Best Practices for Constructing and Specifying HMA Longitudinal Joints

A Cooperative Effort between Asphalt Institute & FHWA

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Sr. Regional Engineer
Asphalt Institute
Don’t We Already Know How To Build a Longitudinal Joint?
• 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
Project Team

- Asphalt Institute
  - Mark Buncher
  - Carlos Rosenberger
  - AI Regional Engineers
- FHWA
  - Thomas Harman
  - Michael Arasteh
  - Stephen Cooper
- PA State Asphalt Paving Association
  - Gary Hoffman
Our Approach

1. Benchmark Survey – FHWA Divisions
2. Literature Review
3. Identify… What we know? Things we don’t?
4. Interview the Experts (19)
5. Visit select State DOT’s (5)
Two Goals

Best way To Build it.

Best way To Spec it.
Takeaways from FHWA Survey to 52 Division Offices

• ½ States are not satisfied with overall performance of L-Joints

• 2/3rds of States have a “L-Joint spec”
  – Half of those (17) have a min. density
    • Range from 89% - 92% min $G_{mm}$ (Rice)
  – Other half are method specs
    • From Joint Adhesive to very prescriptive
1st Goal

Best way
To Build it.
Experts Interviewed…

10 Consultants

• Jim Scherocman
• Chuck Deahl
• Jim Heddrich
• Ron Corun
• Larry Michael
• Steve Neal
• Brian Prowell
• Tom Skinner
• Frank Colella
• Wes McNett
9 NAPA Sheldon D. Hayes Winners

“Single best paving project of the year.”

Note: Lindy Paving has won 3 times in the last 10 years!
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?
   a) Notched wedge joint
   b) Butt Joint

2) Do you prefer a
   a) Notched wedge joint
   b) Compacted wedge (yes) (no)
   c) Butt Joint

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

4) Do you roll the unsupported edges by:
   a) Staying back 6-inches from the edge
   b) Overlapping the edge of the mat by 6-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) (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 infrared 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?

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 onto 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) Cores
    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 9.5mm 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 6.2% 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 you 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**

**Low Density Area**

**Sufficient Material for Roll-Down**
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.
Experts, Q. Prefer Notch-Wedge or Butt Joint?

Nearly Divided
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, NMAS x 3

Offset the L. J. on multiple lifts.

Longitudinal joint should be included in construction plan & sequence
GETTING STARTED OFF RIGHT

- Plant
- Paving
- Trucking
- Compaction

Dump Person

MTV
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 with Joint Matcher
Vibratory Screed should always be On
Uniform Head of Material Across the Entire Screed

Auger

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.
1st Roller Pass on Unsupported Edge 50/50: Overhang vs. Stay Back 4-6”

- Roll When HOT!
If staying back 6”, Watch for lateral movement and stress crack.
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”
Don’t 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)

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

Staying off the Joint by 6” with 1st Pass Avoids Bridging
2nd Goal

Best way To Spec it.
Longitudinal Joint

Literature Review

Construction
What in-place densities are we getting?

Permeability
What is the danger zone?
Joint vs. Mat Density
(Representative of Other Studies)

Joint Density vs. Mat Density

Wearing Surface
12.5mm

Binder Course
19.0mm

D. Maurer, P.E.
Nuclear Density Profile
Texas Transportations Institute Study

Unconf. 88.5%  Middle 93.0%  Hot Side 91.0%
## Methods for Evaluating Longitudinal Joint Quality in Asphalt Pavements

*S. Williams, et al. Univ. of Arkansas*

<table>
<thead>
<tr>
<th>Joint Performance</th>
<th>Percentage</th>
</tr>
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<tbody>
<tr>
<td>Good</td>
<td>97% of the Mat</td>
</tr>
<tr>
<td>Fair</td>
<td>93 to 97%</td>
</tr>
<tr>
<td>Poor</td>
<td>&lt; 93%</td>
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## Longitudinal Asphalt Pavement Joint Construction Performance

*D. Morian, et al. Quality Engineering Solutions, NV*

<table>
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<th>Comparison</th>
<th>Performance</th>
<th>Duration</th>
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<tr>
<td>Significantly better</td>
<td>98% of the Mat</td>
<td>12 years</td>
</tr>
<tr>
<td>vs</td>
<td>95% of the Mat</td>
<td>8 years</td>
</tr>
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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% $V_a$)
Effect of In-Place Voids on Life
Washington State DOT Study

Percent Service Life vs. In-situ Air Voids, %

The graph illustrates the relationship between in-situ air voids and percent service life. As the in-situ air voids increase, the percent service life decreases. This indicates that higher void percentages in the pavement material lead to a shorter service life.
...and then there’s permeability

Permeability at the Longitudinal joint

Photo: Wes McNett
Destined for Failure
Permeability can be Catastrophic
## Various Research Reports on Critical Air Void Level for Permeability

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<th>Critical Voids where permeable</th>
<th>9.5 mm</th>
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<tr>
<td>E. Zube - California Dept. of Highways - 1962</td>
<td>8</td>
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<td>R. Mallick, et al - (fine graded)</td>
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Various Research Reports on Critical Air Void Level for Permeability

- **9.5 mm**
  - E. Zube - California Dept. of Highways - 1962: 8

- **12.5 mm**
  - J. Westerman – Arkansas HTD - 1998: 6
  - NCAT 03-02 – (coarse graded) - 2003: 7
Dilemma at the Joint

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

Standard joint construction practices reach 9-10%
Proposed “End-Game” Criteria for LJ Density Spec

Six-inch Cores -
   Centered on butt joint, or middle of wedge

\[ \geq 92\% \text{ of } G_{mm} : \text{maximum bonus} \]

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

\[ < 90\% \text{ of } G_{mm} : \text{reduced payment, overband joint} \]
Impact on Lot Payment Summary

- $12,000

Disincentive

No Pay Adjustment

Incentive

+$5,000

PWT
Option: Sealing the LJ
Overbanding is not Unusual
Many Agencies require for patching
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
Cutting Back the Joint

B. Prowell photos
Cutting Wheel Fixed to Roller in Europe

- Best practice in Europe on Dense Graded mixes on large projects when traffic is managed.
- Cut when mix is warm and plastic.
- Watering of blade prevents tearing.
- Joint then painted with 50pen binder.
- Cutting and painting not done on open mixes.

http://www.highwaysmaintenance.com/kraktext.htm
CEM Vibratory Wedge compactor
Joint Heaters
Application of proprietary joint adhesive (JA)
Surface Sealers
Next Steps

1. Finalize AI/FHWA Report
   • Soliciting review comments

2. Workshop
   • ½ Day for Agency & Contractor

3. Provide Training
   • Revise based on input

4. Develop Other Training Tools