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Mechanical Properties Characterization of Fiber Reinforced Composite Material

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ABSTRACT

Composites had been charming all of the regions of engineering. Different styles of composites had been investigated. The gift paintings focus on hybrid composites bolstered with fly ash and silica Fly ash is a waste product received from thermal electricity stations. In the prevailing paintings investigations are achieved on a hybrid polymer composites containing glass fiber reinforcement, epoxy resin, fly ash and nano silica has been achieved. Epoxy glass composites with distinctive measures of fly ash have been synthetic with the aid of using the hand lay-up method. The newly evolved composites are subjected to numerous methods to observe their mechanical behavior. Tensile check, Compression check, Flexural check, and Vickers hardness check have been carried out as in step with the ASTM requirements to discover the have an effect on of filler fabric on mechanical traits of GFRP composites. The distribution and interplay of constituent substances play a chief function of their residences. The evaluation showed the extrade in residences of the GFRP regarding the proportion of fly ash gift with inside the composite fabric. From the experimental outcomes received, it changed into observed that the mechanical residences have been more desirable whilst the fly ash percentage changed into elevated and additionally amongst those chances of fly ash, the specimen having 9% changed into owning maximum residences.

KEYWORDS:GFRP,Epoxy Composites, Tensile Test,Fly Ash,Flexural Test

1. INTRODUCTION

Composite material prepared by mixing two (or) more different elements in order to make the resulting material having superior properties from its parental materials. Composite materials are widely used in industry due to their unusual properties. There are several kinds of composite materials classified according to matrix type. One of the most important types of composites materials is polymer matrix composite(PMC)materials. Polymer matrix composites (PMCs) have received more remarkable attentio than conventional polymer materials. They have widely used for many applications in industry because of their lightness, high strength, high wear resistance and specific mechanical properties.

TYPESOF COMPOSITES:

A. Accordingto typeofcontinuous phase

- MetalMatrixComposite(MMC)
- CeramicMatrixComposite(CMC)
- PolymerMatrixComposite(PMC)

B. Accordingtotypeofreinforcement.

- fibrous composites
- particulate composites

2. REALATED WORK

Related work needs to be done in order to understand the background information available, the work already done and also to show the relevance of the current project. This chapter presents a general idea of the factors which affect the mechanical properties of fiber reinforced polymer composites in polymer composites, the matrix is the major load bearing component. In order to increase this load bearing capability, the reinforcements are introduced in the matrix.

Mechanical Properties of Fly Ash filled GFRP Composite Material The distribution and interaction of constituent materials plays major role in their properties. The analysis confirmed the change in properties of the GFRP with respect to the percentage of fly ash present in the composite material. The glass fiber reinforced composite with 2% of fly ash had better strength compared to composite of 5% fly ash.[1]

In the present investigation, synthesis and characterization of a polymer composite material comprising of glass fiber reinforcement, epoxy resin and fly ash has been carried out. Epoxy glass composites with different measure of fly ash were manufactured by hand lay-up method. The newly developed composites are subjected to various tests to study their mechanical behavior. Tensile test, three point bending and Vickers hardness were conducted as per the ASTM standards to find the influence of filler material on mechanical characteristics of GFRP composites [2].The hybrid composite reinforced with 10% glass particles presented the best overall flexural properties. [3]

The utilization of fly ash as filler material in polymercomposites is considered important from both economic and commercial point of view. Fly ash is used as reinforcing filler in High density polyethylene (HDPE) to develop lightweight composites. After surveying they have conclude that if fly ash is used as reinforcing filler material in High density polyethylene (HDPE) some studies have pointed to the excellent compatibility between fly ash and polymer, [4].

3. PROPOSED WORK

The results of various characterization tests are reported here. They include evaluation of tensile strength, compression strength, flexural strength and Hardness strength. From the experiments, it is clear that fly ash stays applied as filler have advanced mechanical overall performance of E-Glass/Epoxy composites. Increased filler composition exhibited better tensile and compression flexural and hardness overall performance at regular reinforcement probabilities.

Fillers play a first-rate position in electricity overall performance, matrix of the composite ensuing uniform distribution of load during the composite. Fly as filler because of its advanced mechanical overall performance may be efficaciously applied in constructing up structural and non- structural materials. From the experimental effects obtained, it turned into observed that the mechanical residences have been more suitable whilst the fly ash percentage turned into accelerated and additionally amongst those probabilities of fly ash, the specimen having 9% turned into owning maximum residences.

The present work is completed by using the 4 layers process same process will be continued upto 8 layer by changing the positions of the glass fibre.In this process we have taken only the glass fibre in the bottom section. But in order to improve all the properties the glass fibre can be used at different cross-sections (different alternate layers) .By varying the position of the glass fibre at the same time the mixture of this fly ash and silica .you can produce 8 and 12 layers of the component .this increases the percentage of the reinforced material and overall thickness of the component.
By conducting the test for this component we can achieve the component with more accurate properties than this.

4. MATERIALS AND METHODS

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MATERIALS

Flyash:

Fly ash is the finely divided residue that results from the combustion of pulverized coal and is transported from the combustion chamber by exhaust gases. Fly ash is most commonly used as a pozzolan in PCC applications. Pozzolans are siliceous or siliceous and aluminous materials, which in a finely divided form and in the presence of water, react with calcium hydroxide at ordinary temperatures to produce cementitious compounds.

The unique spherical shape and particle size distribution of fly ash make it is good mineral filler in hot mix asphalt (HMA) applications and improves the fluidity of flowable fill and grout. The consistency and abundance of fly ash in many areas present unique opportunities for use in structural fills and other highway applications.

Epoxy Resin:

The most common epoxy resins are based on reacting epichlorohydrin (ECH) with bisphenol A, resulting in a different chemical substance known as bisphenol A diglycidyl ether (commonly known as BADGE or DGEBA). Bisphenol A-based resins are the most widely commercialised resins but also other bisphenols are analogously reacted with epichlorohydrin, for example Bisphenol F.

Glass fiber:

Fiberglass (American English) or fibreglass (Commonwealth English) is a common type of fiber-reinforced plastic using glass fiber. The fibers may be randomly arranged, flattened into a sheet called a chopped strand mat, or woven into glass cloth. The plastic matrix may be a thermoset polymer matrix—most often based on thermosetting polymers such as epoxy, polyester resin, or vinyl ester resin—or a thermoplastic.

Mechanical properties:

The strength of glass is usually tested and reported for "virgin" or pristine fibers—those that have just been manufactured. The freshest, thinnest fibers are the strongest because the thinner fibers are more ductile. The more the surface is scratched, the less the resulting tenacity.[5] Because glass has an amorphous structure, its properties are the same along the fiber and across the fiber.Humidity is an important factor in the tensile strength. Moisture is easily adsorbed and can worsen microscopic cracks and surface defects, and lessen tenacity.

METHODS:

PREPARATION OF COMPOSITES

The fiber reinforced composites has been prepared by handlay up process. The detail procedure is as follow:

- First choose the suitable mould and prepare the fiber.
- After that apply the grease on the mould for easy removal of material from mould.
- Prepare the epoxy resin mixture with hardener.
- This chemical will be prepared in a jar and this chemical resin will be swirledcontinuously for reducing the chemical resin at jar.
- Cut the suitable dimension of e-glass fiber for required pieces.
- After completing this process first pour the chemical resin into mould and adjust frequently distribution.
- Add the e-glass fiber on the resin and apply resin after applying resin add fiber again resin.
- Continue this process for required height.
- After completion of preparation, prepare another model of material with only e- glass fiber or with pure resin.
- These moulds are placed at atmosphere for dry and hard.
- After completion of hardening remove the material from the mould and clean the material.
- After completing this process cut the materials for testing different shapes and dimensions what we have required.
- After cutting into pieces grinding the pieces with emery paper for smooth surface finish.

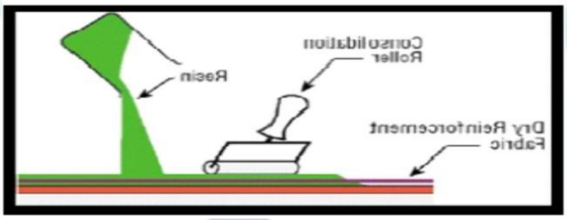


Figure 1:Schematic ofmoldcastingsetup.

SPECIMEN COMPOSITION

- 60% epoxy + 15% glass fiber + 2.5% fly ash + 5% silcon
- 80% epoxy + 7.5% glass fiber +7.5% fly ash + 5% silicon
- 70% epoxy + 12.5% glass fiber +7.5% fly ash + 5% silicon

- 90% epoxy + 2.5% glass fiber +5% fly ash + 5% silicon

TESTING PROCEDURE

Tensile and compressive Tests

- Both the tensile and compressive testing are performed on UTM
- Formulated specimen is proceed to for testing
- Load the specimen into the tensile grips on UTM for tensile test
- Attach the extensometer to the sample.
- Begin the test by separating the tensile grips at a constant rate of speed
- The method for testing compressive is different with tensile the applicaton of pressure is towards the specimen end
- At the end of the test sample is broken and the plots between stress and strain for both tensile and compressive test has been drawn.

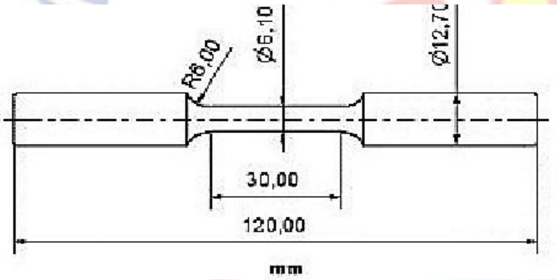


Figure 2:Schematic oftensile sample based on ASTM standard.

FLEXURAL TESTING

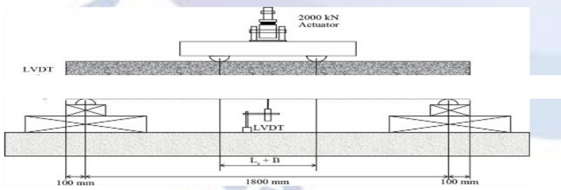


Figure 3:Schematic offlexural testsetup.

The flexural samples using fiber reinforcd composites with varying contents of flyash have been prepared and the procedure is follow as;

- Flexural testing procedure most commonly the specimen lies on a support span
- The load is applied to the center by the loading nose producing three point bending at a specified rate
- The parameters for this test are the support span, speed of the loading and the maximum deflection for the rest.
- The formulae for finding flexural strength is used,

$$\sigma = \frac{3FL}{2bd^2}$$

VICKERS HARDNESS

- Vickers hardness test method consists of indenting the test materials with a diamond indenter
- The form of a pyramid with a square base and an angle of 136 degrees between opposite faces subjected to a test force of between 1gf and 100kgf
- The full load is normally applied for 10 to 15 secounds
- Flexural thickness 20*20*2.5
- The formulae for finding flexural strength is used,

$$HV=\frac{2P\sin\frac{\theta}{2}}{D^2}$$

5. RESULTS

In this section, the mechanical characterization of the polymer matrix composites developed the present investigation. The results of various characterization tests are reported here. They include evaluation of tensile strength, compressive strength, flexural strength, and hardness strength. These composites are listed as

BEFORE TESTING

Figure 4:showing compressive samples before and after testing.

AFTER TESTING

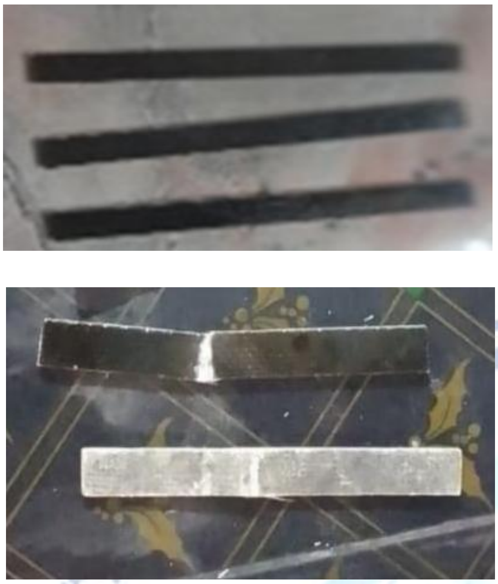


Figure 5:showing tensile samples before and after testing.

Table 1: Mechaniical properties of composites with different composition of flyash

Sample code	Flyash(%)	Tensile strength (MPa)	Compressive strength (MPa)	Fleural strength (MPa)	Hardness (VHN)
1	2.5	136.65	123.45	76.54	29.65
2	5	143.56	131.65	77.64	34.65
3	7.5	161.14	156.76	81.54	39.76
4	10	164.67	176.65	84.98	43.76

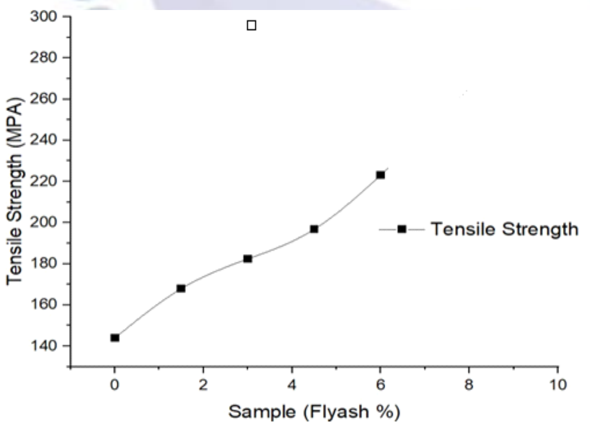


Figure6:showing Tensile strength of composites.

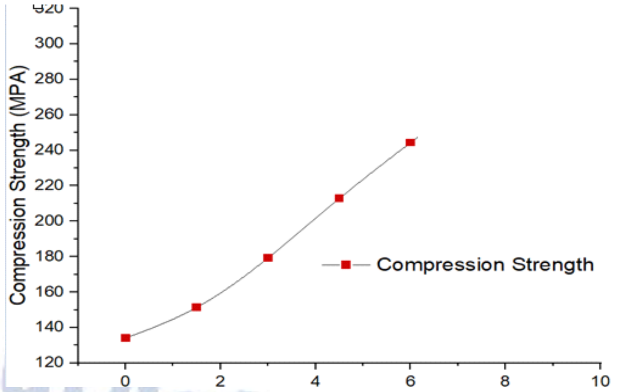


Figure7:showing compressive strength of composites.

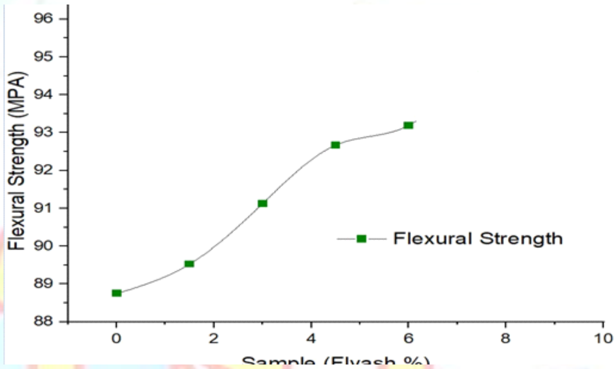
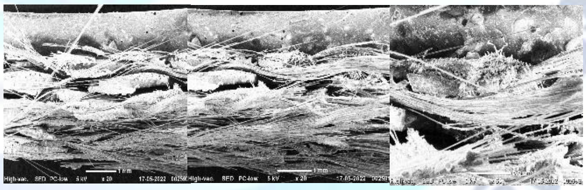


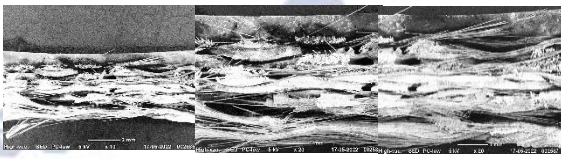
Figure 8:showing Flexural strength of composites.

SCANNED ELECTRONIC MICROSCOPIC RESULTS



Top view middle view Bottom view

Figure 9:showing 2.5% Flyash specimen microstructure of composites



Top view middle viewbottom view

Figure 10:showing 7.5% Flyash specimen microstructure of composites

CONCLUSION

From the experiments, it's miles lucid that fly ash staysapplied as filler have advanced mechanical overall performance of E-Glass/Epoxy composites. Increased filler composition exhibited better tensile and compression flexural and hardness overall performance at regular reinforcement probabilities.As the epoxy reduced, possibilities of matrix agglomeration reduces and with boom in fly ash filler ended in uniform distribution of epoxy improving matrix-fiber interface. Increase in tensile, flexural, hardness and compression conduct is determined with boom in filler as much aspositiveproportions and within additionboom in filler content material a lowerturned intodeterminedbecause of filler agglomeration inflictingflawed wetting of fiber. Decrease in fiber percentage-age ended inaccelerated brittle nature of the composite displayingdiscount in flexural electricity. Fillers play a first-rateposition in electricityoverall performance, matrix of the composite ensuing uniform distribution of load during the composite. Fly as filler because of its advanced mechanical overall performancemay beefficaciouslyapplied in constructing up structural and non- structural materials. From the experimentaleffects obtained, it turned intoobserved that the mechanical residenceshave beenmore suitablewhilst the fly ash percentageturned intoaccelerated and additionallyamongstthoseprobabilities of fly ash, the specimen having 9% turned intoowningmaximumresidences.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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