Experimental Analysis on the Mechanical Properties of Glass-Epoxy composite with Fly ash as a filler material.

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Abstract: Pulverised fuel ash also known as fly ash is a very popular material as it is cheaply available and has good properties such as workability and provides a smooth surface finish. This paper deals with the fabrication of Glass-Epoxy composites having a composition of 60-40% with fly ash as filler. Fly ash is varied by 3%, 6% and 9% in volume. Since Fly ash is cheaply available this is an attempt to study the properties of the composite with the addition of fly ash. Tensile test, Bending Test and compression tests are conducted to find the mechanical properties of the material. The properties of the Glass-Epoxy composites are compared by varying the percentage of fly ash filler.

1. Introduction
Composites are one of the most advanced and versatile engineering materials known to men. Evolution in the field of material science has given birth to these wonderful fascinating materials. Composites are heterogeneous in nature and formed by the assembly of two or more materials with reinforcing fibres or fillers and a compactable matrix. The matrix may be ceramic, metallic or polymeric in origin. This gives the composite its shape, environmental tolerance, surface appearance and overall durability while most of the structural loads are carried by the fibrous reinforcement thus providing macroscopic stiffness and desired strength. The Reinforcement and Matrix are the two constituents of Composites. The essential central purposes of composite materials are their high quality and firmness, combined with low thickness when contrasted and mass materials, considering a weight diminish in the finished part. The Reinforcing phase is said to be made either of fibres, particles, or flakes and the Matrix phase in Composite is said to be continuous. Generally, Composites are known to be Heterogeneous. Although composite materials have advantages over conventional metals, they also have some disadvantages. PMC’s and other composites tend to be anisotropic; i.e. properties like stiffness, strength etc. are different in different directions. This poses a significant challenge for the designer when using composite materials in structures which have multi directional forces.

2. Literature Review
V. Manohar [1] et. Al (2014), carried out a work on Sea Shell Jute Fabric composite and studied the Tensile properties of it. In this study the sea shell powder was used as filler material. The weight% of
sea shell powder used as filler material was varied. By this study they concluded that the composite with 5% of filler material showed better Tensile Characteristics.

Ban Bakir [2] et. Al (2013), studied the effect of Fibre Orientation on Fibre Glass Composite material. They studied the effect of orientation of these fibres on Mechanical properties. This study showed the fibres oriented at 45degree gave better results and this was achieved when volume of fibres exceeded 30% in total volume. The experiment was carried out for 45degree orientation of fibres for Continuous and Discontinuous fibres.

Sandeep M. B. [3] et. Al (2014), carried out a work on Glass/Epoxy composite to study the effect of Orientation of fibres and how it effects the flexural strength of the material. In this study they used glass fibre as reinforcement and epoxy was used as resin and the material was prepared by hand layup process. This study showed that the flexural strength in -45+45 orientation fibres is more than that of 0,90 oriented ones.

Michael Ipki ofem [4] et. Al (2012), carried out a work on composites composed of permissible shell and cashew nut shell liquid (CNSL) resin, to study the mechanical properties and how filler material affects it. The study was carried out for different sizes of filler materials like (400, 600 and 800 microns) and the volume% for the composition was also carried from (10-40%). The material was manufactured by compression mould technique. The results showed good mechanical properties for increase in %volume of filler material. The optimum results were found for 400microns filler size and 30% volume of filler material.

3. Fabrication Methodology

The mould is made of plywood having dimensions of 300×300×3 mm. A plastic sheet is placed in the mould and a thin film of petroleum jelly and coconut oil is applied over it. A sheet of glass fibre having appropriate dimensions is placed over it and epoxy is applied over the sheet of glass fibre. Epoxy is mixed with 10% hardener as well as calculated amount of aluminium filler material. Same procedure is followed for more layers of glass fibre until the required layers are satisfied for the given composition.

The excess epoxy and air gaps are removed using a roller. Then a plastic sheet applied with a thin film of petroleum jelly and coconut oil is placed over it and covered.

4. Results and Discussion

4.1 Tensile Test

Tensile test also known as tension test is one of the widely used destructive tests to determine the tensile strength of a specimen. Tensile test was conducted on the specimen using Intron Machine. The Specimen were cut as per ASTM D 638 standards. The graph shows the results of the tensile test of the specimen with 3%, 6% and 9% filler. The load carrying capacity of the specimen with 3%, 6% and 9% filler were 12.3KN, 12.6KN and 11.8KN respectively. The Tensile stress was found to be 73.6MPa, 77.2MPa and 75.1MPa respectively.

![Figure 1. Tensile Specimen Dimensions](image-url)
Flexural strength also familiar as modulus of rupture, fracture strength or bend strength is a material property outlined as the stress in a material just prior to yielding in a flexure test. It represents the maximum stress experienced within the material at the time of rupture. The flexural test method measures the behavior of materials that are subjected to simple beam bending. The Specimen were cut as per ASTM D690 Standard.

The Maximum flexural capacity of the specimen with 3%, 6% and 9% filler were 1793N, 1833N and 1998N and the Young’s Modulus was found to be 847.34MPa, 863.4MPa and 927.62MPa respectively.

**Figure 2.** Intron 3366 Tensile Test

**Figure 3.** Combined Tensile Test Results

4.2 *Three Point Bending Test*

Flexural strength also familiar as modulus of rupture, fracture strength or bend strength is a material property outlined as the stress in a material just prior to yielding in a flexure test. It represents the maximum stress experienced within the material at the time of rupture. The flexural test method measures the behavior of materials that are subjected to simple beam bending. The Specimen were cut as per ASTM D690 Standard.

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**Figure 2.** Intron 3366 Tensile Test

**Figure 3.** Combined Tensile Test Results
Figure 4. Bending Specimen Dimensions

Figure 5. Instron 3366 Flexural Test

Figure 6. Combined Bending Test Results
4.3 Water Absorption Test
Water Absorption test is used to find the amount of water absorbed by the specimen. The specimen is cut as per ASTM D 570 Standards. The specimens are initially dried and then weighed. Later they are placed in a water bath for 24 Hours. After 24 Hours the specimen are taken out of the water bath and again weighed.

| Specimen | Water Absorption Percentage (%) |
|----------|----------------------------------|
| 3% Filler | 1.38                             |
| 6% Filler | 1.46                             |
| 9% Filler | 2.89                             |

4.4 Rockwell Hardness Test
Rockwell Hardness test was conducted on the specimen with a load of 60Kgf and 1/16th inch steel ball indenter. It was found that as the filler material percentage was increased the hardness of the specimen also increased.

| Specimen | Rockwell Hardness Number (HRB) |
|----------|---------------------------------|
| 3% Filler | 39                              |
| 6% Filler | 42                              |
| 9% Filler | 41                              |

5. Conclusions
- From Tensile tests it is clear that the composites having 6% Fly Ash filler has maximum Tensile strength of 77.2MPa.
- From Three Point Bending Test it is found that the specimen with 9% Filler has the maximum bending strength compared to 3% and 6% filler.
- The specimen with 3% filler has the least water absorption percentage compared to 6% and 9% filler.
- From Rockwell Hardness test it was found that the specimen with 6% Filler material had the maximum HRB compared to 3% and 9% filler material specimen.

References

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