Enhancing the Performance of Asphalt Mixtures Containing High RAP Content with the Use of Different WMA Technologies

Highlight | Nov. 2020

Project No. 19BLSU01

PI: Dr. Husam Sadek (LSU)

POP: August 2019 – November 2020

Enhance the performance of asphalt mixtures containing high RAP content in Region 6 using different WMA technologies

Production of Warm-mix asphalt (WMA) mixtures in conjunction with reclaimed asphalt pavement (RAP) has received considerable interest in recent years for economic & environmental reasons. The objective of this project is to enhance the performance of mixtures containing RAP using different WMA technologies. The effect of utilizing 0%, 25%, & 35% RAP on the performance of different WMA mixtures against rutting, moisture damage, & fatigue cracking are evaluated. The effects of WMA technologies on rutting performance of asphalt mixtures & recovered binders were investigated using loaded wheel tracker (LWT) & multiple stress creep recovery (MSCR), respectively. Further, the influences of these technologies on the cracking performance of asphalt mixtures and recovered binders were evaluated using Semi-Circular Bending (SCB) and linear amplitude sweep (LAS) test, respectively.

Background

For asphalt mixtures containing high RAP, incorporation of aged binder from the RAP and long-term exposure to air and sunlight during service life can increase the stiffness of mixtures. Therefore, mixtures with high RAP are susceptible to the development of intermediate- and low-temperature cracking. Significant efforts have been made to control and decrease the negative impacts of the addition of RAP to asphalt mixtures. WMA technologies have been widely used in the US and worldwide to reduce production and construction costs, extend construction season, improve field compaction, and enhance working conditions without affecting in-service performance. WMA technologies allow more utilization of RAP by decreasing the production temperatures that would result in decreasing binder aging. Thus, high proportions of RAP could be used in WMA mixtures.

Project Summary

The main objective of this study is to enhance the performance of asphalt mixtures containing high RAP content & using different WMA technologies. Specific objectives are to (a) prepare asphalt mixtures with different percentages of RAP (0%, 25%, & 35%) and WMA technologies (organic, chemical, & foaming), (b) evaluate rutting and moisture damage resistance of short-term aged asphalt mixtures, (c) evaluate cracking resistance for long-term aged asphalt mixtures, and (d) evaluate rheological properties of the extracted and recovered binders from the produced mixtures.

Findings

This study concludes that extracted and recovered binders coming from WMA mixtures containing RAP have a lower value of the J_{nr} compared to the HMA control mixture. This is an indication of the better performance of combining WMA technologies and RAP materials against the permanent deformation. Moreover, findings from the LWT test (Figure 1) agreed with the results from the MSCR test, and the rutting resistance of the asphalt mixtures has an increasing rate by applying more % RAP materials in both WMA and HMA mixtures.

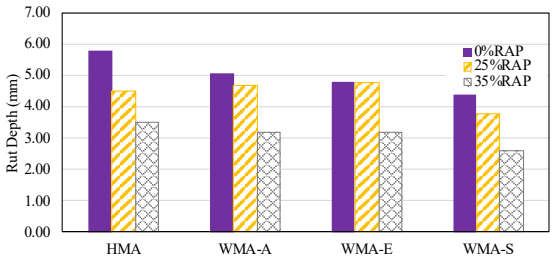

Figure 1. LWT average rut depth vs. mixture type.

The fracture resistance is found to be enhanced with the incorporation of RAP and WMA technologies. Such a trend in the present research work may be attributed to the softening effect of the rejuvenator, WMA additives, and the lower performing temperature. Overall fracture resistance performance of WMA-RAP mixtures is observed to be better compared to HMA-RAP mixtures (Figure 2). Moreover, the results of the LAS test show that the incorporation of RAP materials and WMA technologies is associated with improved fatigue life of the WMA-RAP

mixtures. The better performances of mixtures containing RAP against cracking, which is in contradiction to what would be expected from high RAP mixtures, can come from WMA additives.

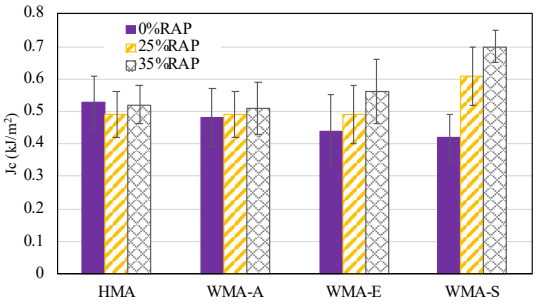

Figure 2. Critical strain energy release rate (Jc) for HMA and WMA mixtures.

Impacts

The results and conclusions of this project are expected to: (a) widen the knowledge of using WMA additives and their impact on the mixture's performance for the transportation community; (b) identify the main differences in performance of asphalt mixtures with high RAP content that contain WMA additives; (c) encourage contractors and designers in Region 6 to design more durable, sustainable and low-cost asphalt mixtures by utilizing more RAP materials in asphalt mixtures; and (d) enhance the performance of produced mixtures in Louisiana and Region 6 against rutting, moisture damage and cracking.

The outcomes of this study are expected to enhance the performance of asphalt pavements in Region 6 and to improve their serviceability by using WMA additives in the produced mixtures with high-recycled materials contents. In addition, the use of WMA technologies is an environmentally-friendly alternative to produce more sustainable and low-cost asphalt pavements in the region. The findings of this study will have a significant impact on the performance of Region 6 mixtures against fatigue cracking and rutting, which will minimize pavement failures and save taxpayers' money in the long-term. The findings of the proposed study can also be extended to other DOTs in the regions.

Tran-SET

Tran-SET is Region 6's University Transportation Center. It is a collaborative partnership between 11 institutions (see below) across 5 states (AR, LA, NM, OK, and TX). Tran-SET is led by Louisiana State University. It was established in late November 2016 "to address the accelerated deterioration of transportation infrastructure through the development, evaluation, and implementation of cutting-edge technologies, novel materials, and innovative construction management processes".

Learn More

For more information about Tran-SET, please visit our website, LinkedIn, Twitter, and YouTube pages. Also, please feel free to contact Dr. Momen Mousa (Tran-SET Program Manager) directly at transet@lsu.edu.

Tran-SET