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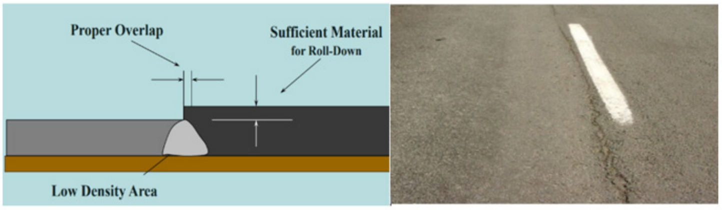
Effect of Longitudinal Joint Construction and Density on Asphalt Pavement Performance – Phase I – State of the Practice

INTRODUCTION

The performance and durability of asphalt pavements are influenced by the installation techniques utilized during construction. One critical aspect that significantly impacts the performance of asphalt pavements is the construction of longitudinal joints and the achievement of specified density levels at the joints. Longitudinal joints are formed when two adjacent asphalt lanes are constructed during the paving operation. These joints are created in situations where the width of the pavement exceeds the paving width of the equipment. Longitudinal joints are critical to the performance of asphalt pavements as they provide continuity to the laid asphalt mat. However, longitudinal joints generally have a lower density than the rest of the pavement due to the formation of an unconfined edge during the placement of the cold asphalt mat and the temperature difference between the freshly paved asphalt lane (hot mat) and the previously paved asphalt lane (cold mat). Higher air voids observed in longitudinal joints result in weaker materials at the joints and facilitate water penetration into the pavement; see Figure 1.



(a) (b)

Figure 1. Longitudinal joint (a) construction and deterioration (The Constructor, 2021)

The Federal Highway Administration (FHWA) has identified in-place density as a significant factor influencing the long-term durability of longitudinal joints. According to available literature, low density and water intrusion near a longitudinal joint can reduce its service life by 36%. To address the problems caused by lower longitudinal joint density, some states in the US have incorporated density specifications for longitudinal joints. These specifications aim to guide the contractor's compaction process while emphasizing the importance of measured density for acceptance. Notably, Alaska, Colorado, Illinois, Kentucky, Minnesota, Missouri, Montana, Nebraska, New York, Ohio, Pennsylvania, Rhode Island, Utah, Vermont, and West Virginia DOTs have established specific longitudinal joint density specifications accompanied by payment schedules that offer incentives for achieving enhanced density and impose penalties for lower density levels. Current Louisiana DOTD specifications for longitudinal joint construction include recommended hot mat overlap width and height, maximum deviation in grade at joints, and minimum joint offset for multiple layer construction. Further, Louisiana DOTD recommends that top-layer joints be kept 6 to 9 inches from the centerline of two-lane highways. The state of the practice for longitudinal joint construction and density is evolving. As more research is conducted, new techniques and materials are being developed that can improve the performance of longitudinal joints. These new techniques and materials have the potential to extend the service life of asphalt pavements and reduce the cost of maintenance.

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OBJECTIVE

The objective of this study was to conduct a literature review regarding the current best practices for longitudinal joint construction.

SCOPE

To achieve the aim of this study, the research team collected and critically reviewed literature regarding best practices for longitudinal joint construction and the use of various techniques and materials for improving longitudinal joint density. The research team also assessed the payment schedules for longitudinal joint density used by different states in the US. The literature search for this study included, but was not limited to, standard sources such as the Transportation Research Information Database (TRID), the Computerized Engineering Index (COMPENDEX), the National Technical Information Services (NTIS), and standard specifications documents for different states.

CONCLUSIONS

The research team identified eight construction techniques that are commonly used to achieve improved longitudinal joint density in asphalt pavements: (1) adopting the echelon or tandem paving technique; (2) modifying the rolling pattern; (3) specifying different joint types (i.e., butt, tapered, or notched wedge) for different field conditions; (4) using edge restraining or pre-compaction devices; (5) using infrared joint heaters; (6) using cutting wheels; (7) using joint adhesives; and (8) using joint sealers. All these techniques, except the technique for modifying the rolling pattern, may require the use of additional equipment, material, and labor, which may increase the cost of construction. Some of these techniques are selected by agencies because the benefits obtained from improved performance offset the additional cost of construction. It was observed from the literature review that different rolling patterns are effective under different conditions. Therefore, state agencies select different rolling patterns based on experience and what works under specific field conditions [19].

Based on the review of different state specifications documents, 23 states were found to specify a minimum density for longitudinal joint construction. The specified minimum longitudinal joint density requirements for these states ranged from 88 to 93% of the theoretical maximum specific gravity (% G_{mm}). Some of these states have a unique way of specifying the minimum longitudinal joint density. Sixteen out of the 23 states that have minimum longitudinal joint density requirements have instituted payment schedules that offer incentives for achieving higher joint densities and impose penalties for lower joint densities. These pay factors are usually applied per foot of longitudinal joint or per ton of asphalt mixture within a lot for a given longitudinal joint.

Despite advancements in longitudinal joint construction specifications, challenges persist in achieving consistently high-quality longitudinal joints. Issues such as inadequate compaction, joint segregation, and improper construction practices continue to impact pavement performance. Continuous research, industry collaboration, and advancements in construction practices will further improve the state of the practice, ensuring the long-term performance of asphalt pavements.

RECOMMENDATIONS

Based on the findings of the study, it is recommended that an additional study be conducted to explore the potential of establishing minimum density requirements and instituting incentive and disincentive pay schedules for longitudinal joint construction in Louisiana. The proposed study will use field experiments, observations, and pavement performance evaluations to assess the effects of different longitudinal joint construction techniques on pavement distress and service life. In addition, the study will aim to further refine construction techniques, optimize material properties, and develop innovative longitudinal joint construction concepts by integrating emerging technologies such as real-time monitoring and quality control systems.