Ohio Department of Transportation Research Project Fact Sheet

Identification of Enhanced Moisture Susceptibility Testing for Asphalt Pavements

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Report Date	September 2023
Project Number	PID No. 114244

The Problem

Over the years, efforts have been made to identify test procedures with appropriate moisture conditioning methods to quantify the potential of moisture susceptibility in asphalt mixtures. Some of the most commonly used test procedures include Modified Lottman Test (AASHTO T 283), Hamburg Wheel-Track Test (AASHTO T 324), and visual strip rating tests conducted on loose mix such as Boiling Test (ASTM D3625). Moisture conditioning methods include hot water bath, freeze-thaw conditioning, and others. However, there is no agreement on how these tests assess the probability moisture damage will occur. In addition, to reduce the effects of moisture damage, some state DOTs required the use of antistripping agents, including liquid anti-strip (LAS) additives and hydrated lime, but reliable laboratory tests are still needed to insure acceptable improvement in resistance to moisture damage is achieved.

The Ohio Department of Transportation (ODOT) has been proactive in addressing potential moisture susceptibility issues in asphalt mixtures by incorporating testing procedures during the mix design phase. However, multiple pavements in Ohio have shown stripping problems, particularly in areas where lower quality sources of aggregates are used. Therefore, there is a need to identify and/or refine mix test procedures that can provide results which correspond to in-place performance. In addition, ODOT needs guidance regarding the use of antistrip agents to determine if their use is a cost-effective solution to their current stripping problems.

Research Approach

A comprehensive literature search, a survey of state agencies, and a review of agency specifications were conducted to identify best practices and laboratory test procedures used within the United States and internationally for identifying moisture susceptibility of asphalt mixtures and the use of antistrip agents to mitigate moisture susceptibility. Two of the more widely used test procedures, the tensile strength ratio (TSR) and Hamburg Wheel Track Tester (HWTT) were evaluated with limited laboratory testing using three aggregate types; granite, gravel, and limestone, and three antistrip agents; two liquid antistrip and lime. Finally, an economic analysis was conducted to assess the potential impact of moisture damage and antistrip usage on the cost of rehabilitation required to keep a pavement in serviceable condition for 35 years in Ohio.

Findings

The review of the literature found the reliability of the TSR test in predicting the moisture resistance performance in the field was mixed, with some researchers finding a good correlation and others finding no correlation. Likewise, the literature also reported mixed results on the correlation of the HWTT results and field performance.

The TSR test was the most widely used test by state agencies based on the survey and specification review. The next most widely used test was the HWTT. The survey also found there has been a move from the TSR to the HWTT over the last 10 years, the benefit being the HWTT can be used to evaluate both moisture susceptibility and rutting resistance. The percent of agencies who indicated lab testing and asphalt mix acceptance criteria reduced the occurrence of moisture damage was higher for agenies who perform multiple tests or the HWTT than for the agencies who perform only TSR test.

Limited TSR and HWTT lab testing was performed using granite, gravel and limestone aggregate. The granite and gravel aggregate was also testing with lime additive and two liquid antistrip additives.

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The lab testing was inconclusive, all three aggregate types performed poorly. Field performance of the mixes was not available to validate the results. Close examination of the TSR samples and verification testing of Hamburg samples at NCAT did not identify the cause of the performance.

Field performance data were not available for the aggregates tested for this project. Therefore, the only "ground truth" for stripping would be the visual examination of the conditioned TSR samples. Only the samples containing gravel aggregate showed stripping (low severity) of the binder from the aggregate. The limestone sample failed the stripping criteria for both tests although no stripping was visible on the conditioned TSR samples. Likewise, even though 33% of the granite samples failed the HWTT criteria, no stripping was visible on the conditioned TSR samples.

Recommendations

- The percent of state DOTs who indicated lab testing and asphalt mix acceptance criteria reduced the occurrence of moisture damage was higher for agenies who perform multiple test or the HWTT, than for the agencies who only perform the TSR test. Based on the literature and state DOT responses to the survey, the TSR test may not be able to accurately capture the moisture susceptibility of mixes in the field. Nothing was discovered in the literature search or other state specifications which would improve the current ODOT Supplement's procedure. Therefore, it is recommended ODOT move forward with implementation of the HWTT AASHTO T 324-22 test procedure.
- The limited testing on this project did not provide sufficient data to develop criteria for the water temperature used for the HWTT. Only one water temperature, 50° C, which may have been too severe, was used for this project. The maximum rutting limit of 12.5 mm resulted in fewer than 20,000 passes at the 50° C temperature. A more robust testing evaluation is needed to establish a test temperature, which may vary based on RAP content and PG grade, and maximum rut depth to use for the testing.
- Many of the states performing multiple tests used the boil test as the second test method to validate test results. This is a quick and inexpensive test to perform. The use of this test along with the TSR test or the HWTT should be investigated.
- The LCCA evaluation showed the use of antistrip additives had a small impact in the cost of rehabilitation activities ($475 per lane mile), and therefore it is justified to require the use of antistrip additives when the moisture susceptibility potential of the aggregates is unknown or when it is known the aggregates are susceptible to moisture.
- The field performance of aggregate sources is needed to establish acceptance criteria for any mix performance test. It is recommended ODOT establish a process for documenting results of internal forensic investigations, such as the one performed on US 33 in Fairfield County, as well as asphalt mix failures observed when coring is performed prior to rehabilitation.

Left: Conditioned sample with gravel and Marshall compaction after indirect tension testing
Right: Specimens with gravel and antistripping additive after HWTT

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