

# Investigation on Mechanical Properties of Jute/Glass Fiber Reinforced Nano Clay Hybrid Composites

Hanamantappa N Unki<sup>1</sup>, Dr H K Shivanand<sup>2</sup>, Dr H N Vidyasagar<sup>2</sup>, Ambarisha M<sup>3</sup>

PhD Scholar, Department of Mechanical Engineering, UVCE, Bangalore, India<sup>1</sup>

Associate Professor, Department of Mechanical Engineering, UVCE, Bangalore, India<sup>2</sup>

ME Scholar, Department of Mechanical Engineering, UVCE, Bangalore, India<sup>3</sup>

**ABSTRACT:** Over the last twenty to thirty years composite materials have been used in engineering field. Composite materials possess high strength, high strength to weight ratio due to these facts composite materials are becoming popular among researchers and scientists. The major proportion of engineering materials consists of composite materials. Composite materials are used in vast applications ranging from day-to-day household articles to highly sophisticated applications. In this paper an attempt is made to prepare three different composite materials using e-glass and jute. In this present investigation hybrid composite of Jute, Glass fiber, Nanoclay will be prepared by Hand-layup technique. The glass fiber used in this present investigation is E-glass fiber bi-directional: 90° orientation. The composite samples will be made in the form of Laminates. The wt% of nanoclay added in the preparation of sample is 20 gm constant. The fabricated composite Laminate will be cut into corresponding profiles as per ASTM standards for Mechanical Testing. The effect of addition of Nano clay and variation of jute/glass fibers will be studied. In the present work, a new Hybrid composite is developed in which jute, E glass fibers is reinforced with epoxy resin and with Nano clay.

**KEYWORDS:** JUTE, EGLASS, BENTONITE NANO CLAY.

## I. INTRODUCTION

Composites are found in countless consumer products including: day to day household items, marine, agricultural equipments and automobile applications. 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 used as the matrix, and the fibres orientated within materials are known as the reinforcement. The reinforcement results to be stiffer and stronger than the matrix material which provides stiffness and strength. Composites have anisotropic properties in nature like reinforcement is laid in a particular direction within the matrix so that the resulting material will have different properties in different directions. This characteristic is useful to optimise the design requirement and provide good mechanical properties where it is required.

There are two different kinds of constituent materials i.e. matrix and reinforcement. At least one fraction (portion) of each type is needed. By maintaining their relative positions the matrix material surrounds and supports the reinforcement materials and its main objective is to transfer the load between reinforcement components for a better composite material. The reinforcements impart special mechanical properties to enhance the matrix properties. The points to be careful while selecting the reinforcements include compatibility with matrix material, thermal stability, density, melting temperature etc.

Fibers are of two types, namely natural fibers and synthetic fibers. Natural fibers such as Bamboo, Sisal, Jute, Kevlar etc are used as reinforcement and either thermoset or thermoplastic are used as matrix. Synthetic fibers are polyesters, aramide, nylon etc. The fibers may be continuous or discontinuous.

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The matrix and reinforcement must be compatible i.e. both should have a mechanical strength commensurate with that of the reinforcement. 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

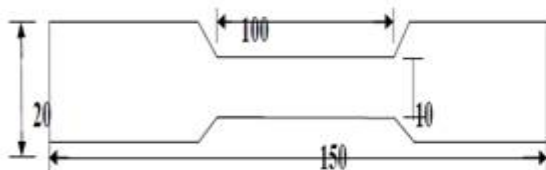
Jute fibre, Glass fibers, nano clay of bentonite is used as filler material these are collected. Fibers are cut to a length equal to the length of the mould. Epoxy mixed with hardener was used as matrix material. Bentonite nano clay of 20 gm is added as filler upon the fibres. Epoxy and hardener were mixed at a ratio of 10:1 respectively. A 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 hard wax used as releasing agent which is applied over the mould such that the wax is equally spread and it is dried for about 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 vacuum bagging process is carried out on it about an hour in order to cure thoroughly to avoid formation of voids within the composite. After that mould was kept for about 24 hours to get hardened. After that the mould was kept in an oven for curing purpose about an hour such that the releasing agent gets melted and to increase the properties too. After curing the material gets a uniform shape like the shape of the mould cavity.

### Tensile Test

The material is cut into specimens with dimensions 150mm x 20mm 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 digitalized UTM tensile tester. The samples were tested at a cross head speed of 2mm/min using an electronic tensometer (UTM). It 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. Tensile test provides vital information related to a composites durability including yield point, tensile strength and proof stress.



Note: - All dimensions are in mm



Figure 2.1: Tensile Test specimens

### Flexural Test

The material is cut into specimens with dimensions 150mm x 20mm x 3mm testing as per ASTM D790-03 specifications. Flexural tests were performed using UTM 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%.



Note: All dimensions are in mm



Figure 2.2: Flexural Test specimens

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## Compressive test

The material is cut into specimens with dimensions 50mm x 50mm x 3mm testing as per ASTM D695 specifications. The Compressive strength of the specimen is determined using digitalized UTM tensile tester. The samples were tested at a cross head speed of 2mm/min using an electronic tensometer (UTM). The Compressive test determines the overall strength of the given object. In a Compressive test, the object is fitted between two grippers at either end then slowly compressed apart until it breaks. A Compressive test provides vital information related to a composite's durability including yield point, Compressive strength and proof stress.

## IV. RESULTS AND DISCUSSION

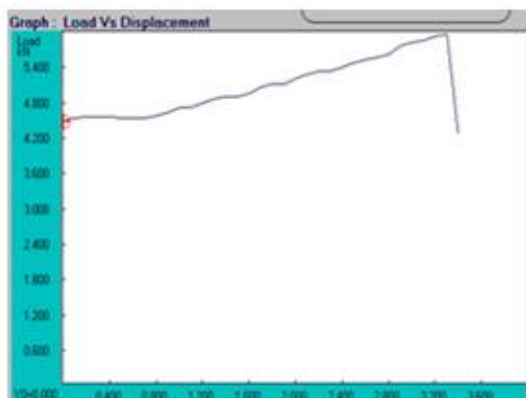
### Tensile Test

Table 1 shows the tensile testing values of glass/jute fibers with constant 20gm Bentonite nano clay reinforced epoxy matrix composites respectively. Graph 1, 2 & 3 shows the variation of load v/s displacement plots of tensile test for different composite compositions.

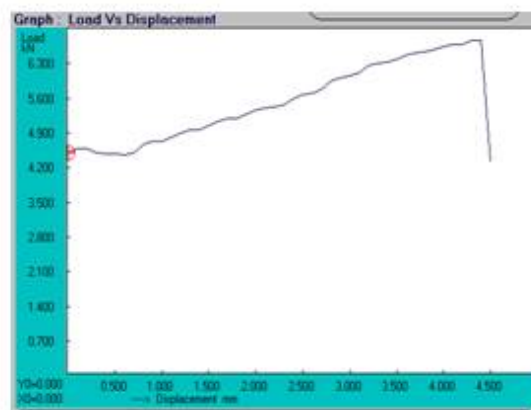
From the Table 1 & Graph 1, 2 & 3 it is observed that equal proportion of glass and jute fibers gives better results, this is due to addition of jute beyond certain limit will result in decrease of force hence of tensile properties too.

**Table 1 - Properties of composites with different fiber percentages, 20 Gms bentonite nano clay, epoxy at tensile test;**

	Break load, KN	Displacement mm	Max Displacement (F max) mm	Ultimate stress, KN/sq.-mm	Elongation, %	Yield stress, KN/sq.-mm	Peak load, KN
<b>70%J-30%G</b>	<b>4.28</b>	<b>3.3</b>	<b>3.4</b>	<b>0.119</b>	<b>4.25</b>	<b>0.152</b>	<b>5.96</b>
<b>50%J-50%G</b>	<b>4.32</b>	<b>4.3</b>	<b>4.5</b>	<b>0.225</b>	<b>5.625</b>	<b>0.153</b>	<b>6.76</b>
<b>30%J-70%G</b>	<b>4.2</b>	<b>3.3</b>	<b>4.0</b>	<b>0.193</b>	<b>5.0</b>	<b>0.150</b>	<b>5.78</b>



**Graph 1 : 70%J – 30% G**

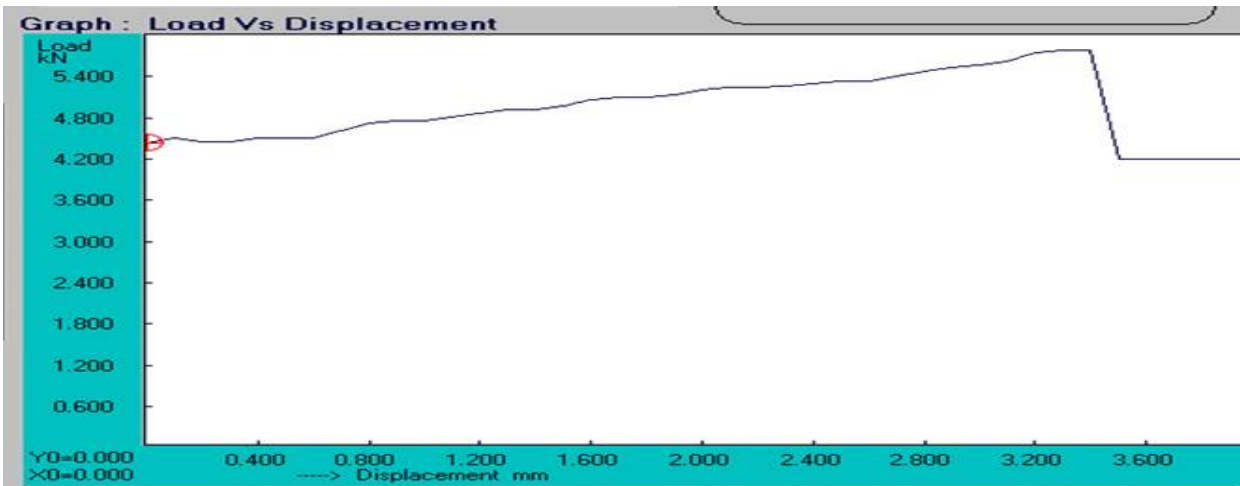


**Graph 2: 50%J -30%G**

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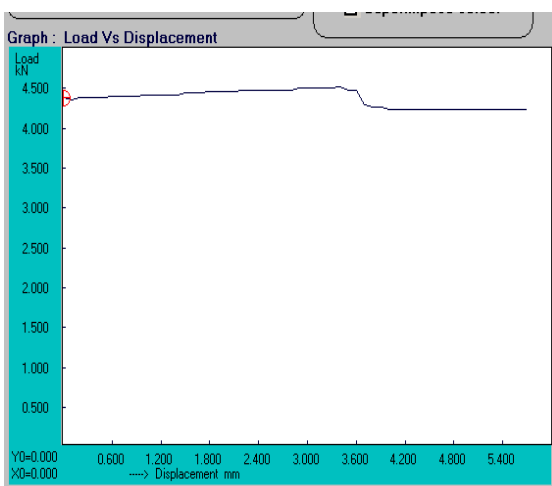


**Graph 3: 30%J-70%G**

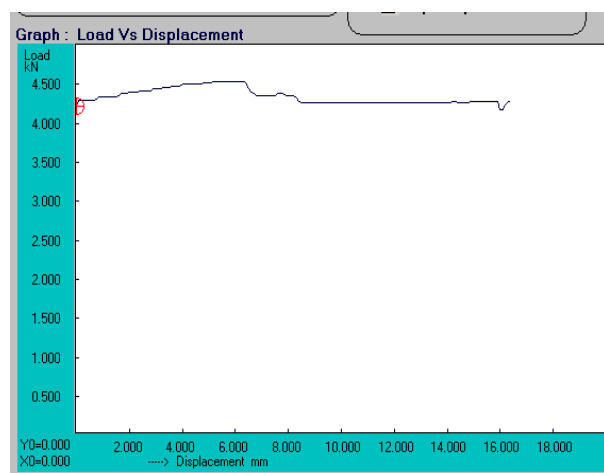
### Flexural Test

Table 2 shows the flexural testing values of glass/jute fibers with constant 20gm Bentonite nano clay reinforced epoxy matrix composites respectively. Graph 4, 5 & 6 shows the variation of load v/s displacement plots of flexural test for different composite compositions.

From the Table 2 & Graph 4, 5 & 6 it is observed that as increase in glass proportions will increase the flexural properties of compositions, this is May due to addition of Nano clay, intermolecular forces of jute, fiber & glass matrix reinforcement effects will decrease flexural properties.



**Graph 4: 70%J-30%G**



**Graph 5: 50%J-50%G**

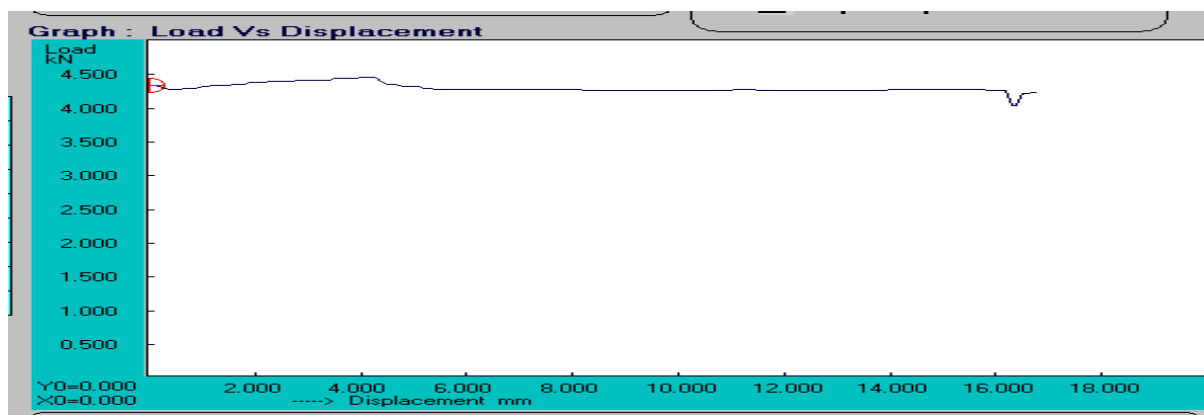
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**Table 2 - Properties of composites with different fiber percentages, 20 Gms bentonite nano clay, epoxy at flexural test;**

	Break load, KN	Displacement mm	Max Displacement (F max) mm	Area, sq.-mm	Bending strength, KN/sq. mm	Bending stress KN/sq. mm	Modules of elasticity KN/sq. mm	Max bending moment, KN-mm
70%J-30%G	4.24	3.4	5.7	60	0.075	1.356	28.715	40.68
50%J-50%G	4.46	4.0	16.8	60	0.074	1.338	24.084	40.14
30%J-70%G	4.54	5.2	16.4	60	0.076	1.362	18.858	40.860



**Graph 6: 30%-70%G**

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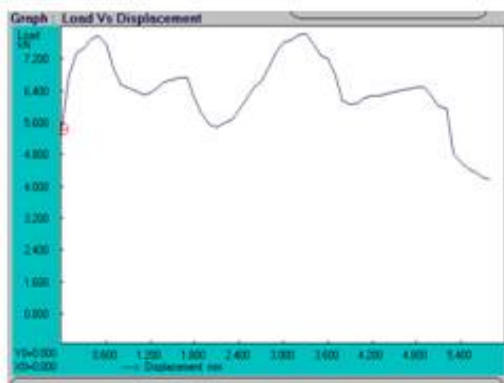
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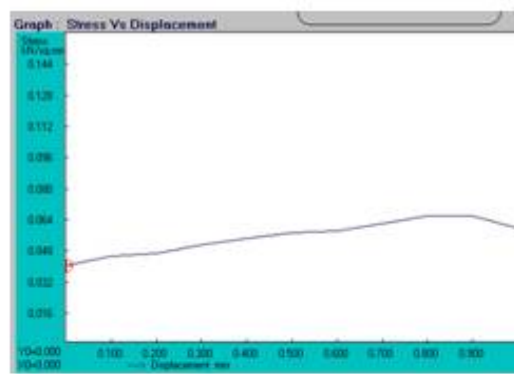
## Compressive Test

Table 3 shows the compressive testing values of glass/jute fibers with constant 20gm Bentonite nano clay reinforced epoxy matrix composites respectively. Graph 7, 8 & 9 shows the variation of load v/s displacement plots of compressive test for different composite compositions.

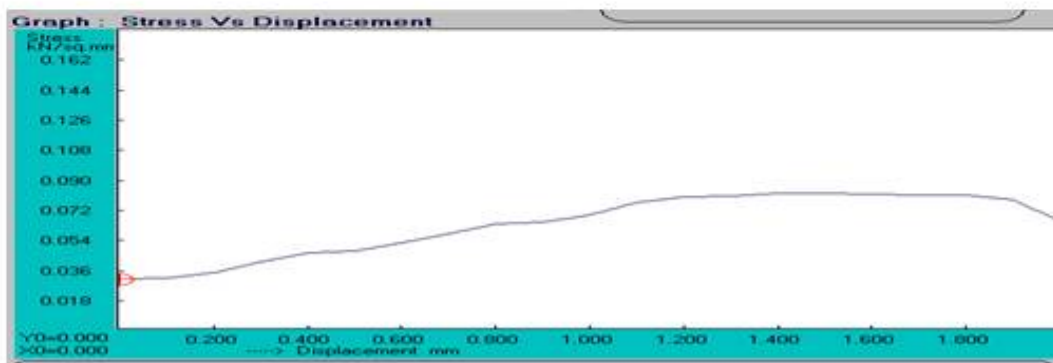
From the Table 3 & Graph 7, 8 & 9 it is observed that increase in proportion jute fiber gives better results due to addition jute will increase the bonding strength because of formation of voids & matrix interactions hence compressive properties too.



Graph7:70%J-30%G



Graph 8: 50%J-50%G



Graph 9: 30%J-70%G

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**TABLE 3 - Properties of composites with different fiber percentages, 20 Gms bentonite nano clay, epoxy at compressive test;**

	<b>Break load, KN</b>	<b>Displacement mm</b>	<b>Max Displacement (F max) mm</b>	<b>Area, sq.-mm</b>	<b>Ultimate stress, KN/sq.-mm</b>	<b>Peak load, KN</b>
<b>70%J-30%G</b>	<b>9.86</b>	<b>1.5</b>	<b>2</b>	<b>150</b>	<b>0.082</b>	<b>12.36</b>
<b>50%J-50%G</b>	<b>8.98</b>	<b>0.9</b>	<b>1</b>	<b>150</b>	<b>0.066</b>	<b>9.88</b>
<b>30%J-70%G</b>	<b>4.18</b>	<b>3.3</b>	<b>5.8</b>	<b>150</b>	<b>0.052</b>	<b>7.80</b>

### V. CONCLUSION

This investigation of glass/jute fibers reinforced epoxy composites with bentonite nano clay filler leads to following significant conclusions.

- The incorporation of nano clay into the epoxy fibers shows the mechanical properties almost enhanced to greater extent.
- It is observed that the addition of nano clay greatly influenced on jute/glass composite strengths.
- This work shows successful fabrication of a new class of epoxy based hybrid composites reinforced with jute/glass fibre is possible.
- A simple hand lay-up technique is adopted to fabricate successfully glass/jute fibers with different fibre proportions is observed.
- It is noticed that the mechanical properties of the composites such strength and compressive test of the glass/jute composites are greatly influenced by the fibre proportions.
- It is observed from tensile strength (young's modulus) test, tensile strength reaches a maximum point when glass and jute fiber is reinforced with equal proportions.

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