



Field Evaluation of Modified Asphalt Binder Guidelines

PUTTING RESEARCH TO WORK
BRIEF

This project assessed the suitability of Wisconsin's asphalt binder modification guidelines. It follows up on a previous Wisconsin Highway Research Program (WHRP) study (0092-03-13) which served as an initial step towards validating WisDOT's asphalt binder selection criteria. The researchers identified field sites and sampled hot mix asphalt (HMA) materials. They characterized the as-built asphalt binder material properties using newly-developed test methods that focused on damage-resistance characteristics. Early-life pavement distress surveys were conducted to evaluate the ability of these test methods to quantify the effect of modified binder use on field performance.

What is the problem?

In the United States, a number of state highway agencies claim that the Superpave specification has some critical gaps, mostly related to the performance characterization of modified binders. Recognizing this, the American Association of State Highway and Transportation Officials (AASHTO) sponsored a study of the applicability of the Superpave specification and protocols developed for asphalt cements to modified asphalt binders (NCHRP Report 459). The report offered a revised system for testing and evaluation of asphalt binders based on damage behavior. The earlier WHRP research effort addressed the implementation of the system for testing and evaluating asphalt binders in Wisconsin, however, there was difficulty differentiating the performance of the pavements due to the relatively short time they were in service. The field sections have now been in service an additional five years which allowed for clear differentiation in field performance and an improved understanding of the ability of the test methods used to characterize the asphalt binder properties.

Research Objective

The objectives of this study were as follows:

- To determine in-service performance assessment of field sections documented in the original research report.
- To assess the tests used in the previous study and also the developments in characterization of modified binders since the study ended. This assessment evaluates the suitability of AASHTO MP 19 recommendations to WisDOT specifications and characterization of original materials using updated testing methodologies if deemed more useful than those from the previous study.
- To establish performance of binders/modifiers used in Wisconsin.

Methodology

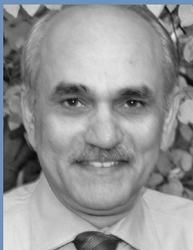
Field performance was assessed through condition surveys conducted between 2004 and 2012 as part of both phase I and phase II of the project. A set of modified binders corresponding to constructed field sections across Wisconsin were tested using recently developed characterization procedures under consideration or standardized by AASHTO as provisional standards. The following performance measures were assessed:

Fatigue Characterization: The Linear Amplitude Sweep (LAS) test, standardized under AASHTO TP101, was considered and evaluated and the resulting Number of cycles to failure (Nf) value was investigated as a potential parameter for ranking binders in terms of expected resistance to fatigue cracking.

Low Temperature Characterization: The Single Edge Notched Bending procedure (BBR-SENB), based on the modification of the Bending Beam Rheometer test, was used to assess the Wisconsin modified binders in terms of resistance to thermal cracking. At the time of the project, this procedure was under consideration by AASHTO for provisional standardization.

Rutting Resistance: The binders were tested using the Multiple Stress Creep and Recovery (MSCR) procedure. The tests were performed at Rolling Thin-Film Oven (RTFO) conditions and at temperatures corresponding to the high temperature performance of the corresponding field section's location.

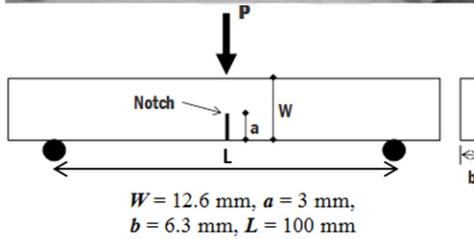
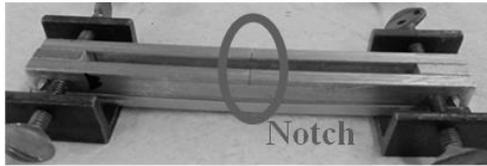
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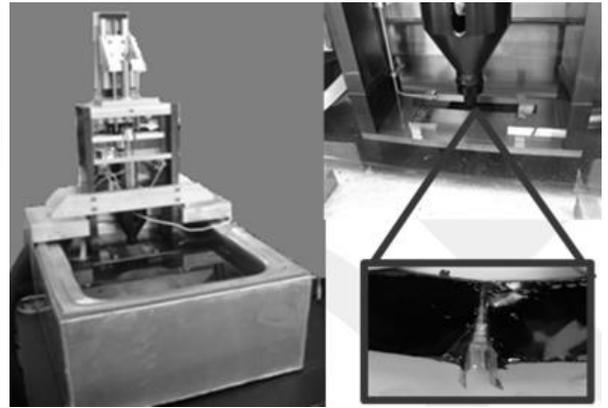
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BBR-SEN Sample Mold and Dimensions



BBR-SEN Loading Device and Setup

Results

- The Superpave $|G^*| \sin \delta$ parameter was found to relate poorly to the field performance of the modified binders investigated in the current study. Therefore, the replacement of this parameter is needed to control binder fatigue resistance.
- Comparison of LAS test results to field performance indicated that the best relationship is achieved when the test is performed at the intermediate temperature performance grade (PG) based on the project location climate in accordance to AASHTO M320.
- Based on the results of phase I and phase II analyses, the LAS test performed at the required Superpave intermediate temperature grade of the project location, and the resultant N_f at peak stress parameter is recommended for use for evaluation of modified binder fatigue damage resistance.
- The BBR-SEN test was shown to be capable of clearly discriminating between modified and unmodified binders in a repeatable fashion. BBR-SEN results correlate well with the observed field thermal cracking pavement condition index (PCI) from the phase II condition survey, indicating the high promise of using this binder fracture test as a modified and unmodified binder low temperature characterization test to complement the current BBR test.
- Binder rutting parameters ($|G^*|/\sin \delta$ and the standard and modified procedure (MSCR method B) were unable to relate directly to the observed field conditions for the studied sections. For the tested binder set, the unmodified binder, showing the worst performance in terms of both $|G^*|/\sin \delta$ and MSCR, performed better in the field in terms of accumulated rut depth.
- No rutting was observed in any section in Wisconsin. The studied Wisconsin binders exceeded the most extreme binder rutting grade requirements according to AASHTO MP 19 (MSCR) at the local high performance temperatures. In addition, looking at Minnesota Department of Transportation's MnROAD pavement testing sections, there are some indications of rutting (0.1 to 0.2 in) that could not be explained solely through use of binder properties. Therefore, at this time, it is difficult to recommend any changes in binder rutting parameters based on the current set of data.

Recommendations

The researchers recommend that pressure aging vessel (PAV)-aged conditions be used for a more conservative controlling of binder failure properties. Development of final acceptance limits will require data from a larger set of binders at both RTFO and PAV-aged conditions to select the most suitable condition for possible use in future specifications. The results confirm previous notions that rutting is not a significant concern in Wisconsin, and development of advanced binder criteria and classification systems for rutting resistance of binders may not be as essential as that of thermal and fatigue cracking.

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This brief summarizes Project 0092-13-02,
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Wisconsin Highway Research Program (WHRP) <http://wisdotresearch.wi.gov/whrp>