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Experimental Investigation and Analysis of Bamboo and Jute Hybrid Composite Material

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Abstract: *This paper presents an experimental disquisition and analysis of a new compound material composed of bamboo and jute filaments corroborated with epoxy resin. The growing demand for sustainable and eco-friendly accoutrements has led to the disquisition of natural filaments as druthers to traditional synthetic mounts. In this study, bamboo and jute filaments were combined to produce a mongrel compound material with enhanced mechanical parcels. The experimental disquisition involved fabricating compound samples with varying fiber compositions and optimizing the resin content. The fabrication process included fiber treatment, Impregnation with epoxy resin and contraction molding. The set samples were also subordinated to a comprehensive characterization of their mechanical parcels.*

Keywords*: Bamboo, Jute, Epoxy, Natural fibers, Tensile, Flexural, Hardness*

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I. INTRODUCTION

Natural Fibre Reinforced Polymeric mixes serve as an important volition to manmade fibre corroborated polymeric mixes because they're abundantly available, provident, recyclable and biodegradable enjoying a high mechanical strength and are snappily springing up in terms of exploration and artificial operations. Lingo cellulosic factory filaments like bamboo, jute, coir, banana, etc., are substantially used as underpinning for natural fibre corroborated polymeric composites. Nowadays, these are used in colourful operations like transportation, defence, civil engineering operations, packaging, consumer products, etc. Natural filaments have numerous significant advantages over synthetic fibres. The design deals with the study of bamboo fibre and coir fibre cut into 2-4mm of length with epoxy resin having arbitrary exposures. colourful tests like Tensile Test, Flexural, Bending and Rockwell Hardness test were conducted on bamboo jute epoxy resin compound. In summary, this disquisition aims to advance the understanding of bamboo and jute matrix mixes corroborated with epoxy resin through an experimental approach. The study will exfoliate light on the mechanical properties of the matrix material.

The Strength of the material which is prepared using epoxy resin with natural sisal and flax fibers mainly depended on the composition based on which matrix and reinforcement being added. The performance of epoxy resins is superior to polyester resins due to their high mechanical properties and good resistance to degradation of water and other solvents. Sisal fiber is especially solid with unimportant wear and tear and flax fiber is fragile, gleaming and versatile.

Materials Used: In this study, Bamboo and Jute fibers are used as the reinforcements and epoxy resin is used as the matrix material.

Bamboo: The compositions of bamboo fibers are mainly cellulose 72%, lignin is about 12%, hemicelluloses are about 10% and the rest are extractives like protein, waxes etc. which are about 2%. The bamboo fibers are brittle in nature when compared to other natural fibers that are available in the nature.

Fig-1. Bamboo Fiber

Jute: The compositions of jute fibers are mainly cellulose 60%, lignin about 14%, hemicelluloses about 22%, the rest are fats, other extractive etc. Jute fiber is one of those natural fibers that is used very commonly due to its high strength.

Fig-2.Jute Fiber

Matrix: The matrix material which we used is transparent Epoxy Resin. The epoxy resin is used because of its water resistance capacity.Epoxy coating resin has a more viscous consistency as compared to casting resin.

Fig-3. Epoxy Resin

***Fabrication Process*Fabrication of Mould:** A glass mould is fabricated to the size of 127 x 76 x 50 mm^3 (L x W x T) as shown in the figure.

Fig-4. Glass Mould used for the preparation of specimen

II. EXPERIMENTAL PROCEDURE

***Process*:** Hand Layup method is used for the fabrication process.This method a limited amount of tooling and is less expensive, Initially a layer of matrix material resin is used and then the reinforcement materials I.e jute and bamboo were placed on the mould with the resin layer by layer. Then rest of the place of the mould volume is filled with the epoxy resin.

***Preparation of Specimen*:** The composite materials are made up of hybrid bamboo, jute and epoxy resin.

1. At room temperature, the first layer of resin is poured into the glass mould.
2. Then the bamboo fibers are placed on this first layer of resin, and then another resin layer is poured.

3.Then again the jute fibers are placed on the layer and then the rest of the volume is filled with the epoxy.

Experiment Details:

Tensile Test: As per the ASTM Standard ASTM D, 3039 specimens were prepared [19]. The specimen is firmly fixed in the fixture. The specimen details are shown in the figure. Computerized Universal Testing Machine of 1-ton capacity is used for testing. In this test, the specimen elongates in a direction parallel to the applied load. The load is applied by gripping opposite ends and paralleling it apart. The test is conducted at a speed of 5mm/min

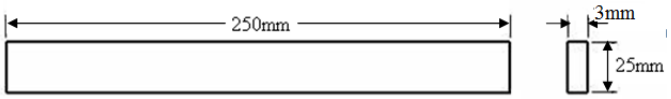

Fig-5. Standard test specimen for tensile test

***Flexural Test*:**This test is conducted to obtain the values of modulus of elasticity, flexural stress, and strain of the material. The advantage of the three-point bending test is the ease of specimen preparation and testing. As per the ASTM Standard D, 790 specimens were prepared [20]. Specimen deflection is measured by the crosshead position. The test is conducted at a speed of 2mm/min.

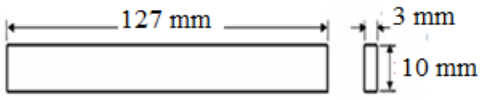

Fig-6.Standard test specimen for flexural test**.**

***Hardness Test*:** As per ASTM standard D785, the specimens were prepared. In this test, the specimen is placed on the hard surface, then the load is applied which produced the permanent depth of indentation. The hardness number is read on the scale.

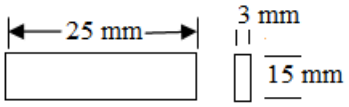

Fig-7. Standard test specimen for hardness test.

Formulae used:

We used several formulae for calculating things such as volume, mass , density.

For volume:

$$V_c = V_b + V_j + V_{epoxy}$$

For mass of the composite:

$$M_c/\rho_c = M_b/\rho_b + M_J/\rho_J + M_{epoxy}/\rho_{epoxy}$$

For density of the composite*:*

$$1/\rho_c = (M_b/M_c)\times 1/\rho_g + (M_J/M_c)\times 1/\rho_J + (M_{epoxy}/M_c)\times 1/\rho_{epoxy}$$

Abbreviations and Acronyms*:*

ASTM- *American Society for Testing and Materials*

Units:

Units used for volume are **mm^3**

Units used for mass are **grams**

Units used for density are **kg/m^3**

III. RESULTS AND DISCUSSIONS

S.no	Test	Result
1	Tensile strength(MPa)	45.86
2	Elongation(%)	9.45
3	Compression strength(MPa)	24.37
4	Flexural Strength(MPa)	48.83

As per ASTM D638-14, ASTM D6641, ASTM D792

IV. CONCLUSION

In conclusion, the hybrid composition of bamboo and jute reinforced with resin shows promising results based on the conducted tests, including compression, Flexural, and tensile stresses. The combination of bamboo and jute as reinforcement materials, along with the resin matrix, exhibits several advantages in terms of mechanical properties and overall performance.The compression test results revealed that the hybrid composition achieved a significantly higher compressive strength compared to individual bamboo or jute composites. This indicates that the synergy between the two materials enhances the load-bearing capacity of the composite structure, making it suitable for applications requiring high compression resistance.Similarly, the

flexure test demonstrated superior performance of the hybrid composite compared to bamboo or jute alone. The hybrid composition displayed improved flexural strength and modulus, indicating enhanced stiffness and resistance to bending forces. These properties make the material well-suited for structural applications where rigidity and load-bearing capacity are crucial.Furthermore, the tensile test results showed increased tensile strength and elongation at break for the hybrid composition. This suggests that the combination of bamboo and jute fibers contributes to enhanced tensile properties, making the composite more resilient and less prone to failure under tensile stresses.

Conflict of interest
There is no conflict to disclose.

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