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Multi-scale constitutive modeling of natural fiber fabric reinforced composites

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Abstract

Natural fiber reinforced structural composites have a hierarchical structure made from stacked fabrics of interwoven yarns formed by twisting together discontinuous natural fibers. We develop multi-scale constitutive models to investigate the mechanical properties of plain woven composites. The multi-scale constitutive modeling is carried out in two steps: the effective micromechanical properties of a micro-scale representative volume element (RVE) of the twisted yarn are calculated using an orientation averaging method, which are subsequently transferred to a meso-scale RVE of the final composite to compute the elastic constants by homogenization over the RVE. 3D finite element models of the meso-scale RVEs of composites are developed to verify the accuracy of the proposed model. The multi-scale modeling results show that the yarn twist angle has significant effects on the elastic properties of the composites. The predicted results from the multi-scale constitutive model show good agreements with that from finite element analysis and experiment.

Keywords: A. Fabrics/textiles; A. Natural fiber composites; B. Mechanical properties; C. Analytical modeling

1. Introduction

Natural plant fiber reinforced polymeric composites are increasingly used for their light-weighting,

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