Research Brief

Wisconsin Highway Research Program
Project 0092-15-09
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Asphaltic Mixture Compaction and Density Validation

Research Objectives

- Evaluate HMA longitudinal joint type, method and compaction data to produce specification recommendations to ensure the highest density at longitudinal joints
- Evaluate thin lift overlay HMA and provide recommendations to ensure proper and consistent compaction throughout

Research Benefits

- Confirmed practice of using standard nuclear density gauges in a parallel orientation is more accurate than a perpendicular orientation
- Confirmed current practice of using notched wedge longitudinal joints is an acceptable method compared to six other tested methods
- Established a minimum density target for increasing durability and reducing permeability

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Background

Density is one of the primary acceptance criteria and indicators of hot mix asphalt (HMA) performance. Poor field compaction may result in low density and significantly increase a pavement's susceptibility to surface cracking due to reduced surface strength. Low density also increases permeability, increasing the potential for water to infiltrate pavement and cause damage. Reducing permeability by improving field compaction can help decrease the rate of pavement damage and avoid premature distress.

This research was performed to evaluate various HMA longitudinal joint types and methods of construction that ensure proper and consistent compaction to maximize durability.

Methodology

Longitudinal joint test data was collected from 28 projects throughout the state of Wisconsin in 2014. In 2015, three projects were visited to validate the 2014 data and the contractor's typical rolling pattern compared to the Asphalt Institute (AI) and Federal Highway Administration (FHWA) best practices rolling pattern. For each project visit, two 1,800-foot sections were tested. Six lots of nuclear density gauge readings were taken in perpendicular and parallel gauge orientations. Each lot included three tests across the mat, with the third test located within two inches of the longitudinal joint. Ten cores were taken at the same locations as nuclear density readings.

One thin lift project was visited, with the addition of a thin lift nuclear density gauge. The standard nuclear density gauge used in the backscatter mode, as well as the thin lift gauge data were compared with cores.

Hamburg performance tests and National Center for Asphalt Technology (NCAT) permeability tests were also performed to determine any mix variability.

Core samples were taken from directly on top of and on either side of the centerline.

"Specifying joint density will lead to better compaction methods at the joints, which will result in more durable HMA pavements."

– Barry Paye, WisDOT

Interested in finding out more?

Final report is available at: WisDOT Research website.

Results

The seven types of longitudinal joints varied in density between 89.3 percent and 92.5 percent. The average longitudinal joint densities listed from highest to lowest percent were: milled confined (92.5); safety edge confined (92.4); notched wedge confined (92.2); notched wedge unconfined (91.0); safety edge unconfined (90.3); vertical confined (90.7); and vertical unconfined (89.3). All joint density averages decreased as Equivalent Single Axle Load (ESAL) designation of the mix type increased. Mainline density proved to be two percent higher, on average, than joint density.

Rolling pattern was only found to be significant in achieving density on one project, where the contractor's standard rolling pattern actually achieved higher densities than the AI/FHWA best practices for the unconfined edge.

When comparing all thin lift overlay gauge data to cores, there is no significant difference. However, when isolating gauge type, the thin lift gauge underestimated core densities by more than two percent while the standard gauge overestimated by the same magnitude.

Results of the Hamburg and NCAT permeability tests were inconclusive.

Recommendations for Implementation

Density validation data supports the continuation of current practice of using standard nuclear density gauges in a parallel orientation on a daily basis for standard thickness and thin lift overlay projects, with the addition of correlating gauges to cores. Cores should be used to establish a nuclear density correlation during a test strip, and gauge measurements should be adjusted to represent the core data.

Longitudinal joints routinely exemplified densities within two percent of mainline when subjected to similar compaction pattern/effort and targets may be specified accordingly. Setting a minimum density requirement for longitudinal joints will result in a more uniform, properly densified joint with reduced permeability and increased durability. No distinction between upper and lower layer density is required as similar densities are achievable for each layer under similar compaction effort.

Notched wedge longitudinal joints should continue as standard practice on all projects, unless echelon paving is possible. Milling the unconfined notched wedge longitudinal joint for high ESAL mixes when paving the adjacent lane also showed improved joint density.

The research also yielded evidence for implementing or further researching the following policies: place rumble strips on either side of the joint, instead of directly over it; and mandate a topical joint sealer in lieu of a monetary penalty for substandard longitudinal joints.

This brief summarizes Project 0092-15-09
"WisDOT Asphaltic Mixture New Specifications Implementation- Field Compaction and Density Validation"
Wisconsin Highway Research Program