Study to Develop Recommended Best Practices for Constructing and Specifying HMA Longitudinal Joints

A Co-operative Effort between AI and FHWA

Mark Buncher, Ph.D., P.E.
Asphalt Institute
Don’t We Already Know How To Build a Longitudinal Joint?
I-81 in Pennsylvania
I-84 in New York
- Note condition of the rest of the mat.
- Also sealed each side of patch.
“In recent years, it has become evident how critical longitudinal joint construction is to the life of the pavement structure…..

Many pavements have been, or are in the process of being, resurfaced as a direct or indirect result of longitudinal joint deterioration”

Kentucky Transportation Center
College of Engineering
Current Project Team

- AI
  - Mark Buncher
  - Carlos Rosenberger
  - AI Regional Engineers
- FHWA
  - Tom Harman
  - Michael Arasteh
  - Stephen Cooper
- PA State Asphalt Paving Association
  - Gary Hoffman
PROJECT STEPS

- FHWA “Benchmark” Survey to Divisions
- Literature Review
- Identify What We Know/ Things We Don’t
- Interview 19 Experts
- Visit Five Select State DOTs
- Draft/ Final Report
- Develop Training Tools
Takeaways from FHWA Survey to 52 Division Offices

• 1/2 of states not satisfied with overall performance of L-Joints.
• 2/3rds of states have a L-Joint spec
  – Half of those (17) have a LJ density spec
    • Range from 89% - 92% min TMD
  – Other half were method specs
    • From Joint Adhesive to very prescriptive
• Great start to point us in the right direction, but no definitive answers
Maybe We Don’t Already Know How to Build a Longitudinal Joint?

• What We Know
  – Certain Steps Everyone Agrees On

• What We Don’t Know
  – Differing Opinions on Other Steps
  – Developed Questionnaire for Experts
    • Interview Consultants, Manufacturers and Contractors (Sheldon Hayes winners since 2000)
    • Compile and Analyze Findings
19 Experts Interviewed

Consultants
- Jim Scherocman
- Chuck Deahl
- Jim Hedrich
- Ron Corun
- Larry Michael
- Steve Neal
- Brian Prowell
- Tom Skinner
- Frank Colella
- Wes McNett

Sheldon Hayes Winners
- Lindy Paving (PA)³
- P. Flanigan & Sons (MD)
- Duininck Bros (TX)
- Thompson-McCully (MI)
- DesMoines Asphalt & Paving (IA)
- K Barnett & Sons (NM)
- Norris Asphalt Paving (IA)
Interview Questions

LONGITUDINAL JOINT CONSTRUCTION INTERVIEW
This survey is part of the Asphalt Institute’s cooperative agreement, “Marketing of Hot Mix Asphalt (HMA) Joint Construction Best Practices”.

1) First pass must be as straight as possible. How do you accomplish that?

2) Do you prefer:
   a) Notched wedge joint
   b) Butt Joint

3) Do you use paver automation (yes) or (no), Your preference is
   a) Joint Matcher
   b) Ski

4) Do you roll the unsupported edges by:
   a) Straying back 6 inches from the edge
   b) Overlapping the edge of the mat by 8 inches
   c) Other_______________________

5) When using a wedge joint do you tack the notch & wedge (yes) or (no) if yes, with
   a) Emulsion
   b) PG-grade Asphalt
   c) Other_______________________ If yes, complete wedge or portion, Any problems?

6) When using a butt joint do you tack the vertical face (yes) or (no) if yes, with
   a) Emulsion
   b) PG-grade Asphalt
   c) Other_______________________ If yes, complete wedge or portion, Any problems?

7) Have you ever used a proprietary joint adhesive, (yes) or (no), if yes
   a) Was it practical? (yes) or (no)
   b) Did it improve the performance of the joint? (yes) or (no)

8) Have you ever cut the cold joint back prior to placing the adjacent lane? (yes) or (no)
   a) Was it practical? (yes) or (no)
   b) Did it improve the performance of the joint? (yes) or (no)

9) Have you ever used an infra-red heater on a longitudinal joint? (yes) or (no)
   a) Was it practical? (yes) or (no)
   b) Did it improve the performance of the joint? (yes) or (no)

10) How much do you overlap the hot material onto the cold material?
   a) ____________________________

11) What do you do with the overlap material?
   a) Push it back to the joint
   b) Do nothing
   c) Other_______________________

12) Do you roll the second pass:
   a) From the hot side overlapping onto the cold
   b) From the cold side overlapping onto the hot
   c) Make the first pass staying back from the joint and overlapping the cold with the second pass
   d) Start rolling on the outside edge and working into the joint
   e) Other_______________________

13) Do you monitor the longitudinal joint density (yes) or (no), if yes, how
   a) Nuclear gage or similar device
   b) Cross
   c) Other_______________________

14) Which type of specification offers the best chance to long term joint performance?
   a) Method
   b) Minimum percent density, What is the practical minimum? ______
   c) No specification

15) Does a fine 0.5mm mix have a better chance for good performance than a 12.5mm?
   a) Yes
   b) No

16) Does a 9.5mm mix with a design asphalt content of 62% asphalt have a better chance for good performance than that same mix at 5.7% asphalt?
   a) Yes
   b) No

17) Could I do anything additional in “late season” paving to improve joint performance?
   a) ____________________________

18) Have you ever been required to seal the surface of a longitudinal joint as part of the contract? (yes) or (no). If yes, what did you use to seal the joint?
   a) The material was
   b) The width of the seal was ______ inches

19) What are the other “Tips that make the difference”? List as many as you like.
   •
   •

We sincerely appreciate your assistance in improving the performance of longitudinal joints. Thank You
Do the Experts Agree?

Not Always
We Know Unsupported Edge Will Have Lower Density

Proper Overlap

Sufficient Material for Roll-Down

Low Density Area
The Best Longitudinal Joint

Echelon Paving

Rolled Hot

I-295 in New Jersey
Echelon Paving Longitudinal Joint

Joint passes between $0.25s$
But, the need to maintain traffic limits the opportunities to pave in echelon. Consequently, most longitudinal joints are built with a cold joint.
Prefer Notch-Wedge or Butt Joint?

Evenly Divided
2nd pass

1st pass

2nd pass

1/2 to 3/4-inch

Wedge 3:1 to 12:1

NMAS
Prior Planning

- Select joint (butt or wedge) best suited for that job
- Choose smallest NMAS that will do the job
- Consider using a “fine” gradation
- Lift thickness = NMAS x 4, exception “fine” gradation x 3
- Longitudinal joint should be included in construction plan & sequence
GETTING STARTED OFF RIGHT

- Plant
- Paving
- Trucking
- Compaction

Dump Person

MTV
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
Paver on Automatic w/ Joint Matcher
Vibratory Screed Should Always Be On
Auger

Uniform Head of Material Across the Entire Screed

Carry Material Within 12 – 18-inches of the End Gate
This is unacceptable
Auger not extended to within 12 to 18-inches of the end gate.

The result - SEGREGATION at joint
Seated on the Existing Surface
1st Roller Pass on Unsupported Edge
50/50: Overhang vs. Stay Back 4-6”
Caution: Watch for lateral movement and stress crack

Rolling Unsupported Edge
(First Paver Pass)

Edge of drum inside unsupported edge
Can cause cracking near the edge and lateral mix movement at the unsupported edge
Quality Control, Monitor Joint Density
Tack the Joint! (Butt or Wedge)

Emulsion, or

PG asphalt or Proprietary Joint Adhesive
Matching Joint

Proper Overlap: 1.0 ± 0.5 inches

Sufficient Depth of HMA to avoid “starving” joint and “bridging” with roller

After all rolling, desired height diff. about 0.1”
Lute the Longitudinal Joint

This lute person is doing a great job
Bumping Joint Properly

Don’t push across!
Rolling the Supported Edge  
(many different opinions and approaches)

Stay off the Joint by 6” with 1st Pass to Avoid Bridging

but, watch for stress cracks along the edge of the drum. May be more of a concern with rolling unsupported edge
Other Options / New Products

- Mill & Pave One Lane at a Time
- Cut Back Joint
- Wedge Compactors
- Joint Heaters
- Joint Adhesives (hot rubberized asphalt)
- Surface Sealers Over Joint
Mill & Fill
Cutting Back the Joint

B. Prowell photos
Joint Heaters
Application of proprietary joint adhesive
Longitudinal Joint Literature Review

- Construction
  (what is typically achieved)
- Air Voids/ Permeability
  (critical point for long-term performance)
Joint vs. Mat Density
(Representative of Other Studies)

<table>
<thead>
<tr>
<th>Wearing Surface 12.5mm</th>
<th>Binder Course 19.0mm</th>
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</thead>
<tbody>
<tr>
<td>Joint Density</td>
<td>Mat Density</td>
</tr>
<tr>
<td>87.8</td>
<td>93.1</td>
</tr>
<tr>
<td>88.1</td>
<td>93.6</td>
</tr>
<tr>
<td>89.7</td>
<td>93.1</td>
</tr>
<tr>
<td>90.5</td>
<td>93.5</td>
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</tbody>
</table>

D. Maurer, P.E.
## Construction

<table>
<thead>
<tr>
<th>Year</th>
<th>Avg</th>
<th>Std Dev</th>
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<tbody>
<tr>
<td>2001 &amp; 2002</td>
<td>89.5</td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>90.3</td>
<td>1.62</td>
</tr>
<tr>
<td>2004</td>
<td>90.0</td>
<td>1.71</td>
</tr>
<tr>
<td>COLORADO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>90.7</td>
<td>1.31</td>
</tr>
<tr>
<td>2006</td>
<td>90.3</td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>90.0</td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>90.7</td>
<td></td>
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“It is unreasonable to expect the average density of the longitudinal joint to achieve a density of 92%”

**Connecticut**
Effect of Voids on Life

WA DOT Study
Methods for Evaluating Longitudinal Joint Quality in Asphalt Pavements
- S. Williams, et al. Univ. of Arkansas

Good Joint Performance  97% of the Mat
Fair  93 to 97%
Poor  < 93%

Longitudinal Asphalt Pavement Joint Construction ........Performance
- D. Morian, et al. Quality Engineering Solutions, NV

Significantly better performance  98% of the Mat  12 years
vs  95% of the Mat  8 years

Assume mat is 94% of G_{mm}, then 98% of 94% is 92% (8\% V_a)
then 95% is 89% (11\% V_a)
then 93% is 87% (13\% V_a)
and then there’s permeability

Permeability at the Longitudinal joint

Wes McNett photo
Destined for Failure
Permeability can be Catastrophic
Permeable Below 92% Density

DENSITY VS. PERMEABILITY
12.5 mm WEARING COURSE

Coefficient of Permeability (K) (cm x 10^{-5} / sec)

Dean Maurer, P.E.
Various Research Reports on Critical Air Void Level for Permeability

<table>
<thead>
<tr>
<th>Critical % AVs where permeable</th>
<th>9.5 mm</th>
<th>12.5 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>R. Mallick, et al - (fine graded)</td>
<td>8.5</td>
<td>NCAT 03-02 – (coarse graded) - 2003</td>
</tr>
</tbody>
</table>
Dilemma at the Joint

Air void & Permeability research says <7-8% AVs needed

Standard joint construction practices reach 9-10%
Proposed Specification

Cores -

Centered on butt joint, or middle of wedge

> 92% of $G_{mm}$ : maximum bonus

Between 92% and 90% of $G_{mm}$: pay 100%, possible pro-rated bonus, and overband joint

< 90% of $G_{mm}$ : reduced payment, overband joint
Sealing the LJ
Thank You