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Glass-Jute Fiber Reinforced Epoxy Composites

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Abstract: ***In this study the Tensile , Bending and Impact test over jute-glass-epoxy composite has been carried out, the jute-glass-epoxy composite specimen consists of 4 layer based on change of stacking sequence of yawn jute and woven glass fiber as reinforcement with epoxy adhesive as matrix. The natural jute glass epoxy composite are made by hand lay up method with weight ratio of fiber to resin 60:40.The natural jute glass epoxy composite plates are tested on universal testing machine has been employed to accomplish this investigation. The failure modes of natural jute glass composite plates has been investigated.***

Keywords: Tensile,Bending, Impact, Jute, glass, epoxy adhesive and Composite material.

1. Introduction

A composite material can be defined as a combination of two or more materials that results in better properties than those of the individual components used alone. The two materials work together to give the composite unique properties.The main objective of composite materials are their high strength and stiffness, combined with low density, when compared with bulk materials, allowing for a weight reduction in the finished part. The reinforcing phase provides the strength and stiffness. In most cases, the reinforcement is harder, stronger, and stiffer than the matrix. Particulate composites tend to be much weaker and less stiff than continuous fiber composites, but they are usually much less expensive. Particulate reinforced composites usually contain less reinforcement (up to 40 to 50 volume percent) due to processing difficulties and brittleness.Although Continuous-Fiber composites are made into laminates by stacking single sheets of continuous fibers in different orientations to obtain the desired strength and stiffness properties with fiber volumes as high as 60 to70 percent in some cases [1]. The availability of natural fibers jute is much abudent in Asian continent and it provide an advantages over reinforcement materials in terms of cost, density, recyclability and biodegradability.

World is provided with enormous amount in availability of natural fiber such as Jute, Banana ,Palm ,Pineapple, Ramie, Bamboo,Abaca and Curaua etc has been in the developing stage of natural fiber composites [2]. Meanwhile Fiber-Reinforced Polymers (FRP) have until now been largely applied to the area of aerospace technology, these construction materials have also been used in many technical applications for achive required strength.

2. Aim of the Project

- To determine the posibility of weight and cost reduction of the composite / Hybrid composite' by reinforcing it with jute fiber & glass fiber.
- To fabricate the specimens to the ASTM standards using the 'Hand Lay up' process for the following combinations.

Table 1: Sequence Layer Details

SpecimentNumber	Number Of Layers	Layer Details
1	4	Jute- Jute-glass-glass
2	4	Jute-glass-Jute-glass
3	4	glass -glass-Jute- Jute

- To Examine the strength and properties of the hybrid composite (glass fiber-jute fiber) through mechanical tests.
- To compare the results with the 4 layer with various sequence of layers.

3. Work Methodology

3.1 Selection of Materials

Glass Fiber , Yawn Jute fiber, Epoxy Resin LY556 and Hardner was supplied by Covai seenu & company, Coimbatore... The jute fiber are mainly composed of cellulose, lignin and pectin. Jute fiber are usually off-white to brown in colour and have length in range of 4 mm and 10 to 25µm breath. Whereas glass fiber cloth measures as 72x40 in., The leaves of the jute fiber have long length and soft with shiny appearance. The properties of glass fiber and Jute fiber are given in Table 3.[3]

Table 2: Raw materials used in hand lay-up method

Materials used	
Matrix	Epoxy LY556
Reinforcement	E-Glass fiber (cloth-10 mill) and Jute fiber (Yawn)
Hardner	Araldite HY951

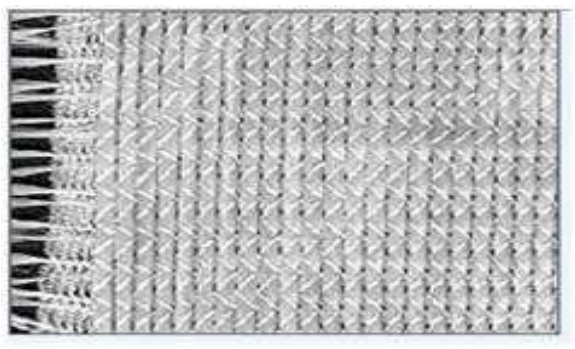

Figure1: Glass Fiber

Figure 2: Jute fiber

Table 3: Mechanical Properties Of Jute, Glass Fibre and Epoxy

Properties	Jute	Glass	Epoxy
Density (g/cm^3)	1.3	2.5	1.08-1.2
Youngs Modulus	72	55.5	3.7
Moisture absorption at 24 hrs	6.9	0.5	-
Aspect ratio	152-365	100-140	-
Specific gravity (gm/cc)	1.3	2.5	1.08
Tensile strength (MN/m^2)	3400	442	85
Specific modulus (GN/m^2)	28.8	42.7	-

3.2 Manufacturing Method

The fabrication of the various composite materials is carried out through the hand lay-up technique. The mould used for preparing composites is made from two rectangular chromium-Plated mild steel sheets having dimensions of 300 mm × 300 mm. Four beadings were used to maintain a 3 mm thickness all around the mould plates. The functions of these plates are to cover, compress the glass and jute fiber after the epoxy is applied, and also to avoid the debris from entering into the composite parts during the curing time.[4]

3.3 Preparation of Epoxy and Hardener

The matrix used to fabricate the fiber specimen was epoxy LY556 of density 1.13 g/cm^3 at 25°C mixed with hardener HY951 of density 0.97 to 0.99 g/cm^3. The weight ratio of mixing epoxy and hardener was followed as per the supplier norms.

3.4. Sample Preparation

For Jute/Glass/Epoxy fabrication, the Jute/Glass fibers were laid uniformly over the mould before applying any releasing agent or epoxy. After arranging the fibers uniformly, they were compressed for a few minutes in the mould. Then the compressed form of Jute/Glass fiber is removed from the mould. This was followed by applying the releasing agent on the mould, after which a coat of epoxy was applied. The compressed fiber was laid over the coat of epoxy, ensuring uniform distribution of fibers. The epoxy mixture is then poured over the fiber uniformly and compressed for a curing time of 24 h. After the curing process, test samples were cut to the required sizes prescribed in the ASTM standards.

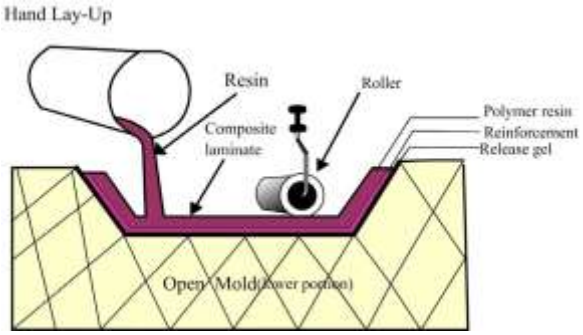

Figure 3: Hand lay-up method.

3.5 Mechanical Tests

After fabrication the test specimens were subjected to various mechanical tests as per ASTM standards. The standards followed were ASTM-D 3039, ASTM-D 790-03 and ASTM-D 256-05 for tensile tests, flexural tests and impact tests, respectively. To obtain a statistically significant result for each condition, five specimens were tested to evaluate the mechanical properties. The tensile tests were conducted at a speed of 2 mm/min at room temperature (303 K). Three-point bending (flexural) tests were carried out on the specimen at room temperature. The specimen is placed onto two supports having a 100-mm span length between the supports. The speed of the jaws was set to 1 mm/min. Izod impact tests were conducted for all specimens at room temperature to evaluate the resistance of the material to fracture

4. Experimental Test

The hybrid composite materials Four, Five and Six layer plate were fabricated by using Jute,glass and epoxy. Tensile test, Bending test and Impact test, were done on the specimens to find out the mechanical properties.Before going testing in speciments, will be cut with the help of abrasive jet machining.The specimens were notched as per ASTM D-3039 standard.The test were done to determine the values of tensile strength, Bending and impact strength. The tensile test for two specimen pieces were performed in the universal testing machine Instron 1195 and impact test were done with the help of Izod impact testing machine.

4.1 Tensile Test

The specimen is tested under Hydraulic Testing Machine by keeping the loading rate constant of 20 KN. A tensile load is applied on the specimen until it fractures. During the tensile test, certain elongation were done on the material due to the load which will be recorded. A load elongation curve is plotted by an x-y recorder, so that the tensile behavior of the material will be calculated over here.

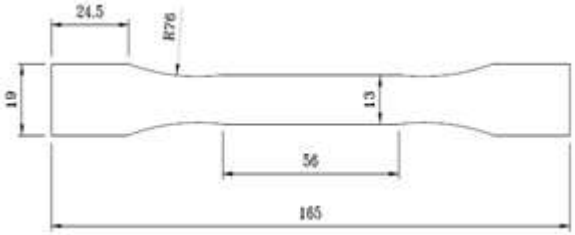

Figure 4: Tensile test sample Dimensions

4.2 Bending Test

The specimen is tested on UTM-machine.It is mainly used to find the ability of a material to be bend before the breaking point. The specimens were notched as per ASTM-D 790-03 standard.

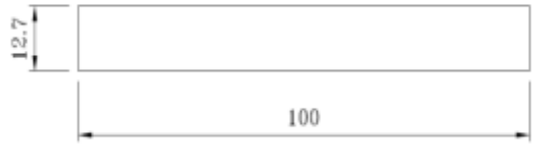

Figure 5: Bending test sample Dimensions

4.3 Impact Test

The speciment is tested on Izod Impact Testing Machine.The test speciment is clamped upright in an anvil, with a V-notch at the level of the top of the clamp. The test specimen will be hit by a striker carried on a pendulum which is allowed to fall freely from a fixed height, to give a blow of nearly 120 ft lb energy. After fracturing the test piece, the height to which the pendulum rises is recorded by a slave friction pointer mounted on the dial.It is mainly used to find the absorbed amount of energy in the speciments. The specimens were notched as per ASTM-D 256-05 standard.

Figure 6: Impact test sample Dimensions

Figure 7: Speciment-1 Before tensile , Bending and Impact test.

Figure 8: Speciment-2 Before tensile , Bending and Impact test

Figure 9: Speciment-3 Before tensile , Bending and Impact test

5. Results and Discussion

The specimens are tested for their tensile , Bending and impact strength and the following results are shown in the Table 4.

Table 4: Results of the mechanical test

Sl.No	Mechanical testing	Speciment Results		
		1	2	3
1	Tensile test (Mpa)	230	246.84	254
2	Bending test (Mpa)	122	146	163
3	Impact test (Joule)	25	32	41

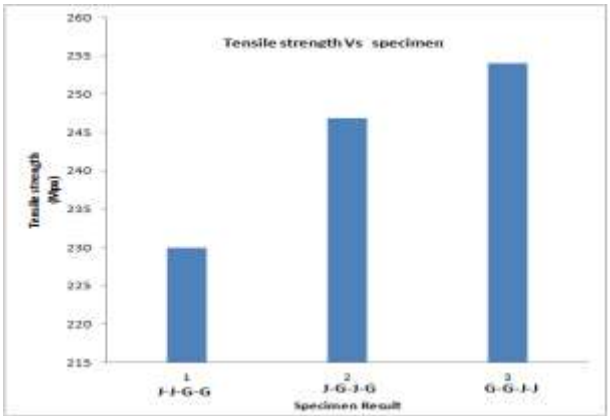

Figure 10: Tensile strength comparison of different specimen in various sequence of 4-Layer.

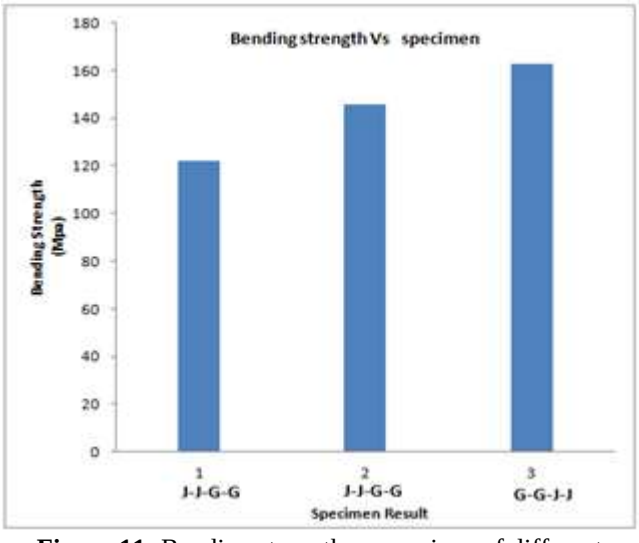

Figure 11: Bending strength comparison of different

specimen in various sequence of 4-Layer.

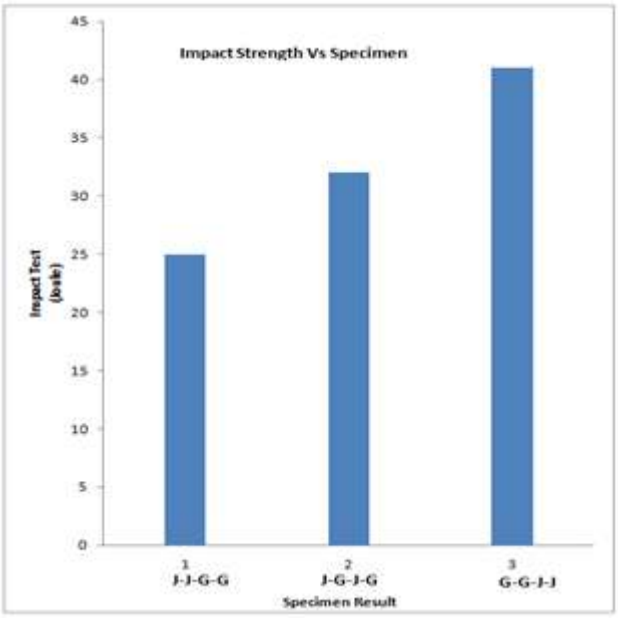

Figure 12: Impact strength comparison of different specimen with various sequence of 4-Layer

6. Conclusions

The results of the present study showed that useful composites with good strength could be successfully developed using Jute and glass fiber as a reinforcing agent for the epoxy matrix. Tensile strength, Bending strength and impact strength of the composites increased with increasing of fiber weight fraction in the Glass/Jute/Epoxy composite compared with pure resin.[6] outer layer containing jute-jute having low strength property as compared to other layers of jute –glass-jute-glass and glass-glass-jute-jute composites.

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