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Master curve approach to axial stiffness calculation for non-crimp fabric biaxial composites with out-of-plane waviness

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Abstract

The effect of 0°-tow out-of-plane waviness on the biaxial Non-Crimp-Fabric (NCF) composite axial stiffness is investigated. Homogenizing, the bundle mesostructure of the NCF composite is replaced by layers. Then the composite is represented by a laminate with flat layers with effective stiffness properties representing the curved 0°-layer and the 90°-layer with varying thickness. It is shown that the NCF composite knock-down factor characterizing the stiffness degradation has almost the same dependence on wave parameters as the knock-down factor for the curved 0°-layer. Numerical analysis showed that 90°-layer knock-down factor versus amplitude curves for different wavelength can be reduced to one master curve which can be described by a one-parameter expression with the parameter dependent on the used material. This observation is used to obtain high accuracy for analytical predictions for knock-down factors for cases with different wavelength and amplitudes based on two FE calculations only.

Keywords: Tow; Polymer-matrix composites (PMCs); Mechanical properties; Laminate mechanics; Finite element analysis (FEA).

1. Introduction

New manufacturing methods and material architectures have been employed over the last decade using dry woven or Non-Crimp-Fabric (NCF) preforms and resin infusion technologies to manufacture high

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