Wisconsin Highway Research Program
Project 0092-16-06
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Research Brief

Regressing Air Voids for Balanced HMA Mix Design

Research Objectives

- Develop protocols for testing WisDOT's low-, medium- and high-traffic asphalt mixtures
- Evaluate the effects of air voids and mixture traffic level on resistance to rutting, cracking and moisture damage
- Recommend specifications for air void regression strategies

Research Benefits

- Demonstrated that regressing air voids can improve cracking resistance without compromising deformation resistance
- Recommended a three-stage implementation strategy for a regressed air void concept

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Background

Since the implementation of Superpave mix design strategies in the 1990s, industry professionals have successfully improved rutting resistance of hot mix asphalt (HMA) by specifying higher grades of asphalt binder and quality of aggregates. Currently, the primary mode of distress in HMA pavements is cracking, which can be caused by poor mix designs, increased use of recycled materials, problems with construction quality and failing to adequately address underlying pavement distresses during pavement rehabilitation. Many state transportation agencies are now specifying increased asphalt contents in their mix-design and acceptance programs to improve cracking resistance of HMA.

In volumetric mix design, the difference between air voids and voids in the mineral aggregate (VMA) controls the effective asphalt content. To increase the effective asphalt content in mixes, it is necessary to either target a lower air void content or increase the minimum VMA criteria. The objective of this study was to assess the impacts and determine the viability of increasing asphalt binder contents using the regressed air voids concept.

Methodology

The research team evaluated the effects of regressed air void mix designs on resistance to cracking, rutting and moisture damage. Six mixes were designed for low-, medium- and high-traffic levels, with various contents of recycled asphalt pavement (RAP) and recycled asphalt shingles (RAS). Three tests were conducted for each mix with asphalt contents corresponding to three air void contents (4.0, 3.5, and 3.0 percent). The Illinois Flexibility Index Test (I-FIT), Disc-Shaped Compacted Tension (DCT) test and Hamburg Wheel Tracking Test (HWTT) were conducted to evaluate intermediate-temperature cracking resistance, low-temperature cracking resistance; and rutting and moisture damage resistance, respectively.

Illinois Flexibility Index Test performed to evaluate intermediate-temperature cracking resistance

"Performance testing completed in this research indicates 3.0% regressed air voids will improve pavement life in Wisconsin."

– Steve Hefel, WisDOT

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Final report is available at: [WisDOT Research website]

Results

In five of the six mixtures, regressing design air voids increased asphalt content by 0.3 to 0.4 percent and resulted in a clear improvement in the Flexibility Index, indicating a positive impact on intermediate-temperature cracking resistance. DCT Fracture Energy results for mixtures designed with regressed air voids were not statistically significant, signaling a regressed air voids approach would not have a significant impact on thermal cracking.

HWTT results indicated that two mixes (medium traffic, PG 58-28, 20 percent RAP, zero percent RAS; and high traffic, PG 58-28, 15 percent RAP, zero percent RAS) are susceptible to stripping. None of the six mixtures exhibited stripping inflection points in the first 10,000 passes of the test. The four mixes that had no signs of stripping completed the full 20,000 passes with rut depths less than 12.5 mm. Corrected rut depths using modified procedures were significantly lower than the common maximum rutting criterion of 12.5 mm. All mixtures designed with air voids regressed to 3.0 percent met the rutting criterion, indicating that the regressed air voids approach will not increase susceptibility to rutting.

Recommendations for implementation

The results of this project indicate that the regressed air voids concept can improve mixture cracking resistance without compromising the deformation resistance of asphalt mixes. The research team recommends a three-stage implementation strategy:

(1) fully implement 3.0% regressed air voids without performance tests, and inform contractors that HWTT will be added;

(2) add Hamburg rutting and stripping criteria based on traffic levels, and inform contractors that IFIT will be added; and

(3) implement Balanced Mix Design, and eventually withdraw regressed air voids and other volumetric criteria for mix design approval.

This brief summarizes Project 0092-16-06,
"Regressing Air Voids for Balanced Mix Design Study"
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