PROJECT SUMMARY

Texas Department of Transportation

0-6815: Improved Overlay Tester for Fatigue Cracking Resistance of Asphalt Mixtures

Background

The accumulation of damage due to premature cracking of asphalt concrete (AC) layers is a major concern in terms of flexible pavements' performance. Over the past decade, AC mixes have been designed using the Hamburg wheel-tracking device to improve their rutting potential, which might have impacted the cracking resistance and flexibility of the AC mixes. This distress is even further aggravated by the current sustainable measures, such as the inclusion of reclaimed asphalt pavement and recycled asphalt shingles. The Texas Department of Transportation (TxDOT) recently implemented the Overlay Tester (OT) test to measure the number of cycles to failure of AC specimens that is used as an indicator of the cracking performance of AC mixes. The variability of the number of cycles used as the performance index has impeded the widespread implementation of the OT as a routine crack performance test (especially with dense- and coarse-graded AC mixes).

What the Researchers Did

The ultimate goal of this project was to provide TxDOT with a consistent and reliable test that can be routinely performed to assess the cracking potential of AC mixes during the mix-design process. A systematic study was conducted to gain in depth understanding of the key issues related to OT.

The researchers evaluated the current OT specifications (Tex-248-F) with the objective of improving the specimen preparation and testing process as well as the consistency of the OT results. A detailed specimen preparation process was proposed to improve the consistency of the results.

About 250 OT results from more than 120 different mix designs and 10 AC mix types contained in a TxDOT database were evaluated using the proposed OT methodology to delineate its effectiveness and applicability in assessing the cracking performance of all types of AC mixes. The typical variability of the current protocol was compared with the variability of the proposed OT methods. Field studies were used to validate and correlate the proposed OT method and the associated performance indices; several pavement sections were monitored and cored to evaluate performance.

What They Found

Although the load reduction curves and hysteresis loops from replicate specimens seem repeatable, the number of cycles to failure is not. Fundamentally, the cracking potential of an AC mix can be characterized in two stages: a) crack initiation and b) crack propagation (Figure 1). A cracking methodology and performance indices were implemented for the OT to assess the cracking properties of the AC specimens during these two stages. A methodology based on the critical fracture energy and crack progression rate from the OT tests is proposed to supplant the current criterion based on the number of cycles to failure. Given its promise in this study, the improved OT test method is recommended as a routine test to help TxDOT balance the cracking and rutting resistance of AC mixes during the mix-design process. A design interaction plot was also created using the critical fracture energy and crack progression rate to better assess the cracking potential of AC mixes (Figure 2). TxDOT may readily implement the OT if the proposed OT method is used to assess the cracking potential of AC mixes.

What This Means

The proposed OT method provides TxDOT engineers and designers a means to properly estimate the cracking performance and fundamental fracture and fatigue properties of AC mixes. Based on the promising performance of the proposed OT method, the final project goal is to implement the proposed OT analysis method into the day-to-day operations within TxDOT using the existing OT device. This is especially valuable since Districts are adding more of their recycled materials with stiff binders into their AC mixes. This paradigm shift in TxDOT's AC mix design had a substantial impact on the cracking performance of AC mixes around the state and needed to be controlled during the mix-design process in the laboratory. By implementing the proposed OT method, TxDOT will be able to not only estimate the cracking potential of AC mixes but also design the desired cracking performance of the AC mixes.

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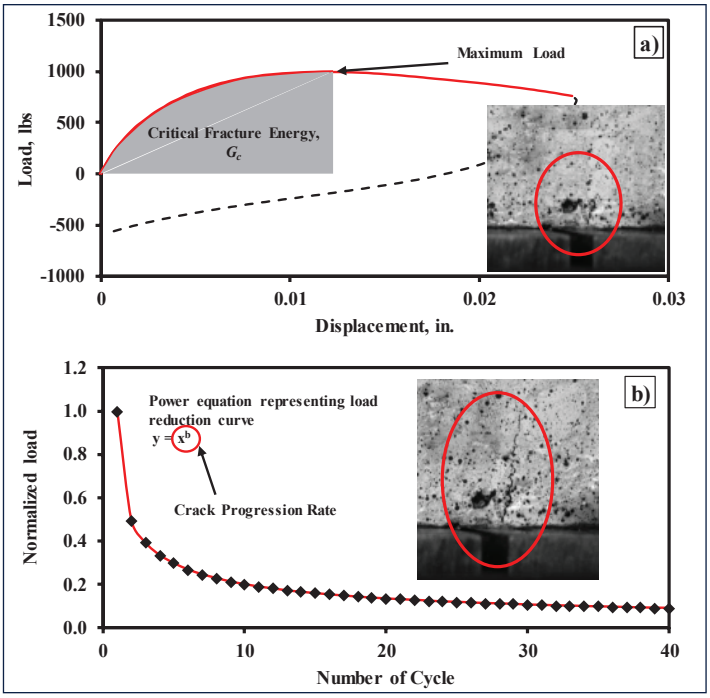

Figure 1 - Test Response Curves: a) Critical Fracture Energy (Crack Initiation) and b) Crack Progression Rate (Crack Propagation)

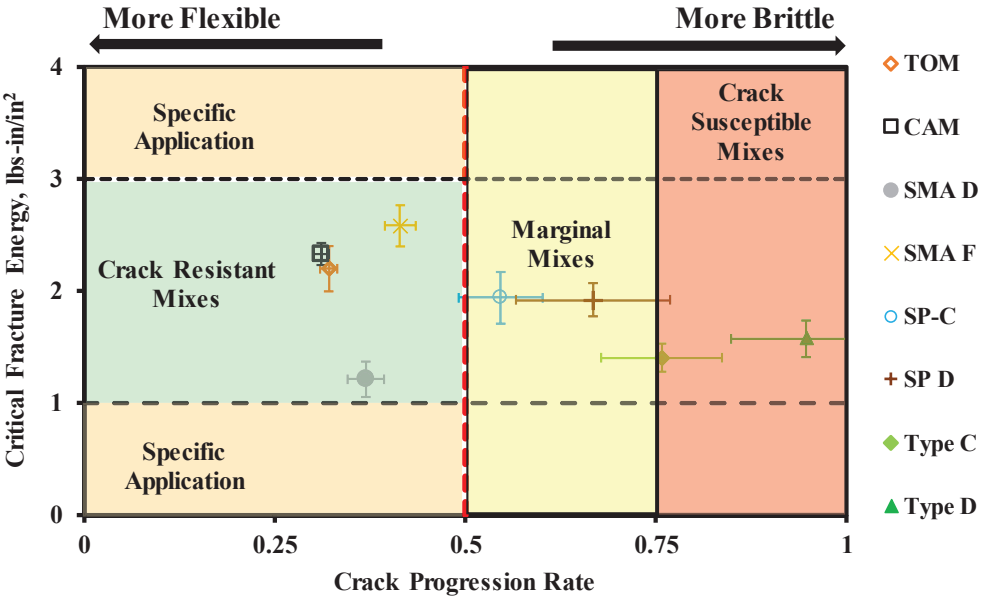

Figure 2 - Design Interaction Plot for Cracking Resistance of AC Mixes

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