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EVALUATION OF THE DYNAMIC COMPLEX MODULUS TEST AND INDIRECT DIAMETRAL TEST FOR IMPLEMENTING THE AASHTO 2002 DESIGN GUIDE FOR PAVEMENT STRUCTURES IN FLORIDA

PROBLEM STATEMENT

The new AASHTO Mechanistic-Empirical (M-E) Design Guide research team advocated the use of the dynamic complex modulus as the primary test protocol to characterize the modulus response of asphalt concrete (AC) mixtures. The research team supported the role, selection, and utilization of the dynamic complex modulus test for asphalt concrete mixtures over the indirect tensile resilient modulus in the National Cooperative Highway Research Program (NCHRP) 1-37A Project concerning the AASHTO M-E Design Guide for Pavement Structures, which is currently aiming to introduce more rigorous measures of performance into hot mix asphalt (HMA) mixture and pavement design procedures.

The Florida Department of Transportation (FDOT) and many other states are currently using the Superpave HMA design method, which was introduced by the Strategic Highway Research Program (SHRP). The Superpave mix design method incorporates almost solely the volumetric properties of asphalt mixtures. The potential impact of adopting the dynamic complex modulus test for the AASHTO Design Guide is tremendous for the FDOT. While the NCHRP research team claimed that a wealth of historic lab data for both the dynamic modulus and the phase angle had been accumulated over the last thirty years, the dynamic complex modulus test was not at all commonly used in Florida. To the contrary, the indirect tensile resilient modulus test has been used to characterize AC mixtures for pavement design in Florida, and this test method has been shown to be both an expedient and a reliable way of obtaining mixture properties from field cores in Florida. Although an effort has been initiated to develop the dynamic complex modulus testing capability and database for Florida mixtures, this effort is far from completing the characterization of Florida AC mixtures based on the dynamic complex modulus. There needs to be more work to expand the dynamic complex modulus database prior to implementing the AASHTO M-E Design Guide.

OBJECTIVES

The primary objective of this study was to evaluate the dynamic complex modulus test and indirect tensile test for implementing the AASHTO M-E Design Guide for Pavement Structures in Florida. The specific goals of the study were to develop the dynamic testing capabilities, to perform the dynamic complex modulus and the indirect diametral tests, and to establish a database for referencing available resilient modulus and dynamic modulus values for targeted Florida asphalt concrete mixtures.

To achieve the objectives and goals, a complete dynamic testing system was acquired to perform the temperature controlled dynamic tests to determine the resilient modulus and dynamic modulus for Florida asphalt concrete mixtures. A laboratory experimental program was developed and involved 20 selected Florida Superpave asphalt concrete mixtures with a range of aggregates and mix designs.

FINDINGS AND CONCLUSIONS

Researchers tested twenty (20) HMA mixtures, which included the following types of aggregates: 14 Georgia granite materials, one Nova Scotia granite, one North Florida limestone, two Central Florida limestone materials, one South Florida oolite, and one Alabama limestone. One type of asphalt binder, PG 67-22 (AC-30), was used for all mixtures tested. To verify the volumetric properties of the mixture, the maximum theoretical specific gravity was measured using the Rice maximum specific gravity method for each of the mixtures. The dynamic complex modulus test specimens were cored from the 150 mm diameter Superpave samples. All 20 Superpave asphalt concrete mixtures were tested for both dynamic complex modulus and indirect tensile resilient modulus. The AASHTO TP31 test procedure was generally followed to perform the indirect diametral test (IDT). However, researchers applied the measurement and analysis system developed for the SHRP IDT. The SHRP IDT approach was used to determine the resilient modulus of asphalt concrete. The dynamic complex modulus tests were conducted at three temperature levels: 5, 25, and 40°C (41, 77, and 104°F). For all temperatures tested, the following frequencies were used: 25, 10, 5, 1, and 0.5 Hz. All of the dynamic modulus and phase angle test results were processed and stored in a database.

The master curves for all of the mixtures were developed and constructed using the time-temperature superposition principle. The Witczak prediction model was adopted to perform the comparison between predicted and measured dynamic modulus for all mixture series. The comparison indicated that the Witczak prediction model worked well for the Florida asphalt concrete mixtures tested in this study. Researchers also compared the dynamic modulus test results with the resilient modulus test results. The linear regression analysis indicated that the total resilient modulus increased with an increase in dynamic modulus at a specific loading frequency. The resilient modulus values were comparable with the dynamic modulus values at the loading frequency of 4 Hz.

BENEFITS

The research findings from this study could be adopted for future implementation of the mechanistic-empirical pavement design in Florida. The developed HMA resilient modulus and dynamic complex modulus databases would provide pavement designers with an easy access to all available resilient modulus and dynamic modulus test results of the Florida HMA mixtures. Generally, the HMA resilient modulus and dynamic modulus databases and the prediction model could be very useful for data management and pavement design. Pavement design is tied to the dynamic and resilient modulus of the hot-mix asphalt mixtures, which means that any process that results in the use of HMA with better performed dynamic modulus will improve the performance of the pavement. Improved pavement performance means less maintenance and reduced interruptions to the traveling public, and cost savings.

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