TECHSUMMARY December 2008

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Performance Evaluation of Louisiana Superpave Mixtures

INTRODUCTION

Currently, more than 93 percent of all the road surfaces in the U.S. are paved with asphalt mixtures. Since the discovery of the petroleum asphalt refining process and the growth of the interstate system, asphalt binder usage in the United States has increased from less than 3 million tons in 1920 to more than 30 million tons in 2000.

The Marshall and Hveem mix design methods have played important roles in the traditional asphalt mix design; however, both are based on empirical relationships and do not produce fundamental engineering properties of the compacted asphalt mixture that are related to pavement design and performance.

The Strategic Highway Research Program (SHRP) was approved by Congress in 1987 to improve the performance and durability of United States roads and make those roads safer for both motorists and highway workers. In 1996, the Superpave asphalt mixture design method was introduced, which incorporates performance based asphalt materials characterization with environmental design conditions to improve performance by controlling rutting, low temperature cracking, and fatigue cracking.

OBJECTIVE

The primary objective of this research was to evaluate the fundamental engineering properties and mixture performance of Superpave hot mix asphalt (HMA) mixtures in Louisiana through laboratory mechanistic tests, aggregate gradation analysis, and field performance. A secondary objective of this investigation was to ascertain mix design variables on mixture performance. Another objective was to compare early field performance to laboratory engineering test results.

SCOPE

This project included 30 Superpave mixtures selected from 21 field implementation projects in Louisiana. Fourteen of these projects were designed for high volume traffic [greater than 30 million equivalent single axle loads (ESALs)], 12 for intermediate volume traffic (3 to 30 million ESALs), and the rest for low volume traffic (less than 3 million ESALs). Seven fundamental engineering tests were performed on those mixtures in order to obtain their fundamental engineering properties.

LTRC Report 410

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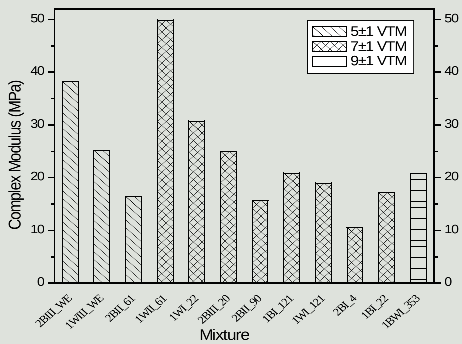
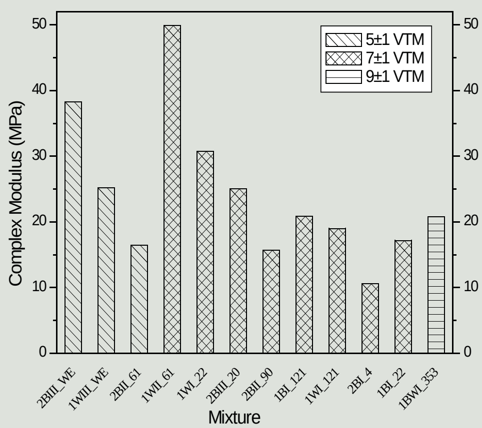
METHODOLOGY

The test results showed that high volume mixtures appeared to have higher indirect tensile (IT) strengths, lower IT and axial creep slopes, and higher shear stiffness when compared to those of low volume mixtures. This indicates that high volume mixtures generally possessed better rut resistance than the low volume mixtures considered. The compaction efforts (the N-design levels), dust/asphalt cement (AC) ratio, film thickness, and the percentage of aggregates passing the 0.075-mm sieve were observed to have certain relations with the rut susceptibility of Superpave mixtures. The Power-law gradation analysis indicated that all four Power-law gradation parameters were sensitive to the mixture mechanistic properties evaluated. This implies that the proposed Power-law gradation analysis could be used as the bridge between aggregate gradation design and mixture performance evaluation.



Complex shear modulus of frequency sweep at constant height test at 0.01 Hz and 48°C



Permanent shear strain of repeated shear at constant height test at 48°C

Finally, the early field performance of those Superpave mixtures was studied and compared to their laboratory performance test results. At present, all project pavements have performed well and have less than 5.0-mm rut depths without any recordable cracking failure.

CONCLUSIONS

Thirty Louisiana Superpave mixtures from 21 field implementation projects constructed between 1998 and 2000 were selected in the present study. After opening to traffic for two to five years, all project pavements were found to perform well and had less than 5.0-mm rut depths, without any recordable cracking failure. The performance of those Superpave mixtures has been evaluated using a suite of laboratory fundamental engineering performance tests based on the ability of the mixture to resist tensile cracking and permanent deformation distresses. The fundamental engineering tests were conducted using three laboratory performance testers: Simple Shear Tester, Material Testing Machine, and Asphalt Pavement Analyzer.

Superpave shear tester

RECOMMENDATIONS

For quality assurance/quality control in plant production of Superpave mixtures, the indirect tensile strength test at 25°C is recommended. The indirect tensile strength value for a Superpave mixture with 7 percent air voids shall be at least 150 psi (1.03 Mpa).

For durability/strength proof checking in laboratory Superpave mix design, the Asphalt Pavement Analyzer test at 64°C is recommended. The average rut depths of three beams or six cylindrical SGC samples shall be less than 6.1, 4.2, and 3.5 mm, respectively, for Level-I (Ndesign = 75), Level-II (Ndesign = 100), and Level-III (Ndesign = 125) Superpave mixtures.

For permanent deformation properties of Superpave mixtures, the indirect tensile creep, frequency sweep at constant height, and repetitive shear at constant height tests are recommended.

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