Longitudinal Joints of Hot Mix Asphalt (HMA) Pavements in Tennessee

Mark Woods – TDOT Materials & Tests
In 2006, the Department determined that poor HMA longitudinal joint construction and premature longitudinal joint failures were affecting the overall life of HMA pavements in Tennessee.
Premature longitudinal joint failures provide pavements with the ability to ravel, propagate cracks throughout the mainline, and ultimately destroy the pavement prior to reaching its desired design life.
Longitudinal Joint Failures

Joints are an issue!!
Longitudinal Joint Failures
Longitudinal Joint Failures
Longitudinal Joint Failures
In 2007, the Department agreed to fund a research project with the University of Tennessee to investigate the cause of and solutions for premature longitudinal joint failure.
Project Objectives

1. Investigate the fundamental mechanisms of longitudinal joint failure
2. Evaluate available technologies and construction practices that may mitigate longitudinal joint failure
3. Recommend potential changes to TDOT specifications
Project Scope

- Perform literature review
- Select field projects
- Evaluate various products and construction techniques
- Perform field and laboratory testing
- Observe field projects annually
Field Project – Sparta, TN

- CNG155 – White County, Sparta, TN
- SR 289 / Spring Street from SR111 to Hwy 70 / W. Bockman Way
- 2.65 miles
- 2 Lanes, plus occ. Center turn lane
- 7 Products / Treatments, 2 Control Sections
- Highways, Inc.
Products / Treatments

- Crafco Joint Adhesive, Crafco Inc.
- Jointbond, Pavement Technology
- Pavon Crack Sealer
- Replay, Pavement Restorations Inc.
- Joint Heater, Heat Design Equipment, Inc.
- SS-1 emulsion
- TST-1p emulsion
## Product / Treatment Layout

<table>
<thead>
<tr>
<th>Section Number</th>
<th>Length</th>
<th>Test Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Begin at bridge near SR111</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>1000’</td>
<td>Equipment heating and stabilizing</td>
</tr>
<tr>
<td>1</td>
<td>1000’</td>
<td>Crafco joint adhesive</td>
</tr>
<tr>
<td>2</td>
<td>1000’</td>
<td>Pavement Technology, Jointbond</td>
</tr>
<tr>
<td>C1</td>
<td>1000’</td>
<td>CONTROL SECTION</td>
</tr>
<tr>
<td>3</td>
<td>550’</td>
<td>Pavon crack sealer</td>
</tr>
<tr>
<td>---</td>
<td>450’</td>
<td>No tests</td>
</tr>
<tr>
<td>4</td>
<td>960’</td>
<td>Replay</td>
</tr>
<tr>
<td>---</td>
<td>???</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; turn lane section. No tests.</td>
</tr>
<tr>
<td>C2</td>
<td>1000’+</td>
<td>Heat Design Equipment&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>---</td>
<td>???</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; turn lane section. No tests.</td>
</tr>
<tr>
<td>5</td>
<td>1000’</td>
<td>Basic emulsion</td>
</tr>
<tr>
<td>6</td>
<td>1000’</td>
<td>Polymer emulsion</td>
</tr>
<tr>
<td>C3</td>
<td>1553’</td>
<td>CONTROL SECTION</td>
</tr>
</tbody>
</table>

End at Rite Aid near Hwy 70 / West Bockman Way
Crafco Joint Adhesive

- Polymerized asphalt
- Hot-applied prior to second pass
- 350-400°F
Crafco Joint Adhesive
Crafco Joint Adhesive
JointBond, Pavement Technology Inc.

- Polymerized Maltene Emulsion
- Sprayed after 2nd pass
- Penetrates, stabilizes, seals
- Does not affect / cover striping
JointBond, Pavement Technology Inc.
JointBond, Pavement Technology Inc.
JointBond, Pavement Technology Inc.
Pavon Crack Sealer

- Cationic latex-polymerized asphalt emulsion
- Applied at ambient temperature.
- Applied prior to 2\textsuperscript{nd} pass
Pavon Crack Sealer
Pavon Crack Sealer
RePlay, Biospan Technologies Inc.

- Pavement Restorations, Inc.
- Spray-applied sealer
- Contains polymer
- Sprayed after 2nd pass
- Penetrates, seals
- Agricultural oil, 30% soybean based
RePlay, Biospan
Technologies Inc.
RePlay, Biospan Technologies Inc.
Joint Heater, Heat Design Equipment

- Propane fueled, infrared heater
- Heats existing cold side prior to paving joint
- Can be attached to paver or towed ahead
- Various sizes, setups
- Heated existing asphalt up to 230°F
Joint Heater, Heat Design Equipment
Joint Heater, Heat Design Equipment
Joint Heater, Heat Design Equipment
SS-1 Emulsion

- Common material, typically used as tack coat
- Anionic emulsion
- No polymer
- Can be applied 60-140°F
- Can be diluted with water
SS-1 Emulsion
SS-1 Emulsion
TST-1p Emulsion

- Also an emulsion which can be used as tack coat
- Polymerized
- Higher elasticity
- Can be applied 60-140°F
- Can be diluted with water
TST-1p Emulsion
TST-1p Emulsion
Coring

- Main pattern

![Diagram showing coring pattern with numbers and measurements: 6 in. between 3 and 4, 6 in. between 4 and 5, and a longitudinal joint at the end.]
Coring

- Alternate pattern
Coring
Coring
Coring
Current Test Results

- After paving, over 100 cores were taken
- Cores were sent to the University of Tennessee, Knoxville
- Current test results include density/air voids and permeability
Air Void Results

- Typical Air Void Cross-section

![Graph showing air void results](image)

**CONTROL SECTION #1**

<table>
<thead>
<tr>
<th>Air Voids (%)</th>
<th>Distance from Joint (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold Side</td>
<td>0, 2, 4, 6</td>
</tr>
<tr>
<td>Hot Side</td>
<td>-6, 0, 6</td>
</tr>
<tr>
<td>Joint</td>
<td></td>
</tr>
</tbody>
</table>
Air Void Results
Air Void Results

Air Voids (%) - Directly On Joint

- Grafco
- Joint Bond
- CONTROL 1
- Pavon
- Replay
- Joint Heater
- TST-1P
- SS1
- CONTROL 3
Air Void Results

[Diagram showing air void results with labeled points and distances.]
Air Void Results

Air Voids (%) - 6" Off Joint On Confined Edge

- Crafco
- Joint Bond
- CONTROL 1
- Pavon
- Replay
- Joint Heater
- TST-1P
- SS1
- CONTROL 3
Air Void Results
Air Void Results

Air Voids (%): 6" Off Joint On Unconfined Edge

Crafco
Joint Bond
CONTROL 1
Pavon
Replay
Joint Heater
TST-1P
SS1
CONTROL 3
Permeability Testing

- Florida DOT Method
- Measures water permeability of asphalt laboratory specimens
- Units of cm/s
Permeability Testing
Permeability Testing

- Typical Permeability Cross-section

![Graph of Typical Permeability Cross-section](null)

**CONTROL SECTION #1**

- Distance from Joint (in)
- Permeability (cm/s)

**Joint**

- Cold Side
- Hot Side
Permeability Testing
Permeability Testing

Permeability - Directly On Joint

<table>
<thead>
<tr>
<th>Material</th>
<th>Permeability (cm/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crafco</td>
<td>0.0E+00</td>
</tr>
<tr>
<td>Joint Bond</td>
<td>0.0E+00</td>
</tr>
<tr>
<td>CONTROL 1</td>
<td>1.5E-03</td>
</tr>
<tr>
<td>Pavon</td>
<td>3.0E-03</td>
</tr>
<tr>
<td>Replay</td>
<td>3.5E-03</td>
</tr>
<tr>
<td>Joint Heater</td>
<td>0.0E+00</td>
</tr>
<tr>
<td>TST-1P</td>
<td>0.0E+00</td>
</tr>
<tr>
<td>SS1</td>
<td>0.0E+00</td>
</tr>
<tr>
<td>CONTROL 3</td>
<td>1.0E-03</td>
</tr>
</tbody>
</table>
Permeability Testing

Diagram showing a cross-section with labeled points 1 to 7, indicating distances of 6 inches from Hot Side to Cold Side, and a longitudinal joint.
Permeability Testing

Permeability - 6" Off Joint On Confined Edge

Permeability (cm/s)

0.0E+00 0.5E-04 1.0E-03 1.5E-03 2.0E-03 2.5E-03 3.0E-03 3.5E-03

Crafco Joint Bond CONTROL 1 Pavon Replay Joint Heater TST-1P SS1 CONTROL 3
Permeability Testing
Permeability Testing

Permeability - 6" Off Joint On Unconfined Edge

Permeability (cm/s)

Crafco
Joint Bond
CONTROL 1
Pavon
Replay
Joint Heater
TST-1P
SS1
CONTROL 3
Additional Testing / Observation

- Signs were placed on site to provide clear indication of the location of test sections with the intention of periodic observation of the performance of each treatment.

- Documentation of test section, product, application, and sign locations should be available soon upon request.
Additional Testing / Observation

- The University is currently testing cores for Dissipated Creep Strain Energy (DCSE).
- Additional cores will be sent to an independent laboratory to be tested with X-Ray Computerized Tomography (CT).
Additional Testing / Observation
Additional Testing / Observation
Additional Testing / Observation
Special Thanks

- Highways, Inc.
- City of Sparta, TN
- Many others!!!
QUESTIONS??