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Nominal Maximum Aggregate Size for WisDOT Specification

PUTTING RESEARCH TO WORK

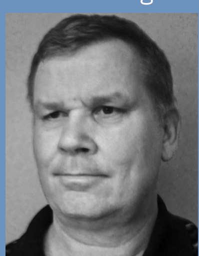
BRIEF

Research in the area of Superpave mix design has resulted in expansion of the nominal maximum aggregate size (NMAS) mix designs available and has established the relationship between NMAS and pavement performance. The NMAS mixes evaluated by the researchers ranged from 4.75 to 37.5 mm. Current Wisconsin Department of Transportation (WisDOT) specifications restrict the NMAS of the standard pavement design structure to 12.5 mm in the upper layer over a 19.0 mm lower layer, a practice that limits both the products available to designers/contractors and the flexibility to specify NMAS based on intended application. Recent advances in mix design at a national level present an opportunity for WisDOT to promote the use of a wider range of mix types through development of application guidelines for mixes of different NMAS.

What is the problem?

Many state transportation departments allow Superpave mixes with a wide range of NMAS to be placed in a variety of lift thicknesses. Current specifications for Wisconsin restrict NMAS and lift thickness in its hot mix asphalt (HMA). The lack of flexibility can have potential negative impacts on the cost and performance of HMA pavements in Wisconsin. Recent national studies have started to make changes across the nation and this study builds on that specifically for Wisconsin. A revision of current standards to allow a wider range of NMAS and lift thicknesses may improve the cost effectiveness of HMA pavement construction in Wisconsin.

Investigator



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Research Objective

The objective of this study was to apply the findings relating NMAS and mixture performance to support revisions to specifications and development of application guidelines for different NMAS mixes. The research project supports the transition to material selection based on performance properties and provides pavement designers with the knowledge and flexibility to broaden the application of non-typical NMAS sizes.

Methodology

The efforts in this project consisted of both laboratory testing and various simulations. Various predictive models were used to analyze the relationship between NMAS and different performance-related properties, including modulus, permeability, layer coefficient and predicted thermal cracking temperature. The specific tasks were conducted to evaluate the effect of NMAS on the following:

- Modulus using predictive equations
- Pavement performance using WisPave and predictive equations for modulus
- Modulus as measured in the laboratory and on segregation using image analysis
- Pavement performance using the Mechanistic Empirical Pavement Design Guide (MEPDG)
- Modulus and permeability using a quality control (QC) database and construct a database of HMA properties from QC data.

Current Wisconsin Specifications for HMA Layer Thickness

NMAS (mm)	Min Layer Thickness (in)	Max Lower Layer Thickness (in)	Max Upper Layer Thickness (in)
25	3.25	5	4
19	2.25	4	3
12.5	1.75	3	2.5
9.5	1.5	3	2

Potential Alternative Specifications for HMA Layer Thickness

NMAS (mm)	Minimum Layer Thickness (in)		Max Layer Thickness (in)
	Fine Mixes	Coarse Mixes	
25	3	4	5
19	2.25	3	4
12.5	1.75	2	2.5
9.5	1.5	1.5	2

Results

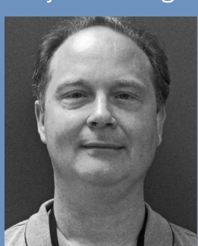
- Analysis of NMAS using predictive models indicates that 9.5-mm HMA mixes should have similar performance to 12.5-mm and 19-mm mixes. However, 25-mm mixes might exhibit unacceptably high permeability values and also could be more prone to low temperature cracking.
- When all other volumetric properties are held constant, NMAS significantly affects dynamic modulus; however, the magnitude of the effect is influenced by loading frequency and asphalt binder performance grade (PG). Results are limited to laboratory-produced mixes designed specifically to isolate the effects of NMAS. It is recommended that these results are verified with field-produced mixes designed to meet current volumetric requirements.
- Findings from a combination of laboratory testing and MEPDG simulation indicate that the 9.5-mm NMAS mix is a viable alternative as a surface course as similar values of dynamic modulus and MEPDG predicted distresses were observed. However, conflicting results using these two methods were obtained regarding use of lower NMAS mixes in the binder course. Laboratory testing indicates that significant decreases in dynamic modulus are realized for smaller NMAS sizes relative to 19.0-mm and 25.0-mm mixes, particularly at lower loading frequencies. Whereas, MEPDG analysis indicates a marginal increase in distress when smaller NMAS sizes are used in the binder course, particularly when the pavement structure is composed of two 9.5-mm NMAS lifts. Further research is recommended to measure dynamic modulus and conduct MEPDG Level 1 analysis on mixes that represent the current pavement structure used and smaller NMAS mixes to resolve this discrepancy.
- The image analysis technique proved an effective method to quantify the aggregate sizes present at different depths within the mix. The mixes evaluated in this study did not indicate increased potential for segregation with NMAS size; however, the study is limited to one set of cores taken from one project. If mixture segregation is a concern, it is suggested that application of the image analysis technique (using IPas2 software) be expanded to provide an assessment of in-project and between project segregation. This work could benefit WisDOT by identifying if segregation is occurring during field production and would provide an expanded data set to support development of vertical segregation limits using the IPas2 software.

Recommendations

Based upon the research findings, the researchers recommend that WisDOT specifications allow both 9.5-mm and 12.5-mm NMAS HMA in surface courses, 12.5-mm and 19-mm NMAS HMA in intermediate courses and base courses, and 9.5-mm NMAS HMA in leveling courses.

Recommended minimum and maximum layer thicknesses are, in general, based upon a ratio of lift thickness/NMAS of 3 to 5 for fine mixtures and 4 to 5 for coarse mixtures, and a minimum lift thickness of 1.5 inches to prevent unacceptably fast cooling of the mat during compaction. Restriction of HMA pavement structure to a 12.5-mm mix in the surface coarse and a 19-mm mix in the binder and/or base coarse is not warranted by the results of this study.

Project Manager



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This brief summarizes Project 0092-12-01,
"Refinement of Current WisDOT HMA Mixture Application Guidelines Related to NMAS and Aggregate Characteristics"
Wisconsin Highway Research Program (WHRP) http://wisdotresearch.wi.gov/whrp