# THE BEST WAY TO ROLL A JOINT

## And Everything Else You Should Know About Constructing Longitudinal Joints

*by Mark Buncher*

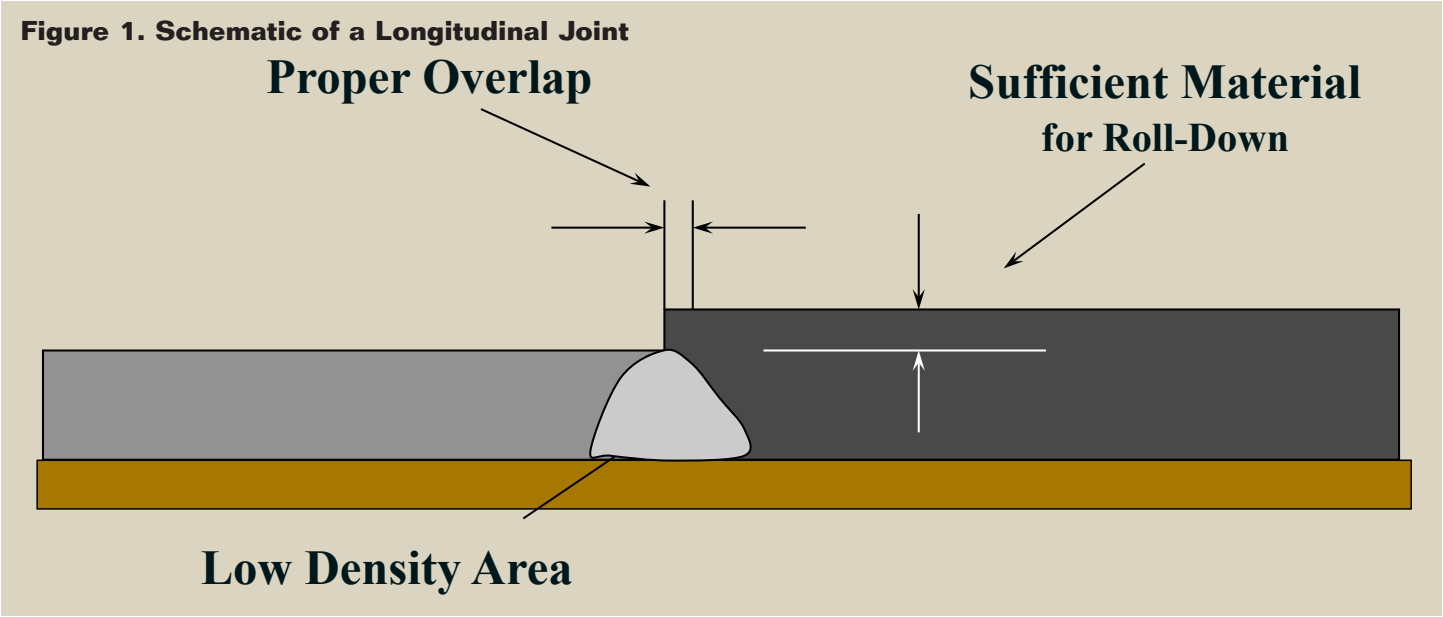
A chain is only as strong as its weakest link and for asphalt pavements that link is the longitudinal joint.

Despite research, trials, studies and training that stretch back more than 50 years, joint deterioration continues to be the most often cited cause of premature pavement failure. Improving joint construction, which in turn improves density and decreases permeability at the joint, is probably the single most important thing the asphalt industry can do to improve its pavements' performance.

The U.S. Federal Highway Administration and the Asphalt Institute recently completed a two-year review of longitudinal joints. The study looked at past studies and research as well as state-of-the-practice for specifying and constructing joints in an effort to develop a consensus on best practices. The report, titled Best Practices for Constructing and Specifying Longitudinal Joints, will be available on the Asphalt Institute's website.

This article presents some of those findings, focusing on construction.

**Figure 1. Schematic of a Longitudinal Joint**




## Methods to Minimize Unconfined Cold Joints

A *Longitudinal Joint* is the interface between two adjacent and parallel HMA mats. Premature joint failures are the result of a combination of low density, permeability, segregation, and lack of adhesion at the interface.

Inherent factors, such as the joint interface and lateral movement of the HMA mat under the rollers at an unconfined edge, typically result in lower density at the joint. Figure 1 shows the low density area on the unconfined side, referred to as the cold side of the joint. Figure 1 also points out two other important aspects of constructing a quality joint that will be discussed later, proper overlap and sufficient material for roll down, each on the hot side of the joint.

Since most paving projects are done under traffic, contractors typically pave one lane at a time. The edge of the pavement cools before the adjacent lane is placed, hence the conventional "cold joint."

The most obvious way to avoid a cold joint is to pave more than one lane at a time, either by using a paver capable of paving multiple lanes in one pass, or by paving in echelon, with two or three pavers side-by-side. Since the mat is hot on both sides of the longitudinal joint when rolled (thus the name "hot joint"), the densities are similar to those in the middle of the mat. Unfortunately, the opportunity to pave in echelon is usually limited to airfields, new construction and major highway rehabilitation.

If providing a "hot joint" is impractical or too expensive, there are other ways to circumvent the unsupported edge cold joint and subsequent low density area.

Cutting back the unsupported low density material (typically between 3 and 8 inches) after the mat has been rolled but is still while warm, provides higher joint densities and better joint performance. The cutting tool is typically a disk blade mounted on a tractor or roller with a 60-degree angle from vertical. It is important to cut the edge in a straight or smooth flowing line to facilitate a uniform and proper overlap when the joint is closed up (see Fig. 1). Cutting back the joint is often done on airfields with a closed runway or taxiway. It is not practical if there is traffic in the adjacent lane.

For mill and fill projects, the contractor can mill and pave a lane before milling the adjacent lane. Both sides of the paving mat will have a confined edge and therefore the joint density will be higher. There is, however, one obvious disadvantage to this method. Milling contractors like to mill an entire project and move on, rather than mill a small quantity and wait for the paving operation. Restricting the milling operation will likely result in some additional costs. It is also difficult to thoroughly clean the corners created at the milled edges before paving, especially at night.

The use of joint heaters has undergone a resurgence in our industry of late. Longer, more efficient infrared heaters, and automation to match the speed of the paver provide uniform heat along the joint, eliminating overheating and under-heating, which had been a long-standing concern. Recent research projects at Arkansas and Tennessee Universities have shown joint heaters can improve joint density by 1 to 2 percent.

## Butt versus Notched Wedge

There are two types of joints: the butt and the notched wedge.

Butt joints are typically placed with a paver, but can also be formed by cut back or milling. Some contractors believe that butt joints are better for smoothness than notch wedge joints.

The notch wedge (shown in figure 2) has several different configurations, with slopes ranging from 3:1 to 12:1. The notch is a critical feature, otherwise the slope tapers to nothing and the larger sized aggregate will drag. The required notch thickness can also vary, but typically will be one nominal maximum aggregate size of the mix.

The wedge joint has a safety and production advantage because contractors can continue paving without an edge drop-off. For butt joints, the maximum allowable drop-off while keeping traffic open is typically 1.5 to 2.0 inches. If the mat is thicker than this, the contractor will have to stop midway and regroup the paving train to level up the adjacent lane. Wedge joints eliminate this issue.

Research shows that the notch wedge joint provides slightly higher densities than the butt joint, most likely due to the

confinement offered by the wedge under the roller. Critics, however, are concerned about the limited compaction of the wedge itself. Methods vary from hand vibratory plates, to small tow behind rollers, to commercially available paver attachments that shape and compact the wedge through vibration (shown in Figure 2).

## Best Practice Steps for Constructing a Joint

***Start Off Right:*** A good joint requires a balanced paving operation; plant production, number of trucks, delivery time, paver speed and roller speed all co-ordinated to match tonnage arriving on the project.

Segregation must be minimized, including when loading the trucks and maintaining the hopper. Using a Material Transfer Vehicle helps minimize segregation and allows the paver to maintain a consistent speed without getting bumped by trucks. The "dump person" plays a critical role by guiding the trucks to the paver for "dumping" in a manner that allows the paver to continue in a straight or smooth line without wiggle.

***Tack Full Width:*** The application of a properly cured tack coat (asphalt cement or emulsion) uniformly across the full width of paving lane is critical to minimize the lateral movement of the unsupported edge.

***String-line to Ensure First Pass:*** Use a string-line guide to ensure the first pull is straight. The paver operator should have a clearly visible reference off the paver that can be used in conjunction with the string-line. A straight first pull allows the paver operator to make a consistent and uniform overlap that closes up the joint (future step).

***Vibratory Screed On:*** Ensure that the vibrator screed is always turned on, as it provides an initial level of compaction to the mat and at the joint. Unfortunately, the vibration on the screed makes for a less than pleasant platform to stand on all day (if you press some contractors for an honest estimate, you find that the vibratory screed is on only about 50% of the time while paving).

***Automatics On:*** Run the paver with grade automation on instead of trying to control the grade manually.

***End Gate Seated:*** The end gate should be seated firmly on the existing surface to prevent material from squeezing out underneath. Remove any escaped material as it will not be compacted.

***Uniform Head of Material across Auger:*** Co-ordinate the paver and auger speed to allow for a uniform head of material across the entire width of the paver. Maintain paver and auger speed.

***Use Auger and Tunnel Extensions:*** The auger and tunnel should be extended within 12 to 18 inches of the end-gate so the material is carried, and not pushed, out to the joint. Augers that fail to carry material to the end-gate will create an excess of material being pushed in front of the screed at the edge. This is a source of segregation and the resulting low density, high permeability found in many longitudinal joints. Tunnels control the flow of material and just like the augers should be extended 12 to 18 inches from the end-gate.

Figure 2. Notched Wedge Joint

***First Roller Pass to Overlap Unsupported Edge:*** There are two predominant opinions on the best way to roll the unsupported edge. The first method, and the one recommended here, is that the first pass of a vibratory roller drum be extended out over the edge of the mat approximately 6 inches.

Alternatively, the contractor can make the first pass of vibratory roller back 6-inches from the unsupported edge, and then extend the drum out over the unsupported edge on the second pass. The proponents of this method believe the unrolled strip of material limits the lateral movement of the mat under the roller during the first pass. However, there are concerns that stress cracks parallel to the joint can develop at the edge of the roller from the first pass.

The alternative method should be used only if the contractor is certain that stress cracks are not occurring. The new mat should be checked for stress cracks, even after the project is finished. The development of stress cracks may be mix dependent.

***Monitor Density of Unsupported Side Using Gauge:*** As part of the contractor's quality control program, relative joint density should be monitored at both the unsupported edge and supported edge using density gauges.

Gauges should be set parallel to the longitudinal joint, with the edge of the gauge offset 2-inches from the joint. The density measurement should be an average of two (or four) 1-minute readings, rotating the gauge 180 degrees between readings. Gauges should be calibrated and a correlation factor calculated based on core densities taken from the mat.

Many agencies require a minimum density at the joint (often done with cores) for their quality assurance program.

***Paint the Joint Face:*** Tack the existing face of the joint with the material (emulsion or asphalt binder) being used to tack the mat.

If an emulsion is being used, double tacking will increase the residual binder on the joint face. A better option is to paint the open joint face with a proprietary rubberized joint adhesive, which has been rated highly for performance under several research projects.

***Use a Joint Matcher to Never Starve Hot-side:*** Remember, the best joint is not the prettiest joint. The use of a ski, versus the joint matcher, averages over the length of the ski the depth of material needed, providing a smoother pavement but not the best joint.

When closing up the joint for the surface lift, the use of a "Joint Matcher" rather than a Ski for grade control is highly recommended. Multiple lifts offer the opportunity to use a ski on intermediate lifts for smoothness and a Joint Matcher on the surface lift for the best joint. A ski can also be used on the other side of the mat that is not closing up the joint.

Having sufficient depth of material at the hot-side is critical for joint density. The joint matcher, set adjacent to the end gate, provides the optimum depth of material (with roll down) needed right at that location.

If insufficient material is placed, known as "starving the joint," the roller drum will "bridge" onto the cold mat and no further densification will occur. To ensure this does not occur, target a height difference of 0.1 inches between the two sides of the joint after compaction.

***Overlap 1 Inch:*** Proper overlap of mix at the joint is 1 inch plus or minus 0.5 inches. When the butt joint is constructed by milling or cutting back the existing lane, the overlap should be approximately 0.5 inches because the edge is more vertical.

***Do Not Lute the Overlapped Material:*** Assuming no more than the proper overlap was placed, the material should not be pushed back (luted). The 1 inch overlap is rolled into the cold mat and will not cause a problem (other than at most a minor amount of broken aggregate).

Once again, the best joint is not the prettiest joint. If the overlap does exceed 1 inch, the material can be carefully bumped with a lute. Overly excessive material can be removed with a flat-end shovel. It is extremely important to ensure the material is never luted across the joint in a manner where the roll-down material is spread across the mat. This will almost certainly starve the joint.

***First Roller Pass to Stay Back 6 to 12 Inches:*** Compact the supported edge of the joint with the first pass of a vibratory roller drum staying back from the joint by 6 to 8 inches. The second pass should then overlap onto the cold mat by 4 to 6 inches. Watch for any stress cracks developing at the edge of the roller from the first pass.

Alternatively, have the first pass of the vibratory roller overlap the cold mat by 2 to 6 inches. Note, however, that if there is insufficient depth of material placed on the hot side, the roller will immediately bridge over and not compact the hot side of the joint.

While there are other methods to roll the supported edge, these two are the most commonly used.

***Monitor Density of Supported Edge Using Gauge:*** (See the guidance above where the use of a density gauge on the unsupported edge was recommended as part of a contractor's QC program).

Gauges on the supported side should not be placed directly over the joint because the surface is typically not flush at the joint. The gauge cannot be seated properly and will not give an accurate reading.

As with the unsupported edge, the gauge should be set parallel to the joint with its edge offset 2 inches from the joint. Of course, densities should be higher on the supported side compared to the unsupported side.

Additional monitoring could include cutting a core at the joint for density after each day of paving.

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