IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 5, May 2021

DOI: 10.17148/IARJSET.2021.85108

CHARACTERISATION OF MECHANICAL BEHAVIOUR OF POLYMER COMPOSITES REINFORCED WITH GLASS FIBER AND GLASS POWDER

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Abstract: Researchers are triggered by daily growth of environmental awareness and this leads to invention of more eco friendly composites. Natural fiber can be used instead of Synthetic fiber due to its superior mechanical properties in recent days as it possess high specific strength, small weight to strength ratio, low cost, eco friendly and bio degradable characteristics. It serves as a best alternative to glass, carbon and manmade fibers. Synthetic fibers burn more readily than natural fiber. In this present work, glass fiber and glass powder is reinforced with epoxy resin and hardener by using hand layup technique. Fiber length, orientation and thickness play a major role in determining the mechanical properties. Various samples were prepared by changing the fiber Proportion.

Keywords: Polymer Matrix Composite, Impact test, tensile test, Hardness test, Hybrid Composite

I. INTRODUCTION

Polymer Matrix Composite (PMC) has been produced from waste materials such as glass powder, ceramic powder.In this work epoxy is chosen as a matrix material, because of its strong adhesive properties, chemical resistance and toughness. Glass fiber is used as reinforcement and Glass powder is used as filler material. In this method Hand Lay–Up method is used to fabricate the composite and the it was made in Three compositions (i.e.) 50:50:5, 50:50:10, 50:50:15. To evaluate the mechanical properties of the composite certain mechanical tests are carried out such as Impact test, Tensile Test, Hardness Test.

II. MATERIALS

In this Working method Epoxy resin is used as matrix material and Glass fiber and glass powder is used as Reinforcement material.

2.1 EPOXY RESIN

Figure 1 Epoxy Resin

Properties of epoxy resin are tabulated in Table 2.1

Table 1 Properties of Epoxy Resin

Axial Modulus of elasticity (MPa)	46.88
Transverse Modulus of elasticity (MPa)	46.88

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Coefficient of thermal expansion	63
Coefficient of moisture expansion	0.33
Specific Gravity	1.2

2.2 HARDENER

A curing agent is a substance that is used to harden a surface or material. It is typically applied to polymer surfaces to facilitate the bonding of the molecular components of the material

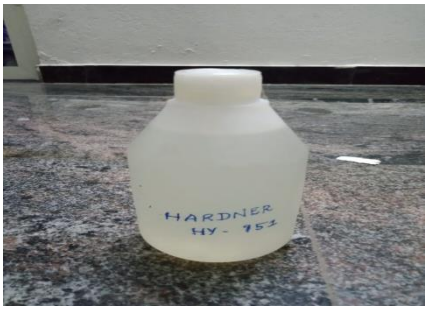

Figure 2 Hardener

2.3 GLASS FIBER

Glass fiber is consisting of numerous extremely line fibers of glass. Glass fiber is formed when thin strands of silica-based or other formulation glass are extruded into many fibers with small diameters suitable for textile processing

Figure 3 Glass Fiber

2.4 GLASS POWDER

Figure 4 Glass Powder

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Table 2 Properties of Glass powder

COMPOSITION	%
Silica (SiO_2)	75.31
Alumina (Al_2O_3)	1.11
Calcium (CaO)	8.83
Magnesium (MgO)	2.80
Sodium (Na_2O)	10.77
Potassium (K_2O)	0.41

Properties of glass powder are tabulated in Table 2.2

III.METHODOLOGY

3.1 FABRICATION OF THE COMPOSITE MATERIAL

Here circular pipe is used as the die. In the meanwhile, two plungers are fabricated to compress the material on either sides of the pipe. The plungers are turned from the steel rods or wooden pieces to the inner diameter of the pipe, so tight fit can be obtained to fabricate the material.

The samples were prepared in three compositions. First is 50% of Epoxy resin, 50% of Glass fiber and 5% of Glass powder; secondly 50% of Epoxy resin,50% of Glass fiber and 10% of Glass powder and the third is 50% of Epoxy resin,50% of Glass fiber and 15% of Glass powder. In addition to composite, hardener is added to harden the material in the ratio of 1:10.

The mixture is manually stirred by using iron rod. Through plunger, one end of the pipe is arrested and the mixture is gradually poured into the die. After the material is completely filled inside the die, another plunger is used to arrest the material on the other side with a tight fit. Then the whole setup is fixed on the lathe. One end of the plunger is fixed to the chuck, whereas on other end, the compressive force is applied by means of tail stock. Now the die is completely sealed against any movement with the applied pressure.

After curing either at room temperature or at some specific temperature, the plunger is removed from the mold and the developed composite part is taken out for further process. The curing time is based on polymer used for composite processing. For example, for epoxy based system, the normal curing time at room temperature is 24-48 hours. During removal of plunger ensure that whether it's dried completely. Finally the composite material which is removed from the die is turned and the surface roughness test is taken out.

Table 3 Composition of Fabrication

S. No	Epoxy resin		Glass Fiber		Glass Powder	
	(wt %)	(grams)	(wt %)	(grams)	(wt %)	(grams)
1	50	200	50	200	5	10
2	50	200	50	200	10	20
3	50	200	50	200	15	30

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Fig 5 Mixing of Epoxy, Glass fiber and Glass Powder

The samples are fabricated with the above combination shown in table 5.1 of epoxy and glass fiber. The samples were prepared in this combination. One is 50% of epoxy resin 50% of glass fiber and 5% of glass powder. The Composite is a developed part is taken out and further processed. There are epoxy, glass fiber and glass powder add in required ratio. Time curing depends on type of polymer used for composite processing.

Fig 5 Composite Material of Composition 1

IV. RESULTS AND DISCUSSION

4.1 IMPACT TEST

The Charpy V-notch impact test is a standardized high strain rate test which determines the amount of energy absorbed by materials during fracture. The Charpy test is performed by preparing the test method ISO 148-1: 2016.

Table 4 IMPACT TEST

COMPOSITION	IMPACT ENERGY (joules)
Composition 1	4
Composition 2	3
Composition 3	5
AVERAGE	4

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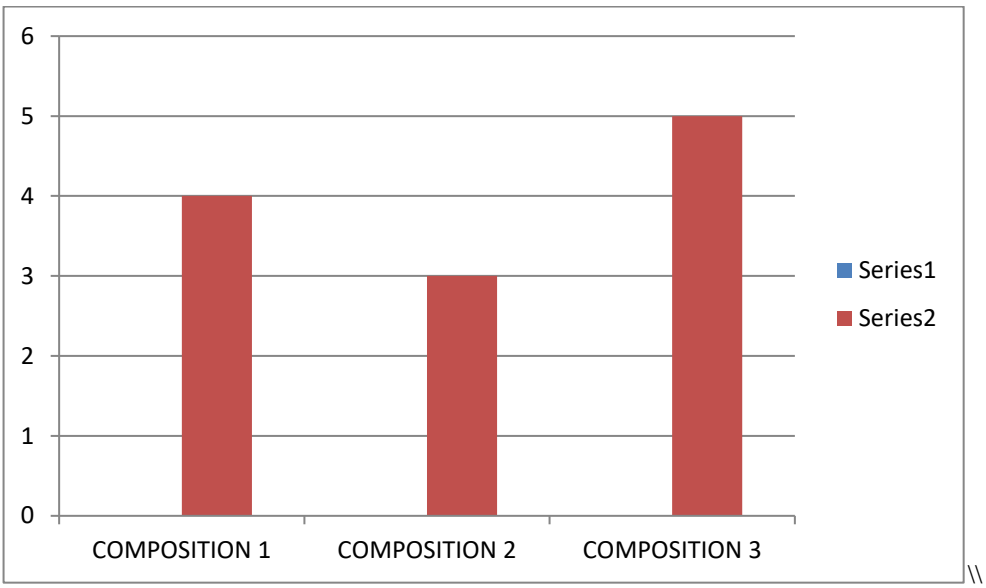

Fig 6 IMPACT TEST GRAPH

Figure 6 represents the impact test results for various compositions

4.2 HARDNESS TEST

Hardness is a measure of how resistant solid matter is of various kinds, permanent shape changes, when a compressive force is applied. It is a composite of tested as per ASTM standard D2240.

Table 4 HARDNESS TEST

COMPOSITION	HARDNESS
Composition 1	85
Composition 2	80
Composition 3	90

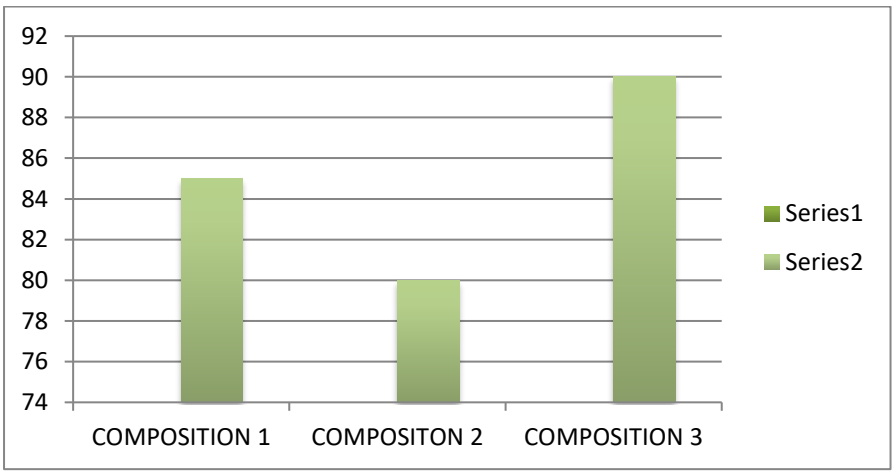

Fig 7 HARDNESS TEST GRAPH

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4.2 TENSILE TEST

Tensile testing is a fundamental materials science test in which a simple material is subjected to a controlled tension until failure. The specimen preparation, dimensions, gauge length and speeds are Prepared according to the ASTM D638 standard. The test is performed on the Universal Testing Machine (UTM) and the surrounding temperature is 35ºC.

Table 5 TENSILE TEST

COMPOSITION	TENSILEN/mm2
Composition 1	27.66
Composition 2	45.9
Composition 3	42

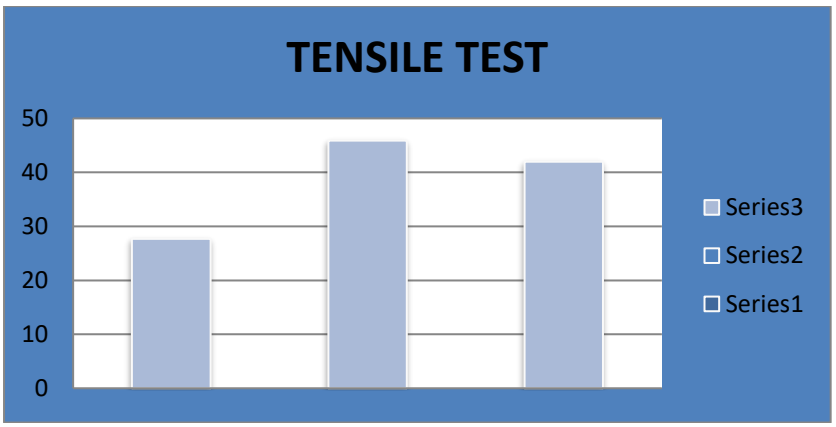

Fig 8 TENSILE TEST GRAPH

Figure 8 represents the tensile test results for various compositions

V. CONCLUSION

The Epoxy based glass fiber reinforced matrix was fabricated by Hand Lay-up method. And glass powder is added as filler material in the composite in terms of 5%, 10%, and 15%. Then to evaluate the mechanical property, the various mechanical tests are carried out. The glass fiber and glass powder filled epoxy resin polymer matrix composite was successfully fabricated by compression moulding method. The composites have been tested for its mechanical properties.

From that, the following conclusions were concluded

1. The tensile strength of the composite was enormously increased when adding 10% of glass powder compared with 15% of glass powder in the composite.
2. And the tensile strength was slightly decreased when adding 5% of glass powder as filler material.
3. When adding 5% of glass powder as filler material in the composite the impact energy was increased.
4. When adding 10% of glass powder as filler material in the composite the impact energy was decreased.
5. The hardness of the composite was increased when adding 15% of glass powder and slightly decreased when adding 10% of glass powder as filler material with the composite.
6. The impact test done and the composition of 15% gives high value

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