Research on vehicle-asphalt pavement interaction and microstructure by discrete element method

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Abstract

The early damage of asphalt pavement is closely related to the mechanical behavior of asphalt mixture. In order to study the mechanical response of asphalt mixture particles under vehicle load, a 2 DOF 1/4 vehicle model composed of mass block-spring-damper was constructed in this paper. Based on the discrete element theory, a three-dimensional discrete element model of asphalt pavement with random distribution of coarse aggregate was constructed according to material gradation and porosity. The dynamic load of vehicle on the road surface was solved by using road roughness as excitation. The constitutive relation between particles was described by parallel bond and linear bond. The microstructure parameters of each structure layer were obtained by trial and error method. The "fish" language program was written to realize vehicle load movement. Finally, the mechanical response and velocity of the pavement structure layer particles were solved. The results show that the vertical displacement of the pavement calculated by the discrete element method is less than 8.9% of that calculated by the finite element method, which indicates that the discrete element method is more feasible. The vertical compressive stress of the upper layer is 14.1% higher than that of the middle layer, 57.7% higher than that of the lower layer, and 80% higher than that of the base layer. The longitudinal compressive stress of the upper layer is 64.3% greater than that of the upper layer. The grain at the bottom of the middle layer is mainly subjected to tensile stress. The particles in the upper and middle layers mainly bear transverse compressive stress while the other structural layers bear transverse tensile stress. The transverse, longitudinal and vertical velocities of the upper layer particles vary dramatically during vehicle startup and braking. When the vehicle is running stably, the particle velocity of each structure layer is small. The lateral and vertical velocity curves of the particles are antisymmetric, while the longitudinal velocity curves of the particles are symmetric.

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