

# FABRICATION AND CHARACTERIZATION OF JUTE/GLASS FIBRE REINFORCED EPOXY HYBRID COMPOSITES

M. Pradeep<sup>1</sup>, B. Nela Baludu<sup>2</sup>, Sk. Khadar Basha<sup>3</sup>, P. Naga Naveen<sup>4</sup>, M. Somaiah Chowdary<sup>5</sup>

<sup>1,2,3,4</sup>Student; Dept. of Aeronautical Engg., PVPSIT, Andhra Pradesh, India

<sup>5</sup>Professor; Dept. of Mechanical Engg., PVPSIT, Andhra Pradesh, India

\*\*\*

**Abstract:** - Now a day's composites are playing a dominant role in many industrial applications. Major OMEs such as Airbus and Boeing have shown the potential for large-scale composite application in aviation, and NASA is continually looking to composite manufacturers for innovative space solutions for rocket and other spacecraft. In this point of view, the objective of our present work is to analyze the effect of hybrid fibers (glass fiber and jute fiber) on mechanical behavior of epoxy resin based composite. Different types of composites are fabricated by using hand layup method with 35wt% jute & 15wt% glass fiber, 25wt% jute & 25wt% glass fiber, 15wt% jute & 35wt% glass fiber, 28wt% jute & 12wt% glass fiber, 20wt% jute & 20wt% glass fiber, 12wt% jute & 28wt% glass fiber, 21wt% jute & 9wt% glass fiber, 15wt% jute & 15wt% glass fiber, 21wt% jute & 9wt% glass fiber. Tensile and bending tests conducted. The results of the study show that the presence of hybrid composites has a significant effect on the mechanical behavior of composites. The maximum loading of jute/glass fiber reinforced composites for tensile test was obtained at 20wt% jute & 20wt% glass fiber, where the maximum tensile strength obtained. The maximum loading of jute/glass fiber reinforced composites for bending test was obtained at 28wt% jute & 12wt% glass fiber, where the maximum flexural strength obtained.

**Key words:**-glass fiber, jute, OME (original equipment manufacturer), epoxy etc.

## 1. Introduction

**Composite:**-A composite material is a material fabricated of two or more materials that are combined in a way that allows the materials to stay distinct and identifiable. Most of composite materials have concrete, fiberglass, mud bricks, and natural composites such as animal fibers and wood. Composites are divided into two groups depending on a) Matrix Material b) Reinforcing Material.

**Glass fiber:** - Glass fiber has approximately similar mechanical properties to other fibers for instance polymers and carbon fiber. Though not as rigid as carbon fiber, it is much cheaper and significantly less brittle when used in composites. Therefore Glass fibers are used as a reinforcing material for

many polymer composites; to form a strong and moderately lightweight fiber-reinforced polymer (FRP) composite material called glass-reinforced plastic (GRP), also popularly known as "fiberglass". Glass reinforced composites not only limited to weight sensitive aerospace industry but also in automobiles, marine, railways, sport goods etc. This is ascribed to high specific strength and specific stiffness of the glass fiber reinforced composites.

**Jute fiber:** - Jute is one of the most affordable natural fibers, and second only to cotton in the amount produced and variety of uses. Jute fibers are composed primarily of the plant materials cellulose and lignin. Jute fiber is 100% bio-degradable and recyclable and thus environmentally friendly. Jute has low pesticide and fertilizer needs.

**Epoxy:** - In general, epoxies are known for their excellent adhesion, chemical and heat resistance, good-to-excellent mechanical properties and very good electrical insulating properties. Epoxy resins are low molecular weight pre-polymers or higher molecular weight polymers which normally contain at least two epoxide groups.

**Hybrid composite:**-Hybrid composites are more sophisticated composites as compared to conventional FRP composites. Hybrid composites may have more than one reinforcing phase and a single matrix phase or single reinforcing phase with multiple matrix phases or multiple reinforcing and multiple matrix phases. They have enhanced flexibility than other fiber reinforced composites. Generally it holds a high modulus fiber with low modulus fiber. The high-modulus fiber supply the stiffness and load bearing qualities, whereas the low-modulus fiber formulate the composite more damage tolerant and maintain the material cost low.

## 2. Materials and Fabrication:

### 2.1 Materials:-

1. Jute fiber
2. Glass fiber
3. Epoxy resin
4. Hardener

**2.2 Fabrication:-**The composites are fabricated by conventional hand layup method. The jute fiber and the glass fibers are taken as reinforcement and epoxy is used as matrix material. Glass fibers are obtained from Go Green products Ltd. The epoxy resin and the hardener are also obtained from Go Green products Limited. The low temperature epoxy resin and hardener are mixed in a ratio of 2:1 by weight percentage respectively. Composites of different compositions with three different fiber loading (30wt%, 40wt% and 50wt %) are made. Figure 2.1a and b shows jute fiber and glass fiber respectively. Similarly, Figure 2.2 shows jute/glass fiber reinforced epoxy hybrid composite. Each component is cured under a load of 40kgs for 24hours.



**2.1(A) jute fiber**



**2.1(b) glass fiber**

**2.3 Testing:-**

**2.3.1 Tensile test:-**

The most fundamental mechanical test that can be carrying out on a material is the tensile test. A given test sample is laden in tension when it experiences opposing forces acting upon opposite faces both located on the same axis that attempt to pull the specimen apart. These tests are so simple to setup and complete and divulge various characteristics of the material which is tested. The tensile specimens are prepared according to the ASTM D 638 M standards.

S.NO	composite	Tensile strength	Tensile modulus	Fiber percentage	
1	C1	72.67	302.8	15%J	35%G
2	C2	83.7	326.92	25%J	25%G
3	C3	92.87	363.311	35%J	15%G
4	C4	72.61	370.40	12%J	28%G
5	C5	111	490.84	20%J	20%G
6	C6	107.56	433.8	28%J	12%G
7	C7	94	456.31	9%J	21%G
8	C8	70	398.13	15%J	15%G
9	C9	88.15	489.13	21%J	9%G



**2.2) Tensile specimens**



2.3) Bending specimens

**2.3.2 Flexural test:-**

Flexure tests are usually performed to evaluate the flexural modulus or flexural strength of a material. It is more affordable than a tensile test and the results are somewhat different. The material is laid vertically with supports and load support is placed at middle of the specimen and then a force is applied to specimen until the sample fails. The maximum force recorded is the flexural strength of that particular sample. The flexural test samples are prepared according to the ASTM D 790 M standards.

The flexure test does not measure fundamental material properties as compression test or tension test.

When a specimen undergoes flexural loading then the three fundamental stresses are present: compressive, tensile and shear and so the flexural properties of a specimen are the result of the combined effect of all three stresses.

**3. Results and Discussions**

**3.1 Results:**

**3.1.1 Tensile test results:**

**Effect of Fiber Loading on Tensile Strengths of Composites:**

The tensile strength and tensile modulus of the composites that are under influence of fiber loading is shown in Figure 3.1 and 3.2 respectively. Therefore from the Figure 3.1 the tensile strength of the composites with 60%matrix and 40% fiber is higher than other two compositions. The maximum tensile strength is observed for composite with 40 wt% fiber loading.

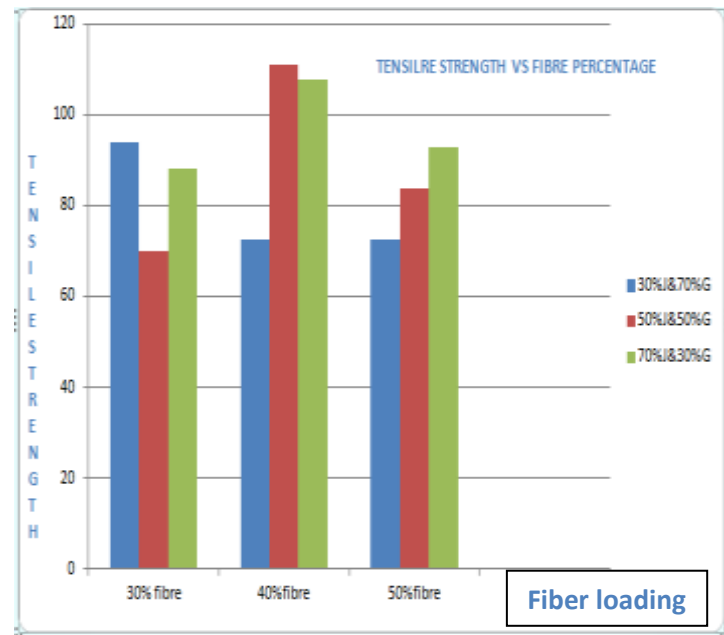


Figure (3.1) Effect of fiber loading on tensile strength of composites

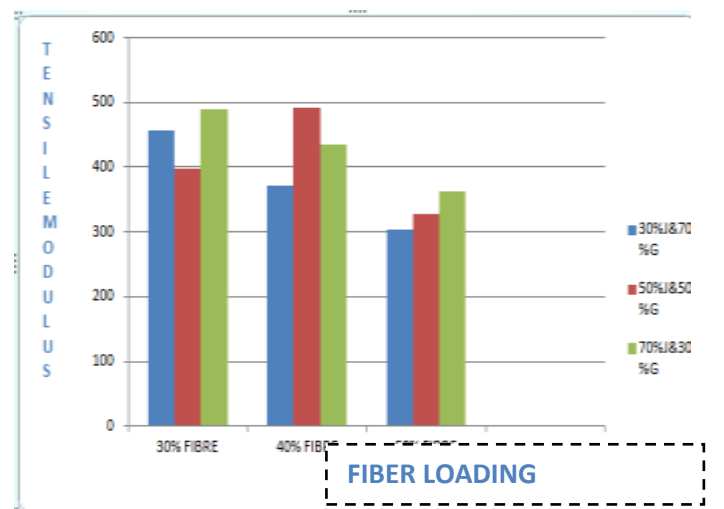


Figure (3.2) Effect of fiber loading on tensile modulus of composites

**3.1.2 Flexural test results:**

**Effect of Fiber Loading on flexural strength of Composites**

S.NO	composite	Flexural strength	Fiber percentage	
1	C1	438.34	15%J	35%G
2	C2	280	25%J	25%G



3	C3	515	35%J	15%G
4	C4	330	12%J	28%G
5	C5	663.37	20%J	20%G
6	C6	691.17	28%J	12%G
7	C7	51.67	9%J	21%G
8	C8	478.34	15%J	15%G
9	C9	546.67	21%J	9%G

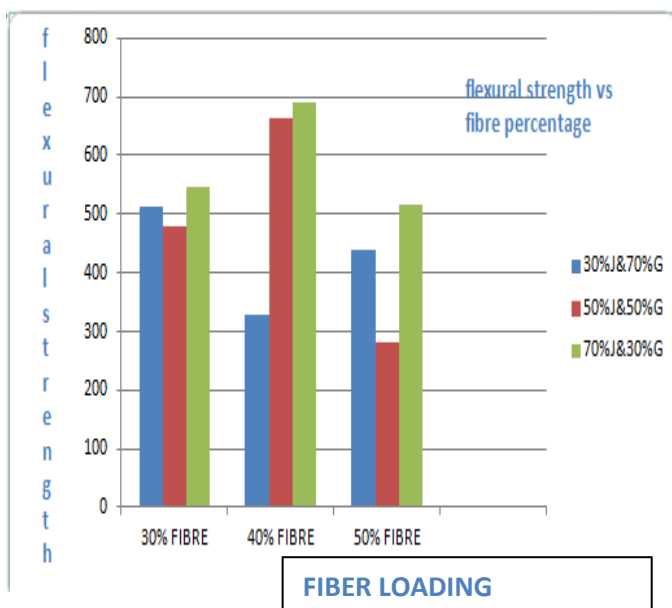
influences the different properties of composites. The maximum Tensile strength, flexural strengths for composites are obtained at 40 wt% fiber loading especially tensile strength at 20%jute&20%glass fiber and flexural strength at 28%jute&12%glass fiber.

- It can be concluded from the graphs that the hybrid composites have better properties than single fiber composites.

Though the composites have some pros and cons, the combination of the useful properties of two different materials, quicker processing time, lower manufacturing cost, etc., make them as an adaptable material in the field of engineering and technology. Hence with this conclusion, it is sure that the technology shows composite is the most hunted material in the modern trend.

**References:-**

1. Joseph, K., Thomas, S. & Pavithran, C. (1992). Viscoelastic properties of short-sisal-fiber filled low-density polyethylene composites: effect of fiber length and orientation. *Materials Letters*, Vol.15, pp. 224-228.
2. Opricovic, S., & Tzeng, G. H. (2004). Compromise solution by MCDM methods: A comparative analysis of VIKOR and TOPSIS. *European Journal of Operational Research*, Vol.156 (2), pp. 445-455.
3. Luo, S. & Netravali, A. N. (1999). Mechanical and thermal properties of environmentally friendly green composites made from pineapple leaf fibers and Poly (hydroxybutyrate-covalerate) resin. *Polymer Composites*, Vol. 20(3), pp. 367-378.
4. Xess, P.A., Erosion Wear behavior of Bamboo Fiber Based Hybrid Composites, Thesis NIT Rourkela, (2012).
5. Gowda, T. M., Naidu, A. C. B., & Chhaya, R. (1999). Some Mechanical Properties of Untreated Jute Fabric-Reinforced Polyester Composites. *Composites Part A: Applied Science and Manufacturing*, Vol.30 (3), pp. 277-284.
6. Amash, A. & Zugenmaier, P. (2000). Morphology and properties of isotropic and oriented samples of cellulose fiber-polypropylene composites. *Polymer*, Vol. 41(4), pp.1589-1596.
7. John, M. J., & Anandjiwala, R. D. (2008). Recent developments in chemical modification and characterization of natural fiber-reinforced composites. *Polymer composites*, Vol. 29(2), pp. 187-207.



**Figure (3.3)** Effect of fiber loading on flexural strength of composites

**3.2 Conclusions:**

The experimental study on the influence of fiber loading on mechanical behavior of jute/glass fiber reinforced epoxy based hybrid composites leads to the following conclusions.

- The effect of reinforcement of Jute fiber and glass fiber into epoxy resin matrix is investigated on the basis on the fiber loading.
- From the experimental results it is confirmed the fact that Jute fiber and glass fiber can used as filler as it improved the mechanical properties of the composite when compare to epoxy resin.
- Fabrications of new epoxy based hybrid composite reinforced with jute and glass fiber have been done successfully. The present research exposed that fiber loading appreciably

8. Monteiro, S. N., Terrones, L. A. H. & D'Almeida, J. R. M. (2008). Mechanical performance of coir fiber/polyester composites. *Polymer Testing*, Vol. 27(5), pp. 591- 595.

9. Biswas S., Kindo S., Patnaik A., (2011). Effect of Length on Coir Fiber Reinforced Epoxy Composites, *Fiber and Polymers* 12, pp. 73-78.

10. Lundquist, L., Marque, B., Hagstrand, P. O., Leterrier, Y. & Manson, J. A. E. (2003). Novel pulp fiber reinforced thermoplastic composites. *Composites Science and Technology*, Vol.63 (1), pp. 137-152.