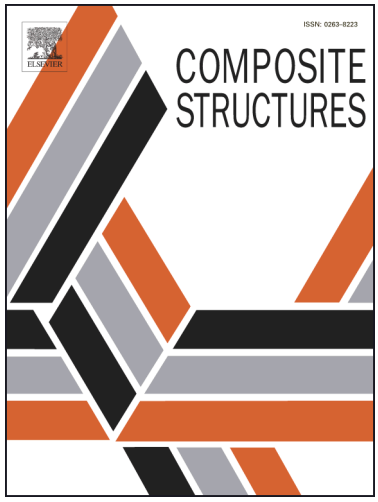


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*Revised manuscript*

# Determination of local stiffness of a cross-ply composite plate with delaminations and matrix cracks

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## Abstract

This paper studies the local stiffness determination method in cracked regions to apply continuum mechanics to the cross-ply composite plate with delaminations and matrix cracks, subjected to transverse and in-plane loads.

The plate is divided into adequate regions according to crack distribution density and then strain energy in each element (region) is computed from complementary energy by cracks in that element. Matrix cracks are of the mode I, II, III and thus corresponding stress intensity factors are calculated. The stiffness of element in the cracked region, i.e. the local stiffness is determined from the Green's theorem using the obtained strain energy.

The simply supported cross-ply composite plate with matrix cracks and delaminations under transverse and in-plane loads is analyzed by using the obtained local stiffness in the ANSYS APDL. The availability of the proposed method based on crack modeling and local stiffness is evaluated through comparison.

## Keywords

Matrix Crack, Delamination, Local Stiffness, Cross-ply Composite Plate, Mode I, II, III Stress Intensity Factor

## 1. Introduction

Today, plates and shells fabricated by composite materials are widely used in many fields and structures such as aerospace, turbine, wind turbine blades, nuclear reactor, etc., where it is very important to design those structures properly regarding for cracks and defects initiated in the process of manufacture and operation. Mechanical behaviors of composite plates with cracks are being widely researched.

In Allam and Zenkour [1] researchers emphasized that problems related to the determination of stresses in a plate weakened by an opening and deformed by forces applied to the middle plane are very important in the design of engineering structures and the effect of opening in an isotropic plate, which is not filled or reinforced, causes an increase of stress in certain. And the determination of stress concentration factor for a fiber-reinforced viscoelastic plate was given using the method of effective moduli. Also, the numerical results of stress concentration factor were obtained for tension and pure bending problems in the various directions of a structurally anisotropic composite plate.

In many references including Wang and Tong [2], Parlapalli et al. [3], the plate or plate-beam with