

(An ISO 3297: 2007 Certified Organization) Vol. 4, Special Issue 6, May 2015

Fabrication and Property Evaluation of Kenaf-Jute Fiber Reinforced Composites

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ABSTRACT: Basically, to produce the natural fiber composite, two natural fibers compounded with a suitable resin. In this project, kenaf and jute fibers compounded with epoxy resin. Kenaf and Jute fibers were treated using sodium hydroxide with 5wt% concentration and were soaked in the solution for 24 hours at room temperature. Kenaf and jute reinforced epoxy resin polymer matrix composites have been developed by compression moulding technique with jute fiber treated conditions and kenaf with different volume fraction of fibers as in 1:2 ratio (25%, 30%, 35%). Test specimens are prepared with different weight fractions of kenaf fiber at the optimization point of ultimate strength a small percentage of jute are added and tests were conducted and the substitution of the traditionally used composite of natural fibers such as, kenaf and jute can lead to a reduction of the component's weight. The main objective of this experimental study is to fabricate the kenaf – jute fibers reinforced hybrid composites and to evaluate the mechanical properties such as tensile strength, flexural strength and impact strength of hybrid kenaf – jute reinforced epoxy composites.

KEYWORDS: Natural fiber, Hybrid composite, FRC, Epoxy resin, Volume fraction, Weight percentage.

I. INTRODUCTION

In general, fibers are the principal load-carrying members, while the surrounding matrix keeps them in the desired location and orientation, acts as a load transfer medium between them, and protects them from environmental damages due to elevated temperatures and humidity.

A composite is defined as a material containing two or more distinct phases combined in such a way so that each remains distinct. A composite laminate comprised of laminate of two or more composite material systems or a combination of two or more different fibers such as carbon and glass or carbon and aramid into a structure (tapes, fabrics and other forms may be combined).

Fibers are the important class of reinforcements, as they satisfy the desired conditions and transfer strength to the matrix constituent influencing and enhancing their properties as desired. Fibers fall short of ideal performance due to several factors. The performance of a fiber composite is judged by its length, shape, orientation, and composition of the fibers and the mechanical properties of the matrix. The orientation of the fiber in the matrix is an indication of the strength of the composite and the strength is greatest along the longitudinal directional of fiber.

Short fibers are also known to their theoretical strength. Most fibers in use currently are solids which are easy to produce and handle, having a circular cross-section, although a few non-conventional shaped and hollow fibers show signs of capabilities that can improve the mechanical qualities of the composites.

R.Panneerdhass this paper presents the study of the tensile, compressive, flexural, impact energy and water absorption characteristics of the luffa fiber and Ground nut reinforced epoxy polymer hybrid composites. Luffa fiber and Ground nut reinforced epoxy resin matrix composites have been developed by hand lay-up technique with luffa fiber treated conditions and Ground nut with different volume fraction of fibers as in 1:1 ratio (10%, 20%, 30%, 40% and 50%). Effects of volume fraction on the Tensile, Compressive, Flexural, Impact strength were studied. SEM analysis on the composite materials was performed. Tensile strength varies from 10.35 MPa to 19.31 MPa, compressive strength varies from 26.66 MPa to 52.22 MPa, flexural strength varies from35.75 MPa to 58.95 MPa and impact energy varies from



(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 6, May 2015

0.6 Joules to 1.3 Joules, as a function of fiber volume fraction. The optimum mechanical properties were obtained at 40% of fiber volume fraction of treated fiber composites.

Vasanta V present the paper a Study of Mechanical Properties of Hybrid Natural Fiber Composite. Samples of several Jute-Bagasse-Epoxy & Jute-Lantana camara-Epoxy hybrids were manufactured using hand layup method were kept at 40%-60%. With increase of fiber loading capacity by 20%, the flexural strength value increases to 155.5MPa for Jute-bagasse and 310.9MPa for jute-lantana camara. The tensile strength of epoxy is 62-72 MPa wit 3-4 % elongation and with increase of fiber loading capacity by 20 % the tensile strength increases.

R. Bhoopathi, M. Ramesh,, C. Deepa present the paper of the role of natural and manmade fibers reinforced hybrid composite materials are growing in a faster rate in the field of engineering and technology due to its favorable properties. The main objective of this experimental study is to fabricate the banana-hemp-glass fibers reinforced hybrid composites and to evaluate the mechanical properties such as tensile strength, flexural strength and impact strength. There are three different types hybrid laminates are fabricated by hand lay-up method by using glass, banana and hemp fibers as reinforcing material with epoxy resin. The specimen is prepared according to ASTM standards and the experiment has been carried out by using universal testing machine (UTM).

II. MATERIALS AND METHODS

Raw Materials: The materials are Jute fiber, Kenaf fiber, Epoxy Resin, Hardener.

Jute Fiber: The jute fibers are extracted from the ribbon of the stem. When harvested the plants are cut near the ground with a sickles shaped knife. The small fibers, 5 mm, are obtained by successively retting in water, beating, stripping the fiber from the core and drying.



Fig. 1. Jute Fiber

Table 1. Properties of the Jute Fiber

| Fiber | DENSITY | TENSILE | TENSILE MODULUS OF | |
|-------|------------|------------|--------------------|------------|
| | $[G/CM^3]$ | STRENGTH | ELASTICITY | ABSORPTION |
| | | $[N/MM^2]$ | (GPA) | [%] |
| JUTE | 1460 | 400-800 | 10-30 | 13 |

Kenaf Fiber: Kenaf fiber purchased by vellaiyampalayam village, with an average fiber's density of 1.157g/cm3, and the unit area weight of the kenaf fiber of 542g/m2) is selected.



(An ISO 3297: 2007 Certified Organization) Vol. 4, Special Issue 6, May 2015



Fig. 2. Kenaf Fiber

Table 2. Properties of the Kenaf Fiber

| Fiber | TENSILE STRENGTH | ELASTIC MODULUS | ELONGATION |
|-------|------------------|-----------------|------------|
| | (MPA) | (GPA) | (%) |
| Kenaf | 930 | 53 | 1-6 |

Epoxy Resin: Starting material s for epoxy matrix are low-molecular -weight organic liquid resins containing a number of epoxide groups, which are three-member rings of one oxygen atom and two carbon atoms :The raw materials involved in the fabrication were Epoxy resin LY 556.

| DENSITY (G=CM3) | 1.2–1.3 |
|-----------------------------|-----------------------|
| TENSILE STRENGTH, MPA (PSI) | 55-130 (8,000-19,000) |
| POISSON'S RATIO | 0.2–0.33 |

Specimen Preparation Method: The jute and kenaf fiber based epoxy composite is fabricated using compression process. The moulds have been prepared with dimensions of $290 \times 290 \times 3$ mm. A sliding roller has been used to remove the trapped air from the uncured composite and mould has been closed at temperature 80° C duration 4-5 hour. The constant presser 1500Psi is applied on the mould in which the mixture of the jute and kenaf, epoxy resin and hardener has been poured.

After curing, the specimen has been taken out from the mould. The composite material has been cut in suitable dimensions with help of zig saw for mechanical tests as per the ASTM standards.





Fig. 3. Fabricated Jute and Kenaf Reinforced Composite



(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 6, May 2015

Table 4. Composition of Composites

| DESIGNATION | COMPOSITION |
|-------------|---|
| C1 | FIBER LENGTH (5 MM) (25 WT %) + EPOXY (75 WT%) |
| C2 | FIBER LENGTH (5 MM) (30 WT %) + EPOXY (70 WT %) |
| C3 | FIBER LENGTH (5 MM) (35WT %) + EPOXY (65 WT %) |

The composite materials having the following weight percentages (wt %).

Table 5. Weight percentages of Fiber Volume Fraction

| SAMPLE PLATE | JUTE(%) | KENAF (%) | MATRIX (%) |
|--------------|---------|-----------|------------|
| 1 | 10 | 15 | 75 |
| 2 | 10 | 20 | 70 |
| 3 | 10 | 25 | 65 |

III. TESTING

Tensile Test: The tensile tests were conducted according to ASTM D 3039-76 standard on a computerized Universal Testing Machine. Fabricated composite was cut to get the desired dimension of specimen for mechanical testing. For the tensile test, the specimen size was 250×25 mm gauge length and thickness was 3 mm.



Fig 4. Experimental Setup for Tensile Test

Flexural Test: The flexural strengths of the specimens were determined for specimens using the three-point bending test as per ASTM-D790. The specimens of dimensions 80 mm x 15 mm x 3 mm tested with a span length of 63mm.

Fig 5. Experimental Setup for Flexural Test

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 6, May 2015

Impact Test: The impact test specimens are prepared according to the required dimension following the ASTM-A370 standard. Specimen dimension for impact test was $65 \text{ mm} \times 13 \text{ mm}$ and 3mm.

Fig 6. Experimental Setup for Impact Test

IV. EXPERIMENTAL RESULTS

Tensile Test Results:

| Table | 6 | Tensile | Test | Results |
|--------|----|---------|------|---------|
| 1 auto | υ. | rensite | rest | resuits |

| SAMPLES | WT % OF | TENSILE | TENSILE | TENSILE | AVERAGE |
|---------|----------|----------|----------|----------|----------|
| | JUTE AND | STRENGTH | STRENGTH | STRENGTH | TENSILE |
| | KENAF | Trial 1 | TRIAL 2 | TRIAL 3 | STRENGTH |
| | Fiber | (MPA) | (MPA) | (MPA) | (MPA) |
| PLATE 1 | 25 | 29.195 | 26.997 | 32.147 | 29.446 |
| PLATE 2 | 30 | 38.053 | 33.053 | 32.117 | 34.269 |
| PLATE 3 | 35 | 39.289 | 38.612 | 34.806 | 37.569 |

From the figure 7 it can be observed that, the load is gradually increasing up to the maximum load carrying capacity of the material and then decreasing. From the figure it has been clearly indicated that the 35% jute and kenaf fiber and 65% epoxy resin polymer composites are performing better than the other composite combinations tested.

Fig. 7. Tensile Strength of Jute and Kenaf Composite

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 6, May 2015

Flexural Test Results:

Table 6. Flexural Test Results

| SAMPLES | WT % OF Jute and kenaf Fiber | Flexural Strength Trial 1 (MPa) | FLEXURAL STRENGTH TRIAL 2 (MPA) | FLEXURAL STRENGTH TRIAL 3 (MPA) | Average Flexural strengtH (MPa) |
|---------|------------------------------------|--|--|--|--|
| Plate 1 | 25 | 81.508 | 69.433 | 54.394 | 68.445 |
| Plate 2 | 30 | 72.721 | 88.909 | 97.213 | 86.281 |
| Plate 3 | 35 | 89.433 | 90.146 | 87.697 | 89.092 |

The influence of fiber percentage and loading on flexural strength of fabricated composites is shown in Figure 8. When fiber loading increase then flexural strength increase up to fiber loading 30% then increases. The maximum flexural strength is observed when fiber loading is 35%.

Fig. 8. Flexural Strength of Jute and Kenaf Composite

Impact Test Results:

Table 7. Impact Test Results

| | IMPACT | IMPACT IMPACT | | AVERAGE |
|---------|-------------|---------------|-------------|-------------|
| SAMPLES | STRENGTH(J) | STRENGTH(J) | STRENGTH(J) | IMPACT |
| | Trial 1 | TRIAL 2 | TRIAL 3 | STRENGTH(J) |
| PLATE 1 | 0.25 | 0.25 | 0.30 | 0.266 |
| PLATE 2 | 0.25 | 0.40 | 0.50 | 0.383 |
| PLATE 3 | 0.30 | 0.25 | 0.30 | 0.283 |

The impact strength comparison of the different combination of jute and kenaf fiber reinforced polymer composites is presented in Fig. 9. From the figure it can be observed that, the 30% jute and kenaf fiber and 70% epoxy resin polymer composites are performing better than the other composite combinations tested which can hold the impact load of 0.383Joules. It also show that the impact energy increases with increases in 30% fiber loading then decrease. The maximum impact energy absorbed by and 30% fiber content.

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 6, May 2015

Fig. 9. Impact Strength of Jute and Kenaf Composite

V. CONCLUSION

The jute-kenaf fiber reinforced hybrid composites are fabricated and the mechanical properties such as tensile strength, flexural strength and impact strength of these composites are evaluated.

- The jute-kenaf fiber hybrid composites have more tensile strength than other composites can withstand the tensile strength of 37.56MPa. The maximum tensile strength is 37.56MPa which is hold by the 35% jute-kenaf fiber and 65% epoxy resin composite.
- The maximum flexural strength of 89.09 MPa hold by the jute-kenaf fiber reinforced composites. This is also hold by same combination of the composite samples.
- The impact strength of the hybrid composites varies from the 0.383Joules. This composite is that there is significant increase flexural strength of the composite where as lose its impact strength.
- ✤ From the experimental study it can be is suggested that the 35% jute-kenaf fibers and 65% epoxy resin composite materials can withstand the higher loads when compared to the other combinations and used as an alternate materials for conventional fiber reinforced polymer composites.

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