Transportation Consortium of South Central States

Key Points

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17BASU03

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Principal Investigator(s):
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Arkansas State University

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$35,716

Funding Source(s):
Tran-SET
Ergon, Inc.
Arkansas State University

Total Project Cost:
$71,542

Impacts of Moisture on Asphalt Properties

Brief Project Description

Stripping in asphalt concrete pavement is a complex phenomenon coupled with physical and mechanical properties of the materials and their interactions. Even though the Mechanistic-Empirical approaches are being followed by many agencies, they inherit some limitations as they are not based on materials' surface chemistries, which are predictors of moisture resistance. For an accurate prediction of moisture susceptibility, the mineral aggregates and asphalt binder interaction along with the physical test results should be considered. The proposed study will consider these shortcomings and develop a simple and meaningful tool to predict moisture-induced potentials of asphalts. Furthermore, a database of compatible aggregate-binder systems will be helpful for Arkansas State Highway and Transportation Department to proactively include/exclude any aggregates for a particular paving grade binder. As such, the principal goal of this project is to evaluate the impact of moisture on the properties of asphalt binders and to predict compatible asphalt-aggregate systems.

Problem Statement

Moisture susceptibility has been recognized as a major pavement distress since early 1990s. Great effort has been given in this field to come up with effective test methods to quantify the moisture susceptibility of asphalt concrete to take remedial action for longevity of the structures. The most popular forms of moisture resistance tests of asphalt mixtures are the Boiling, Indirect Tensile Strength and Hamburg Wheel test methods, which are followed by over 80% of the agencies while only the Arkansas State Highway and Transportation Department (AHTD) uses the Marshall-based Retained Stability (AASHTO T 245) test. AASHTO T 245 (Retained Stability) is obsolete and has been abandoned by other states due to its poor correlation with the field performance. Conventional Mechanistic-Empirical tests such as Texas Boiling Test (ASTM D3625), Tensile Strength Ratio (AASHTO T 283), Hamburg Wheel Test (AASHTO T 324) have been reported superior to the Retained Stability method to predict the in-service behavior of pavement. Even though the Mechanistic-Empirical approaches are being followed by many agencies, they inherit some limitations as they are not based on materials' surface chemistries, which are predictors of moisture resistance. For an accurate prediction of moisture susceptibility, the mineral aggregates and asphalt binder interaction along with the physical test results will have to be considered. The proposed study will consider these

shortcomings, reduce the research gap, and develop a simple and meaningful tool to predict moisture-induced potentials of asphalts. Furthermore, a database of compatible aggregate-binder systems will be helpful for AHTD to proactively include/exclude any aggregates for a particular paving grade binder. The outcome of this project is expected to minimize premature stripping-related pavement failures and save taxpayers' money by adopting the most effective test method and compatible materials. The findings of the proposed study can be extended for other DOTs in the region.

Objective

The main objective of this study is to establish an effective test protocol to quantify moisture susceptibility of asphalt mixture considering the surface chemistries and molecular level properties as well as aggregate-binder compatibility. Specific objectives of the proposed study are to:

(1) Estimate stripping resistance of aggregate-binder systems using surface chemistries and molecular level material properties;
(2) Evaluate moisture susceptibility of asphalt mixture samples using conventional mechanistic-empirical test procedures (Texas Boiling test, Tensile Strength Ratio, Retained Stability and Hamburg Wheel Tester);
(3) Find the most effective test method based on materials' surface chemistries, mechanistic and field performance data; and
(4) Provide recommendations to AHTD for possible revision of asphalt mixture test specification (Article 404.04 Quality Control of Asphalt Mixtures) by new test protocol.

Intended Implementation of Research

Technology Transfer

The findings from this research study will be disseminated via webinars, AHTD Transportation Research Council Meetings, Tran-SET Research Day, technical papers, final report, and possibly via presentations at FHWA ETG meeting. In addition, research findings will be disseminated through presentations and workshops to DOT engineers.

Education, Workforce Development, and Outreach

This proposal is expected to increase training and education for students and researchers. Further, the PI will train a local high school student as part of an existing internship program with Jonesboro High School. Also, a high school senior preview session will be made throughout the project period. These sessions will be helpful educating school going future citizens about the recent innovations in infrastructure technologies.

The PI will also blend this research into undergraduate and graduate curricula. This initiative is aligned with the recent nation-wide policy to disseminate research in classrooms. Students enrolled in Civil Engineering Materials and Advanced Civil Engineering Materials will be introduced with the application surface science approaches in predicting stripping damage in AC pavements. The maximum enrollments in the undergraduate and graduate level courses are 20 and 10, respectively. Of which, about 20% students are expected to be from the underrepresented groups. Such initiatives will also increase the participation of underrepresented groups.

Anticipated Impacts/Benefits of Implementation

The proposed research is guided by the expectation that the analysis will lead to the awareness of selecting compatible binder-aggregate systems in construction projects. It will also help DOTs in the region to use proper evaluation technique of asphalt binders and aggregates while reducing the risk of failures due moisture-induced damage. The findings from this research will also promote the use appropriate anti-stripping agents and other additives that can mitigate pavement failures due to moisture-induced damage. The main anticipated benefit of implementation is to improve the existing durability and resilience of asphalt pavements against moisture damage in the region.

Weblinks:

- Tran-SET's website (http://transet.lsu.edu/completed-research/)
- TRB's Research in Progress (RIP) database (https://rip.trb.org/view/1467537)