Direct assessment of Interlaminar Stresses in Composite Multilayered Plates using a Layer-wise Mixed Finite Element Model

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ABSTRACT

An accurate determination of interlaminar transversal stresses in composite multilayered plates, especially near free-edge, is of great important in the study of inter-ply damage modes, mainly in the initiation and growth of delamination. In this paper, interlaminar stresses are determined by layer-wise mixed finite element model. Each layer is analyzed as an isolated one where the displacement continuity is ensured by means Lagrange Multipliers (which represent the statics variables). This procedure allows us to work with any single plate model, obtaining the interlaminar stresses directly without loss of precision. The FSDT with transverse strain effects included is assumed in each layer, but Legendre's Polynomials are used to describe the kinematic instead of Taylor polynomial function of the thickness coordinates, as is common. This expansion allows us to pose the interlaminar displacements compatibility simpler than the second one. The in-plane domain of the plate is discretized by four-node quadrilateral elements, both to the field of displacement and to the Lagrange multipliers. The mixed interpolation of tensorial components technique is applied to avoid the shear-locking in the finite element model. Several examples were carried out and the results have been satisfactorily compared with those available in the literature.

Keywords: Interlaminar stresses, Multilayered plates, Mixed finite elements, Lagrange multipliers.