This co-op study (partnership between AI and FHWA) was limited in scope, funding and time.

Partnership exemplified by cost sharing under contract.

Focus not on doing additional research on LJs, but rather to examining what has been done over last 50 years in this area and search for consensus and make recommendations on how to construct and specify LJs. Effort could be considered as an extensive synthesis, then the development of recommendations based on findings.

Workshop will cover our findings in terms of LJ specifications, and density requirements as they relate to permeability. Workshop will also cover key steps (best practices) that give contractor best chance of building a LJ that will last as well as interior mat.

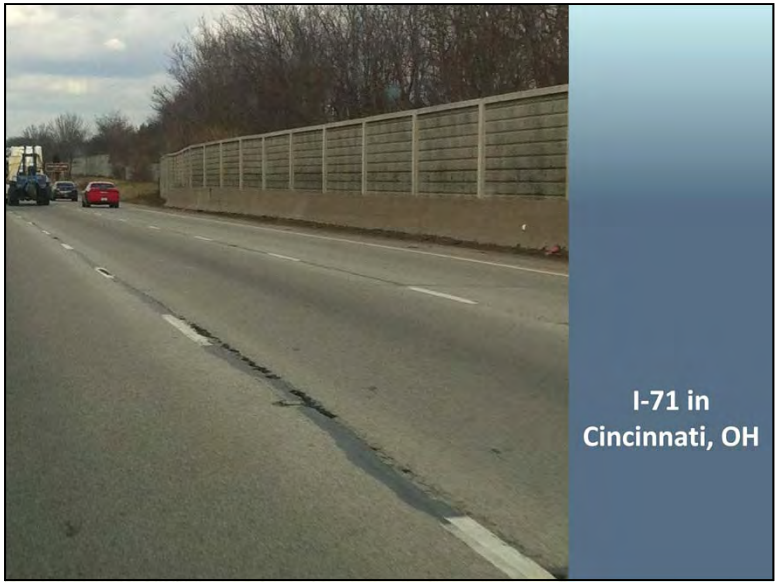
Outline for Today's Presentation

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

This was my first reaction when approached by FHWA about starting this project, but I quickly discovered that not only was there many approaches to specifying a LJ, there were aspects of building a LJ that even experts didn't agree on. This made the project very interesting.

It also became apparent that, even with all the LJ studies that have been done, LJs often fail pre-maturely. For this reason, it's my opinion that LJs are probably our industry's biggest black eye.

This black eye was illustrated clearly when Carlos Rosenberger, one of the lead project members, took the following set of pics when driving from his home in eastern PA to an asphalt alliance meeting in CT, where the purpose was to ironically talk about what we can do as an industry to improve our market.



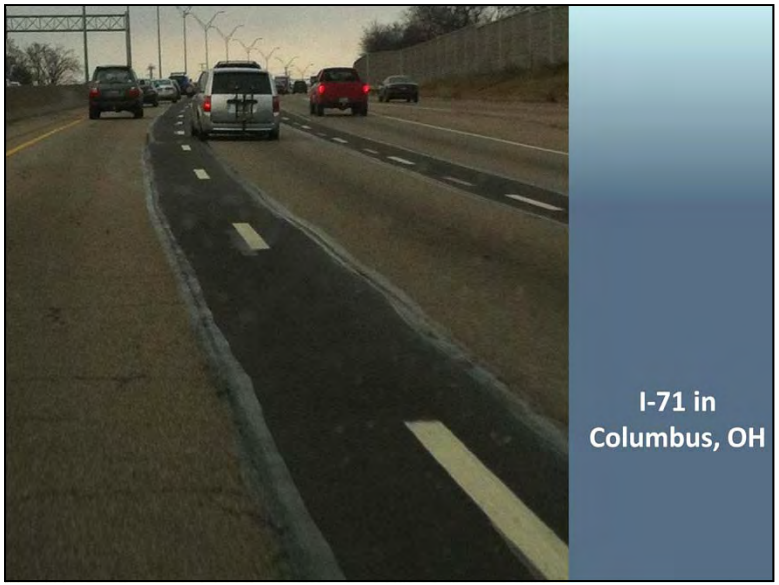
Mark Buncher's short trip to Columbus OH in Mar 2012 to speak on LJs.

Pete Grass was photographer riding shotgun.

Could have taken many pictures of failing joints on many parts of trip.

Cincinnati and Columbus are about 80 miles apart.

Ask audience what is the weakest link in the chain of the asphalt pavements seen in these pictures.



Note that both longitudinal joints failed before the mat and were milled and filled.

" 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

This statement by KY TC is not unique to KY.

Premature failure should be a concern to both industry and agencies. Performance periods, especially the initial performance period, have been shown to be the most critical factor, after initial construction cost, in a life cycle analysis. Increasing the performance period(s) will have a significant impact on the life cycle analysis and ultimately the pavement selection process. The difference in Net Present Worth in a LCCA using performance periods of 15 yrs versus 10 years will probably be in the 8 to 10-percent range (depending on prices; 8.5-percent was calculated in the next hidden slide using assumptions by Carlos in 2011). Performance periods are important to the DOT to stretch insufficient funds, and the DOT continuing to select asphalt pavements as the primary option is critical to the HMA industry's future.

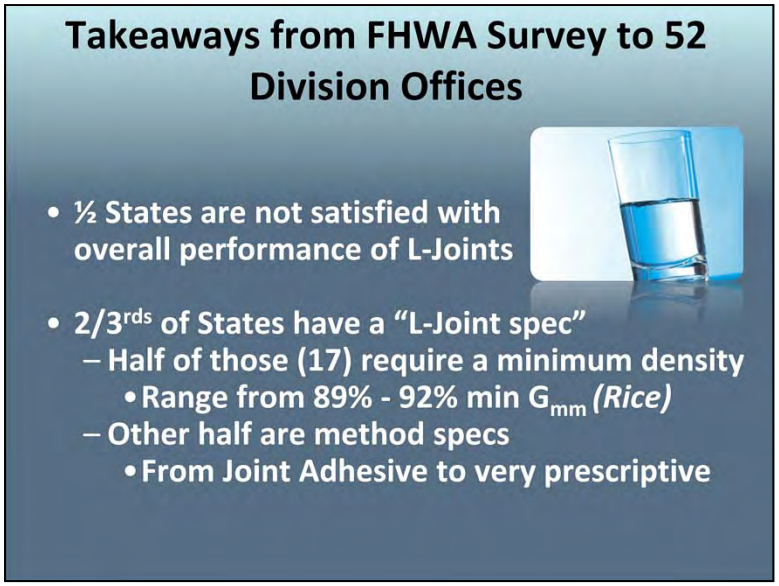
We have all heard the phrase, "Get in, Get out & Stay out", it reminds us that the motoring public does not like to be delayed. Longer performance periods address the "Stay Out" part of the statement and if we can improve the performance periods we will probably eliminate one or more maintenance cycles.

Two Project Goals
Best way
To Build it.
Best way
To Spec it.

Focus for Today's Presentation
Best way
To Build it.

Smooth transition from this slide to next

This study shows that longitudinal joint construction is an area where consensus is nearly unachievable, but that with attention to detail, we can produce good joints with differing techniques.



Antidotal comments of longitudinal joint performance similar to the previous photos and reports with findings that paralleled the Kentucky report prompted the FHWA to survey their Field Offices regarding the performance of the longitudinal joints in their states.

That initial survey provided a great starting point, it gave insight into the specifications and practices being used in the U.S. Specifically it noted:

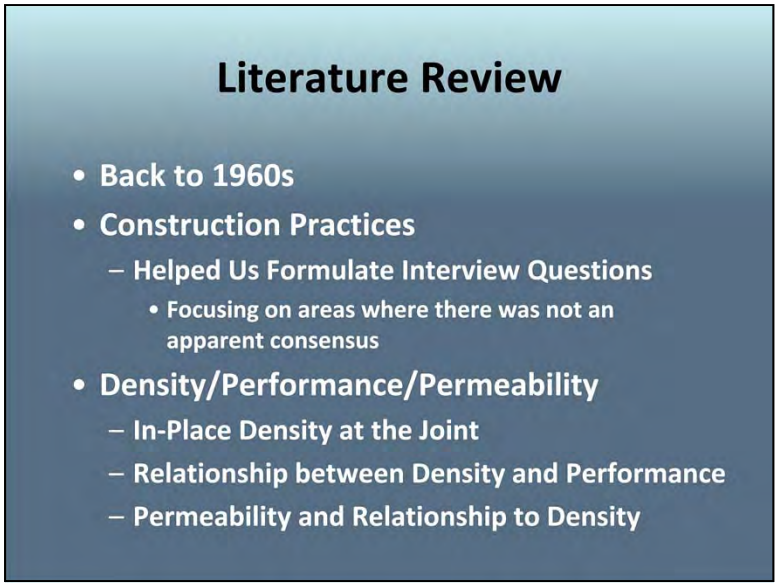
-1/2 of the states were not satisfied with their longitudinal joint performance

-2/3 of the states reported that they have a longitudinal joint specification (in some cases an addendum or special provision), but only ½ of those states accepted based on a minimum density. The other ½ were using "method specifications"

-Some states reported use of longitudinal joint adhesives. New Jersey required it on all projects. MS is now using it routinely on interstate projects.

(Note: This may be a good spot to ask the audience what type of LJ spec or requirements their state has.)

While the initial survey got the project off in the right direction, it did not provide the necessary data to recommend a specification or "best practices".

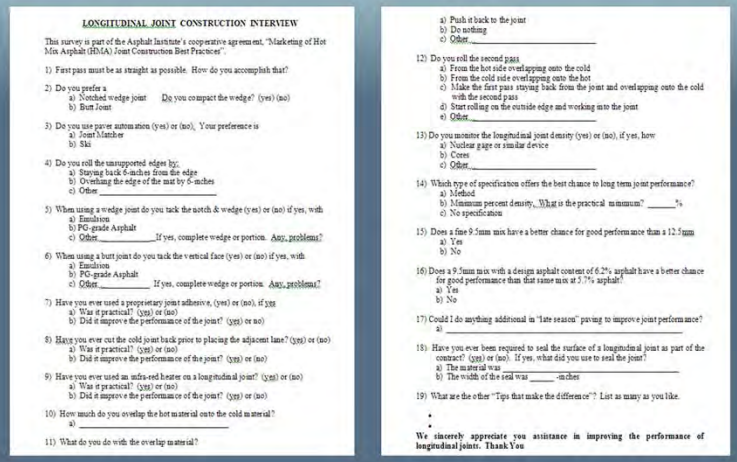


Literature on LJs goes back to 1960s, and <u>continues to grow as LJ studies are conducted by States.</u>

Reviewing everything we could find on constructing LJs helped us formulate the questions to ask the industry experts; honing in on the areas where there was not a clear consensus on what was the best practice.

Section 2 will cover what the literature says on in-place density at the joint; relationship between density and performance, relationship between density and permeability.

Interview Questions to 19 Experts



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) 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) 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 gage or similar device
   b) Cores
   c) Other _____

14) Which type of specification offers the best chance to long term joint performance?
   a) Method
   b) Minimum percent density, What is the practical minimum? _____%
   c) No specification

15) Does a fine 9.5mm mix have a better chance for good performance than a 12.5mm
   a) Yes
   b) No

16) Does a 9.5mm mix with a design asphalt content of 6.2% asphalt have a better chance for good performance than that same mix at 5.7% asphalt?
   a) Yes
   b) No

17) Could I do anything additional in "late season" paving to improve joint performance?
   a) _____

18) Have you ever been required to seal the surface of a longitudinal joint as part of the contract? (yes) or (no). If yes, what did you use to seal the joint?
   a) The material was _____
   b) The width of the seal was _____-inches

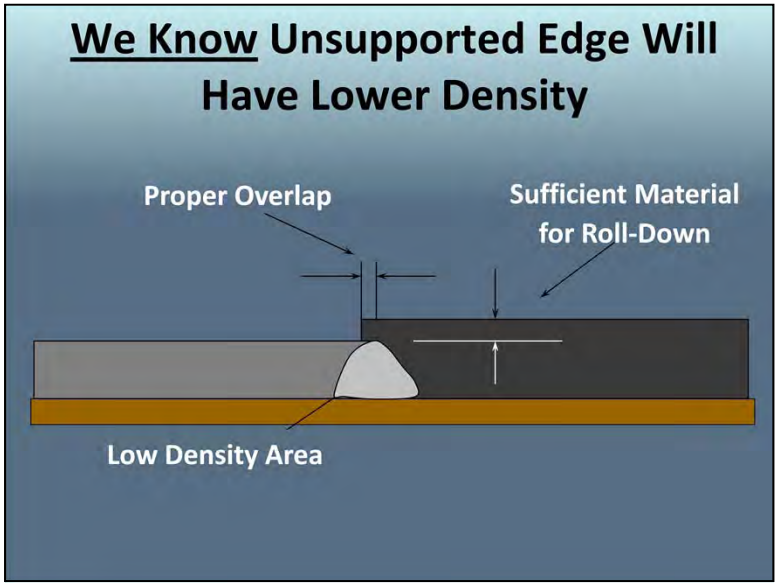
19) What are the other "Tips that make the difference"? List as many as you like.
   •
   •

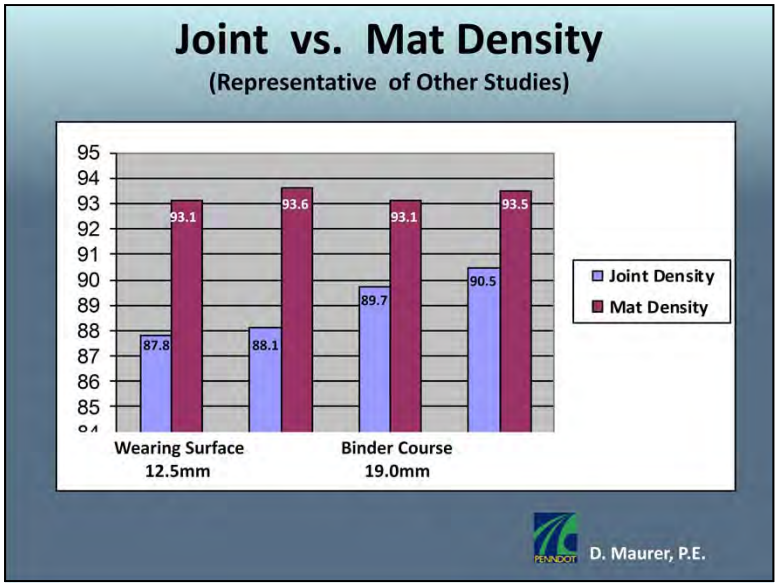
We sincerely appreciate you assistance in improving the performance of longitudinal joints. Thank You

Each expert was sent this 2-page questionnaire 2-3 weeks prior to the interview so they had ample time to prepare for interview.

Actual interview was done face-to-face or over the phone, each lasting between 1-3 hours.

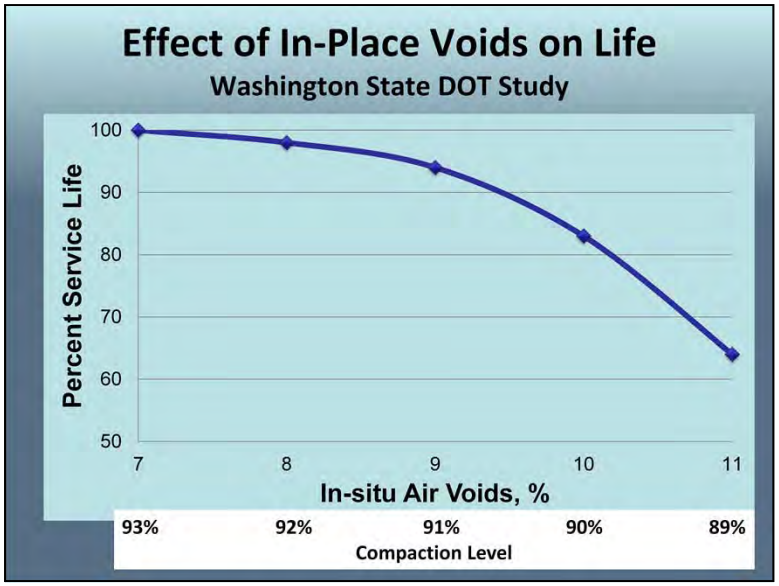
Goal was to find areas of consensus to help us develop set of best practices which offer best probability of constructing a durable LJ.


We Know Unsupported Edge Will Have Lower Density
Proper Overlap
Sufficient Material for Roll-Down
Low Density Area



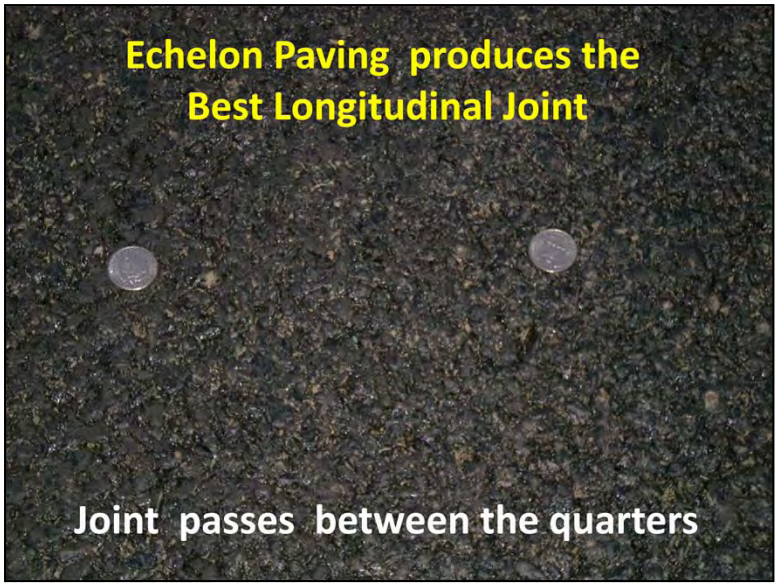
Dean Maurer reported these result while doing a Mat Density vs Longitudinal Joint Density in Pennsylvania. His findings are representative of what other researchers have found. Joint densities are often 2 to 5% (or more) lower than the mat density. Shown here are average of many density measurements in this PA study. Differences are 3 – 5% between joint and mat.

(could have picked one of a dozen studies that have similar density numbers)



This Washington study, has been around for many years, it highlights the relationship between in-place pavement air voids and pavement service life. With longitudinal joint densities typically at 90% or less it is easy to explain those opening photos of premature joint failures. At ninety percent compaction (10-percent air voids) we can expect joint performance to be: joint performance = mat performance – 1/5. When joint density drops to 89% then joint performance can expect to be: joint performance = mat performance – 1/3. For a 15 year expected mat performance, giving up 1/5th means the joints fail 3 yrs earlier than mat (giving up 1/3rd means the joints fail 5 yrs earlier).

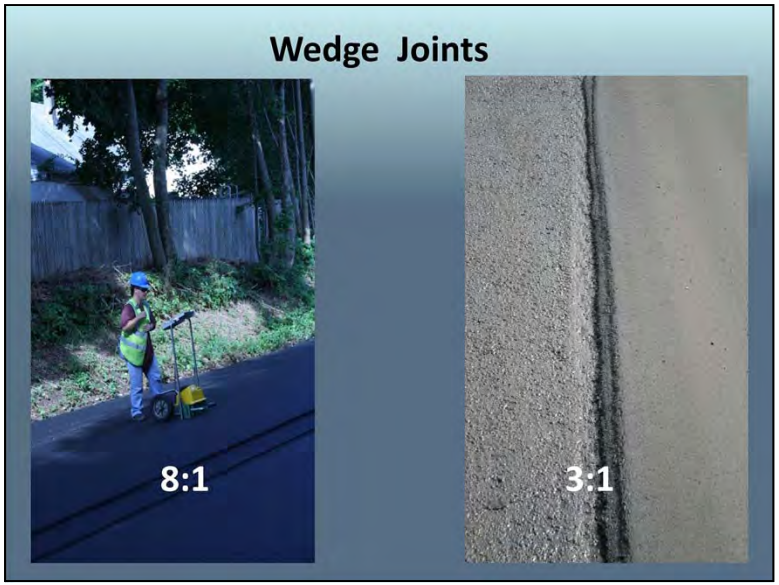
Poor joint density, high air voids, leads to an increased rate of oxidation in the pavement. The combination of an oxidized pavement in combination with permeability and a series of freeze thaw cycles can lead to the catastrophic failure of a longitudinal joint. This section of I-80 in winter of 2009 was scheduled to be overlaid the next construction season, but required an emergency milling operation in the middle of the winter to provide the motoring public a safe roadway.



This is an intermediate mix placed with echelon paving. The joint passes between the $0.25s but unable to tell where it is

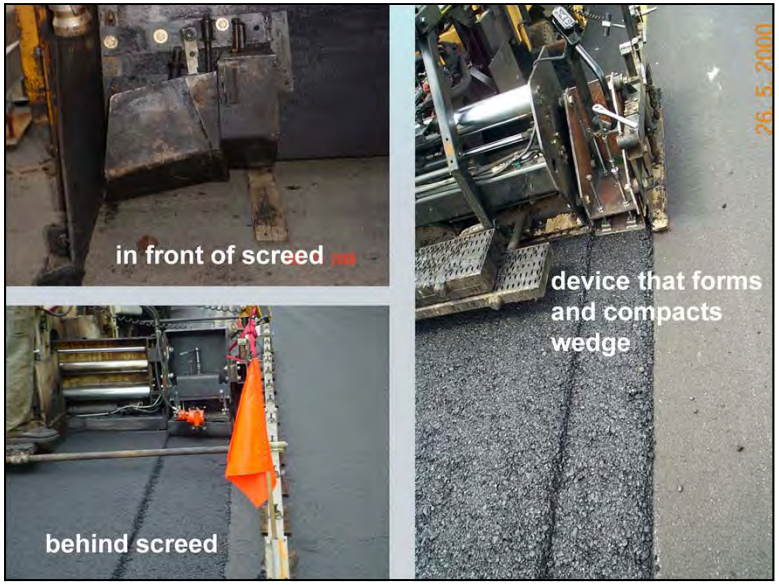
Even in a rural area the opportunities for echelon paving are very limited. Consequently, most of the longitudinal joints are built with a cold joint. Which leaves us with coming up with the best way to build a quality joint when echelon paving is not practical

Looking at longitudinal joints, the research would seem to favor the use of the notched wedge, but the interviewed paving experts were pretty evenly divided. Each joint has its advantages and disadvantages. The notched wedge offers the opportunity for higher tonnage (not required to pull second lane up) and for safety (FHWA requires closing up any lift 2 inches or greater before opening for traffic). Thin overlays do not provide sufficient depth to use the notched wedge. One Sheldon Hayes winner suggested that their company felt they achieved a smoother pavement with the butt joint (An important consideration if there is a ride incentive specification). **Considering previous research and the interviews it appears using "best practices" to constructing the joint outweighs the type of joint.** (Personal comment: If I was a contractor with a minimum density specification I would build the notched wedge to reduce the possibility of a void between lanes. In another 3 slides from here, it is stated in speaker notes that two states (PA and MA) have recently found higher densities with the notch-wedge vs the butt joint.



The choice of type of joint goes beyond butt versus wedge. Wedge joint configurations vary from a 12:1 to an 8:1 to a 3:1 ratio. (Wedge on left is in Connecticut. Wedge on right is in Colorado)

<u>CT requires a notch wedge joint (no butt joints) with slope from 8:1 to 12:1. Also requires notch at top and bottom of wedge.</u>



Various notch wedge devices available. Two shown here. More shown later.

CT requires that the taper on the wedge gets compacted in some fashion. A vibrating wedge device such as shown here is most commonly used. Others use a small roller, often a tow-behind kind.

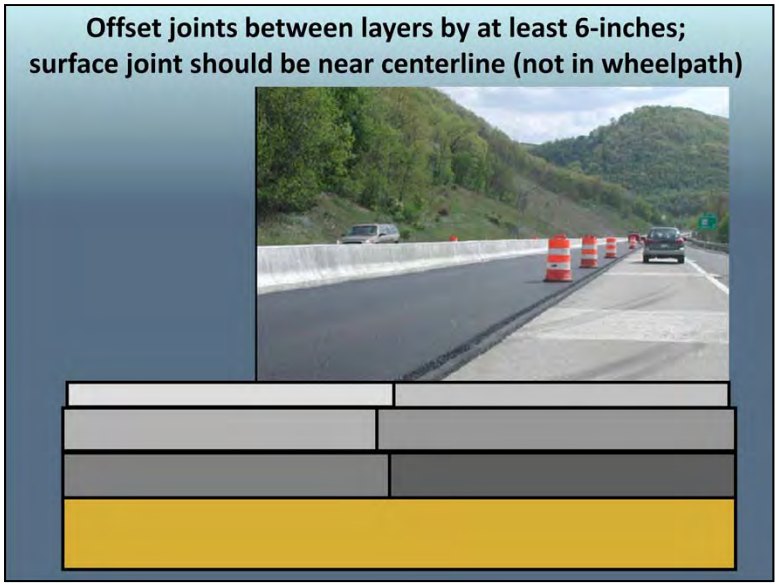
Remember that PA DOT allows either a butt or notch-wedge joint. They looked to see if there was a difference in density due to joint type and determined the average joint density for the notch wedge joint was 1.4% higher than the butt joints. The split was about 60% wedge joints / 40% butt joints on 168 lots in 2011 and 1st quarter of 2012.

Maine recently reported in August 2012 that they have some preliminary data from a LJ research project that shows they get improved density with the notch wedge versus the butt joint.

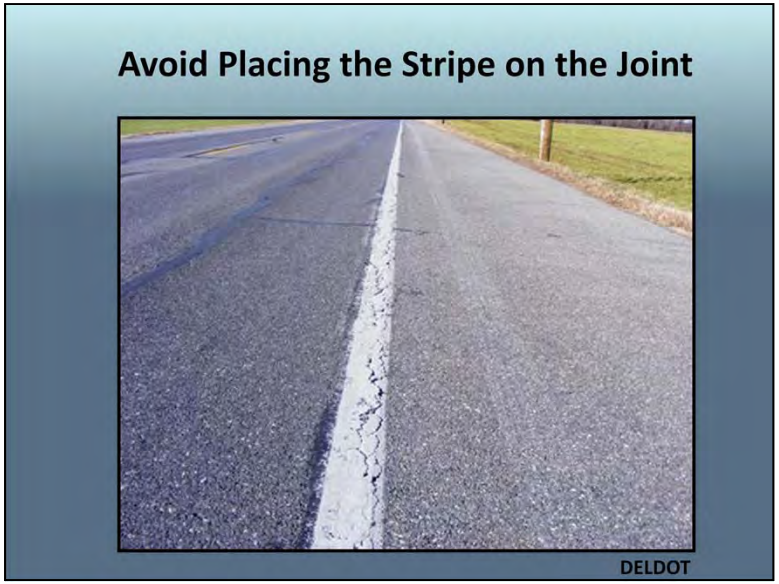
This is not an acceptable way to build a notched wedge joint. The joint density will be low and the resulting joint performance will not be good!

NOT PHOTO-SHOPPED!

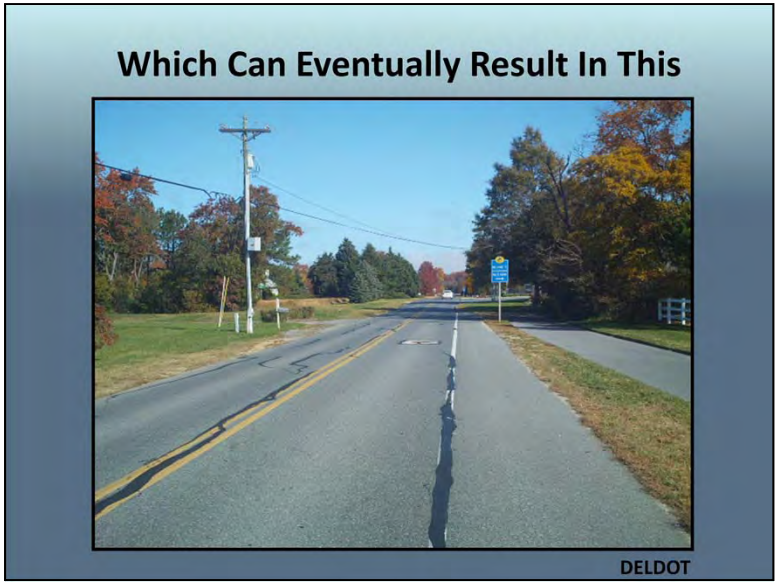
Here’s an example of poor planning that Danny Gierhart took in Oklahoma City recently



The joint is the weakest area of the pavement. Because of this, a longitudinal joint should be offset from that of the layer below by approximately 6". This is to avoid a plane of weakness running down through multiple pavement courses. Locate surface joints at the approximate centerline or line striping locations, away from the wheel paths

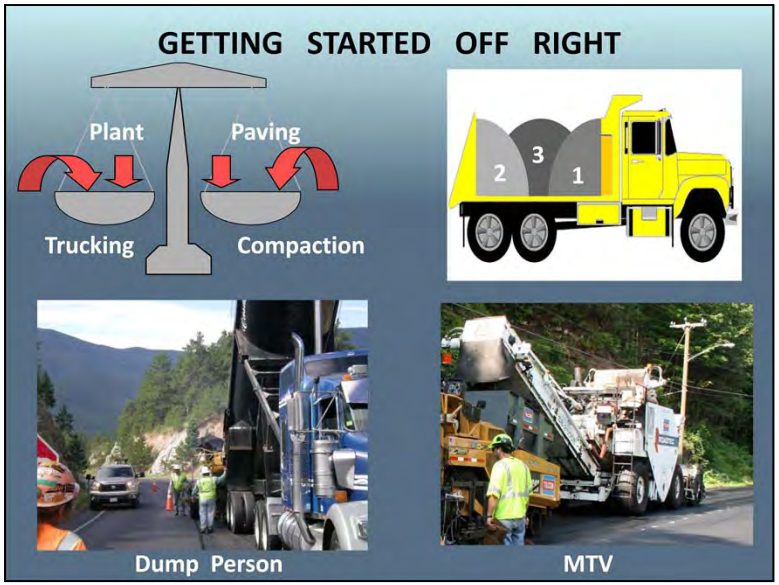


Avoid striping right over the joint.



Sealant hides the striping

Construction Best Practices for Longitudinal Joints



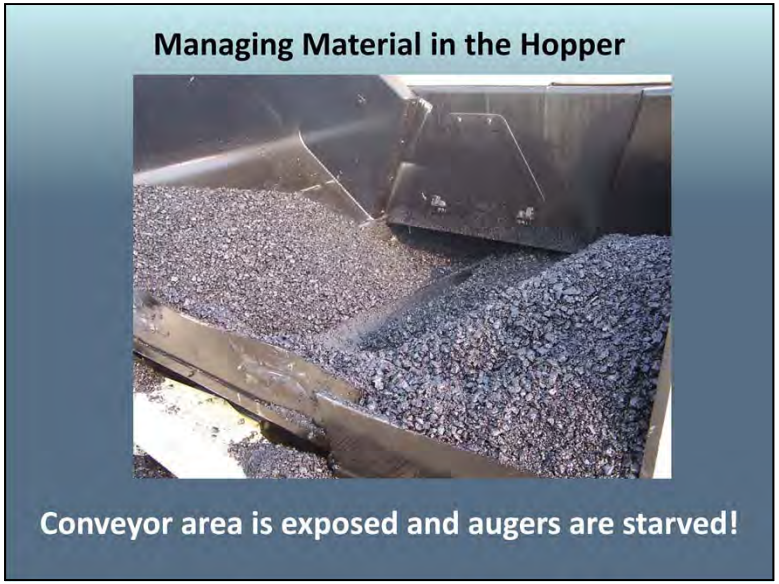
A good joint requires getting started off right.

-That means having a balanced paving operation; plant production, number of trucks (time to / from the project), paver speed and roller speed coordinated to match tonnage arriving on the project.

-Trucks loaded to avoid segregation,

- MTV helps to minimize segregation and allows paver to maintain consistent speed, without getting bumped by trucks.

- Without a MTV, “dump person” is critical to get truck lined up properly to avoid paver deviating from a straight line.



Example of “Basics” don’t starve hopper for material; leads to possible segregation

The application of a properly cured tack coat (PG grade or emulsion) is critical to minimizing the lateral movement of the unsupported edge. It is important the tack coat cover the full width of the lane being placed. In the photo above, the tack was placed beyond the edge of the mat, which is OK too.

It was unanimious, the first pass must be straight. A straight first pass allows the paver operator to consistently and uniformly overlap the existing lane. The examples show here are a stringline and a stringline that has been skip painted. (Circumstances may negate the need for a stringline, one example being urban paving where there is a curb that can be used as a reference.) It is equally important the paver operator have a clearly visible reference that can be used in conjunction with the stringline. Several of the Shedon Hayes winners commented on the importance of a straight first pass and one sends a survey team out to set the line.

Great results. This is the stringline project in the previous slide

Also note that the longitudinal joint from the underlying mat is staggered what looks like about 8 inches.

The inability to get a consistent overlap is obvious in these photos; they highlight the need for a straight first pass. These projects will result in some areas having excess material at the joint and insufficient material in other areas. In all likelihood, the areas with excessive material will see the lute person push that material back and spread it across the mat.

Chuckle: (Orange sign on right “uneven pavement” has dual meaning).

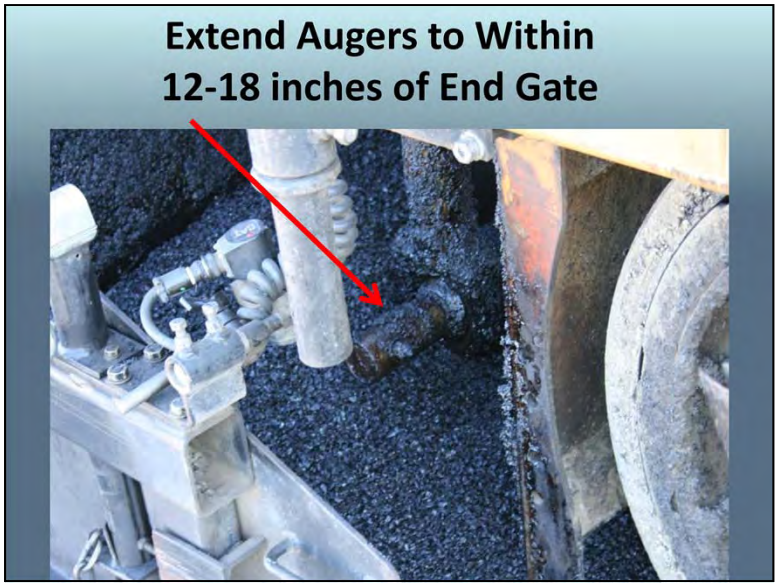
There is overwhelming agreement that the paver must be run with automation rather than manually. When not matching a longitudinal joint or curb, skis are typically used to optimize smoothness. There are many types of skis, but all are designed to provide a smooth surface by paving thinner in high spots and thicker in low spots, with smooth transitions. Skis are typically 30 to 60 ft long, contact variety and laser. Upper left photo is a 55-ft leveler run on both sides of the screed, designed to take out any deep swells. The lower left is a non-contact ski system that can be more accurate than a contact ski system (shown in lower right photo) if running over obstructions.

We'll talk more about contact versus non-contact grade sensors later when we discuss joint matchers, used to close up the joint.

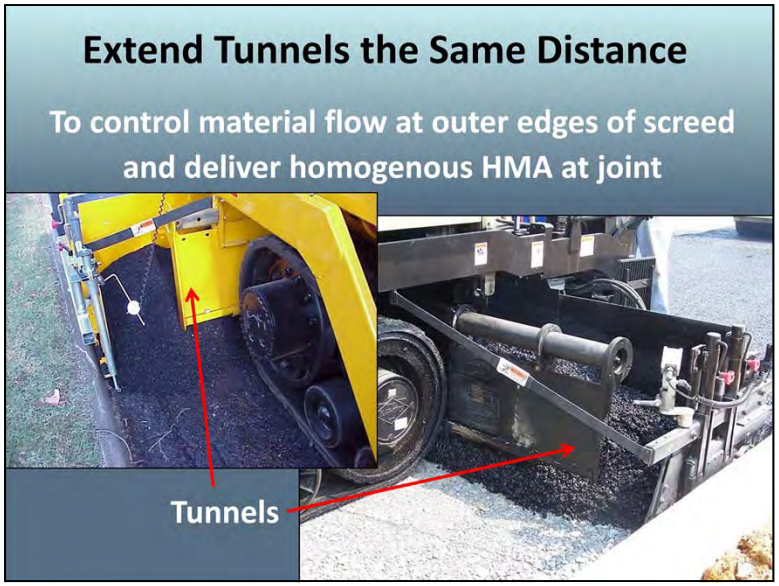
Like the paver automatics, the vibratory screed should always be on, it increases the mat and **the joint** density. When conducting the interviews with the industry experts, it was estimated that the vibratory screed is **not turned on** 50% of the time. (Project visits confirmed that estimate. Paver operators cited being very uncomfortable when having it turned on for a long period of time.)

The end gate should be seated on the existing lane to prevent material from leaking out from underneath; unless removed that material can lead to air voids at the interface of the two lanes.

There should be a uniform head of material across the entire screed. Flow controls are designed to maintain the head of material automatically.

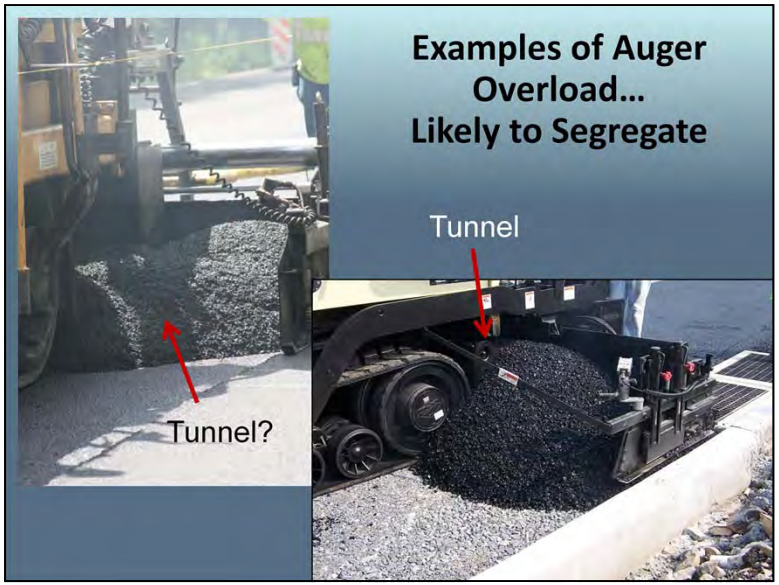


Augers should be extended to within 12 to 18-inches of the end gate to ensure a continual supply of fresh material is carried (not pushed) to the joint. Not doing so is a source of segregation and the resulting low density, high permeability found in many longitudinal joints.

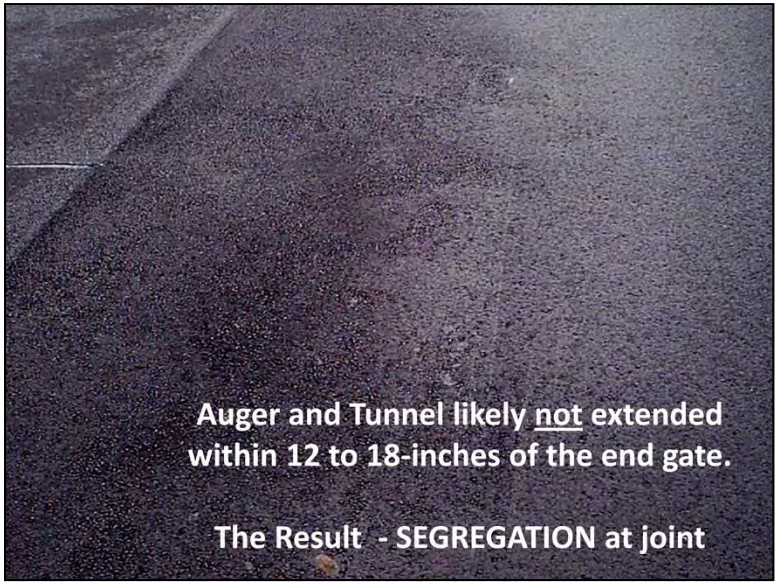


Extend Tunnels to within 12-18” of End Gate. Typically Hydraulically controlled.

When there is a proper head of material and the auger and tunnels carry the material to within 12 to 18-inches of the endgate; the result a uniform, not-segregated joint



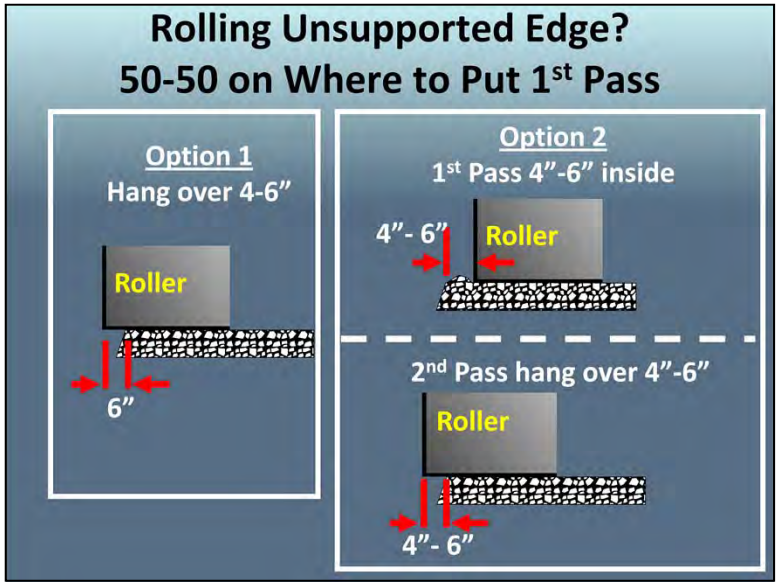
This is unacceptable. The auger is buried, 3+ feet from the end gate, and material is being pushed, rather than carried. The result is a high probability for segregation at the longitudinal joint. <u>Sometimes this is difficult to avoid, such as the lower right photo where the screed width was adjusting back from avoiding the storm drain inlet.</u>



Segregation at the longitudinal joint, most likely the result of improper head of material and the augers not extended to within 12 to 18-inches of the endgate

Keeping the rollers close to the paver is always important, it is critical when the weather turn cool / cold. (This project is just outside Baltimore, MD. Contractor P. Flanigan & Sons, a Sheldon Hayes winner)

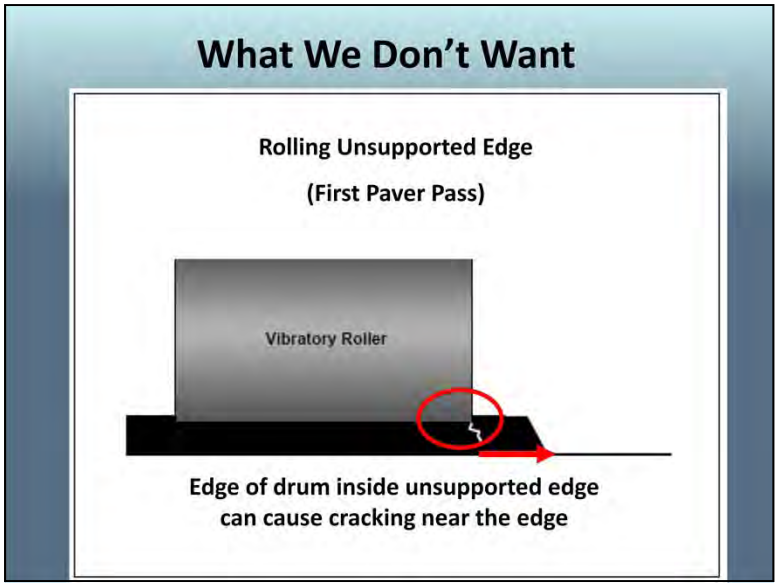
I always get chuckles from the audience at this point and I'm not sure why.



Here was one of the areas where opinions were split almost 50 / 50 among experts interviewed.

- Two methods used to compact unsupported edge:
  - Option 1 (preferred by this project): roller hangs over unsupported edge about 4-6" on first pass.
  - Option 2: roller stays inside unsupported edge 4 to 6 inches on first pass. On second pass, roller hangs over unsupported edge 4 to 6 inches.
- Cautions:
  - Option 1 may break down edge for lifts thicker than 2". If this occurs, use Option 2.

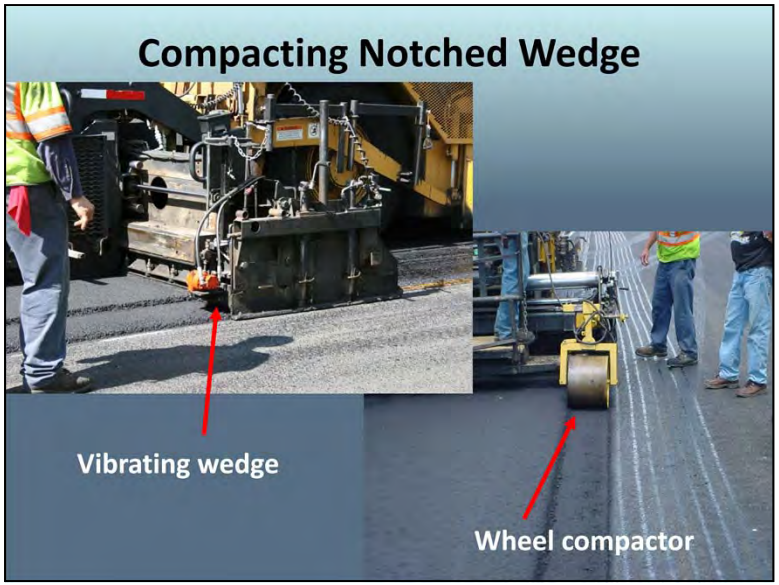
•If cracks are noticed near unsupported edge using Option 2, then use Option 1, or move roller farther inside the edge on first pass using Option 2.



The concern for staying back from the unsupported edge is a stress crack developing along the edge of the roller drum.

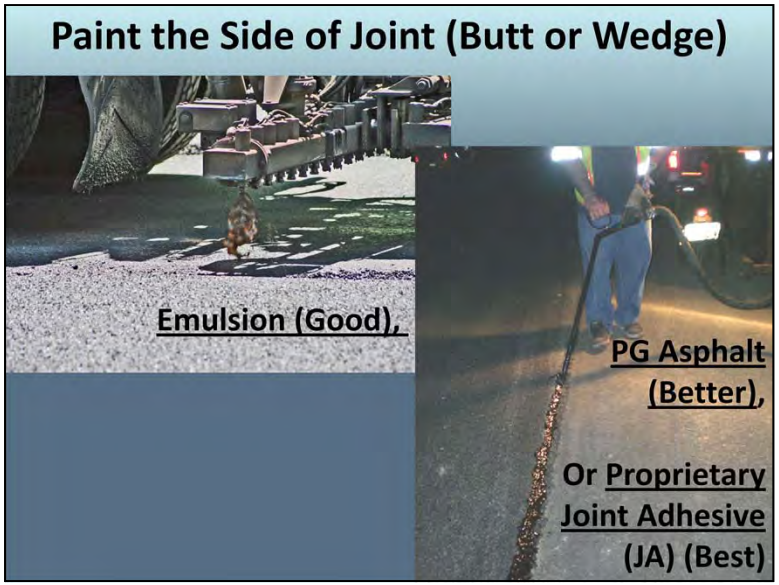
Might be interesting for those that use this method to go back to previous projects to see if stress cracks develop.

May be mix dependent.



Connecticut noted that their early wedge joints raveled when left open to traffic, prior to placing the adjacent lane. Consequently, their specification now requires the wedge be compacted. They do not specify the method of compacting the joint, just that it be compacted.

In PA, their data shows there is significant benefit in terms of increased final joint density by using a notched wedge compactor (also called a vibrating wedge – left photo) to form and compact the wedge joint.



Emulsion pic was on Lindy Paving Job just north of Pittsburgh, PA.

Proprietary Joint Adhesive pic on I-295 in New Jersey

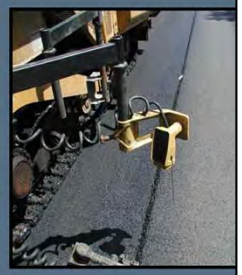
Painting the longitudinal joint (butt or notched wedge) is strongly recommended to increase the bond and help fill any voids. Emulsions, PG-graded asphalts and proprietary joint adhesives have all been used successfully. Contractors in our survey tended to prefer the same emulsion specified for the tack coat, consultants in our survey tended to prefer the joint adhesives. The PA and MD specs require the use of PG binder (either 64-22 or the project grade) for painting the exposed face of the longitudinal joint. When sealing notch wedge joints in PA (they allow both butt and wedge joints), DOT requires painting the full face of wedge (from notch to notch) with PG asphalt.

Work done by Kandhal found the best performing joints were notched wedge joints using joint adhesives. New Jersey and Hew Hampshire require the use of joint adhesives (JA) on their longitudinal joints. Mississippi requires JA on their Interstates. One concern with JA is pickup if trucks traffic over the exposed JA. Pickup can also be a concern with PG binders if not given sufficient time to cool.

Use of an emulsion to paint the joint is considered “Good”, use of a PG asphalt (typically 64-22) is “Better”, and use of the Joint Adhesive (JA) is “Best.” When emulsions are used, double tacking the joint is encouraged for extra residual asphalt. The cost of the JA is around $0.30 per linear foot. A discussion and slide is provided later in this workshop on doing an economic analysis to determine if using a Joint Adhesive is beneficial from a cost/benefit perspective.

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

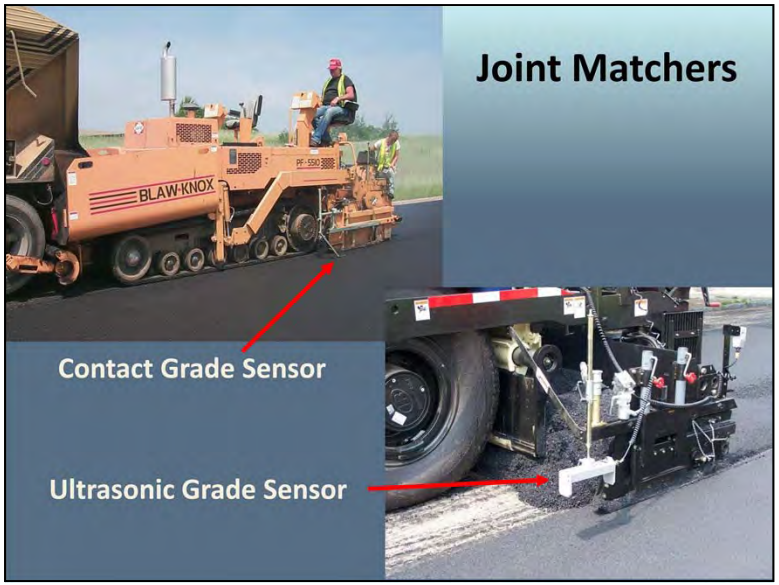
- If hot-side is starved of material, the roller drum will "bridge" onto cold mat and no further densification occurs at joint
- *NEVER STARVE JOINT* by targeting a final height difference of +0.1" on hot-side.
  - NH spec requires compacted hot-side to be 1/8" higher than cold side



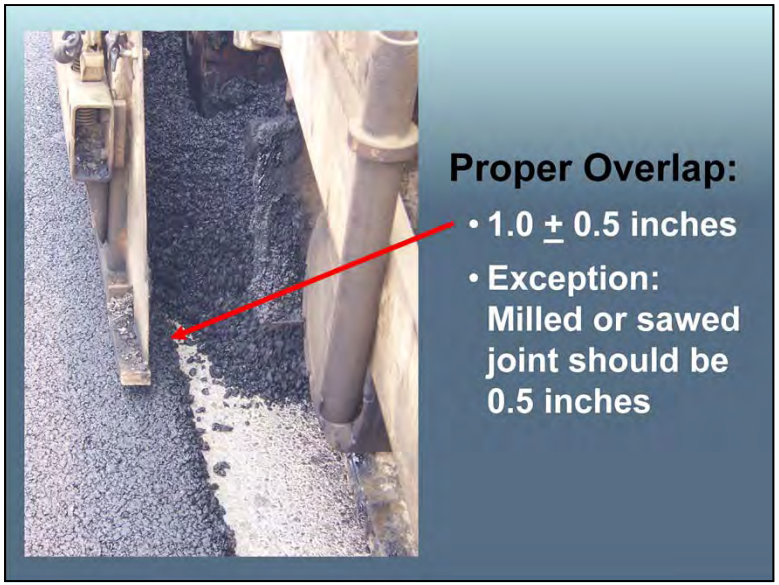
For instance, on a ride spec expressway project… a contractor could first place the 10' shoulder using a ski reading on the travel lane (outboard). Then, when placing the travel lane, also use a ski on the travel lane (inboard) which will yield a consistent depth at the shoulder joint. Then when placing the passing lane, use a joint matcher to maintain a consistent depth at the joint.

Also, there are scenarios where it would not be practical to use a joint matcher such as: short broken up work (intersections, etc.), stacked joints without sufficient width, near barrier for traffic control, etc., etc.

See sub-bullet:


Joint Matchers
BLAW-KNOX
Contact Grade Sensor
Ultrasonic Grade Sensor

You saw this photo earlier. Could this be the result of a ski rather than a joint matcher? Random retained moisture along the longitudinal joint may be result of the ski averaging adjacent joint thickness. Some places just right; some places too low, and some places too high.

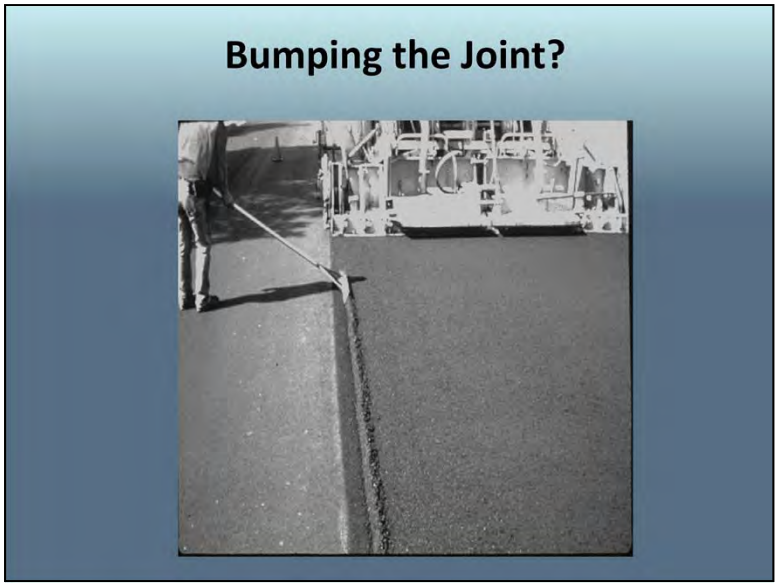


There is general agreement the overlap of material onto the existing lane should be 1-inch + / - one-half inch.

<u>If the overlap is excessive, too much material will be present on the cold mat and will need to be raked off. If there is too little or no overlap, the joint may be starved of material and can result in large voids or very low in place densities.</u>

In a break from the traditional recommendation to lute the material back, the consensus from the experts is the material should not be luted back. If the material could always be properly luted back it would probably be the recommended method, but too often the material is luted across the mat which results in a joint starved for material and one destined for premature failure (see next several slide).

It is important to remember the roll down of a typical hot-mix asphalt pavement is approximately 0.25-inch / 1-inch and make sure that the second lane lift thickness is sufficient to allow for that roll down. When done properly the overlap material will be above the cold lane by roughly 0.1-inch. We are not looking for a pretty joint (one that is smooth measured transversely). One inch wide band of crushed aggregate is OK.



If the material would always be properly luted back, it would probably be the recommended method, but too often the material is pushed across the mat; the result is a joint starved for material and one destined for premature failure.

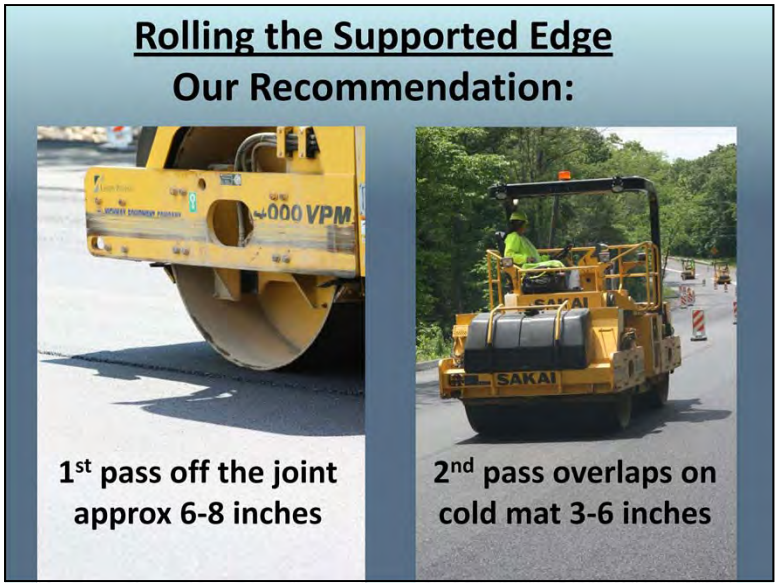
Picture on right will result in “starving the joint.”

<u>For this reason we recommend avoid luting the overlap material under normal conditions (proper overlap). If excess overlap, carefully remove excess with flat-end shovel. DO NOT BROADCAST EXCESS MATERIAL ACROSS MAT.</u>

All too common event; overlapped material being broadcast across the mat. The result is a joint starved for material and a non-uniform (segregated) mat.

In a break from the traditional method of luting the material back to the joint; the consensus is the material should not be luted back. Not luting the joint provides the highest probability of good joint performance. <u>It also increases the safety of the paving operation as the lute person no longer has to contend with luting the joint and having the lute handle out in the passing traffic.</u>

(Note : Only use the following sentence only if not using slide with title: "Bump the Joint". If the material could always be properly luted back it would may well be the recommended method, but too often the material is luted across the mat; the result is a joint starved for material and one destined for premature failure.)

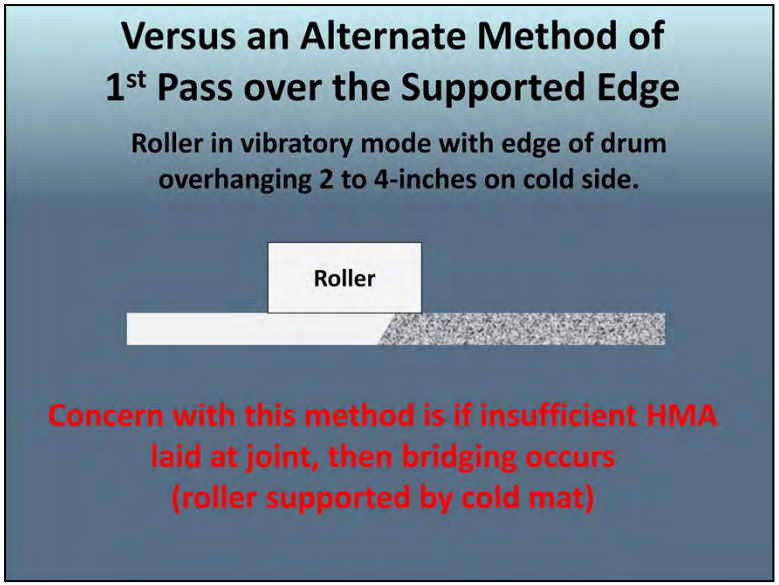


Recommended method of compacting the supported edge is to stay off the joint on the first pass overlapping onto the cold lane on the succeeding pass.

<u>This method allows the material right at the joint to be confined on both sides prior to rolling. By confining both sides, the full weight of the roller will force the mix down into the joint to achieve the best density available.</u>

This method also minimizes any bridging effect of the roller being supported by the cold lane.

This recommended rolling pattern is opposite of what we recommend for the unconfined joint (staying off joint versus overlapping joint).



An alternate method of rolling the supported edge is to overlap onto the cold lane on the first pass. This method was not chosen due to concern of a bridging that would result in low density just off the joint on hot side. It was also felt that the recommended method confines the mix at the joint from both sides, providing the best density possible.

Wide range of opinions on optimum method to roll hot side of joint.

Some said 1st pass should be on cold side, overlapping 6" onto hot.

Some said 1st pass should be on hot, overlapping onto cold.

Some said 1st pass should be on hot and 6-8" off the joint, with 2nd pass then pinching it down by overlapping onto cold side. This is the method we chose.

Like the supported edge, opinions varied on how to roll the supported (hot side) of the joint. Ultimately the recommendation is to roll the supported edge by staying back from the joint 6-8 inches from the joint. This decision is based on the possibility of the roller drum bridging when part of the drum is supported by the cold mat. There is concern with this method that a stress crack may develop along the edge of the roller drum as discussed earlier in rolling the unsupported edge. We believe the possibility of bridging outweighs the concern over a stress crack. Roller operators should be vigilant and if they see the stress crack developing they should switch to overlapping onto the cold lane with the first pass.

Pictures are during state visit in CO showing the alleged stress crack that can occur at edge of drum by staying 6" off joint with 1st pass. More likely to occur on tender mixes, and when rolling unsupported edge.

The final pass on a crowned section

This contractor chose to make his final passes on the pavement crown by not quite centering his drum at the crown. This exerted maximum pressure at the joint.

Point on this slide is the Contractor should be checking his density on both sides of the joint soon after the rolling operation is complete. Just as it was important to test the unsupported side as part of the contractors QC plan, it us also important to check density on the supported side. If the agency checks density with cores as part fo QA, the contractor may also want to be taking cores as a check.

The following has essentially been covered under the "Specification Section", but may want to reiterate:

Acceptance of the joint is best measured with a 6-inch core, (but it does have the negative aspect of being destructive testing). Cores taken on butt joints should be centered on the joint. Cores taken on a notched-wedge joint should be centered on the wedge, equally spaced between the two notches. The acceptance value should be the average G_{mm} of the two mats. (Centering on the butt joint and centering on the notched-wedge will provide a 50/50 split of the material)

The gauge will not seat properly and will giving an inaccurate reading if placed directly over the joint, especially if joint was not luted and is not perfectly flush as we recommend. The gauge locations for readings will need to be parallel to the joint and offset from the joint 2-inches.

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

There are other traditional options, a re-visiting of joint heaters and some brand new ideas that can be explored.

-Milling and paving one lane at a time eliminates the unsupported edge, the area of highest voids

-Cutting back the joint, common on airport paving projects, removes the unsupported edge, eliminating the high void area

-Joint heaters are being re-visited. This re-visit includes new technology that may overcome the shortcomings of their predecessors; over heating or under-heating.

-Proprietary joint adhesives are not new they have been around for years (see Kandhal study dating back to 2002), but have not been a standard specification, except for New Jersey

-The realization that longitudinal joints regularly do not achieve the density required to be impermeable has a few states experimenting with surface sealers.

Following is a slide on each of these options.

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 $\geq$ 1.5 inches and $\leq$ 3 inches
  - Shown to obtain higher joint densities

Prior planning is a key factor in constructing a successful longitudinal joint. As noted in the previous slide there are advantages to each type of joint; **choose the joint best suited for your particular project**.

-Permeability is related to the nominal maximum aggregate size (NMAS); the smaller the NMAS mixture the less likely it is to be permeable. Consider the type of traffic and choose the smallest NMAS with which you are comfortable

-Permeability is also a factor of gradation selection; fine mixtures (those below the maximum density line) are less likely to be permeable. Again, consider the type of traffic and choose the gradation understanding that fine gradations offer a greater probability of being impermeable

- Higher binder contents will improve compactability resulting in reduced in-place air voids and less permeability.

- Compaction, whether it is the mat or the longitudinal joint requires sufficient lift thickness to allow the rollers to do their job. National recommendations currently recommend a minimum of 4 x NMAS for coarse graded mixtures and 3 x NMAS for fine graded mixtures.

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

Contents of Workshop Packets

Thank you for your attention

Discussion/Questions?

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