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Evaluation of cross-ply laminate stiffness with a non-uniform distribution of transverse matrix cracks by means of a computational meso-mechanic model

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Abstract

This work addresses the evaluation of the stiffness of fiber-reinforced composite laminates, by means of a computational meso-mechanic model, considering two non-uniformly spaced transverse matrix cracks. Laminates with $[0_n/90_s]_s$ and $[90_s/0_n]_s$, with $n = 1$ and 8 , have been studied. The meso-mechanic model includes a three dimensional Finite Element continuum model at meso-scale and the macro-scale contains a classical thin laminated plate model. Periodic boundary conditions were used and the stress resultants were evaluated accounting for the equivalence of mechanical power between scales (Hill-Mandel principle). The results obtained with the present model showed good agreement with numerical and experimental data reported in the literature. A parametric analysis allowed identifying the stiffness components which are more influenced by a non-uniform crack distribution. The results suggest that the model with uniformly distributed cracks underestimates the in-plane and bending stiffness, while the bending-extension coupling stiffness components are overestimated.

Keywords: composite laminate; intra-laminar cracks; finite elements; plate homogenization

1 Introduction

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