PREPARATION AND CHARACTERIZATION OF GLASS FIBER REINFORCED EPOXY BASED COMPOSITE WITH AND WITHOUT FILLER MATERIALS

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Abstract

Composites, now days playing a pre dominant role in the engineering sector with numerous experimentations and analysis in different fields replacing several renewable resources. Composites which are formed by the mixing of two or more substances (Matrix and reinforcement) having glass fiber in it have good mechanical properties. Glass fiber reinforced polymer composites find prevalent uses in existing conditions due to their numerous advantages like high wear resistance, strength-to-weight ratio and low cost. In this project the properties of the composites can further enhanced by adding particulate fillers to them. To this end, this work successfully uses coal powder and fly ash as a filler material in polymer. The present work includes the processing, characterization and study of the strength behaviour of a series of such coal powder and fly ash filled glass fiber reinforced epoxy composites. It further outlines a methodology based on Tensile and flexural strengths to make a parametric analysis of strength behaviour
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KEYWORD: *Composites, Glass fiber, coal powder, fly ash, filler material*

1. INTRODUCTION

In the current technological advancements in engineering, material science has assumed a position of utmost importance. The awareness in advanced materials is increasing rapidly, both in terms of their research and application. It is supposed that the advancement in technology depends on constant research and applications which is same in the field of materials as well. It's a known actuality that the most advanced machines such as turbines or aircraft design are of no use if the chosen material doesn't have better bearing capacities. So the ultimate goal or the final gate for success in any field depends on the type of material that is being utilized. Composite materials in this term represent the final solution in constant research for the betterment of the material properties such as optimization in materials. The required results are obtained by introducing different materials as reinforcements and addition of filler materials to get better outputs. So glass fiber is used as the reinforcement and coal powder, fly ash is used as filler materials.

The study on mechanical properties of glass fiber reinforced epoxy composite with filled and unfilled coal powder and fly ash were conducted by Rout et al. [1] and concluded that Tensile modulus, hardness and impact energy improves with addition of filler content. Also the utilization of glass fibre reinforced epoxy composite at different volume fraction as layers were experimented by Al-Hasani [2]. Deng et al. [3] studied the influence of different types of E-glass fibre cross-section (round, oval and peanut-shaped) were tested and reported that delamination resistance of composites is lower for the composites having larger fibre cross-section compared to the composites reinforced with round cross-section, because of the fibre overlapping.

2. Material and Methods

2.1. Materials:
Epoxy resin (Araldite LY 556) made by CIBA GUGYE Limited and Araldite Hy951 is utilized.

2.2. *Filler material*
Unburnt Anthracite coal or hard coal in the powdered form is utilized and the fly ash is also used as filler material.

2.3. *Fabrication of composites*

Unidirectional composites were prepared, using Epoxy matrix to assess the reinforcing capacity of coal powder and fly ash. The quantity of Harder added to Epoxy resin at room temperature for curing was1.5% by volume of epoxy resin each. Hand lay-up method was adopted to fill up the prepared mould with an appropriate amount of epoxy resin matrix (coal powder + fly ash separately) with glass fiber as layers was prepared and laminates are achieved. At the time of curing, a compressive pressure of 0.05MPa was applied on the mould and the composite specimens were cured for 24 hours. The specimens were also post cured at 70° C for 2 h after removing from the mould. Composite samples were prepared by varying the filler material.

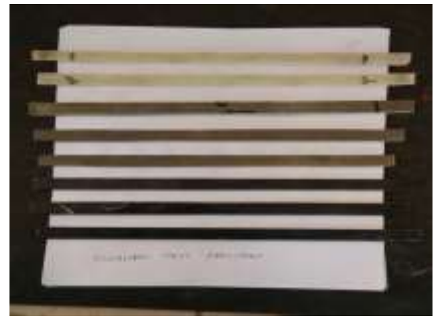
Fig:1 1) Glass fiber 2) Resin and Hardner 3) Fly ash and coal powder 4) Mould

2.4. *Tensile and flexural testing*
After the lamination of the composites three compositions namely c1, c2 and c3 are achieved. The laminates are cut into dog bone shape according to ASTM standards. The composite laminates are shown in the following figure

C1 C2 C3

Fig 2: C1:without filler material C2:with coal powder C3:with fly-ash

Tensile specimens



Flexural specimens

Fig 3: Dogbone shaed specimen after cutting according to ASTM standard

3. Results and discussion

The composite sheets were fabricated from glass fiber ,with coal powder, fly ash and resin matrix. The resin used was epoxy resin. The weight fraction of composites was maintained at (i). 50% glass fiber and 50% epoxy, (ii).50% glass fiber,40%epoxy and 10% filler material(coal powder), (iii)50% glass fiber,40% epoxy ,10% filler material (fly ash).After preparation of the hybrid composites fabrication cutting of the specimen is done in the desired shape to test the mechanical properties of the prepared composite. The tensile and flexural testing of the samples was done by UTM (Universal testing machine).

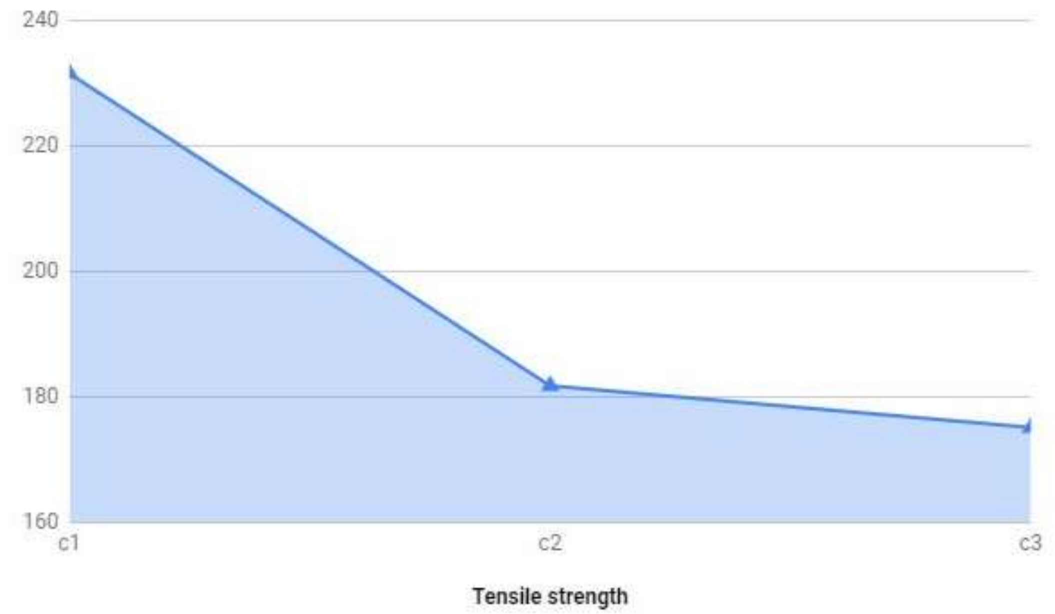
Table 1: composition of the specimens

Designation of composite	Composition
C1	Glass fiber(50%) = 463gm Resin(50%)(E+H) = 463 x (50/50) = 463gm Epoxy = 463 x (100/110) = 421gm Hardener = 463 x (10/110) = 42gm
C2	Glass fiber (50%) = 465gm Resin (40%) (E+H) = 465 x (40/50) = 372gm Epoxy = 372 x (100/110) = 339gm Hardener = 372 x (10/110) = 34gm Filler material (10%) = 465 x (10/50) = 93gms
C3	Glass fiber (50%) = 468gm Resin (40%)(E+H) = 468 x (40/50) = 374.4gm Epoxy = 374.4 x (100/110) = 340.36gm Hardener = 374.4 x (10/110) = 34.036gm Filler material (10%) = 468 x (10/50) = 93.6gms

The specimens are tested in universal testing machine and bending test was three point bending test.

Fig 4: specimens after testing are shown below

The tensile strengths observed for 50% glass fiber and 50% epoxy is 231.56MPa, for 50% glass fiber,40% epoxy and 10% filler material(coal Powder) is 181.78MPa and for 50% glass fiber,40% epoxy ,10% filler material (fly ash) is 175.13MPa.



The test results for tensile strengths are shown in Figure 4.1. It is seen that in all the samples irrespective of the filler material the tensile strength of the composite decreases with increase in filler content. The unfilled glass polyester composite has a strength of 231.56MPa in tension and it may be seen from Table 4.1 that this value drops to 181.786Mpa and 175.13MPa with the addition of 10wt% of coal powder and 10 wt% of fly ash content respectively. There can be two reasons for this decline in the strength properties of these particulate filled composites compared to the unfilled.

The flexural strengths observed for 50% glass fiber and 50% epoxy is 972.575 MPa, for 50% glass fiber,40% epoxy and 10% filler material(coal Powder) is 750.54MPa and for 50% glass fiber,40% epoxy ,10% filler material (fly ash) is 693.07 MPa.

The test results for flexural strengths are shown in Figure 4.2. It is seen that in all the samples irrespective of the filler material the flexural strength of the composite decreases with increase in filler content. The unfilled glass polyester composite has strength of 972.57MPa in tension and it may be seen from fig. That this value drops to 750.54Mpa and 693.07MPa with the addition of 10wt% of coal powder and 10 wt% of fly ash content respectively. There can be two reasons for this decline in the strength properties of these particulate filled composites compared to the unfilled ones.

4. CONCLUSIONS:

There reasons for the decline in the strength properties of these particulate filled composites compared to the unfilled ones.

1. Due to the presence of pores at the interface between filler particles and the matrix, the interfacing adhesion may be too weak to transfer the tensile stress.
2. The corner points of the irregular shaped particulates result in stress concentration in the matrix base.
3. The in compatibility of the particulates and the epoxy matrix, leading to poor interfacial bonding.
4. The lower values of flexural strength may also be attributed to fiber to fiber interaction, voids and dispersion problems.
5. It has been observed from this work tensile strength of the composites slightly increases in all the three different fiber loading irrespective of fiber lengths. The maximum tensile strength among all the composites is 231.56M.Pa and 972.57 to flexural strength for 50% glass fiber and 50% epoxy.
6. After adding the filler materials to the epoxy the values that are observed to be decreasing than the pure epoxy phase and the values are 181.78M.Pa for (50% glass fiber,40%epoxy and 10% filler material(coal Powder) , 175.13M.Pa for(50% glass fiber,40% epoxy ,10% filler material (fly ash).
7. However, Flexural strength of these composites increases for all the fiber length. After adding the filler materials to the epoxy the values that are observed to be decreasing than the pure epoxy phase and the values are 750.54M.Pa for (50% glass fiber,40%epoxy and 10% filler material(coal Powder) , 693.07M.Pa for(50% glass fiber,40% epoxy ,10% filler material (fly ash).

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