JOINT TRANSPORTATION RESEARCH PROGRAM

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Analysis of the Multiple Stress Creep Recovery Asphalt Binder Test and Specifications for Use in Indiana

Introduction

The Indiana Department of Transportation (INDOT) currently uses the Superpave performance grading (PG) system as standardized in AASHTO M 320. Although the Superpave PG binder specification was a significant step forward to select binders based on their performance, the test methods specified have been found to inaccurately predict the characteristics of modified asphalt binders, especially at high temperatures. In some cases, this has resulted in binders being over-engineered—using higher polymer loadings than needed to meet the climatic and traffic demands—resulting in higher material costs.

To overcome the disadvantages of M 320, especially regarding modified binders, a new test method and standard specification have been adopted by AASHTO. The new specification (M 332) uses a multiple stress creep recovery (MSCR) test, described in AASHTO T 350, to characterize binder behavior at high temperatures. The test is expected to more accurately reflect the binder contribution to rutting resistance, especially with modified binders, than the current M 320 standard.

This research was initiated to determine if implementing the new MSCR test and M 332 binder specification could lead to optimized binder properties and avoid the perceived over-engineering of modified binders. The results will allow INDOT to consider the possible benefits of implementing the MSCR test by comparing the performance of binders formulated to meet the existing M 320 specifications to those formulated to meet the M 332 specification through binder and mixture testing. Reduced cost, longer pavement service life and improved performance are potential benefits of implementation of the new standards.

Findings

- The MSCR creep compliance and Superpave rutting parameter do not correlate well to each other, especially with regard to modified binders, as shown by a comparison of paired test results on over 2400 binder samples over a six-year period. At higher concentrations of modifiers in the asphalt binders, the coefficient of determination between the creep compliance and rutting parameter decreased drastically. This is due to the fact that these two grading systems capture the viscoelastic behavior of modified asphalt binders differently. (See Figure 1.)
- The MSCR can be used to test and successfully rank neat, GTR and polymer-modified binders. This means that the MSCR specification (M 332) could be implemented and applied to all binders regardless of modification.
- The MSCR test grades the binders considering both environmental and traffic conditions. That is, the expected traffic levels do not have to be addressed by so-called “grade bumping” anymore. In addition, the MSCR test is expected to optimize the binder formulation to avoid the use of over-engineered binders.
- Correlation between asphalt binder performance with asphalt mixture performance shows that the MSCR provides a better coefficient of correlation at both stress levels with flow number test results than the PG rutting parameter. That is, the MSCR grading would be expected to better reflect ultimate high temperature mixture performance, specifically resistance to rutting. Since the MSCR specification uses the same low temperature test and criteria, no changes in the low temperature mixture behavior would be expected.

Implementation

Results of the statistical and experimental approaches that were applied in the current study suggest that the MSCR test provides a better tool than the currently used PG grading system for characterizing high temperature performance properties of commonly used asphalt binders in the state of Indiana. These results suggest that INDOT could implement the MSCR test and have reasonable expectations that binders meeting the needed climatic and traffic conditions would perform well and could possibly be less expensive.

This change can be accommodated by revising Section 902 of the Standard Specifications, along with applicable design guidance. The pay items will also have to be changed to include the new binder grade designations.

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Figure 1. Correlation of $G^*/\sin \delta$ to MSCR creep compliance (J_{nr} @ 3.2 and 0.1 kPa) for (a) unmodified PG 64-22 and (b) modified PG 76-22 showing lack of correlation as polymer content increases.