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Computations of Permeability Tensor Coefficients and Anisotropy of Hot Mix Asphalt Based on Microstructure Simulation of Fluid Flow

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Abstract: Asphalt concrete is the most widely used material for building the surface layer of pavements. It is a porous material that consists of a non-uniform arrangement of asphalt binder, aggregate particles and air voids. One of the primary factors controlling pavement performance is the fluid flow characteristics within the surface asphalt concrete layer. This paper focuses on the numerical simulation of fluid flow in the three-dimensional (3-D) microstructure of asphalt concrete, and the calculation of permeability from the flow field. The asphalt concrete microstructure was captured using the non-destructive X-ray computed tomography (CT) technique. X- ray CT images were processed in order to identify and retain interconnected air voids and eliminate isolated voids. This image processing enhanced the efficiency of the model as it does not have to solve for flow in isolated voids that do not contribute to fluid flow. The X-ray CT images were analyzed and the results were used to determine the relationship between air void distribution and permeability directional distribution or anisotropy. The computed permeability values were found to have good correlation with the experimental measurements. The major and minor principal directions of the permeability tensor were found to correspond to the horizontal and vertical directions, respectively. The results indicated that the non-uniform spatial distribution of air voids created more open flow paths in the horizontal directional than the vertical direction, and hence was the much higher permeability in the horizontal directions. Keywords Permeability; X-ray CT; Fluid flow; Microstructure; Anisotropy; Air void distribution