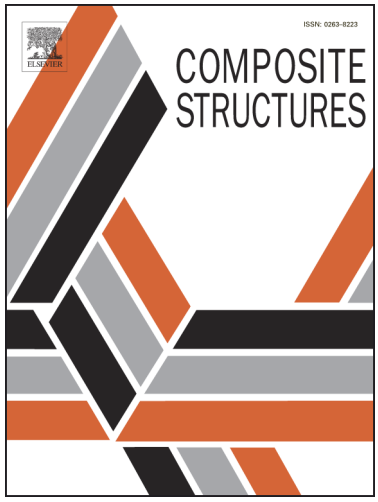

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Effect of matrix cracks and delamination on extension-twist coupling of thin pretwisted composite strips

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Abstract

An asymptotically exact cross-sectional model coupled with geometrically nonlinear one-dimensional (1D) theory is developed for a thin composite strip in the presence of defects. Two types of defects are considered: intralaminar cracks and interlaminar cracks. Model development is based on the dimensional reduction of laminated shell theory to nonlinear 1D theory using the variational asymptotic method. The cross-sectional nonlinearity accounts for matrix cracks, quantified in terms of crack density and delamination, quantified in terms of the delamination width. For modeling intralaminar cracks continuum damage mechanics based framework is used along with computational micromechanics to account for intralaminar cracks in laminate plies in different orientations. Delamination modeling follows a methodology adapted from the sublaminate approach. The model developed is used to investigate the effect of defects on the trapeze effect - nonlinear axial-twist coupling in strip with Winckler kind of layup. It was found that cracks in transverse plies enhance the trapeze effect; on the contrary, symmetric edge mid-surface delamination leads to decrease in the coupling effect. This contrarian behavior of the two types of defects on the trapeze effect is explained on the effect these defects have on the various cross-sectional coupling stiffness terms influencing the coupling behavior. Model predictions are presented for strip stiffness degradation due to matrix cracks and delamination.

Keywords: Composite structure, Pretwist, Trapeze effect, Matrix cracks, Delamination