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BUCKLING BEHAVIOUR OF WOVEN GLASS FIBER COMPOSITE LAMINATE WITH DIFFERENT CUTOUTS

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Abstract— Advanced composite materials are widely used in modern industrial fields. Composites materials can be used in all department of engineering like aerospace, biomedical, civil, electronics, instrumentation, marine and mechanical engineering. Due to their properties such as durability, high tensile strength, good corrosion resistance, dimensional stability, good thermal and electrical conductivity, ease of handling, light weight and dimensional stability when compared to conventional materials. Glass fiber composites are used in flat plate, and accordingly the load bearing the capability of composite plate against critical buckling load has been actively considered by researchers under various loading and boundary conditions. When the applied load reaches the Euler load is called the critical load, the column comes to be in a state of unstable equilibrium. At that load, the introduction of the slightest lateral force will cause the column to fail by suddenly "jumping" to a new configuration, and column is said to have buckled. This load acting is called as "critical buckling load." A composite material consist of two or more material with good less weight characteristics, weight ratios and fabulous buckling strength. In glass fibers material contains the main load carrying members which has less modulus and high in elongation, provides the necessary flexibility and also keeps the fibers in position and protect them from the environment. Characteristics of glass fiber composite arise as a utility of its constituent materials, their distribution and the interaction among them and as a result an unusual combination of material properties can be obtained.

Keywords— Hand lay-up technique (both GFRPC &GFRP); Buckling analysis; different cutouts; UTM (with buckling setup)

Introduction—glass fiber is a material consisting of numerous extremely fine fiber of glass. Glass fiber first invented by Edward Drummond libbey in 1893 for textile purpose. After that it is developed for using all engineering components because of its properties. Comparing other fibers glass fiber having more buckling strength and less weight characteristics except carbon fiber. But glass fiber is low cost compared with carbon fiber and not to much difference in buckling strength. Buckling behavior is important consideration in aerospace component design such as luggage bins, interior paneling, flooring and structural parts. In these cases for replacement the cutouts is required. Colin v Jacob finds glass fiber having more buckling strength then aluminium plate. Here we proving the glass fiber aluminium composite plate having more buckling strength then glass fiber. In glass fiber normally having the knit, unidirectional, bidirectional and woven glass fiber. But comparing all those woven type is more flexible and good strength. Hence woven glass fiber is laminate with aluminium powder by using hand-lay-up technique. Hand-lay-up technique is easy method for lamination. The epoxy is used as a resin and it is more adhesive and reinforcement resin by comparing all other resin. The epoxy and hardener is laminate with ratio of 10:1. The buckling behavior is tested by using universal testing machine.

Experimental work-- Only one mould surface was used in the open mould process. This single mould represented the glass table surface and the matrix materials used were thermosetting resins of epoxy, while the reinforcement materials used was E-glass fibers. Depending on the desired thickness (4.2 mm), the matrix resins and the reinforcement fibers were applied to the mould surface layer by layer; hand lay-up process was applied in this work. The fiber reinforcement was used in the form of woven roving. After the lay-up process, the curing treatment would be necessary for rigid thermoset matrices. The first step of the hand lay-up process was cleaning the surface of the mould, followed by the application of a release agent for ease of part removal. In the second step, a thin gel coating was applied to the outside surface of the mould because the surface quality of the product was important. The gel coating resin was performed perpendicularly, it was applied to the mould by using a piece of sponge. The third step began when the gel coat was partially set. The sample was laid-out between two glass plates by laminating the mixture onto the fibers layer-by-layer, in this hand lay-up step, as the name suggested the resin and fiber forms were manually applied to the open mould as successive layers, the resins were generally catalyzed by hardeners and accelerators. Each layer was consolidated by a roller to ensure that the resin impregnated the fiber and that any air bubbles that were present were removed as this would otherwise decrease the mechanical strength of the final product depending on the thickness of the product. Alternating layers of resin and reinforcement may be added. After each new layer had been added, it was rolled out manually. Time, temperature and pressure were the three main parameters influencing the degree of cross linking in the curing process. In thermosetting the resins, curing would start at room temperature, which was rather slow. Increased temperature will decrease the time necessary for the curing process to be completed. In the present study, the time necessary was (24 hours) with room temperature at (25°C). A little pressure was necessary during curing by applying a flat glass surface to ensure all layers would stick together and to make the specimen surface flat and smooth. In the fifth and final step, the component was removed from the mould, and the big sample was then ready for trimming and other surface finishing processes. Seven big rectangular plates of glass fiber/Epoxy with (+45°/-45°/+45°)s orientation were ready for the finishing and cutting process into 21 specimens that the buckling tests would be applied on them after the cutout process for the 18 specimens and three specimens have remained without cut-out. The sizes of the form of the specimens that were needed should be marked out in this step using a marker pen in order to cut them accurately and perfectly. By using the cutting in the workshop, the cutting processes should be done carefully, bearing in mind the safety instructions on each machine. Each plate had lines that were made earlier during the required sizes of the specimen. By cutting the plates according to these lines would form the specimens. After the cutting process, the measurement of the dimensions for each specimen would ensure that all the dimensions were the same for all each specimen. Six specimens of glass fiber/Epoxy with (+45°/-45°/+45°) s orientation were ready for the cutout process in order to cover all the factors which were required to compare amongst them in this work.

A) Hand lay-up technique

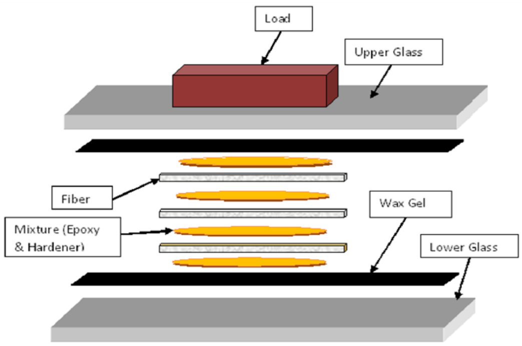

Fig. 1 Schematic Diagram showing the Open Mould Process

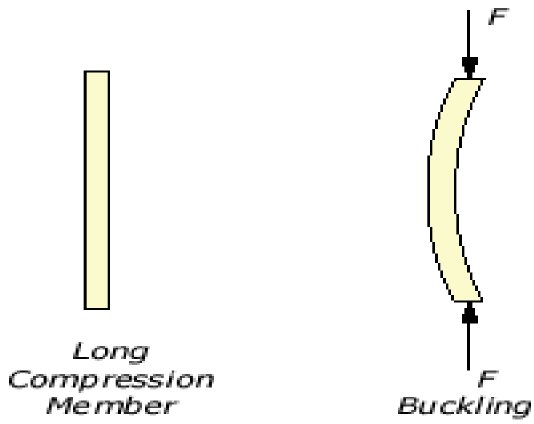

Fig.2. Buckling analysis

B) Woven glass fiber and woven glass fiber composites laminated— the laminated specimens is shown in fig.

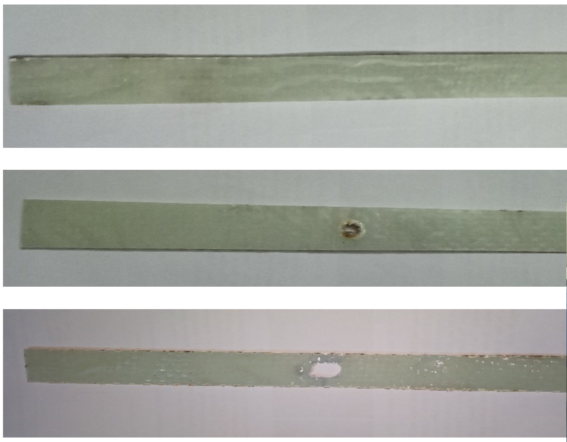

Figure 3 Glass fiber without cutout, with circular cutout, square cutout

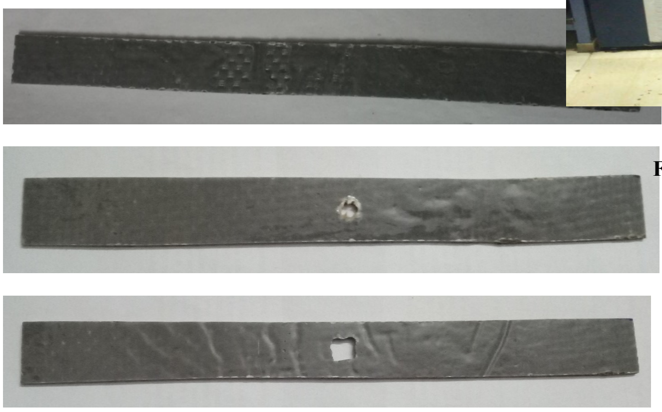

Fig 4 Glass fiber with aluminium composite without cutout, with circular cutout, square cutout

C) Universal Testing Machine— In universal testing the laminated specimen is testing on critical buckling load. The compressive load is acting at one end and other end is fixed. The buckling is noted until the specimen is breaking based on how much load is applied. Totally six specimens are testing with and without cut outs. Every specimen has different buckling loads. These loads are comparing and finding the specimen which have more buckling load. The reason for using UTM is having more intense and accuracy while comparing other testing machine. UTM machine have the capability to test buckling, tensile, compressive loading mechanism and all other load testing is carried out.

Fig 4 Buckling setup in UTM machine

RESULT AND DISSCUSSION

- This work shows successful fabrication of glass fiber composite and successful comparison of critical buckling load between glass fiber and glass fiber with aluminium composite
- It has been noticed that glass fiber composites can withstand more critical buckling load than glass fiber. Glass fiber composite is preferred instead of glass fiber material because it withstand more critical buckling load.
- The tested results given below on the table,

S.NO	SPECIMEN	BUCKLING LOAD
1	Glass fiber square	0.06
2	Glass fiber with aluminium square	0.075
3	Glass fiber round	0.05
4	Glass fiber with aluminium round	0.09
5	Glass fiber plain	0.05
6	Glass fiber with aluminium plain	0.08

Table 1 Buckling test results

EFFECT OF CRITICAL BUCKLING LOAD ON GLASSFIBER COMPOSITE WITHOUT CUTOUT

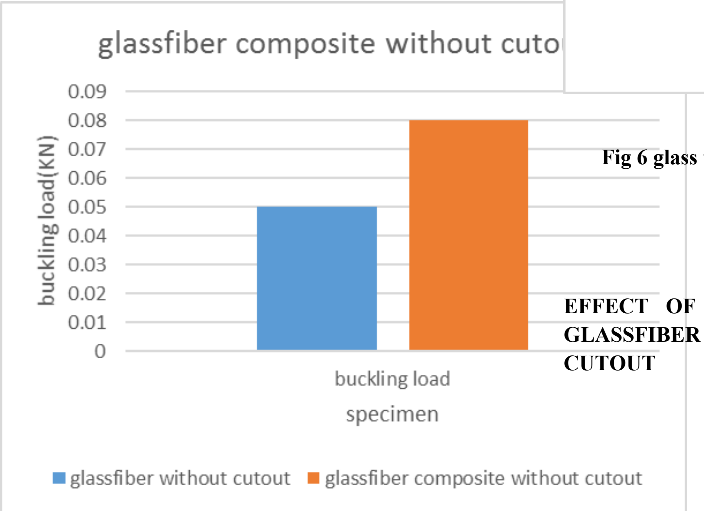

Fig 5 glass fiber composite without cutouts

EFFECT OF CRITICAL BUCKLING LOAD ON GLASSFIBER COMPOSITE WITH CIRCULAR CUTOUT

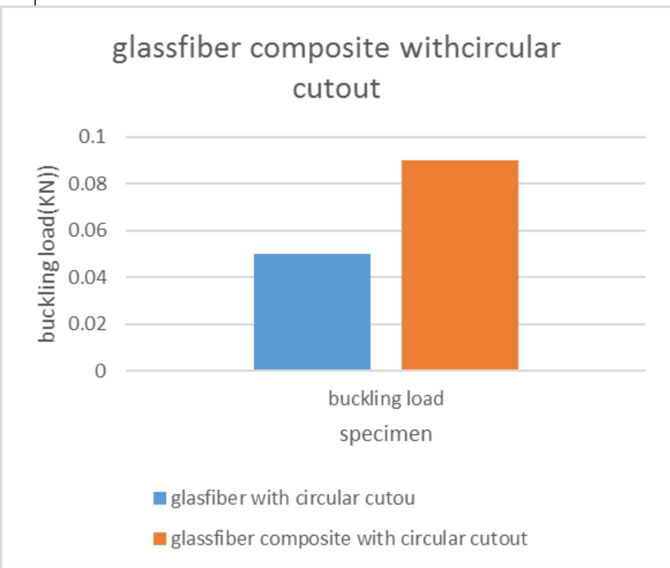

Fig 6 glass fiber composite with circular cutouts

EFFECT OF CRITICAL BUCKLING LOAD ON GLASSFIBER COMPOSITE WITH SQUARE CUTOUT

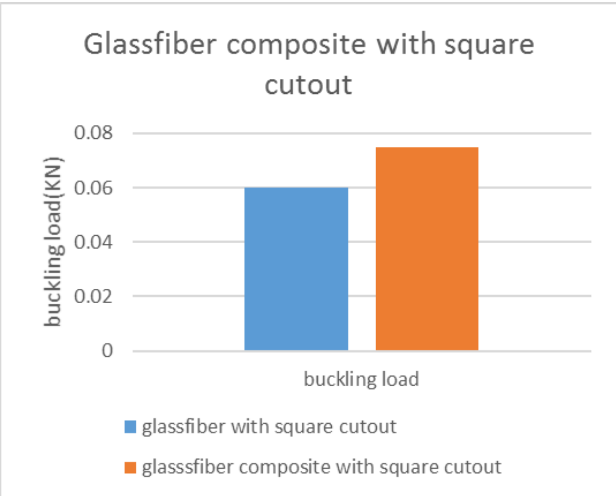

Fig 7 glass fiber composite with square cutouts

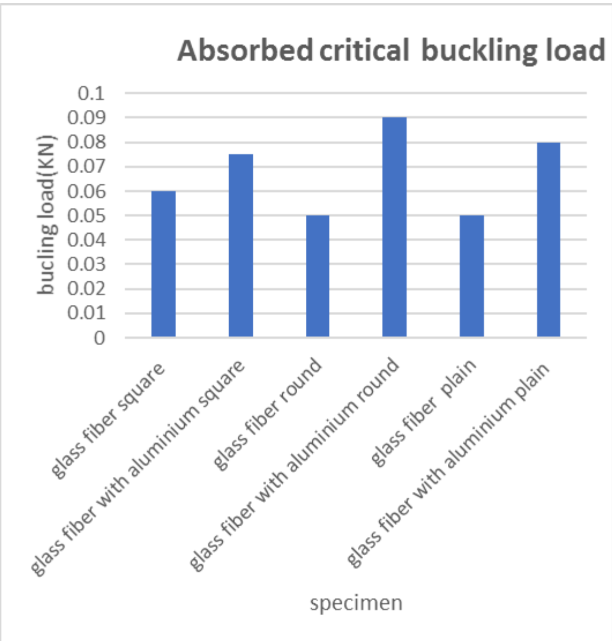

Figure 8 Absorbed Critical buckling load

COMPARISON OF BUCKLING LOAD RESULTS

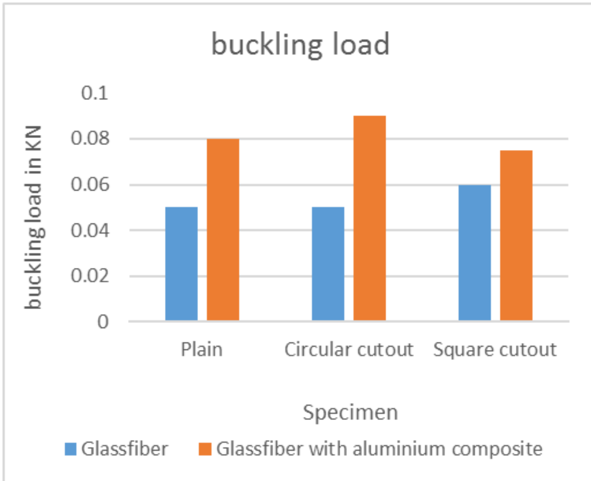

Fig 9 buckling load comparison

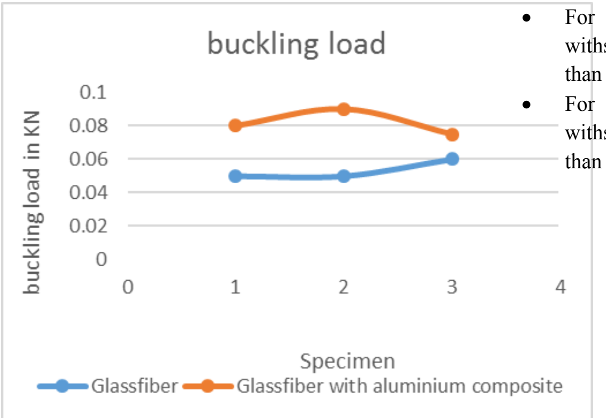

Fig 10 buckling load glass fiber vs glass fiber composite

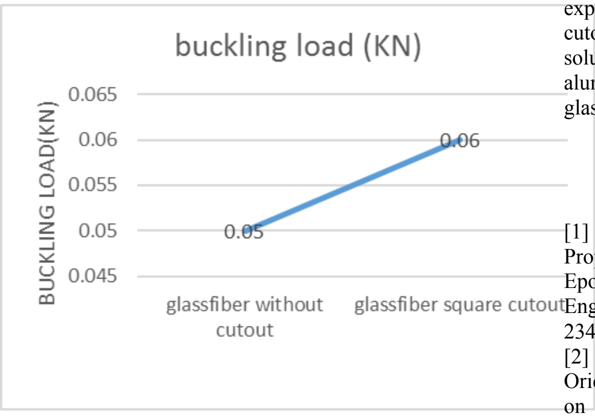

Figure 11 glassfiber without cutout vs square cutout

- From this study it has been found that for without cutout glass fiber composite withstand more critical buckling load (0.08 KN) than glass fiber material (0.05KN)
- For circular cutout glass fiber composite can withstand more critical buckling load(0.09KN) than glass fiber material (0.05KN)
- For square cutout glass fiber composite can withstand more critical buckling load(0.075KN) than glass fiber material (0.06KN)

CONCLUSION

The conclusion of woven glass fiber composite is having more strength and effective by comparing with the woven glass fiber. And it can be proved experimentally on buckling testing machine. The different cutouts of square, circle and plain specimen is gives the solution for aerodynamic failure and proved glass fiber aluminium composite having more strength then normal glass fiber.

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