Experimental Investigation on E-Glass Fiber with Additives

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Abstract: **The aim of this present topic is to fabricate glass fiber reinforced polymer laminates using Hand lay-up and press moulding techniques, sample prepared as per ASTM standards. These specimens are tested under tensile test, flexural test and compressive tests. These laminates will be prepared with varying additives. The main theme of this project is to study the strength of glass fiber reinforced polymer composites. These composites are known to enhance the mechanical properties. In the present work, E-glass fiber is incorporated in a polyester resin matrix to form bi-directional reinforced composite.**

***Keywords*:- E-Glass fiber, Additives, Resin, Laminates, ASTM standards.**

I. INTRODUCTION

1.1 Composite Materials

Composite materials are those that are produced by the combination of two or more materials to accomplish properties that are greater to those of its constituents. In general, a composite material is composed of reinforcement (fibers, particles, flakes, and/or fillers) embedded in a matrix (polymers, metals, or ceramics). The matrix holds the reinforcement to form the desired shape while the reinforcement improves the overall mechanical properties of the matrix. When designed properly, the new combined material exhibits better strength than each individual material. Most commonly, composite materials have a bulk phase, which is continuous, called the matrix, and one dispersed, non- continuous, phase called the reinforcement, which is usually harder and stronger.

II. EXPERIMENTAL SET UP

2.1 Materials and components used: Following is the list of materials used while preparing the laminate:

I. Die.
II. Resin. (Ly 556)
III. Hardener. (Hy 951)
IV. Glass fibers. (E-glass WOVEN ROVING)
V. Additives(silicon/slag/whiteclay/graphite)
VI. Other accessories

2.2 Preparation for composites

Material Required For Specimen Preparation

Preparation for making a composite material is done in two phases.

Phase1: Ply and laminate preparation
Phase2: Test specimen preparation

Phase1

2.2.1 Ply preparation

Bidirectional (woven roving) ply is used in preparation of laminates.

2.2.2 Preparation of bi-directional ply

Woven roving is cut into 300mm by 300mm dimensions. Sixteen such chopped mats are required to form the four types of laminates. Woven roving preparation does not need much preparation work as required for unidirectional plies.

2.2.3 Manufacturing method for composite Hand lay –up

It is manual fabrication process. It involves building up layers of chopped glass or woven glass mat impregnated with catalyzed resin around a suitable mold. The reinforcement is then rolled for better wet-out and removing trapped air. Resin is mixed with a hardener if working with epoxy, otherwise it will not cure (harden) for days/ weeks. Next, the mold is wetted out with the mixture. The sheets of fiberglass are placed over the mold and rolled down into the mold using steel rollers. The material must be securely attached to the mold; Air must not be trapped in between the fiberglass and the mold.

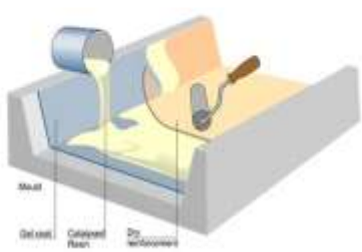

Fig. 2.1 Hand Lay-Up

Additional resin is applied and possibly additional sheets of fiberglass. Rollers are used to make sure the resin is between all the layers, the glass is wetted throughout the entire thickness of the laminate, and any air pockets are removed. The work must be done quickly enough to complete the job before the resin starts to cure. After completing the rolling action, a compressive force is applied by putting some weight on it ,and it removed after 24 hrs. Various curing times can be achieved by altering the amount of catalyst employed. It is used for large diameter structure and custom shapes like asymmetric shapes and for bonding two or more modules.

III. RESULTS AND DISCUSSION

At the outset, the data obtained on the basic characteristics of E-Glass fiber of polymer matrix composite with additives is presented and discussed. It is followed by a laboratory study under the influence of external force acting upon that composite by performing the different types of mechanical behavior tests. Inter-relations between different parameters involved are presented and discussed. The test results are obtained from tested samples (i.e. from tensile, flexural and compressive tests) is presented and analyzed.

a. Tensile Strength (ASTM D638)
b. Compressive Strength (ASTM D695)
c. Flexural Strength (ASTM D790)

Tabular form of compressive test results

specimen	Thickness (mm)	Width (mm)	Maximum Load (N)	Yield Strength	Compressive Strength(MPA)	Anvil height(mm)
graphite	25.71	12.55	19667.86	57.95	60.96	24.59
Iron slag	25.71	13.4	23746.49	40.12	68.93	25.66
Silicon	21.64	12.16	27917.22	89.85	197.24	24.62
White sand	25.62	12.99	18166.71	51.5	54.59	25.4
Fiber without additive	25.5	12.35	19234.12	58.12	60.23	24.87

3.1 Compressive test results:

Here the compressive test results of composite, there is difference in compressive strength varying the additives

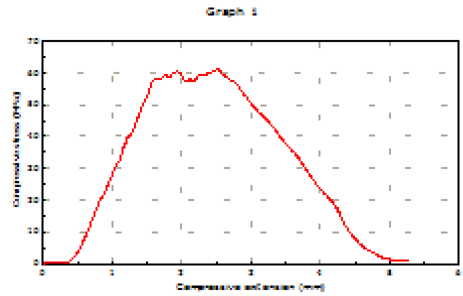

Fig 3.1.1 Compressive Graph of Graphite

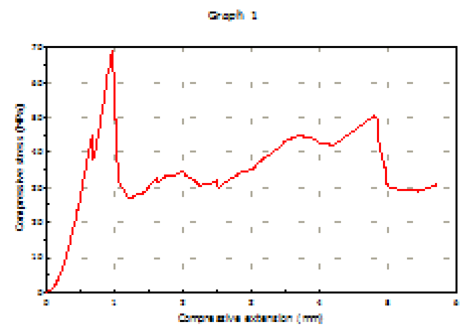

Fig 3.1.2 Compressive graph of iron slag

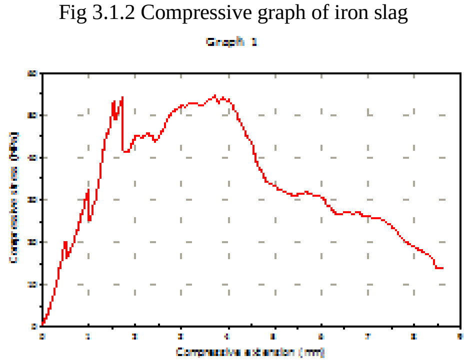

Fig 3.1.3 Compressive graph of silicon

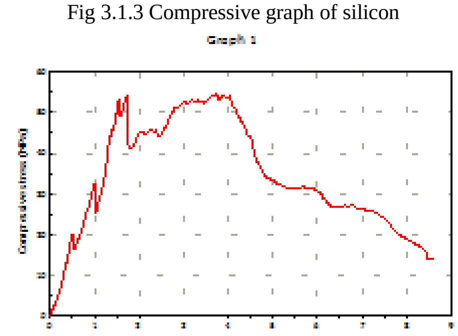

Fig 3.1.4 Compressive Graphs of White Sand

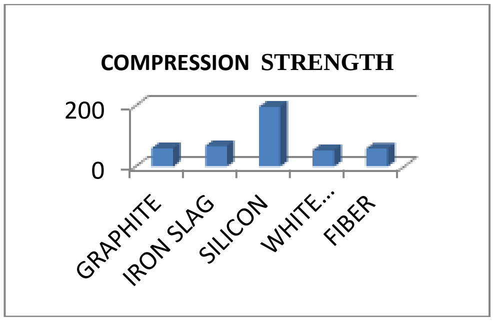

Fig 3.1.5 Bar diagram of compressive results of varying additives

3.2 Flexural test results :

Here the Flexural test results of composite, varying the additives

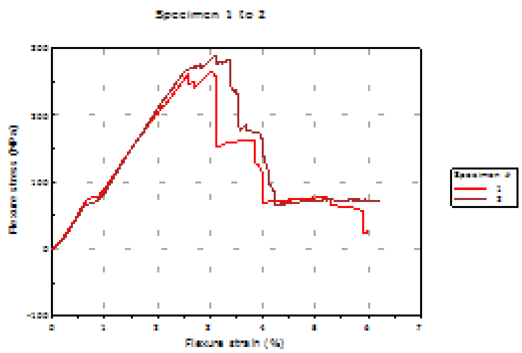

Fig 3.2.1 Flexure Graph of Graphite

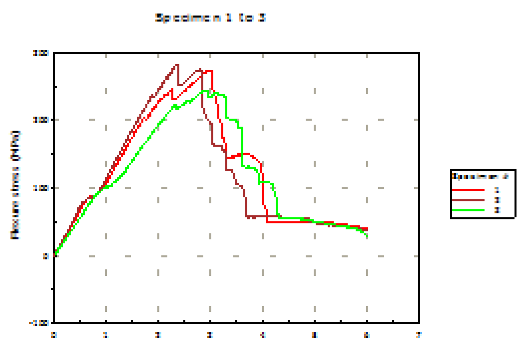

Fig 3.2.2 Flexure Graph of Iron slag

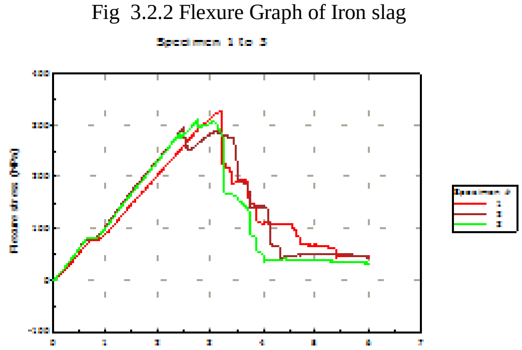

Fig 3.2.3 Flexure Graph of silicon

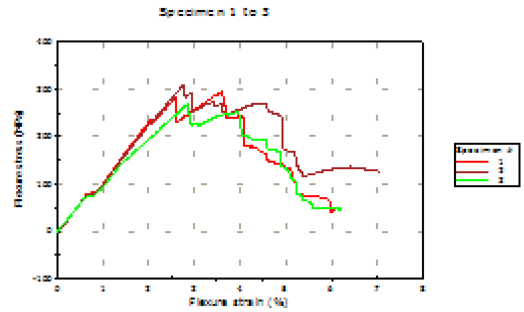

Fig 3.2.4 Flexure Graph of white sand

Specimen	Thickness(mm)	Width (mm)	Max load(N)	Max stress (mpa)	Flex Modulus (mpa)	Flexure extension at Maximum Flexure load (mm)	Flexure stress at maximum flexure load (mpa)
Graphite	3.16	12.85	491.9	277.969	12303.8	3.80	277.96
Iron slag	3.09	12.88	383.2	266.961	13014.7	3.49	266.96
Silicon	3.03	12.68	501.62	311.621	13029.3	3.61	311.62
White sand	3.08	12.68	478.4	291.709	12751.5	3.92	291.70
E GLASS FIBER	2.6	13.82	692.84	367.03	16733.9	3.58	289.52

Fig 3.2.5.Tabular form of mean values of flexural results

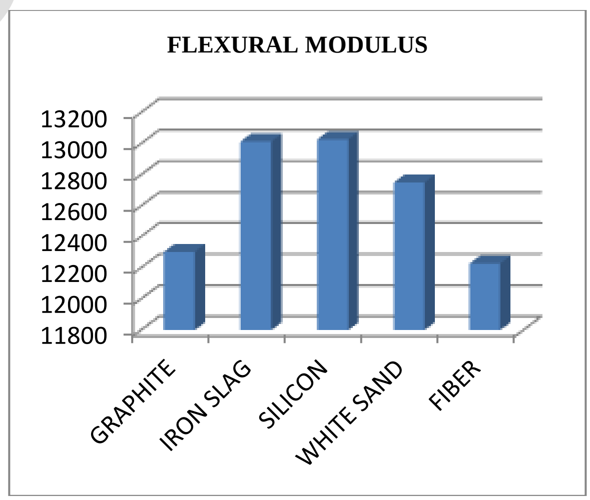

Fig.3.2.6 Bar chart of flexural results of varying additives

3.3 Tensile test results :

Here the tensile test results of composite,varying the additives

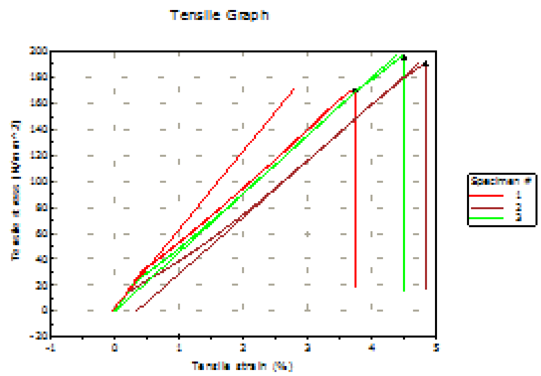

Fig 3.3.1 Tensile graph of graphite

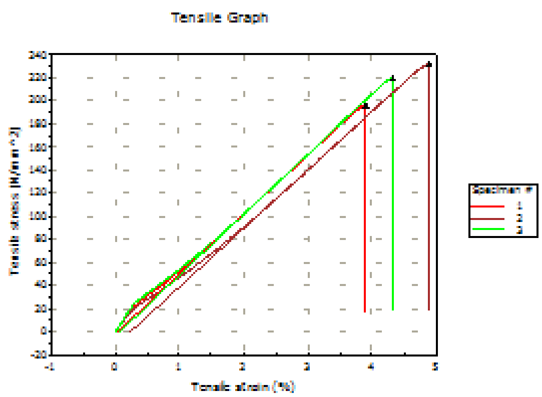

Fig 3.3.2 Tensile graph of iron slag

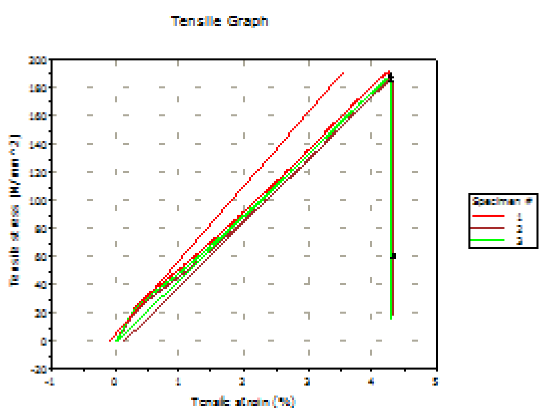

Fig 3.3.3 Tensile graph of silicon

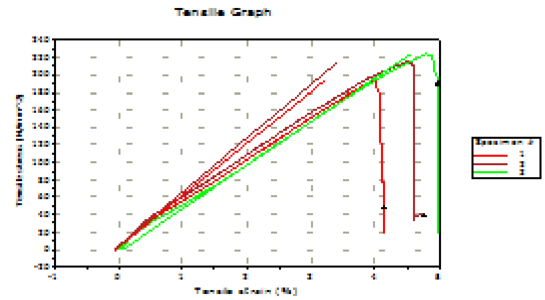

Fig 3.3.4 Tensile graph of white sand

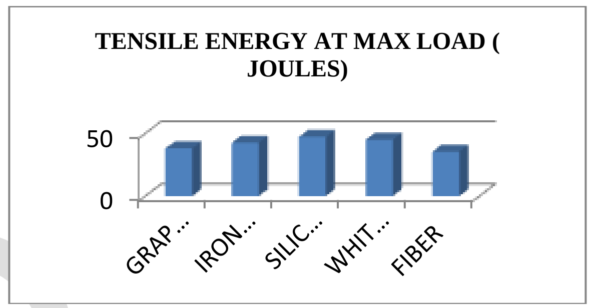

Fig.3.3.5 Bar diagram of Tensile results of varying additives

Result Analysis of Data

specimen	Thickness (mm)	Width (mm)	Maximum Load (N)	Tensile stress at Maximum Load (mpa)	Load at Break (Standard) (N)	Tensile extension at Maximum Load (mm)	Energy at Break (Standard) (J)	Energy at Maximum Load (J)
graphite	3	25	12873.74	171.65	12842.6	4.29516	29.107	29.00
Iron slag	3	25	16756.3	216.467	16725.1	5.02003	42.801	42.69
silicon	3.15	24.8	16773.9	188.683	17393.5	5.92233	47.504	47.13
white sand	3.1	25.1	16443.5	211.329	7246.16	5.09829	47.496	45.01
Eglass fibre	3.35	24.4	14630.7	169.8	14630.7	4.71	38.495	35.53

SI.NO	TENSILE TEST				COMPRESSIVE TEST			FLEXURAL TEST			
	THICKNESS (mm)	WIDTH (mm)	ENERGY AT MAXIMUM LOAD (J)	TENSILE EXTENSION AT MAX LOAD (mm)	THICKNESS (mm)	WIDTH (mm)	COMPRESSIVE STRENGTH (MPA)	THICKNESS (mm)	WIDTH (mm)	FLEXURAL STRESS AT MAXIUM FLEXURAL LOAD (MPA)	Flex modulus (mpa)
GRAPHITE	3	25	37.93158	5.01460	25.71	12.55	60.96	3.16	12.85	277.96	12303.811
IRON SLAG	3	25	42.69903	5.02003	25.71	13.4	68.93	3.09	12.88	266.96	13014.708

SILICON	3.15	24.8	46.79882	5.92233	21.64	12.16	197.24	3.03	12.68	311.62	13029.315
WHITE SAND	3.1	25.1	45.01785	5.09223	25.62	12.99	54.59	3.08	12.68	291.70	12751.579
FIBRE WITHOUT ADDTIVE	3.35	24.24	35.53159	4.71	25.50	12.35	60.23	3.03	12.90	293.45	12229.145

IV. CONCLUSION

E Glass reinforced with additives i.e., graphite, silicon, white sand and iron slag were successfully fabricated with reinforcement of additives by casting (hand lay up method). The tests were conducted on those material. Based on the experimental observations the following conclusions have been drawn.

Various tests were conducted on the specimens of E Glass fiber fabricated with additives from those testing results. We can observe the best material for further application like cooling towers household appliances automotive fields.

The Energy at maximum load is (35.5315 J) for E Glass. From the previous observed data. the Energy at maximum load is better in fiber reinforced with silicon(46.7988 J) the rate of Energy is increased, when compared to other additives .So that E GLASS fiber composites can be used in application where a greater extent of tensile strength is desirable .

The yield strength (offset 0.2%) is greater in fiber reinforced with silicon (89.85%)when compared to other additives The flexure test(3 pointed) will provide mechanical behavior of the specimen.

Flexure stress at maximum flexure load and flexure modulus (tendency for a material to bend) is greater in fiber reinforced with silicon when compared with E Glass fiber and other additive materials.,So that finally concluded that the E GLASS fiber is greater in strength but when we fabricated with additives it will gain strength more over the fiber composite will increase its strength with increase in thickness.

Future scope

E GLASS with additives we can test creep and fatigue, wear test and we can apply the material on components and scope of doing thermal analysis.

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