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EXPERIMENTAL INVESTIGATION of MECHANICAL PROPERTIES of GLASS FIBER/EPOXY COMPOSITES WITH VARIABLE VOLUME FRACTION

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Abstract: This study deals with the experimental investigation of mechanical properties of glass fiber/epoxy composite material with variation in volume fraction of fiber in the composites. For manufacturing of composites combined hand layup and compression molding methods are used. The volume fraction of fiber is maintained about 40%, 50% & 60% in the total composition. With the help of experimental testing the mechanical properties such as tensile strength, shear strength. The results shows better mechanical properties with 50% of Volume fraction, however further increase in fiber content increases mechanical properties but composites starts delaminating. So at the end we got the material with 50:50 compositions is better for application with optimum strength.

Keywords: composite materials, Volume Fraction, Mechanical properties, Delamination.

I. INTRODUCTION

Development of new composite materials or modification of existing composite material is the real challenge for most of the material engineers. Epoxy base matrix composite has high strength and Specific properties. This modification can be done by variation of different volume fraction of glass fiber to achieve the required mechanical properties. Suresh kumar.P et al. (2014) the glass fiber reinforced polyurethane composite is prepared and the Tensile, Flexural and Impact Strengths are analyzed. The composites were manufactured at various ratios such as 30:70, 35:65, and 40:60 (Fiber: Resin). McGrath et al. (2008) studied the effect of alumina powder in epoxy on mechanical properties. They found that there is a little effect on change in particle size, shape and size distribution on final properties. Patil Deogonda et.al. (2013) described development and mechanical characterization of new polymer composites consisting of glass fiber reinforcement, epoxy resin and filler materials such as ZnS. The newly developed composites are characterized for their mechanical properties.

Ramesh K. Nayak et al.(2014) In this paper we have modified the epoxy matrix by Al2O3, SiO2 and TiO2 micro particles in glass fiber/epoxy composite to improve the mechanical properties. A. Pegoretti et.al.(2001) worked the mechanical response to external applied loads of a new glass fiber reinforced endodontic post is simulated by finite element (FE) analysis of a bi dimensional model. Prashanth Banakar et.al. The objective of their research was to gain a better understanding of tensile properties of epoxy resin composites reinforced with glass fiber. The effect of fiber orientation & thickness of laminates has been investigated & experimentation was performed to determine property data for material specifications, the laminates were obtained by hand layup process. Zhao et al. (2008) studied the mechanism leading to improved mechanical performance in nanoscale alumina filled epoxy. In their observation it is found that the improvement of the tensile strength is because of stronger interface lead to crack deflection and micro cracking. It is observed from literature that there is a significant improvement on mechanical properties with epoxy matrix modification. So we are decided to do work on composite material by changing volume fraction for obtaining best desirable mechanical properties.

II. EXPERIMENTAL WORK

2.1 Selection of Material

In our study, composite material is made up by glass 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-PAM. 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. The Epoxy Resin-520 and Epoxy hardener-PAM were mixed in the ratio of 10:1 by weight as suggested. 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:

E- Glass fiber with composition 54% SiO_2-15%Al_2O_3-12%CaO is used. The symbol E shows it is used in electrical application also. The fibers of glass with 300 GSM is selected as it has optimum properties with less brittleness.

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

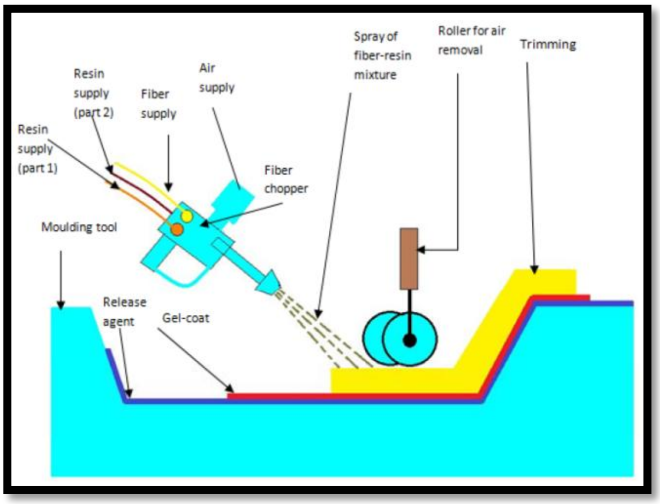

Fig 1: Hand layup process

We have chosen hand layup process 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.

Table 1. Composition of Sample

Sample ID	Volume Fraction of Glass Fibre (%)	Volume Fraction of 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 2: Tensile Testing Machine

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.

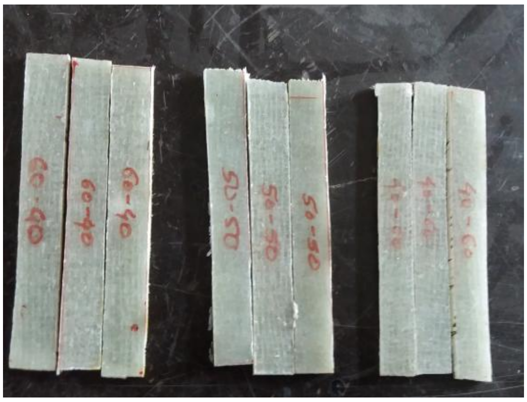

Fig 3: Specimens for test

Table 2: Results of Experimental Testing

Test		Tensile (MPa)	Shear (MPa)
A	L	196.8	73.3
	T	229.2	81.1
B	L	209.1	89.8
	T	209.7	103.4
C	L	194.8	111.7
	T	191.1	122.5

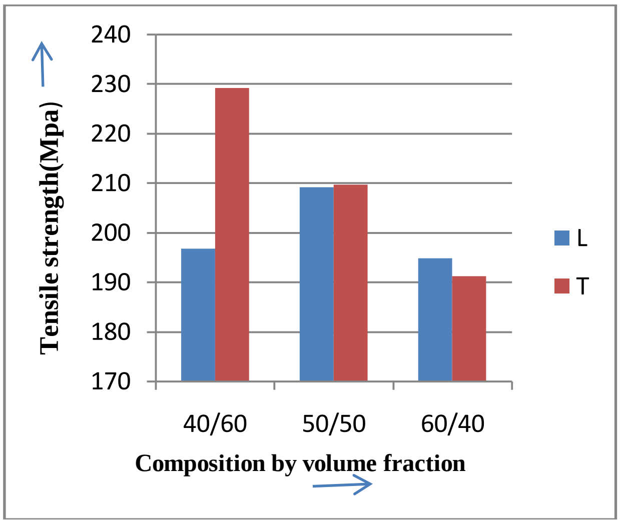

Fig: (a) comparison of Tensile Strength

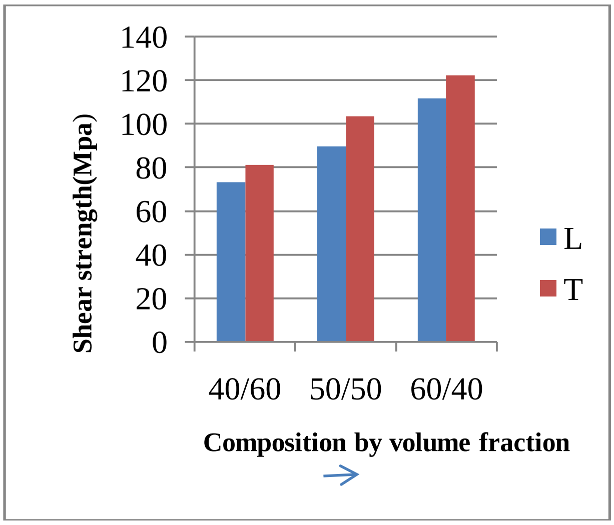

Fig: (b) comparison of Shear Strength

IV. CONCLUSION

With the help of this work we found out composite material with optimum strength for practical use. We also come to know that increase in fiber content increases mechanical properties but increases brittleness and start delaminating. The material with 50:50 compositions is good for application as it has optimum properties with less brittleness.

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