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EXPERIMENTAL INVESTIGATION AND BUCKLING ANALYSIS OF WOVEN GLASS EPOXY LAMINATED COMPOSITE PLATE

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ABSTRACT

In this project the Buckling behavior of laminated composite plates subjected to in-plane loads is an important consideration in the preliminary design of aircraft components. The sizing of many structural subcomponents of the aircraft structures is often determined by stability constraints. The objective of the current study is to understand the influence of the length-to-thickness ratio, the aspect ratio, the fiber orientation and the cut-out shapes on the buckling load for the woven glass epoxy laminated composite plate in clamped-free-clamped-free configuration by finite element analysis using ANSYS software. Initially buckling analysis was carried out on woven glass epoxy laminated composite plate, both; experimentally and numerically; for the two different geometric configurations to predict the critical buckling load and the test results were compared with the FEA predictions, to check the validity of the analysis methodology. The same methodology was further followed for analyzing the buckling behavior of the composite plates. The results shows the effect of orientation of fiber, aspect ratio, cut-out shape and length-to-thickness ratio on the buckling of the glass epoxy laminated composite plate.

Keywords: - Plate buckling, woven glass epoxy laminate, length-to-thickness ratio, aspect ratio, fiber orientation, cut-out shapes.

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1. INTRODUCTION

There are many types of failures in engineering structures. Some of them include creep, fatigue, alternate stresses, bending, buckling etc. Buckling takes place in columns, plates, shells, and other structures of regular or irregular geometry. In this project only buckling of laminated composite plates has been considered. If the loads applied to a flat plate are low then there is low no observed distortion of the plate however as the load is increased then the equilibrium configuration of the plate changes into no flat configuration. A composite has dual character. These materials have important properties like they are light in weight because the combined properties give rise to significant weight loss character. Thus they have high strength and high stiffness compared to their weight.

2. PROBLEM IDENTIFICATON

Form the literature review its clear that the bending analysis is the main problem associated with the E-Glass fiber plate and in woven glass fiber plate material. As discussed earlier, the thin laminated composite plates are capable to carry extra amount of load under compressive loading. To achieve the same majority of work has been carried out in modeling and numerical investigation of the buckling behavior of the laminated composite plates time to time.

3. METHODOLOGY

The methodology includes the process sequentially which carried out, this project includes the process of analysis and experiment for the characterization of materials. The manufacturing process can be classified into two broad categories:

- Hand methods
- Mould methods

4. HAND LAYUP TECHNIQUE

Hand lay-up refers to the manual method of laying or applying the reinforcement material into the mold. In the hand lay-up process, the reinforcing material (usually fiberglass mat) is placed in the mold and then saturated with polyester resin using a brush or a two-component spray system.

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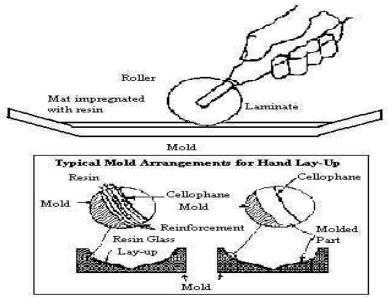

Figure 4.1 hand layup technique

6. ANALYSIS

6.1RECTANGLE AND SQUARE PLATE

RECTANGLE PLATE:

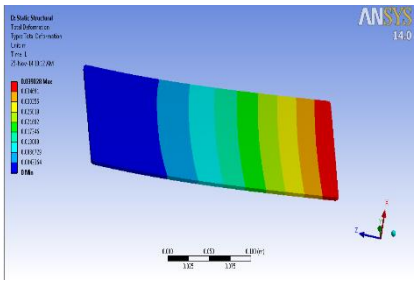

Fig 6.1 Rectangle Plate Without Cut-Out

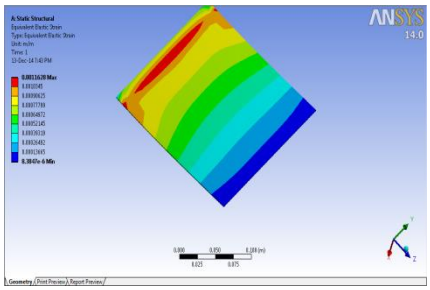

Fig 6.2 Square Plate without Cut-Out

6.2 RECTANGLE AND SQUARE PLATE WITH CIRCULAR CUT-OUT

RECTANGLE PLATE:

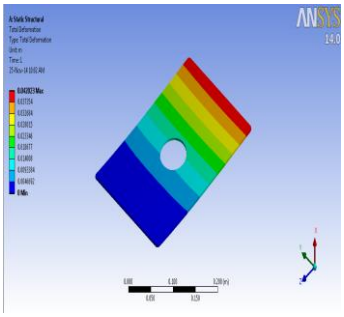

Fig 6.3 Rectangle Plate with Circular Cut-Out

SQUARE PLATE:

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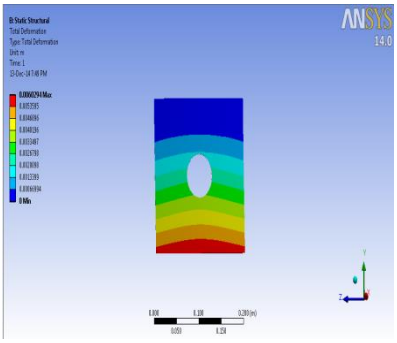

Fig 6.4 Square Plate with Circular Cut-Out

6.3 RECTANGLE AND SQUARE PLATE WITH SQUARE CUT-OUT RECTANGLE PLATE:

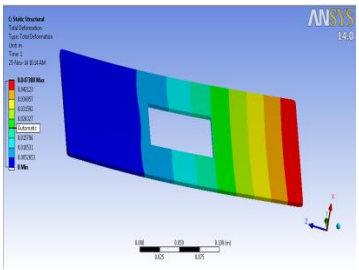

Fig 6.5 Rectangle Plate with Square Cut-Out

SQUARE PLATE:

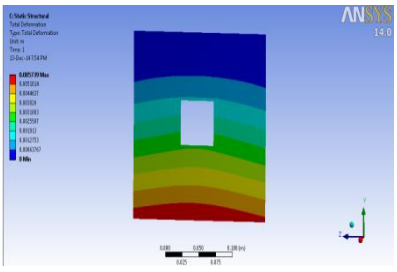

Fig 6.6 Square Plate with Square Cut-Out

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6.4 RECTANGLE AND SQUARE PLATE WITH RECTANGLE CUT-OUT

RECTANGLE PLATE:

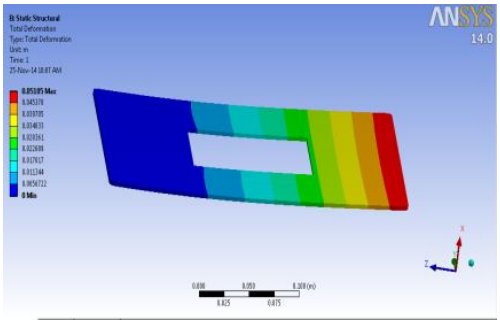

Fig 6.7 Rectangle Plate with Rectangle Cut-Out

SQUARE PLATE:

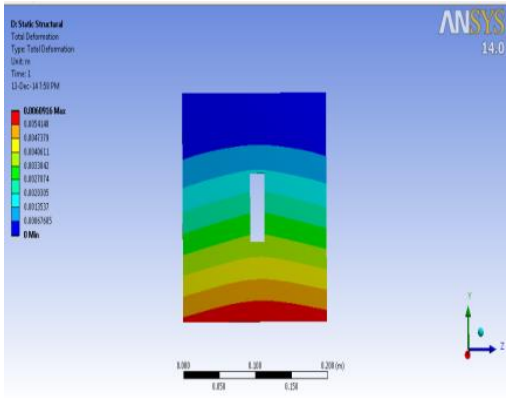

Fig 6.8 Square Plate with Rectangle Cut out

7. EXPERIMENTAL STUDY

Experimental studies were carried on the following two woven glass plate configurations to find out the critical buckling load

- Rectangular woven glass plate (400×200×3.2 mm)
- Square woven glass plate (200×200×3.2 mm)

This experimental study was carried out to validate the buckling results obtained from FEA, so that the same analysis methodology can be followed for the buckling analysis of woven fabric composite plates.

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8. CONCLUSION

The composite plate is made with the help of woven glass epoxy laminated resin for two geometric configuration namely square plate and rectangular plate. Modeling is done with the help of CATIA software for two geometrical configurations for square and rectangle plate with cut-out such as (circular, rectangle, square). It was noted that variations in length-to-thickness ratio affects the critical buckling load. The buckling load decreases as the a/t ratio increases. The rate of decrease of buckling load is not uniform with the rate of increase of a/t ratio.

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