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Validity of Multiple Stress Creep Recovery (MSCR) Test for DOTD Asphalt Binder Specification

INTRODUCTION

Higher traffic coupled with heavier loads led the asphalt industry to introduce polymer-modified binders to enhance the durability and strength of hot mix asphalt (HMA) pavements. When the Superpave Performance Graded (PG) binder specification (AASHTO M 320) was introduced, it was expected that all asphalt binders with the same "Performance Grade" would function the same under a similar climate and traffic condition, regardless of how those binders are produced. Since then, numerous research studies have shown that G*/Sinδ, the high temperature specification parameter for current PG asphalt binder, is not adequate to reflect the rutting characteristics of modified binders. As such, many state DOTs have adopted supplemental specifications, also known as "PG-Plus" tests in addition to the conventional PG specifications. However, in most cases, the PG-Plus tests do not reflect the binder performance and only identify the presence of polymer in polymer-modified binders. The Multiple Stress Creep Recovery (MSCR) test, which has already been included in the latest AASHTO specifications for PG asphalt binder (AASHTO MP 19), showed potential to resolve the previously mentioned issues. Louisiana has been using various polymer and crumb rubber modified binders for a long time. With the inclusion of the MSCR test in the AASHTO MP 19 and an anticipation of its wide spread utilization, there has been a need for DOTD to verify whether the parameters such as: J_{nr} and MSCR percent recovery are sensitive to polymer and crumb rubber modified binders commonly used in Louisiana. This study was initiated to identify the feasibility of DOTD to make a transition to the latest MSCR-based AASHTO asphalt binder specifications.

OBJECTIVE

The major goal of this study was to characterize the elastic behavior of various asphalt binders (mainly PG 76-22m and PG 70-22m), which are listed in the Qualified Products List of DOTD, on the basis of MSCR test results. It was anticipated that the outcome of this study would eventually lead to identifying the suitability of the MSCR parameters to be included in the current DOTD asphalt binder specifications. Additional analyses were conducted to find possible correlations between MSCR percent recovery and currently utilized PG-plus (i.e., elastic recovery and force ductility) test results with an aim to replace the current tests with MSCR. Finally, several recommendations have been proposed to revise the current asphalt binder specifications for the state of Louisiana.

LTRC Report 564

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SCOPE & METHODOLOGY

A total of 44 SBS-modified asphalt binders from seven asphalt binder suppliers were evaluated. Among those, 21 binders were PG 76-22m, and the remaining binders were PG 70-22m, as per the current DOTD asphalt binder specifications. A suite of asphalt binder characterization tests were conducted to evaluate the high temperature performance of binders investigated under the scope of this study. These tests were the MSCR, Dynamic Shear Rheometer (DSR), Elastic Recovery, Force Ductility, and Gel Permeation Chromatography (GPC).

CONCLUSIONS

Based on the experimental results of the 44 SBS polymer-modified asphalt binders under the scope of this study, it appears that DOTD is capable of making a smooth transition from its current asphalt binder specifications to AASHTO MP 19, the new MSCR based asphalt binder specifications. It is also possible to replace the currently used "PG-Plus" tests such as: elastic recovery and force ductility with the MSCR percent recovery and DSR phase angle criteria.

RECOMMENDATIONS

The outcome of this study clearly indicates that DOTD is ready to make a transition to the new MSCR-based AASHTO MP 19 asphalt binder specifications. The authors recommend starting a support study to establish a MSCR-based specification criterion for CRM and Latex modified binders, which could not be completed under the scope of this study due to their availability. It is also recommended that the proposed support study keep collecting the force ductility and DSR phase angle data for unaged binders to fine tune the replacement of force ductility with DSR phase angle or MSCR recovery criteria. At this point, the authors highly recommend the implementation of AASHTO MP 19 at 67°C with the following guidelines:

- **For unaged original binders:** The authors recommend keeping all current PG test requirements with the exception of replacing force ductility ratio with a DSR phase angle of 75° max for unaged PG 76-22m binders tested at 76°C and a DSR phase angle of 78° max for unaged PG 70-22m binders tested at 70°C. There will be no change at all for the current PG 64-22 binders.
- **For RTFO-aged binders:** MSCR testing to be conducted at 67°C, with traffic level requirements designated as "E" (AASHTO MP 19) for the current PG 76-22m and "H" for the PG 70-22m binders respectively. More specifically, the current PG 76-22m polymer-modified binders have to meet the PG 67-22E requirements as mentioned in AASHTO MP 19. Similarly, all polymer-modified binders currently specified as PG 70-22m have to meet the requirements of PG 67-22H. The requirement of regular RTFO binder DSR testing at the corresponding PG temperatures (i.e., 76°C and 70°C) will be waived for PG 76-22m and PG 70-22m binders. However, there will be no change at all for the current PG 64-22 binders.
- **For RTFO-aged binders:** The elastic response curve as required in AASHTO TP 70 shall be used to replace the current elastic recovery requirements.
- **For PAV-aged binders:** No change will be made to the current PG test requirements for PAV-aged binders.