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Two small unit cell models for prediction of thermal properties of 8-harness satin woven pierced composites

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Abstract

Optimization design of thermal protection system of aerospace vehicles with progressive increasing flying speeds needs a deepened study on the thermal conduction characteristics of corresponding materials. As a potential thermal protection material, C/C-SiC 8-harness (8HS) satin woven composites with piercing fiber bundles are numerically studied in this work. The numerical model is established based on the investigation of 8HS satin weave textile. A full and a half unit cell models are formulated according to three non-orthogonal translational and one further 180° rotational symmetries, respectively. The two unit cells have much smaller sizes and also less computational costs than the rectangle unit cell available in previous literatures. The thermal boundary conditions are derived rigorously and are verified by the identical numerical results obtained by the two unit cells. The developed unit cell method and the related boundary conditions derivation process can be references for other multi-harness satin woven composites. The numerical model is validated by the experimental result obtained in this work and that available in the literature. The influences of constituents (carbon fiber, matrix C, matrix SiC and porosities) volume fractions, piercing fiber bundles and thermal contact resistance between matrix and fiber bundles on the effective thermal conductivities are studied.

Keywords: *unit cell*; *effective thermal conductivities*; *numerical prediction*; *8-harness satin*