Transportation Consortium of South-Central States (Tran-SET)

Evaluation of Asphalt Mixtures Resistance to Cement-Treated Base (CTB) Reflective Cracking in the Laboratory

Highlight | Nov. 2020

Project No. 19BLSU02

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Propose a laboratory setup to test and evaluate an asphalt mixture layer on top of a simulated Cement-Treated Base (CTB) layer against reflective cracking

Reflective Cracking is a prime concern during the selection of HMA overlays with stabilized bases like Cement-Treated Base (CTB) or Cement-Stabilized Base (CSB). CTB/CSB has an inherent tendency to generate shrinkage cracks. Traffic loading and seasonal temperature variation cause vertical and horizontal movements within these cracks, which propagate upward and cause reflective cracking in the surface course. The main objective of this project is to propose a laboratory setup to test and evaluate an asphalt mixture layer on top of a simulated CTB layer against reflective cracking. Texas Transportation Institute (TTI) Overlay Tester (OT) was found to be the most appropriate equipment to study thermally-induced reflective cracking in the laboratory and thereby was selected to be modified and used to assess the performance of asphalt mixtures on top of a pre-cracked CTB layer.

Background

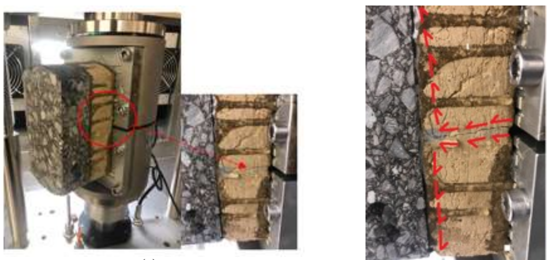
Reflective cracking is one of the major forms of deterioration in flexible pavements constructed over old pavements with discontinuities in their surface. Although narrow reflective cracks do not negatively affect pavement performance, wide reflective cracks can lead to many performance-related problems. CTB is a composite material that is widely used as a base for pavement structures to enhance the strength and durability of the surface course and reduce deflections and tensile strain in the HMA surface under the wheel load. CTB is susceptible to the development of shrinkage cracks due to drying shrinkage. These shrinkage cracks deteriorate under traffic load and temperature variations, propagate upward, and eventually reflect through the pavement surface.

Project Summary

In this research project, the available laboratory test setups that are used to evaluate the resistance of asphalt mixtures to reflective cracking were conceptually assessed and evaluated. Through an extensive literature review, a total of seventeen reflective cracking testing devices were found and evaluated. The best three among the available devices were chosen and ranked based on various factors, i.e., commercial availability, ease of use, variability and repeatability of the test results, and field validation. The device that has been ranked first was considered and the efficiency of the considered setup was evaluated as a true representative of field reflective cracking, as well as its ability to accurately differentiate between the performances of various HMA mixtures. Some potential modifications have been proposed to be incorporated into the considered test setup so that it can simulate field reflective cracking more closely. Finally, the performance of various asphalt mixtures against reflective cracking was assessed using the considered test setup before and after the incorporation of proposed modifications.

Findings

The attempt to modify the conventional OT setup for better mimicking field reflective cracking was unsuccessful. The glue used to attach the HMA layer with the underlying CTB/CSB layer was very strong, which prevented the crack from propagating to the HMA layer. When the prime coat was used as a substitute for epoxy glue, the prime coat was unable to generate any bond between the top and bottom layers. As a result, the HMA layer slipped when the composite OT specimen was mounted in the vertical OT setup (Figure 1).



(a) (b)

Figure 1. Testing of composite OT specimens (a)crack initiation and propagation, (b) path of crack propagation.

Results of the conventional OT testing (Figure 2) showed that decreasing test temperature from room to low temperature caused an increase in the Critical Fracture Energy (Gc) while a decrease in Crack Progression Rate (CPR). Therefore, a reduction of test temperature from room to low temperature resulted in the mixtures to change their behavior from "soft crack-resistant" mixtures to "tough crack-resistant" mixtures. Although the specimens prepared with unmodified and softer asphalt binder exhibited higher Gc values in most cases, no trend was observed in CPR values due to the change in binder type. A similar conclusion was made when the effect of RAP content on the reflective cracking performance was evaluated (Figure 3). The specimens prepared with 20% RAP or no RAP sometimes behaved as tough crack-resistant while sometimes showed soft crack-resistant behavior.

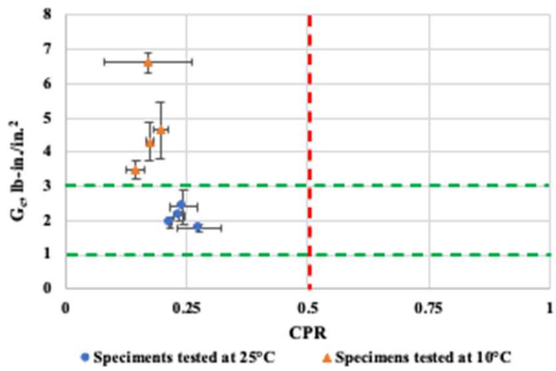


Figure 2. Cracking interaction plot for all the specimens tested – effect of testing temperature.

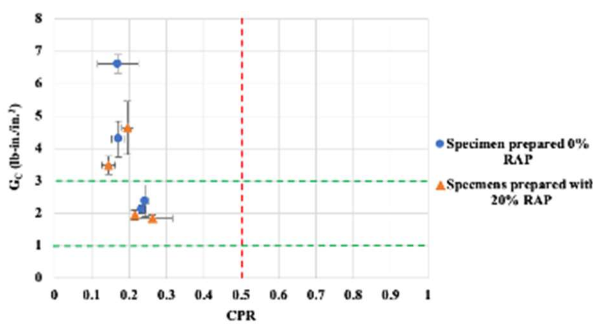


Figure 3. Cracking interaction plot for all the specimens tested – effect of RAP content.

Impacts

The results and conclusions of this project are expected to (a) broaden the knowledge of the effect of reflective cracking on asphalt mixtures performance in the region; (b) encourage contractors and designers in Region 6 to design highways, parking lots, and airports with CTB layers when reflective cracking is more controlled; and (c) finding a test setup that will be used/upgraded to help the DOTs and contractors in Region 6 in predicting the performance of the produced mixtures against reflective cracking, which will improve the durability and extend the service life of these mixtures.

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."

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