Best Practices for Constructing and Specifying HMA Longitudinal Joints

A Cooperative Effort between Asphalt Institute & FHWA

Bob Humer
Asphalt Institute
“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.”
Study Approach

1. Benchmark Survey – FHWA Divisions
2. Literature Review
3. Identify… What we know? Things we don’t?
4. Interview the Experts (18)
5. Visit select State DOT’s (5)
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
<table>
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<th>Experts Interviewed…</th>
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<tr>
<th>10 Consultants</th>
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<td>52 FHWA Division offices</td>
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<td>5 DOTs</td>
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<td>10 Consultants</td>
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<td>8 NAPA Sheldon D. Hayes award winning Contractors</td>
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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
   a) Notched wedge joint  Do you compact the wedge? (yes) (no)
   b) Butt Joint

3) Do you use paver automation (yes) or (no), Your preference is
   a) JointMatcher 
   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, 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 onto the cold

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 0.9mm 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% 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 (about 1”)

Sufficient Material for Roll-Down (25% overheight)

Low Density Area (unconfined edge)
The Best Longitudinal Joint
Echelon Paving

New Jersey

Interstate 295

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.
Q. Prefer Notch-Wedge or Butt Joint?

The experts are equally divided
1st pass

Wedge 3:1 to 12:1

2nd pass

1/2 to 3/4-inch

NMAS

2nd pass

Wedge 3:1 to 12:1
What we do know!

- A pavement is permeable when the voids are interconnected.

- Coarse-graded 9.5mm and 12.5mm Superpave mixes become permeable at 7.7% voids.

- Coarse-graded 19mm mixes at 5.5%, and 25mm mixes at 4.4%. (ref: NCAT study)

- At what % the voids become interconnected depends on the type of mix.
Effect of Voids on Life

Percent Pavement Voids

Percent Service Life

WA DOT Study
What we do know!

- A fine-graded 9.5mm mix with a 6.2% obc is less permeable than a coarse-graded 9.5mm mix with a 5.7% obc.

- On the other hand, small size finer graded mixes have more potential for rutting and bleeding.

- For dense-graded mixes, we should strive for the mat and joints to be impervious.

- As a “rule-of-thumb”, the % voids should not exceed 8%.
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, NMAS x 3

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

Plant  Paving

Trucking  Compaction

Dump Person

MTV; Keep paving moving
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, to get a consistent 1” overlap with 2nd pass.
Tough to get proper overlap (1”) with next pass
Paver on Automatic with Joint Matcher
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”
Set Material Depth to Fill the Joint Completely When Compacted

If the joint is starved of material the roller will simply bridge onto the cold mat and joint density will be poor.

To avoid this, where practical set automated controls to function as joint matchers when paving between traveled lanes.
Bumping Joint Properly

Don’t push across!
Vibratory Screed should always be On
Tack the Joint! (Butt or Wedge)

- Emulsion, or

- PG asphalt or Proprietary Joint Adhesive
Auger

Uniform Head of Material Across the Entire Screed

Carry Material Within 12 – 18-inches of the End Gate
Carrying the mix out this far is unacceptable
Auger not extended to within 12 to 18-inches of the end gate.

The result - SEGREGATION at joint
1<sup>st</sup> Roller Pass on Unsupported Edge
50/50 opinion: Overhang vs. Stay Back 4-6”

- Roll When HOT!
If staying back 6”, Watch for lateral movement and stress crack.

Edge of drum inside unsupported edge
Can cause cracking near the edge and lateral mix movement at the unsupported edge.
Rolling the Supported Edge
(many different opinions and approaches)

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

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

Photo: Wes McNett
Destined for Failure
Longitudinal Joint Specification

Literature Review

Construction
What in-place densities are we getting?

Permeability
What is the danger zone?
Nuclear Density Profile
Texas Transportations Institute Study

Unconf. 88.5 %
Middle 93.0%
Hot Side 91.0%
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% $V_a$)
Effect of In-Place Voids on Life
Washington State DOT Study

Percent Service Life

In-situ Air Voids, %
Permeable Below 92% Density

DENSITY VS. PERMEABILITY
12.5 mm WEARING COURSE

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

LONGITUDINAL JOINTS
MAT

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

9.5 mm

E. Zube - California Dept. of Highways - 1962 8
R. Mallick, et al - (fine graded) 8.5

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%
Option: Sealing the LJ
Overbanding is not Unusual
Many Agencies require for patching
Proposed “End-Game” Criteria for LJ Density Spec

Six-inch Cores -

Centered on butt joint, or middle of wedge

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

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

$< 90\% \text{ of } G_{mm}$ : reduced payment, overband joint
Other Options / New Products

- Mill & Fill One Lane at a Time
- Joint Heaters
- Cut Back Joint
- Wedge Compactors
- 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
Smoothness
Keep the Operation Moving

One of the essentials for a smooth riding asphalt pavement is to provide for a continuous operation!

This requires planning!
Smoothness

The effects of changing the Paver Speed

Maintain Constant Paving Speed
Planning the Speed of Paving

\[
S = \frac{(2,000 \times P)}{(60 \times W \times H \times D)} \quad \text{(in U.S. Customary Units)}
\]

\[
S = \text{Speed of the Paver} \quad \text{(in feet / minute)}
\]

\[
P = \text{Production at the Plant} \quad \text{(in Tons / hour)}
\]

\[
W = \text{Width of paving} \quad \text{(in feet)}
\]

\[
H = \text{Lift thickness} \quad \text{(in feet)}
\]

\[
D = \text{in-place Density} \quad \text{(in pounds / ft}^3\text{)}
\]

\[
S = \frac{P}{(60 \times W \times H \times D)} \quad \text{(In metric units)}
\]

\[
S = \text{Speed of the Paver} \quad \text{(in meter / minute)}
\]

\[
P = \text{Production at the Plant} \quad \text{(in Tonnes / hour)}
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\]

\[
D = \text{in-place Density} \quad \text{(in grams / cm}^3\text{)}
\]
Planning the Speed of Paving

- Paver Speed vs. Mat Thickness
  - tons per hour
  - 12 feet wide
  - 144 lbs./cu. ft. compacted

Paver Speed (in feet per minute) vs. Mat Thickness (in inches):
- 80
- 60
- 40
- 20
- 100
- 250
- 500

Note: The graph illustrates the relationship between paver speed and mat thickness for paving projects.
Avoid disruptions of the paving operation

An “over-active” screed operator will cause surface roughness. You will not be able to roll this out. What the Paving Machine places is the final smoothness.
Questions?

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