Balanced Mixture Design Implementation Support

Research Objectives

- Evaluate performance-based methodologies for asphalt mixture design
- Develop preliminary balanced mixture design (BMD) specifications

Research Benefits

- Recommended BMD specifications for stone matrix asphalt and low-, medium- and high-traffic mixtures
- Identified several successful mixture design modification strategies
- Highlighted opportunities for asphalt industry innovation

Background

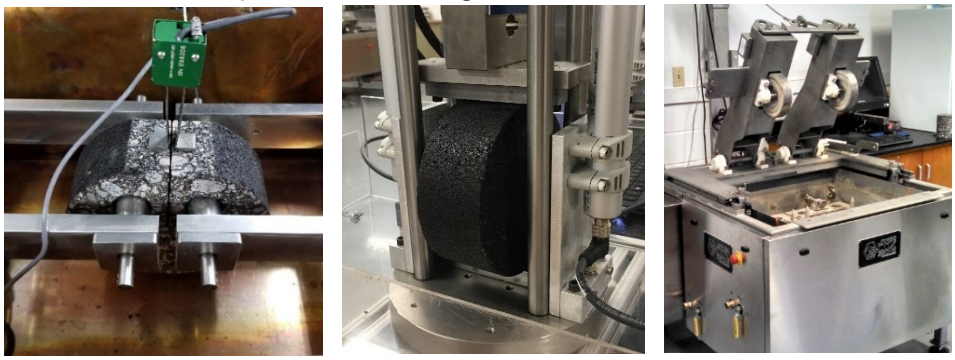
The Superpave system is the most commonly used asphalt mixture design system in the United States. WisDOT and several other state transportation agencies share concerns of asphalt durability and cracking issues associated with the system. To address these issues, WisDOT started implementing the regressed air voids approach in 2017, which was proved effective in improving cracking resistance without compromising rutting resistance in Wisconsin Highway Research Program (WHRP) project 0092-16-06 *Regressing Air Voids for Balanced HMA Mix Design Study.* This modified Superpave approach still has significant limitations that hinder innovations and lead to an unacceptable range of field performance for current asphalt pavements.

WisDOT has interest in implementing performance tests for balanced mixture design (BMD) that will better assess resistance to common distresses and enable designers to better utilize sustainable and innovative materials. The objective of this research project was to evaluate performance-based methodologies for asphalt mixture design with the intent of developing a preliminary implementable BMD specification for WisDOT projects.

Methodology

The research team interviewed Wisconsin mixture designers, conducted a BMD workshop, benchmarked existing WisDOT designs, modified selected designs for improved performance and conducted a cost analysis of design modifications.

Mixture resistance to common distresses was assessed using Hamburg Wheel Tracking Testing (HWTT) to evaluate rutting and moisture resistance; the Indirect Tensile Asphalt Cracking Testing (IDEAL-CT) to evaluate intermediate-temperature cracking resistance; and the Disc-shaped Compact Tension (DCT) testing to evaluate low-temperature cracking resistance.



Specimen testing with (from left to right) DCT, IDEAL-CT and HWTT.

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"This research identifies important aspects of performance testing benchmarking and specification development that Wisconsin will need to move toward implementation of Balanced Mix Designs."
– Steven Hefel, WisDOT

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Final report is available at:
WisDOT Research website

Results

The interviews of mixture designers revealed no consensus on which of the current Superpave volumetric criteria should be relaxed or eliminated for BMD. Although designers recognized the benefits of implementing BMD, they also expressed concerns about the selection of performance tests and criteria; changes to the current practice with design and quality assurance; and several other implementation challenges.

The BMD optimization experiments affirmed that fixing one performance issue can create another performance issue elsewhere in the design modification process, highlighting the need for multiple performance tests to ensure a balance between rutting, cracking and moisture damage resistance. Several successful design modification strategies were identified through performance testing, such as using a rejuvenator and increasing the asphalt content to improve IDEAL-CT results. In another case, eliminating recycled asphalt shingles was found to be less cost effective than increasing the asphalt content for improving cracking resistance.

Recommendations for implementation

The research team recommends WisDOT continue using its current specifications with the regressed air voids approach for the design of low-traffic mixtures. For medium-traffic, high-traffic and stone matrix asphalt (SMA) mixtures, the researchers recommended the BMD approach referred to as performance-modified volumetric mix design and provided preliminary criteria of the HWTT, IDEAL-CT, and DCT. This BMD approach will help ensure satisfactory rutting and cracking resistance while providing designers opportunity to innovate to meet performance test requirements.

Cost analysis of the design modifications indicated that material costs could increase by approximately eight to 22 percent to meet proposed criteria. For asphalt contractors to remain competitive in a low-bid environment, there is need to explore different design modification strategies to determine the most cost-effective options for materials.

This brief summarizes Project 0092-20-04,
"Balanced Mixture Design Implementation Support"
Wisconsin Highway Research Program