Joint
Compaction

Important Safety Information

Most accidents involving product operation, maintenance and repair are caused by failure to observe basic safety rules and precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “WARNING” as shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning, explaining the hazard, can be either written or pictorially presented.

Operation that may cause product damage are identified by NOTICE labels on the product and in this presentation.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this presentation and on the product are therefore not all inclusive. If a tool, procedure, work method or operating technique not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made usafe by the operation, lubrication, maintenance or repair procedures you choose.

The information, specifications, and illustrations in this presentation are on the basis of information available at the time it was written. The specifications, illustrations and other items can change at any time. These changes can effect the service given to the product. obtain the complete and most current information available.

⚠ WARNING

Do not operate or work on a machine unless you have read and understand the instructions and warnings in the Operator and Maintenance Manuals. Failure to follow the instructions or heed the warnings could result in injury or death. Contact any Cat® dealer for replacement manauls. Proper care is your responsibility.

Joint Compaction

BUILT FOR IT.

CAT

Joint Compaction Techniques & Issues

Transverse Joints

Longitudinal Joints

Transverse Joint Compaction

Transverse Joint Compaction

- Straight edge tells the story
- Too high – more rolling may help
- Too low – hand work needed to fill in

What We're Trying to Avoid

- Came off too high - wrong starter boards?
- Poor hand work?
- Using compactor to try knocking down high joint
- Fractured rock
- Large bump

Another challenge is prevention of fractured aggregates in the mat. Fractured aggregate shows up as un-coated rock surfaces in the mat. In the example seen here, there are lots of fractured aggregates along the longitudinal joint. This was caused by operating the vibratory compactor with the drums straddling the joint. Too much of the load was concentrated on a small area of the mat. The solution is to roll in the static mode with most of the drum on the hot mat and just a small overlap on the cold side.

Other possible causes of fractured aggregate are:

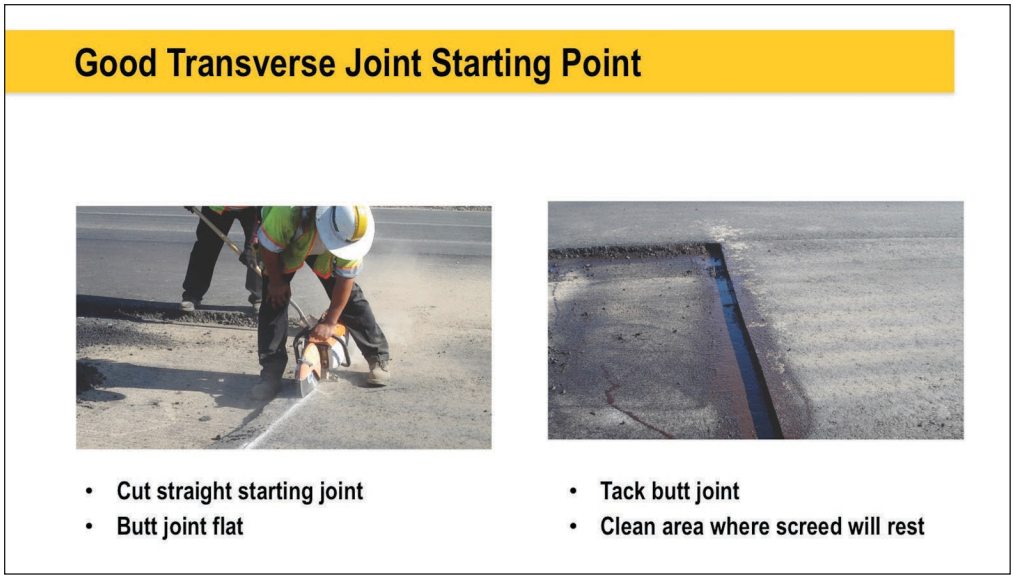
- operating at too high an amplitude,
- using a roller that is too heavy, or
- vibrating when the mat is too cool.

Poor Transverse Joint Starting Point

Incorrect Starting Reference

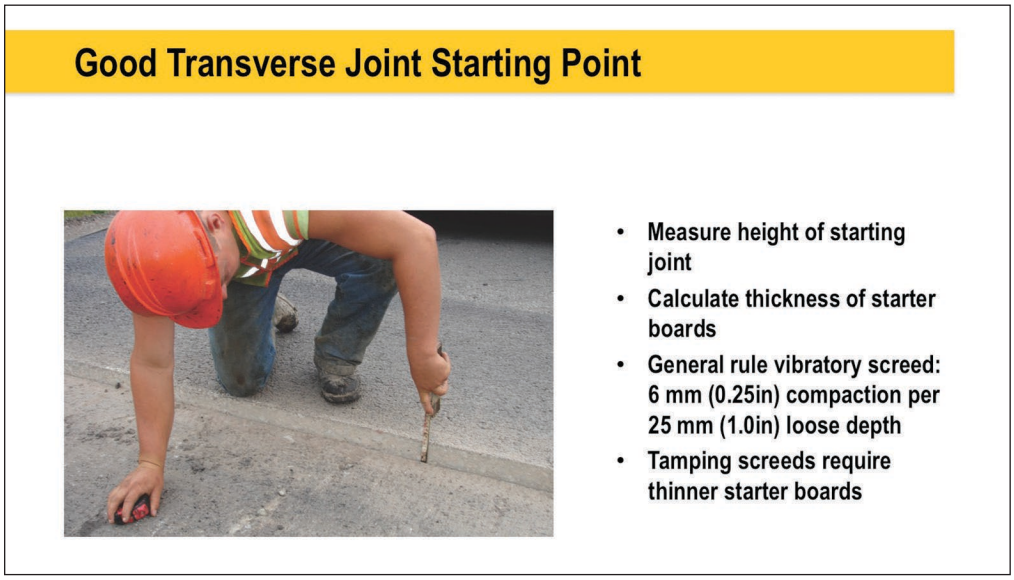
- Rounded face at the joint
- Plunge cut too deep

First, always make sure the transverse joint is in good condition prior to paving and compaction. Never start with a rounded or irregular edge at the transverse joint. If the grade is incorrect – such as too deep – at the starting joint, correct the problems prior to paving. In this example, fill in low spot and compact it prior to paving.



A utility cold planer, a skid steer with a cold planer attachment, or a circular saw must be used to cut a straight vertical face at the transverse joint. The area where the joint is cut should be the correct thickness and parallel to the line of paving.

A good starting joint will have a vertical face and the asphalt layer will be flat, not rounded, tilted up or tilted down. The face of the joint should be coated with tack to help create a bond between the cold asphalt layer and the hot asphalt layer. Clean the area of the cold mat just behind the joint so the height reference for the paver screed is accurate.



Another important factor in constructing and compacting a transverse joint is putting the correct starter boards under the paver screed as the screed is set down at the starting point. The starter boards provide the pre-compaction thickness of the mat as the paving crew pulls the screed off the starting joint. For estimating purposes, you can assume that the mat laid by a vibratory screed will compact at a rate of about 6 mm (1/4 in) per 25 mm (1.0 in) of loose mat thickness. Therefore, if the loose depth is 50 mm (2.0in), the starter boards would need to be 12 mm (1/2 in) thick. If the paver has a tamping screed, the compaction rate will be much less, typically around 10% and the starter board thickness will be less.

Good Transverse Joint Starting Point

- Minimum hand work is the goal
- Fill in low areas prior to compaction
- Rake off high spots prior to compaction

If the paving crew has done a good job building the transverse starting joint, the joint should need only minor handwork. If the joint is too high or too low, substantial handwork may have to be done prior to the start of the joint compaction process. Joint compaction should begin as soon as all corrections, if any, have been completed.

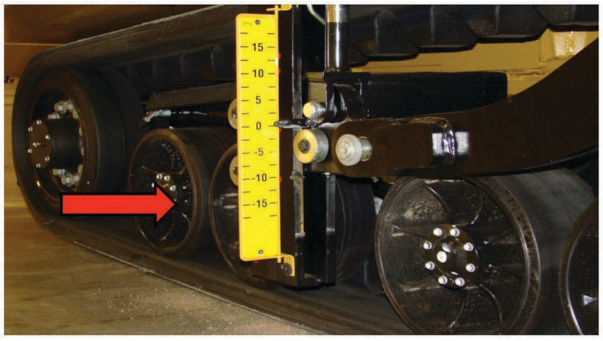
Good Transverse Joint

- Joint should be flat and smooth
- No bumps
- No dips
- Build the joint correctly

A transverse joint is created when paving begins at a point where the fresh asphalt layer meets a previously laid and compacted asphalt layer. The transverse joint will then be perpendicular to the direction of paving and the direction of compaction.

There are several techniques used to compact transverse joints, but the goal is always the same. The joint should be compacted flat and the area in front of the joint should be flat and smooth without high spots or depressions. Before paving and compacting a transverse joint, there are fundamental best practices that the crew should follow.

Correct Line of Pull



- Adjust both tow point cylinders to match the height of the screed pivot point
- Helps screed come off starting joint parallel to line of paving

After the screed has warmed up, center the tow points on both sides. When automatic grade and slope is used, mat thickness corrections are created by tow point movement. That's why it is important to center the tow point for equal travel in both directions. The whole concept behind setting the tow point to match the height of the screed pivot point is to establish a straight line of pull at the take off to start paving.

Correct Pre-Compaction Height

- Select starter boards of proper thickness
- Support main screed and extender screed
- Board length 0.9-1.2 m (3-4ft)
- Start with good paving and minimal hand work
- Mat depth must allow for rate of compaction
- Rule of thumb: ¼ in of compaction for each 1 in mat depth

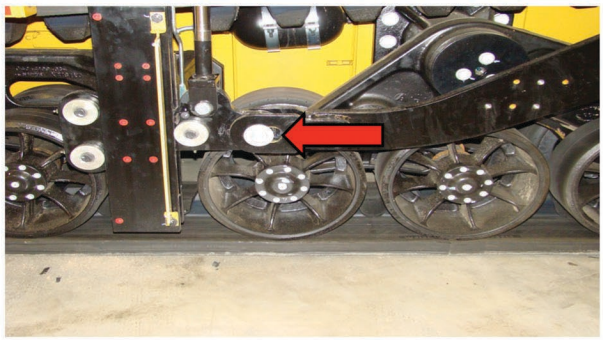
Position the starter boards under the screed.

Select starter boards whose thickness matches the mat depth and the rate c compaction. Normally, the mat will compact about 6 mm (1/4 in) per 25 mm (1 in) of mat depth. For example, to get a 50 mm (2 in) compacted mat, use starter boards which are 63 mm (2.5 in) thick.

Use two boards. Position them so they completely support both the main screed and the screed extension from front to back. The normal length is between 0.9 to 1.2 m (3 to 4 ft).

When the boards are in position, lower the screed so it rests on both boards.

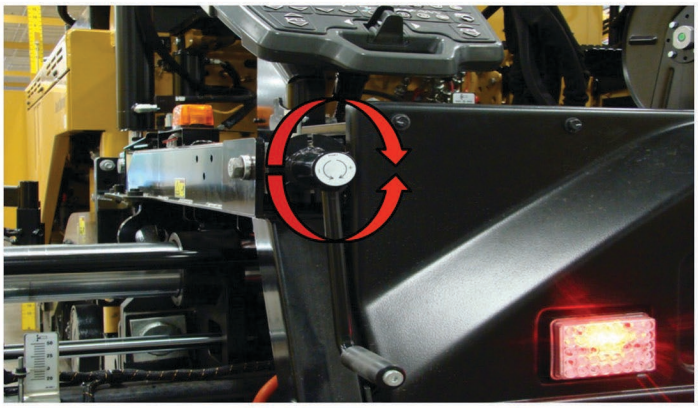
Correct Tension on Tow Arms



- Move the machine forward to remove the slack from the tow point

Move the machine forward until the tow arm roller contacts the tow point frame to remove the slack from the tow point. If this small, but critical step is not done, the screed will have a tendency to shift to one side as the tractor takes off, resulting in a transverse joint that is not square and possibly a small void of mix (gap) at the transverse joint that will need to be filled by hand work.

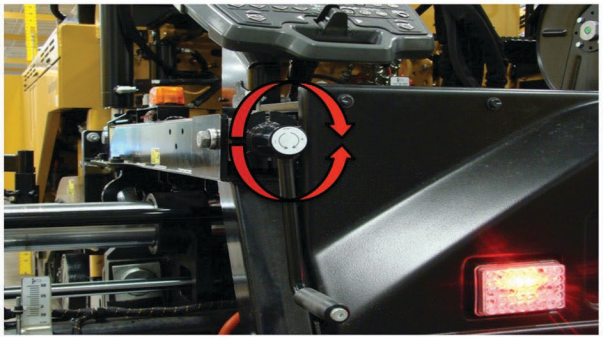
Screed Totally Relaxed



- Null screed by turning depth crank until no resistance is felt
- Null other depth crank

Use the manual depth control cranks to null the screed. Turn the crank in either direction until no resistance is felt. This ensures that the full weight of the screed is supported by the starting reference. Move to the other side and follow the same nulling procedure. Be sure the crank turns freely. Then, go back to the other side. Make sure the crank still turns freely.

Correct Angle of Attack



- Turn depth crank in direction of increase until tension is felt
- Set other depth crank the same way
- Screed reaches equilibrium with diving or climbing

Then, turn the depth crank in the direction that increases mat thickness until resistance is felt. Lock the depth crank in this position. On the other side, turn the crank until you feel resistance and lock it. On other types of screeds, you may have to turn the depth cranks one or more revolutions to set the angle of attack. Follow the manufacturer's guidelines for the screed you're setting up.

Correct Head of Material

- Manually fill auger chamber to 1/2 level
- Use manual override switches
- Alternately convey and auger material

Fill the auger chamber in front of the screed until it is one half full.

Using the manual override switches on the operator's console, alternately convey and auger material to the auger chamber and out to the ends of the augers. Your goal is to fill the auger chamber evenly on both sides. Use one conveyor switch at a time to move material out until it just touches the auger shaft.

Do Not Overfill

- Common crew mistake is overfilling
- Screed climbs off joint and creates a bump
- Using shovel, hand fill area between last auger and end gate

Don't force material out to the end gate. You'll probably overfill the chamber. Instead, move some material with a shovel to the area in front of the extension.

Do not fill in the area adjacent to the main screed and directly in front of the extension. This area will be filled by material automatically as the paver pulls forward off the starting reference.

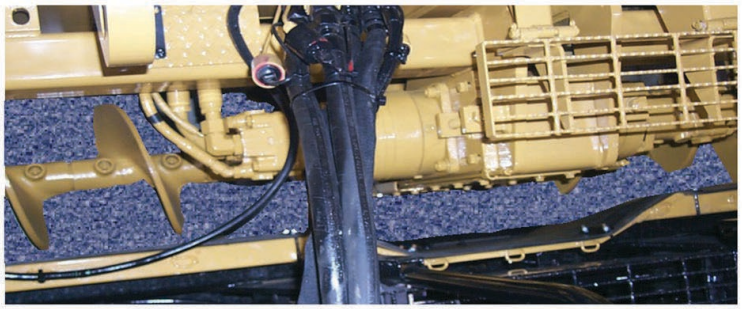
Keep Correct Head of Material

As paving begins…

- Screed personnel check material level at outboard end of augers
- Adjust mix height controls if needed to maintain material level at 1/2 auger
- No voids

Screed personnel observe the level of material at the outboard ends of the auger shafts to see if the auger shafts are one half covered. There are individual material height dials on the screed control boxes which are adjusted to control the height of material at the outboard ends.

Keep Correct Head of Material



As paving begins…

- Screed personnel check material level at outboard end of augers
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- No voids

CAT

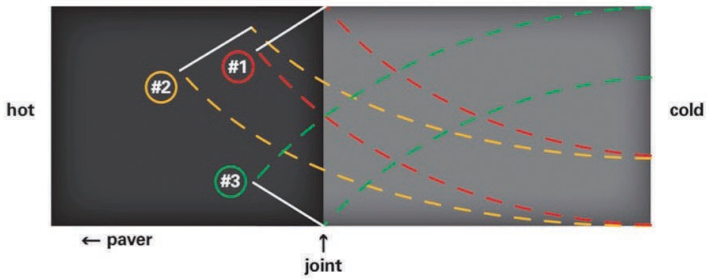
The transverse joint compaction technique recommended by Caterpillar is designed to flatten the hot / cold transverse joint while maintaining the smoothness of the mat in front of the joint.

The compactor operator can start in the center of the cold compacted mat or along one side of the compacted mat. Proceed forward, starting to turn the drums at an angle as the first drum approaches the joint. Work the front drum across the outer portion of the joint at an angle with both drums static, being careful not distort the edge of the fresh mat if the edge is unconfined. Back up in the same path.

Move over to one edge of the cold, compacted mat. Proceed forward in the static mode and work the front drum across the joint in the center of the mat. Reverse in the same path.

Move to the center of the cold mat. Proceed forward and work the front drum at an angle across the remaining outer portion of the mat. Use a straight edge to verify that the joint has been compacted flat across its entire width. Repeat static passes if needed.

Transverse Joint Rolling Patterns



- Pinches joint at angle rather than pushing hot mix away
- All stop marks can be cleaned up during first normal rolling pattern
- Pattern is always available for operator

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Transverse Joint Rolling Patterns

- Initial phase compactor starts normal pattern
- Paver should not have to stop and wait for joint to be prepared and compacted

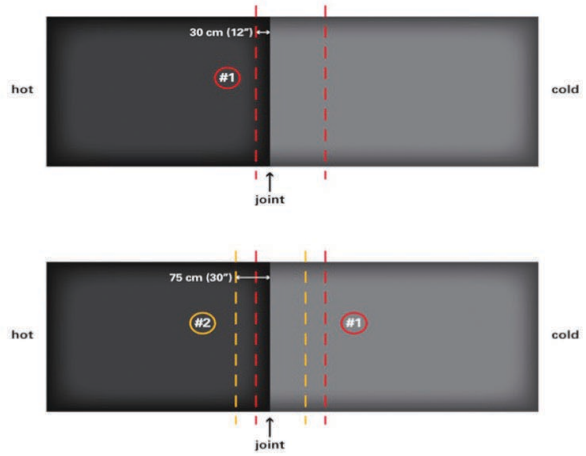
When all the elements of paving and compacting the transverse joint have been done correctly, the initial compactor operator should be able to start the established rolling pattern. The paver should not have to wait for the transverse joint to be compacted, but should be able to pave at the calculated speed and still be a reasonable distance away from the joint as initial compaction starts.

Transverse Joint Rolling Patterns

- Can pinch joint from the side if space permits
- Utility size compactor makes job easier
- Leaves drum edge cut mark perpendicular to direction of rolling pattern

Some crews prefer, when possible, to compact a transverse joint by rolling across the joint from the side. This technique is very effective at flattening the joint, but it leaves drum edge cut marks that are perpendicular to the direction of compaction. Utility size compactors make it easier to approach the transverse joint from the side.

Transverse Joint Rolling Patterns



- First pass most of drums on cold side
- Check flatness
- Second pass, if needed, move farther onto hot side
- All passes static
- Should not have to vibrate to pinch a transverse joint

When compacting a transverse joint from the side, make the first pass with most of the drums on the cold mat with a 30 cm (12in) overlap on the hot mat. Check the flatness of the joint.

If another pass is necessary to flatten the transverse joint, move over with more of the drums on the hot mat. The larger overlap will clean up the first drum edge mark.

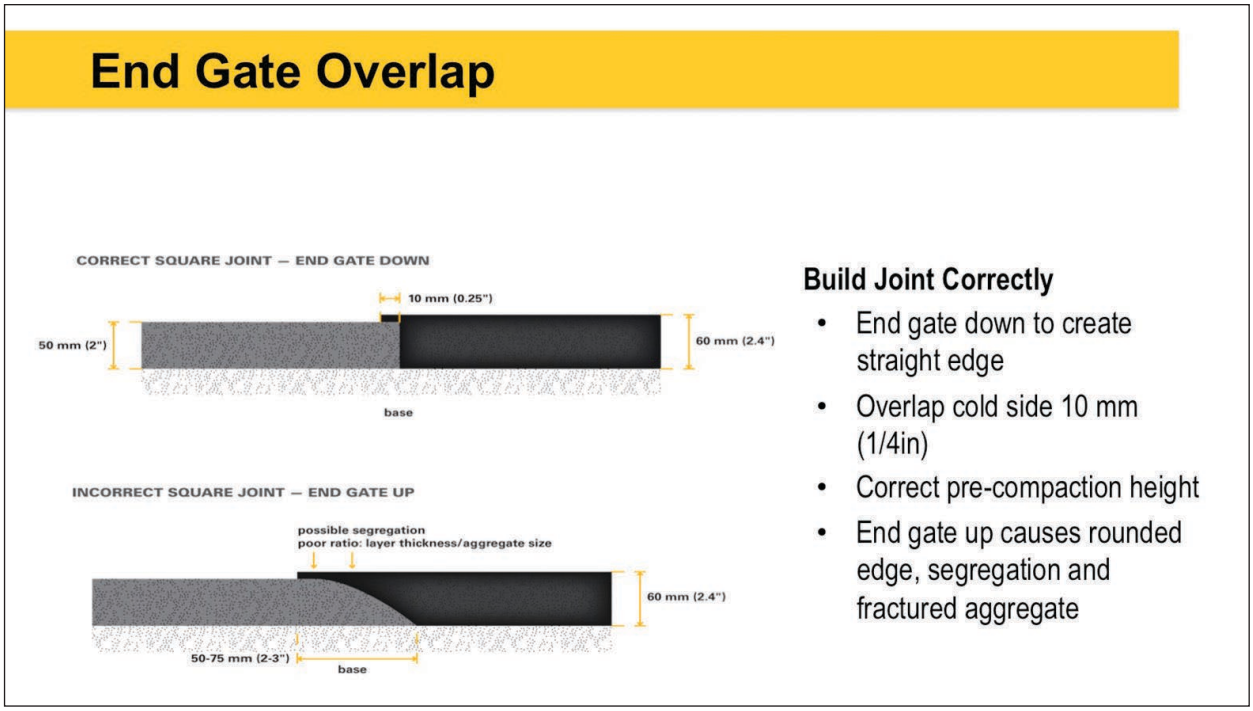
If another pass is necessary, move across the joint with most the drums on the hot mat to clean up the second drum edge mark. The drum edge cut mark left by the third pass is perpendicular to the direction of compaction. When the initial compactor starts its first pattern, the it will tend to push over the drum edge mark and can create a bump a short distance in front of the transverse joint. Caterpillar does not recommend this pattern for any project that will be measured for smoothness.

The first step in creating a quality, high-density longitudinal joint is building it correctly during the paving process. The paver operator should have a steering guide, paint stripe or string, to follow. The joint edge should be as straight as possible in order to make the joint matching as easy as possible.

A useful option for some applications is an edge cutter. The edge cutter installs on Cat® Asphalt Compactors in order to trim unconfined edges. The trimmed edges provide an improved vertical face and a better line for matching.

Joint Overlap / Joint Height

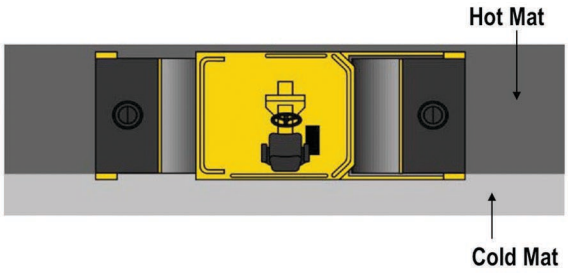
- End gate overlap 1in
- Precompaction height 1/4in per inch of mat thickness
- No raking required
- Can use averaging ski or joint matcher



Next, the paving crew should have the end gate ski in contact with the grade being paved. The end gate ski should float on the grade and create a uniform vertical edge that will provide a good bonding surface for joint matching. When the paving crew matches the unconfined edge to create the longitudinal joint, they should overlap the cold asphalt layer about 10 mm (0.25 in). The overlap is necessary to make sure there is enough material at the joint to provide a good seal in order to prevent moisture penetration. The height of the hot asphalt layer should be enough to allow for the compaction rate of the asphalt layer. In the example above, the cold compacted layer is 50 mm (2.0 in) thick. The hot asphalt layer is laid 60 mm (2.4 in) thick. After compaction, the hot asphalt layer will match the height of the cold mat, assuming that the crew has correctly calculated the compaction rate. Remember, the compaction rate, as a general rule, is about 6 mm (1/4 in) per 25 mm (1.0 in) of screed laid thickness when a vibratory screed is used and about 5 mm (1/5 in) per 25 mm (1.0 in) when a tamping and vibrating screed is used. Always verify the compaction rate of the fresh layer when building a longitudinal joint.

When the paving crew operates the screed with the end gates in the raised position, the unconfined edge rolls over, especially when being compacted. The sloped edge causes larger aggregate to drag under the screed when the joint is being matched by the next paving operation. You are likely to see broken aggregate along the longitudinal joint when the joint is compacted.

Longitudinal Joint Rolling Patterns



- Both drums on hot side first pass
- Force hot material against joint
- Exception: layers more than 100 mm (4in) thick may need a pass to "pinch" the joint first

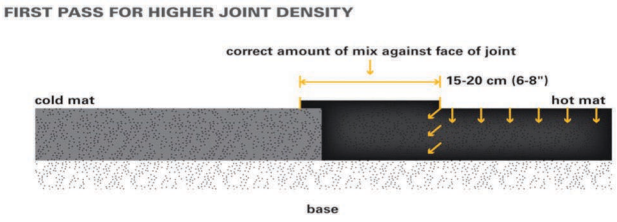
The commonly recommended procedure for compacting a longitudinal joint is to, first, roll with both drums vibrating right along the joint with all the drum surface on the hot side. The drums force the hot asphalt into the joint.

An exception to this pattern is when you are compacting layers 4in thick or greater. To pinch the joint shut, you should slightly overlap the joint on the first pass. Make this pass in the static mode.

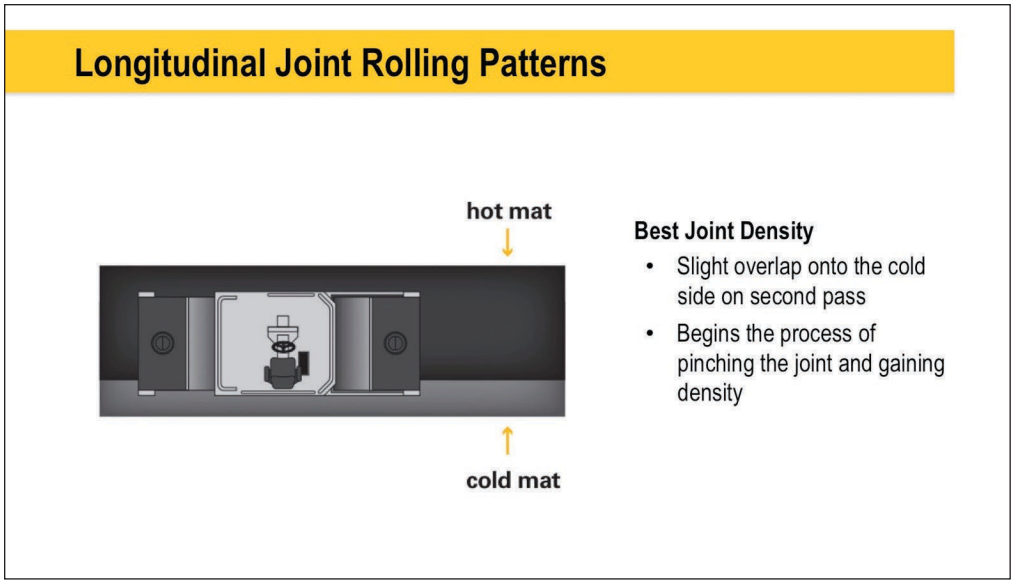
Longitudinal Joint Rolling Patterns

Best Joint Density

- First pass on hot side 15-20 cm (6-8in) away from joint
- Pushes asphalt toward the joint to help gain density



When joint density is the main objective of the compaction process, the first pass made by the initial phase compactor should be made with both drums on the hot mat about 15 – 20 cm (6 – 8 in) away from the joint. By keeping the drums slightly away from the hot / cold joint, asphalt mix is pushed toward the vertical joint face. Pushing mix toward the joint helps ensure that there will be fewer air voids in the mat after compaction is completed.



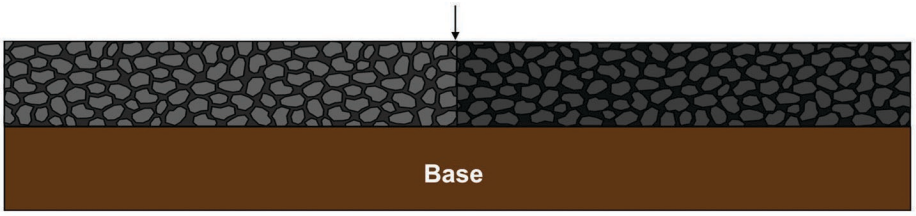
During the return pass along the longitudinal joint, the drums should slightly overlap onto the cold mat. The slight overlap will begin the process of creating joint density, sealing the joint and knocking down the hot mat so its height will be the same as the cold mat.

During all phases of compaction and with all types of compaction equipment, the longitudinal joint can be overlapped once the initial pass has been made. Pneumatic compactors are especially good at knocking down the hot layer in order to equalize the height of the two asphalt layers.

Properly Built & Compacted Joint

Correct Square Joint
End Gate Down

Should pinch down without raking



Sealed Joint

- No segregation
- Correct height match
- No material voids
- Good density

Excessive Overlap

- Poor compaction, loose rock at joint
- Joint needed raking prior to compaction
- Real solution is to control end gate overlap

Raking is not the Answer

- Creates segregation at the joint
- Pushes mix away from the joint
- Light "bumping" is acceptable

In the end, nothing worked very well on a consistent basis. There was no real benefit in high amplitude, low amplitude, high frequency, or low frequency.

The real problem was that the road design and mix design made the job of construction, and compaction in particular, very difficult. For this project, it was not possible to significantly change either road or mix design to improve the end result.

There were also some construction methods that were preventing good density results. For example, the crew was raking the coarse material at the joint over onto the hot mat. Since this mat was so thin, any raking at all caused significant segregation. This was the one of the main reasons they were getting density variations.

In the end, they were able to find a few working conditions that helped them get to their minimum density specifications. Vibrating only one drum on the breakdown roller helped. Keeping the working speed down also helped to keep densities up.

Compaction of Specialty Joints

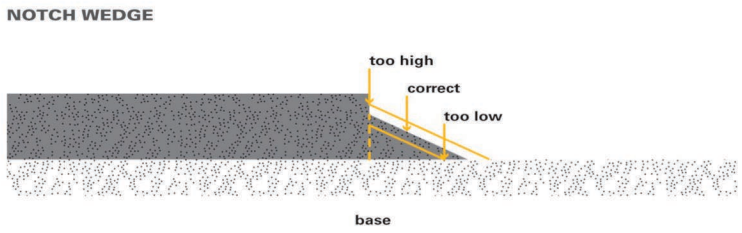
Notched Wedge

- Often required for traffic safety
- Towed compactor used as an aid on some projects

Some public works departments require the construction of a notched wedge joint whenever there is a possibility that an unconfined edge may be opened to traffic and that unconfined edge is 50 mm (2.0in) high or higher. The purpose of the notched wedge is to make it easier for vehicles to cross the open vertical edge.

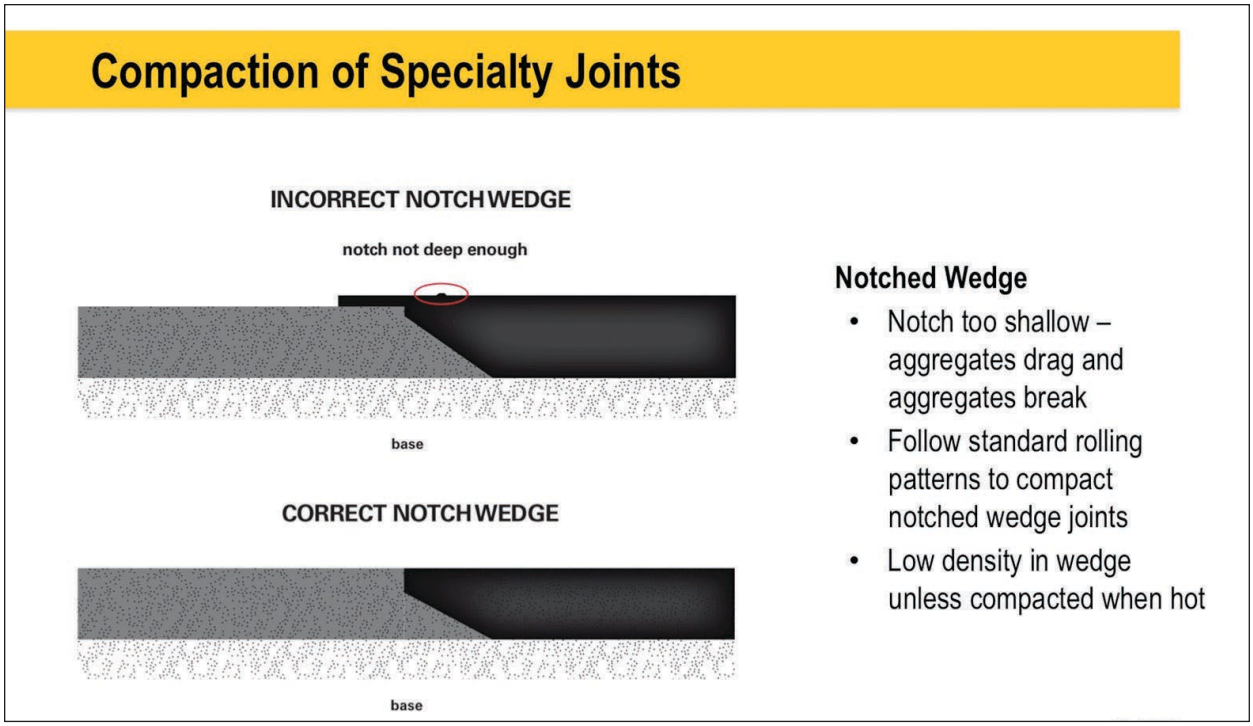
As an aid to the compaction of notched wedge joints, towed rollers are sometimes attached to the paver screed. The towed roller is normally used when the asphalt layer includes a notch that is at least 50 mm (2.0in) high and a wedge that is at least 50 mm (2.0in) thick. Properly constructing notched wedges is the key to getting good notched wedge joint density.

Compaction of Specialty Joints



- **Depth of notch at least two times the size of largest aggregate**
- **Thickness of wedge at least two times the size of largest aggregate**

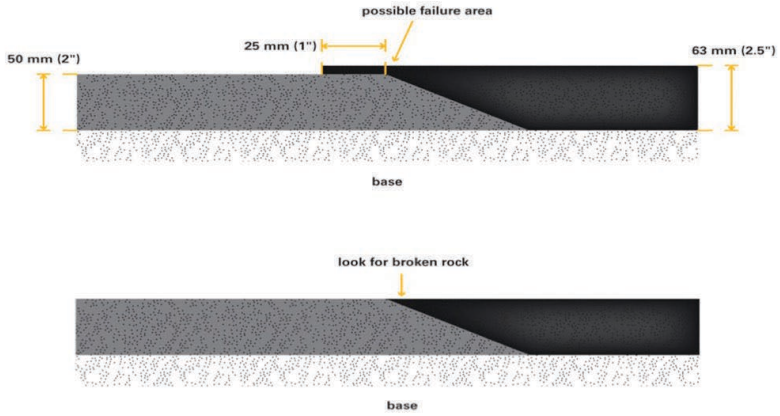
Getting the correct notch height and wedge thickness is critical when paving notched wedges. The height of the notch should be at least twice the size of the largest aggregate in the asphalt mix. Likewise, the thickness of the wedge should be at least twice the size of the largest aggregate. If the notch is too short, aggregate will drag along the face of the notch. If the wedge is too thin, aggregate will drag along the edge of the wedge.



A shallow notch will result in a line of segregated large aggregate along the face of the notch. You may see uncoated rock surfaces in this area, a sign that aggregates are being fractured because the layer is too thin in this area. Over time, moisture will penetrate through the segregated material and the joint will begin to separate causing premature joint failure.

When the notched wedge is built correctly, it can be compacted correctly. Follow the same procedures as if you were compacting a joint with a vertical face. Stay 15 – 20 cm (6 – 8in) away from the joint with the drums entirely on the hot mat during the first pass along the longitudinal joint. Most research shows that notched wedge joints have as high or even higher density when compared to the densities of vertical joints – if the wedge portion of the joint can be compacted when the wedge is hot.

Compaction of Specialty Joints



Wedge Joints

- Thin layer at top of wedge
- Leads to segregation stripe and broken rock
- Only suitable for mixes with small aggregates

Wedge joints are another option sometimes specified by public works departments for the same reason that notched wedges are specified – traffic safety.

Wedge joints have an inherent problem due to lack of mat thickness in the area next to the intersection of the hot and cold mats. There is no vertical notch. There is only an angled face, or wedge, upon which the fresh asphalt placed. Therefore, there is always a possibility of segregation at the top the wedge. Prior to compaction, you may see a segregation stripe just inside of the joint. After compaction, you may see a stripe of uncoated rock just inside the joint. Wedge joints are most suitable when the largest aggregate in the mix formula is 9 mm (3/8in). Mixes with larger aggregates are prone to segregation at the wedge joint.

Lack of Mix at the Joint

- Joint separation normally caused by lack of mix prior to compaction -- incorrect overlap
- Can be excessive raking
- Can be lack of tack on face of joint

Joint Compaction for Appearance

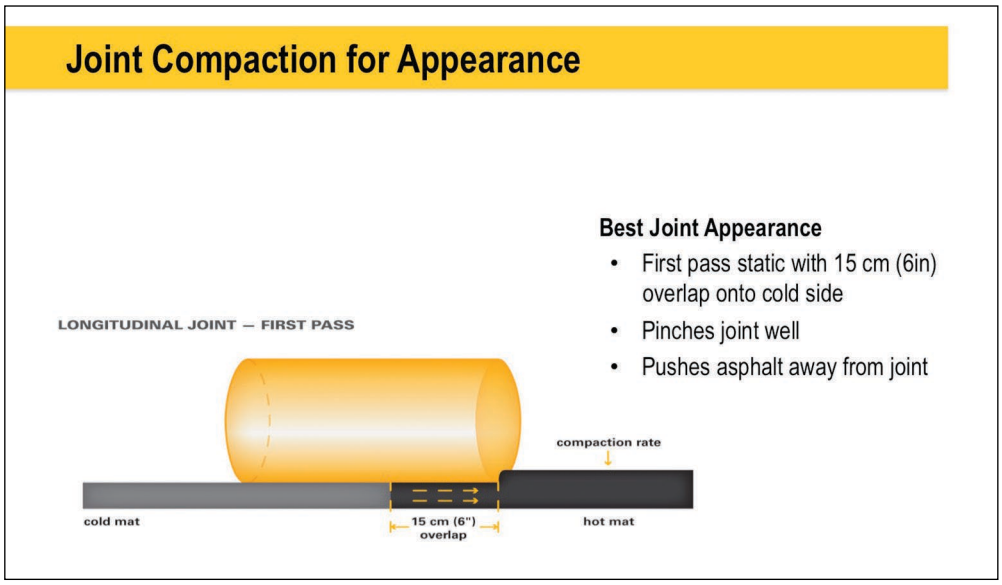
Best Joint Appearance

- First pass pinch joint with drums mostly on cold side in static mode
- Verify there is ample space for this pattern
- Verify that production and temperature permit this pass when doing high production work

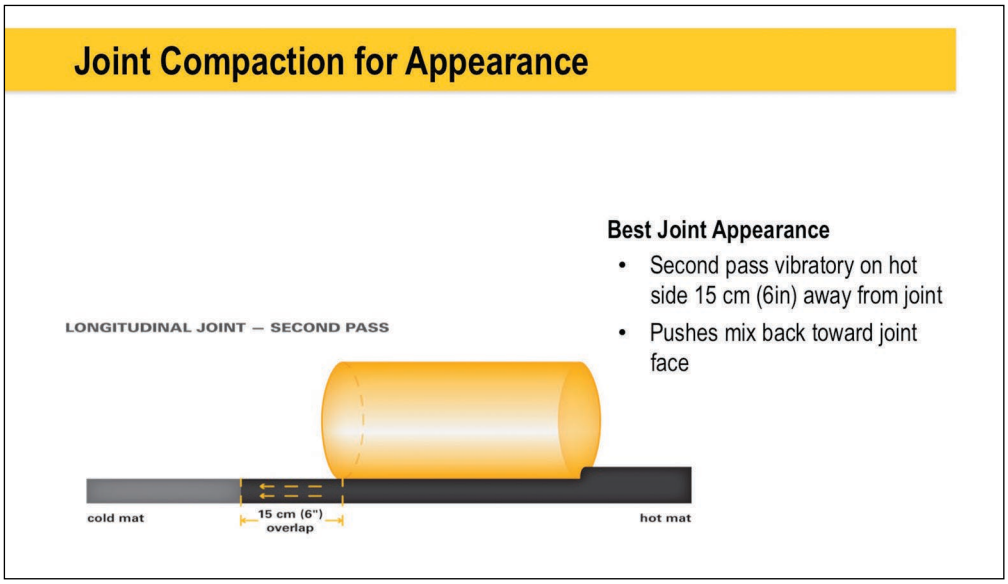
On some projects, the main goal is the make the longitudinal joint disappear as much as possible. The task is made easier if the longitudinal joint is between hot mats being laid down simultaneously by multiple pavers working in echelon. Creating better appearance is also easier if the joint is between a hot mat and a warm mat that is still somewhat pliable at the surface.

To create a longitudinal joint with the best final appearance, make the first pass along the joint with most of the drums on the cold side of the joint and a slight overlap on the hot side. The compactor must be operated in the static mode during this pass to avoid bouncing on the cold side.

If you're paving and compacting a parking lot or working in a new residential area, you probably will not have to worry about traffic or space. However, you should always confirm production requirements and mat temperatures when planning to include a joint-sealing pass.



During Pass One, the drums slightly overlap onto the hot side. From an appearance standpoint, the drums effectively push the hot mix down to make the joint height equal on both sides. From a density standpoint, some mix is pushed away from the joint as there is no confinement near the drum edge.

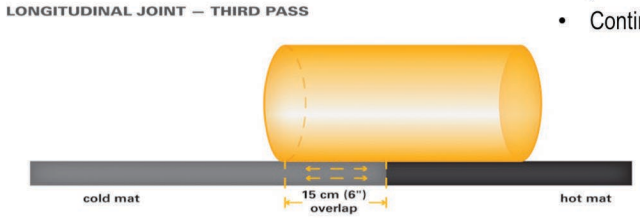


During Pass Two, position the compactor with both vibratory drums completely on the hot mat with the drum edge about 15 cm (6 in) away from the joint face. This vibratory pass starts to create the required density and tends to push a little mix back toward the longitudinal joint.

Joint Compaction for Appearance

Best Joint Appearance

- Third pass vibratory 15 cm (6in) overlap onto cold side
- Starts to create density in the joint
- Continues to pinch joint



During Pass Three, position the compactor with so the drums slightly overlap the longitudinal joint with most of the drums on the hot mat. Since the overlap onto the cold mat is small, you can operate with the drums vibrating. All other passes, if any, with all other compactors can overlap the joint during passes adjacent to the longitudinal joint.

Summary

- **Paving crew builds joint correctly**
- **Verify overlap and pre-compaction height**
- **Select rolling pattern that meets project requirements**

Much like transverse joints, building quality longitudinal joints requires the best efforts of both the paving crew and the compaction crew. The compaction process cannot correct mistakes made during the paving process. When troubleshooting longitudinal joint problems, start by looking first at the edge of cold mat; then verify that overlap and height of the hot mat are correct; finally, adjust your rolling pattern to conform to the requirements for joint density or for joint appearance.

Notes

Notes

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