Overview

There is a growing recognition in the design community of the importance of being able to calculate, test, or have the interlaminar properties of composites for use in the analysis of edge effects and critical interlaminar effects in composite structures In addition, the designer may need and want to have knowledge of ways to suppress these effects and to evaluate the structure's damage tolerance In this session, free edge interlaminar stresses, tensile radial stresses induced by bending, and the use of film adhesive interlayers to suppress delamination are covered

Fish and O'Brien's "Free Edge Stress Analysis of Glass-Epoxy Laminates with Matrix Cracks," presents the results of a three-dimensional (3-D) finite element analysis to determine the interlaminar stresses near a laminate free edge in the presence of an in-plane matrix crack They model matrix cracks in the 15° surface plies of $(15/-15)_s$ and $(15/90_n/-15)_s$ glass-epoxy laminates Experimental results from tension tests show that delaminations initiate at the free edge in the 15/−15 or 15/90 interface and are bounded by the matrix crack in the 15° surface ply The 3-D analysis indicates that large interlaminar normal tensile stresses are present in these interfaces, in addition to the interlaminar shear stresses, where the matrix crack intersects the free edge Hence, the interlaminar normal stresses may play a significant role in the formation of delamination in these laminates

Martin in "Delamination Failure in a Unidirectional Curved Composite Laminate" analyzes and tests graphite-epoxy unidirectional curved laminates that delaminate as a result of the tensile radial stresses induced by an applied bending moment Initially, no stress singularities exist in these unidirectional laminates The radial stresses have a finite distribution, which he calculates using both an anisotropic elasticity solution and a 2-D finite element analysis Therefore, a strength-based failure criterion is used to predict the initial delamination Then, a fracture mechanics model is used to describe the growth and accumulation through the thickness of subsequent delaminations The progression of failure is unstable, as predicted, and delaminations continue to accumulate through the thickness until the curved laminate loses all its stiffness

In Lagace and Bhat's "Efficient Use of Film Adhesive Interlayers to Suppress Delamination," film adhesive interlayers are placed in $(\pm 15_7/0_7)_s$ graphite epoxy laminates to suppress the initiation of delamination The adhesive interlayer is placed only at the critical 15/−15 interface where delamination was observed Several different width strips are used to ascertain the effect of strip width on the ability to suppress delamination onset For all the specimens with film adhesive interlayers, the load at which delaminations initiate is 50% higher than the control specimens without adhesive strips, and they fail at loads 40% higher than the control specimens These improvements are obtained for all the laminates, regardless of the strip width

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