Best Practices for HMA Longitudinal Joints

A Cooperative Effort between Asphalt Institute & FHWA

Outline for Webinar Today

- Introduction, Project
- Density/ Performance/ Permeability
- Construction Best Practices
- Other Options/ New Products

Don’t We Already Know How To Build a Longitudinal Joint?

I-71 in Cincinnati, OH
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, 2002

An Agency
and
Industry Concern

Longevity matters, it impacts:

- DOT Program Costs
- HMA Industry’s Livelihood
  - LCCA
  - Alternate Bid Competitiveness
- Travelling Public
  - “...Stay Out”

Goal LJP = MP

Longitudinal Joint Performance equals Mat Performance
Two Project Goals

Best way To Build it.

Best way To Spec it.

Focus for Today’s Presentation

Best way To Build it.

Our Approach

1. Survey – FHWA Divisions
2. Literature Review
3. Identify... What we know? Things we don’t?
4. Interview the Experts
5. Visit State DOT’s
6. Report Findings (Al’s LJ webpage)

Takeaways from FHWA Survey to 52 Division Offices

1. ½ States are not satisfied with overall performance of L-Joints
2. 2/3 of States have a “L-Joint spec”
   - Half of those (17) require a minimum density
     - Range from 89% - 92% min $G_{mm}$ (Rice)
   - Other half are method specs
     - From Joint Adhesive to very prescriptive
Literature Review

- Back to 1960s
- Construction Practices
  - Helped Us Formulate Interview Questions
    - Focusing on areas where there was not an apparent consensus
- Density/Performance/Permeability
  - In-Place Density at the Joint
  - Relationship between Density and Performance
  - Permeability and Relationship to Density

Interview Questions to 19 Experts

Joint vs. Mat Density
(Representative of Other Studies)
Various Research Projects on Critical Air Void Level for Permeability

**9.5 mm Mixes**

- E. Zube - California Dept. of Highways - 1962  
  - 8.0
  - 7.7
  - 8.5

**12.5 mm Mixes**

  - 7
- J. Westerman – Arkansas HTD - 1998  
  - 6
  - 7
Air Voids $> 10\%$

Mix generally permeable

Permeability at the LJ?

Permeability at the Longitudinal joint

Permeability can be Catastrophic

The Best Longitudinal Joint

Thru Echelon Paving

New Jersey

Rolled Hot

Photo: Wes McNett
But, the need to maintain traffic limits the opportunities to pave in echelon. Consequently, most longitudinal joints are built with a cold joint.

Preferred Joint Type? Experts Evenly Divided.

- Butt Joint (paver construction)
- Butt Joint (milled or cutback)
- Notched Wedge Joint

Joint passes between the quarters.
**Wedge Joints**

- 8:1
- 3:1

**Unacceptable Notched Wedge Joint Construction**

**Plan for Longitudinal Joints...**
(i.e. Discuss During Pre-Con Meeting)

- **Joint Type**
- **Surface Lift Layout Plan with Joints**
  - Consider need to offset joints between layers
  - Avoid wheel paths, RPMs, striping (if possible)
- **Testing of Joint**
  - Type, location, schedule, by whom
- **Joint Construction Practices**
  - Paving, rolling, materials
- **Pave low to high when possible for shingle effect**
  - Avoids holding rain water at joint by hot side being slightly higher (recommendation later)
Poor planning – joint in wheelpath

Offset joints between layers by at least 6-inches; surface joint should be near centerline (not in wheelpath)

Avoid Placing the Stripe on the Joint

Which Can Eventually Result In This
Construction Best Practices for Longitudinal Joints

"We've built a culture that everyone in our company buys into," says Vince Tutino, president of Lindy Paving. "And that culture is quality in asphalt pavements. The whole company is continually working to improve what they do toward the goal of quality and excellent riding pavements.

"Everybody says, 'Oh, you've got a good paving crew,'" says Tutino. "Winning paving awards isn't just done by the paving crew. It’s done by the people who design the asphalt mix, the people who make the mix at the plant, the trucking people who make timely deliveries, the paver operators, the roller operators - everyone who’s involved."

GETTING STARTED OFF RIGHT

Managing Material in the Hopper

Conveyor area is exposed and augers are starved!
**Tack Coat**

Full width of mat to minimize movement of unsupported edge.

**Dump Person**

**First Pass Must Be Straight!**

Unanimous that a string-line should be used to assure first pass is straight.

**String-line**  **Skip Paint**  **Reference**

**Great Results**
Tough to get proper overlap (1”) with next pass

Don’t Rely on Manual Windmill Johnny

Use Automatic Grade Control (Versus Manual)

Vibratory Screed Should Always Be On
To Achieve Pre-Compaction

- Screed Weight
- Forward Motion
- Vibration
- Screed Heating
- Angle of Attack

END GATE

Seated Flat on the Existing Surface

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

Example of uniform head of HMA with auger and tunnel properly extended providing non-segregated mix at joint

Examples of Auger Overload... Likely to Segregate

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

Best Way to Roll a Joint

Critical in cool and cold weather!

Rolling Unsupported Edge?
50-50 on Where to Put 1st Pass

Option 1
Hang over 4-6"

Roller

Option 2
1st Pass 4”-6” inside

Roller

2nd Pass hang over 4”-6”

Roller

What We Don’t Want

Rolling Unsupported Edge
(First Paver Pass)

Edge of drum inside unsupported edge
 can cause cracking near the edge
Our Recommendation: Option 1
1st Roller Pass Hangs Over 4-6 inches

Alternative: Option 2
Stay Back 4-6 inches on 1st pass, then roll 2nd pass w/ slight overhang

- Concern: – developing stress crack?
- Merit: – minimize lateral movement?

Compacting Notched Wedge

Quality Control, Monitor Joint Density

Vibrating wedge
Wheel compactor
Paint the Side of Joint (Butt or Wedge)

- Emulsion (Good),
- PG Asphalt (Better),
- Or Proprietary Joint Adhesive (JA) (Best)

Paver Automation Using Joint Matcher (versus Ski) to Always Achieve Exact Thickness of Mat Needed

- If hot-side is starved of material, the roller drum will “bridge” onto cold mat and no further densification occurs at joint
- NEVER STARVE JOINT by targeting a final height difference of +0.1” on hot-side.
  - NH spec requires compacted hot-side to be 1/8” higher than cold side

Joint Matchers

- Contact Grade Sensor
- Ultrasonic Grade Sensor

Destined for Failure

Hot side of joint starved of material where bridging occurred?
Ski Best for Smoothness
reference is from average over length of ski

Versus Joint Matcher, which uses reference from exact location

Proper Overlap:
• 1.0 ± 0.5 inches
• Exception: Milled or sawed joint should be 0.5 inches

Bumping the Joint?

Don’t broadcast material across the mat
Lute the Longitudinal Joint

This lute person is doing a great job

No lute person

Rolling the Supported Edge
Our Recommendation:

1st pass off the joint approx 6-8 inches
2nd pass overlaps on cold mat 3-6 inches

Versus an Alternate Method of 1st Pass over the Supported Edge

Roller in vibratory mode with edge of drum overhanging 2 to 4-inches on cold side.

Concern with this method is if insufficient HMA laid at joint, then bridging occurs (roller supported by cold mat)
With Recommended Method, Still Must Watch for Stress Cracks

During Site Visit to CO, Staying off 6” on 1st Pass

Stress cracks evident at edge of the drum (while more likely from rolling unsupported edge, can also occur from rolling supported edge)

The final pass on a crowned section

Quality Control of Joint Density

• Density Gauge
• 6-inch Core

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
• Overband with PG Binder
• Rubber Tire Rollers
• Warm Mix Asphalt
Mill & Pave One Lane at a Time

Cutting Back the Joint
- Eliminates low density area
- When HMA still warm
- Straight is critical

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 50 pen binder
- Cutting and painting not done on open mixes

New Wedge Compactors
CEM Vibratory Wedge Compactor
Plate Compactor

Photo in IL. Courtesy Hal Wakefield
B. Prowell photos

http://www.highwaysmaintenance.com/kraktext.htm
Infrared Joint Heaters

Application of Proprietary Joint Adhesive (JA)

Post-applied LJ Surface Sealers

**“Rejuvenator” Types**
(dries clear, no restriping)
- JOINTBOND by D&D Emulsions Inc
  - Petroleum resin oil base emulsion w/ SBR
- REPLAY by BIOSpan Technologies Inc
  - Agricultural oil (no petroleum) w/ SBS
- Others?
  - Advertised to dry fast, not reduce skid resistance

**Asphalt-based Types**
(require restriping)
- Slow set emulsions (fog)
  - Skid?
- Other spray seal products w/ angular sand

Jointed Joint

Jointed Joint
**Overband L-Joint with PG Binder**

Frequently Done in AK and PA

**“Overbanding” Not a New Concept**

Considered best practice around perimeter of patches

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**Pneumatic Rubber Tired Rollers**

- Many experts believe these help in providing a tighter surface that is more dense and less permeable compared to rolling from 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.
WMA as Compaction Aid

Mix Selection and Design Considerations

- Less permeable mixes
  - Smallest NMAS that will do the job
  - Consider using a “fine” gradation
  - Slightly lower design gyration or design air void levels

- Ensure adequate lift thickness:
  - Minimum is NMAS x 4 for coarse gradation, NMAS x 3 for fine gradation

- Tack as separate bid item to facilitate proper appl. rate
- Warm Mix asphalt may serve as compaction aid
- Consider use of the notch wedge joint (versus butt) for lift thicknesses ≥ 1.5 inches and ≤ 3 inches
  - Shown to obtain higher joint densities

Project Website with Findings/Deliverables

http://www.asphaltinstitute.org/public/engineering/longitudinal_joints_info.asp

- Draft final report
- 5-page summary of recommendations
- Several magazine articles
- Info on half-day workshop for State DOTs

Idaho Joint Density

- District 1
- One project 2012
- Nuke readings at the joint
  - Average 90.7%
  - Std. Dev. 1.28
Thank you for your attention

Discussion/Questions?