

Best Practices for HMA Longitudinal Joints

A Cooperative Effort between
Asphalt Institute & FHWA



Outline for Webinar Today

• Introduction, Project

• Density/ Performance/ Permeability

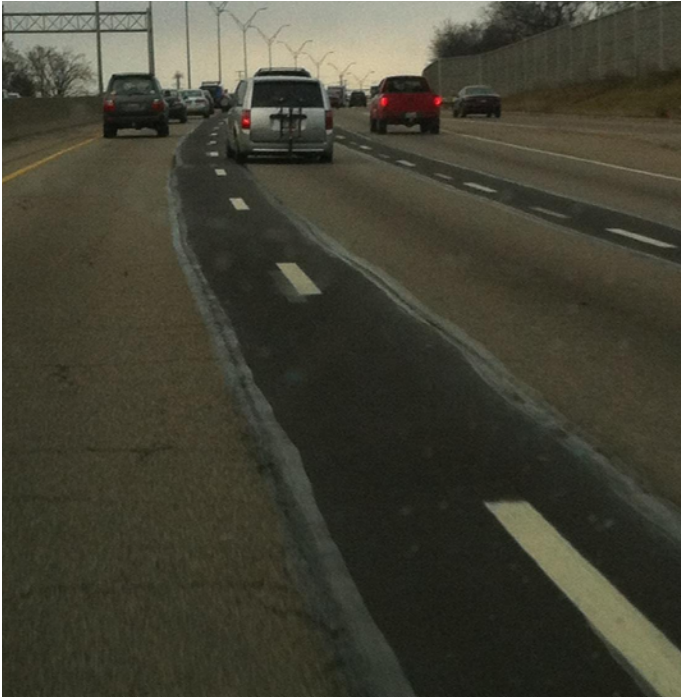
• Construction Best Practices

• Other Options/ New Products

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



I-71 in
Cincinnati, OH



I-71 in
Columbus, 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”



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 (AI's LJ webpage)

Takeaways from FHWA Survey to 52 Division Offices

- ½ States are not satisfied with overall performance of L-Joints
- 2/3^{ds} 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

LONGITUDINAL JOINT CONSTRUCTION INTERVIEW

This survey is part of the Asphalt Institute's cooperative agreement, "Marking of Hot Mix Asphalt (HMA) Joint Construction Best Practices"

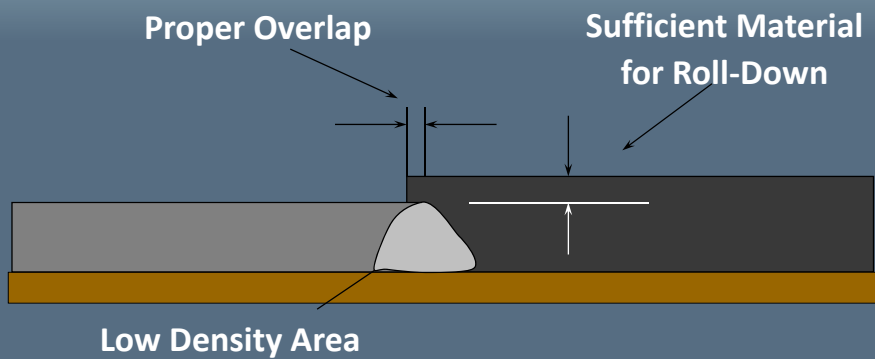
- 1) First pass must be as straight as possible. How do you accomplish that?
- 2) Do you prefer a
 - a) Notched wedge joint
 - b) Butt Joint
 Do you compact the wedge? (yes/no)
- 3) Do you use paver automation (yes) or (no). Your preference is
 - a) Joint Matcher
 - b) Sks
- 4) Do you roll the unsupported edges by:
 - a) Staying back 6-inches from the edge
 - b) Overlaping 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) 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 _____

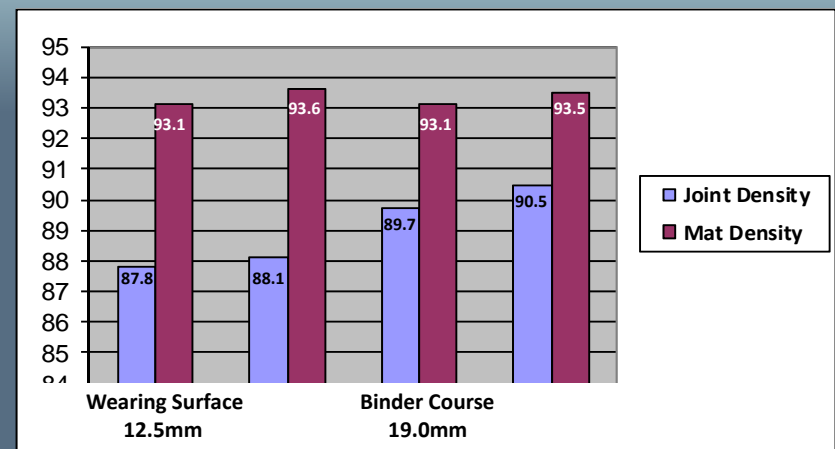
- 12) Do you roll the second pass
 - a) From the hot side overlapping onto the cold
 - b) From the cold side overlapping onto the hot
 - c) Make the first pass staying back from the joint and overlapping onto the cold with the second pass
 - d) Start rolling on the outside edge and working into the joint
 - e) Other _____
- 13) Do you monitor the longitudinal joint density (yes) or (no), if yes, how
 - a) Nuclear gauge 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 your assistance in improving the performance of longitudinal joints. Thank You

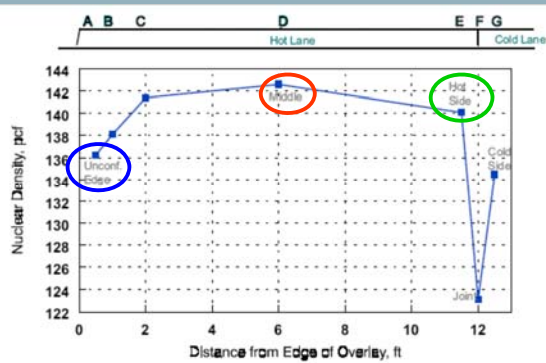
We Know Unsupported Edge Will Have Lower Density



Joint vs. Mat Density (Representative of Other Studies)



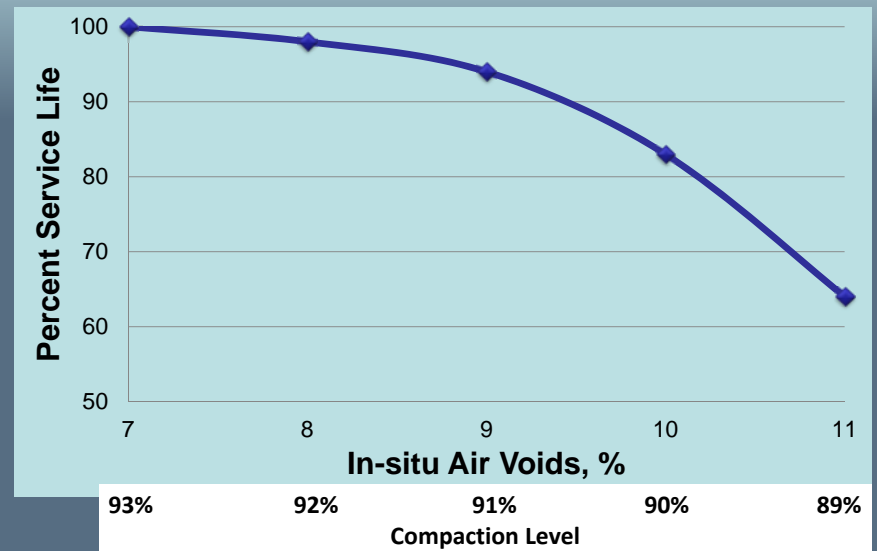
Nuclear Density Profile Texas Transportation Institute Study



Unconfined **Middle** **Hot Side**
Lowest **Highest** **In-between**



Effect of In-Place Voids on Life Washington State DOT Study



Various Research Projects on Critical Air Void Level for Permeability

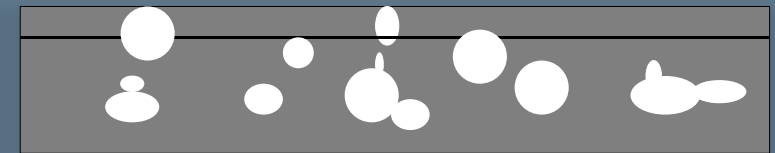
9.5 mm Mixes

Researcher	Critical Voids where permeable
E. Zube - California Dept. of Highways - 1962	8.0
L. Cooley, B. Prowell, R. Brown - NCAT - 2002	7.7
R. Mallick, et al - NCAT Report No. 2003-(fine graded)	8.5

12.5 mm Mixes


B. Choubane, et al - Florida DOT - 1998	7
J. Westerman - Arkansas HTD - 1998	6
R. Mallick, et al - NCAT Report No. 2003(coarse graded)	7

Critical Voids
where permeable



● Air Voids ≤ 7 or 8%

Mix generally not permeable



Air Voids > 10%

Mix generally permeable

The diagram shows a cross-section of a pavement mix with numerous white circles of varying sizes representing air voids. A legend below indicates that these circles represent air voids greater than 10%.

Permeability at the LJ?



Permeability at the Longitudinal joint

Photo: Wes McNett

The photograph shows a road under construction with a longitudinal joint. A red machine is visible in the distance, and the road surface is wet, illustrating the permeability at the joint.



Permeability can be Catastrophic

The top image shows a road with significant water damage and potholes. The bottom image is a close-up of a road surface showing water infiltration through a longitudinal joint, illustrating catastrophic permeability.

The Best Longitudinal Joint Thru Echelon Paving

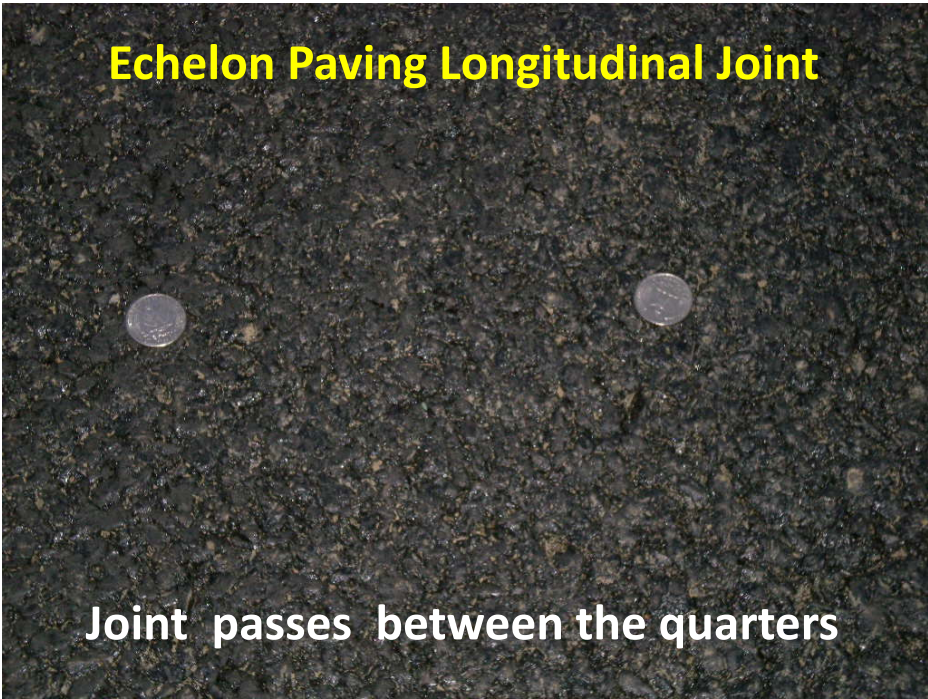
New Jersey



Rolled Hot

The photograph shows a construction site with several pieces of heavy machinery, including a BOMAG roller and a HYPAC roller, paving a road. An Interstate 295 sign is visible in the background. The text 'Rolled Hot' is written in red at the bottom.

Echelon Paving Longitudinal Joint



Joint passes between the quarters

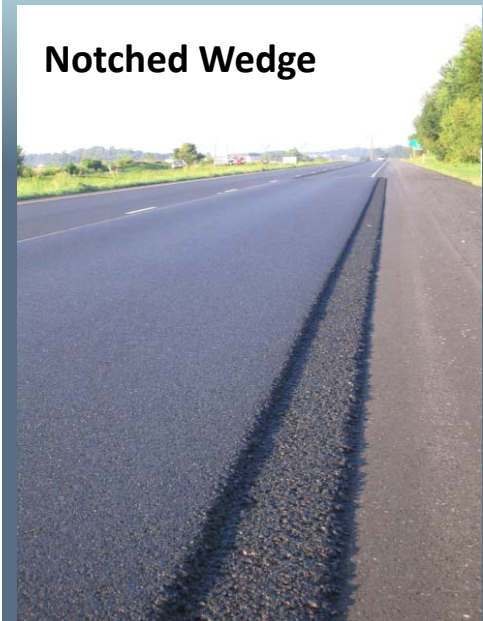
But, the need to maintain traffic limits the opportunities to pave in echelon



Consequently, most longitudinal joints are built with a cold joint.

Preferred Joint Type? Experts Evenly Divided.

Notched Wedge



Butt

Butt Joint (paver construction)



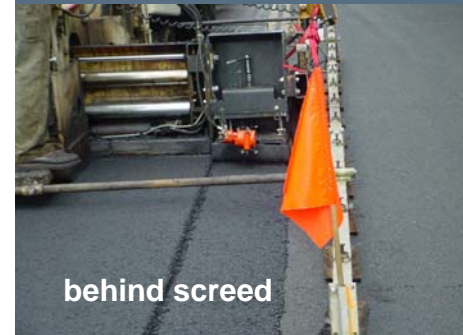
Butt Joint (milled or cutback)



Notched Wedge Joint



Wedge Joints



Unacceptable Notched Wedge Joint Construction



Plan for Longitudinal Joints...

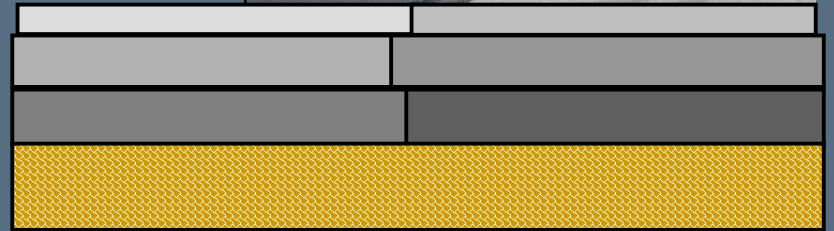
(i.e. Discuss During Pre-Con Meeting)

- 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)





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



DELDOT

Which Can Eventually Result In This



DELDOT

Construction Best Practices for Longitudinal Joints

Management

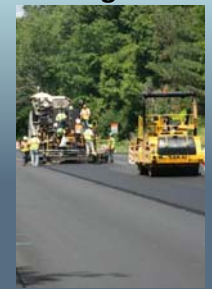


3x Sheldon Hayes Awards

Quality Control



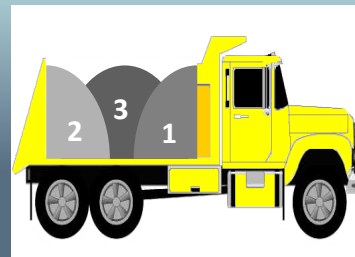
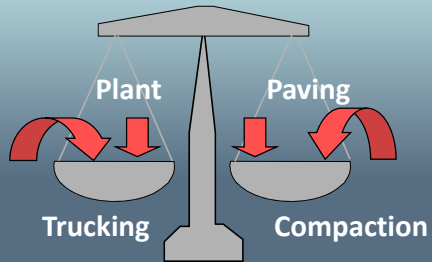
Paving Crew



"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



Dump Person



MTV

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

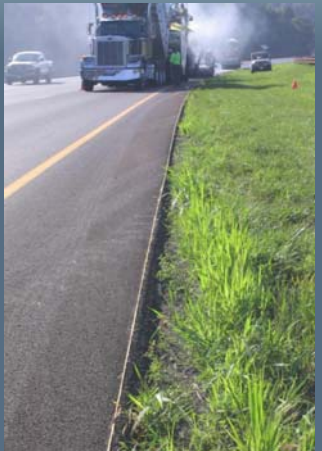


Dump Person

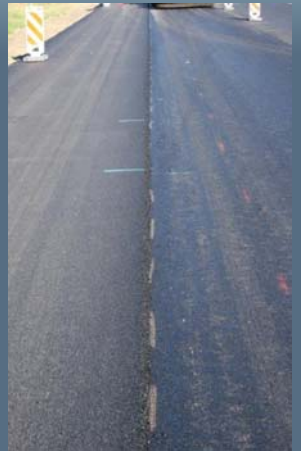


First Pass Must Be Straight!

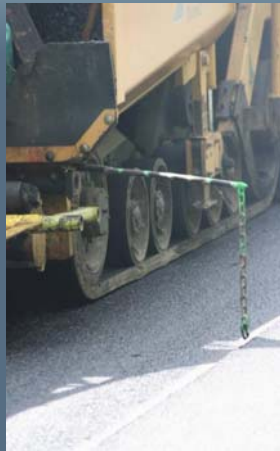
Unanimous that a string-line should be used to assure first pass is straight



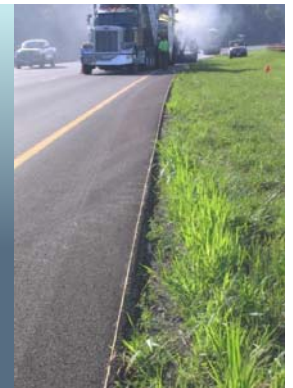
String-line



Skip Paint



Reference



Great Results

**Tough to get proper overlap (1")
with next pass**



**Use Automatic
Grade Control
(Versus Manual)**



Double 55' Ski



Ultrasonic Ski



Contact Ski

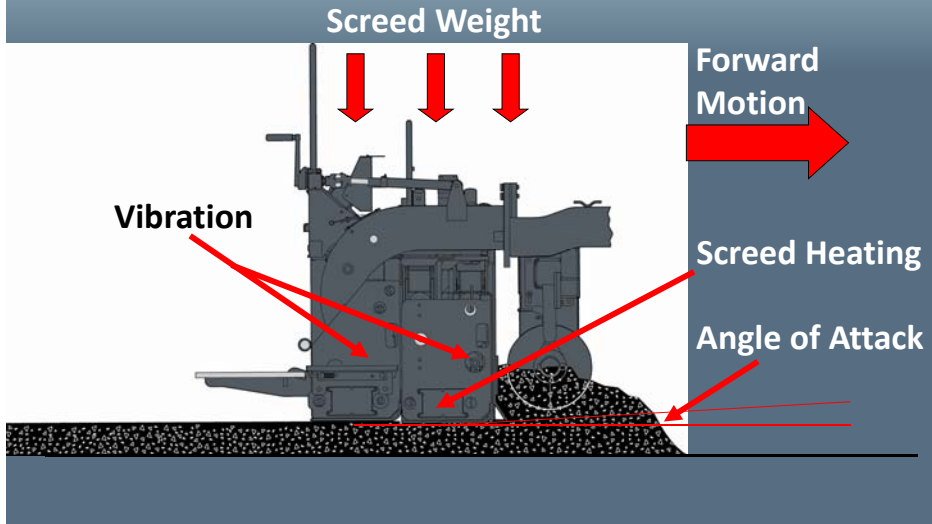
Don't Rely on Manual Windmill Johnny



Vibratory Screed Should Always Be On



To Achieve Pre-Compaction



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



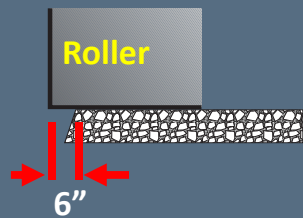
Rollers Need to Be Kept Close to the Paver



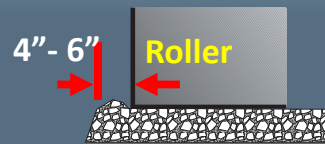
Best Way to Roll a Joint

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

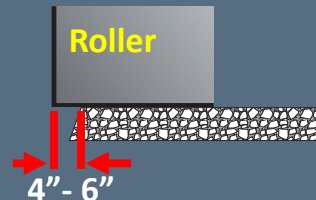
Option 1
Hang over 4-6"



Option 2
1st Pass 4"-6" inside

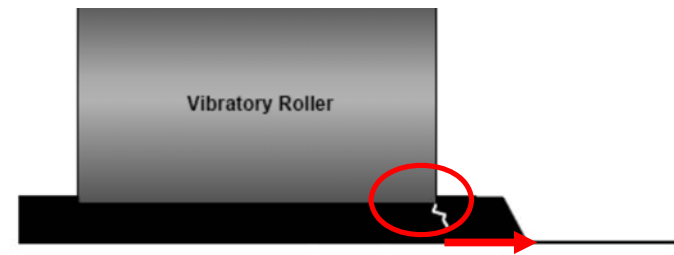


2nd Pass hang over 4"-6"



What We Don't Want

Rolling Unsupported Edge
(First Paver Pass)



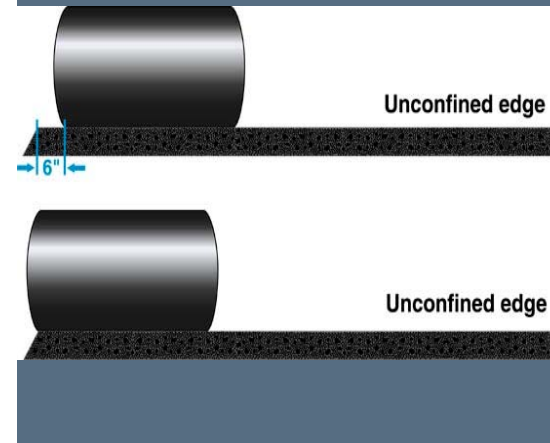
Edge of drum inside unsupported edge
can cause cracking near the edge

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



Vibrating wedge



Wheel compactor

Quality Control, Monitor Joint Density



Paint the Side of Joint (Butt or Wedge)



Emulsion (Good),

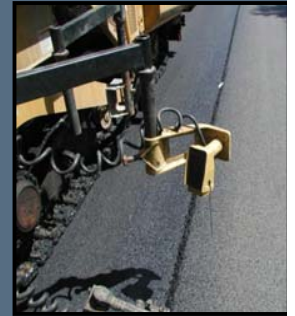


PG Asphalt (Better),

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

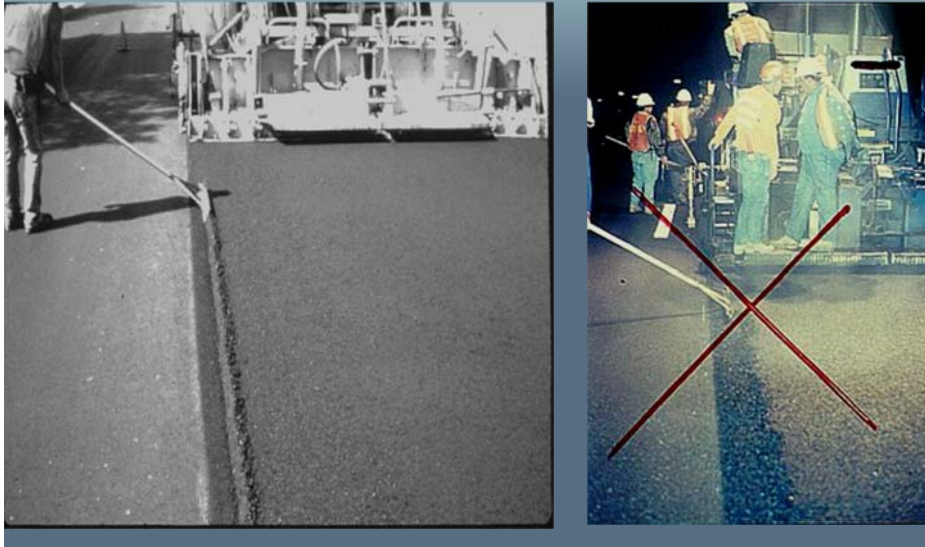
reference is from average over length of ski



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.

Roller

**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)

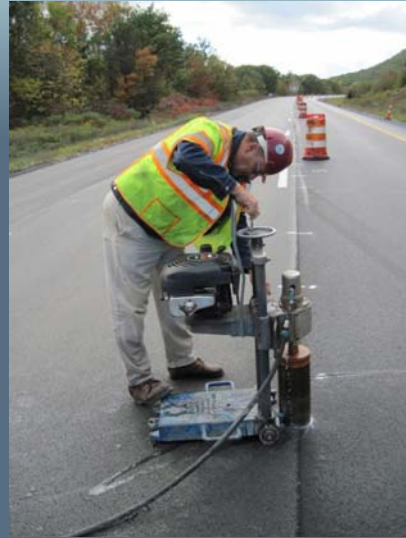


The final pass on a crowned section

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 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



Infrared Joint Heaters



Application of Proprietary Joint Adhesive (JA)



Post-applied LJ Surface Sealers

“Rejuvenator” Types

(dries clear, no restriping)

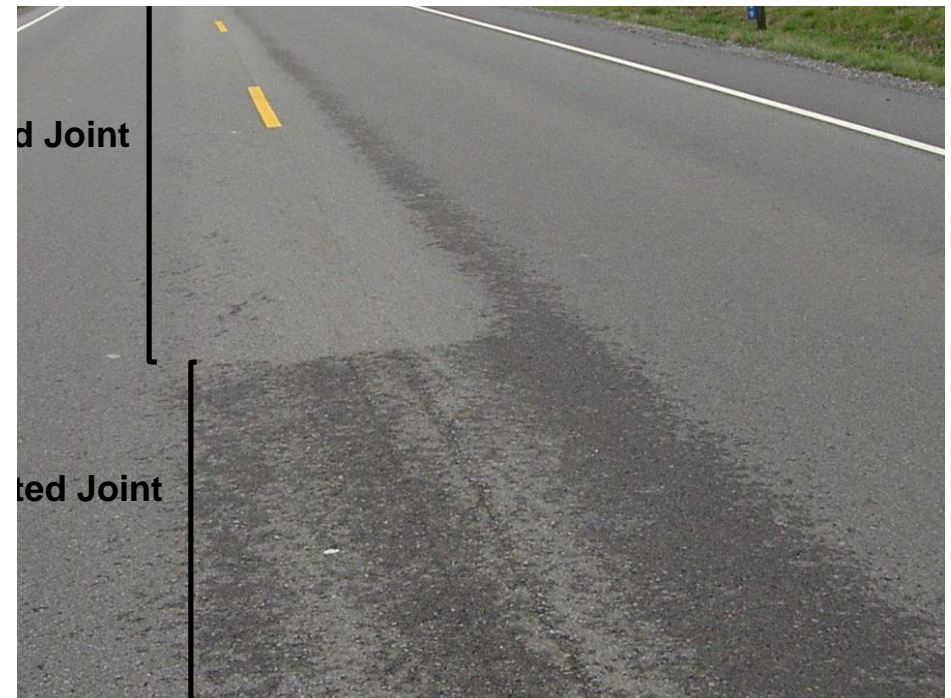
- JOINTBOND by D&D Emulsions Inc
 - Petroleum resin oil base emulsion w/ SBR
- REPLAY by BIOSpan Technologies Inc
 - Agricultural oil (no petroleum) w/ SBS
- Others?

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



Open Joint

Sealed 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

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 gradation 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

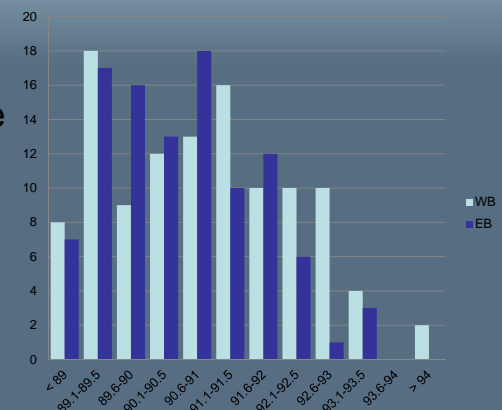
http://www.asphaltinstitute.org/public/engineering/longitudinal_joints_info.asp

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

Idaho Joint Density

District 1 ITD Data on Longitudinal Joints

- District 1
- One project 2012
- Nuke readings at the joint
- Average 90.7%
- Std. Dev. 1.28



Thank you for your attention

Discussion/Questions?

