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Prediction of Free Edge Stresses in the Composite Laminates and It's Validation through Experimental Means

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Abstract: It is well known that interlaminar stresses are developed at free edges in composite laminates where we have material discontinuity. These stresses can lead to delamination and failure of the laminate at loads that are much lower than the failure strength predicted by the classical lamination theory. Within the frame work of linear elasticity, the free-edge effect of a symmetric cross-ply laminate is treated in a closed form analytical way. In order to enhance the accuracy, a higher order plate theory is proposed. The essential characteristic of this analysis is the introduction of a warp deformation mode for the near-edge displacements. For a laminate coupon under uniaxial tension, the displacement field and the accompanying stresses have been determined. In particular, this includes the straight forward calculation of the inter-laminar stress components. In addition to this work, two case studies have been made for E-Glass Epoxy composite laminate and Graphite Epoxy composite laminate and free edge stress values for both the cases have been calculated using the formulated results. To justify the value obtained from our calculation, both the same cases have been analyzed using ANSYS software. Since an additional mode has been included with the existing method, we can clearly state that the results have been improved while using our results.

Index Terms- Inter laminar stresses, free edge stresses, Delamination, warping deformation.