Prediction of Transverse Cracking and Stiffness Reduction in Cross-Ply Laminated Composites

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ABSTRACT: A modified shear lag analysis, taking into account the concept of interlaminar shear layer, is employed to predict the onset of a transverse crack and multiple transverse cracking. In this analysis, the boundary conditions are satisfied for any transverse crack spacing. The crack multiplication is simulated by adjusting the crack spacing. Based on this analysis the laminate stiffness reduction due to the multiple transverse cracking is also evaluated in cross-ply laminated composites. The energy concept is utilized to assess the effect of 90° layer thickness and the constraining effect of 0° layer on the transverse cracking behavior of cross-ply laminated composites. Predictions of the onset of a transverse crack and stiffness reduction due to transverse cracks are compared with those of previous analyses and existing experimental data. The present analysis is simple, yet its results show reasonable agreement with experimental results.

1. INTRODUCTION

The most frequently encountered first ply failure mode in laminated composites is the transverse crack which is one of the matrix dominated failure modes [1–9]. Transverse cracks can be detrimental to the structural reliability and durability of laminated composites since they result in a redistribution of layer stresses and other damage developments such as local fiber failure, local delamination, crack coupling, etc. [10] which can effect the stiffness reduction of laminated composites [5–7]. The comprehensive understanding of the transverse cracking behavior is of fundamental importance to the structural design and integrity consideration of laminated composite structures. Many investigations have endeavored to explain and predict the transverse cracking behavior and its effects on the stiffness reduction of laminated composites.

Recent experimental studies have shown that the thickness of the transverse