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RESEARCH ARTICLE

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CRACK PROPAGATION AND ANALYSIS ON THIN PLATE

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ABSTRACT

This deals with the analysis and modelling of the crack propagation on a 2d plate, which computes crack propagating on a thin plate. It simulate the case by giving the conditions like crack length, pressure, displacement. It calculate the entire varying properties in post-processor such as crack deformation, stress in x, y, z direction, stress intensity, shear stress etc. Further extend this analysis in 3D and calculate the same properties. And by doing NDT test on thin plate using aluminum 2024 sheet, and by applying similar boundary conditions. In result obtain entire varying properties along the crack propagation. Also the stress is verified to the theoretical results.

Keywords: Interlaminar stresses, Finite element method, laminated composite plate.

I INTRODUCTION

Fracture mechanics is a field of solid mechanics that deals with the mechanical behavior of cracked bodies. Failures have occurred for many reasons, including uncertainties in the loading or environment, defects in the materials, inadequacies in design, and deficiencies in construction or maintenance. Design against fracture has a technology of its own, and this is a very active area of current research. This module will provide an introduction to an important aspect of this field.

It is important to realize that the critical crack length is an absolute number, not depending on the size of the structure containing it. Each time the crack jumps ahead, say by a small increamentδa, an additional quantity of strain energy is released from the newly-unloaded material near a crack. Again using our simplistic picture of a triangular shaped region that is zero stress while the rest of the structure continues to feel the overall applied stress, it is easy to see in Fig. That much more energy is released due to the jump at position that at position at 1. This is yet another reason why small things tend to be stronger; they simply aren't large enough to contain a critical-length crack.

If the stress-strain curve is plotted in terms of true stress and true strain the curve will always slope upwards and never reverse, as true stress is corrected for the decrease in cross-sectional area. The true stress on the material at the time of rupture is known as the breaking strength. This is the maximum stress on the true stress-strain curve.

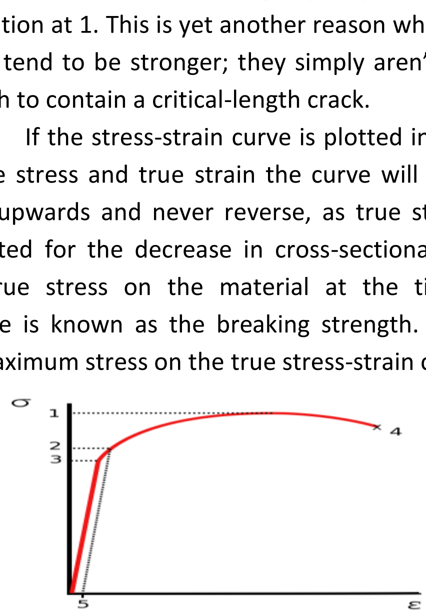

Fig. Stress vs. strain curve typical of aluminium9

II FINITE ELEMENT METHOD

The basic idea in the finite element method is to find the solution of a complicated problem by replacing it by a simpler oneIn the finite element method, the solution region is considered as built of many small inter connected sub regions called finite elements.General description of finite element method contains for steps as follows

1. Discretization of structure (domain)
2. Selection of a proper interpolation model.
3. Derivation of element stiffness matrices
4. Assemblage of element equation([K]Φ=P)
5. Solution of system equations

III MODELING

Material of Rectangular Plate

Determine the Stress intensity factor for the crack propagation of 2-D Thin plate of length 0.1x 0.1cm. Assuming the pressure of 100N, calculate for the quarter part of the plate of high crack intensity. By increasing the crack length by 10% simultaneously up to 5 calculations, show the effect of Deformation and Stress intensity. Also differ the intensity from theoretical to the experimental values

This total project of modeling and analysis of this test case is done using ANSYS 13.0 which is a product of ANSYS Inc.

In ANSYS 13.0, we create a model in pre-processor and results are obtained in post processor. This crack analysis includes 4 different modules as follows:

The standard 4-node Iso-parametric quadrilateral. This is usually processed a 2 x 2 Gauss integration rule, which represents full integration

The material used for composite laminate is graphite/epoxy laminate. The Layup of the laminate chosen as 15^0,-15^0,30^0,-30^0,45^0,-45^0,60^0,-60^0,75^0,-75^0.For different d/w ratios has been studied. The staking sequence of laminate is [15/-15/30/-30/45/-45/60/-60/75/-75]. The laminate consists of 10 layers, with ply thickness 0.508 each. The orthotropic material properties for the material are given as follows. Material used as Graphite/Epoxy.

$E_1=1.6\times10^5$ N/mm^2 $E_2=E_3= 0.09\times10^5$ N/mm^2

$\mu_{12}= \mu_{13}= 0.293$ $\mu_{23}= 0.342$

$G_{12}= G_{13} = 0.06\times10^5$ N/mm^2

$G_{23}=0.03\times10^5$ N/mm^2

Pressure=1 N/mm^2

Influence of a hole in a composite material in the following way as the laminated composite plate is assumed to be symmetric about the x- axis, y-axis.To generate 3-D model having SOLID191 elements for individual layers, we will first generate 2-D plot in XY plane at Z=0. Then will extrude it along Z-axis

IV MESH GENERATION

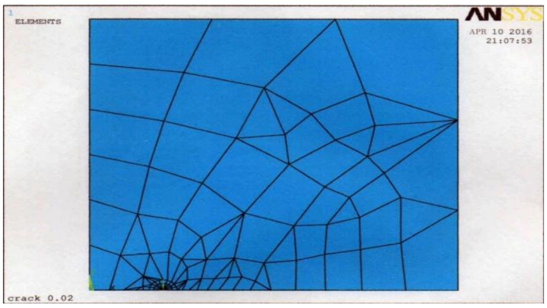

Fig. Mapped mesh model of orthotropic plate

V ANALYSIS

Taking crack length as 0.022 by 10% increase of 0.02

The analysis done for the rectangular plate to analyze the inter laminar stresses with a circular hole. The hole diameter varies in the X, Y direction. The maximum stress concentration evaluated.

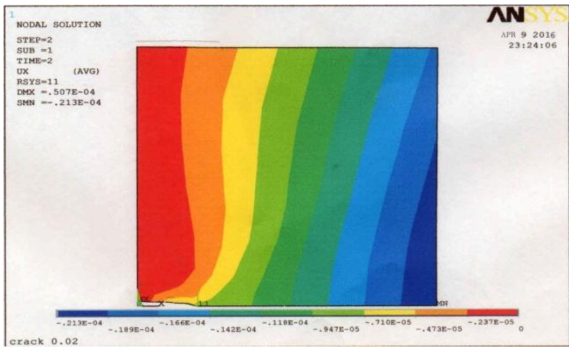

Fig. Nodal Solution in X direction

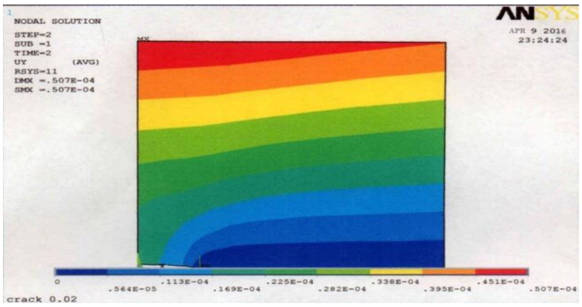

Fig.Nodal Solution in Ydirection.

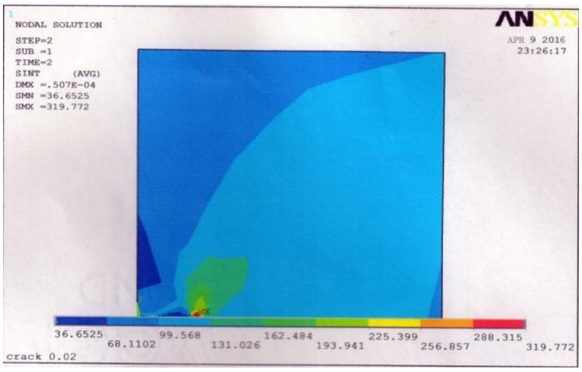

Fig. Stress Intensity

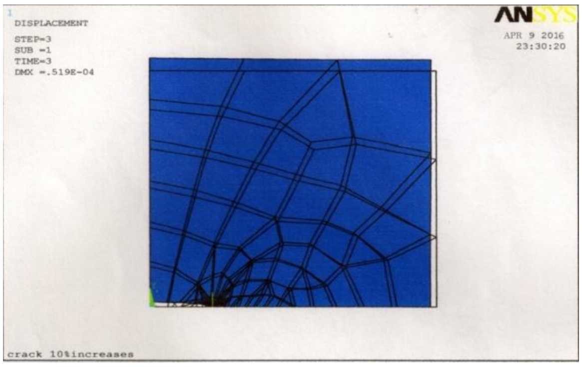

Fig Deformed shape

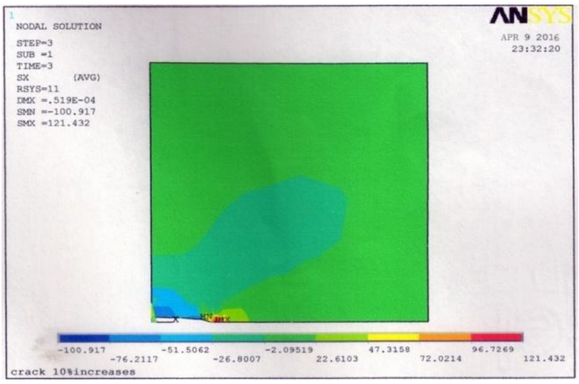

Fig. Stress in in x-direction

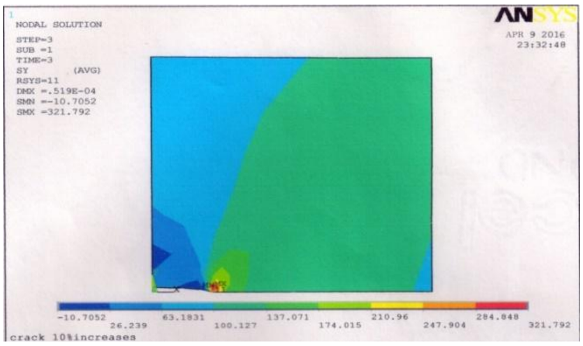

Fig. Stress in y-direction

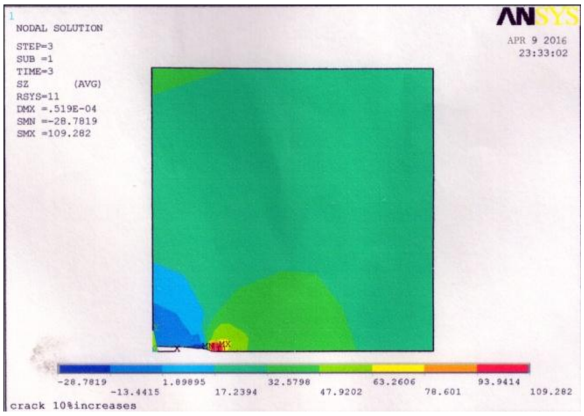

Fig. Stress in Z- direction

VI RESULTS AND DISCUSSION

The interlaminar stresses near the curved edge are prominent than those near the straight edge. The results of various cases to estimate stress concentration by varying the D/Wratio and apply the uniformpressure of 1nit load. The interlaminar stresses in the XZ direction are maximum in cases. The delimitation damage occur at the X direction.

VII CONCLUSION

It is observed that maximum stress concentration occurs when the fibers are oriented parallel to the x-axis. The influence of hole size over stress concentration is more in transverse direction over the longitudinal direction. While varying the hole in X direction the maximum interlaminar stresses obtained. Interlaminar shear stresses in xz plane are greater than yz plane irrespective of the location change in x and y-direction changes.

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