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# Mechanical Characterization of Gloss Epoxy Composites

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***Abstract: composites are used many fields, i.e air craft structures and automobiles. Fabrication of the E-glass epoxy composite in the laminate form involves the design of the mould and the manufacturing of a composite laminate using the hand lay-up technique. The laminate is fabricated by hand lay-up method manually and then subjected to a compressive load for through distribution of resin in respective lamina, curing is done by gradual heating towards high temperature in a closed control thermal oven. Test the laminate for its flexural stress, tensile strength and hardness.***
***Now a day's lot of research is directed to understand the fatigue failure behaviour of laminated composites. In all sorts of engineering applications the material usage is increasing due to high specific strength and stiffness. Fibre reinforced composite materials are selected for critical load applications and these materials have good rating as per the fatigue is concerned. Tensile test, hardness test and flexural test were performed at different compositions of glass epoxy composites.***

***Key words: E-glass epoxy composite, Hand lay-up technique, flexural test, tensile strength and hardness.***

## I INTRODUCTION

Composite are used in board warships and submarines due to number of advantages viz. Better EMI performance, high strength to weight ratio, ability to be moulded into complex shapes, absence of corrosion palliatives which otherwise are source for electronic and magnetic signature. Composite material are made by E-Glass fibers and epoxy resins have become very popular as a radome material due to its outstanding transparency to microwave and having good mechanical properties.
Composite materials are influenced by several process due to good mechanical properties etc. Conducting the experiments on standard specimens and evaluating mechanical properties is the most important aspect in design of composite material applications. The failure mechanism of composite material is very complex compared to the conventional isotropic materials. Depending on its percentage, the reinforcement, and composition content, appropriate theory & failure mechanism can be considered for designing the air craft structure made of E-Glass epoxy composite.
The composite material consiss of two or more distinct parts. Thus a material has two or more chemically distinct constituents or phases, on a macro scale, having a distinct interface separating them, may be considered a composite material. Advanced composites, frequently referred to as modern structural composites are a blend of two or more components, one of which is made up of stiff, long fibers, and the other, a binder or matrix which holds the fibers in place. The matrix and fibers are generally orthotropic (having different properties in two different directions). The fiber, for modern structural composites, is long, with aspect ratio (length to diameter ratios) of over 100.

## II MANUFACTURING PROCESS OF THE COMPOSITE LAMINATE

### A. MATERIAL REQUIRED:

The different materials and components required for this manufacturing process

Table 1: Different Materials and quantity

| S.No. | Materials | Quantity |
|---|---|---|
| 1 | Glass fiber(mat form) | 500gm |
| 2 | Glass fiber(cloth form) | 500gm |
| 3 | Epoxy resin LY-556 | 2 Lit |
| 4 | Hardener HY-556 | 250ml |
| 5 | Poly vinyl alchohol | 500ml |
| 6 | Glass mould (160x160x3)mm | 10 |
| 7 | Plain glass (200x200x3)mm | 10 |
| 8 | Wax polish | 50gm |
| 9 | OHP sheets | 50 |

| | | |
|---|---|---|
| 10 | Measuring jar | 2 |
| 11 | Stirring rod | 2 |
| 12 | Gloves | 4 |
| 13 | knife | 2 |
| 14 | Hot iron oven | 1 |
| 15 | Weighing Instrument | 1 |
| 16 | Brick | 30 |
| 17 | scissors | 2 |

### B. DETERMINATION OF REQUIRED EPOXY RESIN AND GLASS FIBER

Generally for measuring for the required amount of materials for manufacturing composite laminate, we require an electronic weighing machine which measures exactly in gms. In this project we are using five different ratios of glass fiber to epoxy resin.

Table 2.2 ratios of glass fiber to epoxy resin

| S.No. | Ratio of glass fiber | Ratio of epoxy resin |
|---|---|---|
| 1 | 0% | 100% |
| 2 | 20% | 80% |
| 3 | 40% | 60% |
| 4 | 60% | 40% |
| 5 | 80% | 20% |
| 6 | 100% | 0% |

For determining the exact weight of the material, we need to find out the density of the glass fiber. Density formulae can be given as
d = m/v,
where d= density, m= mass, v= volume, mass = density x volume = 1.45x76.8 = 111.36gm

### C. ESTIMATION OF WEIGHTS

Table 2.3 Estimation of weights

| Composite ratios | Glass fiber(gm) | Epoxy (ml) |
|---|---|---|
| 100% pure epoxy | 0 | 500 |
| 20% glass fiber,80% pure epoxy | 22.4 | 400 |
| 40% glass fiber,60% pure epoxy | 44.48 | 300 |
| 60% glass fiber,40% pure epoxy | 66.64 | 200 |
| 80% glass fiber,20% pure epoxy | 88.86 | 100 |

## III PREPARATION OF MOULD

For making the test specimen different sample plates were prepared for tensile test and density of the glass mould of dimensions 200x200x3mm thick plate were cut and a mould cavity 160x160x3mm is made by fixing 3mm thick glass plates of width 20mm and thickness 3mm on four sid.es of the plate using araldite. The mould was cured in the furnace at temperature of $50^0$C for about 5 hours and for making sample plates in each test.

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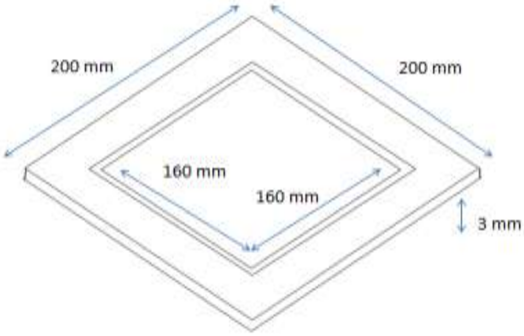


Fig: 2.1 Glass mould to prepare composite material

## IV CUTTING GLASS FIBER

Glasss fiber must be cut into several layers each of dimensions 160x160 so that it will exact fit in to the glass mould. Normal scissors can be used to cut the glass fiber and weight can be measured by electronic weighing machine.

Fig: 2.2 cutting of glass fiber

## V PREPARING THE MOULD

Before final lay-up of composite material, the glass mould must be kept in oven for 30 minutes at $50^0$C. After that the glass mould must be removed and wax must be applied. Wax must be applied uniformly all over the mould and the wax must be applied thoroughly along the four edges. Wax helps in easy removal of composite material and prevents it from striking to the mould.

Fig: 2.3 applying Wax to the mould

## VI FINAL CURED STAGE

This is a stage at which the best physical properties of any moulding are developed. Once the material formed, it is kept in oven for about 4 hours under temperature of $100^0$C. this stage can be recognised by knocking the mould on the floor. If a metallic sound is heard the final cured stage has been attained. The material ready to be tested.

Fig:2.4 Glass epoxy laminate

## VII TESTING OF SPECIMEN

Specimen used for testing should be cut into three different shapes for different test. For tensile test it should be in dimension of 120x25x3. For Impact test it should be in dimension of 100x20X3mm.For Flexural test it should be in dimension of 100x25x3mm.

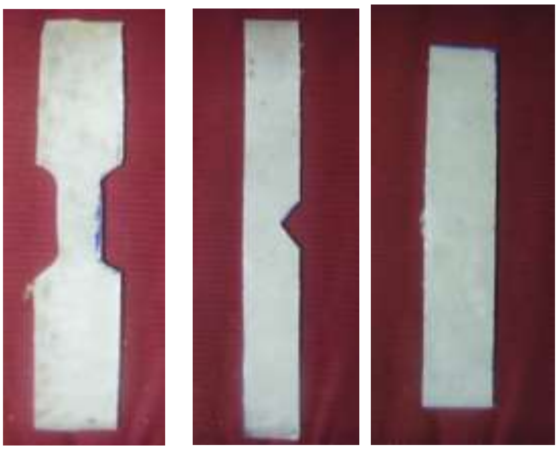

Fig:2.5 Specimen for Tensile, Impact, Flexural tests

## VIII RESULTS AND DISCUSSIONS

### A. TENSILE TEST

The tensile strength for the composite material with different blending compositions of epoxy resin and glass fibers are presented in table 6.1 tensile strength was calculated using the equation

$$S= F/A$$

Where

S= the breading strength (stress)

F= the force applied that caused the failure

A= the lease cross-sectional area of the material

Table 3.1 Tensile test

| % WEIGHT FRACTION OF COMPOSITES | | TENSILE STRENGTH ($N/mm^2$) |
|---|---|---|
| GLASS | EPOXY | |
| 0 | 100 | 22.03 |
| 20 | 80 | 83.54 |
| 40 | 60 | 95.65 |
| 60 | 40 | 110.35 |
| 80 | 20 | 135.01 |
| 100 | 0 | 146.35 |

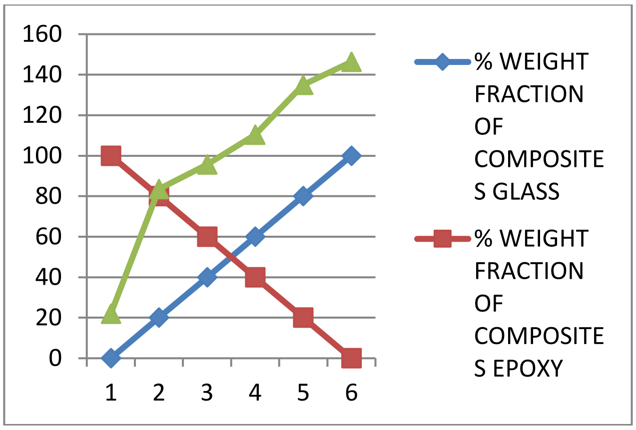


Fig:3.1 Tensile strength

### B. IMPACT TEST

The impact load at break for a composite with different blending compositions of epoxy resin and glass fibers are presented in table 6.2 the impact strength was calculated using the equation. Izod impact test is conducted on the composite materials and the impact strength on the composite material is calculated.

Impact strength = Impact energy (J)

### C. FLEXURAL TEST

The flexural load at break for a composite with different blending compositions of epoxy resin and glass fibers are presented in table 6.3 the flexural strength was calculated using the equation.

$$\text{Flexural Strength} = \frac{3PL}{2bd^2}$$

Where P = Load applied (kgs)
L= Span length of beam (mm)
B= Widthe of Specimen
D= Depth (Thickness of specimen)

Where : b and d are the width and thickness of the test specimen in mm respectively.

| % WEIGHT FRACTION OF COMPOSITES | | IMPACT STRENGTH (J/M) |
|---|---|---|
| GLASS | EPOXY | |
| 0 | 100 | 46.38 |
| 20 | 80 | 165.04 |
| 40 | 60 | 220.35 |
| 60 | 40 | 330.14 |
| 80 | 20 | 401.43 |
| 100 | 0 | 526.99 |

Table 3.2 Impact test

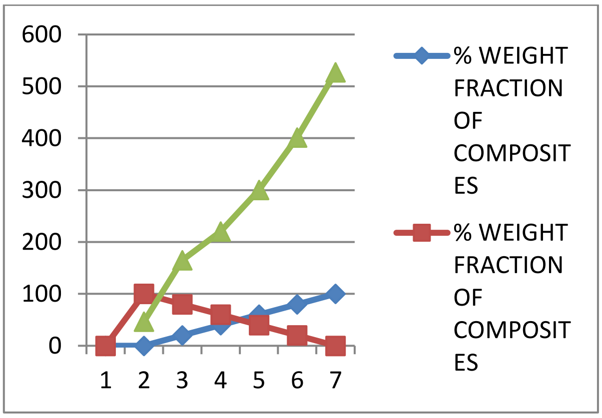

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Fig:3.2 Impact strength

Table 3.3 Flexural test

| % WEIGHT FRACTION OF COMPOSITES | | FLEXURAL STRENGTH |
|---|---|---|
| GLASS | EPOXY | |
| 0 | 100 | 16.12 |
| 20 | 80 | 60.13 |
| 40 | 60 | 76.13 |
| 60 | 40 | 82.45 |
| 80 | 20 | 96.15 |
| 100 | 0 | 116.40 |

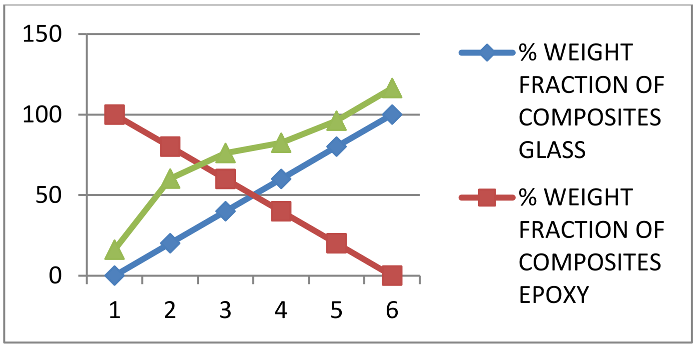


Fig 3.3 Flexural Strength

## IX. CONCLUSIONS

1. From Tensile strength table we conclude that the composite material shows higher tensile strength with the percentage increase in glass fibre. The material with low percentage of glass fibre and high percentage of epoxy has less tensile strength. And the material with high percentage of glass fibre and low percentage of epoxy has high tensile strength.

2. From impact test table we conclude that the composite material with the higher percentage of glass fiber shows high impact strength. The material with low percentage of glass fibre and high percentage of epoxy has less impact strength. And the material with high percentage of glass fibre and low percentage of epoxy has high impact strength.

3. From flexural test table we conclude that the composite material with the higher percentage of glass fibre shows high flexural strength. The material with low percentage of glass fibre and high percentage of epoxy has less flexural strength. And the material with high percentage of glass fibre and low percentage of epoxy has high flexural strength.

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