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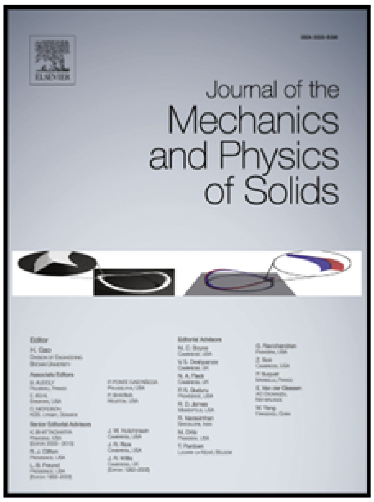

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Compressive Response of Hybrid 3D Woven Textile Composites (H3DWTCs): An Experimentally Validated Computational Model

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Abstract

The compressive response of hybrid 3D woven textile composites (H3DWTCs) is studied experimentally and the results obtained are used to motivate the development of a mechanics model, implemented computationally. The H3DWTCs considered consist of carbon, glass and kevlar fiber tows and a polymer matrix material. The novelty of the modeling approach is to include the in-situ geometric imperfections of the microstructural level composite architecture, measured using high resolution Micro-CT methods, in the micromechanics model and to carefully relate the details of the macroscopic response to the microstructure. A detailed Micro-CT study of the failed specimens reveals details of the dominant failure mechanisms which include multiple and progressive kink banding and matrix damage, responsible for limiting compressive strength. In the numerical predictive model development, the Mohr-Coulomb (MC) criterion is used to model matrix compressive failure in combination with the smeared crack approach (SCA) in the surrounding matrix outside of fiber tows. The fiber tow is modeled as macroscopically homogeneous, but a two-scale method is developed that uses an analytical closed-form micromechanics model at each integration point of the homogenized fiber tow which allows to calculate the fiber and matrix stress states within a tow. The experimental results suggest that carbon fiber compressive strength dictates the initiation of kink banding failure in carbon tows, while glass fiber tow compressive strength dictates the maximum load attainable. This suggests that different aspects of the compres-

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