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MECHANICAL CHARACTERIZATION OF CARBON FIBER/EPOXY COMPOSITES WITH VARIABLE VOLUME FRACTION

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Abstract: Substituting composite structures for conventional metallic structures has many advantages because of higher specific stiffness and strength of composite materials. In the recent days, there is a huge demand for a light weight material such as fibre reinforced polymer composites seems to be a promising solution to this arising demand. These materials have gained attention due to their applications in the field of automotive, aerospace, sports goods, medicines and household appliances. This work focus on mechanical characteristics of carbon epoxy material with volume fraction 0.4, 0.5, 0.6 etc., so that recommendation of carbon fibre for various applications will be possible as per its strength.

Keywords: composite material, volume fraction, conventional structure, household appliances.

I. INTRODUCTION

Historically, technical developments have centre around two main areas, firstly the development of more powerful and efficiently energy sources and secondly to obtain maximum possible motive power from the available energy. The second development is heavily dependent on the properties of engineering materials. In aircraft and aerospace industries, a union of opposites i.e., lightweight in combination with high stiffness is demanded. In pressure vessels technology, high strength and corrosion resistance are both prerequisites for efficient operation. Whenever, a designer faces such situations composite materials provide an efficient solution to such problems. The flexibility that can be achieved with composite materials is immense. Merely by changing the composition variety of properties can be altered thus making the composites versatile and reliable substitutes for the conventional structural materials.properties.

II. EXPERIMENTAL WORK

2.1 Selection of Material

In this study, composite material is made up by carbon fiber and epoxy resin with different volume fraction. The biggest advantage of modern composite material is that they are light as well as more in strength.

The strength-weight ratio of composite material is high. By choosing an appropriate combination of matrix and reinforcement or fiber material, a new material can be made that exactly meets the requirements of a particular application.

The new material produced is totally different from base metal and its properties are different .The composite material has orthographic structure. Hence its properties are different in all directions.

a) Matrix Material

Epoxy resin 520 and Epoxy hardener is used or manufacturing.

The epoxy resin and epoxy hardener were mixed in the ratio of 10:1 by the weight as suggested.

The epoxy resin has the density of 1.22 g/cc. Epoxy resin and hardener mixture was stirred thoroughly before fiber mats were introduced in the matrix material.

Each laminate was cured under constant pressure near about 24hr in the mold and further cured at room temperature at least 12 hrs.

b) Fiber Material:

The fibers of carbon with 300 GSM are selected as it has optimum properties.

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Fig 1: Fiber Material

2.2 Fabrication of FRP composite:

There are three types of FRP composite with different volume fraction are fabricated using hand lay-up method. The designation of composites A, B and C indicate 40:60, 50:50 and 60:40 respectively by volume fraction. The size of laminate is 300×300×3mm.

2.3 Fabrication Procedure

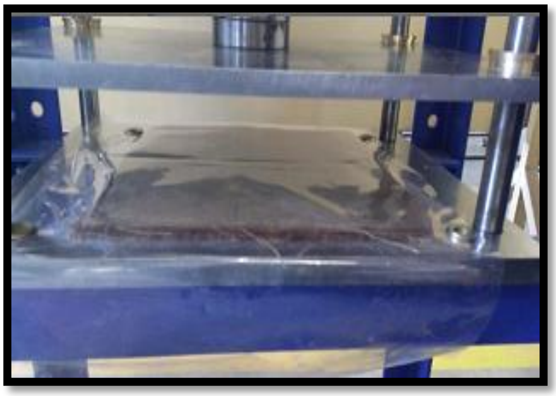

Fig 2: Hand layup process

In this study hand layup process chosen for manufacturing of laminates. The detailed procedure is explained below-

1. Place the wooden plate on the plane surface.
2. Prepare the mixture of epoxy and hardener with 10:1 ratio.
3. Apply the mixture of epoxy and hardener on the wooden plate.
4. Calculate the weight of fibre particular volume fraction.
5. Place the first sheet of fiber at angle of 45º and subsequent apply epoxy this process continues till required thickness maintains.
6. Place the supporting plates on each side of the laminate for maintaining the thickness.
7. Apply external pressure to remove the excessive epoxy resin.
8. Curing for 6 to 8 hours.
9. Cut the excess material.

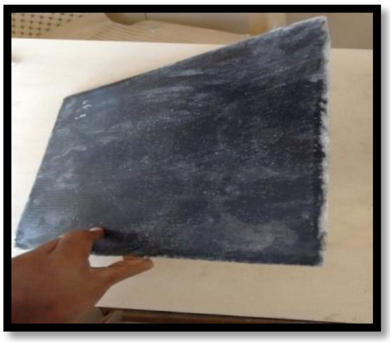

Fig 3: Specimens for tensile test

Table 1. Composition of Sample

Sample ID	Carbon Fibre (%)	Epoxy Resins (%)
A	40	60
B	50	50
C	60	40

III. TESTING

1. Tensile Testing

The specimen is prepared according to the ASTM D732-2010 standard. The testing is carried out in tensile testing machine with displacement velocity at 1.5 mm/min. The gauge length for testing specimen is 200 mm. Initially the breadth and width of specimen is observed and the area of cross section is calculated. The output result is a stress strain curve, from this the ultimate stress, elongation percentage, yields stress and break load is calculated. Two specimens are tested for each fiber resin composition ratio.

Fig 4: Tensile Testing

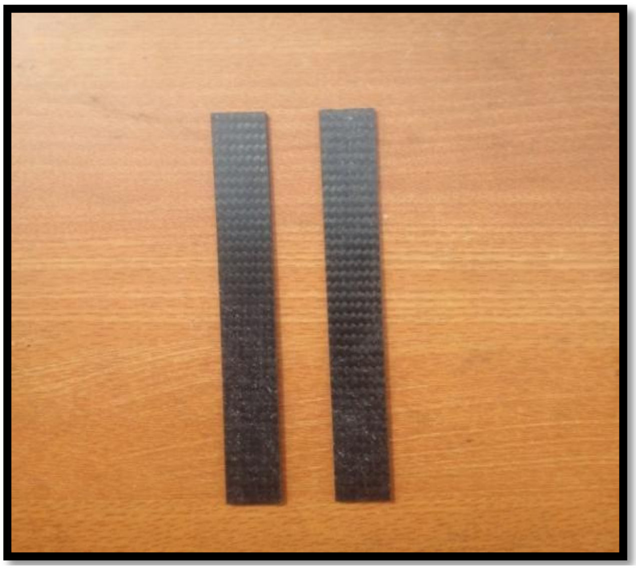

Fig 5: Specimens for tensile test

2. Shear testing

The specimen is prepared according to the ASTM D732-2010 standard. The testing is carried out in universal testing machine. This test is carried out to determine the shear strength of material as it is an important parameter while selecting the composite for application.

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Fig 6: Specimens for shear test

Table 2: Results of Experimental Testing

Test		Tensile Strength (MPa)	Shear Strength (MPa)
A	L	400.72	77.19
	T	377.30	52.60
B	L	336.34	72.06
	T	394.84	75.08
C	L	273.10	76.80
	T	340.62	72.70

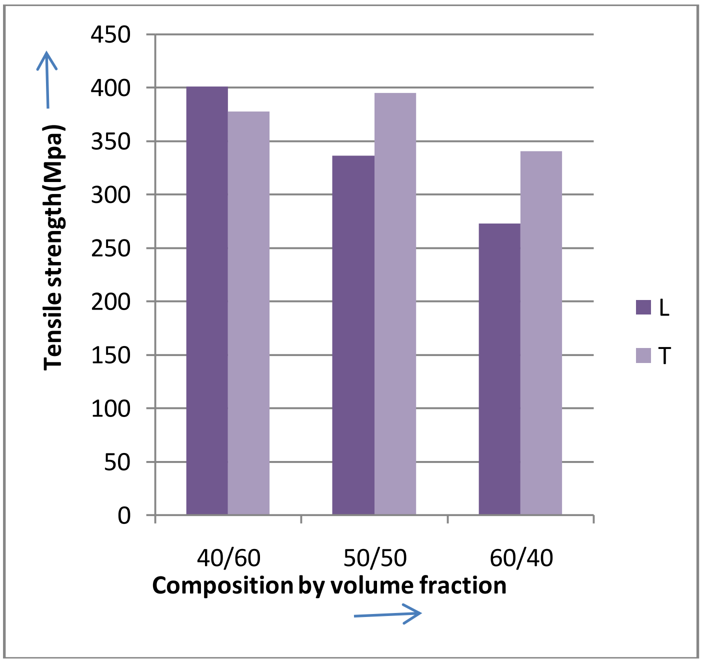

Fig: (a) comparison of Tensile Strength

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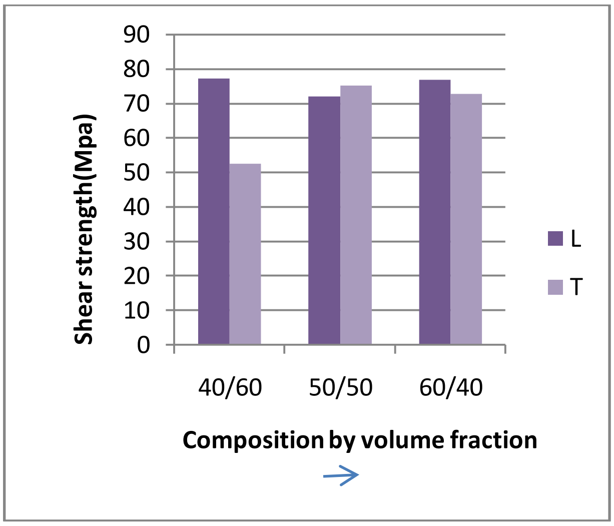

Fig: (b) comparison of Shear Strength

IV. CONCLUSION

With the help of this work it has been found that composite material with optimum strength for practical use. It also comes to know that increase in fiber content increases mechanical properties but increases brittleness. It is also observed that the material with 0.5 volume fraction is good for application.

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