Tack Coat Specification Changes

What was changed to Specification 407

- Increase in the minimum application rate
- No dilution of emulsified asphalt allowed
- Allowing Polymer Modification to any grade

407.4.2 Application. Asphalt emulsion or PG liquid asphalt shall be applied uniformly with a pressure distributor at the minimum rates indicated in the following table. **No dilution of the emulsified asphalt material shall be allowed.** The tack coat material shall be heated at the time of application to a temperature in accordance with Sec 1015. The tack coat shall be properly cured and the tacked surface shall be clean of all dirt before the next course is placed.

<table>
<thead>
<tr>
<th>Surface Type</th>
<th>Minimum Application Rate (gal/sq yd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Asphalt Pavement</td>
<td>0.05</td>
</tr>
<tr>
<td>Existing Asphalt or Concrete Pavement</td>
<td>0.08</td>
</tr>
</tbody>
</table>
Tack Coat Specification Changes

- Why we need a change in the specification.
- How did we come up with the .08 gal/sq yd application rate.
- The 2013 Construction Experience.
- Further testing and evaluation.
- Proposed Revisions to Specification
Tack Coat

Q. Why do we need a revision to the spec?

- Too many cores showing up with poorly bonded or debonded layers
Tack Coat

Q. Why do we need a revision to the spec?

- Early fatigue cracking
- Accelerated stripping
Setting the Application Rate

- Cutbacks / Emulsions since 1968 allowed .02 gal/ yd² as minimum rate.
  - Cutbacks = 85% to 95% AC Content
  - Emulsions = 55% to 65% AC Content
Tack Coat
### Tack Coat

- NCHRP Report 712 - survey results

**Table 2. Typical tack coat application rates (13).**

<table>
<thead>
<tr>
<th>Pavement Condition</th>
<th>Application Rate (gal/yd²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Residual</td>
</tr>
<tr>
<td>New HMA</td>
<td>0.03 ~ 0.04</td>
</tr>
<tr>
<td>Oxidized HMA</td>
<td>0.04 ~ 0.06</td>
</tr>
</tbody>
</table>
Tack Coat

Q. What application rate should be used?

A. You want to accomplish a very uniform application of about 0.03 to 0.05 gal/sy of residual asphalt on the layer to be tacked (a paint job, so to speak). Slow-setting emulsions generally have a residual asphalt content of about 2/3. Therefore, an application rate of 0.10 to 0.15 gals/sy of the diluted material will give you the 0.03 to 0.05 gals/sy.

http://www.asphaltinstitute.org/public/engineering/construction/construction-faqs.dot
Tack Coat

Tack Coat

Application Rate Versus Residual Rate

Uniformity of application and a proper application rate are key to achieving a successful tack coat. Figure 14-8 illustrates a tack coat application that is uneven as a result of improper equipment operation, with too much tack coat in some areas and not enough in others. If the correct amount of tack coat is sprayed on the surface, some of the existing surface will still be visible through the tack coat; not all of the existing pavement surface will be covered. Use of a diluted asphalt emulsion tack coat (slow-setting asphalt emulsion diluted 1:1 with water) will result in complete coverage and a very thin residual asphalt film on the pavement surface. Proper tack coat application will leave a residual asphalt cement content of approximately 0.18 to 0.27 l/m² (0.04 to 0.06 gal/yd²) on the roadway. The amount of residual tack coat needed will depend on the condition of the pavement surface. An open-textured surface requires more tack coat than a surface that is tight.
Q. What application rate is appropriate?

- For an existing surfaces:
  - Decided that 0.045 gal/ sy should be the minimum residual rate needed to develop a good bond.
  - Application rate = 0.08 gal/ sy (0.045 / 0.6 = 0.075)

- For a new asphalt pavement (between lifts):
  - Decided that 0.03 gal/ sy should be the minimum residual rate needed to develop a good bond.
  - Application rate = 0.05 gal/ sy (0.03 / 0.6 = 0.05)
Theory meets the Roadway
Issues Stated by Contractors and MoDOT Inspectors

- 0.08 is too high!!!!
  - Paver slides and cannot pull up grades!
  - A loaded truck almost slid off the roadway due to the excessive tack coat!
  - Builds up on tires & tracks then spalls off leaving tack balls in the mat.
  - Need to dilute it with water by at least 20 %.
  - It’s running into the ditches!
Construction Issue #1

- Tack Tracking Off Roadway
  - Tracking more severe on two-lane roadways.
Construction Issue #1

- Tack Tracking Off Roadway
  - TIME before 1st wheel hits the tack = 0 !
Construction Issue #1

- Tack Tracking Off Roadway
  - After numerous trucks have pulled onto tack.
Construction Issue #1

- Tack Tracking Off Roadway
  - Lack of Tack behind the Paver
Was Bond Strength an Issue?

Middle of Lane

Pull off Strength = 24.4 psi
Bond Energy = 123 J/m²

Wheel path

Pull off Strength = 11.9 psi
Bond Energy = 44 J/m²
Resolutions to Tracking?

- Use harder pen asphalt products...freeze/thaw concerns.

- Longer Set Time Needed.
  - Reduced Contractor’s production.
  - Allow contractor to utilize longer work zones...safety concerns.

- Use spray paver on thin lift overlays.
Construction Issue #2

- Variability of Application Rate
Construction Issue #2

- Variability of Application Rate
Construction Issue #2

- Variability of Application Rate

<table>
<thead>
<tr>
<th>Location</th>
<th>Application Rate</th>
<th>Residual Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left Wheel Path</td>
<td>.075</td>
<td>.051</td>
</tr>
<tr>
<td>Mid-Lane</td>
<td>.047</td>
<td>.032</td>
</tr>
</tbody>
</table>
Table 6. Etnyre spray bar nozzles and associated application rate ranges.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Part No.</th>
<th>Description</th>
<th>Application (per square yard)</th>
<th>Application (Metric) Liters per square meter</th>
<th>Flow Gallons per minute per foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3353788</td>
<td>V Slot Tack Nozzle</td>
<td>0.05 - 0.20</td>
<td>0.19 - 0.75</td>
<td>3.0 to 4.5</td>
</tr>
<tr>
<td>2</td>
<td>3351008</td>
<td>S36-4 V Slot</td>
<td>0.10 - 0.35</td>
<td>0.38 - 1.30</td>
<td>4.0 to 7.5</td>
</tr>
<tr>
<td>3</td>
<td>3351009</td>
<td>S36-5 V Slot</td>
<td>0.18 - 0.45</td>
<td></td>
<td>7.0 to 10.0</td>
</tr>
<tr>
<td>4</td>
<td>3352368</td>
<td>Multi-Material V Slot</td>
<td>0.15 - 0.40</td>
<td>0.57 - 1.50</td>
<td>6.0 to 9.0</td>
</tr>
<tr>
<td>5</td>
<td>3351015</td>
<td>3/32-inch Coin Slot</td>
<td>0.15 - 0.40</td>
<td>0.57 - 1.50</td>
<td>6.0 to 9.0</td>
</tr>
<tr>
<td>6</td>
<td>3352204*</td>
<td>Multi-Material V Slot</td>
<td>0.35 - 0.95</td>
<td>1.30 - 3.60</td>
<td>12.0 to 21.0</td>
</tr>
<tr>
<td>7</td>
<td>3352205*</td>
<td>Multi-Material V Slot</td>
<td>0.20 - 0.55</td>
<td>0.75 - 2.08</td>
<td>7.5 to 12.0</td>
</tr>
<tr>
<td>8</td>
<td>3352210</td>
<td>End Nozzle</td>
<td>0.20 - 0.55</td>
<td>0.75 - 2.08</td>
<td>7.5 to 12.0</td>
</tr>
<tr>
<td>9</td>
<td>3351014</td>
<td>3/16-inch Coin Slot</td>
<td>0.35 - 0.95</td>
<td>1.30 - 3.60</td>
<td>12.0 to 21.0</td>
</tr>
<tr>
<td>10</td>
<td>3351010</td>
<td>¼-inch” Coin Slot</td>
<td>0.40 - 1.10</td>
<td>1.50 - 4.16</td>
<td>15.0 to 24.0</td>
</tr>
</tbody>
</table>

* Recommended nozzles for chip seal when using emulsified asphalt
Construction Issue #3

- Tack pulling pavement up
Construction Issue #4

- Stringers on polymer tack coats
For the Interim

- 0.08 gal/yd² that is undiluted is the target application rate for all existing surfaces.
- 0.05 gal/yd² undiluted is the target application rate between new HMA lifts.
- Continue to approve trackless and less tracking tack products on a job by job basis.
- Some Districts and projects will mandate the use of polymer tack.
Pilot Project Tested

- Joint Research Project on US 36, Buchanan and Dekalb County with Herzog Contr. Corp.
- 3-Lift HMA overlay over existing PCCP

Different Products Tested:
- Calumet Trackless Tack
- SS1H @ 80 %
- SS1HP @ 80 %
- SS1HP @ 100 %
What is acceptable bond strength?

- Bond Strength $\geq$ Mix Strength @ Room Temp.
- 75 to 100 psi OR 300 to 600 J/m²

**US 36 - Buchanan and Dekalb County - Paved by Herzog Corp.**

<table>
<thead>
<tr>
<th>Product Type</th>
<th>Bond Strength Results @ 70 F</th>
<th>Force per Area (psi)</th>
<th>Bond Energy - J/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calumet Trackless Tack @ 100 %</td>
<td></td>
<td>97.2</td>
<td>673.3</td>
</tr>
<tr>
<td>SS 1H @ 80 %</td>
<td></td>
<td>90.2</td>
<td>605.9</td>
</tr>
<tr>
<td>SS1HP @ 80 %</td>
<td></td>
<td>Stored Testing @ 70 F – Mix was failing.</td>
<td></td>
</tr>
<tr>
<td>SS1HP @ 100 %</td>
<td></td>
<td>Tried 40 F – Bond Strength Exceeded Load Cell.</td>
<td></td>
</tr>
</tbody>
</table>
US 36 Pilot Project

MoDOT US 36 Buchanan Co

Bond Energy @ 6C vs Tack Type and Surface Type

Bond Energy @ 6C, J/m²

SP048 over PCC  
- SS-1hP 100%: (185) 455
- SS-1hP 80%: (202) 531
- Trackless: (215) 582

SP048 over SP190  
- SS-1H 80%: (311) 1192

Legend:
- SS-1hP 100%
- SS-1hP 80%
- Trackless
- SS-1H 80%
Observations from US 36

- All products were acceptable in achieving the needed bond strength.
- The 100% SS1-HP gave the highest bond strength to PCCP; however, the contractor had constructability issues.
- Trackless Tack did not track; but neither did the SS1H and SS1HP @ 80%.
- Further evaluation needed for Trackless Tack after numerous freeze/thaw cycles.
- At room temperature; the bond strength should at least be equal to the mix strength.
Biggest Issue in Field Evaluation

- Measuring tack application in the field is highly variable - Especially when undiluted.
Issue in Field Evaluation

- The application rate needed is depended on surface type, environmental conditions, and product characteristics.
Proposed Laboratory Study

- Different Product Types
- Different Application Rates
- Bonding to HMA and PCCP surfaces
- Freeze/Thaw Conditioning vs Room Temperature
# Laboratory Study Matrix

<table>
<thead>
<tr>
<th>Control Products</th>
<th>HMA to PCCP</th>
<th>HMA to HMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable Rates</td>
<td>.03 to .15</td>
<td>.03 to .15</td>
</tr>
<tr>
<td>SS-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SS-1H</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SS-1HP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRS-1H</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPEM-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRS-2P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calumet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blacklidge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MO Petroleum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heartland</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ergon</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**BOND STRENGTH TESTING**

Freeze/Thaw Conditioned Samples

**VS**

Control at Room Temperature
Proposed Laboratory Study
Bond Strength Results

Bond Energy = \( \sum \) Work / Area

Acceptable Bond Energy
\(~ 300 \text{ J/m}^2\)
Proposed Spec Changes - TBD

- Set a target rate for plan quantity, but allow a range for field conditions.
- Different target rates for different surface types.
- Dilution?
- Require tack coat issues to be addressed in the QM plans for asphalt overlays.
CORRECT BAD TACK JOBS
CORRECT BAD TACK JOBS
CORRECT BAD TACK JOBS
Properly Applied Tack
Properly Applied Tack
Questions