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Illinois Asphalt Pavement Association
Scholarship Research Report

Longitudinal Joints in Flexible Pavements

Prepared for the IAPA Scholarship Committee
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Acknowledgment

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Abstract

This research report explores asphalt pavement construction procedure specifically the longitudinal joint construction. In addition, construction techniques, longitudinal joint failure and maintenance techniques have been discussed. Asphalt roadways date back to the beginning of the 20^{th} century. It is often used for its durability but a common problem occurs along the longitudinal joints. There are many different construction methods to properly complete and connect a joint at two ends. Once a joint is installed, many times irregularities appear and issues arise. Common issues that appear often are cracks. These cracks can be repaired by using a rubberized material to patch over the existing crack and prevent the crack from becoming more severe and spreading. The findings of this research have concluded that there are many options and methods of best practice to help prevent longitudinal joint failure and increase the longevity of longitudinal joints to create better more efficient asphalt roadways and surfaces for the future.

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INTRODUCTION

Flexible asphalt pavements have been in use since the beginning of the 20th century. Throughout the course of time, millions of miles of pavement have been constructed and reconstructed using asphalt. Asphalt paving is one of the most sustainable forms of construction. Where many doubt flexible pavements performance is along the longitudinal joints. Longitudinal joints are a key component in asphalt paving. The care taken to pave at these joints can result in a good pavement or a poor pavement. In this report, the longitudinal joints are analyzed with the proper construction, issues involved at the joint, the repairing process, and maintenance to help increase the longevity of asphalt roadways. Discussing these topics will introduce proven methods that further innovate the asphalt paving industry.

ASPHALT PAVING

In a typical new construction project, flexible pavement consists of a properly prepped base course, which consists of a structural stone or aggregate. The aggregate is compacted to the resident engineer's specifications, and then the asphalt concrete can be paved. Asphalt concrete consists of a mixture of aggregate and asphaltic cement which is a byproduct of crude oil. Mixing both ingredients together and heating them creates what is known as hot mix asphalt (HMA). Once the base course has been prepared with aggregate a prime coat is spread to insure proper bonding of the asphalt concrete and the aggregate base. Next, hot mix asphalt is loaded into the hopper of an asphalt paver and is spread on the ground evenly. A roller drives across the asphalt concrete to properly compact and finish the pavement. Once a lane has been completed, the paver will repeat the process for additional lanes. Figures 1 and 2 show pavers used for the placing of HMA as well as the location of longitudinal joints within the pavement. Multiple lanes may be paved if needed, when two lanes are paved the joint that connects the two lanes is the longitudinal joint. It is impossible to avoid making longitudinal joints as a much larger paver would be needed to cover all the lanes. Traffic control would become a nightmare if multiple lanes were paved at the same time, resulting in congestion.

Figure 1. Asphalt paving operation with a paver.

Figure 2. Asphalt paving operation with a paver and flow boy trailer.

LONGITUDINAL JOINT CONSTRUCTION TECHNIQUES

When driving down an interstate, spotting longitudinal joints can either be quite difficult or fairly easy. They are typically masked by pavement markings or clearly visible by a distinctive crack right down the middle of two lanes. A longitudinal joint is the contact point where two asphalt lanes meet. It is the most important portion of the paving process due to its nature and role in the structure. In order to achieve an efficient joint proper density must be achieved. “Density is the compaction percentage of the material” (Estakhri 2001). Neglecting proper joint construction practices can cause major issues on a project, leading to poor performance and unhappy motorists. There are many techniques used in the industry to maintain a high level of quality along longitudinal joints.

One popular method often used for its proven performance is the restrained edge method. “This technique utilizes an edge compacting device attached to a compacting roller shown in Figure 3 which allows the roller to pinch in-between the joints while compacting” (Kandhal 2002).

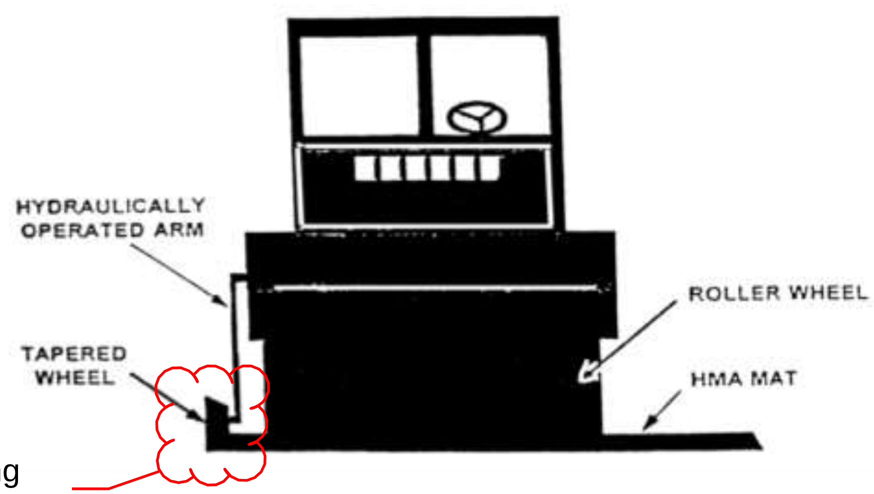

Figure 3. Edge restraining device. (Kandhal 2002)

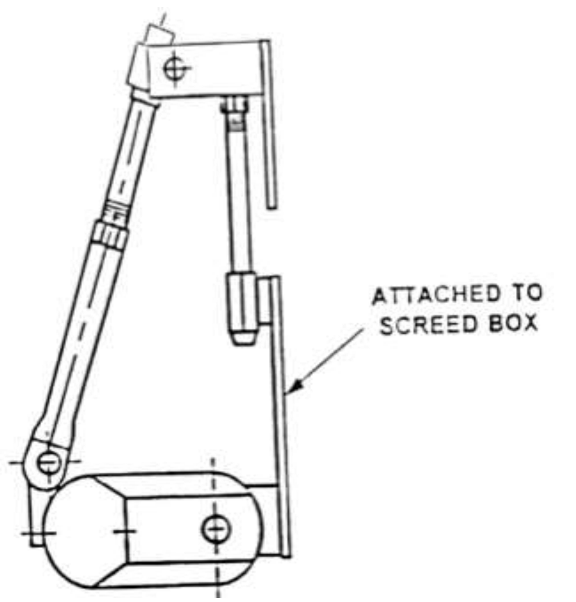

Figure 4. Joint maker. (Kandhal 2002)

A joint maker is another technique being used. Shown in Figure 4 a joint maker consists of a boot shaped device which is attached to the side of a screed on a paver. “A joint maker provides initial compaction of the asphalt before going under the paver which makes for a much cleaner looking joint” (Fleckenstein 2002). “Proper use of the joint maker significantly increases density at the joint and better interlocks aggregates at the joint" (Kandhal 2002).

Figure 5 shows roller compactors used for paving. Two roller techniques used at the joints are rolling from the hot side and rolling from the cold side.

When rolling from the hot side, the compaction of the joint is done from the most recent lane being constructed. When rolling from the cold side the majority of the compaction is done on the cold side of the lane which was paved earlier in the day. Rolling from the cold side causes the hot side to undergo cooling which makes it difficult to achieve proper compaction (Kandhal 2002).

Figure 5. Rolling over asphalt concrete.

A method used in conjunction with hot and cold rolling is infrared joint heating. “Infrared joint heating is used to preheat the edge of a pavement before paving the other lane to better create better adhesion when roller compacting” (Daniel 2006).

Furthermore, the cutting wheel technique involves cutting to take place roughly 25-30 mm away from the low-density edge of a lane while it is still plastic. The cutting wheel method increases density by discarding the low-density edge (Kandhal 2002).

The New Jersey Wedge technique is a wedge joint made up of a 3:1 taper formed during the pavement of the cold side using a sloping steel plate attached to the inside of the paver screed” (Huang 2010). The New Jersey method is not used often due to the lack of density it achieves.

The bumped joint technique uses overlapped material pushed back with a lute at the joint. A roller will then compact the bump into the joint overlapping by 4 inches or pinching up against the joint (Estakhri 2001).

Showcased in Figure 6 Kandhal conducted an experiment where core samples were taken at the joints and tested to verify different joint techniques densities. It is clear that the edge restraining device allows for the greatest amount of compaction. The letters above each bar indicate a grouping of cores where the densities do not significantly differ and are approximately 5% off from one another.

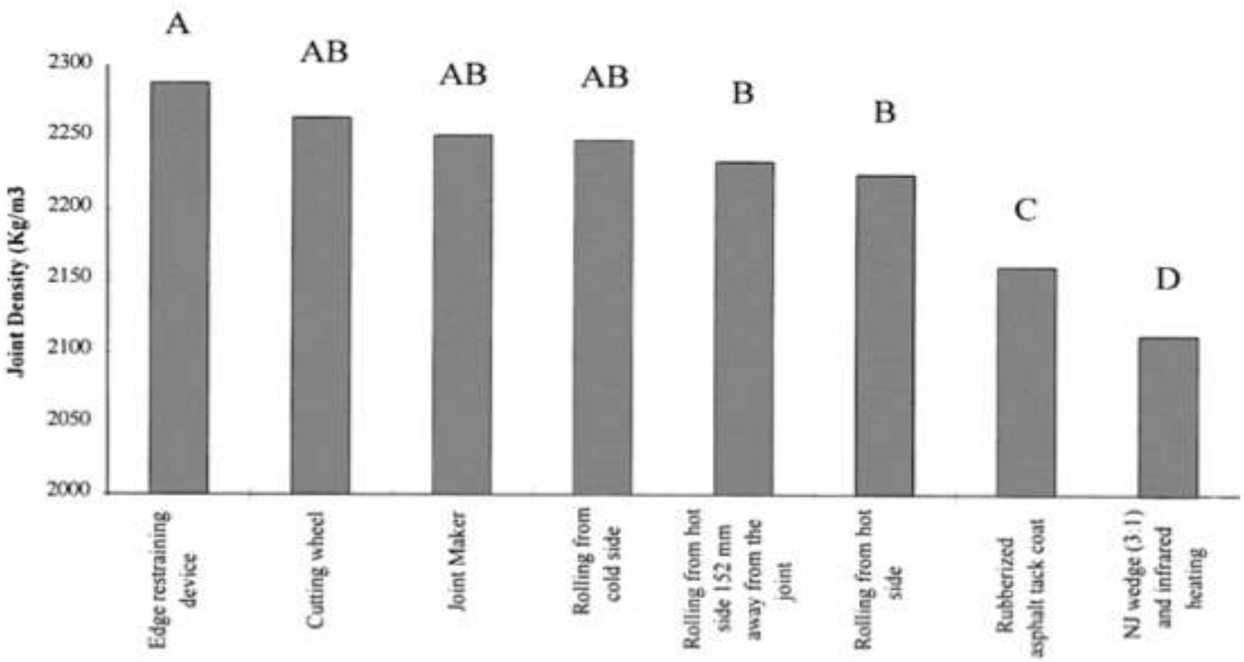

Figure 6. Joint density achieved by various techniques. (Kandhal 2002)

LONGITUDINAL JOINT IRREGULARITIES & ISSUES

Often during the paving process, irregularities can be introduced. The most common irregularity that forms along the longitudinal joint is segregation. Some pavers push material irregularly, causing the large aggregates to separate from the fine aggregates which leads to what is known as segregation. Segregation can be caused by many factors such as mishandling the material from the plant and unloading into the paver. Segregation happens at the joints due to the fact that they are created at the edges of a lane. Another cause of irregularities comes from improper raking with a lute to push back the edges. When a laborer pushes back the asphalt, it could cause a rough texture to appear on the surface.

After completing a project and using one of the jointing methods mentioned previously, issues may arise depending how the site was prepped and if the joint methods were improperly practiced. The most frequent issue encountered at longitudinal joints is longitudinal joint cracking. Figure 7 and 8 show minor and moderate longitudinal cracks. The severity of cracking can be measured by the thickness of the crack. “The primary cause of longitudinal joint cracking is the difference in densities on either side of the joint” (Akpinar 2004).

Figure 7. Minor longitudinal crack.

Figure 8. Moderate longitudinal joint crack. (Pavement Interactive)

LONGITUDINAL JOINT REPAIR

Over time, all asphalt pavements can undergo cracking or deformation. “The majority of the cracks encountered occur at the longitudinal joints” (Nicholls 2008). Once a crack forms, water can enter the crack and cause further damage. “The method used to repair longitudinal cracks is to first clean out the area of loose dirt, debris, and mud, and then add rubberized asphalt to the crack and patching the crack with a thermoplastic material” (Wirtgen 1983). Figure 9 and 10 are examples of a crack that has been patched with the rubberized asphalt coating.

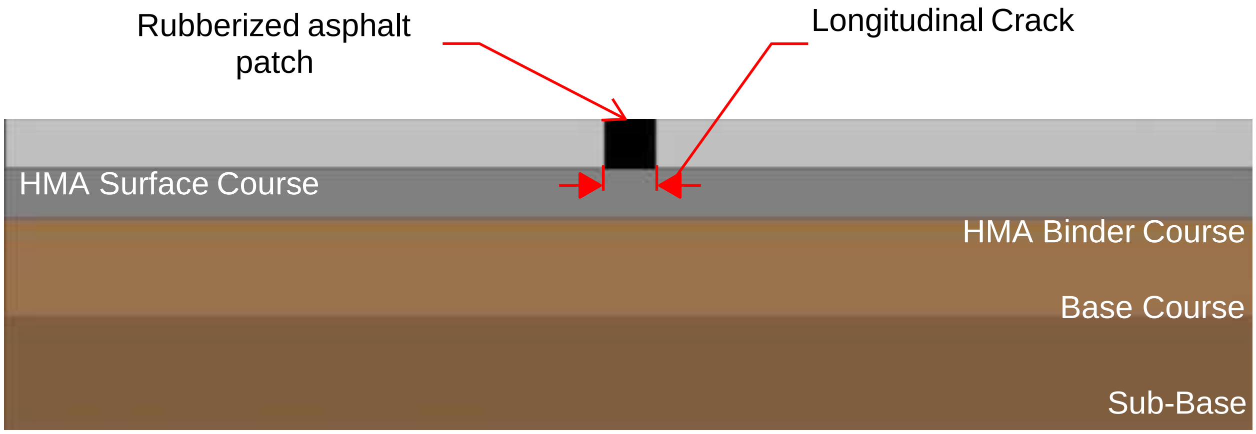

Figure 9. Section cut of a repaired crack.

Figure 10. Longitudinal joint repair using rubberized asphalt patch. (Keybot)

CURRENT PRACTICE FOR JOINT CONSTRUCTION

For contractors to be successful, it is important to achieve a high-quality pavement. Contractors are trying to improve the longevity of joints and prevent issues from reoccurring. As stated in Kandhals Research in Figure 6., using construction methods such as the joint maker, cutting method, or the edge restraining device can substantially improve the density at the joints, further improving the longevity of the pavement as a whole and causing fewer cracks to appear in the future.

Looking back, rolling from the hot side can be a great way to achieve proper density at the joint as well. Many roller operators roll a certain distance away from the joint on the hot side. Though the distance is up to the operator's discretion, many chose anywhere from 4-8 inches away from the joint for the first roll. After that, each roll is creeped closer and closer towards the joint until it has reached the cold side.

Lastly, a new technology being tested in Illinois can further increase the performance at the longitudinal joint. A longitudinal joint sealant made up of a bituminous material. Figure 11 shows a truck spraying the material in-between layers of asphalt along the longitudinal joint. Figure 12 shows where the sealant is placed in a section view. Although there is no research published on longitudinal joint sealant yet, this sealant is currently showing it can increase the longevity at longitudinal joints by withholding the structural integrity of the pavement together under various loading. The sealant also acts as a barrier for water penetration when cracks start to form delaying further damage to the longitudinal joint.

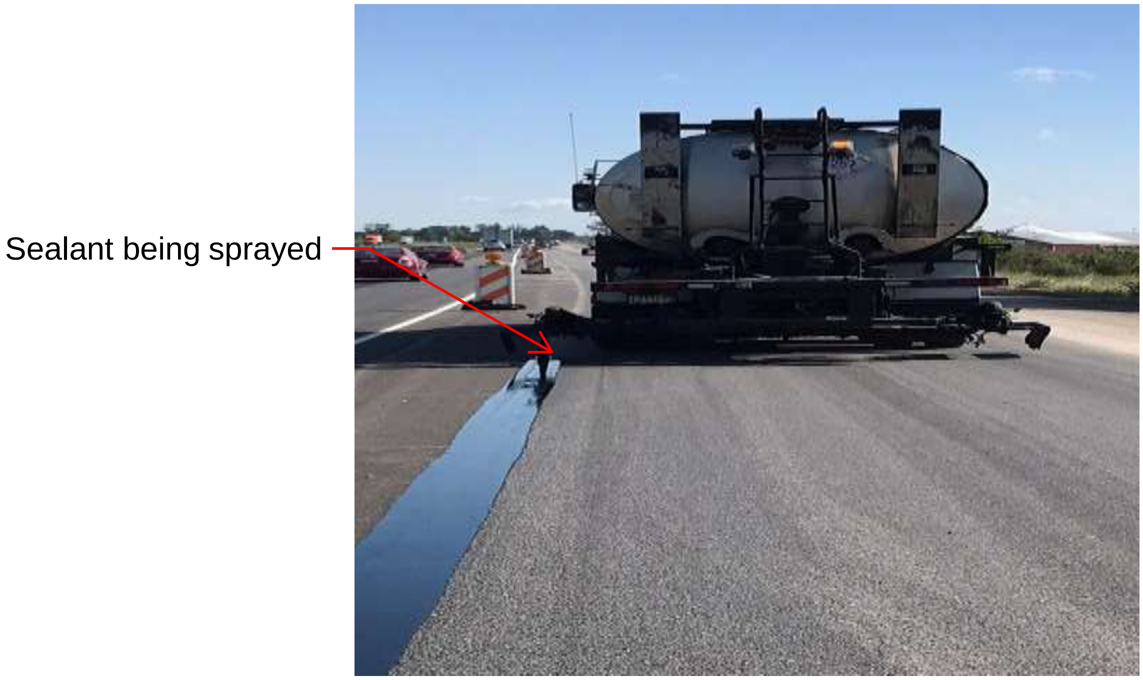

Figure 11. Longitudinal joint sealant being applied.

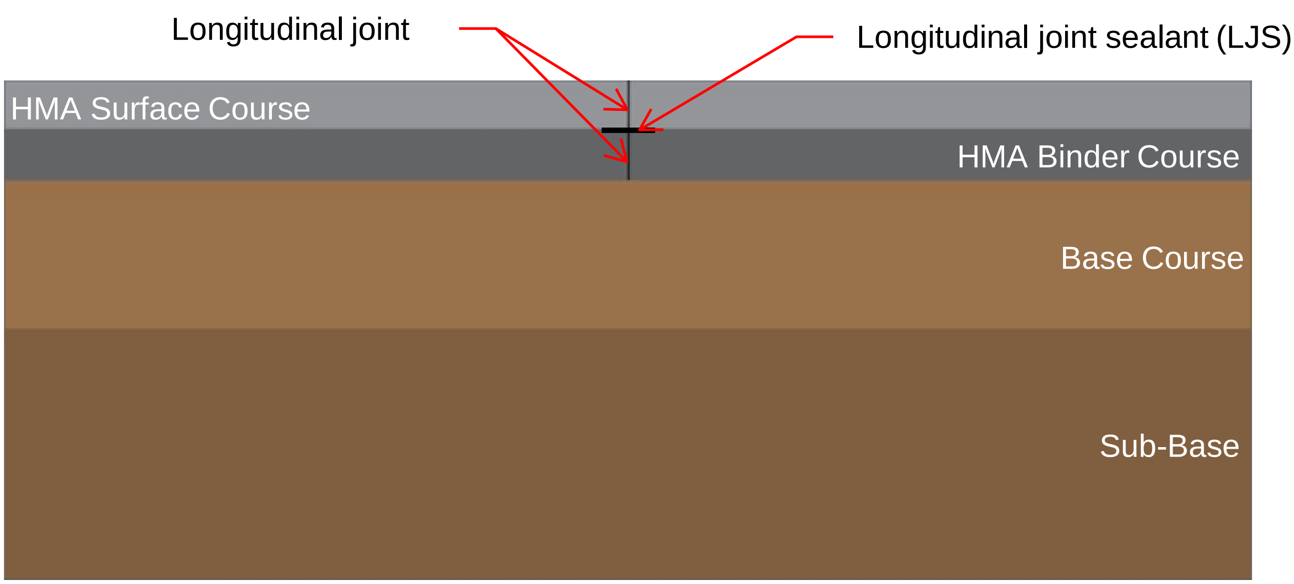

Figure 12. Section of roadway with LJS installed.

CONCLUSION

Overall, asphalt concrete can be a very reliable form of pavement. Although there are competitive options in today's construction industry, asphalt cannot be replaced for its ease of use, application methods, and tried and true reliability. The key to a successful asphalt pavement process is in the longitudinal joints. If the asphalt paving process can be improved, roads will be able to last many more years without repair or replacement. Next time a project is designed, make sure to pick asphalt.

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