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Fabrication and Analysis of Hybrid Natural Fiber Composite Material

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Abstract - *The natural fiber composites finds vital role in research and engineering application. The natural fibers such as banana, sisal, bamboo, jute, coir, linen etc. have high strength, specific strength, better dimensional stability and mechanical properties, ecofriendly, availability, low cost and biodegradable as compared with synthetic fibers. This paper presents the fabrication and experimental property study on jute, banana fibers reinforced hybrid composites. The results of the mechanical properties such as tensile, bending tests are reported. Three different layers of the hybrid composites are fabricated by hand layup method. The test was carried out using the universal testing machine as per the ASTM standard. It has been observed that the jute-banana fibers reinforced hybrid composites shows superior properties and used as an alternate material for synthetic fiber reinforced composite materials.*

Key Words: **Natural fibres, Banana fibre, Jute fibre, tensile and bending tests.**

1. INTRODUCTION

Natural fibre is a type of renewable sources. Natural fibres are one such proficient material which replaces the synthetic materials and its related products for the less weight and energy conservation, by choosing an appropriate combination of matrix and reinforcement material, a new material can be made that exactly meets the requirements for a particular application. The application of natural fibre reinforced polymer composites and natural-based resins for replacing existing synthetic polymer or glass fibre reinforced materials in huge. Automotive and aircrafts industries have been actively developing different kinds of natural fibres, mainly on hemp, flax and sisal and bio-resins systems for their interior components. High specific properties with lower prices of natural fibre composites are making it attractive for various applications.

2. COMPOSITE PREPARATION

Firstly the mould box is prepared with a mild steel of dimension 300x300x10mm^3 is used for the fabrication of composite. Among various natural fibers, Jute and Banana fibers were selected to fabricate a composite. Two types of Composite specimens were prepared, one with Layer by Layer and another is Mixed type specimen. Firstly the mould box is applied with a releasing agent for easy separation of specimen from mould box. In layer by layer jute fiber plies were cut to a size of 300x300mm from jute fiber cloth, the fibers were weighed and accordingly the epoxy resin and the hardener are mixed in the proportion of 10:1. The epoxy resin act as a binding material, epoxy and hardener were mixed by using glass rod in a bowl. Care was taken to avoid formation of bubbles, because the air bubbles were trapped in matrix may result failure in the material. The subsequent fabrication process is carried out by placing fiber ply of one kind was put and proper rolling was done. Then resin was again applied, next to it fiber of another kind was put and rolled. Rolling was done using cylindrical mild steel rod. This procedure was repeated until five alternating fibers have been laid. Finally a releasing sheet was put on the top, a light rolling was carried out. Then a 30-50kgs of weight was applied on the composite. It was left for 24hrs to allow sufficient time for curing and subsequent hardening.

In next mixed type specimen, Composite plate is prepared with mixer of epoxy and both the fibers. The mixture is poured into the prepared mould box a light rolling was carried out to avoid formation of bubbles. Finally a releasing sheet was put on the top, weight was applied on the composite. It was left for 24hrs to allow sufficient time for curing and subsequent hardening.

Fig-1: Jute fiber

Fig-2: Banana Fibre

Fig-3: Mould box with cover plate

Table-1: Designation of composites

Specimen Type	Natural Fibers	Compositions
Layer-by-Layer	Jute fiber+ Banana fiber	Epoxy (50%) +Jute fiber (25%) +Banana fiber (25%)
Mixed	Jute fiber+ Banana fiber	Epoxy (50%) +Jute fiber (25%) +Banana fiber (25%)

3. MECHANICAL TESTING

After fabrication the test specimens were subjected to various mechanical tests as per ASTM standards.

Fig-4: Layer by Layered specimen

Fig-5: Mixed specimen

3.1 Tensile test

The tensile test specimen is prepared as per the ASTM A370 standard. The hybrid composite material fabricated is cut into required dimension using a saw cutter. The dimensions, gauge length and cross-head speeds are chosen according to the ASTM standard. A tensile test involves mounting the specimen in a machine and subjecting it to the tension. The testing process involves placing the test specimen in the testing machine and applying tension to it until it fractures. During the application of tension, the elongation of the gauge section is recorded against the applied force. Tensile test specimen for layer by layer and mixed fiber composite is shown in Fig.6 and Fig.7

Fig-6: Tensile and Bending test specimen (layer-by-layer)

Fig-7: Tensile and Bending test specimen (Fibers mixed specimen)

Fig-8: Specimen placed in Universal Testing Machine

3.2 Three Point Bending test

The bending test specimen prepared as per the ASTM standard. The specimen is loaded at the center of the span through loading cell. The test is carried until the specimen completely fails. The bending test specimens are shown in Fig.6 and Fig.7.

Fig-9: Specimen placed in Universal Testing Machine

4. RESULTS AND DISCUSSION

4.1 Tensile test

The tensile strength of a material is the maximum amount of tensile stress that it can take before failure. The tensile behavior of hybrid laminates is as shown in the Fig.10, From the figure it can be observed that the mixed Jute-Banana fiber reinforced composites are performing better than the layer by layer composites. The maximum tensile strength for mixed fibers composite is 8.44 N/mm^2 , peak load is of 380 kg (3.73KN) followed by jute-banana fiber layered reinforced composites can hold the strength of 7.15N/mm^2 peak load of 318.17kg (3.12KN).

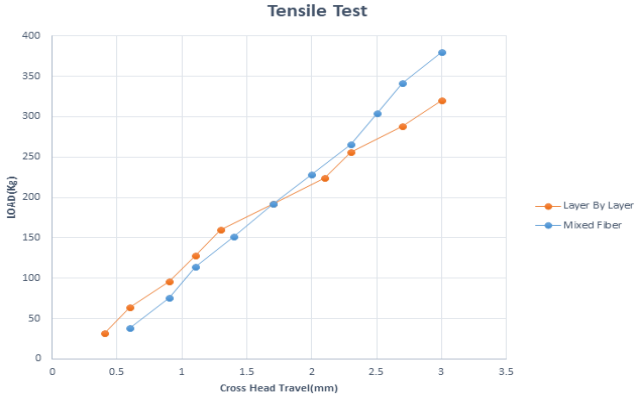

Fig-10: Variation in stresses of fabricated composite laminates with displacements

4.2 Bending test

The bending strength of composites is as shown in Fig.11, From the figure, it is asserted that the ultimate bending load carrying capacity of jute-banana mixed fiber reinforced composites is better than jute-banana layered fiber reinforced composites. Mixed fiber composite has a maximum bending load carrying capacity of 77.50kg (760.27 N) than the layer by layer composite of 57.11kg (560.25 N).

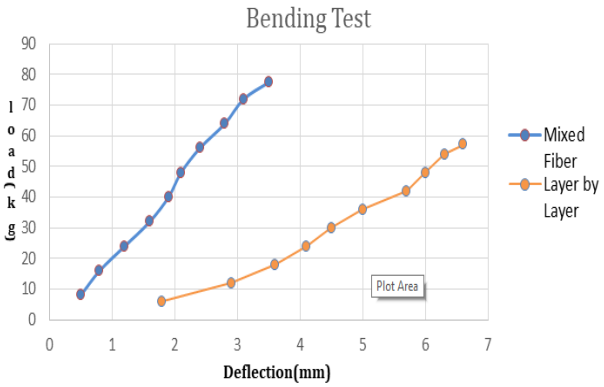

Fig-11: Variation in loads of fabricated composite laminates with displacements

Table-2: Mechanical properties of composites

Composite	Tensile strength (N/mm^2)	Peak bending Load (N)	Trans. Strength (N/mm^2)
Layer-by-Layer	7.15	560.25	19.81
Mixed Fibers	8.44	760.27	24.89

5. CONCLUSION

Jute-Banana fiber reinforced hybrid composites are fabricated and the mechanical properties such as bending and tensile strength of these composites are estimated. The conclusions have been derived from the experimental investigations. The variations of tensile, bending properties of layer by layer and mixed fiber natural composites were studied. It is found that, compared with layer by layer fiber composite, the mixed fiber composite provides better mechanical properties.

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