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Comparatrive Analysis on Mechanical and Interfacial Properties of Jute and Bamboo Reinforced Zirconium Oxide Composite Material

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ABSTRACT: Nowadays, Natural fiber composite material are highly preferred in the automotive industries and aerospace industries because of their characteristics like less weight, low cost, high specific strength and durability. This experimental study mainly focuses on the characterization of mechanical properties of the natural fiber composite material derived from the Jute and Bamboo fibers. The Jute and Bamboo reinforced epoxy composite material is prepared by hand lay-up method and subjected to Mechanical tests like Hardness, Impact and Tensile Tests. On the basis of the outcomes of the results it is found that the Reinforced composite mixture with Jute (50%) , Bamboo(50%) and Zirconium Oxide (30%) show good hardness property, Jute(50%) , Bamboo(50%) and Zirconium Oxide (40%) show good impact strength and show good tensile strength.

KEYWORDS*:* Juite, Bamboo, Zirconium Oxide, Epoxy Resin

I. INTRODUCTION TO MATERIALS

Matter is anything that has mass and occupies space. A useful way to start thinking about matter is to think about the different materials, or substances, that it can be made into. These materials make up the objects around us, and each of these materials has different properties or characteristics that can be observed or tested. Scientists, technologists and engineers investigate these materials – they experiment with them, compare their properties and relate the results to possible uses.

Materials are the fundamental substances utilized in industry to be treated and refined in order to produce additional materials or things. A material is defined as a substance (most often a solid, but other condensed phases can be included) that is intended to be used for certain applications. Material is a relatively broad term to be defined. They are classified based upon their properties. They have properties like hardness, strength, stiffness, thermal conductivity, heat capacity, permeability, and magnetism, etc.

The science dealing with the study of material is called materials science. Materials have a wide range of use. So, they are also classified based upon their use in industries. The process of determining materials to be used for an application is called material selection. When something is needed then we need to choose the best material for the job. Materials can either be a solid, liquid or gas. Some materials can move between these states. This can be done with extreme conditions like when using heat to melt ice from a solid block into a pool of water. There are different properties that can be assigned to materials, most of them have more than one property. These could be things such as strong, weak, bendy, magnetic, hard, soft and insulating.

Types of Materials

The materials are classified into the following categories:

1. Metals
2. Non – Metals

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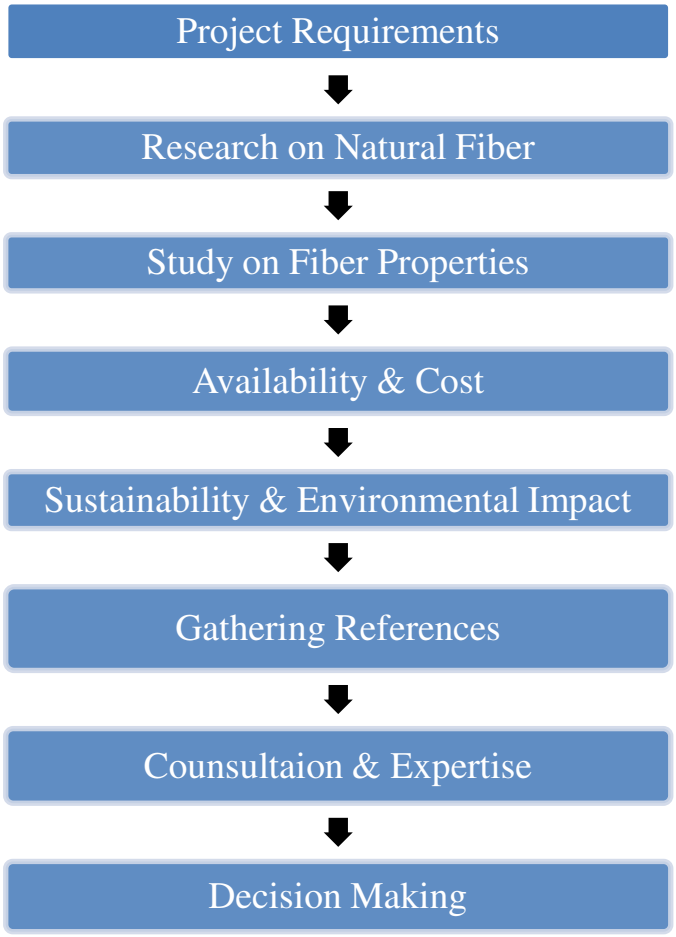

3. Composites

1. Ceramics

Metal is a material (usually solid) comprising one or more metallic elements (e.g., iron, aluminum, copper, chromium, titanium, gold, nickel), and often also nonmetallic elements (e.g., carbon, nitrogen, oxygen) in relatively small amounts. The unique feature of metals as far as their structure is concerned is the presence of charge carriers, specifically electrons. In metallic bond, the atoms do not share or exchange electrons to bond together. Instead, many electrons (roughly one for each atom) are more or less free to move throughout the metal, so that each electron can interact with many of the fixed atoms. The electrical and thermal conductivities of metals originate from the fact that their outer electrons are delocalized.

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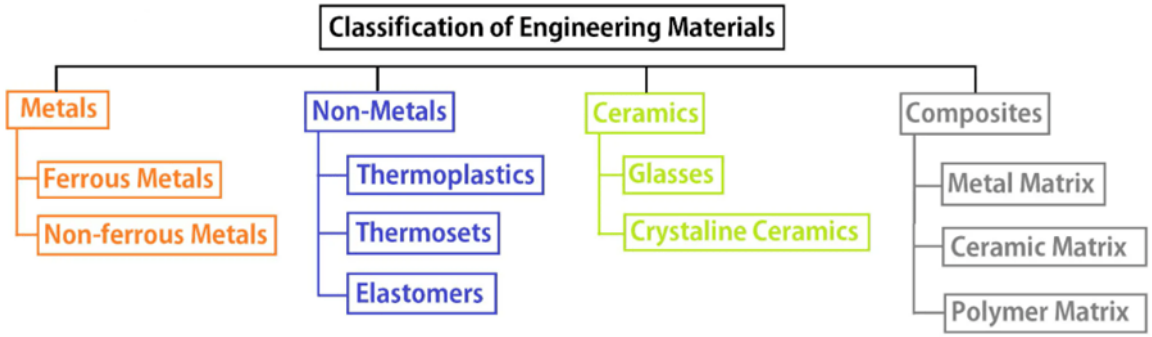
II. MATERIALS AND METHODS

Extraction of Jute Fiber

Jute fiber is extracted from the stem of the jute plant. The process of extracting jute fiber involves several steps, which are as follows:



Mechanical Properties of Jute Fiber

Jute fibers are one of the most important natural fibers and are commonly used in various industries due to their low cost, high tensile strength, and biodegradability. The mechanical properties of jute fiber are influenced by several factors such as fiber source, processing, and treatment. Here are some of the commonly reported mechanical properties of jute fiber:

1. Tensile strength: Jute fiber has high tensile strength, with reported values ranging from 500 to 1100 MPa. The tensile strength of jute fiber is influenced by several factors such as fiber diameter, fiber length, and fiber orientation.
2. Young's modulus: The Young's modulus of jute fiber is around 20 to 25GPa. Young's modulus is a measure of the stiffness of a material, and jute fiber has a relatively low Young's modulus compared to other natural fibers such as flax and hemp.
3. Elongation at break: Jute fiber has high elongation at break, with reported values ranging from 1.5% to 3.5%. This property is related to the flexibility of the fiber and its ability to withstand deformation before breaking.
4. Flexural strength: The flexural strength of jute fiber is around 100 to 250 MPa. This property indicates the ability of the fiber to withstand bending without breaking.
5. Impact strength: Jute fiber has low impact strength, with reported values ranging from 1.5 to 3.5 kJ/m^2. This property indicates the ability of the fiber to withstand sudden shock or impact.

It's important to note that the mechanical properties of jute fiber can be improved by various treatments such as chemical treatments, physical treatments, and the addition of reinforcing agents.

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Bamboo Fiber

Bamboo fiber is a sustainable and versatile textile material derived from the bamboo plant. It has gained popularity as an eco-friendly alternative to traditional fibers like cotton or polyester. Bamboo is highly sustainable, growing rapidly without the need for excessive water, pesticides, or fertilizers. Bamboo forests also contribute to reducing greenhouse gas emissions by absorbing more carbon dioxide and releasing oxygen.

Properties of Epoxy Resin

COMPOSITES	SPECIMENS
JREC - Continuous	Jute fiber (100%)
JREC - Discontinuous	Jute fiber (100%)
J9B1REC	Jute fiber (90%) + Bamboo fiber (10%)
J8B2REC	Jute fiber (80%) + Bamboo fiber (20%)
J7B3REC	Jute fiber (70%) + Bamboo fiber (30%)

Araldite (LY556)

1. Product Type - Epoxies-Bisphenol- A based
2. Chemical Composition - Bisphenol -A-Based-Epoxy Resin
3. Aspect (Visual) - Clear, Pale-Yellow Liquid
4. Viscosity at $25^{o}C$ - 10,000-12,000 mPas
5. Density at $25^{0}C$ - 1.15-1.20 g/cm^{3}

Hardness Test

Hardness testing is a mechanical test used to assess a material's resistance to indentation or scratching. It involves applying a controlled force to the material's surface and measuring the resulting indentation depth or size. Hardness tests provide valuable information about a material's strength, durability, and suitability for various applications.

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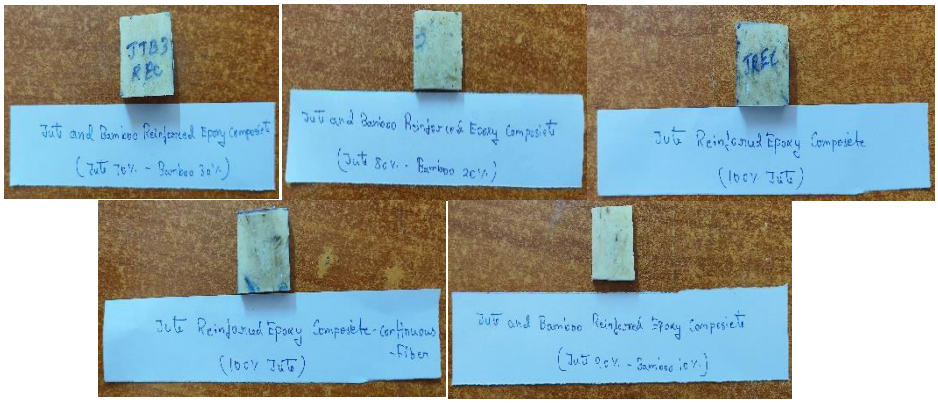
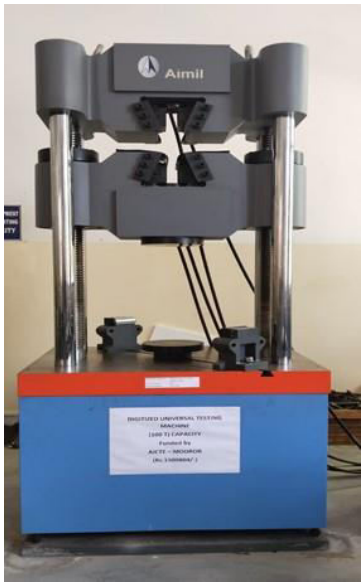


Tensile Test

Tensile testing is a mechanical test performed to evaluate the strength and ductility of a material under tension. It involves applying a gradually increasing axial force to a specimen until it fractures. The test provides valuable data on properties such as ultimate tensile strength, yield strength, and elongation, aiding in material selection and design analysis.



III. RESULT AND DISCUSSION

HARDNESS TEST

The hardness test is carried as per ASTMD785 procedure. The jute and bamboo composite polymer with 80% jute and 20% shows better hardness strength than the other composite polymers.

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COMPOSITE NAME	TRIAL1	TRIAL 2	TRIAL 3	AVERAGE
JREC-CONTINUOUS	82	84	84	83.3
JREC-DISCONTINUOUS	74	78	75	75.6
J9B1REC	87	81	80	82.6
J8B2REC	83	87	84	84.6
J7B3REC	77	73	72	74

IMPACT TEST

The impact test is carried as per ASTMD3039 procedure

SAMPLE NUMBER	IMPACT ENERGY(J)	IMPACT STRENGTH (J/M^2)	ANGLE BEFORE	ANGLE AFTER
JREC-CONTINUOUS	0.315	35	147	150
JREC- DISCONTINUOUS	0.779	67.7	143	150
J9B1REEC	0.208	23.9	148	150
J8B2REC	0.541	45.8	145	150
J7B3REC	3.887	259.1	122	150

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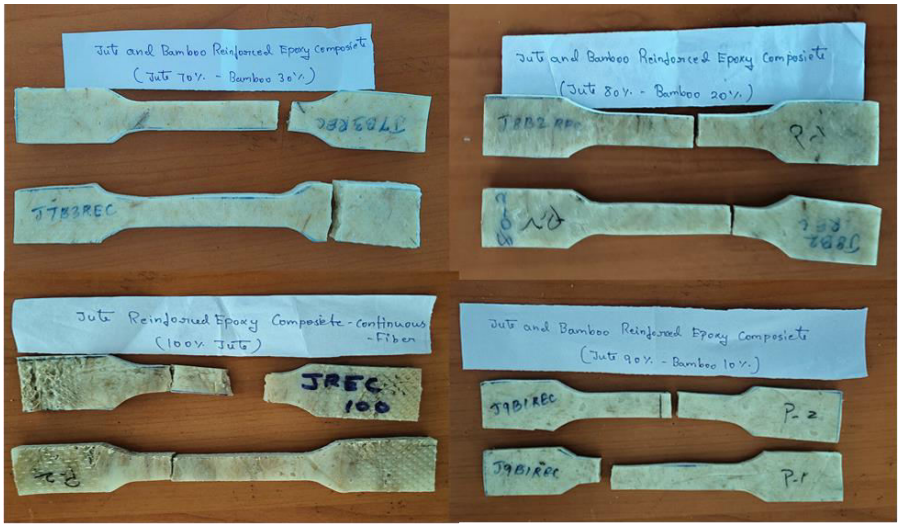
TENSILE TEST

The tensile test is carried as per ASTM D638 procedure.



IV. CONCLUSION

Jute and Bamboo Fiber Reinforced Composites were fabricated and its mechanical behaviour were studied.
It has been concluded from the results:

1. In Hardness Test, the composite material J8B2REC show good hardness compare to other combination of jute and bamboo reinforced epoxy composites. Other than that, J9B1REC and JREC also have good hardness results.
2. In Impact Test, the composite material J7B3REC has high impact strength. Whereas the other composite materials have very low impact strength compare to J7B3REC composite material.
3. In Tensile Test, the composite material with continuous jute fiber has good tensile strength, relatively J8B2REC also have good tensile strength.

We can strongly evident the influence of Bamboo fiber in the mechanical properties of Jute Reinforced Epoxy Composite Material. We can observe the change in different mechanical properties for different combination of materials.

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