Texas A&M Transportation Institute

PROJECT SUMMARY

Texas Department of Transportation

0-6674: Improving Fracture Resistance Measurement in Asphalt Binder Specification with Verification on Asphalt Mixture Cracking Performance

Background

The current performance grading (PG) specification for asphalt binders is based primarily on the study of unmodified asphalt binders. Over the years, experience has proven that the PG grading system, while good for ensuring overall quality, fails in some cases to predict rutting and cracking performance, particularly for modified binders. Recent studies show some mixes with softer binders used outside of Texas have both good rutting and cracking performance. However, the current binder PG system fails to justify/identify this phenomenon. It is necessary to improve the current asphalt grading system and recommend associated specification limits, especially for modified binders.

This project:

- Identified/evaluated simple laboratory evaluation methods to characterize binder properties.
- Recommended a potential binder specification change.
- Tracked the field performance of pavements using different binders including softer but highly modified binders.
- Developed a statewide binder selection catalog for each district based on cracking performance simulation and life-cycle cost analysis (LCCA) results.

What the Researchers Did

Researchers:

- Evaluated multiple stress creep and recovery (MSCR) with a focus on its repeatability and the validity of differentiating the rutting performance of nine asphalt binders.
- Evaluated five asphalt binder cracking tests and compared them with the asphalt mixture cracking test; these binder tests are the PG grading test, elastic recovery test, MSCR test, linear amplitude sweep (LAS) test, and double-edged notched tension (DENT) test.
- Evaluated four asphalt binder adhesive tests.
- Constructed, monitored, and analyzed 11 field test sections.
- Sampled the plant mixes and performed dynamic modulus, repeated load permanent deformation, Hamburg, and overlay test (OT) tests.
- Developed a partial factorial design to consider all critical influential factors including environmental zones, traffic levels, binder types, aggregate types, mix types, overlay thicknesses, etc.
- Conducted 2700 cracking performance simulations to cover different asphalt mixtures, climatic zones, overlay thicknesses, traffic levels, and existing pavement structures.
- Developed the statewide binder selection catalog.
- Conducted the pavement LCCA to evaluate the financial benefits of using the recommended binders.

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8-31-2014

What They Found

Researchers found:

- Both MSCR's $J_{nr0.1}$ and $J_{nr3.2}$ results are very repeatable and reproducible. However, both J_{nrdiff} and $R_{0.1}$ have high variability. Since J_{nrdiff} is one of the parameters for grading asphalt binder, caution should be exercised when applying the MSCR specification. The $R_{3.2}$ results are acceptable in terms of repeatability and reproducibility.
- Asphalt mixture rutting test results showed that the MSCR test and associated specification work better than the current G*/sinδ–based PG specification, especially for those highly modified asphalt binders. However, some caution should be exercised when grading slightly modified asphalt binders.
- Neither the MSCR nor the elastic recovery test shows good correlation with the asphalt mixture OT cracking test. Both the LAS test and the DENT test provide ranking similar to that of the asphalt mixture OT cracking test. The dynamic shear rheometer (DSR)–based LAS test is recommended for the asphalt binder fracture test since the DSR has been widely used in the last 20 years, and laboratory technicians and researchers are very familiar with it.
- All the crack predictions of the 11 field test sections during the first two years are close to zero or very small, which is consistent with the field observation. Except in Loop 820, the predicted rutting depths on SH 15 and US 62 test sections are small (less than 0.1 inches), which the field survey had confirmed.
- According to the prediction results, the asphalt mixtures that have PG 64-34, the softer but highly modified binder, did show good rutting and cracking resistance. The predicted performance ranking and the difference among test sections are reasonable and helpful in validating the embedded models (cracking model and rutting model).
- Based on the simulation results, researchers determined the required OT cycles of overlay mixtures for different environmental zones, existing pavement structures, overlay thicknesses, and traffic levels. Engineers in hot areas should exercise caution when using the recommended catalog because the rutting issue might also be a concern.
- The LCCA result shows that the best options (based on lowest agency costs) are consistent with the binder recommendations (based on cracking life and mixture OT cycles). In addition, the potential use of softer but highly modified binders, especially in cold areas, shows financial benefits.

What This Means

The results indicate that softer but highly modified binders in Texas, especially in cold areas, have good performance and financial benefits. In order to justify/identify this phenomenon, researchers recommend changes to:

- The recommendations for statewide binder type selection.
- The binder test methods and specifications, such as the MSCR test and the DSR-based LAS test.

The researchers also recommend that the test sections continue to be monitored and compared to model predictions. The specification change recommended for the binder test and statewide binder type selection should be further validated. Also, the binder alone does not determine rutting, fatigue cracking, and moisture damage of asphalt pavements.

For More Information

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