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A Double-Phase-Field Model for the Cohesive Failure Modelling in Laminated Composite Materials

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ABSTRACT

This work presents a novel double-phase-field formulation to characterize the distinct damage mechanisms and the mixed-mode cohesive fracture behaviors in fiber-reinforced composites (FRC). A hybrid phase field formulation is first proposed to derive the phase field and stress through distinct energy functionals. Then, the phase field degradation function and material damaged stiffness are properly defined based on the unique failure mechanisms, which enable the derivation of the embedded Hashin failure criteria for fiber and matrix failures in FRC respectively. Furthermore, the mixed-model cohesive law with linear softening is analytically derived within the phase field framework and is validated by the numerical results of composite bar under off-axial traction. Finally, the standard MMB tests are simulated to validate the model in modelling the mixed-mode fractures in FRC. The distinct advantage of the proposed mode is that it predicts an accurate mixed-mode fracture toughness without the need of any ad hoc model parameters as compared to the classical B-K law. The numerical results presented here demonstrate the capability of the proposed model in predicting qualitatively and quantitatively the mixed-mode fracture behaviors in FRC.

KEYWORDS

Mixed-mode fracture; multi phase-field; cohesive fracture; fiber-reinforced composites

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