Best Practices For Full Depth Repair, Tack Coat, and Longitudinal Joint Construction

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Surface Preparation

The performance of a hot mix asphalt pavement is strongly related to the condition of the surface on which it is constructed.
The most common surfaces overlaid with HMA or WMA include:

- Subgrade
- Granular Base Course (Aggregate Base)
- Existing Asphalt Pavement
- Existing PC Concrete Pavement
Subgrade & Base Support

- Good support critical to obtain proper density
- Spongy or unstable support
  - Provides little resistance to the rollers
  - Mixture not confined, energy dissipated
- Mixture moves and cracks rather than compacts
Subgrade Preparation

– The subgrade is the pavement foundation
– Must support the pavement and anticipated traffic
  • Soil type considered in thickness design
– Must be properly graded to provide drainage
  • Transverse and longitudinal grade
  • Smoothness and cross slope
– Must be uniformly compacted to required density
Proof Rolling

- Tire pressure at least 90% of maximum
- At least 6600 lb. per tire
- Roll full width using two complete passes
- If test rolling reveals soft, yielding, or unstable areas, remove
- Replace with approved material
- Test roll corrected area
Why do we use Prime Coat?

- To seal in the subgrade at the proper moisture content
- To fill the surface voids and protect from the weather
- To stabilize the surface fines
- To promote bonding to the subsequent pavement layer
Prime Coat

- Often use MC-30 or MC-70
- Can use emulsion on non-cohesive soils or in areas where cutbacks banned, but are often not effective
- Remove loose material from roadway before application
- 0.2 to 0.5 gal/yd^2
- Blot excess prime with sand
- Broom off excess sand

Allow prime coat to cure 24 - 72 hours
Aggregate Base Preparation

• Mix to proper moisture content
• Best Practice - place using a laydown machine
• Place in 4” - 8” compacted lifts
• Stagger longitudinal and transverse joints at least 1’ in each succeeding layer
• Compact base to percentage of Proctor specified
Preparing an existing asphalt surface may be as simple as sweeping (*multiple passes may be necessary*) the existing surface and applying tack coat.
Or it may involve one or more of the following:

- Patching
- Cleaning and filling cracks
- Placing a leveling course
- Milling the surface

**Failed areas MUST be cleaned, repaired and brought into good structural condition before overlaying.**
Patching

- Make sure to get at least 1 foot into the sound pavement when you mark the patch for removal
- Use good straight lines that are cut with vertical faces
- Remove all loose material
- Tack base and all vertical surfaces
- Patches must be strong enough to become a part of the permanent structure or they will be back!
Patching

Irregular patch - getting proper compaction is going to be difficult on this one.

Nice straight lines, no distress visible outside the patched area.
Surface Preparation

- Rarely gets due consideration
- It is often time consuming and labor intensive
- Asphalt layers cover up the potential problems
- THE PROBLEMS WE DO NOT TAKE CARE OF TODAY WILL NOT GO AWAY
  - Often the problems get worse
  - They are more costly to fix the second time
• To promote the bond between pavement layers.
  • Prevent slippage/shoving failures.
  • Full bond is vital for structural performance of the pavement.
  • When bonded, all layers working together.
  • Critical that tack materials are applied uniformly at appropriate application rate.
  • Apply tack coat on all surfaces including vertical surfaces.

Why do we use Tack Coats?
Far too frequent practices
Consequences of Poor Bonding

• Poor pavement performance
  • Slippage cracks
  • Shoving
  • Early fatigue cracking
    • Bottom up
    • Top down

• Costly pavement repairs
  • Repair of isolated area relatively inexpensive
  • Removal and replacement of a portion or the entire pavement structure is very expensive
  • Shorter than expected pavement life can be devastating for agency budgets
Days later!

Courtesy of Road Science
Consequences of Poor Bonding

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

Direction of traffic?
Bonding Demonstration

½” Deflection, 60# Load

Unbonded

¼” Deflection, 160# Load

Fully Bonded
• 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 $2\frac{1}{2}x$ the load deflected half as much as 5 unbonded.
Consequences of Debonding

Courtesy of NCAT
Loss of Fatigue Life Research

• May and King:
  • 10% bond loss = 50% less fatigue life

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

• Brown and Brunton
  • No Bond = 75% loss of life
  • 30% bond loss = 70% loss of life
Key Factors for Tack Coat Success

- Condition of Existing Pavement
- Tack Coat Application Rate
- Residual Binder Content
- Proper Distributor Operation
- Emulsion Break and Set Times
Emulsions are asphalt droplets suspended in water

- **Breaking**
  - Contact with surface changes pH; reducing charge
- **Setting**
  - Evaporation leads to coalescence
  - Original asphalt characteristics return
Tack Coat Application
• 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.
Nozzle Selection

• Consult with distributor truck manufacturer to match the material to the nozzle.

• ONE SIZE DOES NOT FIT ALL
Proper nozzle angle of 15-30% assures proper overlap between nozzles without interference of tack streams.
Spray Bar/Nozzles

4 IN.

SINGLE COVERAGE
DOUBLE COVERAGE
TRIPLE COVERAGE

NOZZLE ANGLE SETTING: 15 TO 30 DEGREES

SPRAY BAR AXIS
Full width of mat to minimize movement of unsupported edge

Photo Courtesy of Jim Scherocman
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
  - Mass
  - ASTM D2995
Common Tack Coat Questions

• “When can I pave on the emulsion?”
  • Has emulsion broken?
  • Does it need to be set?

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

• “How can I prevent tack pull-up/tracking?”
  • Make sure tack coat is broken
  • Use emulsions with hard base asphalt (CSS-1h)
  • Use a proprietary reduced-tracking emulsion
  • Use a spray paver
Common Tack Coat Questions

• What is the optimal application rate?
  • Surface type
  • Surface condition

• Asphalt Institute recommended ranges

<table>
<thead>
<tr>
<th>Surface Type</th>
<th>Residual Application Rate (gsy)</th>
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<tbody>
<tr>
<td>New Asphalt</td>
<td>0.020 – 0.045</td>
</tr>
<tr>
<td>Existing Asphalt</td>
<td>0.040 - 0.070</td>
</tr>
<tr>
<td>Milled Surface</td>
<td>0.040 – 0.080</td>
</tr>
<tr>
<td>Portland Cement Concrete</td>
<td>0.030 – 0.050</td>
</tr>
</tbody>
</table>
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.**
Successful Tack Coat

The Ultimate Goal:
Uniform tack coat coverage
Longitudinal Joints are a Major Issue for Most Agencies.
Some States have more challenges than others!

ALASKA
Too often longitudinal joints are the weak link in an otherwise durable long-lasting asphalt pavement.

- Major concern for industry as well as agencies
- Offers greatest opportunity to improve overall life.
Joint Issues In PA
<table>
<thead>
<tr>
<th>YEAR</th>
<th>DENSITY LOTS</th>
<th>AVG. JOINT DENSITY</th>
<th>AVG. MAT DENSITY</th>
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</thead>
<tbody>
<tr>
<td>2007</td>
<td>18</td>
<td>87.8%</td>
<td>93.9%</td>
</tr>
<tr>
<td>2008</td>
<td>43</td>
<td>88.9%</td>
<td>94.1%</td>
</tr>
<tr>
<td>2009</td>
<td>29</td>
<td>89.2%</td>
<td>94.1%</td>
</tr>
<tr>
<td>2010</td>
<td>NO DATA, TRANSITION TO PWL SPEC.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>137</td>
<td>91.1%</td>
<td>94.1%</td>
</tr>
<tr>
<td>2012</td>
<td>162</td>
<td>91.6%</td>
<td>94.0%</td>
</tr>
<tr>
<td>2013</td>
<td>167</td>
<td>91.4%</td>
<td>93.9%</td>
</tr>
<tr>
<td>2014</td>
<td>316</td>
<td>92.3%</td>
<td>94.1%</td>
</tr>
</tbody>
</table>
# CT DOT Average In-Place Lot Density on Cores for Entire Year Roadway (Non-Bridge)

<table>
<thead>
<tr>
<th>Year</th>
<th>Mat (Rqd. Min. of 92%)</th>
<th>Joint (Rqd. Min. of 91%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior to 2010: Acceptance from gauges</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>92.6%</td>
<td>91.6%</td>
</tr>
<tr>
<td>2012</td>
<td>93.0%</td>
<td>91.4%</td>
</tr>
<tr>
<td>Std. Dev. (on 2082 measurements)</td>
<td>2.07</td>
<td>2.40 (on 1863 measurements)</td>
</tr>
<tr>
<td>2013</td>
<td>93.1%</td>
<td>91.8%</td>
</tr>
</tbody>
</table>
The Best Longitudinal Joint: 
Echelon Paving

New Jersey

Rolled Hot
Echelon Paving Longitudinal Joint

Joint passes between the quarters
But, the need to maintain traffic limits
the opportunities to pave in echelon

Consequently, most longitudinal joints
are built with a cold joint.
Unsupported Edge Will Have Lower Density

**Key:** Proper Overlap

**Key:** Sufficient Material for Roll-Down

Cold side

Hot side

Low Density Area
Experts Evenly Divided on Preferred Joint Type

Notched Wedge

Butt
Offset joints between layers by at least 6-inches; surface joint should be near centerline (not in wheelpath)
Plan to Avoid Placing Joint Where Striping Will Go
If Not, Can Eventually Result In This
Tack Coat

Full width of mat to minimize movement of unsupported edge
First Pass Must Be Straight!

Unanimous that a string-line should be used to assure first pass is straight.
Great Results
Tough to get proper overlap (1”) with next pass
Vibratory Screed Should Always Be On
Uniform Head of Material

Maintained Across Width of Auger
Extend Augers to Within 12-18 inches of End Gate
Extend Tunnels the Same Distance

To control material flow at outer edges of screed and deliver homogenous HMA at joint
Examples of Auger Overload... Likely to Segregate

Tunnel

Tunnel?
Auger and Tunnel likely not extended within 12 to 18-inches of the end gate.

The Result - SEGREGATION at joint
Rollers Need to Be Kept Close to the Paver

Critical in cool and cold weather!
Best Way to Roll a Joint
Rolling Unsupported Edge?
Experts 50-50 on Where to Put 1\textsuperscript{st} Pass

Option 1
Hang over 4-6”

Option 2
1\textsuperscript{st} Pass 4”-6” inside

2\textsuperscript{nd} Pass hang over 4”-6”
Paint the Side of Joint (Butt or Wedge)

Emulsion (Good),

PG Asphalt (Better),

Or

Joint Adhesive (JA) (Best)
When Closing Joint, Set Paver Automation to Never Starve the Joint of Material

- Target final height difference of +0.1” on hot-side versus cold side
  - NH spec requires 1/8” higher
- Joint Matcher (versus Ski) is best option to ensure placing exact amount of material needed
- If hot-side is starved, roller drum will “bridge” onto cold mat and no further densification occurs at joint
Automatic Grade Control

Joint Match

Courtesy of Caterpillar
Destined for Failure

Hot side of joint starved of material at each end of load. Bridging occurs.
Proper Overlap:

• 1.0 ± 0.5 inches

• Exception: Milled or sawed joint should be 0.5 inches
Don’t Rake Overlap Across the Joint! – Starves the Joint

Photo by James Scherocman, P.E
This lute person is doing a great job
Rolling the Supported Edge
Our Recommendation to Minimize Bridging:

1\textsuperscript{st} pass all on hot mat with roller edge off joint approx 6-12 inches

2\textsuperscript{nd} pass overlaps on cold mat 3-6 inches
Pneumatic Rubber Tired Rollers

- Many experts believe kneading action helps in providing a tighter surface that is more dense and less permeable compared to drum rollers.
  - Research supports this
- But must keep these away from the unsupported edge to avoid excessive lateral movement of mat
- Use during intermediate rolling of the supported edge.
  - Not finish rolling.
Alternative Techniques / Products Not Mentioned Today

- Mill & Pave One Lane at a Time
- Cut Back Joint
- Joint Heaters
- Surface Sealers Over Joint
Commonly asked questions

• Does the first pass have to be straight?
  • Absolutely in order to match up

• When matching up, what is the proper overlap onto the cold side of the joint?
  • 1” +/- 0.5” (0.5” for milled or sawed joints)

• Is tack coat required?
  • Yes – on all surfaces including vertical faces – PG binder or joint adhesives may also used

• Which automation should used when matching up?
  • Joint matcher will insure the right amount of material to not starve the joint – account for rolldown and finish 0.1” higher (ski is for smoothness)
OUR GOAL: Joint Life = Mat Life

- 14 year old surface
- I-65 in IN: SR252 to US31
Questions?