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COMPARATIVE STUDY ON TENSILE BEHAVIOUR OF E-GLASS (WOVEN & CHOPPED) FIBRE REINFORCED WITH EPOXY COMPOSITES

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ABSTRACT
Composite materials play a vital role in many industrial applications. Researchers are working on fabrication of new composite materials worldwide to enhance the applicability of these materials. In view of this, the objective of the present work is to analyse the effect of varying thickness on the mechanical behaviour of chopped strand mat E-glass fiber, woven E-glass fiber reinforced in epoxy matrix. Three different thicknesses (3mm, 6mm, and 9mm) of composites are fabricated using fiber, epoxy resin and hardener. The epoxy resin and hardener are mixed in 10:1 weight ratio. The results of the study show that the varying of thickness has decrease tensile strength and also decrease the effect on the mechanical behaviour of composites.

Keywords: GFRP, woven fibre, chopped fibre, tensile behavior.

INTRODUCTION
A composite material is made by combining two or more dissimilar materials. They are combined in such a way that the resulting composite materials possess superior properties, which are not obtainable with a single constituent material [1]. The most common synthetic composite material is glass fibre reinforced plastics (GFRP) which is made out of plastics and glass fibre [1, 2]. Since then, there has been tremendous development in terms of new reinforcement materials, matrix materials and production methods. Fibre reinforced plastics (FRP), particular glass fibre reinforced Plastics are meeting the demanding techno-economic requirements of various industries as can be seen [1].The individual components have altogether different properties to that of the composite material, GFRP. Plastics are light, durable, have excellent corrosion resistance and can be easily moulded to any complex shape. But they are not fit for load-bearing applications because of lack of strength, stiffness and dimensional stability. Glass fibre, on the other hand, possesses very high strength and is sufficiently stiff and durable. Like plastics, it also cannot be used for loadbearing applications because of its brittleness and fibrous structure. But when both of these are combined in the correct proportions and a particular glass fibre arrangement, we obtain GFRP which has the improved mechanical and other properties suitable for loadbearing applications [1, 2-4].

MATERIALS AND METHOD

A. Fabrication of E-glass epoxy composites
The main materials used are, Epoxy resin (araldite GY250), Glass fiber (360 gsm woven & 200 gsm chopped). Epoxy is the cured end product of epoxy resins, as well as a colloquial name for the epoxide functional group. Epoxy resins, also known as polyepoxides are a class of reactive prepolymers and polymers which contain epoxide groups. Epoxy resins may be reacted either with themselves through catalytic homopolymerisation, or with a wide range of co-reactants including polyfunctional amines, acids. These co reactants are often referred to as hardeners or curatives, and the cross-linking reaction is commonly referred to as curing .Glass fiber is a material consisting of numerous extremely fine fibers of glass. It is most commonly used as reinforcement material because of is exceptional properties. Although not as strong or as rigid as carbon fiber, it is much

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cheaper and significantly less brittle. The die arrangement for preparing composites and pressing arrangements are shown in Fig1and fig 2.

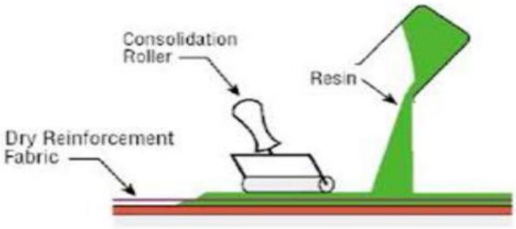

Fig .1- hand lay up method

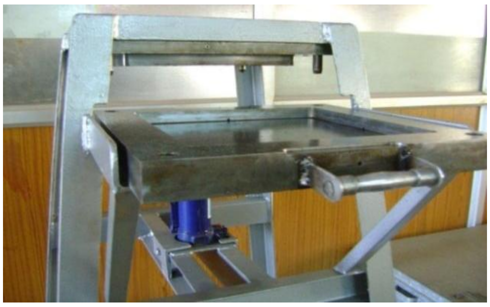

Fig 2.Die used for preparing specimens

The volume fraction of the fibre and resin taken is (60:40%), as per the calculations no. of layers of 250x250 sized glass fiber was cut. The required amount of Epoxy resin was weighed. The hardener of 1% was mixed and thoroughly stirred. By using Hand layup technique the glass fiber along with resin was compressed and cured in the die for 24hours. And the specimens were prepared by varying thickness (3, 6, 9 mm); Fig 3 represents the compressed specimens of prepared composites respectively.

Fig 3. Woven Chopped

The specimens were cut from the plates of 250x250 mm for the tensile test according to the ASTM standards. Shown in fig 4.

Fig 4:Chopped Woven

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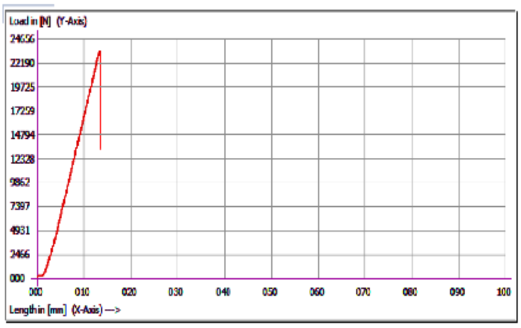
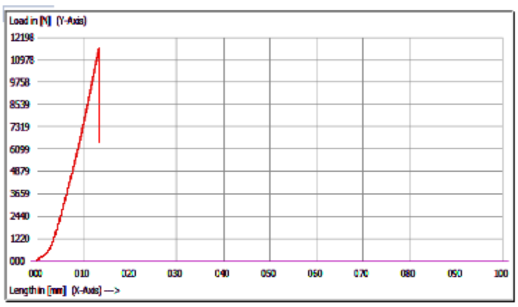
Fig 5: UTM Machine (three point bend test)



Graph 1;Tensile test load v/s deflection(woven)



Graph 2;Tensile test load v/s deflection(woven)

B. Standard specimen size

The mechanical tests were carried out in a Universal testing machine. The Universal testing machine is a highly accurate instrument. It comprises of a standing frame designed for testing in either tension or compression and a microprocessor based console. The frame has a maximum load capacity of 100kN. A moving crosshead can be operated on the frame through two vertical ball screws in a drive system with positional electronic control servo mechanism. At least 3 specimens were tested for each thickness of laminate. The crosshead speed was maintained at 1mm/min.

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C. Tensile Testing

Mechanical characterization of composite materials is a complex scenario to deal with, either because of the infinite number of combinations of fiber and matrix that can be used, or because of the enormous variety of spatial arrangements of the fibers and their volume content. The foundation of the testing methods for the measurement of mechanical properties [6] is the classical lamination theory; this theory was developed during the nineteenth century for homogeneous isotropic materials and only later extended to accommodate features enhanced by fiber-reinforced material, such as inhomogeneity, anisotropy, and elasticity. Two basic approaches are proposed to determine the mechanical properties of composite materials: constituent testing and composite sample testing.

Table 1: Indicates the details of breaking load, Maximum displacement

Material	Maximum load (N)	Maximum displacement (mm) Average	Tensile Strength (MPA)
3mm thick woven	24451.984	14.5	543.376
6mm thick woven	33716.254	18	374.624
9mm thick woven	37865.433	17.5	280.488
3mm thick chopped	12926.088	13.5	287.247
6mm thick chopped	14117.424	9.8	156.862
9mm thick chopped	28376.298	15.5	210.199

RESULTS & DISCUSSIONS

The fabrication details of laminated Composite specimens with three different thicknesses such as 3 mm, 6 mm & 9 mm using woven & chopped glass carried out successfully. Simple Digital tensile test System is utilized to determine tensile parameters such as tensile stiffness, & Strength for composite specimens. Tensile parameters of laminated Composites were tested and results tabulated for various variation of sample thickness as per tests recommended by ASTM standards. Graph 1 and 2 describes typical tensile load vs. deflection of woven and chopped specimens (only 2 sample graphs have been indicated). Curves for both specimens show linear behavior until failure. Curves show inflection at the point of yielding in both cases; tensile strength and tensile stiffness have been recorded. It can be observed from table 1, that increase in the thickness of specimen for both woven and chopped specimens there is significant decrease in the strength as well as stiffness values. However, the increase in strength and stiffness in case of woven seems to be more significant as compared to chopped fibers. Finally we observe, though glass/epoxy (woven) with 3mm thickness have higher strength, stiffness and load carrying capacity than any other thickness. Hence, it is suggested that woven fiber is preferred for designing of structures like which is more beneficial for sectors like, Aerospace, auto motives, marine, space etc.

CONCLUSION

Tensile tests were performed on Glass fiber (360 gsm woven & 200 gsm chopped) lay-up composite specimens. The load-deflection curve was evaluated. Two types of laminates were tested with three different thicknesses. The main findings of the present investigation are as follows:

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1. Effect of thickness on tensile strength and stiffness seems to play a vital role in assessing material behaviour under tensile loading conditions.
2. Experiments were conducted on Glass/Epoxy laminate composite specimens with varying fiber orientation to evaluate the tensile properties.
3. It is observed from the result that glass/Epoxy with woven fiber with 3mm thickness Yields' high strength when compare to 6mm & 9mm.
4. It is observed from the results, compare to choppe fiber woven glass fiber/Epoxy composites yields high strength.

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