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Fabrication of Jute Coir Fiber and Resinnatural Composites by using Hand Layup Method

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Abstract: *In this project, epoxy resin composites were fabricated and tested by reinforcing them with jute fiber and wood dust using the open mould, or hand lay-up, technique. Jute fiber was chosen because it is strong, lightweight, and biodegradable, while wooddust was added to increase stiffness and make use of waste material. The composite was prepared by mixing LEPOX-12 epoxy resin with a hardener, adding the jute fiber and wood dust, and pouring the mixture into a mould to cure at room temperature. After curing, the specimens were cut and tested for mechanical properties, including tensile strength, flexural strength.The results showed that adding jute fiber improved the strength and flexibility of the composite, while wood dust helped make it stiffer and harder. Overall, this study demonstrates that jute fiber and wood dust–reinforced epoxy composites can be made easily and cheaply, and they have potential for use in low-load structural applications,suchaspanels, partitions,and interior automotive components.*

Keywords: Jute fiber, coir fiber, natural fiber composite, hybrid composite, epoxy (polymer) resin, hand layup method, natural fiber filler, mechanical properties, tensile strength, flexural strength, and sustainable eco-friendly materials

I. INTRODUCTION

Natural fiber reinforced composites are gaining wide attention due to the increasing need for eco-friendly and sustainable materials. jute and coir fibers are abundantly available natural fibers with good mechanical properties and low environmental impact. jutefiber provides high tensile strength and stiffness, while coir fiber offers excellent toughness and moisture resistance. the combination of jute and coir fibers as fillers results in a hybrid natural composite with balanced strength and durability. polymer resins such as epoxy are commonly used as matrix materials because of their good bonding and mechanical performance. the resin matrix helps in uniform load transfer between the fibers and improves the overall strength of the composite. the hand layup method is one of the simplest and most cost-effective fabrication techniques for natural fiber composites. this method requires minimal equipment and is suitable for laboratory and small-scale production. in the hand layup process, jute and coir fillers are placed in a mould and impregnated with resin manually. proper curing ensures good fiber–matrix bonding and structural integrity. the fabrication process is easy to control and economical. the developed jute–coir composite aims to reduce the use of synthetic fibers. such natural composites contribute to sustainability and waste reduction. the present work focuses on the fabrication of jute coir filler and resin composite using the hand layup method. the mechanical properties such as tensile and flexural strength are evaluated. these composites have potential applications in automotive interiors and building materials. the study promotes the use of biodegradable and renewable materials.

II. PROBLEM STATEMENT

The increasing demand for lightweight, cost-effective, and environmentally sustainable materials has highlighted the limitations of conventional synthetic fiber–reinforced composites, which are expensive, non-biodegradable, and energy-intensive to produce. Natural fibers such as jute offer an eco-friendly alternative due to their low cost, biodegradability, and acceptable mechanical properties; however, their application is restricted by issues such as poor fiber–matrix interfacial bonding, moisture absorption, and comparatively lower strength

III. PROJECT OBJECTIVES

To fabricate a natural fiber reinforced composite using jute fiber and resin by the hand layup method. To study the hand layup (open moulding) technique as a simple, economical, and effective fabrication process. To carry out manual layering of jute fibers and resin, followed by proper curing under ambient conditions. To understand the interfacial bonding between jute fiber and resin matrix.

To evaluate the mechanical properties of the fabricated jute fiber composite (if testing is performed).To reduce the material cost by replacing synthetic fibers with natural jute fiber. To promote the use of eco-friendly and biodegradable materials in composite manufacturing. To develop a lightweight composite material suitable for non-structural applications. To explore the potential applications of jute fiber composites in panels, packaging, and interior components.

IV. SCOPE OF PROJECT

The scope of this project is focused on the fabrication and evaluation of jute fiber–reinforced epoxy composites incorporated with wood dust filler using a simple and economical hand lay-up technique. The study covers the selection and surface treatment of natural jute fibers, preparation of epoxy resin matrix, and controlled addition of neem wood dust filler in varying weight percentages to develop eco-friendly composite laminates.

The project scope includes studying the influence of filler content on mechanical properties, particularly tensile and flexural strength, to identify an optimum composition suitable for practical use. It also emphasizes the utilization of natural fibers and waste wood dust to reduce material cost and environmental impact. The fabricated composites are intended for non-structural applications such as automotive interior panels, partition boards, furniture components, packaging materials, and decorative building elements. Overall, the project aims to promote sustainable, lightweight, and biodegradable composite materials as alternatives to conventional synthetic fiber composites.

V. OUT OF SCOPE

- Detailed microstructural analysis such as SEM, XRD, or FTIR studies to examine fiber–matrix interaction.
- Evaluation of advanced mechanical properties like impact strength, fatigue behavior, creep, or fracture toughness.
- Thermal and chemical characterization including TGA, DSC, fire resistance, and long-term chemical durability studies.
- Moisture absorption, weathering, and aging tests under prolonged environmental exposure.
- Use of advanced fabrication techniques such as vacuum bagging, compression molding, or resin transfer molding.
- Investigation of different natural fibers or synthetic fibers other than jute.
- Study of alternative resins or bio-resins apart from epoxy resin.
- Large-scale industrial production, life-cycle assessment, or cost optimization at commercial level.
- Structural or load-bearing applications requiring high safety factors and compliance with industrial standards.
- This project is therefore limited to laboratory-scale fabrication and basic mechanical evaluation for non-structural applications.

VI. PROJECT CONTEXT AND STRATEGIC IMPERATIVE

The growing emphasis on sustainability, environmental protection, and resource efficiency has created a strong need to replace conventional synthetic fiber composites with eco-friendly alternatives. Synthetic composites, though mechanically superior, are expensive, non-biodegradable, and generate significant environmental impact during production and disposal. In this context, natural fibers such as jute have emerged as promising reinforcement materials

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due to their renewability, low cost, biodegradability, and widespread availability, particularly in countries like India. However, the practical application of jute fiber composites is often limited by poor fiber–matrix adhesion, moisture sensitivity, and moderate mechanical strength.

Within this framework, the present project addresses the strategic need to develop sustainable composite materials using locally available natural fibers and industrial waste fillers. The incorporation of wood dust as a filler material not only enhances certain mechanical properties such as flexural strength and dimensional stability but also promotes waste utilization and cost reduction. The use of epoxy resin as a matrix ensures adequate strength, durability, and compatibility with treated jute fibers, while the hand lay-up method aligns with low-cost, small-scale manufacturing strategies.

VII. METHODOLOGY

The composite material was fabricated using the hand lay-up technique due to its simplicity and cost-effectiveness. Initially, jute fibers were subjected to alkali (NaOH) treatment to remove impurities, reduce moisture absorption, and improve fiber–matrix adhesion. The treated fibers were washed, dried, and cut to the required dimensions. Epoxy resin (LEPOX-12) was mixed with K-6 hardener in a 10:1 weight ratio to ensure proper curing. Neem wood dust filler, pre-dried and sieved to obtain uniform particle size, was then added to the resin mixture in varying weight percentages (0%, 5%, 10%, and 15%) and stirred thoroughly to achieve uniform dispersion.

Prepared molds were cleaned and coated with a mold release agent before fabrication. The treated jute fiber mats were placed in the mold, and the epoxy–filler mixture was applied uniformly over the fibers using brushes and rollers to ensure complete wetting and removal of air bubbles. Layer-by-layer stacking was carried out until the required thickness was achieved. The composite laminate was then cured at room temperature for 24 hours, followed by post-curing as required to enhance mechanical properties.

After curing, the laminates were removed from the molds and cut into standard test specimens. Tensile and flexural tests were conducted to evaluate the mechanical performance of the composites. The results were analyzed to study the effect of wood dust filler content on the strength and suitability of jute fiber–reinforced epoxy composites for eco-friendly, non-structural applications.

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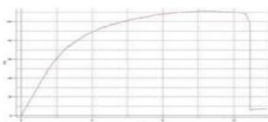
VIII. RESULTS AND DISCUSSION

Sample 2 : Flexural test

∴ X-axis: Distance
Y-axis: load

Composite of Jute(%) = 25
Composite of Epoxy(%) = 75
Filler (%) = 0
Flexural strength(mpa) = 38.61



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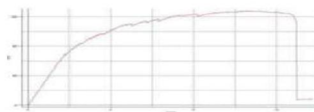

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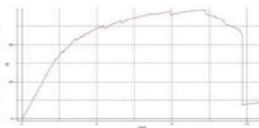

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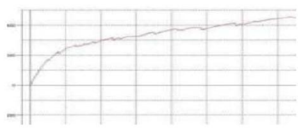
Sample 2 : Tensile test

Composite of Jute(%) = 25
Composite of Epoxy(%)= 75
Filler (%) = 0
Tensilestrength(mpa)=7.90



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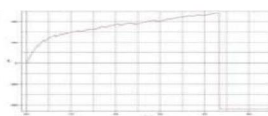

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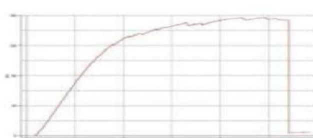
Sample 3 : Flexural Test

∴ X-axis: Distance
Y-axis: load

Composite of Jute(%) = 25
Composite of Epoxy(%) = 62.5
Filler (%) = 12.5
Flexural strength(mpa) = 55.08



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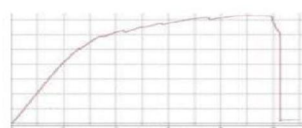

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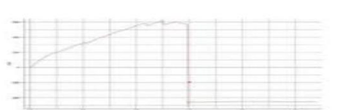
Sample 3 : Tensile Test

Composite of Jute(%) = 25
Composite of Epoxy(%)= 62.5
Filler (%) = 12.5
Tensile strength(mpa) = 4.66



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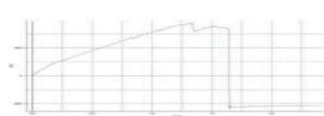

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Graph Results – High Strength Observations

From the graphical results of tensile and flexural tests, it is observed that the composite containing jute fiber, epoxy resin, and an optimum amount of wood dust filler exhibited the highest strength compared to other compositions.

Flexural Strength:

The highest flexural strength was obtained for Sample 3, containing 25% jute fiber, 62.5% epoxy resin, and 12.5% wood dust filler, with a flexural strength of approximately 55.08 MPa. This indicates that the addition of wood dust filler up to an optimal level significantly improves bending resistance by enhancing stress transfer and reducing voids in the composite.

Tensile Strength:

The maximum tensile strength was observed in Sample 1, which contained 28.57% jute fiber and 71.43% epoxy resin without filler, showing a tensile strength of about 9.99 MPa. This suggests that higher fiber content and good fiber–matrix bonding play a dominant role in tensile load carrying capacity.

Overall, the graph results show that moderate filler content improves flexural strength, while filler-free or low-filler composites perform better in tensile strength. Hence, an optimum balance of jute fiber, epoxy resin, and wood dust filler is essential to achieve improved mechanical performance depending on the application requirement.

IX. CONCLUSION

The version of this template is V2. Most of the formatting instructions in this document have been compiled by Causal Productions from the IEEE LaTeX style files. Causal Productions offers both A4 templates and US Letter templates for LaTeX and Microsoft Word. The LaTeX templates depend on the officialIEEEfiles, whereas the Microsoft Word templatesare self-contained.

X. ACKNOWLEDGMENT

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