Elastoplastic Stress Analysis in a Woven Ni–Cr Reinforced Thermoplastic-matrix Composite Laminated Plates under Transverse Loading

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ABSTRACT: In this study, an elastoplastic stress analysis is carried out on the symmetric and antisymmetric cross-ply and angle-ply thermoplastic-laminated plates for transverse loading. A low density polyethylene (LDPE) thermoplastic-matrix and woven Ni–Cr fibers are used to produce composite plates by using molds. A first-order shear deformation theory and a nine-node Lagrangian finite element are used. Mathematical formulation is given for the elastoplastic stress analysis of a laminated plate for small deformations. The yield points and stresses are obtained for symmetric and antisymmetric clamp supported laminated plates with a square hole. The residual stresses in the thermoplastic plates are given in the tables. The expansion of plastic zones is illustrated for 200, 350, and 500 loading steps. The yield points and expansion of plastic zones are compared for different plates. The mechanical properties of a layer are obtained experimentally. The intensity of the residual stress components is maximum near the square hole and clamped supports.

KEY WORDS: elastic–plastic stress analysis, thermoplastic composite, reinforced laminated plates, residual stress, plastic expansion, finite element method, transverse loading.

INTRODUCTION

AMONG THE FIBER-REINFORCED composites, the thermoplastic-matrix composites are gaining popularity due to many advantages they offer in relation to the thermoset composite systems, including their improved interlaminar fracture toughness, increased impact resistance, and higher solvent resistance. In addition to their competitive mechanical properties, thermoplastic composites do not require complex chemical reactions to be processed and can be formed without a lengthy curing process.

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