

# A Study on the Effect of Various Loads on Glass Fiber Composites

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**Abstract**— Composite materials play a vital role in the aerospace and the automotive, electrical applications. New material of high strength to weight ratio in low cost is been researched. In view of this, the objective of the present work is to analyse the mechanical behaviour of glass fiber, reinforced in epoxy matrix. The composites are fabricated by using chopped strand E-glass fiber, epoxy resin and hardener. The mechanical testing such as the tensile, flexural, hardness, impact test, double shear and the drop impact test are carried out. The breakage of the fibers is studied through the inter-delamination test. The mechanical properties of the glass fiber are determined and the effect of loads on the material, stress strain behaviour of the material is studied.

**Key words:** Composite materials, E-glass fiber, inter-delamination test

## I. INTRODUCTION

Fiber reinforced polymer composites are very widely used because of their favourable properties such as high specific tensile and compressive strength, good fatigue resistance, and low coefficient of thermal expansion, controllable electrical conductivity, and suitability for the production of complex materials. These composites have become the alternative of conventional materials in many applications. Widely used areas of composite applications are aircraft fabrication, car industry, boats, ships, wind power plant, etc. The Glass Fiber Epoxy Resin Composites gave the high mechanical properties, highest tensile strength & Vickers hardness value. [1]

Literature survey indicates that very limited work has been done on mechanical behavior of Glass fiber reinforced epoxy composite. Therefore, the aim of this work is to fabricate the Glass composite using hand layup technique and to study the mechanical properties of the composites. Various other methods of fabricating the polymer matrix composites are compression molding, resin transfer molding, wet lay up (hand layup), and filament winding. Among the above mentioned techniques, Hand layup technique is selected for fabrication as it is easier, effective, economic and has good surface finish [1, 2]

## II. COMPOSITE PREPARATION

The composite material used for this study is prepared by hand layup method (Fig.1).The resin mixture is mixed with the hardener in the appropriate ratio, and applied to the milar sheet. It is followed by placing the E-glass fiber chopped strand mat (Fig.2) and final mixture is applied to the mat. Then, roller is used to eliminate air bubbles. Another milar sheet is kept on this to remove the air bubbles. The composites so prepared are cured at room temperature for 18 hours. The post curing is carried out in sun light for 4 hours and finally, the fabricated glass fiber is obtained.

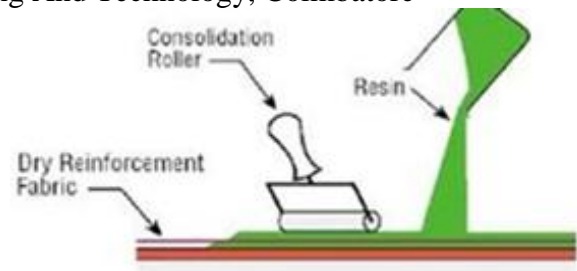


Fig. 1: Hand Lay Up Method



Fig. 2: E-Glass Chopped Strand Mat

## III. MECHANICAL TESTING

The Mechanical Testing was done at the MetMech Engineers, Chennai.

### A. Hardness Test:

The test was conducted using Rockwell L- scale, which is especially for FRP materials. The indenter was a steel ball of 1/4<sup>th</sup> inch diameter.



Fig. 3: Hardness Test Specimen



Fig. 4: Rockwell Hardness Machine

**B. Tensile Test:**

The tensile test was carried out using a universal testing machine of capacity 5 tons. The test specimen is prepared according to ASTM D638-03 standard.



Fig. 5: Tensile Specimen



Fig. 6: Tensile Testing of Glass Fiber

**C. Flexural Test:**

The flexural test is carried out using the universal testing machine of capacity 5 tons. The test specimen was prepared according to ASTM D790 standard.



Fig. 7: Flexural Specimen



Fig. 8: Flexural Testing

**D. Izod Impact Test:**

The charpy impact test, also known as the Izod v – notch test, is a standardized high strain – rate test which determines the amount of energy absorbed by a material during fracture. The test specimen was prepared according to ASTM D 256 standard.

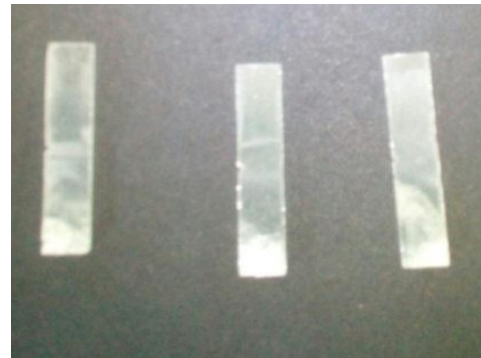


Fig. 9: Izod Specimen



Fig. 10: Izod Impact Testing

**E. Interdelamination Test:**

The interdelamination test is carried out as per ASTM 2344 standards. The delamination effect was observed through an USB Microscope.



Fig. 11: Glass fiber specimen



Fig. 12: InterDelamination setup

F. Double Shear Test:

The Double shear test was conducted in UTM machine, as per ASTM D7617 standards



Fig. 13: Specimen for Double Shear



Fig. 14: Double shear setup

G. Drop Impact Test:

The Drop Impact test was conducted by mass ball of 2.5kg, diameter 10mm. The height of the load to the specimen was 0.5 m, 0.75 m and 1 m.

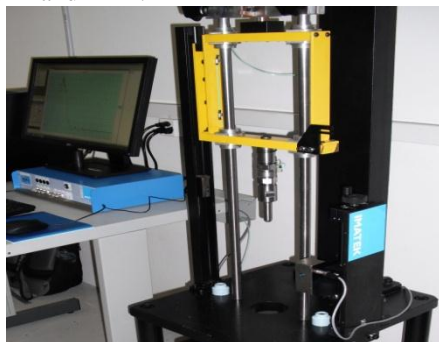


Fig. 15: Drop Impact Test

IV. RESULTS AND DISCUSSION

In Tensile test, the material is said to withstand an ultimate load of 4160N, and the tensile strength of the material is found to be 115 MPa.

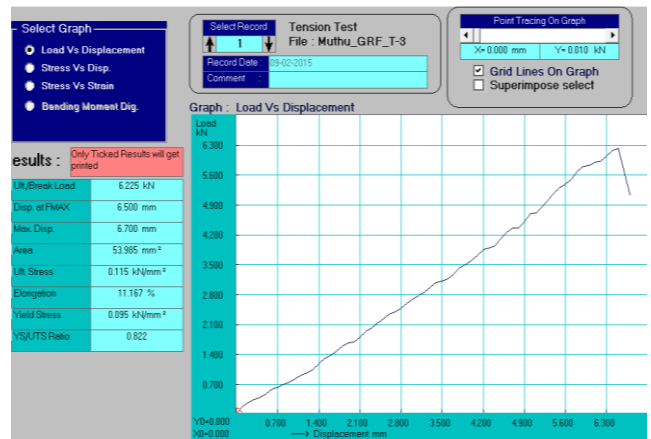


Fig. 16: Load vs Displacement Graph of Glass Fiber in Tensile Load

In flexural test, the glass fiber material is said to withstand an ultimate load of 800N and the Flexural strength of the material is 15 MPa.

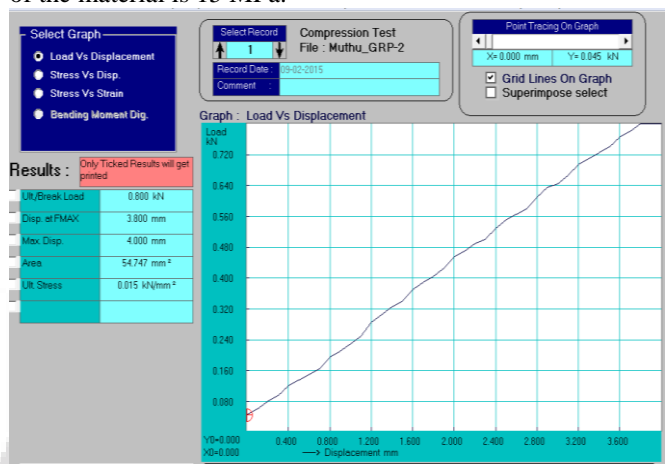


Fig. 17: Load vs Displacement Graph of Glass Fiber in Flexure Load

In the Double Shear Test, the glass fiber breaks at 2950 N load, and has an displacement of 4700mm

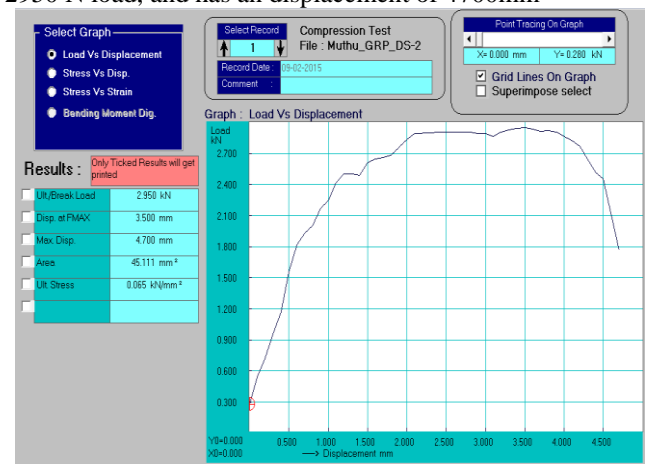


Fig. 18: Load Vs Displacement Graph of Glass Fiber in Shear Load

The breakage of laminae fibers in Interdelamination test was observed. The Glass fiber is said to have the fiber – matrix breakage. 1000 N load was applied on the material and the breakage was found to be in the load applied area.



Fig. 19: Delamination effect on the Glass fiber

In Rockwell Hardness test, The Glass fiber was found to have a hardness of 105 HR L scale and the I-ZOD Impact strength is 3.1 Joules.

In Drop Impact Test, for the various forces applied, the Impact area obtained is depicted as follows.

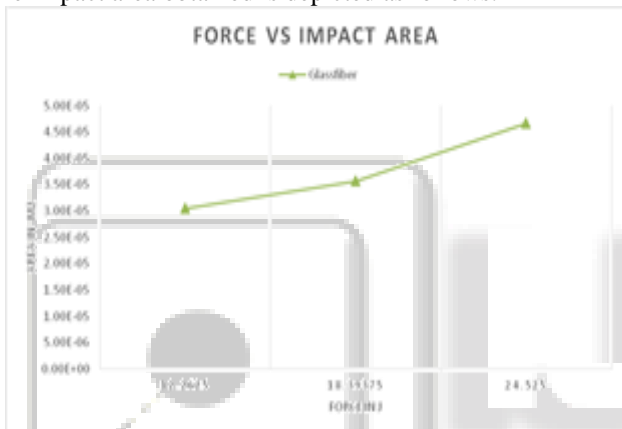


Fig. 20: Force vs Impact in Drop Impact Test

The mechanical properties, calculated from the observed results are as follows.

- Young's Modulus  $E = 10500$  MPa
- Poisson Ratio = 0.1904
- Shear Modulus  $G = 4400$  MPa

## V. CONCLUSION

In this research work, a Glass fiber composite has been fabricated by the hand layup method and the effect of various loads on the composite has been studied. The Mechanical properties such as the Young's Modulus and Poisson Ratio have been determined.

This Material is found to exhibit good tensile and flexural properties. The Breakage of the fibers has also been examined.

This Glass fiber composite can be fabricated in cheap cost and can be used for various applications.

## VI. ACKNOWLEDGMENT

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