

Research Summary

Effect of Asphalt Binder Source on Asphalt Mixture Performance

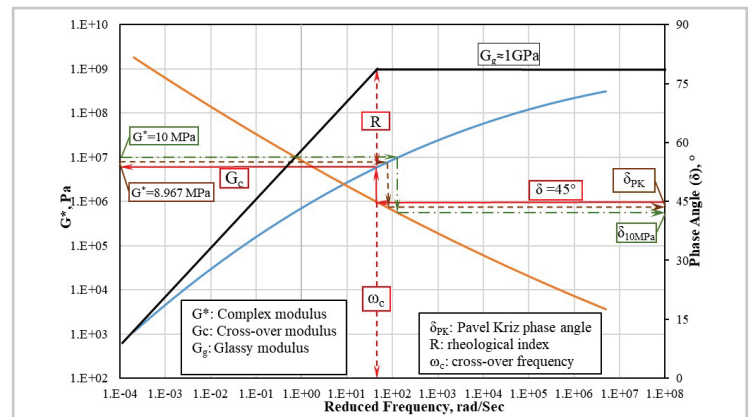
Research Need

Recent research has shown that transportation agencies are increasingly experiencing premature failures of some of their asphalt mixtures that did not fail previously. Some reasons that might attribute to these failures include: variability in the source of the base binder used to produce the mixture, switching to a different binder supplier during production as compared to the mixture design phase, and suppliers using different modifiers and/or additives with a base binder to meet the target Performance Grade. Hence, research is needed to evaluate if the quality of the asphalt binders used during the entire production process, regardless of the binder source or type of modification, will provide the targeted mixture performance.

Goals/Objectives

The main objective is to assess the implications of changes in asphalt binder formulation and source during mix design and production. The following research objectives were established:

1. Determine which binder properties display significant variations between different production lots and sources.
2. Determine which changes in binder properties alter a mixture's laboratory performance.
3. Perform life cycle cost analysis.
4. Establish specifications for allowable binder property tolerances.



Goals/Objectives (Continued)

5. Provide a roadmap for MassDOT to update their asphalt pavement specifications to incorporate new binder testing protocols for both mix design approval and construction.

Methodology

The experimental plan designed for this study included:

1. Develop and conduct internet surveys of asphalt binder suppliers and producers.
2. Obtain asphalt binders used in Massachusetts and conduct asphalt binder testing.
3. Determine which asphalt binder parameters capture any significant variation between production lots and sources.
4. Perform a mixture design and conduct performance testing.
5. Perform life cycle cost analysis (LCCA).
6. Select a binder property and develop specification tolerance.
7. Develop a roadmap for MassDOT.

Key Findings

The study successfully identified point and shape rheological parameters specifically, Glover-Rowe (G-R) at 15°C and 10 rad/s and the phase angle at a modulus of 10 MPa as effective indicators for evaluating asphalt binder quality. These parameters reliably differentiated between low-quality binders (such as PG64-16 and formulated PG64-22 and PG64-28) and high-quality binders (such as PG52-34 and PG76E-34), even when the binder source or formulation changed within the same performance grade.

The effectiveness of the selected rheological parameters was validated through the Indirect Tensile Asphalt Cracking Test (IDEAL-CT). The CTIndex values of the asphalt mixtures correlated well with the binder rankings derived from G-R at 15°C and 10 rad/s and the phase angle at a modulus of 10 MPa. Hence, based on the IDEAL-CT test results these parameters are reliable predictors of asphalt binder quality in terms of their susceptibility to intermediate-temperature cracking.

A simplified and rapid method was developed using the dynamic shear rheometer (DSR) to measure G-R at 15°C and 10 rad/s and the phase angle at a modulus of 10 MPa, bypassing the need for extensive master curve analysis. This approach, utilizing polynomial interpolation of DSR data, demonstrated strong agreement with traditional master curve results. The new method provides an efficient and accurate tool for routine quality control during production, ensuring consistent binder performance and enhanced resistance to intermediate-temperature cracking.

Project Information

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Principal Investigators:

Professor Walaa S. Mogawer, P.E., F. ASCE

Performing Organization:

University of Massachusetts Dartmouth

Project Champion:

Edmund Naras, MassDOT

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Key Words:

Point & Shape Rheological Parameters, Phase Angle, Master curve, Glover-Rowe Parameter, Intermediate-Temperature Cracking, IDEAL-CT

Use of Findings

The combination of G-R at 15°C and 10 rad/s and the phase angle at a modulus of 10 MPa parameters, along with the development of a simplified testing method, offers a practical and efficient framework for evaluating asphalt binder's performance in terms of their resistance to intermediate-temperature cracking.

Integrating these tandem parameters with the simplified DSR method into Balanced Mix Design (BMD) and quality assurance can improve binder selection and reduce cracking, particularly when binder sources or formulations change without altering the Performance Grade (PG).

Research and Technology Transfer Section
MassDOT Office of Transportation Planning
Planning.Research@dot.state.ma.us

