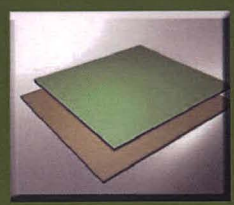
ADVANCES IN COMPOSITE MATERIALS



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Finite Element Analysis of Interlaminar Stresses in Edge Delamination

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Keywords: FEA, fibre feinforced laminates, delamination, interlaminar stresses.

Abstract: Edge delamination in fiber-reinforced composite laminates has been a significant structural reliability concern. This particular laminate failure mode is caused by the high interlaminar stresses concentrated near the free edges. Due to the complex fiber/matrix microstructure of laminates, an accurate evaluation of these stresses and determining their exact role in laminate failure has been difficult. This chapter aims to investigate the interlaminar stresses in edge delamination by modeling it using finite element analysis software (ANSYS).

Introduction

Fiber-reinforced laminates are one of the basic forms of composite materials. Laminates are typically manufactured using a number of pre-peg unidirectional plies bonded together into a layered structure. They are most effective in the form of thin plates or shells and are used in a wide variety of high-performance applications, such as military and aerospace structures [1]. The appeal of laminates, in addition to their superior strength-to-weight and stiffness-to-weight ratios, is in their ability to be custom-tailored to meet specific performance needs. The ply fiber orientation and ply stacking sequence in lamination allow the stiffness and strength properties to be designed directionally dependent in response to the applied load. This gives laminates a unique advantage over conventional materials [2].

Design and material parameters can cause laminates to fail in unusual modes. One major mode of failure is inter-ply debonding, or delamination. While laminates are primarily designed to withstand in-plane loads, high interlaminar stresses can develop in regions with abrupt changes in material and/or geometry, such as at free-edges, holes, cut-outs, etc. The interlaminar stresses in these regions are highly localized with steep gradients. As a result, delamination may form and propagate into a large crack. It is well known that a localized delamination can lead to severe structural weakening as well as reduce structure durability. For this reason, there have been many theoretical and experimental studies on the mechanics of delamination in composite laminates [3]. However, due to the complex nature of the delamination mechanisms, the problem continues to attract research interest.

Method

ANSYS is a comprehensive general-purpose finite element computer program that contains more than 100,000 lines of code. ANSYS is capable of performing static, dynamic, heat transfer, fluid flow, and electromagnetism analyses. ANSYS has multiple windows incorporating a graphical user interface (GUI), pull-down menus, dialog boxes, and tool bar.