TECHSUMMARY *November 2020*

State Project No. DOTLT1000214 / LTRC Project No. 18-4B

Demonstration Project for Enhanced Durability of Asphalt Pavements through Increased In-Place Pavement Density

INTRODUCTION

In-place density of hot mix asphalt (HMA) is a significant factor influencing the durability and long-term performance of asphalt pavements. The required in-place density of an asphalt pavement can be achieved through a combination of different activities that include proper design, production, placement, compaction, and quality control of the mixture. During pavement construction, mixtures behind pavers prior to roller compaction have densities within the range of 80-85% of G_{mm}. Most state highway agencies usually specify an average in-place density of 92-93% of G_{mm} (i.e., the equivalent of 7-8% air voids) for a compacted asphalt pavement. Previous studies have shown that a 1% increase in in-place density can lead to a 10-30% increase in asphalt pavement service life. Anticipated cost savings due to increased service life are significantly greater than the added costs for achieving increased density. There have been significant advancements in technology and techniques for pavement design and construction. These advancements have the potential to increase asphalt pavement density and improve both durability and cost-effectiveness. Many of these advancements are already being employed; however, in many instances, standards for in-place density have remained unchanged. It is proposed that by using already adopted practices, in-place density targets can be increased. Thus, with enhanced density targets, improved mixture durability, and extended pavement service life can be achieved.

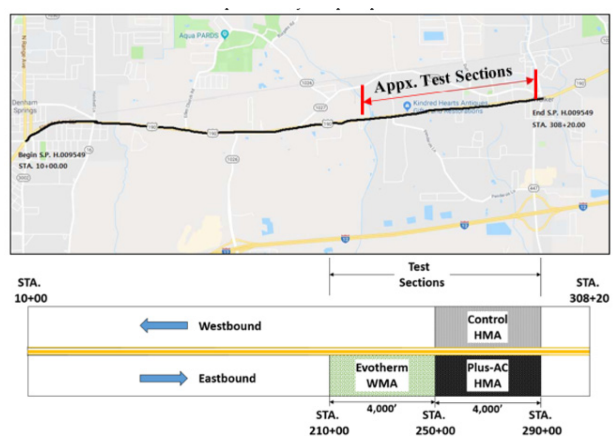

Figure 1
Project location and test sections

LTRC Report 628

Read online summary or final report:
www.ltrc.lsu.edu/publications.html

PRINCIPAL INVESTIGATOR:
Louay N. Mohammad, Ph.D., P.E. (WY)

LTRC CONTACT:
Tyson Rupnow, Ph.D., P.E.
(225) 767-9124

FUNDING:
FHWA

Louisiana Transportation Research Center

4101 Gourrier Ave
Baton Rouge, LA 70808-4443

www.ltrc.lsu.edu

OBJECTIVE

The objective of this project was to evaluate the effects of increasing the initial in-place density of asphalt pavements in Louisiana on field performance and durability. Specific objectives included: (1) identifying an efficient methodology for achieving increased in-place density of asphalt pavements with minimal additional costs and without damaging aggregate structure; (2) constructing a demonstration pavement section that includes a control one (meeting current minimum density requirement) and a test section having an average of 1.5% increased in-place density; and (3) evaluating volumetric and mechanistic properties of laboratory and field asphalt samples.

SCOPE AND METHODOLOGY

A field rehabilitation project in Louisiana was selected for this study. This test section was part of an FHWA demonstration project on enhanced durability through increased in-place pavement density; see Figure 1 above. The rehabilitation project consisted of milling off approximately 4-in. of existing asphalt pavement and replacing it with a 2-in. Level 2 binder course mixture followed by a 2- in. Level 2 wearing course mixture meeting the 2016 DOTD *Standard Specifications for Roads and Bridges*. Two techniques were used to increase the in-place density of the binder and wearing course mixtures. The first one included the addition of Evotherm additive (Evotherm WMA) at a dosage rate of 0.6% by the weight of mix to both binder and wearing course mixtures. The second approach added a 0.2% asphalt binder to the design optimum asphalt content (Plus AC HMA). A styrene butadiene styrene (SBS) polymer-modified asphalt binder meeting Louisiana specifications for PG 76-22M was utilized for both the binder and wearing course mixtures. Three 4000-ft. wearing and binder course sections (i.e., control with optimum asphalt binder content; Evotherm WMA; and Plus AC HMA) were placed and compacted. These test sections (two experimental and one control section) comprised of the following:

Control Section (Control HMA): Conventional HMA mix overlay on the westbound lane;
Evotherm Test Section (Evotherm WMA): Evotherm WMA mix on the eastbound lane; and
Plus AC Test Section (Plus AC HMA): Plus AC mix section on the eastbound lane.

Densities of the compacted test sections were evaluated. A suite of laboratory mechanical tests was performed to ascertain the performance and durability of the asphalt mixtures evaluated. Tests conducted include the semi-circular bend (SCB) at intermediate temperature, loaded wheel test (LWT) at high temperature, and indirect tensile dynamic modulus (IDT |E*|) test at multiple temperatures (i.e., -10°C, 10°C, and 30°C) for full viscoelastic characterization of the asphalt mixtures; see Figure 2. Four and three replicates were tested in LWT and SCB tests and an IDT |E*| test, respectively.

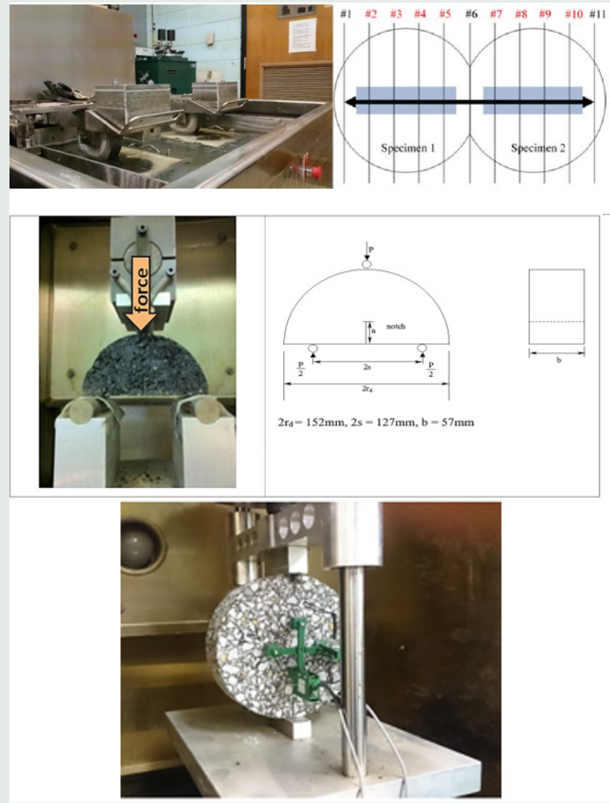

Figure 2
Set-up for LWT, SCB, and IDT|E*| tests

CONCLUSIONS

Results from density measurements and asphalt mixture performance tests (LWT, SCB, IDT |E*|) were analyzed and conclusions drawn for the study. In general, the two increased in-place density approaches considered in this study were successful in improving field density, and high- and intermediate-temperature properties of field cores. Specific observations include:

- For the binder course test sections, Evotherm WMA and Plus AC HMA sections had a significant increase in in-place densities as compared to control HMA section. However, the improvement in the in-place densities of the wearing course sections was not as significant. This is because the control HMA mixture had a high initial density (i.e., 95.6% of G_{mm}) and further densifications were not expected.
- Evotherm WMA and Plus AC wearing and binder test sections achieved much higher field densities than the FHWA proposed density increase requirements of 1.5%.
- Two increasing in-place density approaches considered in this study were effective in improving rutting performance as measured by the LWT test. Evotherm WMA and Plus AC HMA wearing course mixtures had significantly lower LWT rut depths as compared to the control section.
- Two increasing in-place density approaches considered in this study were effective in improving intermediate temperature cracking performance as measured by the SCB test. The Evotherm WMA technology resulted in a significant increase in the SCB J_c parameter.
- For the binder course test sections, Evotherm WMA and Plus AC HMA sections showed increased stiffness (i.e., higher |E*|) at the low reduced frequency range (i.e., 10-5 Hz to 10-3 Hz) and higher $|E^*|_{54°C,\ 5Hz}$ values as compared to the control section. A similar trend was observed for the wearing course test sections.

RECOMMENDATIONS

Two different approaches (Evotherm WMA and Plus AC HMA) to increase in-place density were utilized. In general, improvement in mixture density resulted in an improvement in asphalt mixtures' laboratory performance indicators, which is expected to improve field performance and durability. Thus, this study recommends that DOTD adopts these two technologies in order to improve in-place field density of asphalt pavements in Louisiana. Furthermore, it is recommended that long-term pavement performance monitoring of test sections of this study is performed to validate benefits of the increased in-place density of asphalt pavements.