"INVESTIGATION OF MECHANICAL PROPERTIES OF GLASS FIBER REINFORCEMENT COMPOSITE MATERIAL FOR NAVAL APPLICATIONS"

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Abstract – This paper constitutes the study and manufacturing of fiberglass composite laminates of 3mm thickness consisting of woven type fiber glass with Epoxy resin LY556, hardener HY951 and additives (silicon carbide, calcium sulphate) in different mixtures by vacuum bag method for the application of "boat hull". This project is to overcome the problems with the material used for boat hull. To reduce density, increase toughness, build up corrosion resistance property, increase wear resistance property and to reduce moisture absorption rate of the material. Test specimens were prepared as per ASTM standards and analysis were performed by Wear test, moisture absorption test in normal and sea water, Rockwell hardness test and Tensile test.

Index Terms- composite, glass fiber, Epoxy, Silicon Carbide, Calcium Sulphate, Wear, Moisture absorption, Hardness, Tensile

1. Introduction

A composite material is a material made from two or more constituent materials with significantly different physical or chemical properties that, when combined, produce a material with characteristics different from the individual components. The individual components remain separate and distinct within the finished structure, differentiating composites from mixtures and solid solutions. The new material may be preferred for many reasons: common examples include materials which are stronger, lighter, or less expensive when compared to traditional materials. Composite materials are generally used for buildings, bridges and structures such as boat hulls, swimming pool panels, racing car bodies, bathtubs, and storage tanks. Constituents are Filler matrix (Epoxy resin), Fiber (Glass fiber), Additive / material (Silicon carbide). The matrix binds the fiber reinforcement, gives the composite component its shape and determines its surface quality. The matrix used is Epoxy resin LY 556. Fiber adds rigidity, high strength and impedes crack propagation. Glass fiber used is E-glass.

2. Material used and composition

Woven shape fiberglass of 0.28mm thickness used as reinforcement, Epoxy resin LY556 used as matrix, Hardener HY951, Silicon Carbide and Calcium Sulphate are used as additives.

Table 1: Composition of materials

Glass fiber	Epoxy resin with 10% hardener	Silicon carbide	Calcium sulphate
50%	50%	0	0
50%	35%	7.5%	7.5%
50%	35%	10%	5%

3. Objectives

- To investigate and compare the moisture absorption rate of all the three laminates in normal and sea water.
- To investigate and compare the wear property of all the three laminates at different load and different speed.
- To perform Rockwell hardness test on all three specimens.
- To perform and investigate tensile properties of all three specimens.

4. Experimental work

The method used for manufacturing composite laminate is vaccum bag method. Size of composite laminate 500 mm * 500 mm and 3 mm thickness. Three laminates are prepared as per the composition provided in table 1. The laminates are cut into specimens as per the ASTM standards. Different tests are conducted like Moisture absorption, tensile test, Rockwell hardness test, Wear test.

Table2. Standards for specimens.

Test	Size (mm)	Standard
Moisture absorption	75*25*3	ISO
Tensile	250*25*3	ASTM3039
Rockwell hardness	30*30*3	_
Wear	50*5*3	ASTM G99

4.1 Moisture absorption test

Three specimens from each laminate is taken and weighed initially. Dipping them into sea water and normal water separately, weighing at equal interval of time to get moisture absorption rate. Plotting graph weight vs time and comparing moisture absorption rate of each specimen.

4.2 Tensile test

Material strength testing, using the tensile or tension test method involves applying an ever-increasing load to a test sample up to the point of failure using UTM (Universal testing Machine). The process creates a load/cross-head travel curve showing how the material reacts throughout the tensile test. The data generated during tensile testing is used to determine mechanical properties of materials and provides the quantitative measurements. Tensile strength also known as ultimate tensile strength (UTS), is the maximum tensile stress carried by the specimen defined as the maximum load divided by the original cross-sectional area of the test sample.

4.3 Rockwell hardness test

Specimens are tested in Rockwell hardness tester. Ball indenter of (1/16) inches diameter is used for indenting the specimen at 100kgf load and hardness number is found. Finally comparing the hardness property of all three specimens.

4.4 Wear test

The machine used for wear test is pin-on-disk wear testing machine. Specimen is fit into the machine and required input data is provided. Load and speed information is fed into the computer. Machine starts and readings are displayed on the computer screen. Finally results are recorded and comparing the hardness property of all three specimens.

5. Results and discussion

The results and discussion of composite laminates are discussed below

5.1 Moisture absorption test

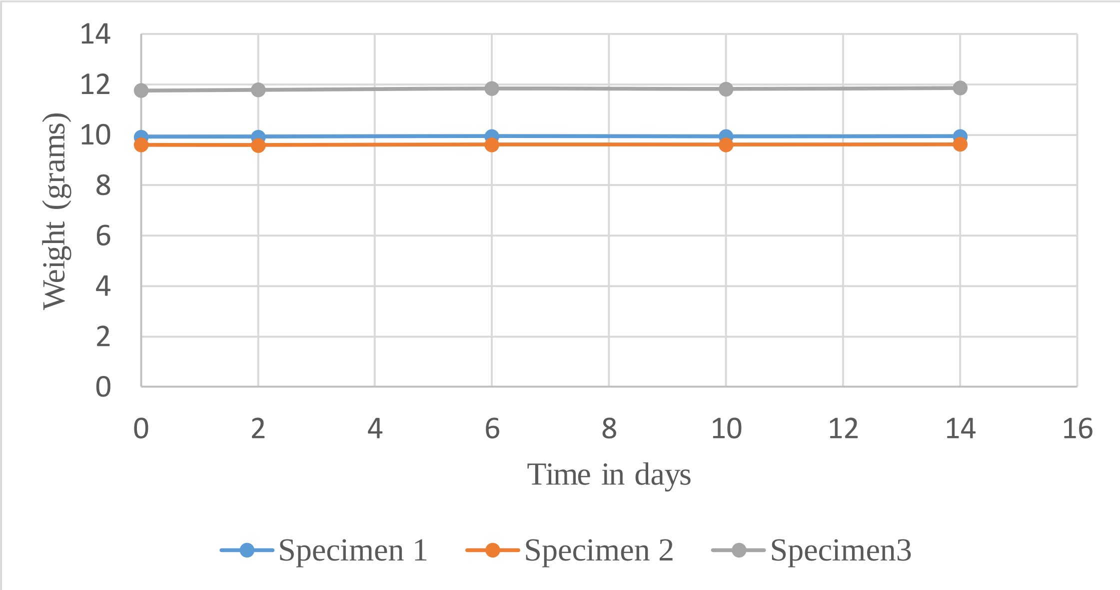

Figure 5.1a: Graph for water absorption in normal water (weight vs time)

Figure 5.1a shows graph for water absorption in normal water, straight or linear lines for each specimen shows very little amount of water absorbed by each specimen.

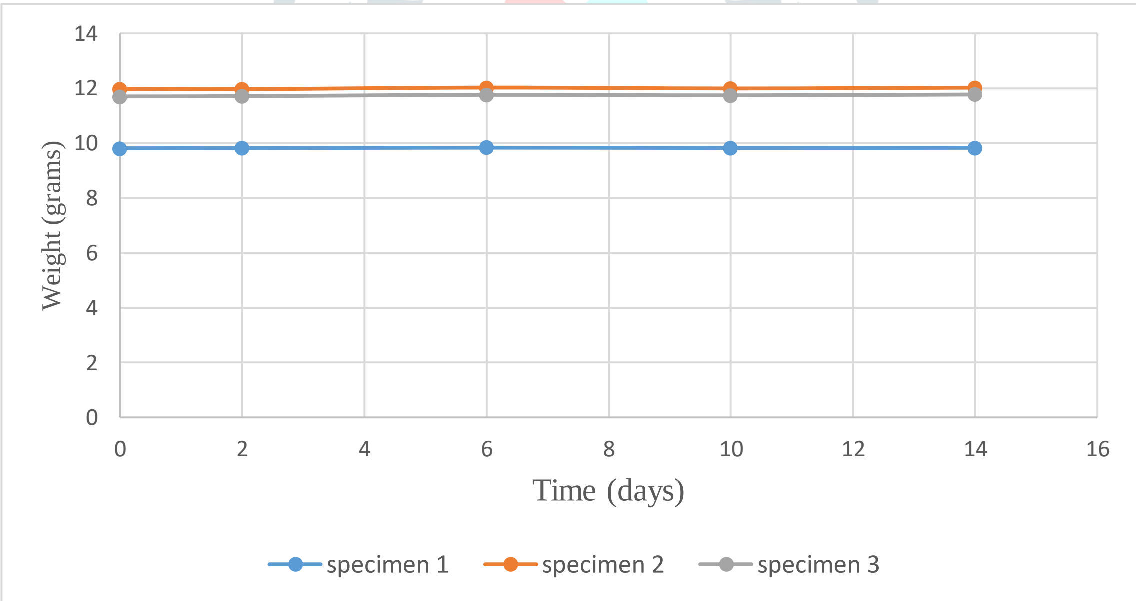

Figure 5.1b: Graph for water absorption in sea water (weight vs time)

Figure 5.1b shows graph for water absorption in sea water, Linear lines for each specimen says that there is very little amount of water absorbed by each specimen.

5.2 Tensile test

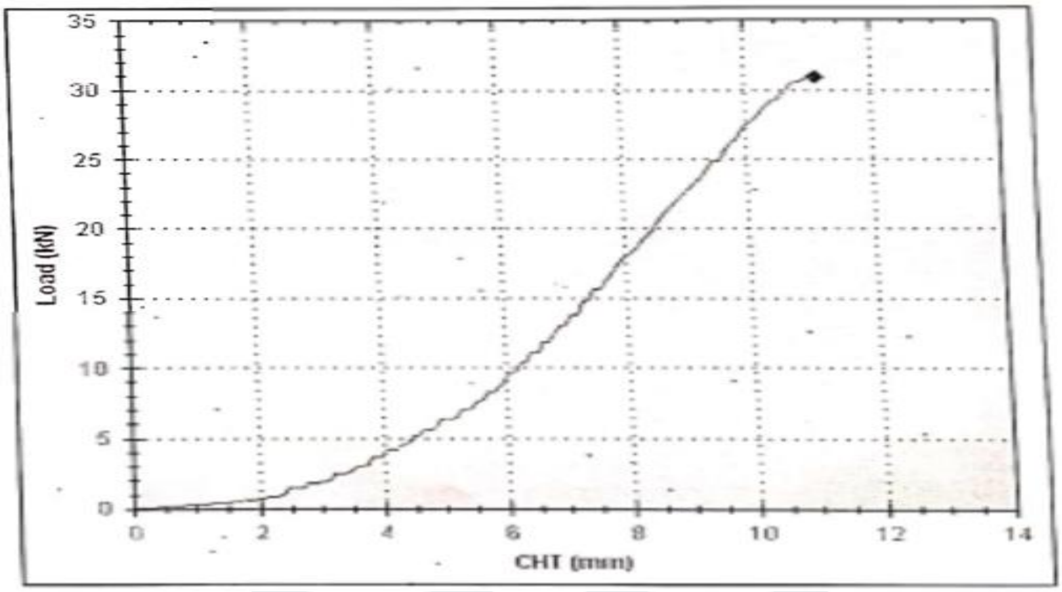

Figure 5.2a: Specimen 1 (load vs cross-head travel)

Figure 5.2a shows graph load vs cross head travel for specimen 1.As the load increases cross head travel or displacement also increases. At one point specimen breaks down, which is known as peak point and load at that point is peak load.

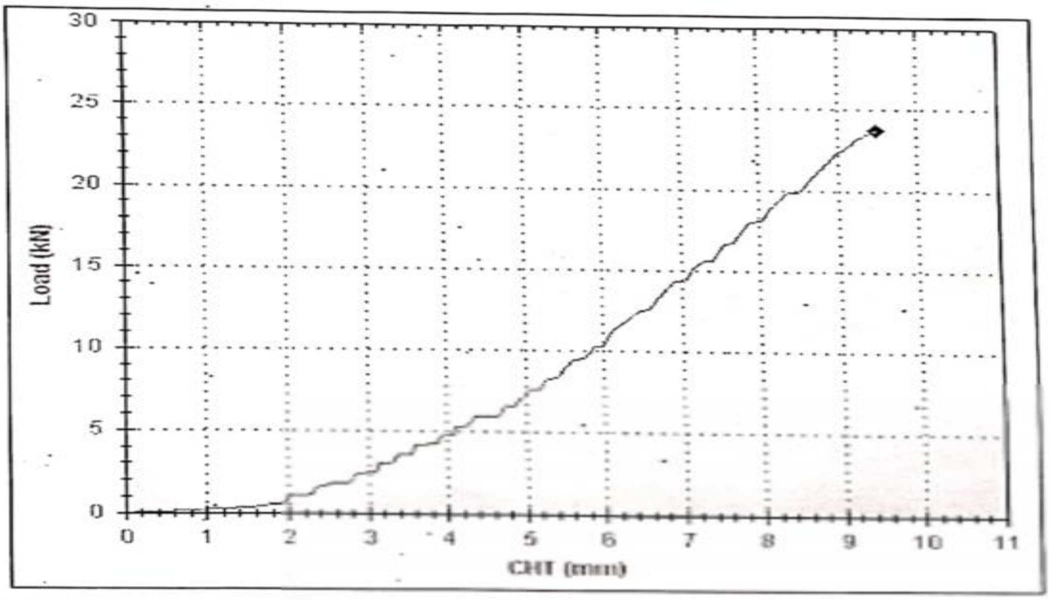

Figure 5.2b: Specimen 2 (load vs cross-head travel)

Figure 5.2b shows graph load vs cross head travel for specimen 2.As the load increases cross head travel or displacement also increases. At one point specimen breaks down, which is known as peak point and load at that point is peak load.

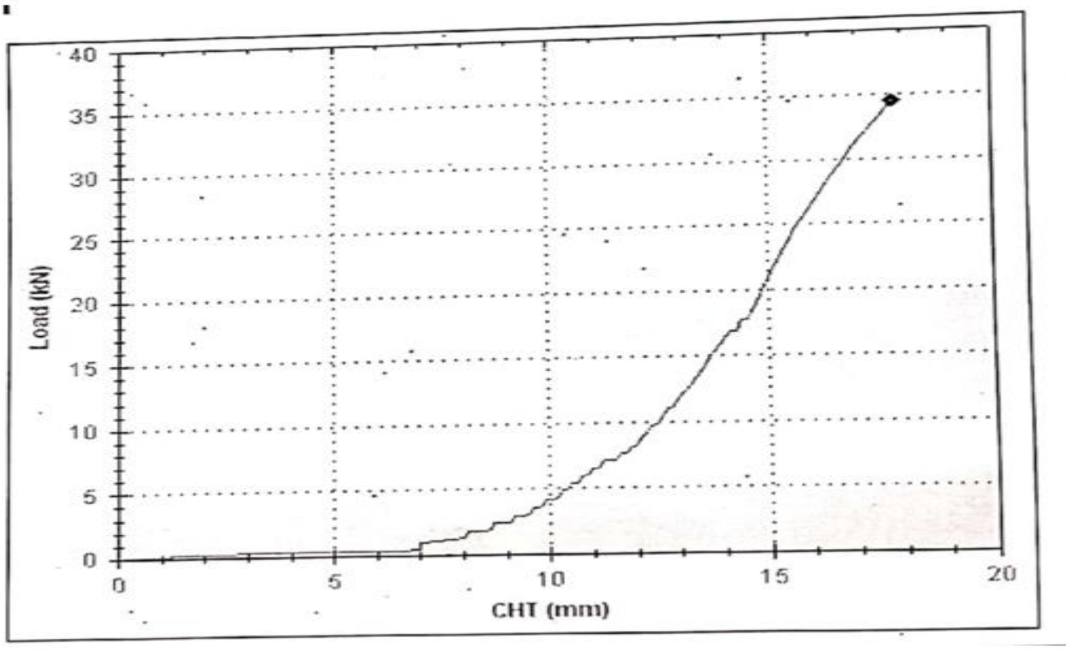

Figure 5.2c: Specimen 3 (load vs cross-head travel)

Figure 5.2c shows graph load vs cross head travel for specimen 3.As the load increases cross head travel or displacement also increases. At one point specimen breaks down, which is known as peak point and load at that point is peak load.

5.3 Rockwell hardness test

Table 5.3: Rockwell hardness readings

Specimen no.	Load (kgf)	Hardness number	Avg. hardness no.
1	100	68 69 53 66	64
2	100	68 63 68 68	66.75
3	100	53 57 55 76	60.25

Above table 5.3 shows Rockwell hardness results. Hardness number for specimen 2 is more than other two. At particular composition of specimen 2 hardness number is 66.75 which goes on decreasing either by increasing or decreasing silicon carbide and calcium sulphate content.

5.4 Wear test:

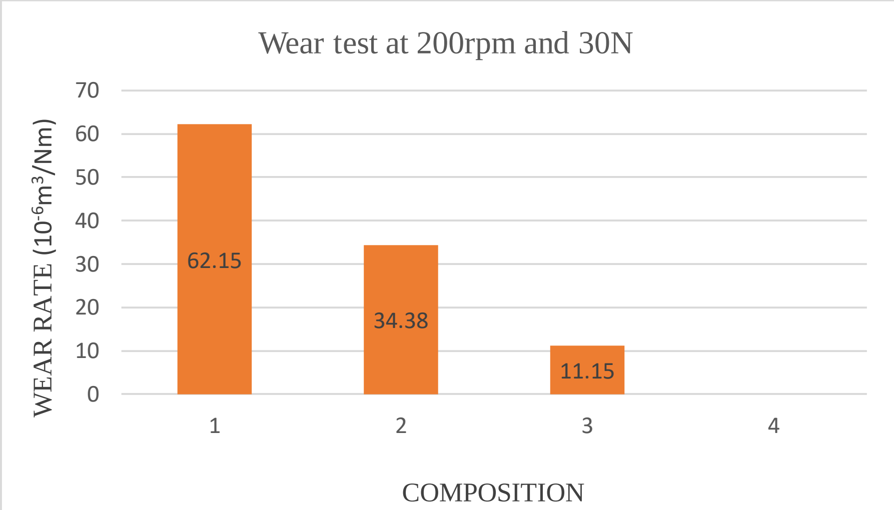

Figure 5.4a: Wear rate vs Composition

Figure 5.4a shows graph wear rate at 200 rpm and 30 N for specimen 1, specimen 2 and specimen 3 respectively. Wear rate for specimen 1, specimen 2 and specimen 3 are 62.15, 34.38 and 11.15 respectively. Wear rate goes on decreasing from specimen 1 to specimen 3 because of the increase in amount of silicon carbide. As the amount of silicon carbide increases in the specimen wear rate decreases.

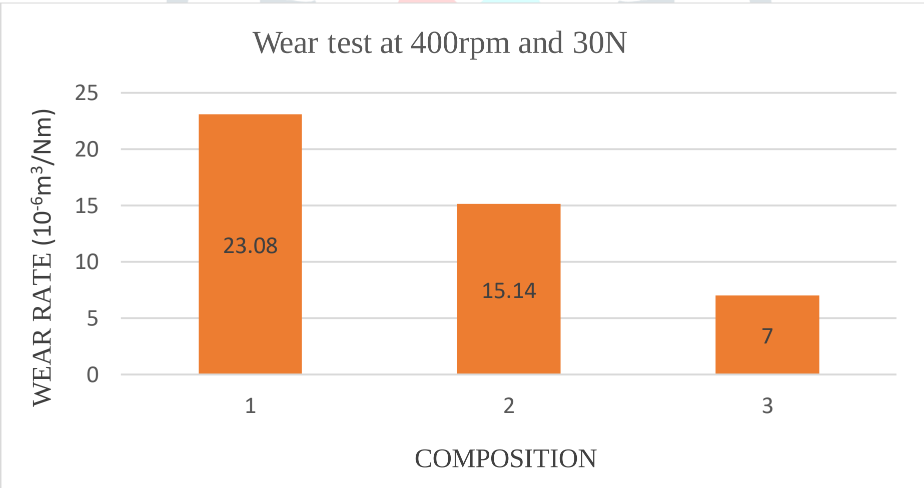

Figure 5.4b: Wear rate vs Composition

Figure 5.4b shows graph wear rate at 400 rpm and 30 N for specimen 1, specimen 2 and specimen 3 respectively. Wear rate for specimen 1, specimen 2 and specimen 3 are 23.08, 15.14 and 7.0 respectively. Wear rate goes on decreasing from specimen 1 to specimen 3 because of the increase in amount of silicon carbide. As the amount of silicon carbide increases in the specimen wear rate decreases.

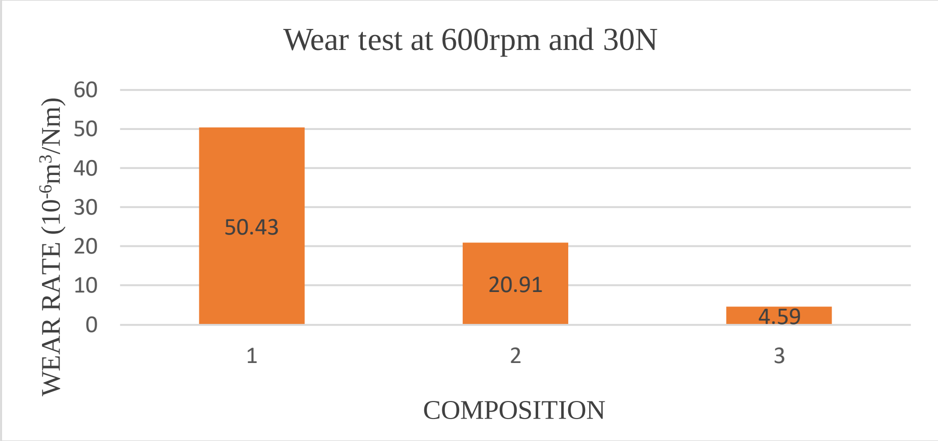

Figure 5.4c: Wear rate vs Composition

Figure 5.4c shows the wear rate at 600 rpm and 30 N for specimen 1, specimen 2 and specimen 3 respectively. Wear rate for specimen 1, specimen 2 and specimen 3 are 50.43, 20.91 and 4.59 respectively. Wear rate goes on decreasing from specimen 1 to specimen 3 because of the increase in amount of silicon carbide. As the amount of silicon carbide increases in the specimen wear rate decreases.

Conclusions

- This work shows that fabrication of glass fiber reinforced epoxy composite by vaccum bag method gives for better results than hand layup technique.
- Density of the composite material is found to be 666.66 kg/ m^3, which is lesser than steel (8050 kg/ m^3) and aluminium (2710 kg/ m^3) so it can be used for naval application (boat hull).
- This composite material is fire resistant and has low thermal expansion.
- Moisture absorption rate is very less.
- Tensile strength of the composite material is comparatively little less than the steel.
- High wear resistance due to presence of silicon carbide.

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