Experimental Investigation on Stiched And Unstiched Fiber Glass Epoxy Laminated To Improve Stregth In Aircraft Structure

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Abstract- *Composite materials are most commonly used in the place of metals which is having more strength to weight ratio. These composite materials are most promising and discerned materials in the place of some metals. It posing very unique properties li water repellent, high impact and wear resistance corrosive resistance and vibrations and sound damping property which allow the frequent application of this material in the aerospace industry, automobile and medical industries. Performance and life of material depends upon their constituent and fabrication and manufacturing techniques.*

In this paper fiber reinforced stitched and unstitched glass epoxy laminated composite fabricated and their effect in the mechanical properties were investigated. The composite is fabricated by using hand layup method in two dimensional orientations, i.e., stitched and unstitched (random orientation). In this thesis, the conventional destructive tests are carried out to evaluate the flexural strength and tensile strength of the specimens of two different orientations. To fabricate the composite, resign transfer moulds are was used. Tensile test is carried out by using UTM and DCB (double cantilever beam) is done to evaluate fracture toughness of both stitched and unstitched composite.

FEA (Finite element analysis) is done on the two orientations of glass fiber that at the fabricated constant volumetric ratio of 30% with the fiber orientation the specimens are tested at various standard loading conditions for tensile test and flexural test. It has been observed that tensile and flexural strength are maximum for stitched fiber composite orientation compared with unstitched (random) fiber orientation.

I. INTRODUCTION

Fiber reinforced composites are the best replacement of the many metals due to its light weight to strength ratio. The lower weight plays a significant contribution to success of the product in many cases. Especially the aircraft and racing cars body etc. In traditional fiber reinforcement plastics and composites which is having random orientation that cannot having exact mechanical properties as predicted. Here in this thesis the fiber orientation plays the vital role in the change of the mechanical properties of the material.

Science and technology constantly trying to provide the performance of composite material to the exceptional range which helps to replace most of conventional materials. Reinforcement of material is done to obtain desire properties where the single material cannot meet the requirement. The reinforcement fiber are used for the function to carry out the tensile load while subjected and act as the crack barrier i.e. it prevents the crack propagation when subjected to the tensile load.

The present paper focusing on the investigation of the characteristics and properties of glass fiber orientation stitched and unstitched glass fiber. Which is having the benefits of improving the performance.

Composite materials are made up of two or more materials in different composition or in different orientation to meet the appropriate application.

A large range of composite materials can be prepared by changing orientations, or by changing process parameters or by changing the matrix materials

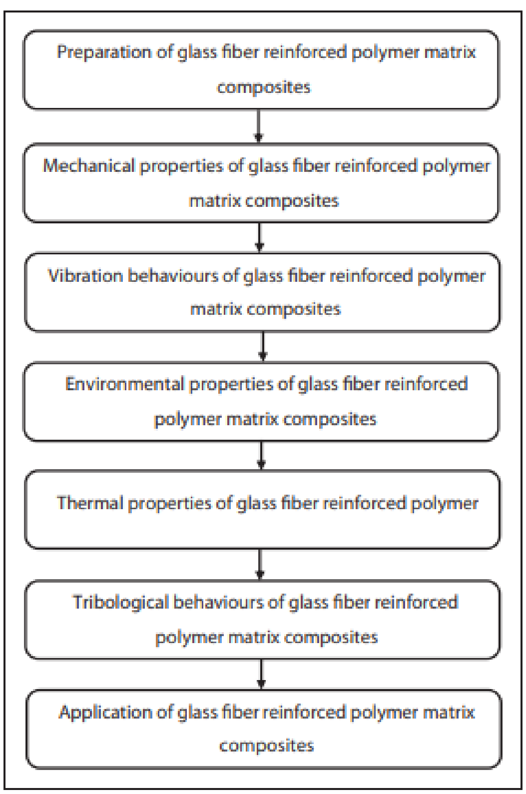
Fig-1: The stitched orientation of fiber glass reinforced epoxy composite

In stitched orientation of fiber glass reinforced epoxy composite not only the chemical composition physical and geometrical parameters also play a vital role in the mechanical behavior of that composite.

Fig-2: Unstitched orientation of fiber glass Reinforced Epoxy Composite

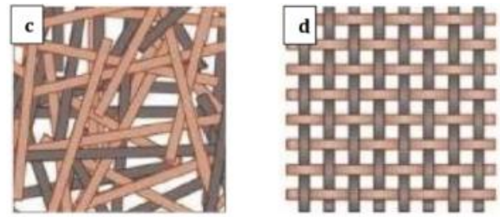
II. PREPARATION OF GLASS FIBER REINFORCED POLYMER MATRIX COMPOSITES

The GFRP composites were prepared by adopting various manufacturing techniques as discussed below. In this thesis we used hand layup processes.



III. ORIENTATIONS OF COMPOSITE FIBER

Stitched: ASewed glass fiber reinforced composite. In which the fibers are bonded with each other by the small fiber rope or any thread like material. Which high tensile strength.



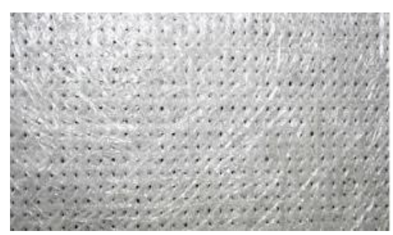
Unstitched: Random orientation of the material which allows free but the properties can be predicted easily because they may very with the presence of glass fiber concentration.

IV. DESIGN, FABRICATION AND TESTING

In this chapter there is a detailed discerption of material preparation, design, preparation of test specimens and testing procedure.The dimensions of test specimen are taken according to the American Society for Testing and Materials (ASTM) standards.

Fabrication of stitched fiber glass epoxy laminate:

The stitched fiber is made up of multiple yarns which wounded with each other firmly.Thin strands of materials that we obtain either from natural or synthetic sources. Coarsely woven yarns roving use for fast buildup in application whee coat is saved.



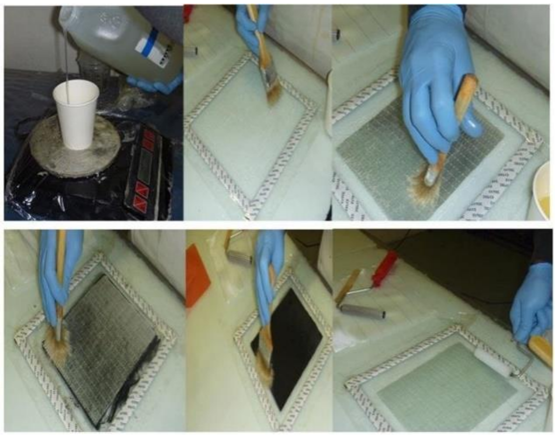
Stitched fiber

V. HAND LAYUP PROCESS

This method of fabrication of composite materials have the following steps:

Mould preparation, Gel coating, Layup and curing

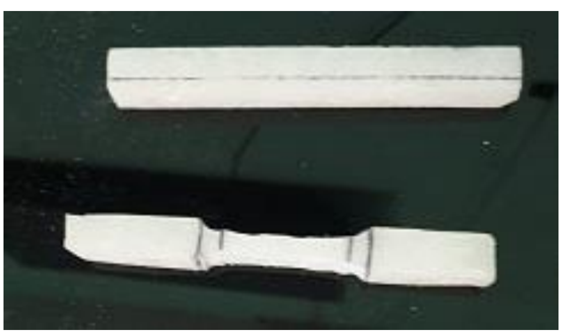
The mould is prepared such that the epoxy resin should not flow over it generally box and the fibers are placed in that and epoxy is coated over the fiber.This process is repeated up the requires thickness is attained and allow to curing. Curing is the processes of allowing the fiber reinforcement to hardening without any external pressor or heat. A layer of gel is applied on the mould to obtain quality of surface finish of specimens.



Hand layup process

VI. PREPARATION OF THE SPECIMENS ACCORDING TO THE ASTM STANDARDS

After hand layup process the specimens are cut according to the dimensions for tensile and flexural strength of both orientations. The properties of the specimens are investigated by using UTM for tensile test, and for flexural strength three point bending test is used.



Specimens for tensile test and bending test

VII. FEA ANALYSIS OF THE SPECIMEN

To create a specimen model solid works is used in FEA model and analysis is done by ANSYS. in order to study the effect of fiber orientation on the mechanical properties like tensile and flexural strength. Specimen is made according to the astm standards.

Fig-6: FEA model for test as per ASTM standard

Tensile test:

Tensile test is the process of applying load axially to evaluate the tensile strength of the specimen. The variation in the stress concentration is represented by the red and blue colours. The red colour indicate high stress concentration where as low stress is represented in blue. The range of light colour variations indicates the changes in the stress concentration.

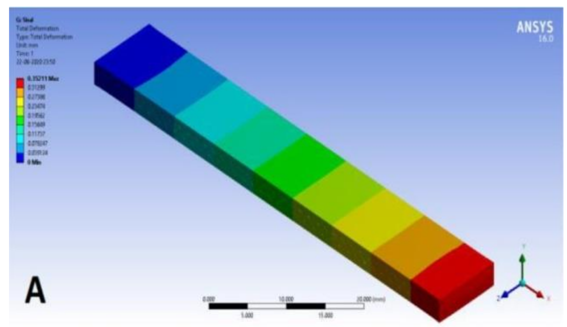


Fig-8: Results of tensile test of the specimen of Unstitched orientation of fiber glass reinforced epoxy composite

The structural analysis is done by preparing specimen in the rectangular cross section by using pro-e for random orientation. The difference in the colour variations shown in the figure represents stress concentrations in the various parts of the specimen. Red colour indicates the max Stress and bule colour indicate min stress concentration. Thus the mechanical properties are investigated by using ansys software.

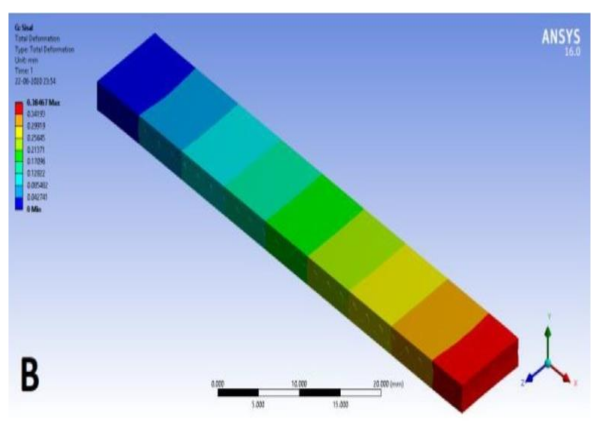


Fig-9: Results of tensile test of the specimen of Stitched orientation of fiber glass reinforced epoxy composite

Orientation	Tensile strength (MPa)
Unstitched orientation of fiber glass reinforced epoxy composite	231.67
Stitched orientation of fiber glass reinforced epoxy composite	280.68

Table-2: Results obtained by the FEA of the specimen of two different orientations for tensile test

Flexural testing:

The three point flexural test is conducted on the specimen by supporting the two ends and applying load at the center of the specimen. As a result the colour variations has been seen on the specimen in image which red colour on the specimen indicates high in stress concentration where as blue colour indicates low stress concentration.

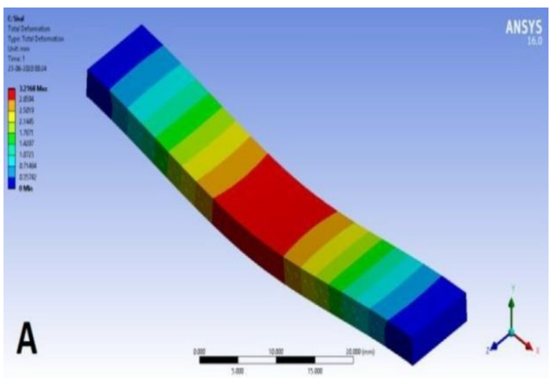


Fig-11: Results of flexural test of the specimen of Unstitched orientation of fiber glass reinforced epoxy composite.

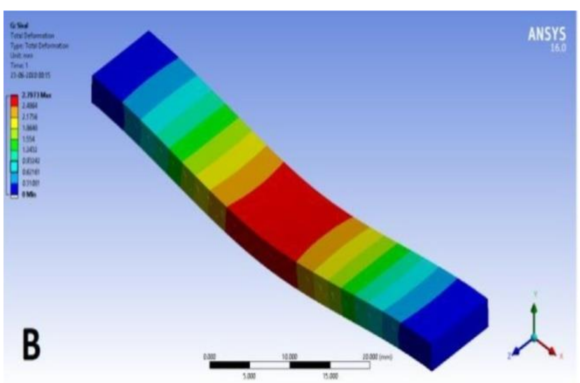


Fig-10: Results of flexural test of the specimen of Stitched orientation of fiber glass reinforced epoxy composite.

After getting appropriate results by using fem analysis the stitched and unstitched orientation of the specimen's flexural strength

Orientation	Flexural strength (MPa)
Unstitched orientation of fiber glass reinforced epoxy composite	305.89
Unstitched orientation of fiber glass reinforced epoxy composite	381.23

Table-3 results obtained by the FEA of the specimen of different orientations of flexural test

VIII. RESULTS AND DISCUSSION

The results that abstained from the practical and ANSYS are compared. Difference in the both tests are evaluated in the below tabular form. There is no much difference in the theoretical and practical approach so the results are taken as granted

Table 4 Indicate the comparison of tensile strength of two different orientations.

Tensile test:

Orientation	Tensile strength in MPa		Difference
	Practical	Analysis	
Unstitched orientation of fiber glass reinforced epoxy composite	239	231.67	7.33
Stitched orientation of fiber glass reinforced epoxy composite	289	280.68	8.32

Table-4: Indicate the comparison of tensile strength of different orientations.

From the table 4, we observe that tensile strength of the specimen Stitched orientation of fiber glass reinforced epoxy composite is more when compared with the Unstitched orientation of fiber glass reinforced epoxy composite. The differences are less then 10 so values are taken as granted.

Flexural test:

The results obtained from the practical testing and ANSYS results are compared to evaluate the difference in tensile strength. Table 5 Indicate the comparison of flexural strength of different orientations.

Orientation	Flexural strength in MPa		Difference
	Practical	Analysis	
Unstitched orientation of fiber glass reinforced epoxy composite	321	315.89	5.11
Unstitched orientation of fiber glass reinforced epoxy composite	362	371.23	9.23

Table-5: Indicate the comparison of flexural strength of different orientations.

From the table 5, we observe that tensile strength of the specimen Stitched orientation of fiber glass reinforced epoxy composite is more when compared with the Unstitched orientation of fiber glass reinforced epoxy composite. The differences are less then 10 so values are taken as granted.

IX. CONCLUSION

The following are the conclusions made friom this thesis.

1. The Stitched orientation of fiber glass reinforced epoxy composite posses high tensile and flexural strength.
2. The Unstitched orientation of fiber glass reinforced epoxy composite posses less tensile and flexural strength.
3. The results obtained from the ANSYS are similar to the experimental investigation with small variations.

The Finite Element Method is an effective method for predicting the mechanical properties of composite materials. In this study, an effort was made to determine the effects of fiber orientation on the stress distribution in the composite specimen under tensile and flexural loading conditions. This was done in order to determine the angle of orientation with the least amount of equivalent stress induced. Based on the collective data,

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