Nonlinear Analysis of Woven Fabric-Reinforced Graphite/PMR-15 Composites under Shear-Dominated Biaxial Loads

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Abstract

An elastic-plastic, time-independent, macroscopic, homogenous model of an 8HS woven graphite/PMR-15 composite material has been developed that predicts the nonlinear response of the material subjected to shear-dominated biaxial loads. The model has been used to determine the response of woven composite off-axis and Iosipescu test specimens in nonlinear finite element analyses using a multilinear averaging technique. The numerically calculated response of the specimen was then compared to experimentally obtained data. It has been shown that the numerically calculated stress - strain diagrams of the off-axis specimens are very close to the experimentally obtained curves. It has also been shown that the numerically determined shear stress - strain and load-displacement curves of the woven Iosipescu specimens are close to the experimentally obtained curves up to the point of significant interlaminar damage initiation and propagation. The results obtained in this study clearly demonstrate that the nonlinear material behavior of the graphite/polyimide woven composites subjected to shear-dominated biaxial loading conditions cannot be ignored and should be considered in any stress analysis. The linear-elastic approach grossly overestimates the loads and stresses at failure of these materials in the off-axis and Iosipescu tests. It can be assumed that the same discrepancies will arise in the numerical analysis of the woven composites tested under other biaxial shear-dominated loading conditions using other biaxial test methods.