TECHSUMMARY October 2022

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

INTRODUCTION

Asphalt binders are modified to increase the durability and reliability of asphalt pavements. While the dynamic shear rheometer (DSR) has shown to be successful in characterizing neat (un-modified) binders, it has been less reliable with modified binder results. Due to this issue, many state agencies adopted "PG-Plus" tests to identify the presence of polymer modified binders. PG-Plus tests include the force ductility, elastic recovery, and separation of polymer tests. These tests were able to determine the presence of a modifier; though unable to evaluate the performance of the binders. The multiple stress creep recovery (MSCR) test was the latest improvement to the Superpave Performance Graded (PG) Asphalt Binder specification and was developed to more accurately indicate the performance of the asphalt binders. MSCR is a creep and recovery test that is "blind" to modification type. MSCR differs from DSR and the PG Plus test by applying higher stresses and strains on the binder that activates the binder's polymer network.

A MSCR validation study was completed by the Louisiana Transportation Research Center (LTRC) in 2016. The researchers determined it was possible to replace the currently used PG-Plus tests with the MSCR percent recovery and phase angle criteria. From the recommendations of the initial MSCR study, DOTD has implemented the MSCR for PG 70-22m and PG 76-22m (SBS-modified) binders in the new DOTD specifications. However, CRM and latex modified binders were not included to these new specifications. Additionally, since the new MSCR specifications were implemented, there have been issues with producers passing the MSCR curve with PG 70-22m binders in the updated specifications.

OBJECTIVE

The original objectives of this research project were to evaluate non-SBS modified binders (i.e., crumb rubber and latex) used in DOTD asphalt mixtures by means of the MSCR test and to fine tune the replacement of PG Plus tests with the MSCR. An additional objective was added during the course of the research project to review PG 70-22m asphalt binder specifications due to issues of binders being unable to pass MSCR curve requirements.

METHODOLOGY

A suite of asphalt binder characterization tests was conducted to evaluate the high temperature performance of binders investigated under the scope of this study.
The MSCR test was performed in accordance with AASHTO T350. The MSCR results measure the non-recoverable creep compliance (J_{nr}) and percent recoveries (R) to characterize the stress dependency and temperature sensitivity of polymer-modified binders.

The DSR is used to characterize the viscous and elastic behavior of asphalt binders at medium to high temperatures. DSR testing was done on original, RTFO- and PAV-aged binder samples following AASHTO T315 procedures.

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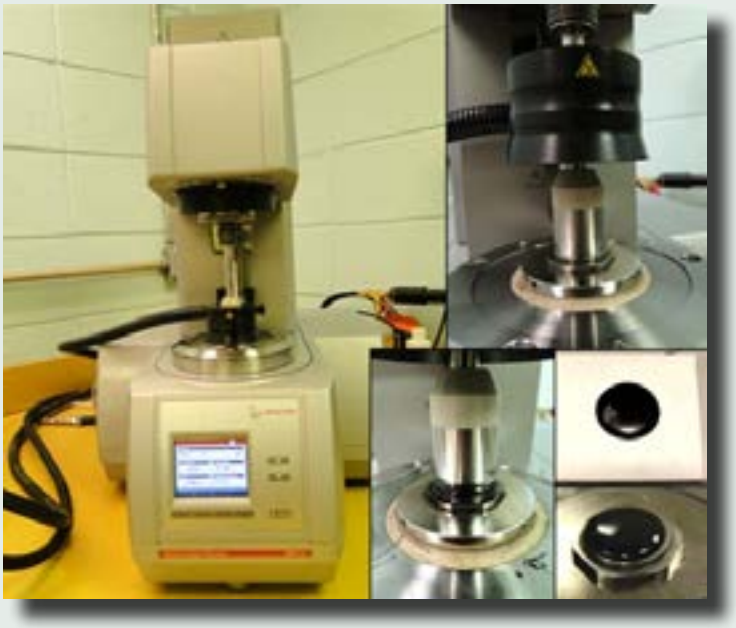
The forced ductility test involves measuring the tensile properties of polymer-modified asphalt binders by determining the force required to maintain a specific elongation rate of a test specimen at a certain elongation and a specified temperature, therefore characterizing the toughness of a binder sample. The procedure was followed in accordance with AASHTO T300.

The elastic recovery test measures the tensile property of polymer-modified asphalt using the same ductilometer used for ductility and force ductility. The AASHTO T301 method was followed in this study to conduct elastic recovery tests on RTFO aged binders at 25°C with 10 cm elongation.



Anton Paar MCR 302 DSR

CONCLUSIONS

Based on the experimental results of 17 non-SBS modified asphalt binders under the scope of this study, the following conclusions can be drawn:

- The MSCR test is capable of evaluating the performance of non-SBS modified binders (i.e., CRM, latex, and hybrid mixes). Non-SBS binders graded as PG 82-22rm are able to meet MSCR curve and maximum J_{nr} parameters that can withstand extreme traffic loadings.
- Test results indicated that a greater sensitivity to elastomeric response was found using the MSCR percent recovery test as opposed to elastic recovery, showing that MSCR percent recovery is capable of capturing a limitation that existed in the elastic recovery test.
- The base binder source of modified binders can have significant impact on MSCR results based on the MSCR curve. Also hybrid binders, comprised of rubber and polymer mixtures, performed better than binders with just crumb rubber or latex.
- Phase angle and MSCR percent recovery correlated well with force ductility ratio, while they both correlated poorly with force ductility at 30 cm.
- Gap height testing showed no significant differences. The testing indicated that the rubber particles contained in the binders were not interfering with MSCR testing.
- Modified binders graded at PG 70-22 (SBS and non-SBS) have trouble meeting current DOTD MSCR specifications. LWT latex mixture results showed acceptable performance of latex binders when in mixture form.

RECOMMENDATIONS/IMPLEMENTATION

From the outcomes of this study, the authors recommend the following:

- Non-SBS modified (i.e., crumb rubber, latex, and hybrid) asphalt binders to be included into DOTD specifications utilizing MSCR specifications. PG 82-22rm binders are capable of meeting maximum $J_{nr3.2}$ of 0.5 and MSCR curve requirements.
- PG 70-22 modified binders (SBS and non-SBS) specifications should be updated to require a minimum MSCR Recovery of 15% and to require a non-creep recovery ($J_{nr3.2}$) value to be between 1.0 and 2.0.
- LTRC should continue collecting PG 70-22 binders (SBS and non-SBS) to further support updated MSCR parameters and also to determine if a 78° max phase angle should be implemented for PG 70-22 binders.