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Fabrication and Experimental Study of Mechanical Properties of GFRP with White Cement as Filler Material

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Abstract - *In recent years advanced polymer material composites are used in automobile ,marine applications in glass fiber with polymer resin. To enhance the properties of GFRP, in this work, white cement was used as filler material with glass fiber – polymer resin matrix. The composites were fabricated by varying the weight percentage of white cement in matrix material, 0 wt%, 5 wt% and 10 wt% respectively. The composites were fabricated by hand-layup process, As per ASTM standards, the specimen were prepared and studied experimentally for mechanical properties. The results were compared for different percentage of filler material. It was observed that addition of cement lead to change in mechanical properties of GFRP.*

Keywords: *GFRP, white Cement, Mechanical Properties)*

1.INTRODUCTION *(Size 11 , cambria font)*

Fiber reinforced polymer composite materials show strong future for integration into the immense infrastructure. Typically, these materials have protracted and fruitful lives; are light in weight and easy to construct; provide excellent strength to weight characteristics; and can be fabricated for customer specifications, strength, stiffness, geometry, and other properties. The current work is focused on the behavior of randomly arranged E-glass fiber and epoxy LY-556 polymer resin composite purely meant for marine application.

Randomly arranged GFRP has great application in the marine parts because of its cheaper cost and resistance to water (mainly salt water). Usually these marine parts are constructed using metal or wooden slabs, which are more susceptible for the damages from the water, so as to protect these structures from the adverse effect of water the GFRPs are used as the coating material to the areas of automobile, marine which comes in contact with water .

Research is underway worldwide to develop newer composites with varied combinations of fibers and fillers so as to make them useable under different operational conditions. In most of these applications, the properties of polymers are modified using fillers. A notable advance in the polymer industry has been the use of fiber and particulate fillers as reinforcements in polymer matrix. Particulate fillers are of considerable interest, not only from an economic viewpoint, but as modifiers especially the physical properties of the polymer. It is well documented in the literature that majority fillers have a positive influence on mechanical properties. Particulate fillers consisting of ceramic or metal particles and fiber fillers made of glass are being used these days to dramatically improve the properties of composite materials [1]. Various kinds of polymers and polymer matrix composites reinforced with metal particles have shown the increased tensile strength, impact strength, hardness and flexural strength [2-3]. These engineering composites are desired due to their low density, high corrosion resistance, ease of fabrication and low cost [4-6]. Similarly, ceramic filled polymer composites have been the subject of extensive research in last two decades. The inclusion of inorganic fillers into polymers for commercial applications is primarily aimed at the cost reduction and stiffness improvement [7, 8]. Along with fiber-reinforced composites, the composites made with particulate fillers have been found to perform well in many real operational conditions. When silica particles are added into a polymer matrix to form a composite, they play an important role in improving electrical, mechanical and thermal properties of the composites [9, 10]. Hence by this research survey, it is motivated to make some experiments to investigate the effect of the varied volume fraction of cement as filler content on glass /polymer resin. The objective is to investigate the mechanical properties.

2. Fabrication Method:

Fabrication of composite is done by conventional method called hand lay-up method. A mold of dimension 310 × 210 × 3.2 mm is used. Epoxy resin with its corresponding hardener in a ratio of 10:1 is thoroughly mixed. Mold releasing silicon spray is applied to mold releasing sheet and then the chopped fiber, mixed with the resin is gently poured on the sheet which is placed inside the mold. The purpose of releasing agent is to facilitate easy removal of the composite from the mold after curing. The mixture is allow to set inside the mold for a period of 24 hr under a pressure of 20kg over the cast. Then the specimen is cut into appropriate dimension for mechanical tests.

Table 1: *Details of specimens prepared for varied percentage of Cement as filler*

S. No	Matrix material	Reinforced material	Filler Weight %
1	polymer	Glass fiber	White cement (0%)
2	polymer	Glass fiber	Glass fiber(5%)
3	polymer	Glass fiber	Glass fiber(10%)

3. Experimentation:

3.1. Tensile test: The Tensile test is performed on specimens according to ASTM test standard D638 as shown in figure (1)on a Universal Testing Machine. In each case three samples are taken and average value are recorded.

Specifications: Dimensions of Tensile Test Specimen as per ASTM D-638.

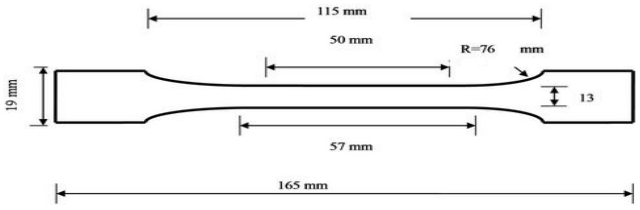


Fig.1. Specifications of Specimen

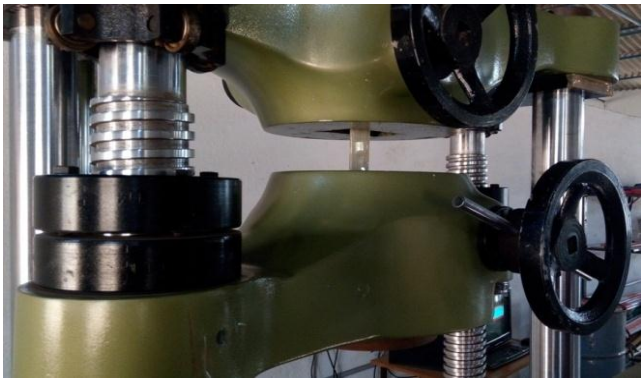


Fig.2. Tensile Test Machine set up

3.2. Flexural test:

Flexural test were performed using 3-point bending method according to ASTM D790 procedure. In each case three samples are taken and average values are recorded. Three point Bending test is conducted to ASTM D 790 as shown in Figure(2),

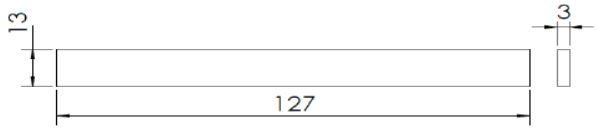


Fig.3. Specifications of flexural specimen

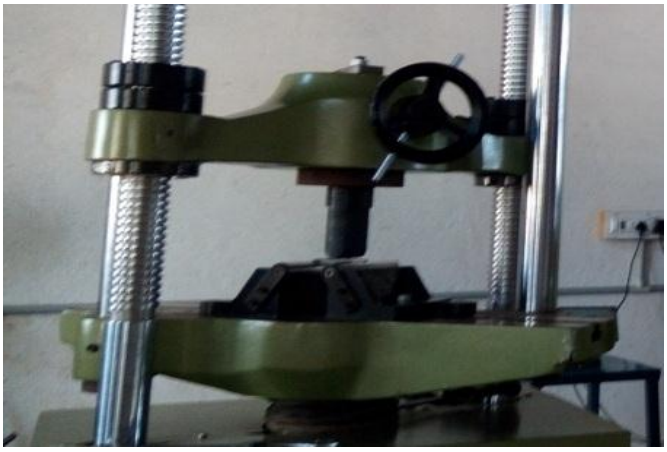


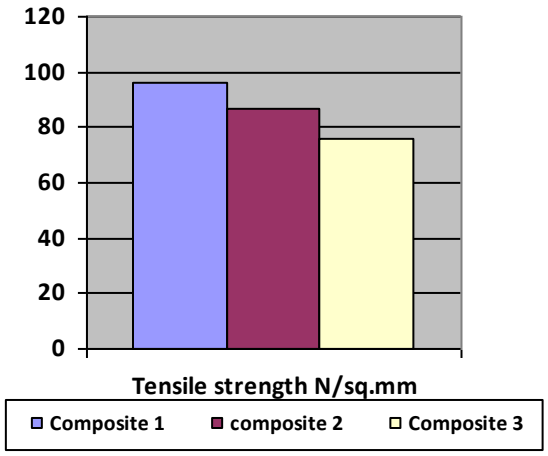
Fig.4. Machine Set up for flexural test

4. Results and discussions:

Table 2. The comparison of UTS of varying filler material

Type of composite	Filler Weight %	Tensile strength N/mm^2
Composite 1	White cement (0%)	96
composite 2	Glass fiber(5%)	84
composite 3	Glass fiber(10%)	76

Graph.1. Tensile strength

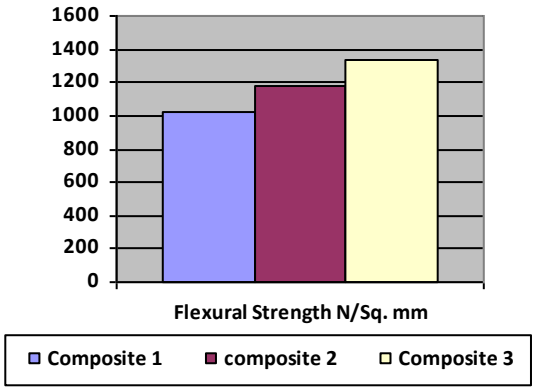


Tensile test as per the ASTM standards, was carried out for unfilled glass/polymer composite and for different proportions of cement filler i.e. 5%, and 10%. The test specimens were prepared as per ASTM D638. The results revealed that tensile strength for filled composite is lower compared to unfilled composite as shown in Table 2. It is known that fracture is due to fiber breakage at the surfaces and delamination of the fibers. It is revealed that fracture is due to delamination of the fibers. The fracture is due to delamination of the fiber increased as the percentage of cement is increased because, cement is laid up along with polymer as the percentage increases matrix percentage.

Table.3: The comparison of flexural strength of varying filler material

Type of composite	Filler Weight %	Flexural strength N/mm²
Composite 1	White cement (0%)	1024
composite 2	White cement (5%)	1178
composite 3	White cement (10%)	1340

Graph.2: Flexural strength:



The bending test measures the force required to bend a beam under 3 point loading conditions. The data is often used to select materials for parts that will support loads without flexing. In bending the materials experiences both tensile and compression loading.

The test specimens were prepared as per ASTM 790. As shown in figure 3, as the percentage of cement increases even the bending strength increases, this may be due to the adhesive property of cement.

5. Conclusion:

The present investigations of mechanical behavior of cement filled glass fiber reinforced polyester composites leads to the following conclusions:

In the present research work, glass fiber reinforced polyester composites filled with cement filler have been successful fabricated by simple hand lay-up technique.

It has been noticed that the mechanical properties of the composites such as tensile strength and flexural strength of the composites are also greatly influenced by the filler content.

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