairly evenly split regarding whether or not dilution is allowed

- **Dilution Pros**
  - Larger liquid volume allows easier flow
  - Larger liquid volume allows easier overlap on “fans”

- **Dilution Cons**
  - Risk of losing control of the product
  - Requires additional time to break
  - Increases risk of tack flowing of roadway surface
Is Dilution of Emulsified Tack Allowed?

Dilution Recommendations

- Verify dilution amount
- Dilution cannot be used to “stretch” tack
- Residual value is key

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The FHWA/Asphalt Institute Tack Coat Workshops recommends dilution occur at the supplier’s terminal.
Dilution verification method(s) allowed?

- Certification by asphalt supplier: 60%
- Certification by contractor: 10%
- Sample from contractor’s storage tank: 30%
- Sample from distributor: 50%
- Visual observation during dilution process: 10%
- Dilution rate not verified: 20%

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Surface Preparation for Tack

Power brooming is the most commonly-used method of cleaning the roadway surface.

Photo courtesy of Jay Lemon, Haskell Lemon Construction Company
Surface Cleaning Methods

- Power Brooming: 41% (25/57)
- Both Brooming and Air Blowing or Vacuum: 25% (15/57)
- Any of Multiple Specified Methods: 2% (1/57)
- Clean, but Method not Specified: 33% (20/57)
Clean, But Must Surface Be Dry?

Literature Review found various viewpoints

- “The goal of surface preparation is to produce a clean, dry surface.” (FHWA Tack Coat Tech Brief, 2016)
- “A small amount of moisture on the pavement surface should not be detrimental to long-term tack coat performance, although a damp pavement will slow the cure and break time of the tack coat emulsion.” (NAPA’s QIP 128 Best Practices for Emulsion Tack Coats, 2013)

NCHRP Report 712 determined that for the effect of water on tacked surfaces in the majority of cases, there was no statistically significant difference between wet and dry conditions
## Application Temperatures

<table>
<thead>
<tr>
<th>Type and Grade</th>
<th>Spraying Temperature, °F</th>
<th>Storage Temperature, °F</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS-1, SS-1, SS-1h, CRS-1, CSS-1, CSS-1h</td>
<td>70 - 160</td>
<td>70 - 140</td>
</tr>
<tr>
<td>RS-2, CRS-2</td>
<td>140 - 185</td>
<td>125 - 185</td>
</tr>
<tr>
<td>Non-Tracking Tack</td>
<td>160 - 180</td>
<td>120 - 130</td>
</tr>
<tr>
<td>Polymer-Modified Emulsion</td>
<td>140 - 180</td>
<td>120 - 130</td>
</tr>
</tbody>
</table>

*(NAPA’s QIP 128 Best Practices for Emulsion Tack Coats, 2013)*
Goal: Complete, Uniform Coverage
Spray Requirements for Distributors

- none
- other
- uniform nozzles
- clean nozzles
- max. angle nozzle angle relative to the...
- min. angle nozzle angle relative to the...
- maximum height of the spraybar
- minimum height of the spraybar
- triple overlap of the emulsion streams
- double overlap of the emulsion streams
- spray without overlap of emulsion streams

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Distributor Calibration - How often?

- Never (18/50) - 36%
- Annually (7/50) - 14%
- Per job (9/50) - 18%
- Other (16/50) - 32%

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Distributor Calibration Method?

- ** ASTM D 2995a
- ** ASTM D 2995b
- ** Mass applied calculation
- ** Volume applied calculation
- ** Agency standard
- ** Not checked

Photo courtesy of Dr. Louay Mohammad

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Who performs the calibration?

- The contractor - 44% (14/32)
- The agency - 28% (9/32)
- Independent testing firm - 16% (5/32)
- Distributor manufacturer - 16% (5/32)
- Other - 3% (1/32)
When is traffic allowed on crack coat?

- Before the emulsion breaks
- After the emulsion breaks
- After the emulsion has set
- After a specific time delay
- Traffic not allowed on fresh crack between distributor and paver
- Does not specify

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Methods Used to Minimize Tracking

- Tack coat must break
- Tack coat must set
- Requires the use of reduced-tracking tack materials
- Allows the use of reduced-tracking tack materials
- Requires the use of spray pavers
- Allows the use of spray pavers
- Sanding of tack coat materials after application
- Allows wetting/dampening of pavement before...
- Other method
- Tracking or pickup continues to be a problem

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Testing and Acceptance of Tack Coats

- acceptance of tack coat material
  - approved source list
  - supplier certification of the product
  - acceptance testing of field samples on a project basis
  - acceptance testing of supplier samples on a material type basis
Testing and Acceptance of Tack Coats

- acceptance of the in-place tack coat application
  - assessment of tack coat coverage
  - determination by volume
  - determination by weight or mass
  - determination by direct measurement, e.g. ASTM D2995
Testing and Acceptance of Tack Coats

- acceptance by laboratory or field bond strength
  - laboratory testing used for product approval
  - field testing used to assess quality of field application
- common methods of load application
  - tension, shear, torsion
  - destructive vs. nondestructive
  - cyclic vs. monotonic
Bond Strength Testing?

9 out of 14 (64%) SEAUPG states conduct some type of bond strength testing.

Testing style?
- field tension testing
- lab tension testing
- field torsion testing
- lab torsion testing
- lab shear testing

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When does your agency perform interface bond testing?

- On every project
- By special provision
- For product evaluation
- As part of forensic investigations
- Other

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Key Items for Inspectors

- Check truck setup.
  - Spray bar height (~12”)
  - 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 (most popular)
  - Mass
  - ASTM D2995
Areas of Known Agreement

- Layer Bonding is Vital
- Surface Preparation
  - Clean
  - Dry
- Milling Improves Field Performance
  - Shear
  - Cleaning
When to Re-Tack?
- Tracking
- Contamination

If in doubt ... Re-Tack
## What is the Optimal Application Rate?

- **Surface Type**
- **Surface Condition**

## Workshop Recommended Ranges

<table>
<thead>
<tr>
<th>Surface Type</th>
<th>Residual Rate (gsy)</th>
<th>Appx. Bar Rate Undiluted* (gsy)</th>
<th>Appx. Bar Rate Diluted 1:1* (gsy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Asphalt</td>
<td>0.020 – 0.045</td>
<td>0.030 – 0.065</td>
<td>0.060 – 0.130</td>
</tr>
<tr>
<td>Existing Asphalt</td>
<td>0.040 – 0.070</td>
<td>0.060 – 0.105</td>
<td>0.120 – 0.210</td>
</tr>
<tr>
<td>Milled Surface</td>
<td>0.040 – 0.080</td>
<td>0.060 – 0.120</td>
<td>0.120 – 0.240</td>
</tr>
<tr>
<td>Portland Cement Concrete</td>
<td>0.030 – 0.050</td>
<td>0.045 – 0.075</td>
<td>0.090 – 0.150</td>
</tr>
</tbody>
</table>

*Assume emulsion is 33% water and 67% asphalt.
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
    - Application amount

- Treat Tack as Separate Pay Item vs. Incidental Item
What questions do you have?
NHI 131139 Training
Inspecting Asphalt Pavement Construction Projects course will be available May 2019
WEBINAR ANNOUNCEMENT

FHWA
EDC-4 Pavement Preservation When/Where

March 20, 2019
2:00 p.m. – 3:30 p.m. Eastern Time

REGISTRATION:
Pre-registration is **required** for this webinar.
Register at: [https://bit.ly/2Qf1cn8](https://bit.ly/2Qf1cn8)
Webinar information will be provided after registration.

This webinar will provide an opportunity for participants to learn about the results from an important FHWA study on the topic of Pavement Preservation When/Where. Outcomes from this webinar that can be used by practitioners who are interested in adopting preservation into strategic business practices include:

- Be able to quantify the effects of preservation on pavement performance, starting with the definition and selection of the right performance measures and associated pavement condition metrics, triggers and thresholds.
- Follow a four-step procedure to support the pavement preservation decision-making processes.
- Explore ways a Pavement Management System can be used to select pavement preservation treatments as well as approaches for using pavement preservation to inform the asset management process.

**Webinar Sponsors:**
Mr. Jason Dietz, P.E., Mr. Thomas Van, P.E.
Federal Highway Administration

**Webinar Facilitators:**
Gonzalo Rada, Ph.D., P.E. and Jonathan Groeger
Wood Environment & Infrastructure Solutions, Inc.

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Thank You!

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