PREDICTION OF COMPLEX MODULUS OF ASPHALT MIXTURE WITH MICROMECHANICAL FINITE ELEMENT AND DISCRETE ELEMENT MODELS

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ABSTRACT

This study presents micromechanical Finite Element (FE) and Discrete Element (DE) models for the prediction of complex stiffness of asphalt mixture. Asphalt mixture is a composite material of graded aggregates bound with mastic (asphalt plus fine aggregates). The two dimensional (2D) microstructure of asphalt mixture was obtained by optically scanning the smoothly sawn surface of superpave gyratory compacted asphalt mixture specimens. For the FE method, the microstructural model of asphalt mixture first incorporates an equivalent lattice network structure whereby intergranular load transfer is simulated through an effective asphalt mastic zone. The ABAQUS FE model then integrates a user material subroutine with continuum elements for the effective asphalt mastic and rigid body elements for each aggregate. An incremental FE algorithm was employed in the user material model for the asphalt mastic to predict global viscoelastic behavior of asphalt mixture. In regard to the DE model, the outlines of aggregates were converted into polygons based on 2D scanned mixture microstructure. The polygons were then mapped onto a sheet of uniformly sized disks, and the intrinsic and interface properties of the aggregates and mastic were assigned for the simulation.

An experimental program was developed to measure the complex modulus of sand mastic under different loading rates, and relaxation moduli are calibrated based on time-frequency relationship for simulation inputs. The laboratory measurements of the mixture complex modulus were compared with FE and DE model predictions under different frequencies. The results indicated both methods were applicable for mixture complex modulus prediction.

Keywords: **Micromechanical model, complex modulus, finite elements, asphalt mixtures.**