RESEARCH
PROJECT CAPSULE [16-4B]
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TECHNOLOGY TRANSFER PROGRAM

Evaluation of Non-SBS Modified Binders using the Multiple Stress Creep Recovery Test

JUST THE FACTS:

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POINTS OF INTEREST:

Problem Addressed / Objective of Research / Methodology Used Implementation Potential

PROBLEM

Higher traffic coupled with heavier loads led the asphalt industry to introduce polymer-modified binders to enhance the durability and strength of HMA pavements. Numerous research projects showed that G*/Sinδ, the high temperature specification parameter for current Performance Graded (PG) asphalt binder is not adequate to reflect the rutting characteristics of modified binders. Even though G*/Sinδ can capture the viscous and elastic effects of neat binders, it is unable to denote the benefits of elastomeric modification of asphalt binder. Consequently, many state DOTs have added supplemental specifications ("PG-Plus" tests) to identify the presence of polymer modified binders. Louisiana is among the states that are currently using a PG-Plus specification. Separation of Polymer, Force Ductility, Elastic Recovery tests are the required tests for the Louisiana Department of Transportation and Development (DOTD) PG-Plus requirement. However, most of these PG-Plus tests are unable to evaluate the performance of the polymer-enhanced binders. To be more specific, these tests can only determine the presence, not the performance, of a modifier.

The lack of a reliable performance-related binder test, especially for elevated temperature, has led to research into development of new tests. As a result, the Multiple Stress Creep Recovery (MSCR) test was introduced as a potential candidate to resolve this problem. The MSCR test is a creep and recovery test conducted using a Dynamic Shear Rheometer (DSR) with a parallel plate geometry set-up. Non-recoverable creep compliance (J_{nr}) computed from this test is used to characterize the stress dependency of polymer-modified asphalt binders. MSCR correlates well with the mixture rutting parameter and has already been included in the AASHTO PG binder specification, AASHTO M 320-09.

The recently completed Louisiana Transportation Research Center (LTRC) project 11-1B evaluated the validity of using this new MSCR test procedure for implementation in the DOTD Specifications. The MSCR test and the corresponding specifications were found to be an improvement to the current PG binder specifications for DOTD. A suite of asphalt binder tests (MSCR, G*/Sinδ, Elastic Recovery, and Force Ductility tests) were conducted to assess the suitability of MSCR to be included in the DOTD asphalt binder specifications in addition to identifying the potential of replacing Elastic Recovery and Force Ductility tests with MSCR recovery techniques. Crumb Rubber Modified (CRM) and Latex Modified binders were tested, but due to their limited availability, it was not possible to establish MSCR-based specification criteria. As part of the recommendations from the Final Report of LTRC Project 11-1B, further investigation on non-SBS modified binders is needed to fully implement MSCR-based binder specifications for all types of modification. Collection of Force Ductility data will be continued, as consideration is given to replacing Force Ductility tests with DSR phase angle or MSCR recovery criteria.

This study will also look into a new test, Binder Quality Control Test (QCT), also known as the laser penetration test, to compare results with the MSCR.

OBJECTIVE

The objectives of this research are to characterize the elastic response of non-SBS modified binders used in DOTD asphalt mixtures using the MSCR, to continue collecting Force Ductility data to justify its replacement with DSR phase angle or MSCR recovery criteria, and to perform cost-benefit analysis to display the benefits of switching from the PG Plus tests to the MSCR.

METHODOLOGY

An extensive literature review will be performed to collect the latest MSCR research information from published materials and ongoing projects.

SBS-modified binders and non-SBS modified binders will be collected from various asphalt suppliers and contractors in Louisiana.

A set of laboratory tests (including MSCR, DSR, Elastic Recovery, Force Ductility, and QCT) will be conducted on each binder. The test results will be collected and compared for binder characterization. The MSCR test results will be processed and statistically analyzed to determine if the results are adequately consistent.

The computed mean J_{nr} for each binder will be compared to the AASHTO M320-09 specification to determine the newly proposed performance grade of that binder. The average percent recovery at 3200 Pa will be plotted against the average non-recoverable creep compliance at the same stress level. This plot will be analyzed to identify whether or not the binder is polymer modified.

Linear and non-linear statistical regression techniques will be employed to determine relationships (if any) among the binder test results. If possible, a suitable model will be developed. The reliability of the model will be assessed using a goodness-of-fit parameter (correlation coefficient, R^2).

A cost-benefit analysis will be conducted to determine the benefits of switching from the "PG-Plus" tests to the MSCR test. This analysis will include a survey of personnel (DOTD and contractors) for equipment cost and time (duration) of testing. A scorecard will be created for comparative analysis, and a final report will be available at the conclusion of this project.

IMPLEMENTATION POTENTIAL

While Louisiana has historically used polymer-modified binders, it may be economically beneficial to utilize non-SBS polymer modification. With the inclusion of the MSCR test in the latest AASHTO binder specification for PG graded asphalt, there is a need for the DOTD to determine whether MSCR parameters such as J_{nr} may be used to characterize non-SBS modified binders. This study will identify if it is feasible for DOTD to make a transition to the latest asphalt binder specification for non-SBS modified binders. It can also provide a necessary tool to evaluate the effectiveness of any new asphalt binder modifiers.