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

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

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$39,999

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Tran-SET
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$120,000

Evaluation of reflective cracking resistance for lab-produced HMA mixtures on top of a CTB layer using laboratory testing

Reflective cracking is one of the main forms of pavements deterioration. When an asphalt mixture is constructed over a cement-treated base (CTB) or subgrade or when an asphalt overlay layer is paved on a cracked pavement for rehabilitation, cracks usually propagate to the surface (bottom-up) in a short period. The initiation and propagation of reflective cracking are mainly due to two reasons: (i) traffic loads and (ii) the horizontal movements due to temperature variations in cement-treated and concrete layers.

CTB is a mixture of aggregates and/or granular soils combined with a defined amount of Portland cement and water that hardens after compaction and curing to form a durable paving material. The use of the correct quantity of Portland cement, adequate water, thorough mixing, and proper curing are all important factors to permit maximum compaction and prevent any cracking. If a CTB layer has cracks, they will most probably propagate as reflective cracking to the upper layer (i.e., asphalt mixture layer). Asphalt mixtures produced to be constructed over a CTB or a cracked base should be evaluated against reflective cracking for better performance during the pavement service life.

There are varieties of laboratory tests that are used to simulate the propagation mechanism of reflective cracking in pavements. These tests can be differentiated based on the type of load applied. While some tests evaluate the effects of traffic and temperature separately, other tests assess the effects of traffic and temperature variations simultaneously through the application of vertical loads and horizontal opening displacement. However, each of the available laboratory tests has limitations. In this project, the available laboratory tests will be evaluated, and a laboratory test setup will be considered and used to test an asphalt mixture layer on top of a simulated CTB layer at low and room temperatures. The considered test setup should properly simulate the propagation mechanism of reflective cracking in pavements. The aim is to examine if adding the CTB layer to the existing test will still give valid data and reasonable findings.

Problem Statement

Reflective cracking is one of the main forms of pavements deterioration. When an asphalt mixture layer is constructed over a cracked cement-treated base (CTB) or when an asphalt overlay layer is paved on a cracked old pavement as rehabilitation, cracks usually propagate to the surface (bottom-up) in a short period of time.

The initiation and propagation of reflective cracking are mainly due to two reasons: (i) traffic loads and (ii) the horizontal movements due to temperature variations in cement-treated layers.

CTB is a mixture of aggregates and/or granular soils combined with measured amounts of Portland cement and water that hardens after compaction and curing to form a durable paving material. CTB is widely used as a pavement base for highways, parking lots, and airports, before paving the wearing (surface) course of bituminous or Portland cement concrete mixture to complete the pavement structure. The use of the correct quantity of Portland cement, enough water, thorough mixing, and proper curing are all important factors to permit maximum compaction and prevent any cracking. If a CTB layer has cracks, they will most probably propagate as reflective cracking to the upper layer. Asphalt mixtures produced to be constructed over a CTB or a cracked base should be evaluated against reflective cracking for better performance during the service life.

There are a variety of laboratory tests available that are used to simulate the propagation mechanism of reflective cracking in pavements. These tests can be differentiated based on the type of load applied. While some tests evaluate the effects of traffic and temperature separately, some other tests assess the effects of traffic and temperature variations simultaneously through the application of vertical loads and horizontal opening displacement. However, each of the available laboratory tests has limitations and the cracked CTB layer is not used in the widely-used testing setups (e.g., Texas Overlay Tester).

Objectives

The accomplishment of the project objective in the research phase will require the following tasks:

Task 1: Conducting an in-depth literature review.

Task 2: Based on the results of Task 1, a laboratory test setup will be selected and assessed to evaluate the effect of CTB reflective cracking on asphalt mixture layers on top of it.

Task 3: Preparation of Hot-Mix Asphalt (HMA) mixtures for testing.

Task 4: Evaluation of reflective cracking resistance for lab-produced HMA mixtures on top of a CTB layer using the considered laboratory test setup at room temperature and low temperature.

Task 5: Preparation and submission of the final report that includes problem description, objective(s), scope, methodology, results, conclusions, and recommendations.

Intended Implementation of Research

Education and Workforce Development: In this task, the research team is planning to:

Fund one Ph.D. student at LSU from this research project. The student will be trained to prepare the asphalt mixtures, prepare the samples for testing, conduct the testing in the lab, and perform the data analysis under the PI's supervision;

• Develop and present a class module that explains the project idea, methodology and testing results to the undergraduate students in LSU;

• Prepare and present the project topic and its results to the LaDOTD pavement engineers to encourage its adoption; and

• Deliver a webinar through Tran-SET on the project topic and findings for workforce development.

Outreach: In this task, the research team is planning to promote the outcomes of this project amongst K-12 students at sponsored events to attract them to pursue a degree in one of the STEM disciplines at the college level. During the technical phase of this project, other implementation activities might be added to the implementation phase plan. The T2 Plan for this project is attached to this proposal as requested.

Anticipated Impacts/Benefits of Implementation

The results, outcomes and conclusions of this project are expected to:

• Broaden the knowledge of the effect of reflective cracking on asphalt mixtures performance in the region;

• The test setup that will be used/upgraded in this study will 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;

• Encourage contractors and designers in Region 6 to design highways, parking lots, and airports with CTB layers when reflective cracking is more controlled; and

• Enhance the knowledge of the undergraduate students at LSU, DOTs personnel and professional workforces in Region 6 with the CTB material and the laboratory testing used to evaluate reflective cracking resistance.

Web Links

- TranSET's website (https://transet.lsu.edu/research-in-progress/)
- TRB's Research in Progress (RIP) database (https://rip.trb.org/View/1644232)

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, Facebook, and YouTube pages. Also, please feel free to contact Mr. Christopher Melson (Tran-SET Program Manager) directly at transet@lsu.edu.