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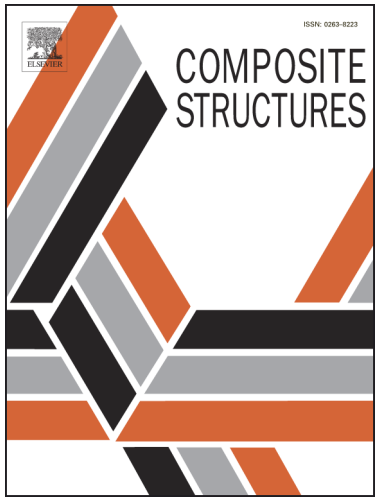

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A Hybrid Micro-meso-scale Unit Cell Model for Homogenization of the Nonlinear Orthotropic Material Behavior of Coated Fabrics Used in Tensioned Membrane Structures

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Abstract

Coated fabric materials is a kind of textile composites. However, at micro scale the coating material is not fully impregnated inside the fabric yarn. Thus, the fabric fibers are free to slip relatively to each other during deformation. This article proposes a novel three-dimensional hybrid micro-meso unit cell model to predict the nonlinear mechanical behavior of coated fabrics using the digital element method. In the model, while the coating material is modeled with 3D solid elements, the fabric yarns are modeled as assemblies of truss elements. Thus, the material constitutive law used in this model is far simpler than the one in which the yarn is modeled with solid elements and the interaction among the fibers can be considered. Different load cases are examined, including uniaxial and biaxial stress states. In these analyses the periodic boundary conditions are applied to the unit cell, and contact friction among the fibers is also considered. The results obtained from the analyses have a good correlation with the experimental data, which proves the validity of the model. Moreover, local

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