

# Fabrication, Testing, Analysis on Glass and Jute Fibers Reinforced with Bentonite Nano Clay Filler, Epoxy Hybrid Composites

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**ABSTRACT:** Composite, the 21<sup>st</sup> century materials to meet the stringent demands of light weight, high strength, corrosion resistance and near-net shapes. Composite is a structural material that consists of two or more combined constituents that are combined at a macroscopic level and are not soluble in each other. Composites are having two phases that are reinforcing phase like fiber, particle, or flakes & matrix phase like polymers, metals, and ceramics.

In this paper an attempt is made to prepare two different composite materials using **glass mill** and **jute** reinforcement, **bentonite nano clay** as filler and **Epoxy** as the matrix material respectively. Composites were prepared by increasing the weight of fibers like 5,10,15,20 grams for reinforcement respectively by Hand Layup technique. Flexure and tensile testing of the material was done by cutting the material into ASTM D790-03 and ASTM D638-10 standards on an UTM Tester. Chemical tests were conducted for the respective composite materials by cutting some specimen into ASTM D 543-87 standards from the material and immersing it in the chemicals like Sodium Hydroxide, Benzene, Toluene, Ammonium Hydroxide etc. It was found that as the weight of fiber increases there is improvement in the flexural and tensile properties of the composite material and also its chemical properties towards various chemicals

**KEYWORDS:** Composite, Glass and jute fibers, Epoxy, Hand layup, Flexure, Tensile, Chemicals.

## I. INTRODUCTION

Composites, primarily glass but including natural reinforced composites are found in countless consumer products including: boats, skis, agricultural machinery and cars. Composite materials are made up of two or more materials on a macroscopic scale possessing hybrid properties of all the materials in the composite. Polymer matrix composites are plastics (resins) within which there are embedded fibres. The plastic is known as the matrix, and the fibres orientated within it are known as the reinforcement. The reinforcement tends to be stiffer and stronger than the matrix providing stiffness and strength. Reinforcement is laid in a particular direction, within the matrix; so that the resulting material will have different properties in different directions i.e. composites have anisotropic properties. This characteristic is exploited to optimise the design and provide high mechanical performance where it is needed.

There are two types of constituent materials: matrix and reinforcement. At least one portion (fraction) of each type is required. The matrix material surrounds and supports the reinforcement materials by maintaining their relative positions and its main function is to transfer the load between reinforcement components for a better composite material. The reinforcements impart special physical (mechanical and electrical) properties to enhance the matrix properties. The points to be noted in selecting the reinforcements include compatibility with matrix material, thermal stability, density, melting temperature etc. Fig.1 shows the various types of reinforcements used in composites.

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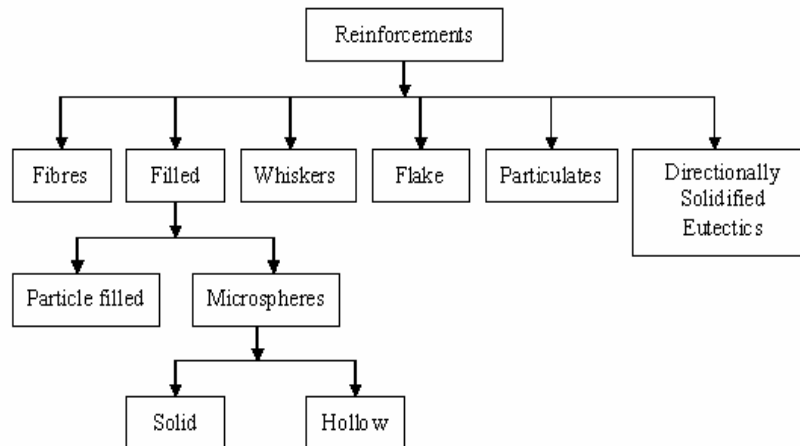


Fig.1 types of reinforcements

Fibers are of two types, namely natural fibers and synthetic fibers. Natural fibers such as bamboo, sisal, jute etc are used as reinforcement and either thermoset or a thermoplastic are used as matrix. Synthetic fibers are polyesters, aramide, nylon etc. The fibers may be continuous (long) or discontinuous (short).

The matrix must have a mechanical strength commensurate with that of the reinforcement i.e. both should be compatible. Thus, if a high strength fibre is used as the reinforcement, there is no point using a low strength matrix, which will not transmit stresses efficiently to the reinforcement. The matrix must stand up to the service conditions, viz., temperature, humidity, exposure to ultra-violet environment, exposure to chemical atmosphere, abrasion by dust particles, etc. It should not be toxic and should have a high flash point.

## II. MATERIAL

Glass, jute fibres and bentonite nano clay is used as filler are collected. Fibers are cut to a length equal to the length of the mould. Epoxy mixed with hardener was used as matrix material. Bentonite nano clay of 20 gms is added as filler upon the fibres. Epoxy and hardener were mixed at a ratio of 20:1 respectively. Glass mould with the dimensions 200mm x 200mm x 3mm (length x width x thickness) was used for the preparation of the composite. Other ingredients which were helpful in preparing the composite are releasing agent, OHP paper and a roller.

## III. EXPERIMENTAL SETUP

The releasing agent used is hard wax which is applied over the mould such that the wax is equally spread and it is dried for about half an hour. Epoxy and hardener are thoroughly mixed in a separate beaker. The composite material is prepared by using Hand Layup Technique and the mould was covered with an OHP paper and weights were kept on it. While performing hand layup technique care should be taken to avoid formation of voids within the composite. After that mould was kept for about 24 hours to get hardened. After 24 hours the mould was kept in an oven for 20 minutes such that the releasing agent gets melted and it will be easy to remove the composite material from the glass mould. And then the composite material was kept in the oven for about one hour for curing purpose. After curing the material is kept under weights so that the material gets a uniform shape like the shape of the mould cavity.

### Chemical Testing

The material is cut into ten specimens with dimensions 10mm x 5mm x 3mm for chemical test as per ASTM D 543-87 specifications. The preweighted specimens were immersed in ten different chemicals for 24 hours in a test tube and

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then were removed, rinsed with distilled water and dried by pressing them on both sides with a filter paper at room temperature. The specimens were reweighted and the % weight gain/loss was recorded with the formula below.

$$W = \frac{W_2 - W_1}{W_1}$$

Where W - Gain/loss weight of final specimen.

w1 - weight of specimen before immersing in chemical.

w2 - weight of specimen after immersing in chemical.



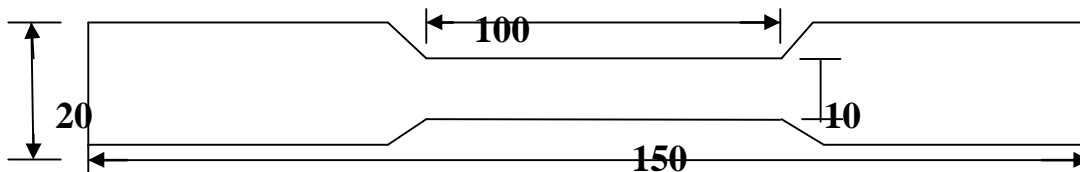
Specimens in chemicals



specimens

### Tensile Testing

The material is cut into specimens with dimensions 120mm x 13mm x 3mm and a notch was made at the centre of the specimen at 45 degrees angle for tensile testing as per ASTM D638-10 specifications. The tensile strength of the specimen is determined using UTM tensile tester. The samples were tested at a cross head speed of 2 mm/min, using an electronic tensometer, (UTM) supplied by M/s Mikrotech, Pune, India. The tensile test determines the overall strength of the given object. In a tensile test, the object fitted between two grippers at either end then slowly pulled apart until it breaks. A tensile provides vital information related to a product's durability including yield point, tensile strength and proof stress.



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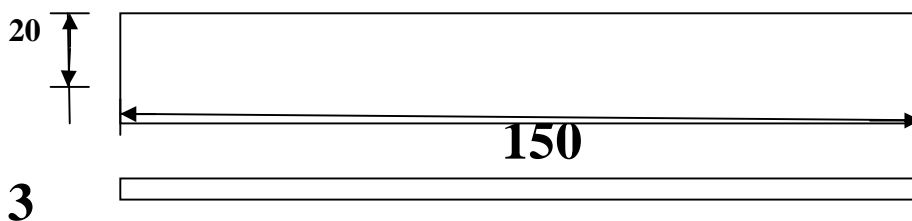
Specimens



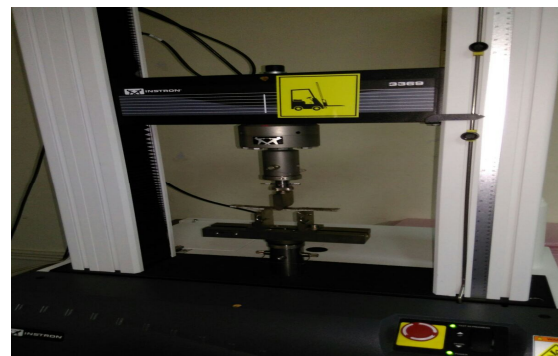
UTM apparatus

## Flexural Test:

Flexural test were performs using 3-point bending method according to ASTM D790-03 procedure. The specimens were tested at a cross head speed of 2 mm/min, at a temperature 22°C and humidity 50%.



Specimens



UTM Apparatus

## IV. RESULTS AND DISCUSSION

### Chemical Test

Chemicals used for the tests are Nitric acid, Hydrochloric acid, Acetic acid, Sodium Hydroxide, Sodium Carbonate, Ammonium Hydroxide, Benzene, Toluene, Carbon Tetrachloride and Distilled water. The test is performed carefully so that our hands are not exposed directly to the chemicals. Table I, Table II and Table III show the chemical test values of the specimens of 20gms glass, 10gms jute 10gms glass and 20gms jute fibre reinforced epoxy matrix composites

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respectively. Weight of specimen before immersing in chemical ( $w_1$ ) and weight of specimen after immersing for 24 hours ( $w_2$ ) are noted and the gain/loss weight of the specimen ( $W$ ) is calculated.

TABLE I  
Chemical Test values of 20gms glass

Chemicals	$W_1$	$W_2$	$W = \frac{w_2 - w_1}{w_1}$
40% nitric acid	0.25	0.19	-0.24
10% Hydrochloric acid	0.31	0.28	-0.097
8% Acetic acid	0.25	0.20	-0.24
10% sodium hydroxide	0.24	0.30	+0.25
20% sodium carbonate	0.29	0.28	-0.034
10% Ammonium Hydroxide	0.24	0.19	-0.21
Benzene	0.28	0.27	+0.036
Toluene	0.25	0.20	-0.24
Carbon tetrachloride	0.30	0.25	-0.16
Distilled Water	0.23	0.20	-0.13

TABLE II  
Chemical Test values of 10gms jute 10gms glass

Chemicals	$W_1$	$W_2$	$W = \frac{w_2 - w_1}{w_1}$
40% nitric acid	0.22	0.21	-0.045
10% Hydrochloric acid	0.24	0.26	+0.08
8% Acetic acid	0.20	0.19	-0.05
10% sodium hydroxide	0.30	0.32	+0.06
20% sodium carbonate	0.26	0.28	+0.077
10% Ammonium Hydroxide	0.21	0.24	+0.14
Benzene	0.25	0.26	+0.045
Toluene	0.26	0.25	+0.038
Carbon tetrachloride	0.23	0.24	+0.044
Distilled Water	0.24	0.26	+0.08

TABLE III  
Chemical Test values of 20gms jute

Chemicals	$W_1$	$W_2$	$W = \frac{w_2 - w_1}{w_1}$
40% nitric acid	0.34	0.35	+0.029
10% Hydrochloric acid	0.29	0.28	-0.034
8% Acetic acid	0.31	0.30	-0.032
10% sodium hydroxide	0.31	0.33	+0.065

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20% sodium carbonate	0.23	0.32	+0.39
10% Ammonium Hydroxide	0.24	0.27	+0.125
Benzene	0.23	0.27	+0.174
Toluene	0.21	0.19	-0.095
Carbon tetrachloride	0.23	0.24	+0.043
Distilled Water	0.24	0.29	0.21

### Tensile Test

The tensile test determines the overall strength of the given object. In a tensile test, the object fitted between two grippers at either end then slowly pulled apart until it breaks. A tensile provides vital information related to a product's durability including yield point, tensile strength and proof stress.

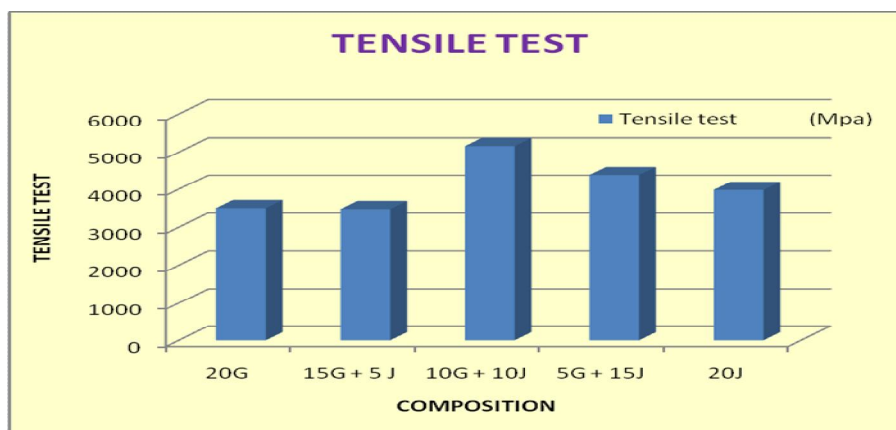
Table IV and Table V show the tensile testing values of glass and jute fibers with bentonite nano clay reinforced epoxy matrix composites respectively.

Table IV

Properties of the composites with different fiber percentages, 20 gms bentonite nano clay, epoxy at tensile test:

Composition	Tensile test (Mpa)	Maximum load (KN)	Maximum stress(Mpa)
20gms glass fiber	3506.71	1485.80	49.53
15gms glass fiber + 5gm jute fiber	3480.14	1050.33	35.01
10gms glass fiber + 10gms jute fiber	5160.32	1366.51	45.55
5gms glass fiber + 15gms jute fiber	4385.42	1340.83	44.69
20gms jute fiber	3981.47	477.67	15.92

Graph 1: Comparison of different percentages of composites at tensile test



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### Flexural Test:

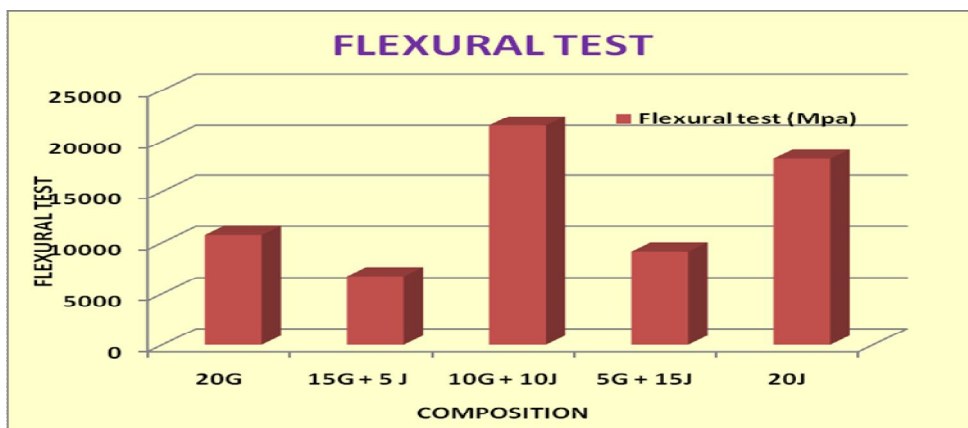
The flexural method measures behaviour of materials subjected to simple beam loading. It is also called as transverse beam test. Flexural strength is defined as maximum in the outer most fiber this is calculated at the surface of the specimen on convex side.

Table V

**Properties of the composites with different fiber percentages, 20 gms bentonite nano clay, epoxy at flexural test:**

Composition	Flexural test (Mpa)	Maximum load (KN)	Maximum stress(Mpa)
20gms glass fiber	10725.60	0.29	161.44
15gms glass fiber + 5gm jute fiber	6701.88	0.15	85.38
10gms glass fiber + 10gms jute fiber	21555.80	0.72	401.48
5gms glass fiber + 15gms jute fiber	9140.32	0.31	178.48
20gms jute fiber	18279.33	0.24	133.46

**Graph 2: Comparison of different percentages of composites at flexural test**



### V. CONCLUSION

These experimental investigation of mechanical behavior of glass and jute fibers reinforced epoxy composites with bentonite nano clay filler leads to following conclusions.

- This work shows that successful fabrications of glass and jute fibers reinforced composites with different fiber weight is possible by simple hand lay-up technique.
- It has been noticed that the mechanical properties of the composites such as tensile strength, flexural strength and chemical test of the glass and jute composites are greatly influenced by the fiber weights

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- From flexural strength (young's modulus) test, we conclude that flexural strength reaches a maximum point when glass and jute fiber is reinforced with equal proportions.
- From tensile test, we conclude that the proposed glass and jute composite materials have strength when glass and jute fiber is reinforced with equal proportions.

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