Best Practices for Specifying and Constructing HMA Longitudinal Joints

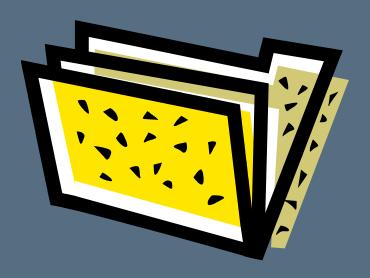
A Cooperative Effort between Asphalt Institute & FHWA





Items in Workshop Folders

- Powerpoint slides
- Feedback Survey
- Summary of Recommendations
- Magazine Article



Project Website

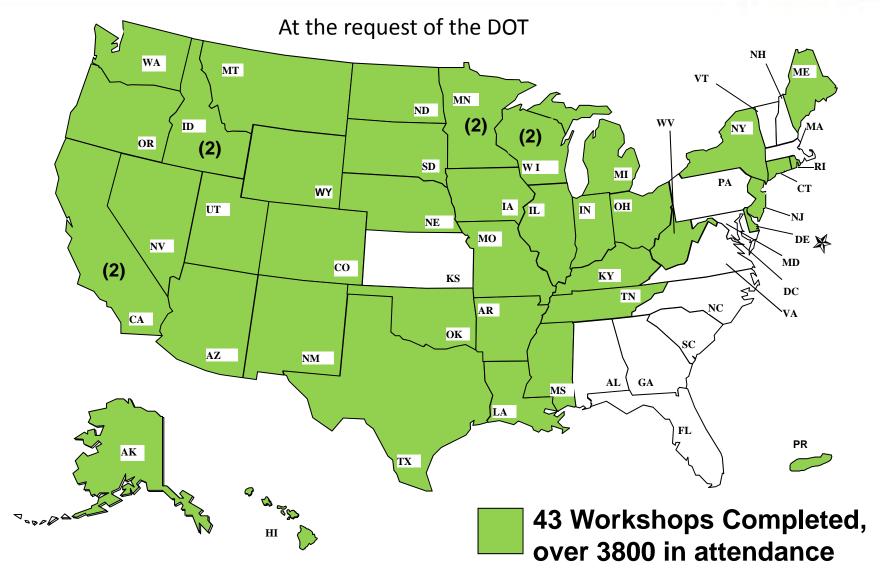
http://www.asphaltinstitute.org/public/engineering/longitudinal-joint-information

-Contains:

- Workshop information
- handout of workshop slides
- Link to entire Workshop in OH, Feb 2013
- 2-hr webinar, Oct 2012
- Project Report
- Magazine articles on project and findings
- 5-page "Summary of Recommendations"

Longitudinal Joint Workshops 2012 - 2016





34 additional presentations to another 3600 over same period

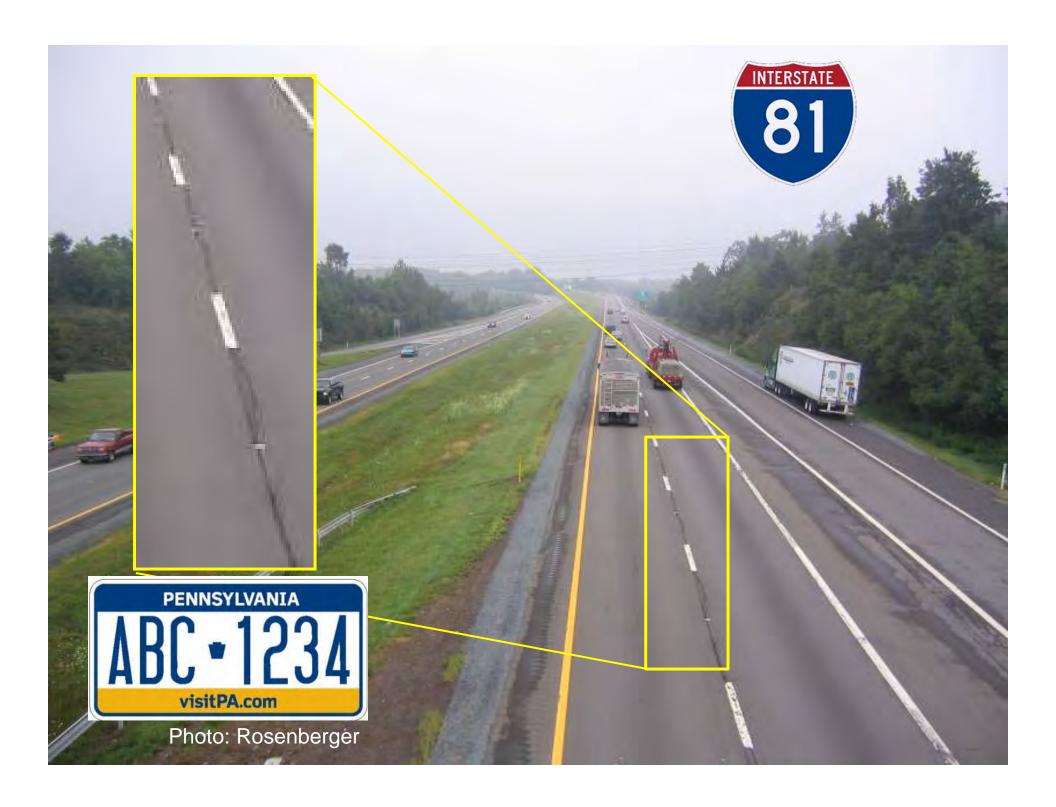
Outline for Workshop Today

- Introduction, This Project
- What We Found in Literature
- Specifications
 - Q & A, BREAK
 - Construction Best Practices
 - Q & A, BREAK
- Other Options/ New Products
- Review
 - Q & A, Safe Travel Home

SECTION 1

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



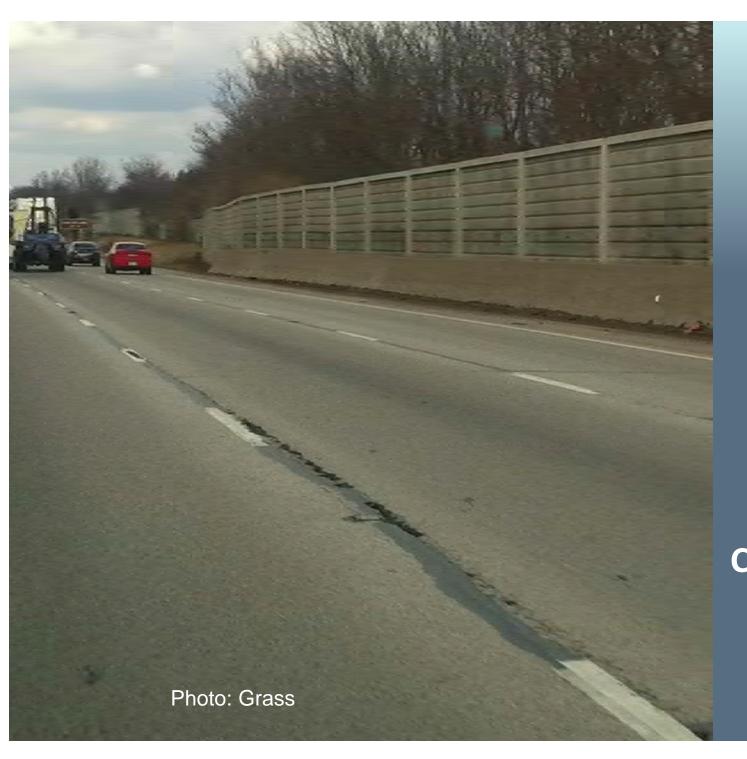




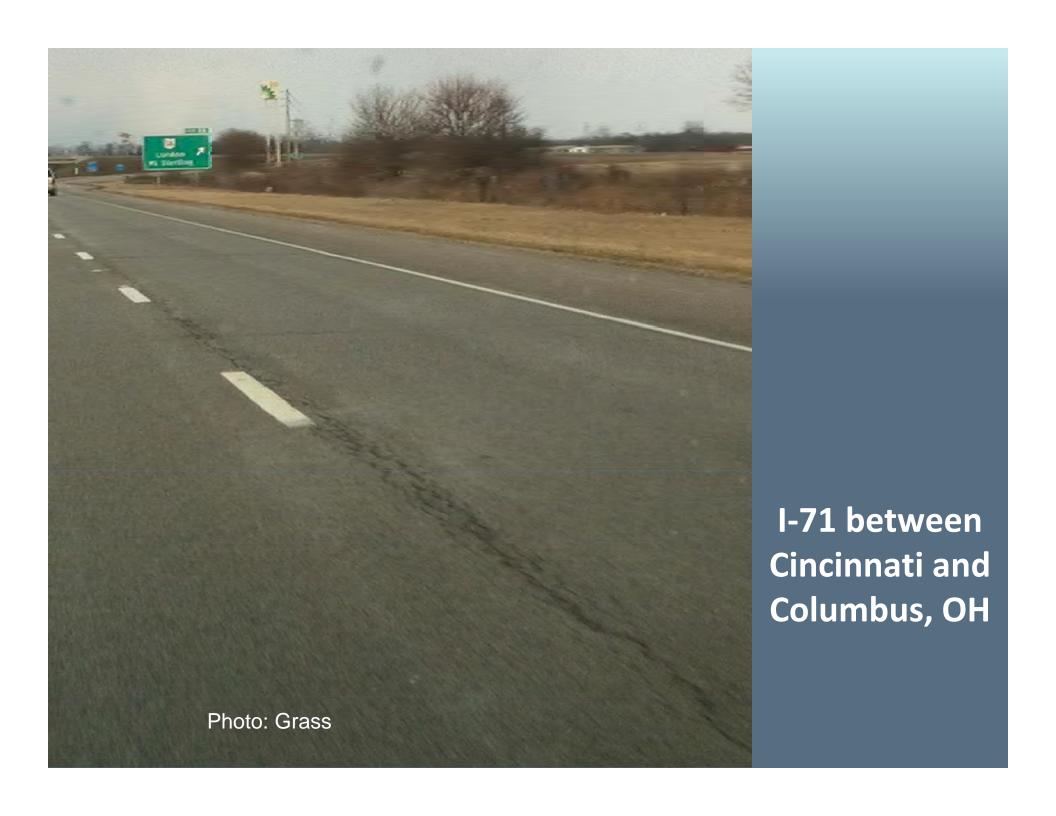


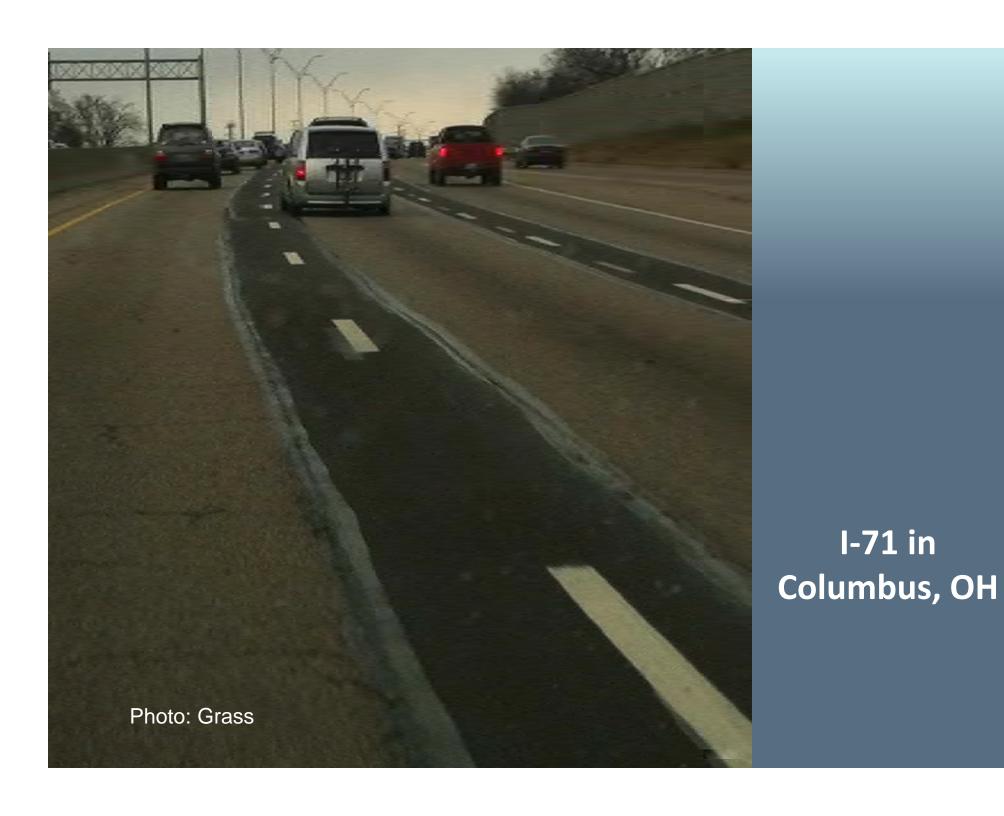






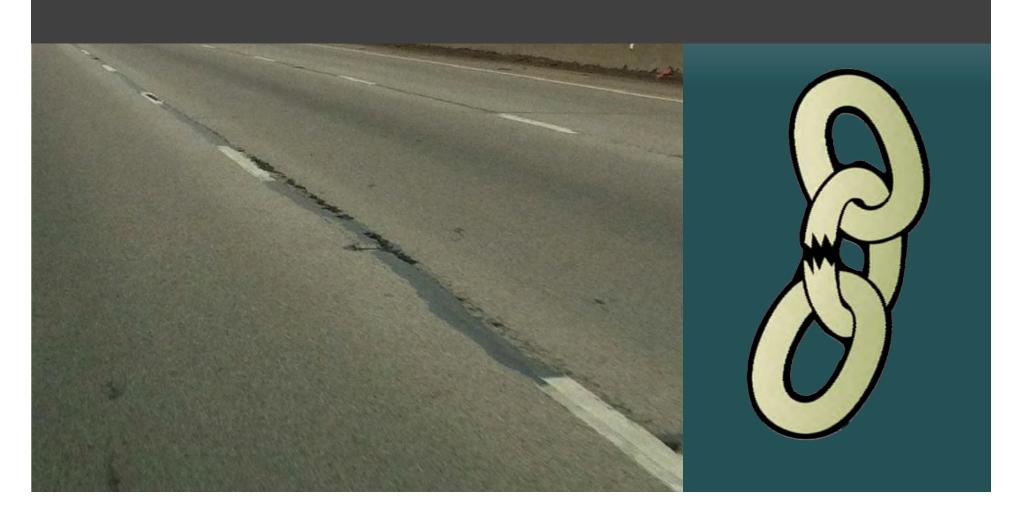
I-71 in Cincinnati, OH





Too often longitudinal joints are the <u>weak link</u> in an otherwise long-lasting asphalt pavement.

- Agency and industry concern!
- Offers greatest opportunity to improve overall life.









An Agency and Industry Concern

Longevity matters, it impacts:

- **□** <u>DOT</u> Program Costs
- ☐ HMA Industry's Livelihood
 - o LCCA
 - Alternate Bid Competitiveness
- ☐ Travelling <u>Public</u>
 - o"...Stay Out"

"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





Best Practices for Constructing and Specifying HMA Longitudinal Joints

Project Team

- >Asphalt Institute
 - Mark Buncher
 - Carlos Rosenberger
 - Al Regional Engineers



- Thomas Harman
- Michael Arasteh
- Stephen Cooper
- Steve Mueller
- > PA State Asphalt Paving Association
 - Gary Hoffman
- > National Asphalt Pavement Association









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)

6

Report & Develop Training Tools...



How many State Agencies have a longitudinal joint specification?

A \blacksquare

About third



В

About half

About two-thirds

Takeaways from FHWA Survey to 52 Division Offices

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

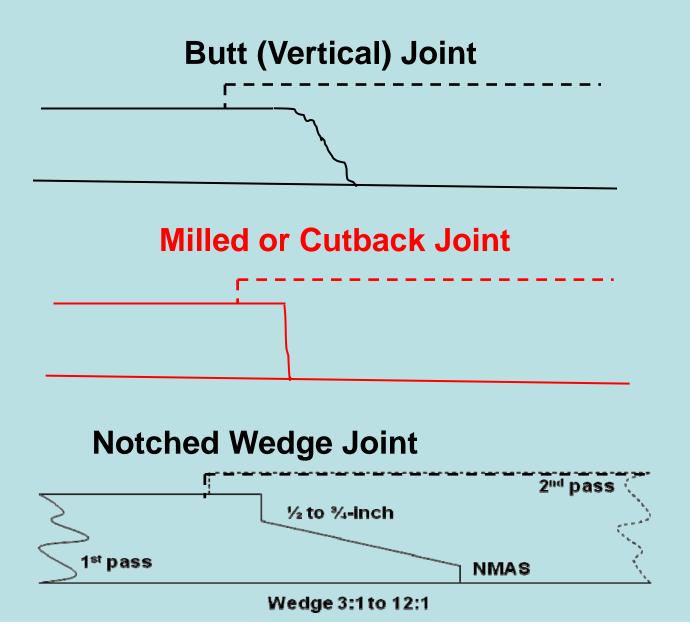


- 2/3^{rds} of States have a "L-Joint spec"
 - Half of those (17) require a minimum density
 - Range from 88% 92% min G_{mm} (Rice)
 - Test methods and locations vary
 - Other half are method specs
 - From Joint Adhesive to very prescriptive

Clarification of Terms

- Density: weight per volume (i.e. 140 pcf)
- Percent Relative Compaction: Comparison of a measured density to a reference density
 - i.e. in place density of 94% TMD
- All industries have jargon
 - Shorthand to simplify communications
- When speaker and slides refer to density, it is jargon for percent relative compaction
 - i.e. 94% density really means 94% TMD

Defining Different Types of Longitudinal Joints



Literature Review

- Back to 1960s
- Construction Practices
 - Helped Us Formulate Interview Questions
 - Focusing on areas where there was not an apparent consensus
- Section 2 to Cover:
 - In-Place Density at the Joint
 - Relationship between Density and Performance
 - Permeability and Relationship to Density

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 G. Hayes Winners "Single best paving project of the year."











K.Barnett & Sons Inc.

Note: Lindy Paving has won 3 times in the last 10 years!

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?
Do you prefer a a) Notched wedge joint
 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) Staying back 6-inches from the edge b) Overhang 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) OtherIf 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 overlan 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
Do you monitor the longitudinal joint density (yes) or (no), if yes, how Nuclear gage or similar device Do Cores Other
14) Which type of specification offers the best chance to long term joint performance? a) Method b) Minimum percent densityWhat is the practical minimum?% c) No specification
 Does a fine 9.5mm mix have a better chance for good performance than a 12.5mm Yes 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 perform ance? 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 wasinches
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

Five Initial State Visits



Note: Content grows and recommendations get tweaked as we visit and learn from each State Meeting and Workshop.

Connecticut
Colorado
Texas
Maryland
Pennsylvania



SECTION 2

Literature Review on Longitudinal Joints

Construction

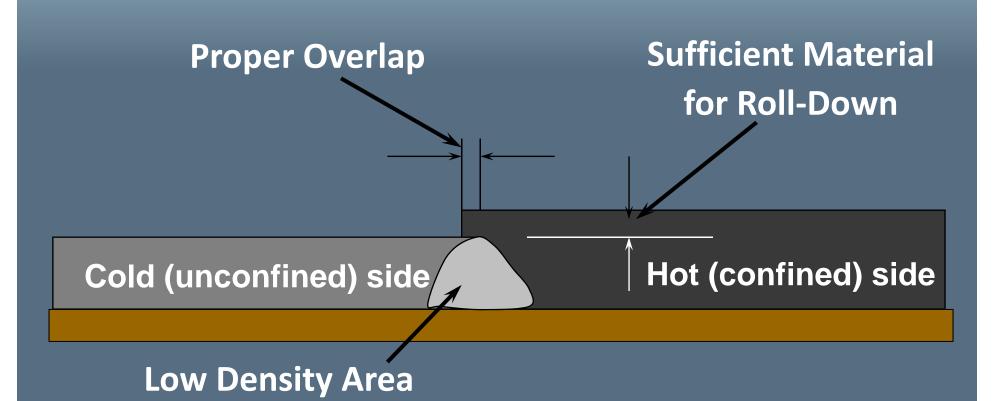
Actual in-place densities?

What is achievable?

Permeability/ Density

Relation to performance?
Where is danger zone?

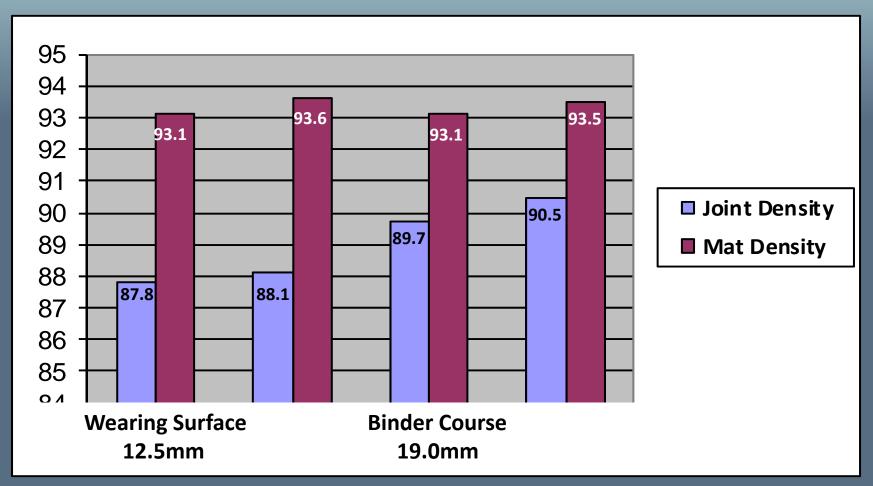
We Know Unsupported Edge Will Have Lower Density



Please note "Cold side" and "Hot side", as they are terms used throughout this Workshop.

Joint vs. Mat Density

(Representative of Other Studies)





Reasonable Upper Limits Using Traditional Construction Practices

<u>Colorado</u>	Avg	Std Dev	
2001, 2002 (info)	89.5		
2003 (pay)	90.3	1.62	
2004 (pay)	90.0	1.71	
2005 (pay)	90.7	1.31	(Based on 6" cores
2006 (pay)	90.3		directly over joint)
2007 (pay)	90.0		

Connecticut, 2008

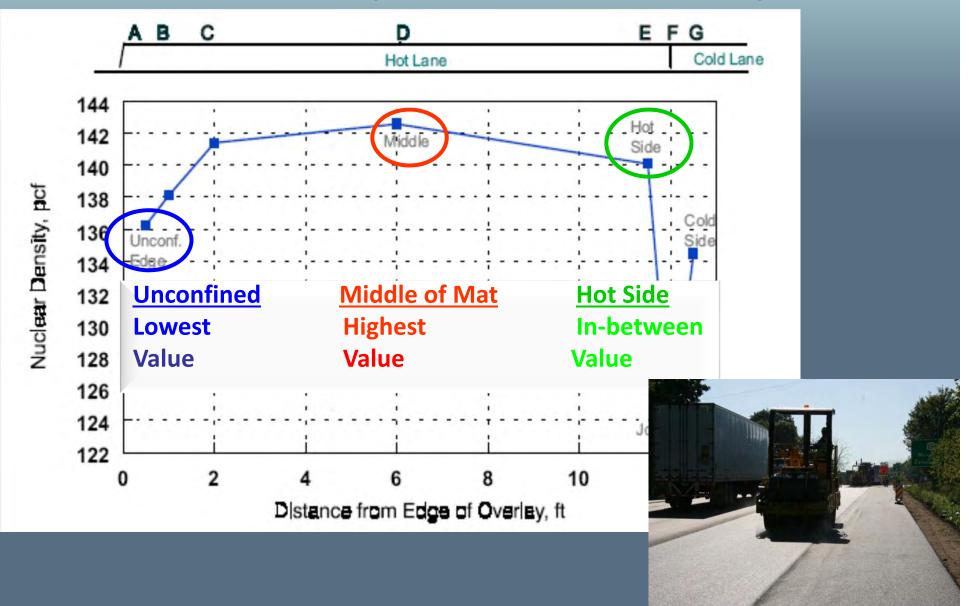
"It is unreasonable to expect the average density of the longitudinal joint to achieve a density of 92%"

Research Recommending a Minimum of 90%TMD, or 2% Less than Required Mat Density

- "It is recommended to specify minimum compaction level at the longitudinal joint (generally 2% lower than that specified for the mat away from the joint)." NCAT / PaDOT, 2002
- "Maximum of 2% less than the corresponding mat density and minimum of 90% of TMD at the specific location." Nevada, 2004
- "The evaluation is considered failing if the joint density is more than 3.0 pcf below the density taken at the core random sample location and the correlated joint density is less than 90%." TTI, 2006
- "Joint density, 2% less than mat density, is achievable when measured with cores." NCAT, 2007

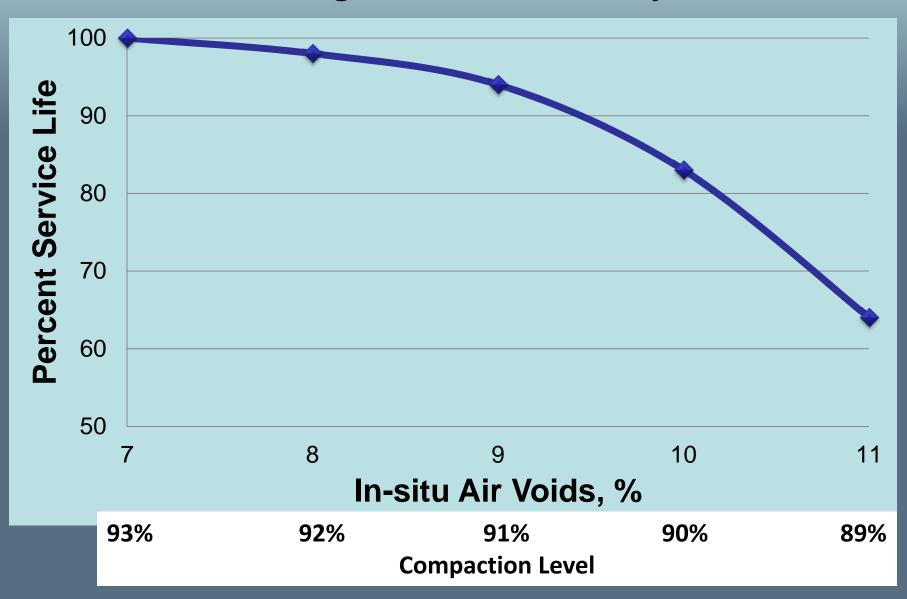
Typical Nuclear Density Profile

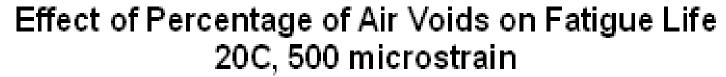
Texas Transportations Institute Study

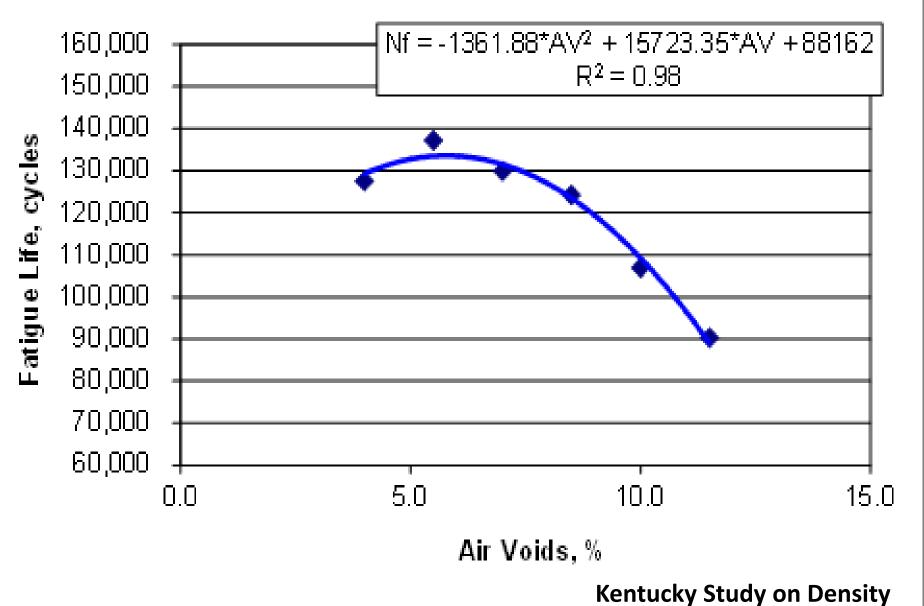


Effect of In-Place Voids on Life

Washington State DOT Study







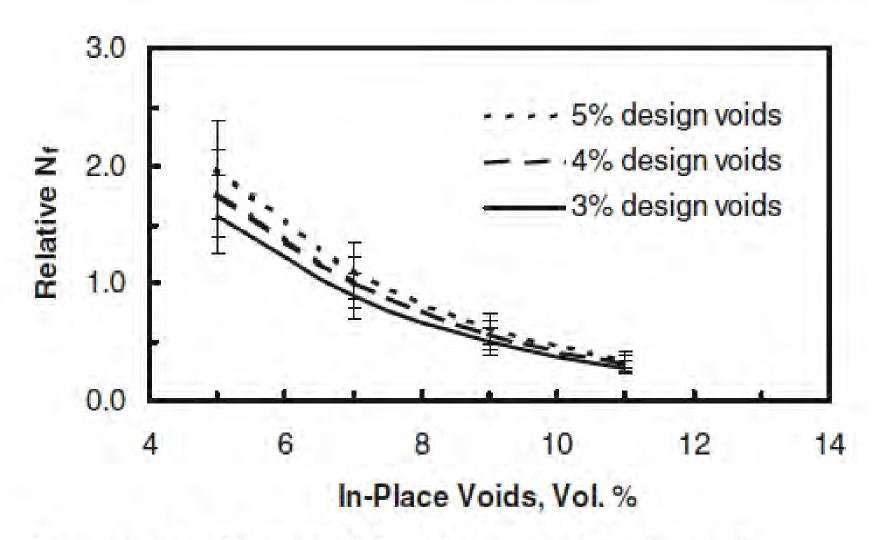


Figure 15. Effect of In-Place Air Voids and Design Air Voids on Relative In-Situ Fatigue Life (Errors Bars = 2s Confidence Limits).

from NCHRP Report 567

Joint Performance vs. Joint Density (as % of Mat)

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

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Good Joint Performance when 97% of the Mat
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Fair Joint Performance when 93 to 97% of the Mat

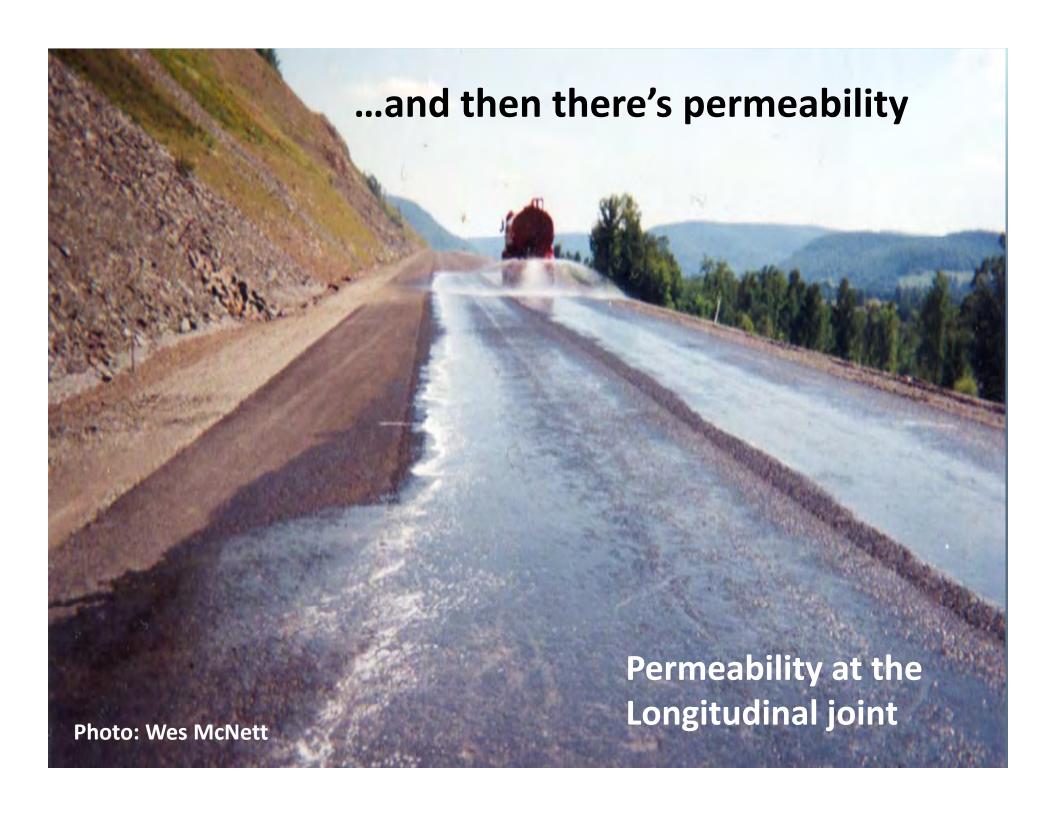
Poor Joint Performance when < 93% of the Mat

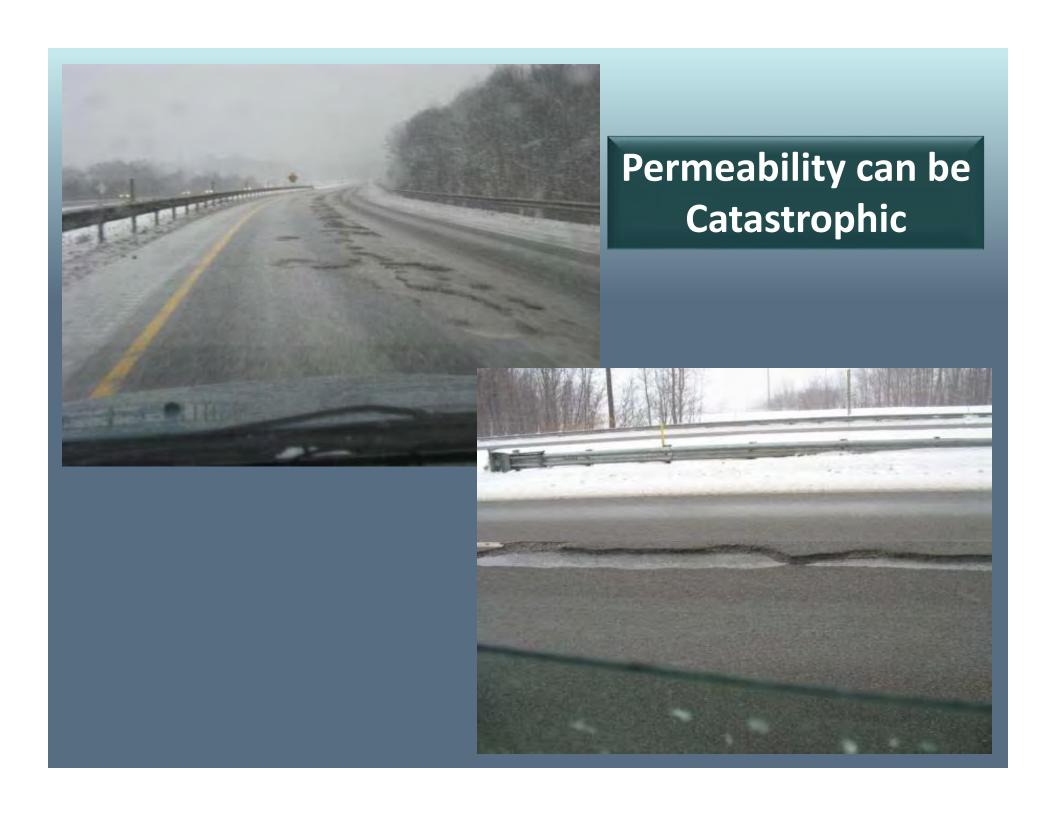
Longitudinal Asphalt Pavement Joint Construction...Performance
- D. Morian, et al. Quality Engineering Solutions, NV

Significantly better joint performance (12 yrs.) when; 98% of the Mat versus lesser joint performance (8 yrs.) when 95% of the Mat

Assuming mat density is 94% of G_{mm}, then:

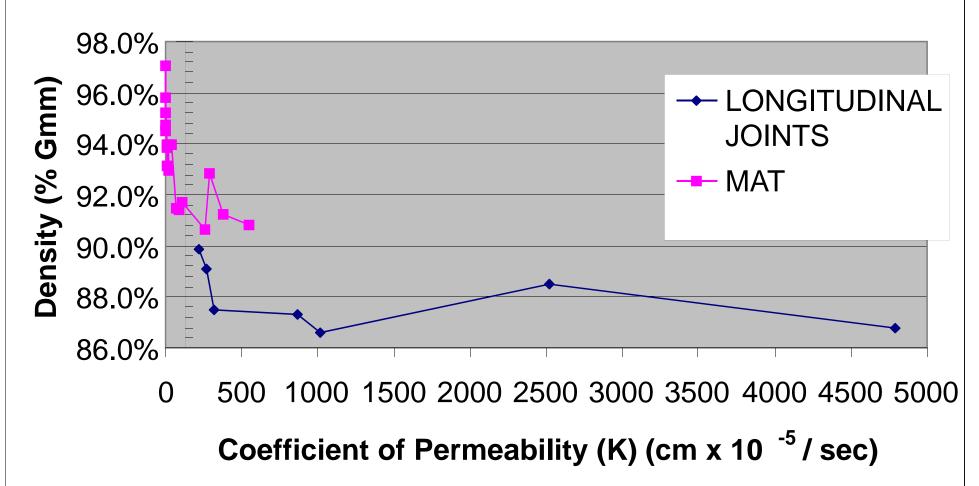
- 98% of the mat density is 92% G_{mm} (8% V_a), = Good Performance
- 95% of the mat density is 89% G_{mm} (11% V_a), = Fair Performance
- 93% of the mat density is 87% G_{mm} (13% V_a), = Poor Performance





Permeable Below 92% Density

DENSITY VS. PERMEABILITY 12.5 mm WEARING COURSE



Various Research Projects on Critical Air Void Level for Permeability

9.5	mm	Mixes
3.3		IAIIVE2

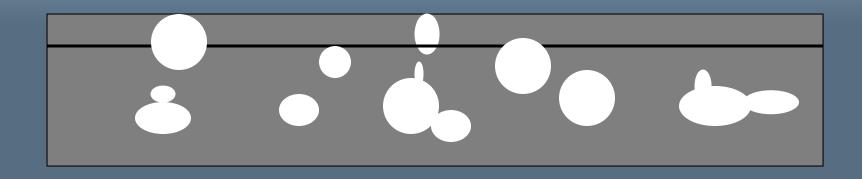
Critical Voids where permeable

E. Zube - California Dept. of Highways - 1962	8.0	0
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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



Air Voids \leq 7 or 8%

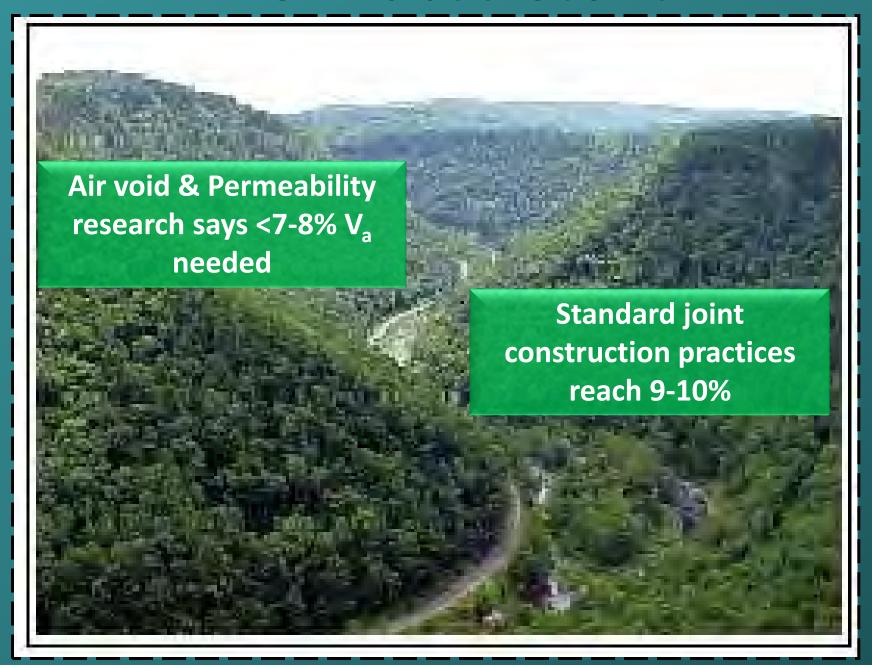
Mix generally not permeable



Air Voids > 10%

Mix generally permeable

Dilemma at the Joint





Section 3

SPECIFICATION



"If you can't measure it, you can't manage it."

Peter Drucker

Various Approaches

No LJ Spec

- High Agency Risk
- No Incentive for Quality

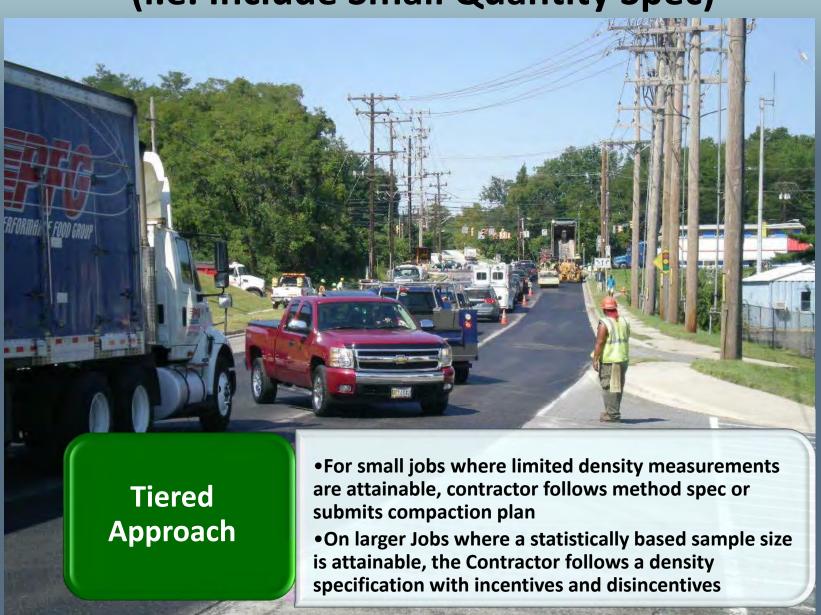
Method Spec

- One size fits All
- Agency assumes some Risk
- No Incentive for Innovation
- Requires On-site Oversight by Agency

Density Spec

- Allows Innovation for Contractor
- Balances Risk, Includes Incentives & Disincentives
- May have Triggers (i.e. Sealing/Overbanding
- Not Appropriate for Small Jobs

Tiered Approach to Spec (i.e. Include Small Quantity Spec)



Your opinion of each of the four specs shown on next slide?

Four Examples of Existing State L-Joint Specs with a Min. Density

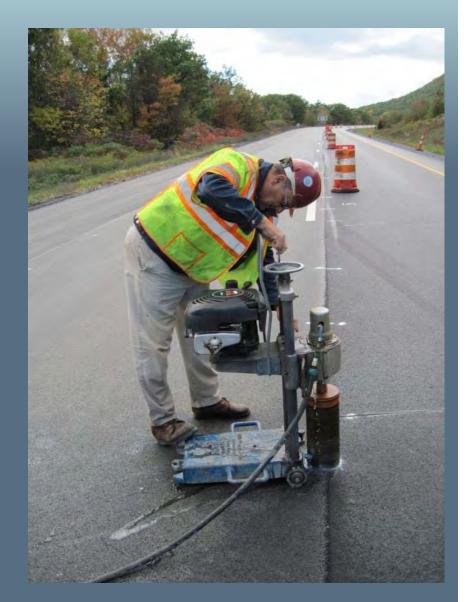
- ☐ State 1: Cores, test only the hot side, minimum 92% of G_{mm}
- ☐ State 2: Cores, directly on the joint, minimum 88% of G_{mm}
- ☐ State 3: Cores, centered on the wedge or over butt, min. of 89% of G_{mm}
- ☐ State 4: Gauge, cold side minimum 90% of G_{mm} hot side minimum 92% of G_{mm}

Many other variations being used

Quality Control and Acceptance of Joint Density



Density Gauge



6-inch Core

Proposed Acceptance Criteria for an LJ Density Spec

Six-inch Cores located either directly over visible joint for butt joint, or middle of wedge for wedge joint. This gives a 50/50 split, in order to average the G_{mm} of both lots.

- \geq 92% of G_{mm} : maximum bonus
- Between 92% and 90% of G_{mm}:
 100% pay, pro-rated bonus, need to "overband" or "surface seal" joint
- < 90% of G_{mm}: reduced payment, overband or surface seal joint

Recommended Core Locations

Vertical Joint

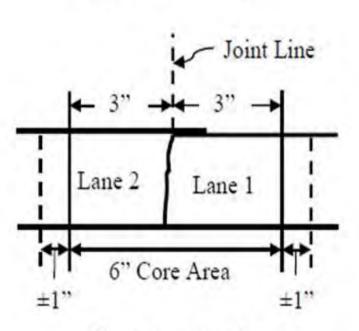


Figure not to scale

Notched Wedge Joint

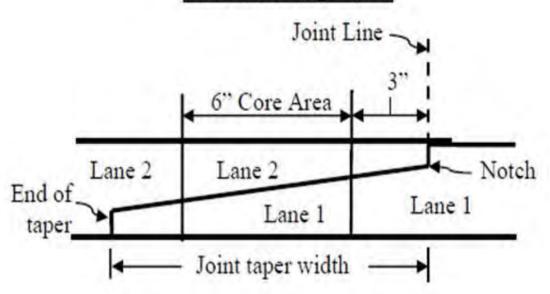
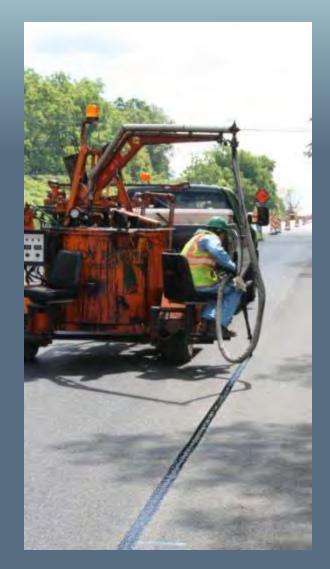


Figure not to scale

From PA DOT

"Overbanding" the L.J.

Frequently Done in AK and PA







"Surface sealing" covered later in Section 5, Other Options

Overbanding Considered Best Practice Around Perimeter of Patches



When Coring is Not Allowed, Use Density Gauges



- Same proposed density criteria
- Gauge set parallel to LJ, edge of gauge offset 2-inches from joint
 - Cannot seat properly directly over joint
- Avg. of 2 (or 4) 1-minute readings, rotating 180-degrees between each
- Gauge calibrated with correction factors based on comparisons with cores

Reference: Troxler and Dep, "Measurement of LJ Density Using Nuclear and Non-Nuclear Devices", Transp. Research Circular E-C105, Sep 2006

Key Steps in Implementing New LJ Spec

- Multi-year plan (versus all at once)
- Agency and industry work together
- Training (best practices, possible alternatives)
- Establish baseline of existing joint densities (randomly selecting projects to test)
- Make incremental changes (trying different techniques, products, or specs.)
- Evaluation Plan: measure densities to compare to baseline, monitor performance, etc.

Key Steps in Implementing New LJ Spec (Continued)

- If requiring a minimal density for first time, take incremental steps:
 - First year require "report only" (calculate any bonus/penalty without adding/subtracting dollars)
 - Second year can start bonuses and penalties
 - Gradually increase density requirement to reach 90%, or possibly higher as it can be shown to be accomplished on regular basis
 - Evaluate progress, comparing densities to baseline

LJ Initiatives in PA, CT, MI, ME



PA Story on Longitudinal Joint Density

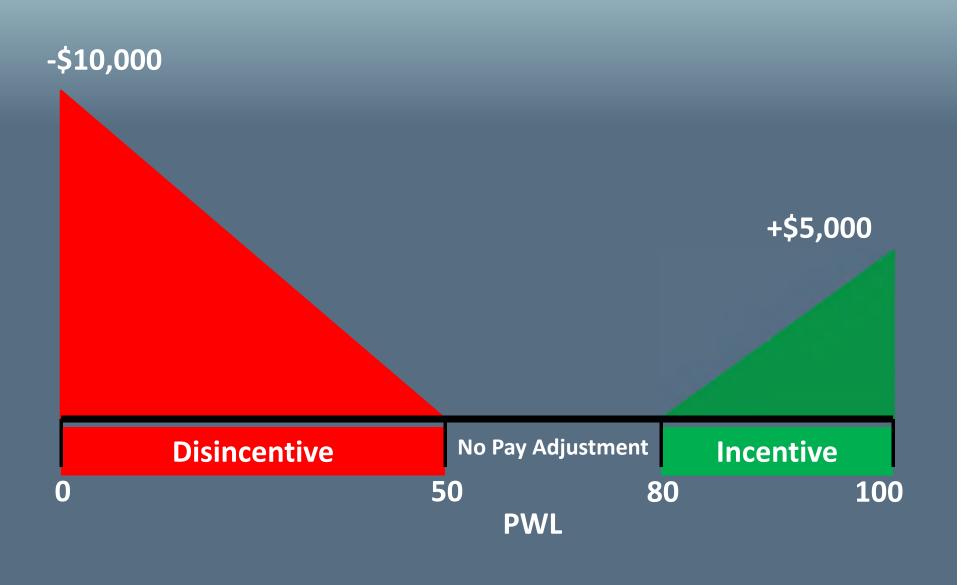
Article in NAPA's magazine, *Asphalt Pavement*, Sept/Oct 2012 http://www.nxtbook.com/nxtbooks/naylor/NAPS0512

- Increasing density was viewed as key
- 2007 began measuring joint density
- 2008 method spec. of best practices
- 2008 and 2009 continued gathering data on joints
- 2010 New joint density specification. Transition year with no bonuses or penalties.
- 2011-2014 bonuses and penalties on joint density

PA Joint Density Spec Highlights

- Both type of LJs allowed (butt or notch wedge)
- Joint Lot = 12,500'. Core every 2,500'. 5 cores per lot.
- Core location
 - For Butt: directly over visible joint
 - For Notch Wedge: middle of wedge
- Percent Within Limits (PWL)
 - Incentive starts at 80% PWL
 - Disincentive at <50% PWL
- Lower Specification Limit
 - o 2010-2013: 89% TMD
 - o 2014: 90% TMD
- Corrective action for < 88% TMD

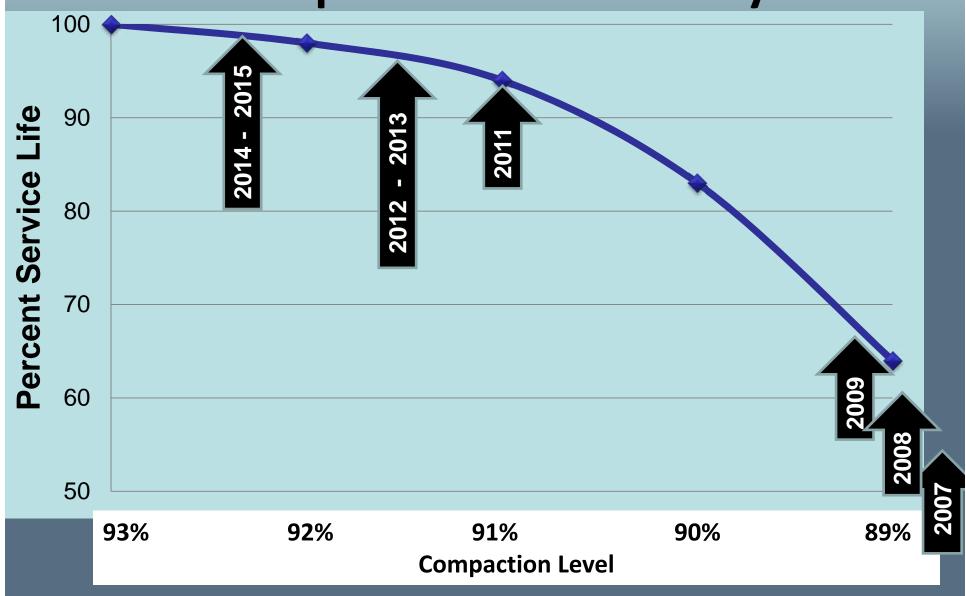
PA: Impact on Lot Payment Summary



In-place Density Summary, Reported by PA DOT

Year	# Lots	Avg. Roadway Density, %TMD	Avg. Joint Density, %TMD	Criteria		
2007	18	93.9	87.8	begin measuring at Jt.		
2008	43	94.1	88.9	method spec		
2009	29	94.1	89.2	method spec		
2010	No data, transition to PWL spec					
2011	137	94.1	91.0	PWL, LSL 89%		
2012	162	94.0	91.6	PWL, LSL 89%		
2013	167	93.9	91.4	PWL, LSL 89%		
2014	316	94.1	92.3	PWL, LSL 90%		
2015	493		92.6	PWL, LSL 90%		

PA: Increased Projected Life of Joints Due to Improved Joint Density



PA: Annual Statewide Totals on Incentives/Disincentives for Joint Density

Year	Incentive Payments	Disincentive Payments
2011	\$268K	\$99K
2012	\$489K	\$63K
2013	\$588K	\$25K
2014	\$1,002K	\$127K



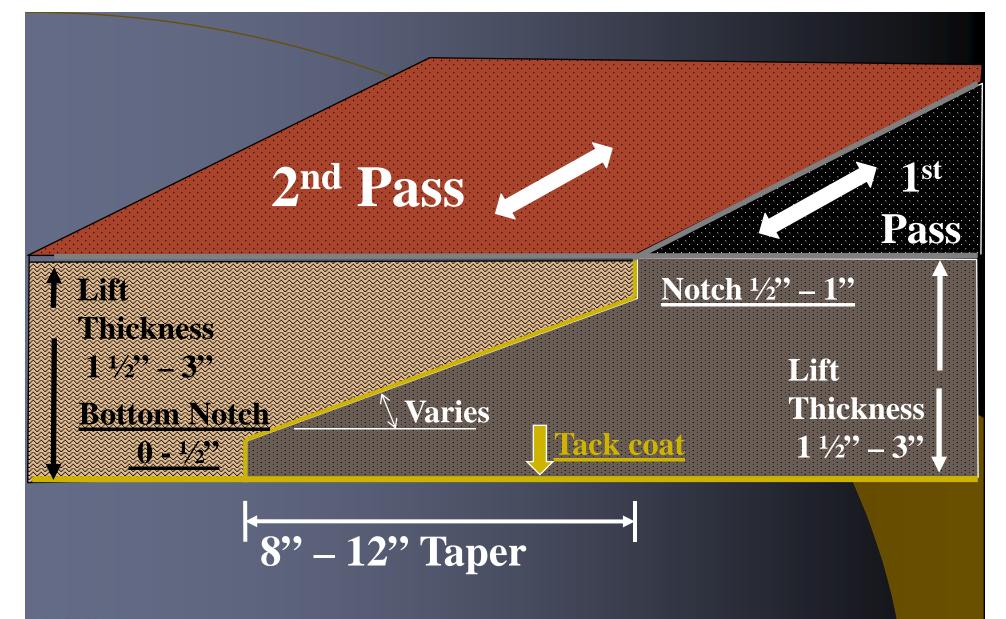
PA: Corrective Action

- Lots with avg. density <88%
 G_{mm} require corrective action
- Contractor must seal the joint with PG 64-22 at no cost to Department
- 10 lots (out of 137) required corrective action in 2011



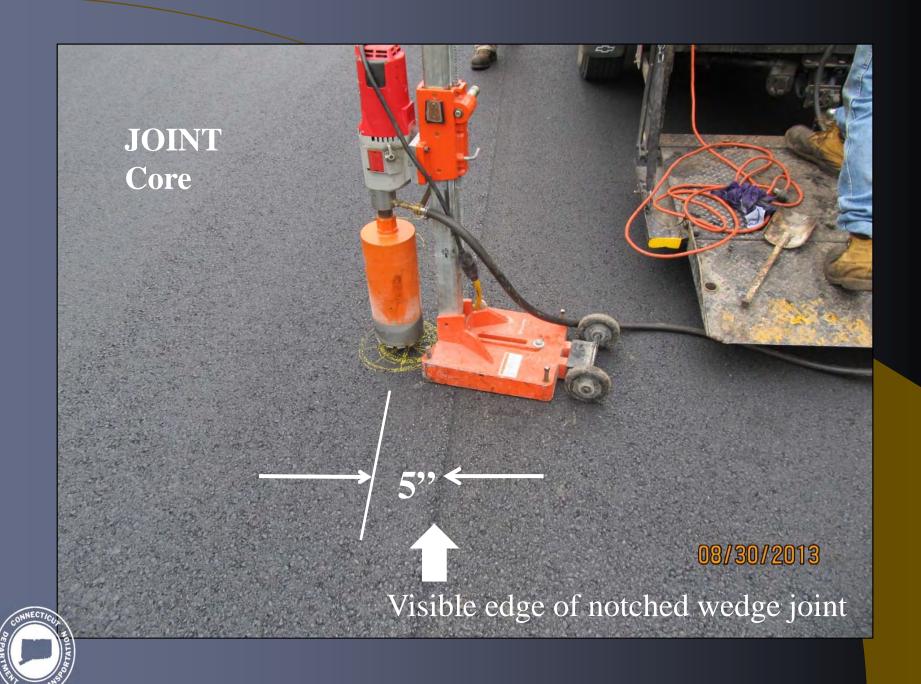
Connecticut Joint Density Spec

- Prior to 2011, acceptance from gauges only
 - Tested joints only on hot side of joint
 - Require notch-wedge joints (12:1 to 8:1)
- In 2011, moved to cores
 - 92% min average required in mat
 - 91% min average required over joint
 - Requirement only for surface lifts
 - -typically 2" lifts of 12.5 SP mix
 - Cores taken over middle of wedge





Notched Wedge Joint



CT DOT Average In-Place Lot Density

Roadway (Non-Bridge)

Year	Mat	Joint			
	(Rqd. Min. of 92%)	(Rqd. Min. of 91%)			
Prior to 2010	Prior to 2010: Acceptance from gauges				
2011	92.6%	91.6%			
2012	93.0%	91.4%			
2013	93.1%	91.8%			
2014	93.1%	91.5%			

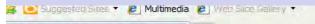
Pay Adjustments for Joint Density

- \gt 100% Pay for 91 92% (29% of lots in 2014)
- Bonus for >92% (31% of lots in 2014)
- Penalty for <91% (40% of lots in 2014)</p>

MI DOT Joint Densities

- 6" cores directly over visible joint
- Type of joint (butt vs wedge) is contractor's option
 - 1 core per 2,000 ft, 10,000 ft per section
- Bonus/penalty based on averages (bonus ≥ 90.5% > penalty)
- Now a Frequently Used Special Provision for base and surface
 - 2009: Average 89.8% (informational only)
 - 2011: Avg. 90.7% (pilot)
 - 2012: Avg. 91.6% (FUSP)
 - 53% sections received bonus (Avg > 91.5%)
 - 20% sections received penalty (Avg < 90.5%)
 - 27% sections no adjustment (90.5 < Avg < 91.5%)
 - 2013: Avg. 92.4% (FUSP)
 - Bonus/penalty breakout unavailable

MI's 2014 Quality Adjustments and Action Reqmts. for LJs



state.mi.us/public/dessssp/spss_source...

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|--|

Density Range	Incentive/Negative Quality Adjustment	Dollar Value	Action Required
90.50% ≥ 93.50%	Incentive	\$0.00/foot - \$1.00/foot (max.) EQ. 1	N/A
88.00% - 90.49%	Negative Quality Adjustment	\$0.83/foot - \$0.00/foot EQ. 1	Stop production if below 89.00%
86.00% - 87.99%	Negative Quality Adjustment	\$9.00/foot - \$0.84/foot EQ. 2	All joints saw or route and sealed
< 86.00%			Full lane width removal plus 6 inches past the longitudinal joint(s)

LEVELING AND BASE COURSE QUALITY ADJUSTMENT

Density Range	Incentive/Negative Quality Adjustment	Dollar Value	Action Required
90.50% ≥ 93.50%	Incentive	\$0.00/foot - \$1.00/foot (max.) EQ. 1	N/A
88.00% - 90.49%	Negative Quality Adjustment	\$0.83/foot - \$0.00/foot EQ. 1	Stop production if below 89.00%
86.00% - 87.99%	Negative Quality Adjustment	\$4.00/foot (max.) - \$0.84/foot EQ 2	N/A
< 86.00%			Remove 30 inches centered on the joint with saw cutting with double tack coat of vertical faces.

Maine's "New" Method Spec Approach to L-joints Will Be Covered Later

 Includes several innovative techniques that we haven't covered yet

Several ways to approach the challenge of L-joint performance



Questions?

Break Time





SECTION 4

Constructing a Quality Longitudinal Joint

- Types of LJs
- Planning for the Joint
- Paving Best Practices (sequentially)

This study showed there is no consensus on the best technique for all aspects of longitudinal joint construction. It also showed that with attention to detail, we can produce good joints with differing techniques.

Management



3x Sheldon Hayes Awards

Quality Control



Paving Crew

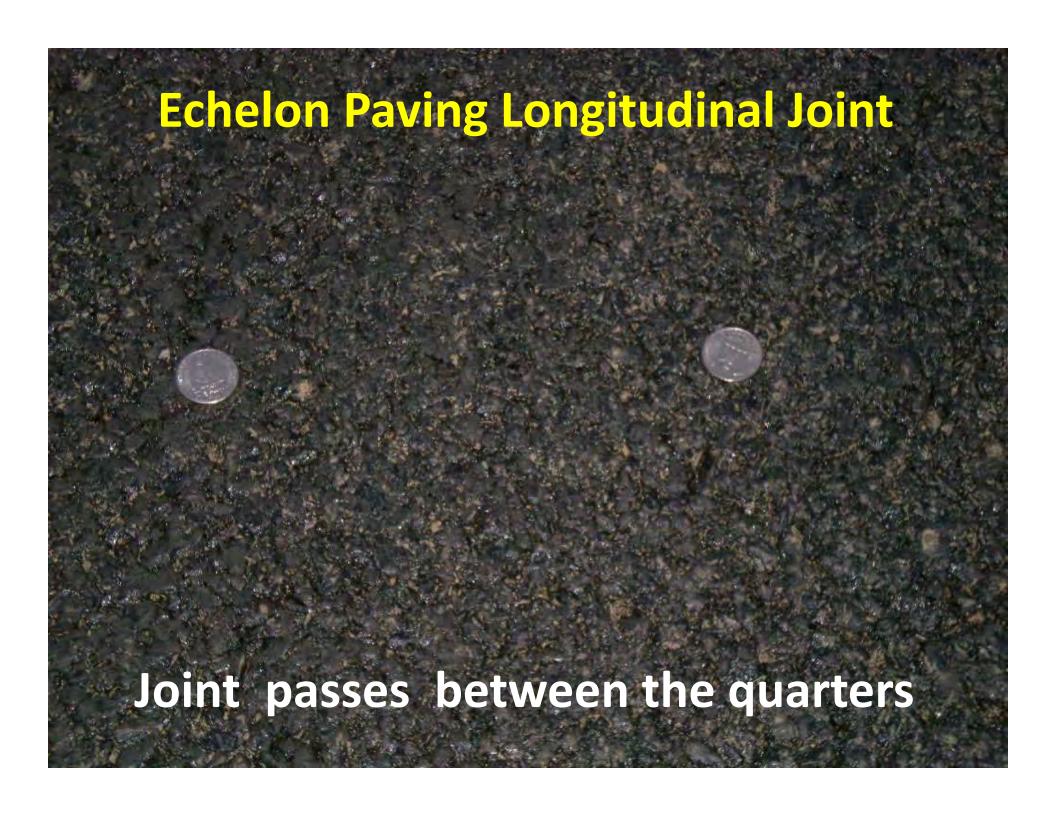


"We've built a culture that everyone in our company buys into," says Vince Tutino, president of Lindy Paving. "And that culture is quality in asphalt pavements. The whole company is continually working to improve what they do toward the goal of quality and excellent riding pavements.

"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."







Echelon paving limits the number of cold joints



Garth Bridenbaugh photo

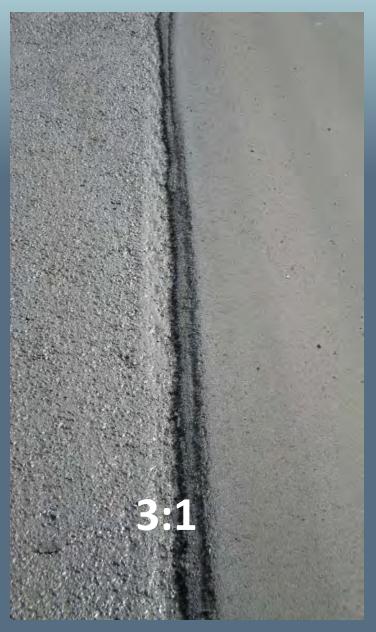


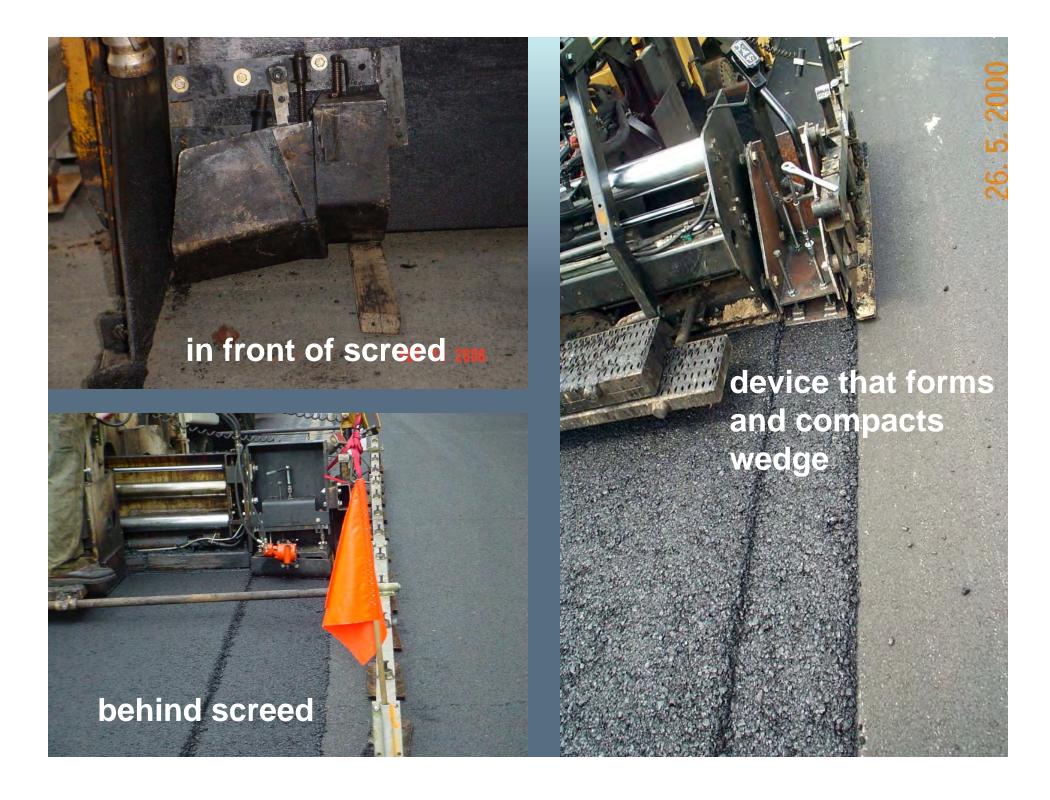
Preferred Joint Type? Experts Evenly Divided.



Wedge Joints







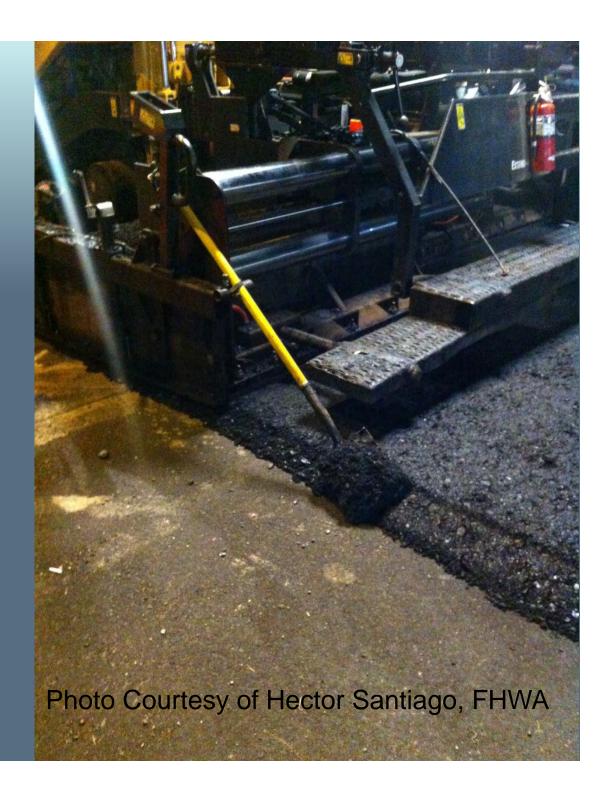


Unacceptable Notched Wedge Joint Construction



Improved Version 2.0?

Another example of how NOT to form a notched wedge joint





Average Joint Densities from PA DOT for Entire Paving Season

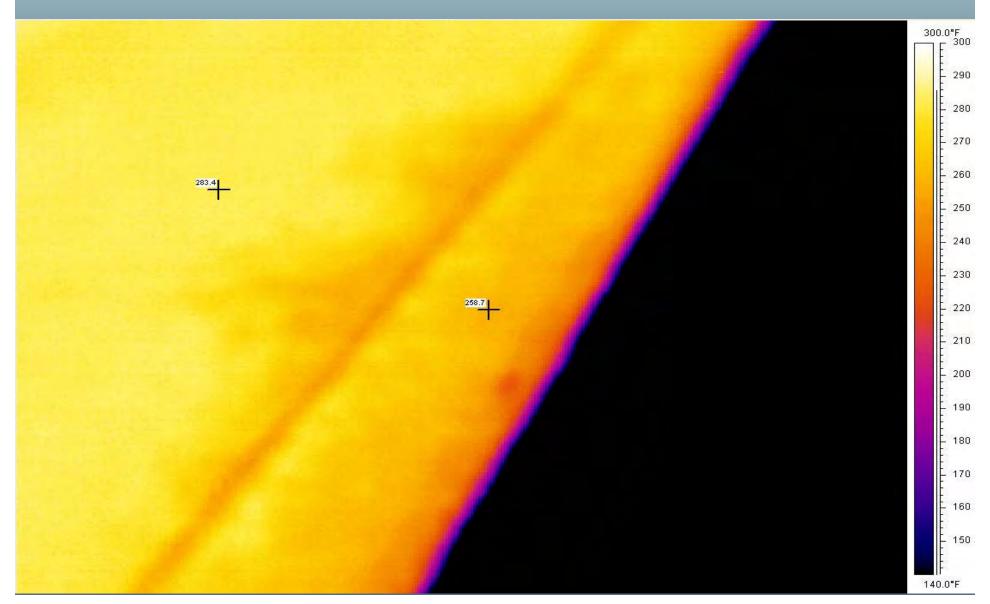
	2011	2012	2013
Notched Wedge	91.7%	91.7%	"mostly notched
Butt (vertical)	90.3%	90.7%	wedge joints"

Wedge Joints and Compactors



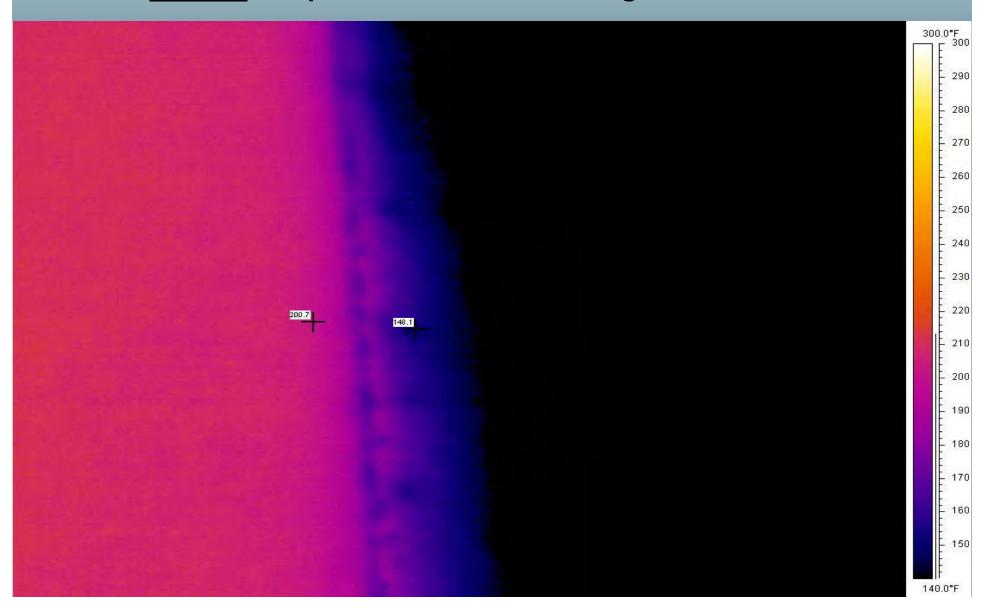
Thermal Image of 2" mat with wedge joint in CT (foamed 76-22 PMA).

- 25-30 feet behind paver, no rollers yet.
- <u>Surface</u> Temp of mat is 283F, but wedge has cooled to 258F.



Same project and same night of paving.

- After break down roller has made its first coverage.
- <u>Surface</u> Temp of mat is 200F, but wedge has cooled to 148F.



Adequate Lift Thickness is Critical to Compaction!

- For both the mat and the joint
- Minimum lift thickness criteria accepted by industry:
 - > 4 x NMAS if "coarse gradation" (below MDL)
 - > 3 x NMAS if "fine gradation" (above MDL)

Plan for Longitudinal Joints...

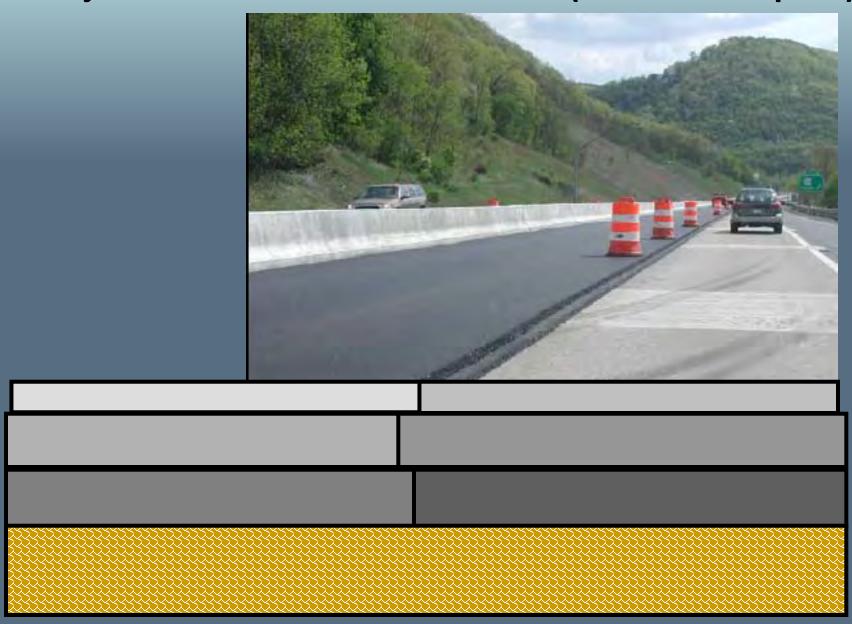
(i.e. Discuss During Pre-Con Meeting)

- Joint Type
- Layout Plan of Final Lift showing joints (DelDOT)
 - Recognize 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)

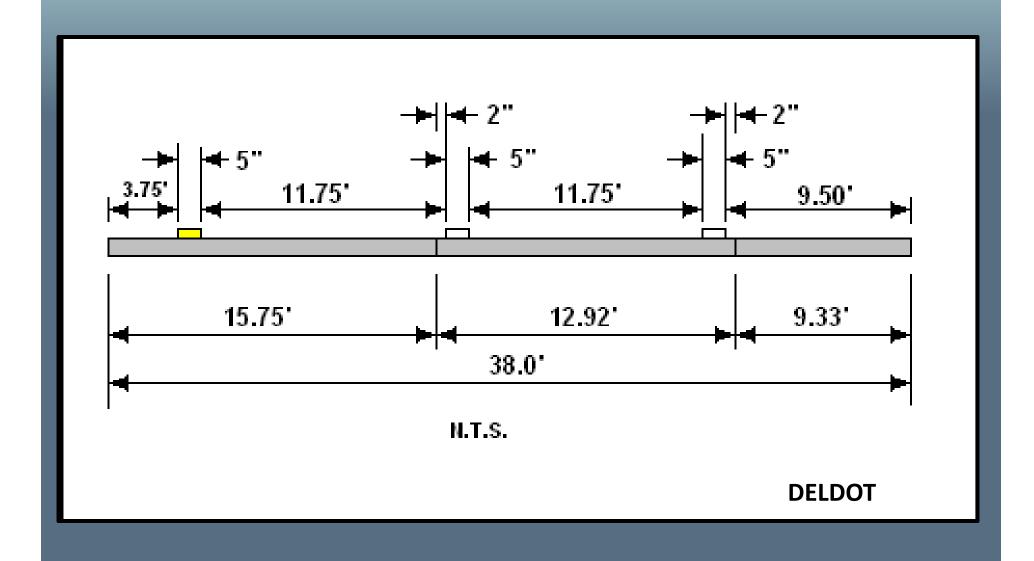




Offset joints between layers by at least 6-inches; surface joint should be near centerline (not in wheelpath)



Final Lift Joint Layout Plan



Avoid Placing the Joint Where Striping Will Go

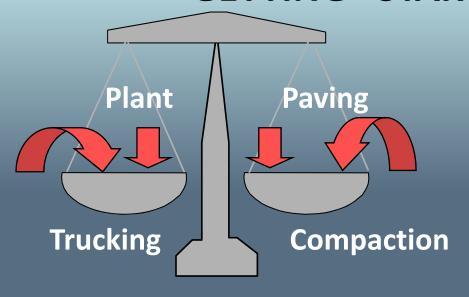


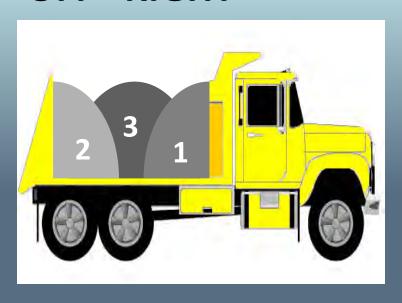
DELDOT

Which Can Eventually Result In This



GETTING STARTED OFF RIGHT











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



Stringline for reference, and/or Skip Paint, Guide for following







Paver operator using the curb as his reference

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







Use Automatic Grade Control (Versus Manual)

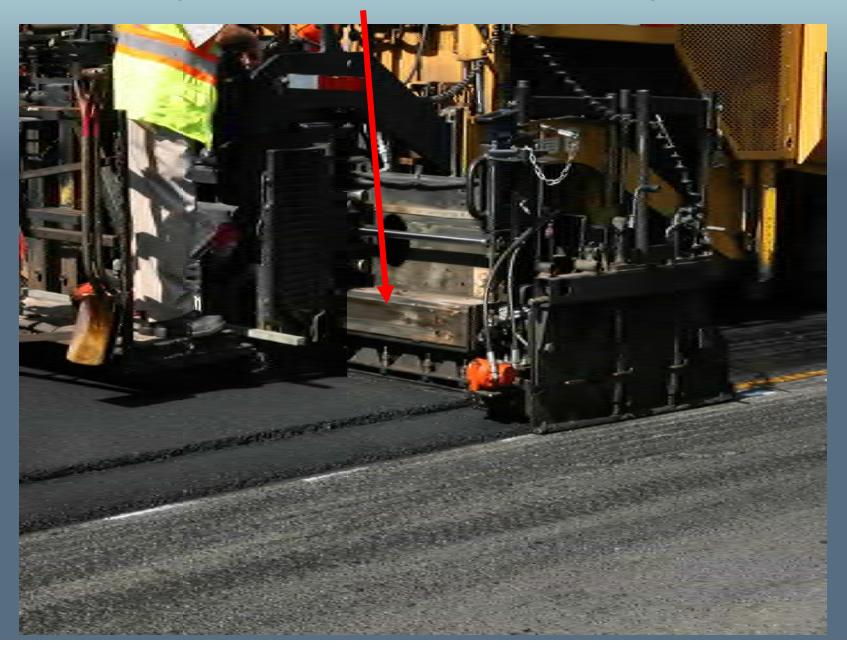




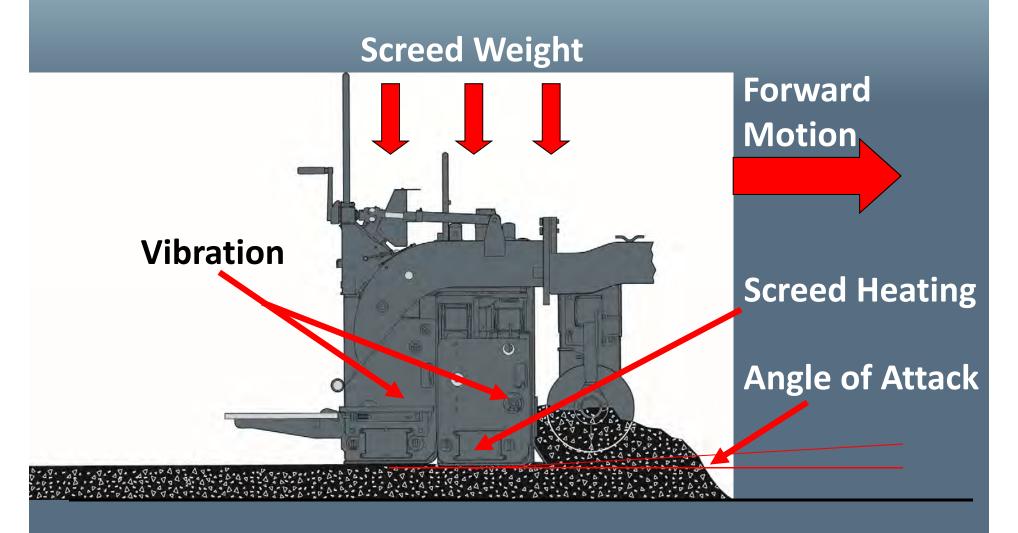
Don't Rely on Manual Windmill Johnny

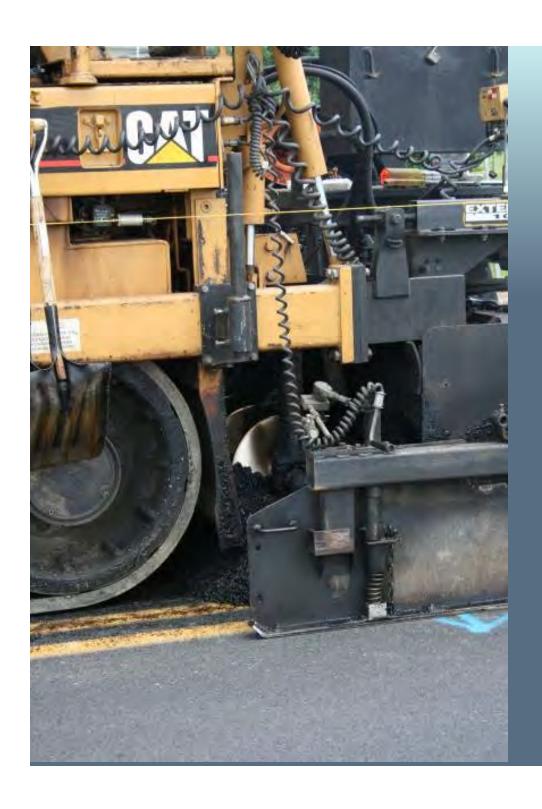


Vibratory Screed Should Always Be On



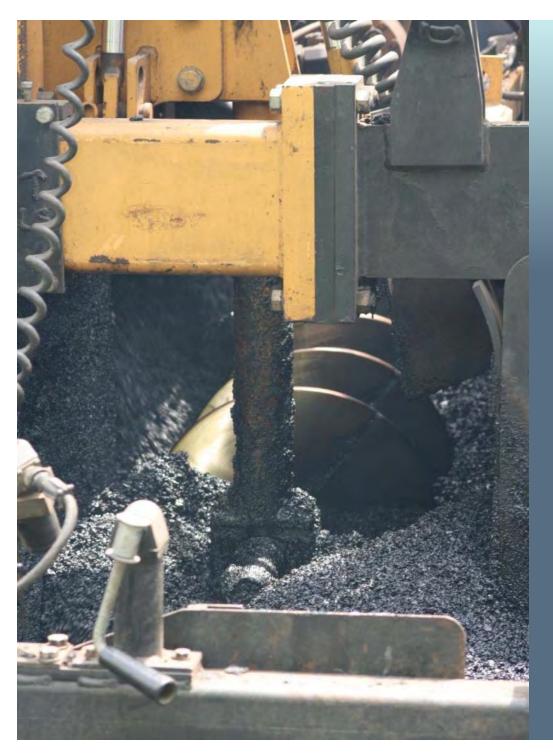
To allow material to flow around bull-nose of screed and to achieve pre-compaction





END GATE

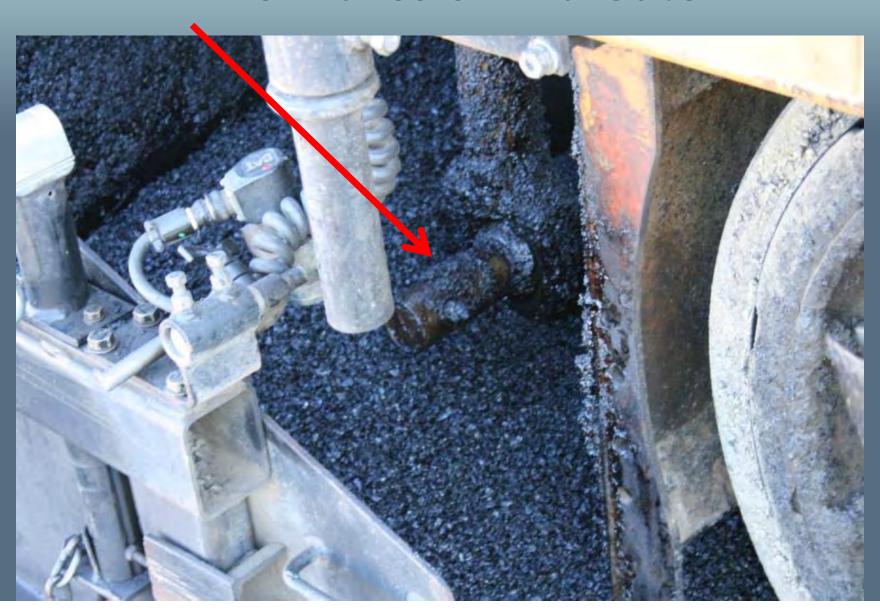
Seated Flat on the Existing Surface



Uniform Head of Material

Maintained Across
Width of Auger

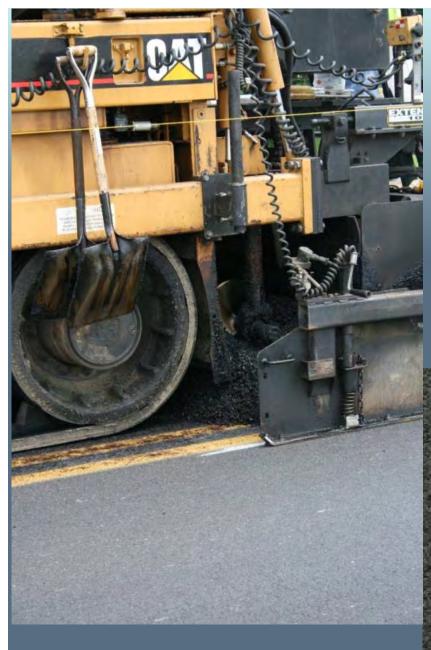
Extend Augers to Within 12-18 inches of End Gate



Extend Tunnels the Same Distance

To control material flow at outer edges of screed and deliver homogenous HMA at joint

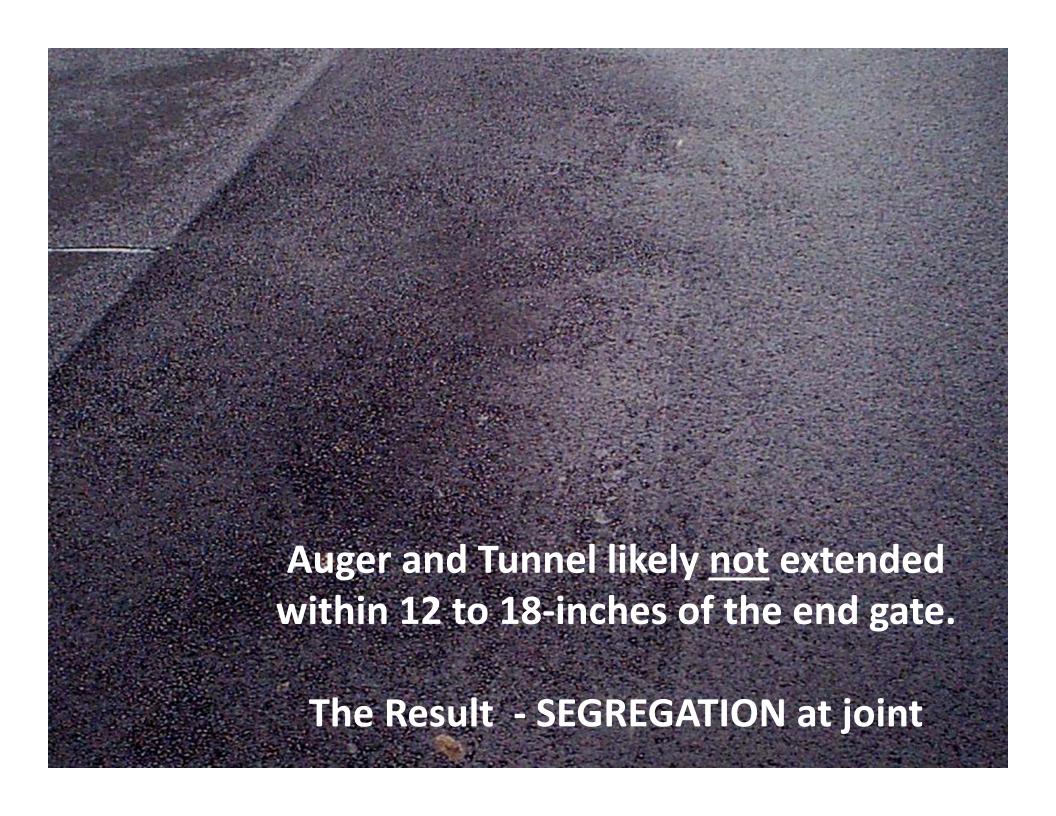




Example of uniform head of HMA with auger and tunnel properly extended providing non-segregated mix at joint





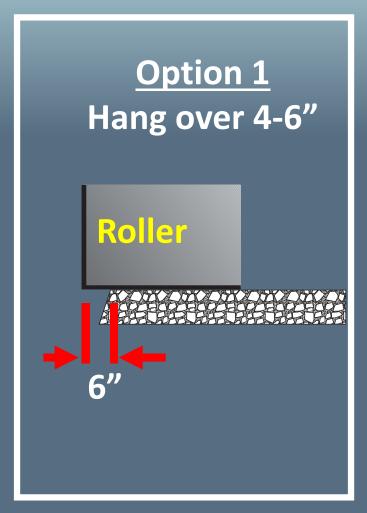


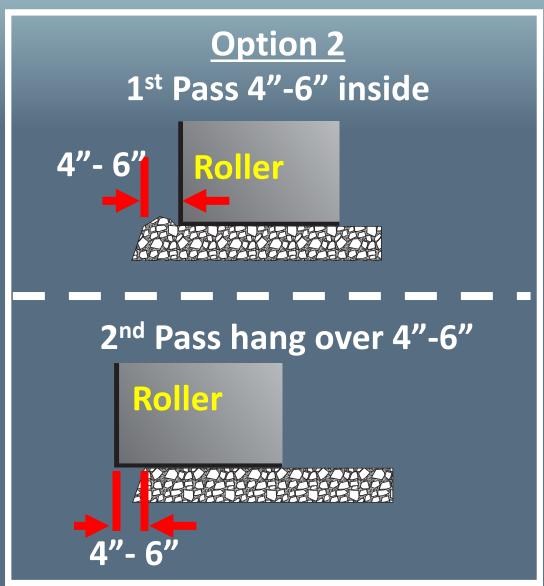
Rollers Need to Be Kept Close to the Paver



Best Way to Roll a Joint

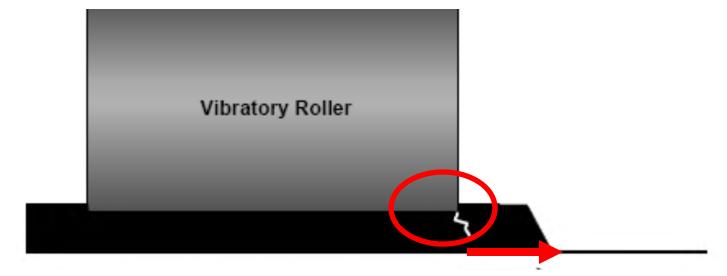
Rolling Unconfined Side? 50-50 on Where to Put 1st Pass





What We Don't Want





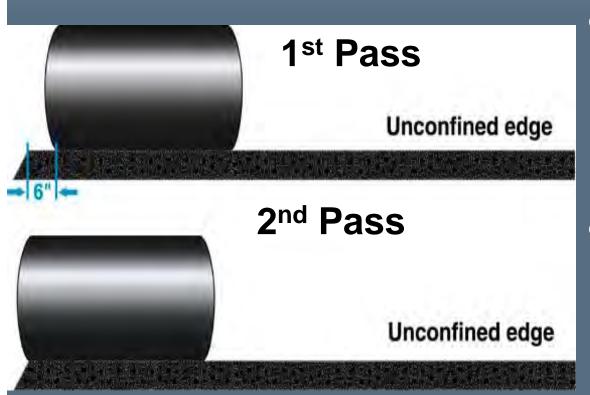
If edge of drum is located just inside the unsupported edge, a stress crack can occur here.

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



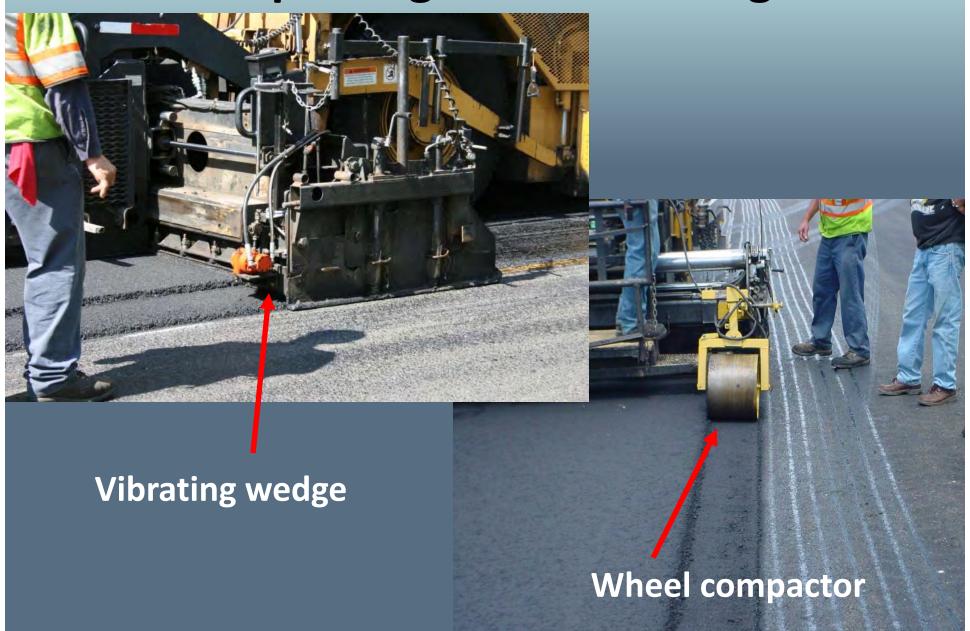
- Concern:
 - developing stress crack?
- Merit:
 - -minimize lateral movement?

Do Not Roll Directly on Edge

Note the mix breaking over at the unsupported edge. This illustrates why rolling directly on the edge is not desirable.



Compacting Notched Wedge

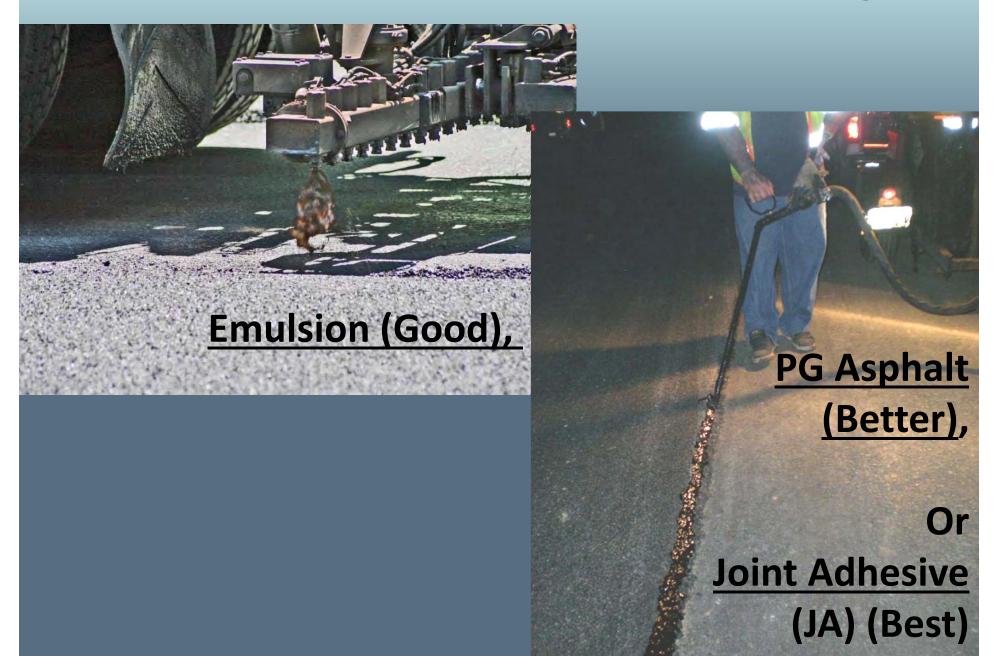


Quality Control: Monitor Joint Density





Paint the Side of Joint (Butt or Wedge)



When Closing Joint, Set Paver Automation to Never Starve the Joint of Material

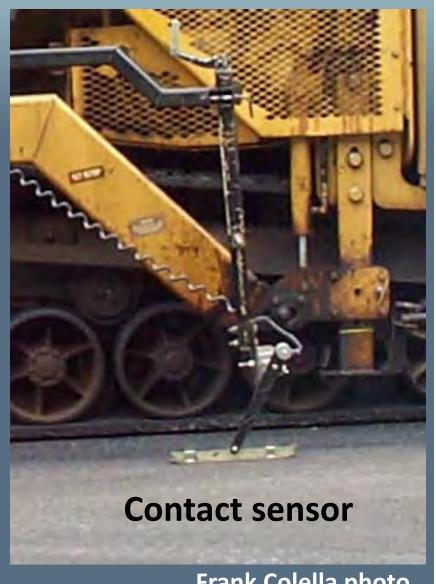
- Target final height difference of +0.1" on hot-side versus cold side
 - NH spec requires 1/8" higher
- Joint Matcher (versus Ski) is best option to ensure placing exact amount of material needed
- If hot-side is starved, roller drum will "bridge" onto cold mat and no further densification occurs at joint



Types of Joint Matchers



G. Bridenbaugh photo



Frank Colella photo



More Joint Matchers

Optimum sensor location:

- Just behind tractor and several feet in front of auger.

Contact Grade Sensor

Ultrasonic Grade Sensor

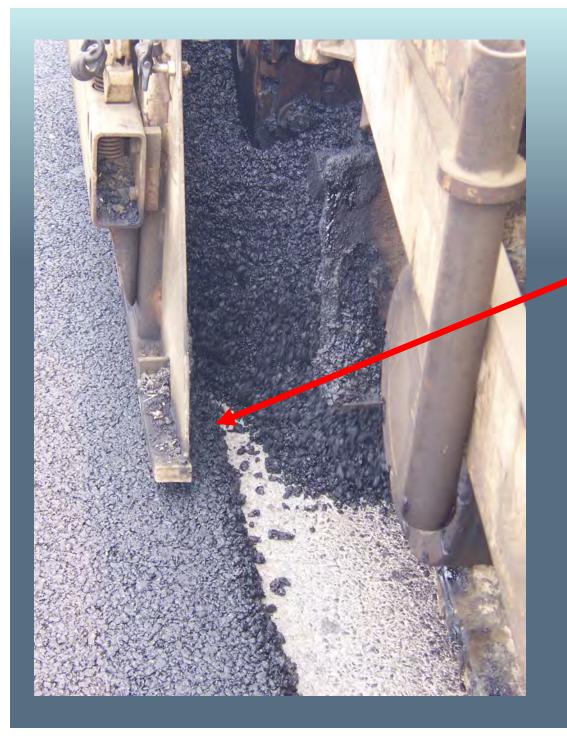


Ski Best for Smoothness

(reference is average over length of ski)



Versus Joint Matcher, which is best for joint (reference is exact location just in front of auger) Note: If underlying pavement already smooth, some contractors feel they can get good joint with ski, but must finish 1/10" high



Proper Overlap:

- 1.0 <u>+</u> 0.5 inches
- Exception:
 Milled or sawed
 joint should be
 0.5 inches

All Photos show Bottom of Lift (Note voids in top two from no overlap)



Core #2 (No Overlap)



Core #7 (No Overlap)

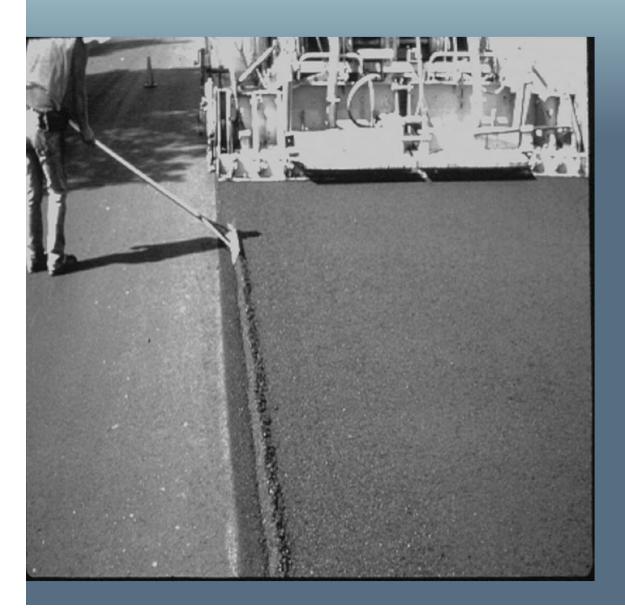


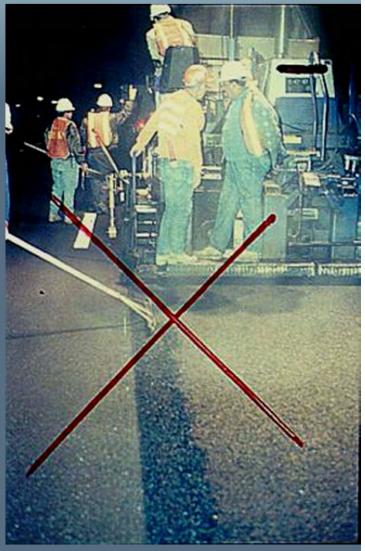
Core #9 (Overlap 1 1/2")



Core #10 (Overlap 1 ½")

Bumping the Joint?





Do NOT Rake Across the Joint



Don't broadcast material across the mat



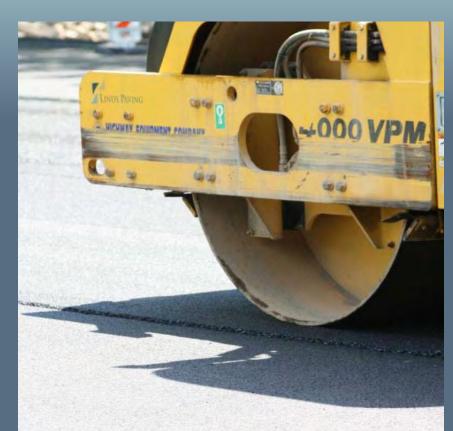




No lute person



Rolling the Supported Edge Our Recommendation:



1st pass all on hot mat with roller edge off joint approx 6-12 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 on hot side at joint, then bridging occurs with first pass (roller supported by cold mat)

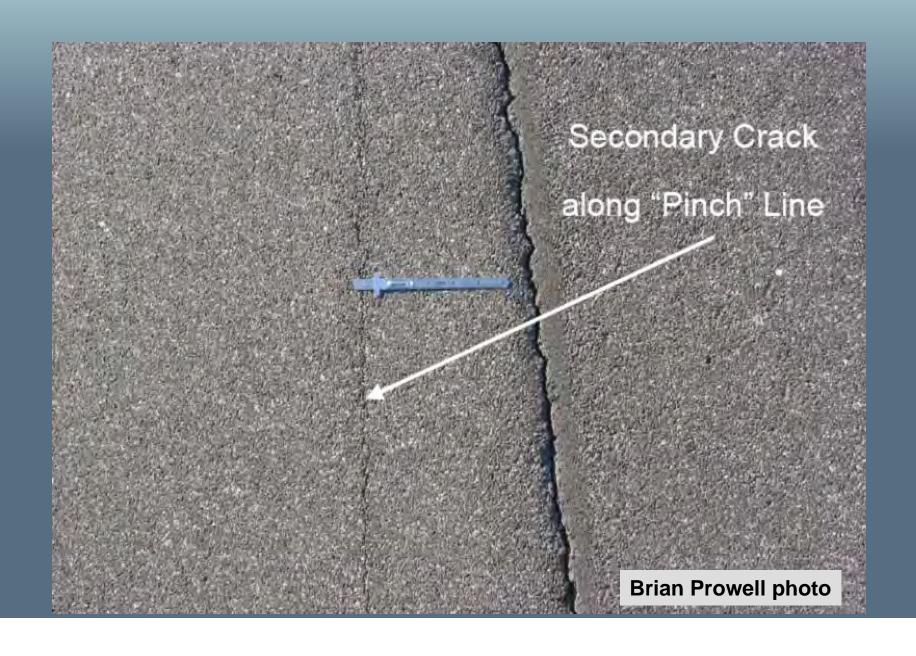
With Recommended Method, Still Must Watch for Stress Cracks

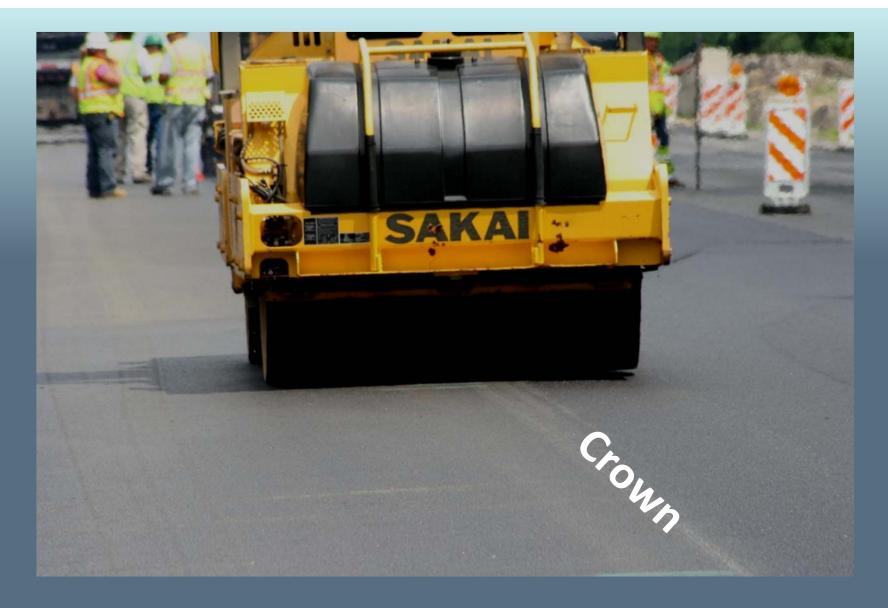


During Site Visit to CO, Staying off 6" on 1st Pass

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

Potential Problem with Hot Side "Pinch"



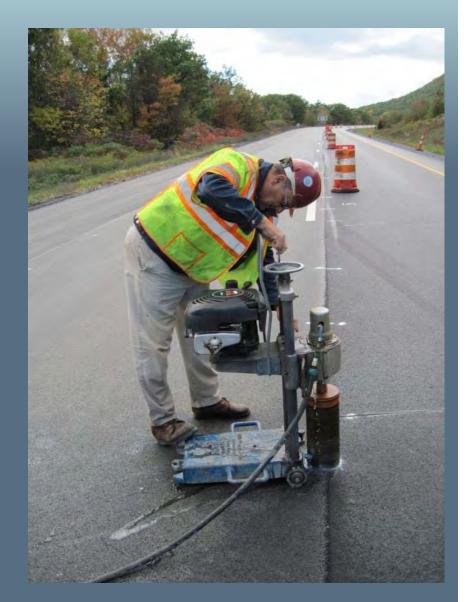


The final pass on a crowned section

Quality Control and Acceptance of Joint Density



Density Gauge



6-inch Core

Questions?

Break Time

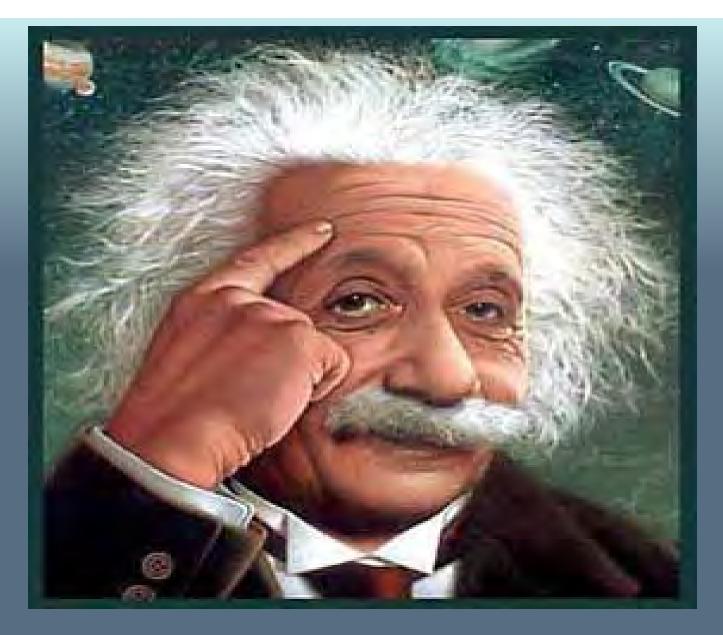




SECTION 5

Other Options / New Products

- Mill & Pave One Lane at a Time
- Cut Back joint
- Joint Heaters
- Joint Adhesives (hot rubberized asphalt)
- Surface Seals Over Joint
- Longitudinal Joint Seal (LJS) / VRAM
- Rubber Tire Rollers
- WMA, IC, IR Bar



"We can't solve problems by using the same kind of thinking we used when we created them"

Mill & Pave One Lane at a Time

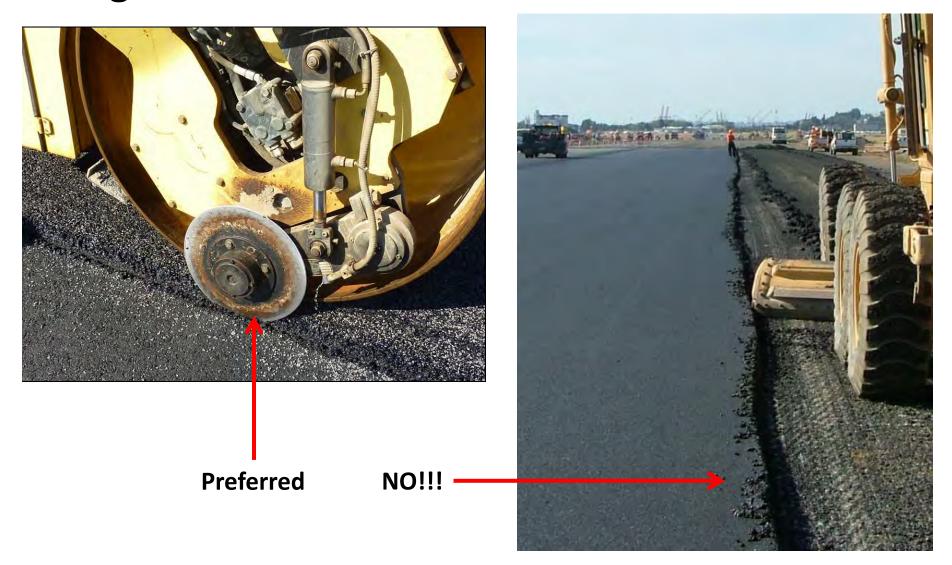








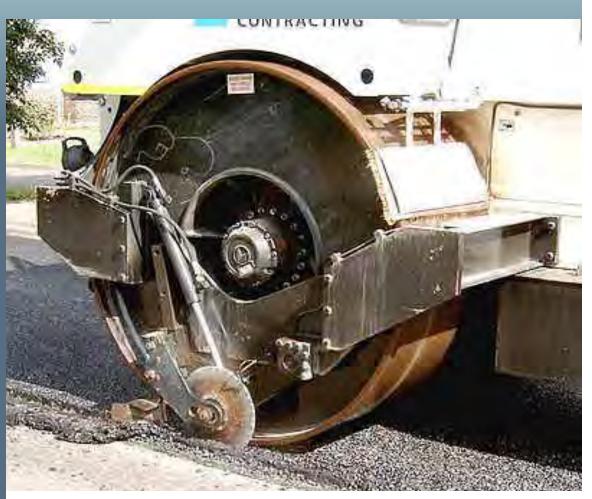
Longitudinal Joint Construction





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 <u>and</u> painting not done on open mixes



http://www.highwaysmaintenance.com/kraktext.htm

Infrared Joint Heaters

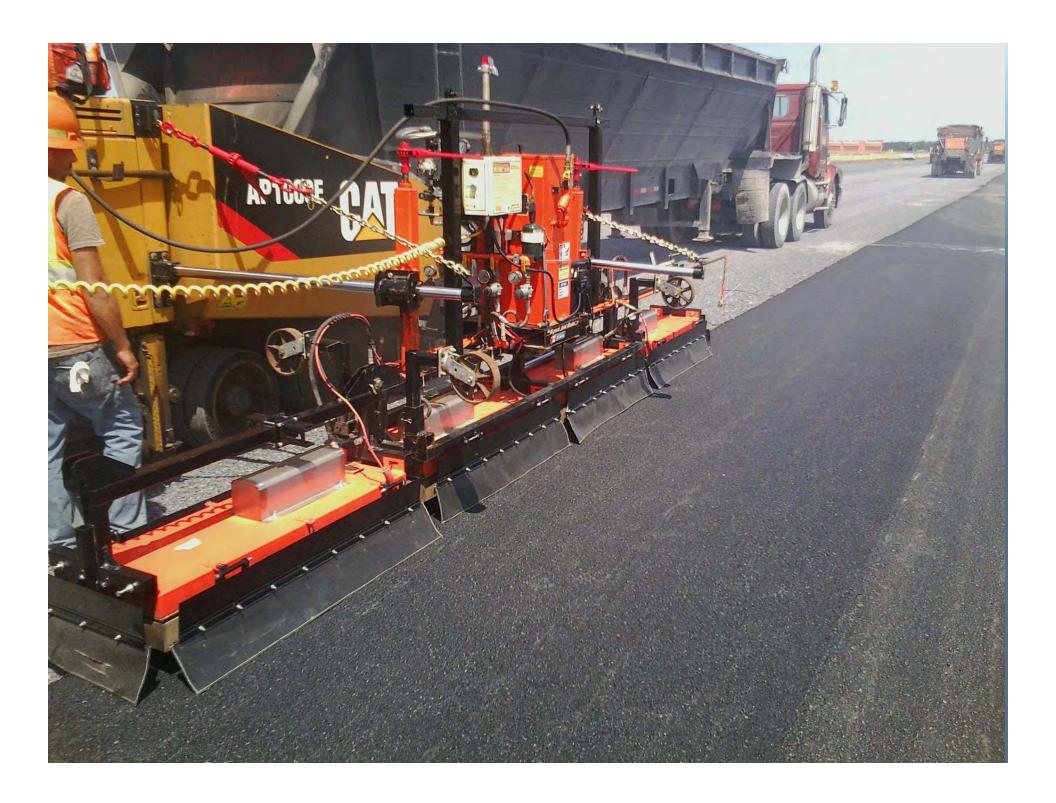














Post-applied LJ Surface Sealers

"Rejuvenator" Types

(dries clear, no restriping)

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

Advertised to dry fast, not reduce skid resistance

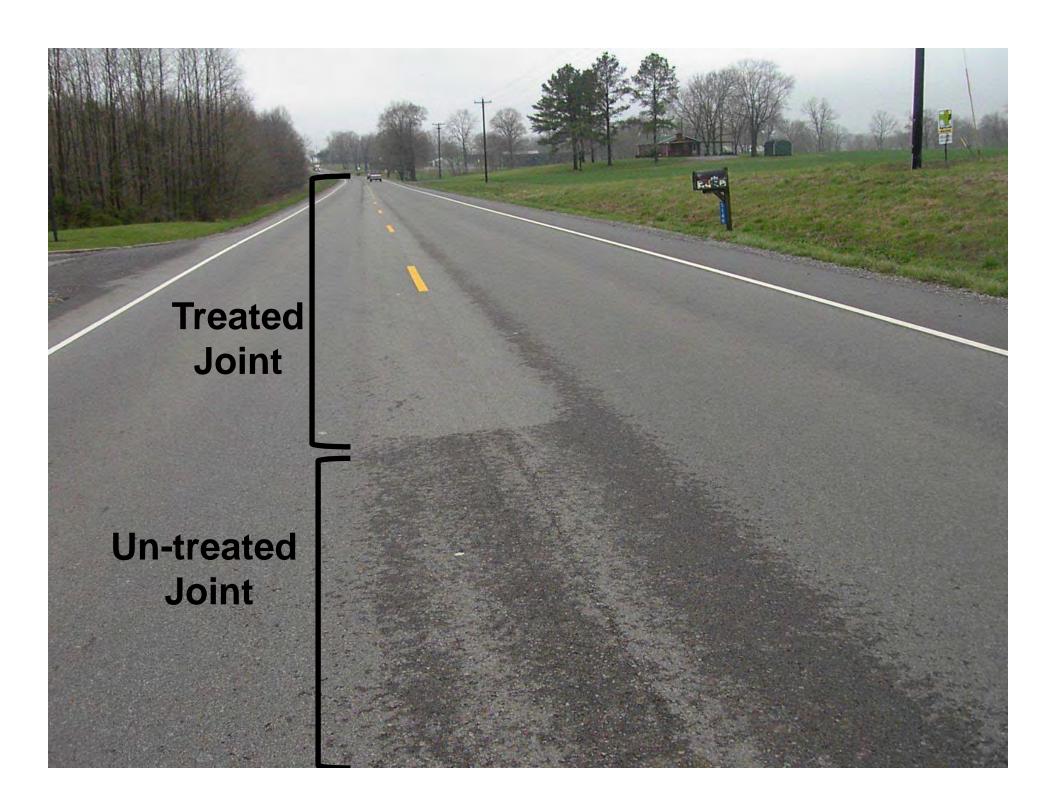
Asphalt-based Types

(require restriping)

- Slow set emulsions (fog)
 - Skid?
- Other spray seal productsw/ angular sand







Micro-surfacing 15" wide over LJ I-64 WB in IL for 25 miles, Aug'14



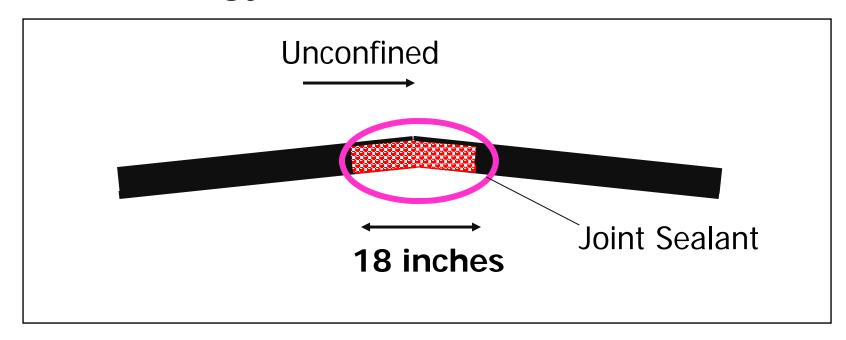
Fog Seal over LJ on I-64 in IN



Photo taken about a year after paving. INDOT uses this technique.

Longitudinal Joint Sealant (LJS) **Concept - IL DOT**

- Hot applied, highly polymer modified binder Band melts up into the joint, thus:
- - Increasing density
 - Decreasing permeability
 - Increasing joint life



How can LJS be applied?





How can LJS be applied?



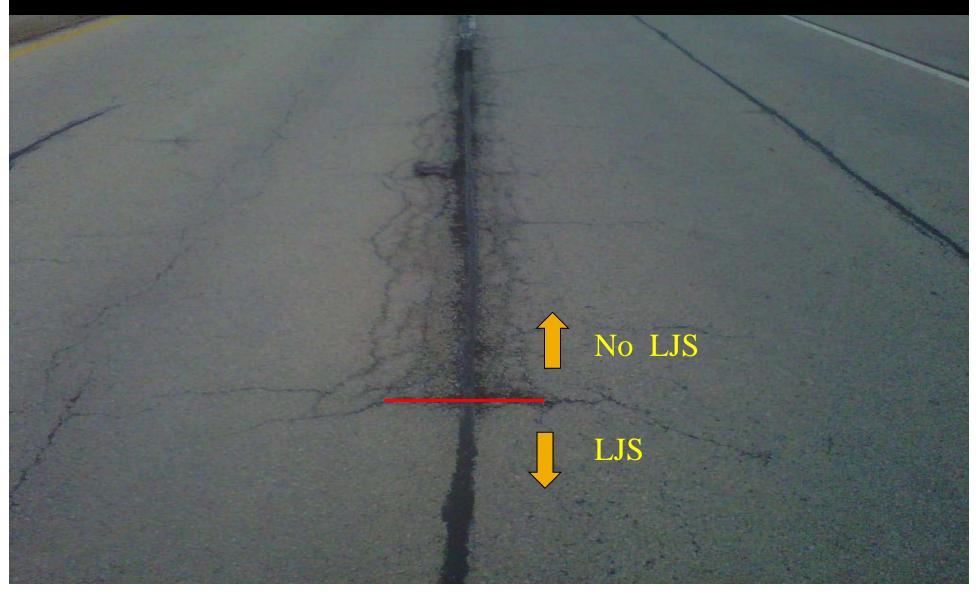
Hot Asphalt Distributor with Modified Spray Bar

LJS is also called Void Reducing Asphalt Membrane (VRAM) by HRG

Features

- During construction
 - Upward migration
 - Non-tracking
 - Resist Flow
- Imparts crack resistance at joint
- Reduces water and air permeability
- Bonds to existing pavement

Longitudinal Joint Seal, 12 Yrs Later US Decatur, IL



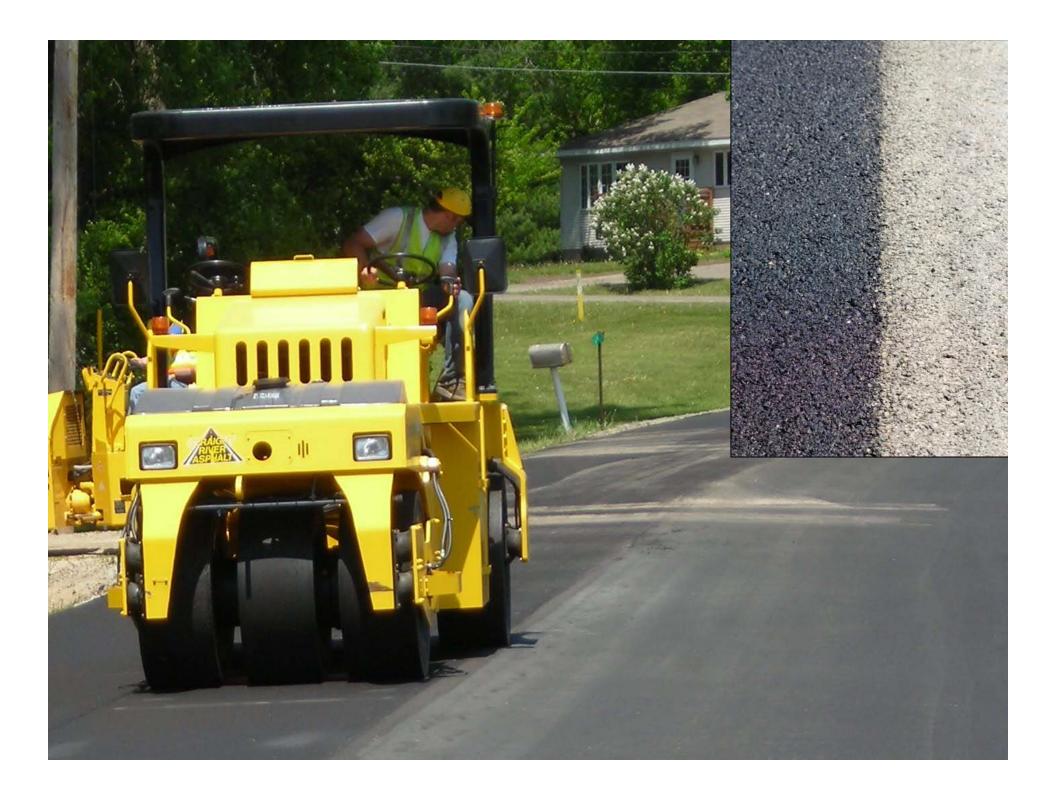
Cost Comparison, IL DOT 2016

- Inlay: \$8.00 / lineal ft
 - Includes: traffic control, mobilization, milling, priming, paving, pavement marking
- Microsurfacing: \$4.81 / lineal ft
 - Includes: crack seal, traffic control, pavement marking/removal
- Route and Seal: \$2.00 / lineal ft
 - Includes: prime, crack seal, traffic control
- Longitudinal Joint Seal: \$2.00 lineal ft

Pneumatic Rubber Tired Rollers

- Many experts believe kneading action helps in providing a tighter surface that is more dense and less permeable compared to 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.



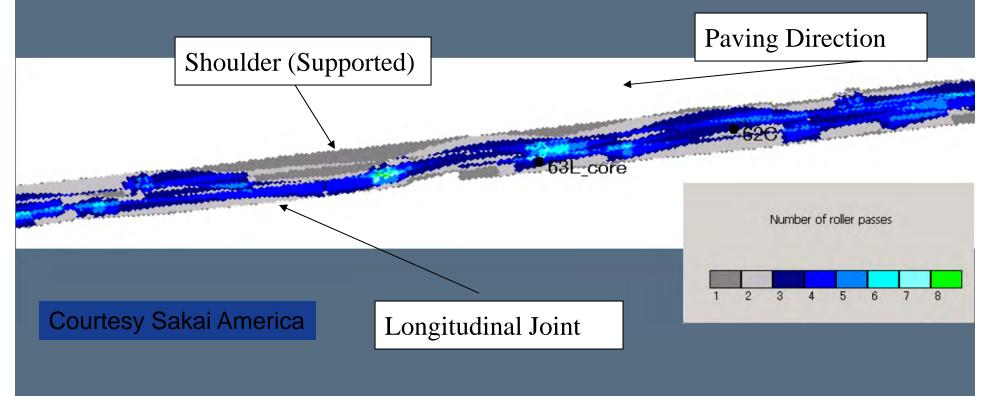


WMA as Compaction Aid



Intelligent Compaction Mapping Feature





Example of Using LCCA to Evaluate Cost Effectiveness of Any New Alternative

Base Mix 10.0-inches \$58.00 / ton

Binder Mix 2.5-inches \$72.72 / ton

Surface Mix 2.0-inches \$72.72/ ton

Mill & Fill Joint \$ 5.25 / sf – inch

Joint Adhesive (JA) \$ 0.30 / If

Looking for Alternative with Lowest NPV

Alternative

Net Present Value

10-Year Overlay Cycle w/o JA

11-Year Overlay Cycle w/JA

\$ 788,608

\$ 790,887

Break Even

12-Year Overlay Cycle w/JA

\$ 786,652

15-Year Overlay Cycle w/ Milling Joint @Year10

\$ 806,361

Let's Review

Show video

Construction Best Practices



Agency Considerations

Construction Best Practices



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."



Contractor's Prior Planning

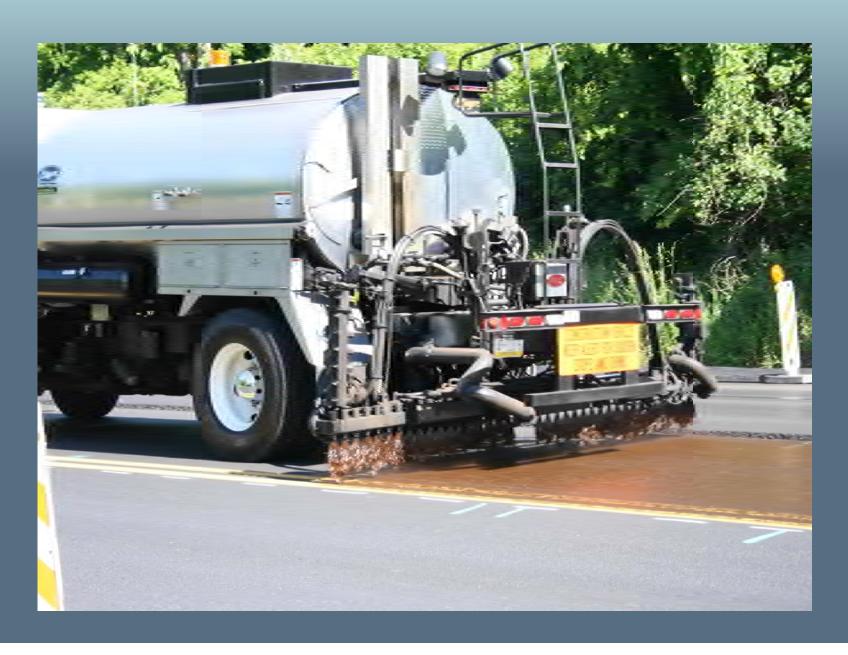
Consideration given to mix selection

Plan joint offsets when multiple lifts

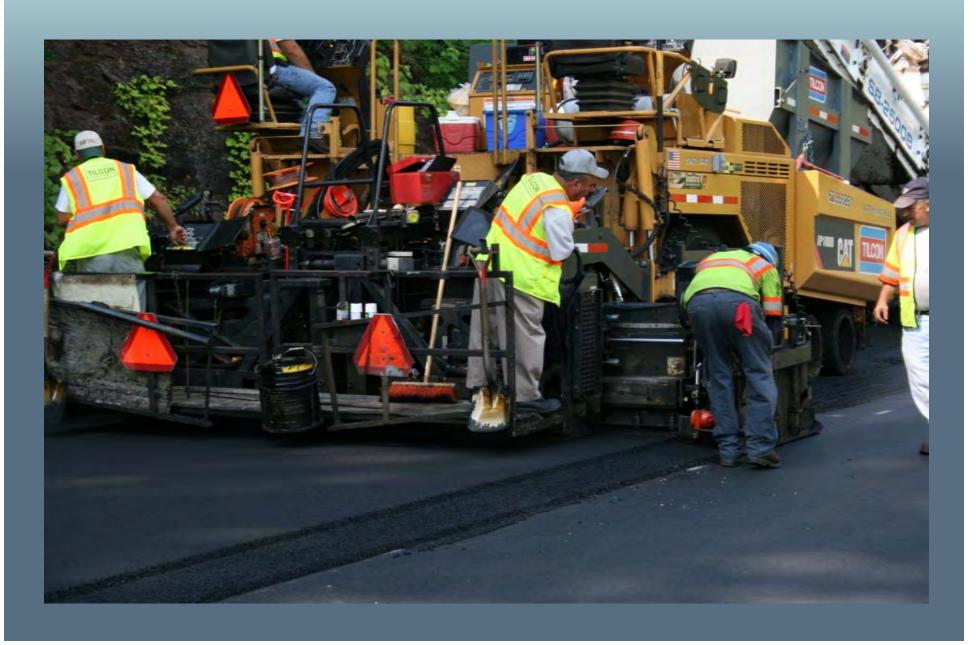
On this day goal was 35 ft/min

- Plant tons/hour
- # of trucks
- Plant to project (time)
- Type of project (rural/urban)
- Ambient / Surface temps
- Paver speed
- # of rollers

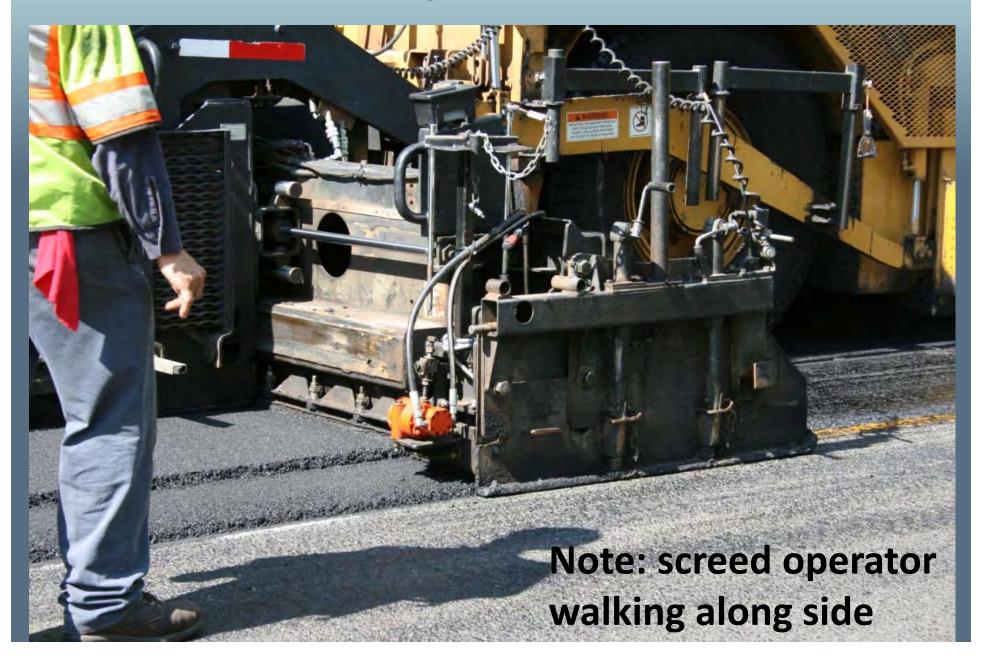
Tack Full Width to Minimize Lateral Movement

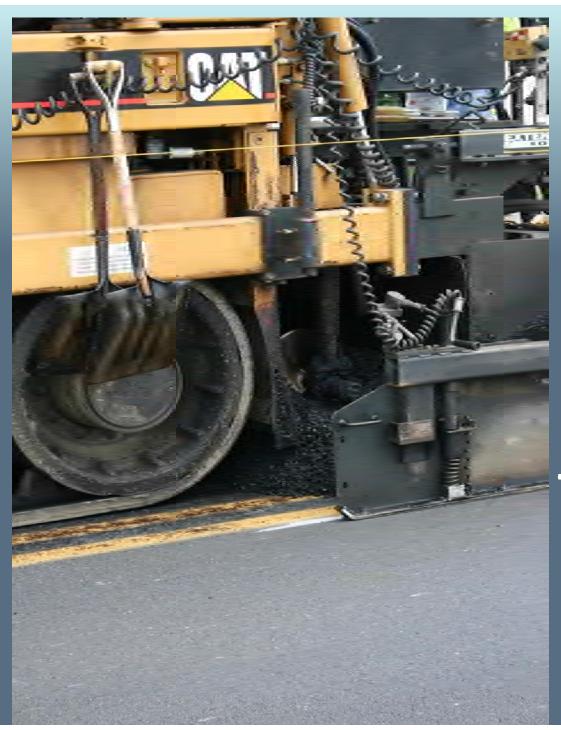


Paver on Automatic



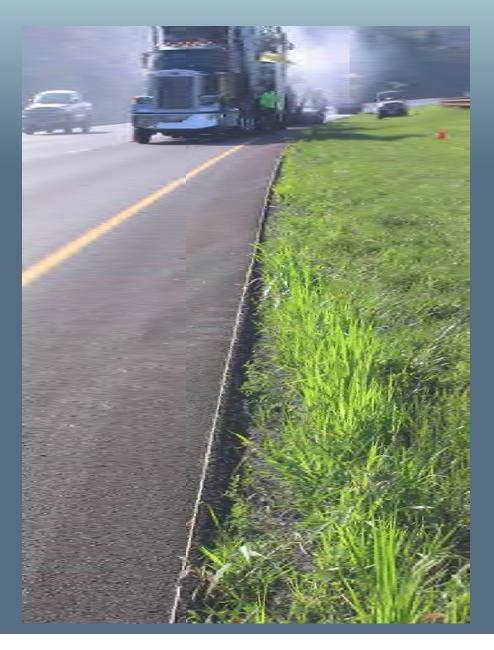
Vibratory Screed "ON"

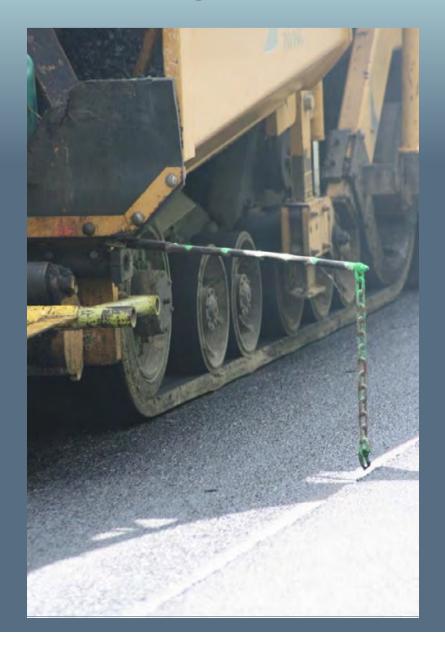




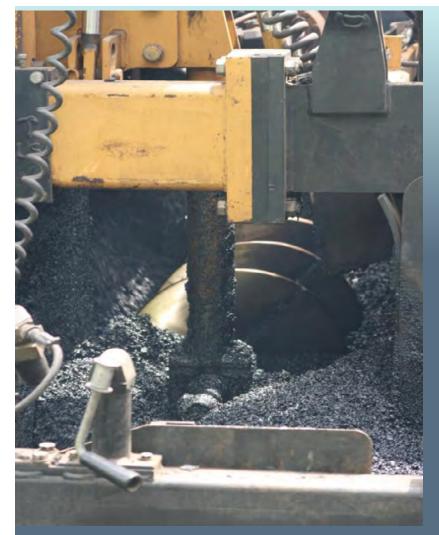
End Gate Flat & Tight on the Existing Surface

First Pass Must be Straight









Uniform head of material across entire screed to joint

...Do Not Overload Auger

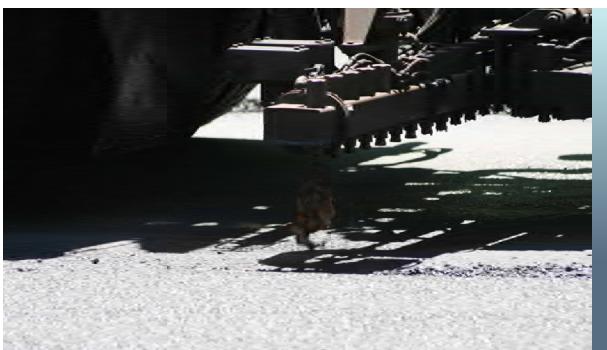
Extend auger and tunnel within 12 to 18 inches of the end gate





Rolling Unsupported Edge: Overlap 6-inches on the First Pass





Paint the Vertical Face

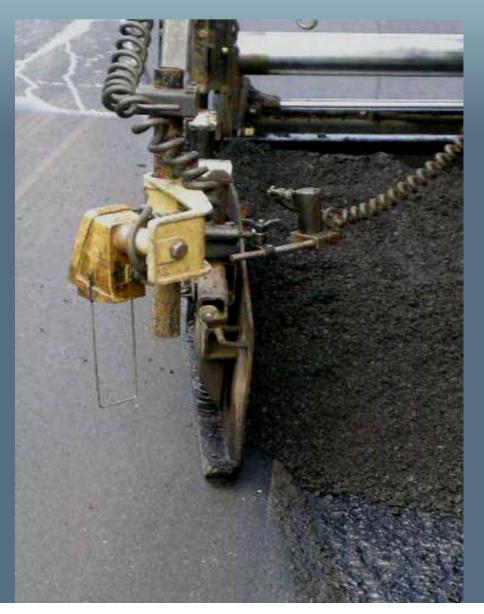
Good: Double Tack
with Emulsion
Better: PG Binder
Best: Joint Adhesive



Overlap the cold lane by 1-inch +/- (If milled or cutback joint, then 0.5-inch)

 Set automation to NEVER STARVE THE JOINT! (1/10" high)

 Joint Matcher best (versus ski) at providing exact amount of material needed at joint



Don't Rake Overlap Across Joint!



Rolling Supported Edge:

- Stay off the Joint 6 -12 inches on the first pass





- Also consider using a rubber tire roller



Attention to Detail

Making sure everything is just right

Monitor density with gauge, on both sides of the joint, as part of QC program



Agency Considerations

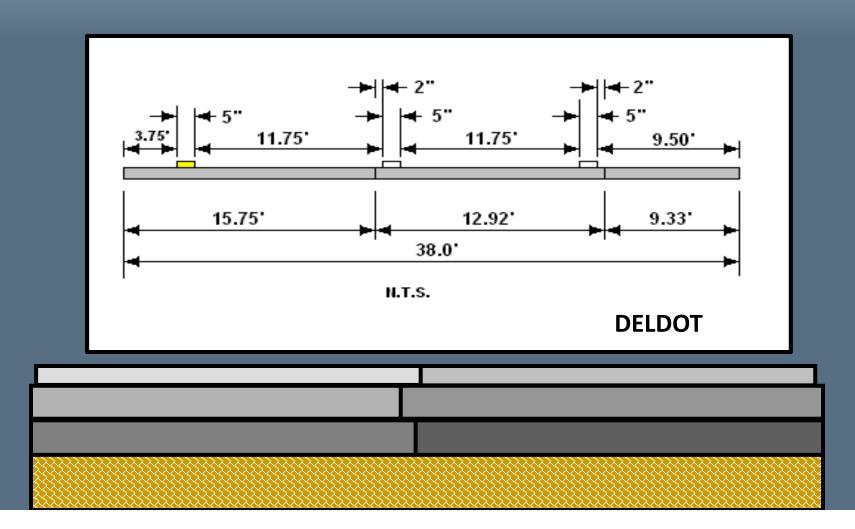


Mix Selection and Design Considerations

- ☐ Less permeable mixes on surface
 - Smallest NMAS that will provide necessary stability
 - Consider designing on "fine" side of Max. Density Line
 - Slightly lower design air void level
- ☐ 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

Plan for the Joints

- Joints offset between layers by at least 6-inches
- Surface joint near centerline and not in wheel-paths
- Try to avoid paint striping and RPMs over joint



LJ Discussion Items for Pre-Paving Meetings

- L-Joint layout plan
- Lane Placement Sequence
 - Low to high when possible for shingle effect
- > Testing of Joint
 - Type, location, schedule, by whom (owner, contractor), for what (QC, acceptance)
- Joint Construction Practices
 - Paving, rolling, materials

Innovative Techniques / Materials

- Treating Face of the Cold Side
 - Infrared Joint Heaters (especially in cold)
 - Joint Adhesives (rubberized asphalt)
- Evaluate Project and Traffic Control for:
 - Echelon Paving
 - Mill / Fill One Lane at a Time
 - Cutting Back the Joint
- Consider Joint Enrichment
 - Overband 4" with PG Binder
 - Surface Sealers

Maine's Method Spec Approach Utilizes Many of These Innovations

Normal Resurfacing: 1.75" mill & fill, w/ ½" mix

• Typically require "vertical edge."

Contractor's option to either:

- 1) Mill and fill one lane at a time
 - Apply "low-modulus crack sealer" on milled edges

Or

- 2) mill full width of project, then cut back (3-6") all unsupported joints
 - Apply "low-modulus crack sealer" on cut edges

Maine's Method Spec Approach

- Upon contractor's request, DOT normally allows use of notch wedge joint versus requiring vertical edge:
 - No milling or cutting back
 - ¾" top notch, ½" bottom notch, 12:1 slope (6" wide wedge typical)
 - Double tack full wedge (no "low-modulus" crack sealer)

LJ Density Spec in Maine Implemented in 2013 for Interstates Only

- Applies to top two lifts
- 100% Pay for 90% PWL
 - Lower Spec Limit of 91%
 - Cores directly over joint
- 2013
 - 3 projects, 23 Lots
 - Average LJ Density 92.9%, PWL 85%, PA .9908
- 2014
 - 1 project, 5 lots
 - Average LJ Density 93.6, PWL 98.6, PA 1.0176



Packets

- If there are any of the handout materials that you don't want to keep, just leave them on the desk in front of you and we'll reuse at a future workshop.
 - You will not hurt our feelings!

- Reminder to complete the evaluation
 - Could hurt our feelings!

Thank you for your attention



Discussion/Questions?