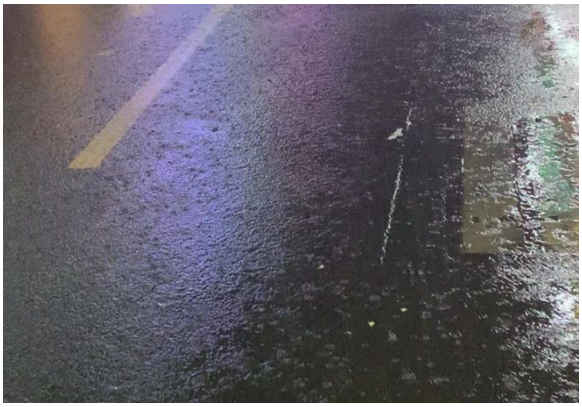
TN TDOT Department of Transportation

Research Summary

Mitigating Stripping in Asphalt Mixtures



Project Number:
RES 2020-07

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WHAT WAS THE RESEARCH NEED?

The presence of water significantly impairs the durability of the asphalt mixture and results in very complicated modes of stiffness and strength loss of the pavement. Although the moisture may not directly initiate the commonly known distresses like fatigue cracking, rutting, permanent deformation, etc., it exacerbates their severity and extent. Therefore, the selection of appropriate raw materials is becoming more and more crucial to the durability of asphalt pavements. Reduction of stripping will prove immediate benefits to the life of pavements and lowered cost of maintenance in Tennessee.

WHAT WERE THE RESEARCH OBJECTIVES?

The major research objectives include (1) the evaluation of Tennessee aggregates with a known history of stripping issues; (2) the identification of countermeasures to reduce the moisture damage of asphalt mixtures; (3) the study on moisture damage mechanisms based on the chemistry of asphalt and aggregate; and (4) the identification of test methods for loose asphalt mixtures.

WHAT WAS THE RESEARCH APPROACH?

The research team worked with TDOT engineers and identified two widely used asphalt binders, one type of liquid antistripping agent, and five types of Tennessee aggregate, including limestone, granite, and gravel. Surface free energy was used to characterize the chemistry of asphalt binders and aggregates, yielding the compatibility of different asphalt-aggregate combinations by moisture

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resistance. A series of laboratory performance tests (tensile strength ratio test, dynamic modulus test, and APA Hamburg test) were also conducted on the compacted asphalt mixtures. Then, a statistical analysis was performed on the surface energy results of asphalt binders and aggregates and the results from the laboratory stripping performance tests, achieving the strategies for material selection and the comparison of different test methods. In addition, the effect of asphalt aging on the moisture resistance and the strategies for mitigating stripping were systematically investigated. The research team also developed a new modified boiling test based on color image processing to evaluate the stripping of loose asphalt mixtures. The proposed image processing method was compared to the two existing digital imaging methods.

WHAT WERE THE FINDINGS?

Key findings include:

- The surface free energy method could fundamentally determine the compatibility of an asphalt-aggregate combination by moisture susceptibility.
- The use of an amine antistripping agent increased the dry adhesion between asphalt and aggregate and slightly reduced the cohesion within asphalt, which led to a better wettability of asphalt over aggregate.
- The asphalt mixtures with acidic aggregate tended to show more severe moisture damage, which could be attributed to the lower dry adhesion energy between asphalt and aggregate and the larger wet adhesive based on the surface free energy results.
- A new digital image processing method based on color images has been successfully developed to evaluate the coating quality of asphalt mixtures with moisture damage.

IMPLEMENTATION AT TDOT

Key recommendations include:

- The surface free energy-based criteria for material selection were tentatively proposed. The moisture resistance of D-mix samples can be categorized into three zones: high moisture resistance (Energy ratio (ER) $\geqslant$ 35.62%), moderate moisture resistance (35.62 > ER $\geqslant$ 26.83%), and low moisture resistance (ER < 26.83%). Similarly, for the BM2-mix, the three zones are high moisture resistance (ER $\geqslant$ 41.08%), moderate moisture resistance (41.08% > ER $\geqslant$ 32.89%), and low moisture resistance (ER < 32.89%), respectively.
- The standard Moisture Induced Sensitivity Test (MIST) procedure (ASTM D7870) is not recommended for the moisture conditioning in the tensile strength ratio (TSR) test.
- The proposed modified boiling test with color image processing should be used instead of the traditional boiling water test.
- The boiling water test should be conducted immediately after the mixing of asphalt and aggregate. The short-term aging of mixtures in the oven will make this test method fail to detect stripping.

MORE INFORMATION

Find the final report here: https://www.tn.gov/content/dam/tn/tdot/long-range-planning/research/final-reports/res2020-final-reports/RES2020-07_Final_Report_Approved.pdf.

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