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Comparison of Tensile, and Impact Strength of GFRP/Banana (20 wt.%) and CFRP/Banana (20 wt.%) Composite

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Abstract: In recent years, with the growing demand for advanced materials, the need for the development of hybrid composites is increasing rapidly. A wide variety of studies have been going on about the natural fiber. Natural fiber uses were increased due to its eco-friendly nature, availability, low cost, ease of fabrication, light weight, biodegradability, high strength, and wide range of engineering applications. The natural fiber, such as banana fiber, offers its availability, low cost, and biodegradability, making it a better alternate to synthetic fiber. This study aims to compare the tensile and impact strength of GFRP/banana (20 wt%) and CFRP/banana (20 wt%) polymer composites. The composites are fabricated by using the hand lay-up method. One is reinforced with glass fiber with banana fiber (20 wt%) and other is the carbon fiber with banana fiber (20 wt%). There are two layers of natural fibers and three layers of carbon and glass in two different composites. Both composites were being prepared by the same procedure. The objective of this study was to evaluate the impact strength and tensile strength of both the materials. The experimental results showed that CFRP/banana (20 wt.%) is better tensile strength than GFRP/banana (20 wt.%) in all three tests.

Keywords: Banana fiber, Glass fiber, Carbon fiber, Impact strength, Tensile strength.

I. INTRODUCTION

Natural fiber such as banana fibers, coconut coir and jute fibers is eco-friendly nature, availability, low cost, ease of fabrication, light weight, biodegradability, high strength, and also safer to handle than synthetic fibers. Generally, the banana fibers are used to make the mats, handicrafts, ropes, and composite material. It has low amount of lignin and a high amount of cellulose is present [1]. In the recent years, natural fiber reinforced composites play a major role of research because of their nature. Natural fibers can be easily extended from the natural plants and other natural sources. The fibers easily bond with the matrix. The mechanical strength of the fibers mainly depends on the cellulose and lignin present on the fiber [2]. Natural fibers reinforcement increases the strength and durability of composites material while keeping them light weight and reducing environmental impact [3]. Hybrid reinforcement composites with different type of fibers exhibit improved mechanical properties can be adjusted according to specific needs of application [4]. The mechanical performance is generally lower than that of synthetic fibers composites such as CFRP and GFRP even with same number of layers. Hybridization of natural fibers with synthetic fibers improves the mechanical properties and strength of reinforced composite materials [5]. In this study banana/glass/carbon fibers-based hybrid composites were fabricated by using hand lay-up method with varying the weight percentages of the banana fibers (20 wt%). The prepared reinforced composites were characterized to studied the tensile strength, impact strength and flexural strength.

II. LITERATURE REVIEW

Md. Mehedi et al. [6] investigated the development of hybrid composites, using banana fiber, glass fiber and epoxy resin. Banana fiber was tested in both treated (NaOH) and untreated sample were maintained at 20%, 30%, and 40% respectively. Results showed that treated fibers especially at 40%, had better tensile strength, flexural strength, impact resistance and lower water absorption than the untreated fibers. These hybrid composites are used as an alternative of conventional materials as making storage boxes, shielding roofs, benches, ecofriendly durable helmets.

Muhammad Azizi et al. [7] studied the compares frond waste fiber composites with glass fiber composites. From the experiment it is showed that glass fibers provide higher strength, banana fibers showed good impact resistance and adequate mechanical performance.

Sabbir Ahmed et al. [8] carried out the hybrid epoxy-based composite reinforced with jute and banana fibers in different orientations. The results showed that fiber orientation significantly affects the composites mechanical properties, particularly tensile strength, impact resistance and hardness. The unidirectional jute banana configuration has achieved

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highest tensile strength and hardness; the unidirectional jute bidirectional banana configuration provided the best impact resistance and lowest water absorption.

Ganapathy et al. [9] investigated the mechanical properties of coconut coir and hybrid coconut-banana fiber reinforced epoxy composites. Improving the bonding the fibers were alkali-treated with 5% NaOH. From the experiment it showed that the hybrid composite 80% of coconut fiber and 20% of banana fiber exhibited better tensile strength, impact resistance, flexural performance, and hardness than the coconut fiber composite alone. ANSYS simulations are used to findings experimental, improved stress-bearing capacity. The hybrid composites were environmentally friendly and cost effective, making them suitable for applications in automotive, construction, and packaging industries.

Satish Gandhi et al. [10] studied the use of banana fiber and cissus quadrangularis fiber as natural reinforcements in epoxy composites. Composite are fabricated by using the hand lay-up method. This composite is containing of 20% Cissus quadrangularis fiber and 80% of banana fiber showed the best performance high flexural strength, improved tensile strength, Impact resistance. Also, in the SEM test it showed the good bonding between the fibers and epoxy matrix. These natural fibers are strong light weight, eco-friendly, and cost-effective alternatives of synthetic fibers.

Ramu Inala et al. [11] investigated banana fiber and glass fiber-reinforced epoxy hybrid composites made with the hand lay-up method. Tests showed that composite with 900 orientations has the highest tensile strength, hardness and impact properties when it compared with the 450 orientations. The demonstrate that the banana fiber glass-reinforced are lightweight, strong, cost-effective, and environmentally friendly materials with potential applications in the automotive. Anish Bajla et al. [12] studied the hybrid composite made from banana, glass and carbon fibers with different banana fiber orientations (0°, 45°, and 90°). The 45^0 orientations provided the highest tensile strength, while the 0^0 orientation lower toughness and the highest strength. The selection of the right fiber orientation is the most important to achieve the desired properties for specific applications.

L. Karthick et al. [13] evaluated the banana and glass fiber reinforced composite are prepared by the hand lay-up method. The impact of fiber volume fraction on composite fracture and tensile strength was investigated. From the studied it was found that the glass-fiber composites exhibited higher tensile strength than banana fiber composites. Banana fiber showed better environmental usable and lower weight in composites.

Kanchan B.M. et al. [14] studied the effect of NaOH and KnMnO4 chemical treatments on banana-fibre-reinforced carbon–Kevlar hybrid composites. Chemical treatment improved fiber-matrix bonding, vibration characteristics is improved, increased the shear strength and also improved the acoustic insulation. NaOH treatment increased stiffness, natural frequency and also improving the rigidity of composites while KMnO4 treatment gave the best damping and sound insulation performance. The treated composites showed the potential for light weight aerospace material, automotive and structural fields, durable and sound-mitigating materials.

III. MATERIAL PREPARATION

The Epoxy resin and hardener is mixed in the ratio 3:1 and it acts as a matrix material. By using Hand Lay Up Technique the two composite i) GFRP / Banana (20 wt.%) ii) CFRP / Banana (20 Wt.%) were prepared as shown in fig. 1. Table 1 represents about the properties of the reinforced materials and matrix materials.

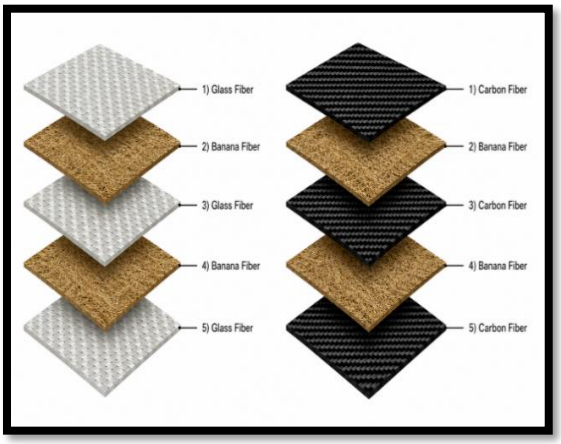

Fig. 1 Layered diagram of GFRP/BANANA composite and CFRP/BANANA composite

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TABLE I MATERIAL AND ITS PROPERTY SPECIFICATION

Material	Procured from	Property/Specification
Glass Fiber	Online market place	Bidirectional (600 GSM)
Carbon Fiber	Online market place	Bidirectional (600 GSM)
Banana Fiber	Locally Extracted and Treated with NaOH solution (5 wt.%)	
Epoxy Resin and Hardener	Soumyya Resin Private Limited	Viscosity of epoxy resin (300 cP) Mixing ratio: 3:1

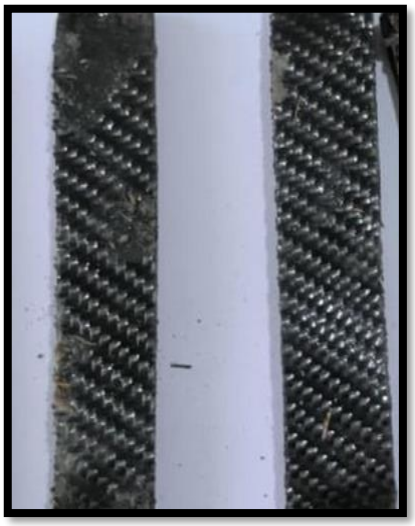

Fig. 2 CFRP/BANANA (20 wt.%) Test samples

Fig. 3 GFRP/BANANA (20 wt.%) Test samples

Fig. 2 and Fig. 3 represents the sample specimen. The Samples were prepared as per ASTM standard.

IV. RESULT AND DISCUSSION

A. *TENSILE TEST*

Tensile tests were conducted as per ASTM D638 Standards. The Data extracted from the tests are

I) For CFRP/BANANA (20 wt.%) composite the average ultimate Tensile Strength is 70.15 MPa, Youngs Modulus 4.66 GPa, Yield Strength of 66MPa, Maximum Load 14029 N.

II) For GFRP/BANANA (20 wt.%) composite the average ultimate Tensile Strength is 34.06 MPa, Youngs Modulus 2.77 GPa, Yield Strength of 30.75MPa, Maximum Load 3405.85 N.

From the results it can be concluded that the CFRP/BANANA composite Exhibit 106% higher tensile strength than GFRP/BANANA **(20 wt.%)** Composite. Also, Youngs Modulus is 68 % higher in CFRP/BANANA **(20 wt.%)** composite. This superior behavior of CFRP/BANANA composite is mainly due to its high strength and modulus of elasticity of Carbon fiber which enhances the load bearing capacity of the composite.

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Fig. 4 Tensile Test of Specimen

Fig. 5 Izod Impact Test

B. *IMPACT STRENGTH*

In order to understand impact strength of both the material Izod impact test was carried out. It was observed from the test results that **GFRP/BANANA (20 wt.%)** composite have average impact Energy of 12.5 Joule where as **CFRP/BANANA (20 wt.%)** composite have average impact Energy of 8.2 Joule. This behavior is opposite to the tensile test results. Progressive damage mechanism, higher strain to failure capacity leads to higher impact strength of **GFRP/BANANA (20 wt.%)** composite.

V. CONCLUSION

The following Conclusions can be drawn from the experiment-

i) The Tensile Strength of CFRP/BANANA (20 wt.%) Composite is greater than GFRP/BANANA (20 wt.%) composite

ii) The Impact Strength of Composite GFRP/BANANA (20 wt.%) is greater than CFRP/BANANA (20 wt.%) composite

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