HIGHLIGHTER

CREEP COMPLIANCE AND PERCENT RECOVERY OF OKLAHOMA CERTIFIED BINDER USING THE MULTIPLE STRESS CREEP RECOVERY (MSCR) METHOD

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OVERVIEW Unlike neat (unmodified) binders, polymer-modified binders are sensitive to the applied stress levels, and they exhibit nonlinear response with respect to rutting factor and phase angle. The Superpave® test protocols work well for neat binders, but they are inadequate for characterizing viscoelastic properties of polymer-modified binders. Consequently, many state agencies have introduced additional tests to characterize polymer-modified binders, which, along with their specifications, are called the Superpave® "PG Plus" specifications. Major drawbacks of the "PG Plus" tests include being generally expensive and time consuming to conduct and they may not be reflective of performance in the field. The absence of common test standards and specifications across states and variations in performing these tests pose additional challenges. The Federal Highway Administration (FHWA) has introduced a new test method for measuring the high temperature properties of binders, called "Multiple Stress Creep Recovery" (MSCR) test that can provide information on both performance and formulation of the binder. A major benefit of the new MSCR test is that it can eliminate the need for the "PG Plus" tests. The MSCR test can also capture the actual field conditions experienced by a pavement through repeated creep-recovery cycles.

RESULTS This laboratory study was conducted to develop guidelines for the Multiple Stress Creep Recovery (MSCR) test method for local conditions prevailing in Oklahoma. The study consisted of commonly used binders in Oklahoma, namely PG 64-22, PG 70-28, and PG 76-28. The testing program also included binders recovered from four reclaimed asphalt pavement (RAP) samples and Sasobit®-modified virgin binders. Non-Recoverable Creep Compliance (J_{nr}) and MSCR *%Recovery*, obtained from the MSCR test data, were analyzed for the MSCR grading (Figure 1).

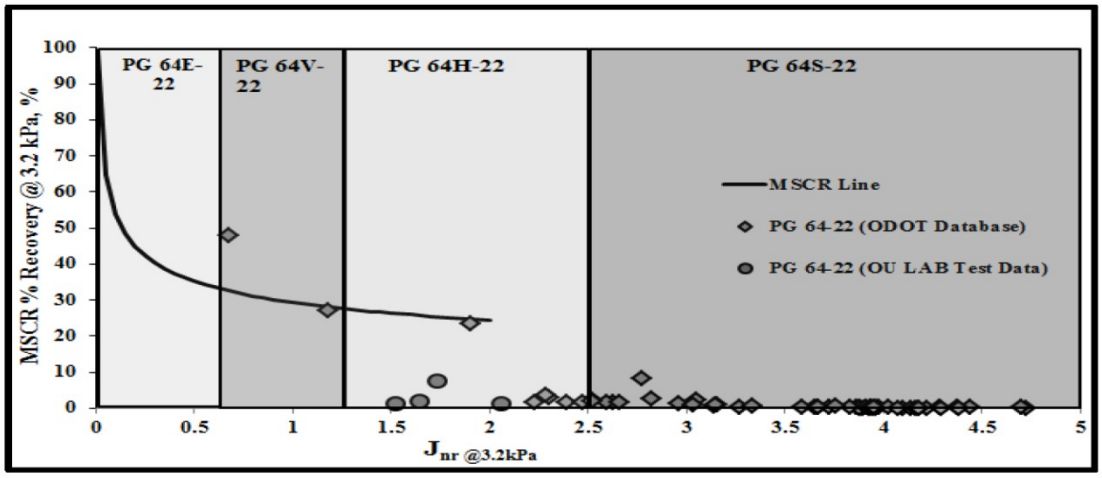

Figure 1 MSCR %Recovery % vs. Jnr @ 3.2 kPa for PG 64-22

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A large number of data points (59 out of 63 samples or 94%) for the PG 64-22 binders were scattered under the AASHTO T 350 MSCR curve. The average %Recovery at 3.2 kPa was found to be very low, about 2.5%, which could be considered "no recovery at all." All PG 70-28 binders (46 total) tested in this study met both the AASHTO T 332 stress sensitivity criterion ($J_{nr,\ diff}$ < 75%) and the AASHTO T 350 criterion for %Recovery. Based on the J_{nr} values, about 80% (37 out of 46) of the PG 70-28 binders were graded as PG 64E-22, which was followed by 20% (9 out of 46) of binders that were graded as PG 64V-22. All 43 tested PG 76-28 binders met both the AASHTO T 332 stress sensitivity criterion and the AASHTO T 350 criterion for the %Recovery. Based on the Jnr values, all PG 76-28 binders were graded as PG 64E-22.

In addition, the Asphalt Institute (AI) recommended Polymer and Quadrant methods were followed in interpreting the test data (Figure 2). Analyses of test results showed that the AASHTO T 350 and AASHTO T 332 recommended J_{nr} criteria could be followed in the MSCR-based grading for conditions prevailing in Oklahoma. It was observed that 97% of the tested polymer-modified binders met the Asphalt Institute (AI) recommended minimum %Recovery and stress sensitivity. It was also found that an addition of 3% Sasobit® would reduce the rut depth by half compared to other binders.

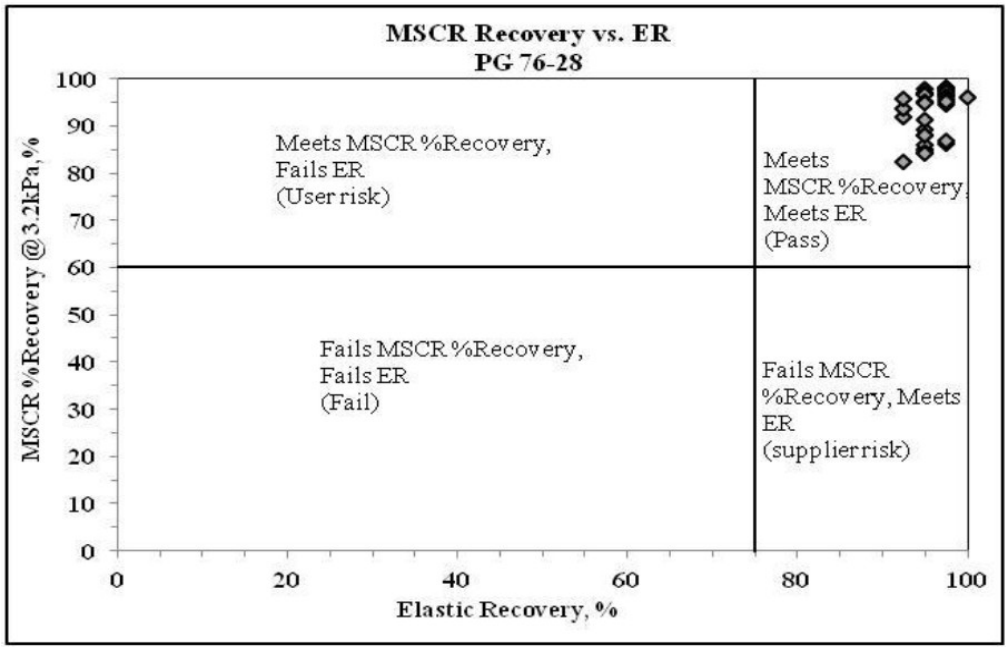

Figure 2 Quadrant Plot for PG 76-28

Acceptable %Recovery limits are proposed for both PG 70-28 (minimum 75%) and PG 76-28 (minimum 80%) binders without penalizing a significant number of suppliers or users. Similar to the PG 70-28 binders, the PG 76-28 binders could be graded based on the AASHTO T 350 recommended J_{nr} thresholds, along with the quadrant plots. This approach to specifying a %Recovery is called a step approach versus the graphical method shown in AASHTO TP 70.

The nonlinear behavior of PG 70-28 and PG 76-28 binders was more prominent at a higher stress level (10 kPa) than 3.2 kPa. Also, the shapes of MSCR curves for these binders at higher temperatures (70°C and 76°C) were found to be different from those at 64°C. Thus, MSCR tests should be performed at 10 kPa and at higher temperatures (70°C and 76°C) to get a better understanding of nonlinearity and polymer networks in polymer-modified binders. The proposed minimum %Recovery values at 10 kPa for PG 70-28 and PG 76-28 binders would be about 45% and 70%, respectively.

The LTPPBind software analysis revealed that at a 95% reliability, the PG 76-28 binder satisfied a wide range of binders (from PG 58-10 to PG 76-16) or weather and traffic conditions prevailing in Oklahoma. If a 50% reliability is considered, then both PG 70-28 and PG 76-28 binders satisfied a larger set of binders ranging from PG 58-10 to PG 70-10. If the proposed MSCR grading was adopted, PG 64V-22 and PG 64E-22 binders would satisfy the recommended wide range of PG binders suggested by the LTPPBind software analysis. These grades would require less polymer and would need %Recovery less than the current limits recommended by this research and currently used by ODOT for PG 70-28 and PG 76-28.

POTENTIAL BENEFITS This study investigated the feasibility of the adoption of the multiple stress creep recovery (MSCR) test method by the Oklahoma Department of Transportation. It provided guidance for grading polymer-modified binders commonly used in the state. It is expected that these guidelines will assist ODOT in a successful transition to the latest MSCR specifications for binders.