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Study and Analysis of Mechanical Properties of Coir Fibre

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ABSTRACT

To address the environmental drawbacks and reduce dependency on conventional synthetic materials, the mechanical engineering sector is increasingly seeking sustainable and eco-friendly alternatives. Natural fibers have gained attention as viable reinforcements in structural applications due to their advantageous properties. Among various plant-based fibers, coconut fiber remains underutilized despite its promising characteristics.

This research aims to develop a series of coconut fiber-reinforced composites by modifying the matrix materials (such as polymer-based resins) and applying different fiber treatment methods, including chemical and mechanical processes, to enhance their mechanical performance. Key mechanical properties—such as tensile strength, flexural strength, and impact resistance—are thoroughly evaluated using standardized testing protocols.

The study also investigates how fabrication techniques and varying fiber content affect the overall performance of the composites, with the goal of identifying the most effective manufacturing parameters. A multidisciplinary approach involving materials science, mechanical evaluation, and optimization techniques is employed to gain detailed insights into the behavior of these coconut fiber composites.

Additionally, environmental and economic assessments are conducted to provide a comprehensive analysis of their sustainability advantages compared to traditional synthetic materials. The findings are expected to offer practical guidance for the development and implementation of high-performance, eco-conscious coconut fiber composites, contributing to the broader goal of reducing reliance on non-renewable resources in engineering applications.

Keywords natural fibers, mechanical properties, durability aspects, coconut fiber mixes, tensile strength

I. INTRODUCTION

Rising Demand for Eco-Friendly Materials and Coconut Fiber

Technological advancement is significantly boosting the demand for materials that are not only affordable and long-lasting but also environmentally sustainable. This trend is especially noticeable in sectors such as the **automotive industry**. In India, the production of **coconut fiber** is increasing at an impressive **rate of 37%**, and coconut yarn production is growing at **10%**, largely driven by global awareness and preference for **eco-friendly, biodegradable, and natural materials**.

It is noteworthy that the global growth rate of coconut fiber production closely mirrors that of India. Meanwhile, the **traditional method of extracting coir**, known as *retting*—which involves soaking coconut husks in lagoons for 6 to 12 months to produce soft, spinnable fiber—is rapidly being replaced in India due to both technological innovations and evolving social practices.

What is Coconut Fiber (Coir)?

Coconut fiber, commonly referred to as **coir**, is a natural fiber extracted from the **outer husk of the coconut**. It is a coarse yet strong and resilient material derived from the coconut shell.

- **Common Name:** Coir
- **Scientific Name:** *Cocos nucifera*
- **Family:** *Arecaceae* (Palm family)

Types of Coconut Fiber

There are two primary types of coconut fiber:

- **Brown Coir:** Extracted from mature coconuts, this fiber is thick, strong, and highly resistant to wear and tear.
- **White Coir:** Sourced from young coconuts, it is finer and smoother but less durable compared to brown coir.

Fiber lengths typically range from **10 to 30 cm (4 to 12 inches)**:

- **Bristle Fiber:** Fibers that are **20 cm or longer**
- **Mattress Fiber:** Shorter, finer fibers

From a **300-gram coconut husk**, about **80 grams** of fiber can be obtained, with approximately **one-third** being bristle fiber. Several countries such as **India, Sri Lanka, Kenya, Tanzania, Bangladesh, Thailand, Nigeria, and Ghana** have developed coir-based industries to utilize this resource.

Structure of the Coconut Husk

The **coconut husk** encompasses the entire fibrous outer covering of the fruit, which includes:

- **Mesocarp (fibrous portion)**
- **Endocarp (inner shell and edible part)**

The mesocarp is made up of fiber bundles and cork-like parenchymatous cells that act as a binding agent. When soaked in water (*retting*), the **outer exocarp** (a thin, slippery layer) separates from the **spongy mesocarp**.

The fibrous strands in the husk are rich in **lignin**, which contributes to their stiffness and rough texture. Meanwhile, the soft parenchymatous material, known as **coir pith**, makes up **50–70%** of the husk's total weight. There are around **300 known coconut eco-types**, and the yield and quality of coir can vary among them.

Coconut Fiber: A Green Engineering Material

Due to its **natural strength, renewability, and biodegradability**, coconut fiber is attracting significant interest for use in **engineering and composite materials**. However, the performance characteristics of **coir-based composites**—particularly those blended with polymers or other reinforcements—still require extensive research and refinement to meet industrial application standards.

Coconut Fiber Extraction Process

Harvesting and Husking:

Coconuts are typically harvested while still green to ensure the extraction of high-quality fibers. The husk accounts for **35–45%** of the total nut weight once matured.

Fiber Extraction:

Husks from coconuts aged **10 to 11 months** are ideal, as they yield superior quality fibers with a golden-yellow hue. The coir is commercially extracted by two primary methods:

- **Traditional Water Retting:** Involves soaking husks for several months to soften them for manual fiber separation
- **Mechanical Decortication:** A faster, machine-based technique to separate fibers from the husk

II. METHODOLOGY

Despite the growing interest in coconut fiber composites, there is limited comprehensive research on their mechanical properties and performance characteristics. Understanding these properties is crucial for optimizing their use in industrial applications and ensuring their reliability and efficiency.

1. Carry out theoretical analysis to find out critical parameters to be analyzed for Coconut fiber
2. To develop 3D CAD model using CATIA V5 and perform FEA analysis using ANSYS Workbench on coconut

fiber testing specimen.

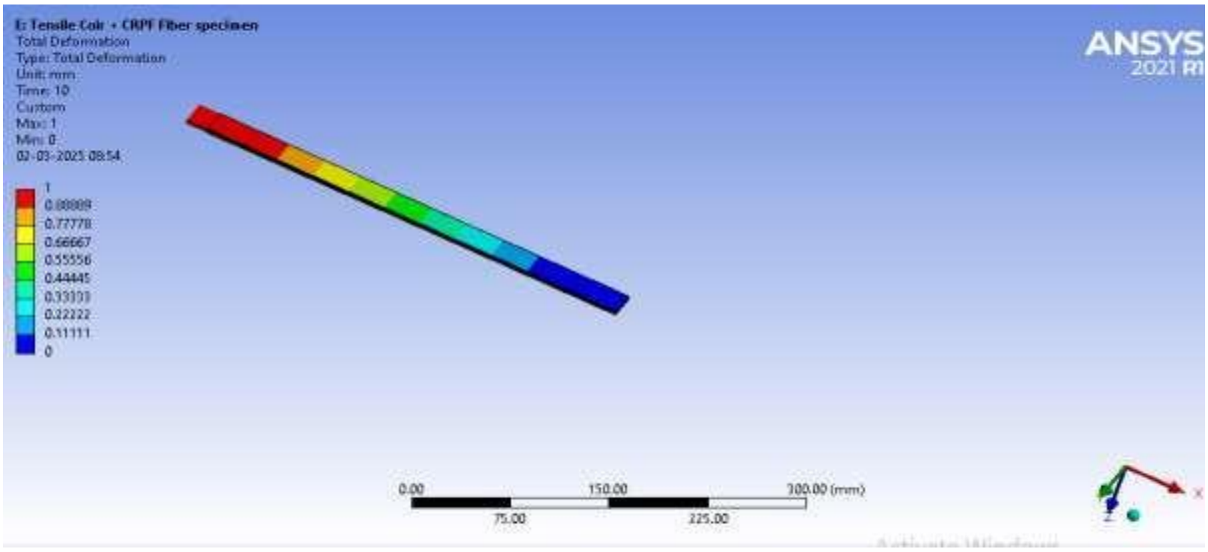
3. To prepare a fiber composite using suitable manufacturing technique.
4. To analyse mechanical properties of composite material such as tensile strength, bending strength
5. To perform experimental tensile test and compression test on different percentage

III. MODELING AND ANALYSIS

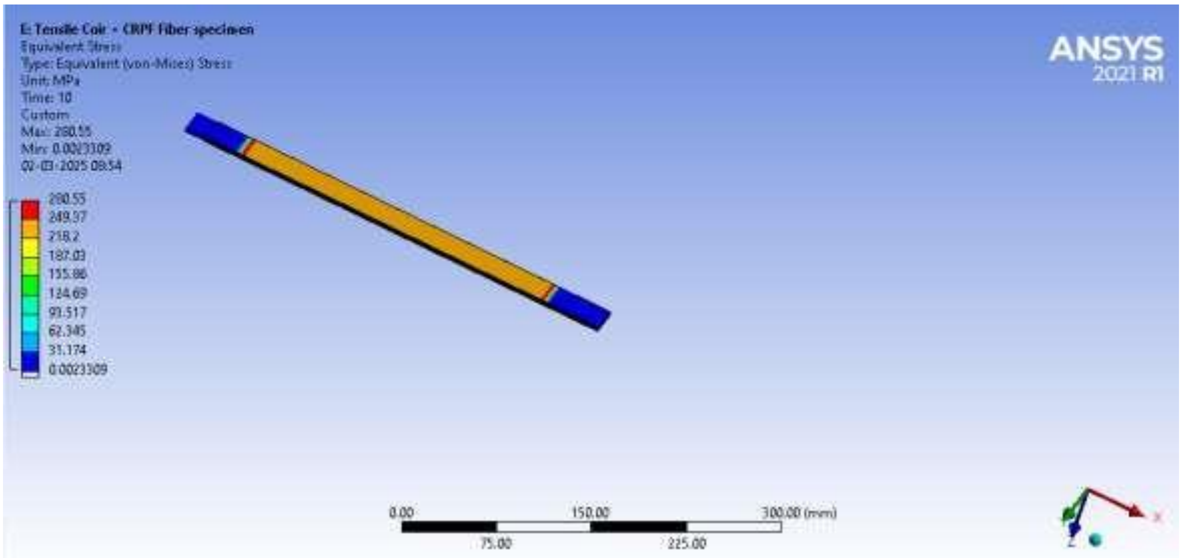
FEA of Carbon fiber +coir fiber specimen at Tensile

Material properties

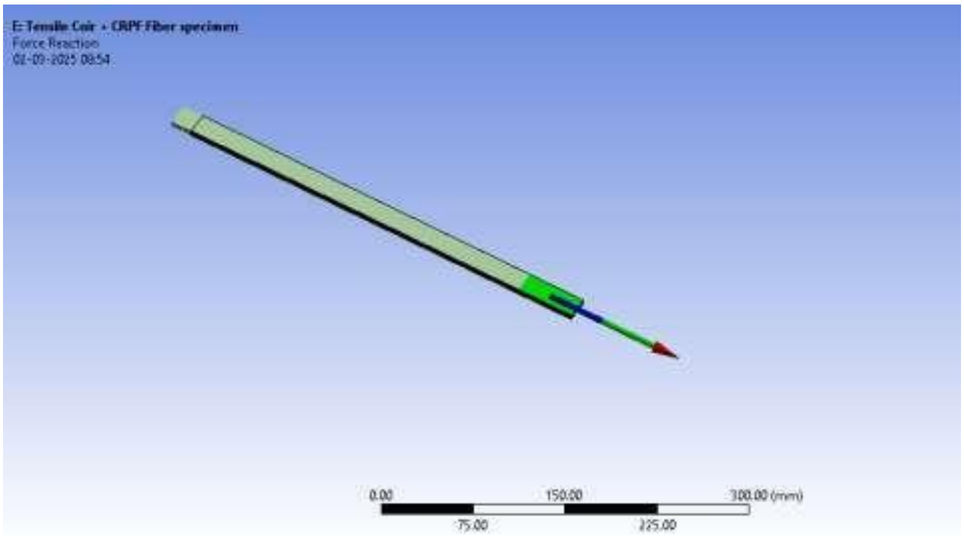
1. Total deformation



2. Equivalent stress



3. Force Reaction



Maximum Value Over Time	
X Axis	17829 N
Y Axis	1.0045e-008 N
Z Axis	4.6461e-005 N
Total	17829 N

Model Making

Figure 1: Model making

1. Glass fibre sheet is cut out with respective dimension of 250mm by 25 mm with 5 layers.

2..Solution is prepared with epoxy (100 ml) and hardener (10 ml) is poured and gently stirred to form homogeneous solution.

3. Before mounting of the first layer of glass fibre, wax is applied at the base of the fixture so that after solidification of the layer it can be easily removed.

- Layer by layer reinforcement is provided:

1. First layer: Glass fibre, gently applying epoxy solution with a brush.

2. Second layer: Glass fibre, gently applying epoxy solution with a brush.

3. Third Layer: Coir Fibre (cut to 250 mm x 25 mm), gently applying epoxy solution with a brush, ensuring even distribution and saturation of the fibres.

4. Fourth layer: Glass fibre, gently applying epoxy solution with a brush.

5. Fifth layer: Glass fibre, gently applying epoxy solution with a brush.

6. After application of layers, it is left to solidify for 24 hours.

RESULTS AND DISCUSSION

FEA results

Parameter	Equivalent stress (Mpa)	force reaction (N)
Tensile GRPF specimen	**263.36 MPa**	**17502 N**
Tensile Coir plus GRPF specimen	**237.66 MPa**	**13797 N**
Tensile Coir plus CRPF specimen	**280.55 MPa**	**17829 N**
Compression GRPF specimen	**226.72 MPa**	**14916 N**
Compression Coir plus GRPF specimen	**203.55 MPa**	**11725 N**
Compression Coir plus CRPF specimen	**243.41 MPa**	**15212 N**

Table 1. Comparison of displacement of all 2 cases

Tensile test on UTM

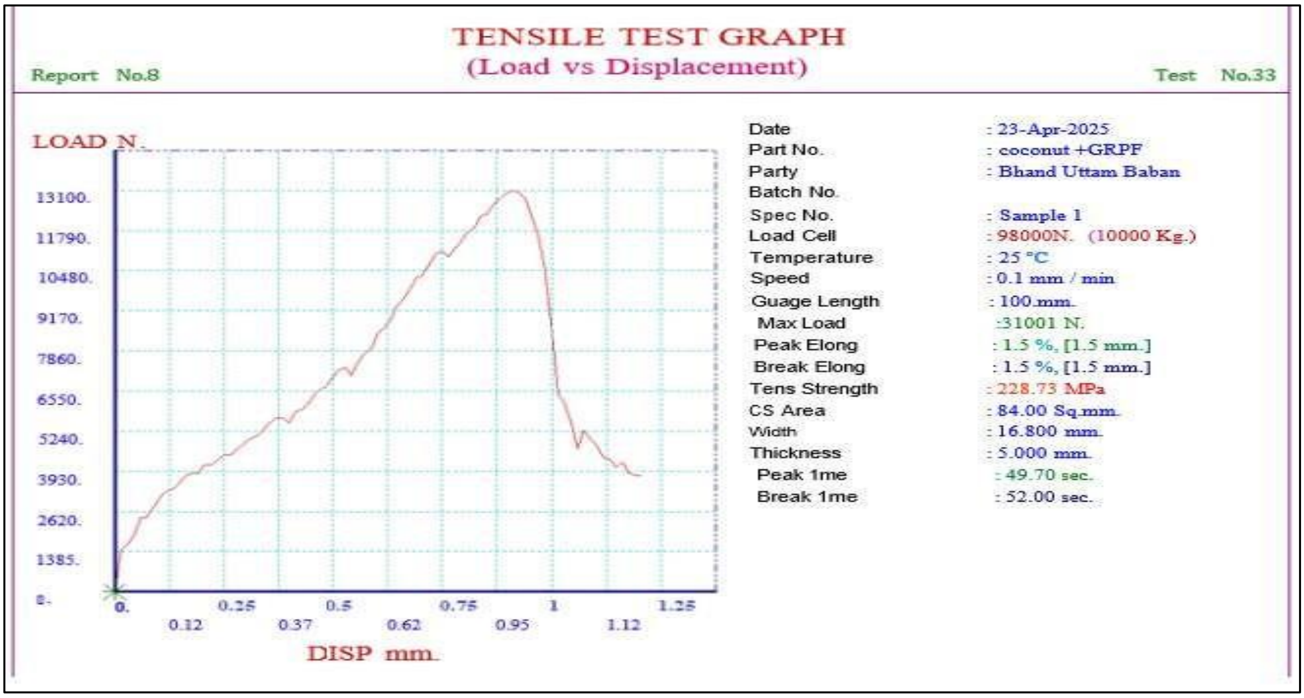


Figure 2: UTM- Tensile test

IV. CONCLUSION

In this paper we can use coir and GRPF fiber , we use 100 mm gauges size , we provide maximum load is 31001N , we got tensile strength is 228.73 Mpa. So we can easily used in various automobile dashboards.

V. REFERENCES

1. S.M Hashim*, W. B Salih. “Study of effect reinforcement by coconut fiber on some mechanical and physical properties of thermoset polymer” doi:10.1088/1757-899X/757/1/012020
2. O. O. Daramola 1*, A. A. Akinwande 1, A. A. Adediran 2*, O. A. Balogun 1, J. L. Olajide 3, K. J. Adedoyin 4, B. O. Adewuyi 1 & T. C. Jen “Optimization of the mechanical properties of polyester/coconut shell ash (CSA) composite for light-weight engineering applications” | https://doi.org/10.1038/s41598-022-26632-X
3. Nutenki Shravan Kumar [a], Tanya Buddi [a], A. Anitha Lakshmi [a], K.V. Durga Rajesh “Synthesis and evaluation of mechanical properties for coconut fiber composites-A review” https://doi.org/10.1016/j.matpr.2020.12.543
4. Velpuri Venkat Raman,1 P. Sathish Kumar,2 Prashant Sunagar,3 K. Bommanna,4 R. Vezhavendhan,5 Sumanta Bhattacharya,6 S. Venkatesa Prabhu and Bashyam Sasikumar 8 “Investigation on Mechanical Properties of Bamboo and Coconut Fiber with Epoxy Hybrid Polymer Composite” Volume 2022, Article ID 9133411, 5 pages https://doi.org/10.1155/2022/9133411
5. Chandra Prakash Singha, Raj Vardhan Patelb, Mohd Faizul Hasanc, Anshul Yadava,⇑, Virendra Kumara, Anil Kumara “Fabrication and evaluation of physical and mechanical properties of jute and coconut coir reinforced polymer matrix composite” https://doi.org/10.1016/j.matpr.2020.07.684
6. Huyen Bui 1,2, Nassim Sebaibi 1, Mohamed Boutouil 1 and Daniel Levacher 3,* “Determination and Review of Physical and Mechanical Properties of Raw and Treated Coconut Fibers for Their Recycling in Construction Materials” Fibers 2020, doi:10.3390/fib8060037
7. Jawad Ahmad,[1,*] Ali Majdi,[2] Amin Al-Fakih,[3] Ahmed Farouk Deifalla,[4,*] Fadi Althoey,[5] Mohamed Hechmi El Ouni,[6,7] and Mohammed A. El-Shorbagy[8] “Mechanical and Durability Performance of Coconut Fiber Reinforced Concrete: A State-of-the-Art Review” doi: 10.3390/ma15103601
8. Juan Randy Simamora1,2,3 , C. Kurniawan1,2,3 , J. Marbun2, P. Simamora3 1 “Mechanical properties of brake pad composite made from candlenut shell and coconut shell” doi:10.1088/1742-6596/1428/1/012018