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Study of Mechanical Characteristics on Hybrid Composites Using Sisal Fiber and Banana Fiber

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Abstract - Fiber reinforced polymer composites have a wide variety of applications as a class of structural materials because of their advantages such as ease of manufacturing, comparatively minimum cost of production & greater stability. The fiber supports polymers can be either factitious or inherent. In spite of synthetic fibers like glass and carbon acquire high specific strength, their field of applications is limited because of their higher costs of fabrication. In recent times, there is a developing concern in hybrid composites that are made by reinforcement of two or more different types of fibers in a single matrix, considering these materials obtain a limit of properties that cannot be obtained with an appropriate support. In addition, material charges can be slow down by careful selection of supporting fibers. Mechanical properties of a composite material depend on many factors. In this connection, the objective of the present research work is to study the effect of fiber content on the mechanical and water absorption behaviour of sisal and banana fibre reinforced epoxy based hybrid composites
Keywords—Hybrid composites, Mechanical properties, Sisal fiber, Banana fiber, Effect of fiber

I. INTRODUCTION

A Composite Material is an apparent combination of two or more different materials, having a strong connection. It is having reinforcing stiffer phase and the matrix phase. The resulting composite material has a balance of structural properties that is superior to either constituent material only. Composites commonly have a fiber or particle phase that is stiffer and stronger than the continuous matrix phase and serve as the principal load conveying members. The matrix is being load transfer medium amid fibers. The matrix also covers the fibers from environmental breakage before, during and after composite development [2]. A hybrid composite is having more than one fiber as a reinforcement phase embedded into a single matrix phase. Hybridization provides the designers with an added degree of freedom in manufacturing composites to achieve high level of mechanical properties. Composites made of a single reinforcing material system may not be suitable if it undergoes different loading conditions during the application. Normally, one of the fibers in a hybrid composite is a high- modulus and high-cost fiber and the other is usually a low-modulus fiber. The high-modulus fiber provides the stiffness and load conducting properties, because it makes the composite more damage tolerant and keeps the material prize reduced [5]. The mechanical characteristics of a hybrid composite can be varied by changing volume ratio and stacking sequence of different plies. High-modulus fibers are widely used in many aerospace applications because of their high specific modulus. Even though the impact energy of composites made of such high-modulus fibers is generally lower than conventional steel alloys or glass reinforced composites. An effective method of improving the impact properties of high-modulus fiber composites is to add some percentage of low-modulus fibers [6]. Most composite materials experience time varying internal disturbance of moisture and temperature during their service life time which can cause swelling and plasticization of the resin, distortion of laminate, deterioration of fiber/resin bond etc. Because of the high performance laminates and composites. In this paper the behaviour of sisal and banana hybrid composites with epoxy resin was described.

The basic reason for working on such a topic arises from the fact that composites are vulnerable to environmental degeneration. A moist circumstance, having high or low temperature conditions is extremely detrimental to composites. There have been several attempts done by researchers in the last few years to establish the much needed correlation between the mechanical properties of the material and the moist. However, most analysis pursuing on mechanical aspects rather than the physical & chemical interface and how this brings in change in the internal mechanical properties and affects a variety of other morphological changes [4].The focus of our research has been to understand the physical changes that take place at the bonding interface between the fibers and the matrix, distribution of load, and it also governs the damage accumulation and generation. It is having broad importance in aerospace practices, due to harsh moist environment [7].Hence this work aims at the mechanical characterization of the sisal and banana fiber reinforced hybrid composites.

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II. COMPOSITE MATERIAL

A composite material which consists of two or more distinctly differing materials is insoluble in each other and differs in chemical composition. The ancient Egyptians manufactured composites. Wattle and daub is one of the oldest man-made examples for them, which are made 6,000 years ago.

Wood is a good example of an inherent composite, connection of cellulose and lignin. The cellulose fiber affords durability and the lignin is the "glue" that bonds and stabilizes the fiber.

A good example of ancient composite is Adobe bricks. The combination of straw and mud forms a composite that is stronger than either the mud or the straw by itself.

Concrete reinforced with steel rebar

A. Phases Of Composite Materials

Composites are combinations of two phases is shown in Fig. 1

Matrix phase and Reinforcement phase

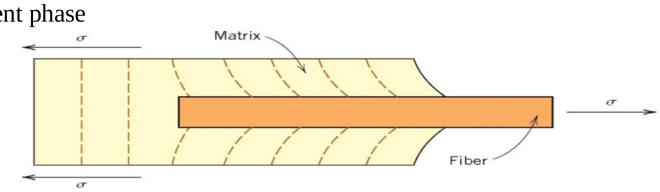

Fig. 1 Phases of composite materials

B. Properties Of Composites

They are active and brittle, yet very light in weight, so ratios of strength-to-weight and stiffness-to-weight are several times greater than steel or aluminium.

Composites having good fatigue for common engineering metals.

Rigidness is much higher than that of the metals.

Composites can be constructed to resist corrosion.

Conceivable to accomplish blending of properties not attainable with metals, ceramics, or polymers alone.

III. BANANA AND SISAL FIBER

Banana fibre is a kind of ligno-cellulosic fibre is which derived from the bogus-stem of banana plant. Banana plant is a huge continual herb with leaf sheaths that form bogus stem. Many countries are planting banana for their domestic and industrial uses. For India concern, the banana plant is most familiar for fruits, stem and leaves. However the life of the banana tree is not more than about 10 months to 13 months. Although the outer layer of the tree getting dried frequently by its growth. From which the Banana fibre is obtained by unwanted layers (dried one by grow) or dead one (by life span ended) can be crushed by applying force on them and it is dried.

Sisal fibre is derived from the leaves. It is achieved by decortications process in which the leaf is crushed between rollers and then mechanically fragmented. The fibre is then cleaned and drained. The dried fibre represents only 4% of the total density of the leaf. After that it is dried-up the fibre is mechanically double brushed. The lustrous strand is usually milky white and passable ranges from 80-120 cm in length and 0.2 to 0.4 mm in diameter. Sisal fibre is fairly coarse and indomitable. It is admired for cordage use due to its durability, endurance, flexibility, compatibility for certain dyestuffs, and detention to corrosion in saltwater. Sisal fiber is entirely biodegradable, green composites were assembled with soy protein resin and composites were calibrated for their mechanical and thermal effects. It is greatly renewable energy source. Sisal fibre is especially reliable and a low maintenance with minimal wear and tear. The chemical compositions of banana and sisal fibres are shown in Table I and II.

TABLE I

CHEMICAL COMPOSITION OF BANANA FIBER

Cellulose	53.52%
Hemi-celluloses	13.9%
Lignin	18.64%
Pectin	3.1%
Extractive	10.7%

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TABLE III

CHEMICAL COMPOSITION OF SISAL FIBER

Cellulose	71.5%
Hemi-celluloses	18.1%
Lignin	5.9%
Pectin	2.3%
Fat and Wax	0.5%
Water soluble matter	1.7%

The process of composite fabrication using hand lay-up process is listed below,
Initially, the sisal fiber and banana fiber are chopped in the size of 3 mm.
The fiber and alumina is weighed to the required quantity and it also mixed well [3].
Then, prepare the matrix by mixing the Epoxy resin and Hardener in the ratio of 10:1
Then the wax is assigned on the die and the developed matrix and fiber is mixed well using glass rod.
Then the appropriate bundle of fiber matrix is accommodated in the square shaped die of dimension 300x300x3 mm.
Then the die is locked and weighted with the compression of 1500 psi at a temperature of 90°C
After 24 hour, the die is opened and the hybrid laminate of sisal fiber and banana fiber is taken out.
Utmost care has been taken to maintain uniformity and homogeneity is shown in Table III.

TABLE IIIII

MIXING RATIO FOR SAMPLES

S.No	Samples	Fiber (%)		Filler (%)	Resin (%)
		Sisal	Banana		
1	S1	45	-	5	50
2	S2	30	15	5	50
3	S3	22.5	22.5	5	50
4	S4	15	30	5	50
5	S5	-	45	5	50

IV. EXPERIMENT PROCEDURE CUTTING OF LAMINATES INTO SAMPLES

A wire hacksaw blade was used to chop separate laminate into smaller pieces, for various experiments [1].

Tensile test- Sample was cut into the size of (250x25x3) mm in accordance with ASTM standards D-638.
Flexural test- Sample was cut into flat shape (125x13x3) mm, in accordance with ASTM standards D-790.
Impact test- Sample was cut into flat shape (65x13x3) mm, in accordance with ASTM standard D-790.
Water absorption test-Sample was cut into flat shape (30x30x3) mm.
Tensile test with bolt joint- Sample was cut into the size of (102x25x3) mm in accordance with ASTM standard D-5868-01.Two plates are made up of for same size and made the single lab joint for testing the tensile strength. One hole is drilled at each plate at the amount of 6mm diameter and the individual lab joint is made with the help of 6mm bolt and nut. Five samples taken for testing are shown in Fig. 2

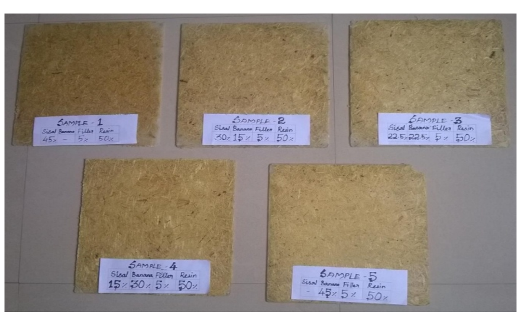

Fig. 2 Samples taken for testing

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V. MECHANICAL CHARACTERISTICS OF COMPOSITES

This chapter presents the mechanical properties of the sisal and banana fiber reinforced epoxy composites prepared for this present analysis. Technicalities of processing of these composites and the tests conducted on them have been described in the preceding chapter. The results of different characterization tests are described here. This admits assessment of mechanical properties. The explanation of the results and the comparison among various composite samples are also presented. The characterization of the composites reveals that the fiber weight (%) is having significant effect on the mechanical properties of composites. The effects of the composites with deviating fiber weight (%) under this investigation are presented in Table IV

TABLE IVV
MECHANICAL PROPERTIES OF THE COMPOSITES

Composites	Tensile strength (MPa)	Tensile strength with bolt (MPa)	Flexural strength (MPa)	Impact Energy(J)	Water absorption (%)
S1	15.941	13.744	45.362	0.75	17.95
S2	18.541	15.117	43.317	0.50	18.53
S3	18.796	14.784	39.942	0.35	10.61
S4	20.838	14.205	43.602	0.35	21.31
S5	24.702	15.431	54.679	0.30	12.68

A. *Effect of Fiber Weight (%) On Tensile Strength*

The test results for tensile strength are shown in Fig. 3. The sample 1 and 5 expose the complete sisal and pure banana reinforced composites and in these composites, perfect banana shows great tensile strength. The sample 2, 3 and 4 expose the tensile strength of hybrid composites and in this hybrid composites, the sample 4(i.e. 15% of sisal and 30% of banana fiber) shows the better tensile strength. From the results it is seen that the tensile strength of the composite increases with increase in banana fiber weight (%).

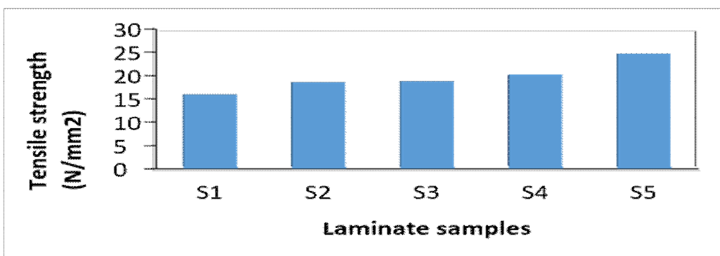

Fig. 3 Effect of fiber weight (%) on tensile strength of composites

B. *Effect Of Fiber Weight (%) On Tensile Strength With Bolt Joint*

The test results for tensile strength are shown in Fig. 4. The sample 1 and 5 are the perfect sisal and pure banana reinforced composites and in these composites, pure banana shows high tensile strength. The sample 2, 3 and 4 shows the tensile strength of hybrid composites and in this hybrid composites, the sample 2(i.e. 30%% of sisal and 15% of banana fiber) shows the better tensile strength. From the results it is seen that the tensile strength of the composite increases with increase in sisal fiber weight (%).

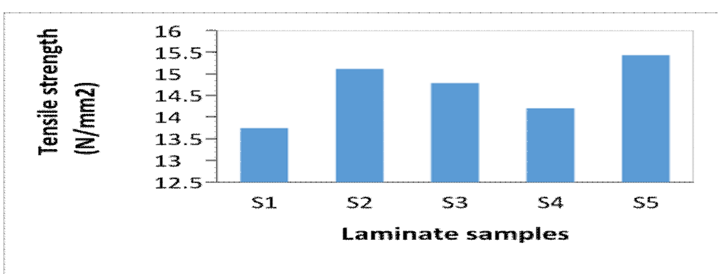

Fig. 4 Effect of fiber weight (%) on tensile strength of composites

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C. Effect Of Fiber Weight (%) On Flexural Strength

The test results for flexural strength are shown in Fig. 5. The sample 1 and 5 shows the pure sisal and pure banana reinforced composites and in this composites, pure banana shows high flexural strength. The sample 2, 3 and 4 shows the flexural strength of hybrid composites and in this hybrid composites, the sample 3(i.e. 15% of sisal and 30% of banana fiber) shows the better flexural strength. From the results it is seen that the flexural strength of the composite increases with increase in banana fiber weight (%).

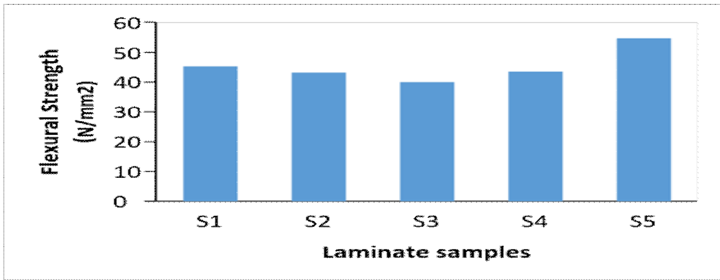

Fig. 5 Effect of fiber length on flexural strength of composites

D. Effect Of Fiber Weight (%) On Impact Energy

The test results for impact energy are shown in Fig. 6. The sample 1 and 5 shows the pure sisal and pure banana reinforced composites and in this composites, pure sisal shows high impact energy. The sample 2, 3 and 4 shows the impact energy of hybrid composites and in this hybrid composites, the sample 2(i.e. 30%% of sisal and 15% of banana fiber) shows the better impact energy. From the results it is seen that the impact energy of the composite increases with increase in sisal fiber weight (%).

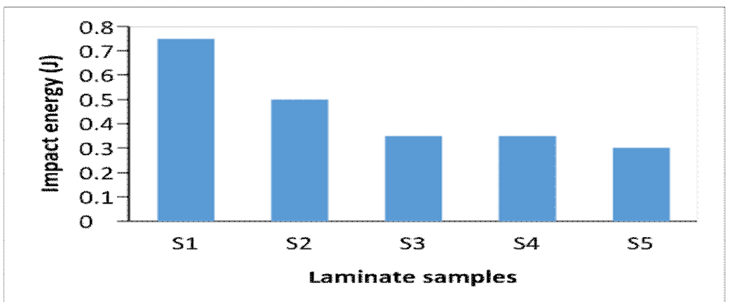

Fig. 6 Effect of fiber length on impact energy of composites.

E. Effect Of Fiber Weight (%) On Water Absorption Rate

The test results for water absorption rate are shown in Fig. 7. The sample 1 and 5 shows the pure sisal and pure banana reinforced composites and in this composites, pure banana shows less water consumption rate. The sample 2, 3 and 4 exposes the water absorption rate of hybrid composites and in this hybrid composites, the sample 3(i.e. 22.5% of sisal and 22.5% of banana fiber) shows the less water absorption rate. From the results it is seen that the water absorption rate of the composite is less in sample 3.

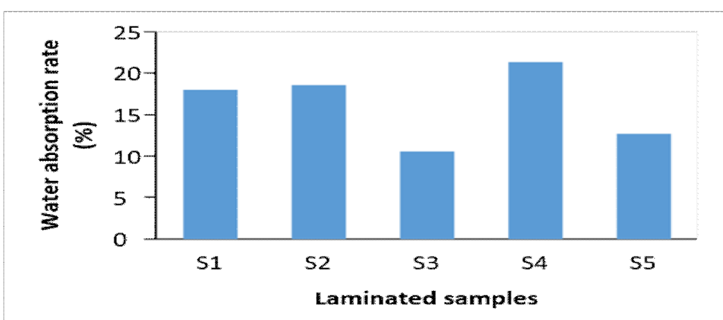

Fig. 7 Effect of fiber weight (%) on water absorption rate

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VI. CONCLUSIONS

This speculative inspection of mechanical attitude of sisal and banana fiber reinforced epoxy hybrid composites leads to the following conclusions:

This work shows that successful fabrication of a sisal and banana fiber reinforced epoxy hybrid composites with different fiber weight (%) is possible by compression molding technique.

It has been noticed that the mechanical properties of the composites such as tensile, flexural, flexural modulus, and impact strength and water absorption rate of the composites are also greatly influenced by the fiber weight (%).

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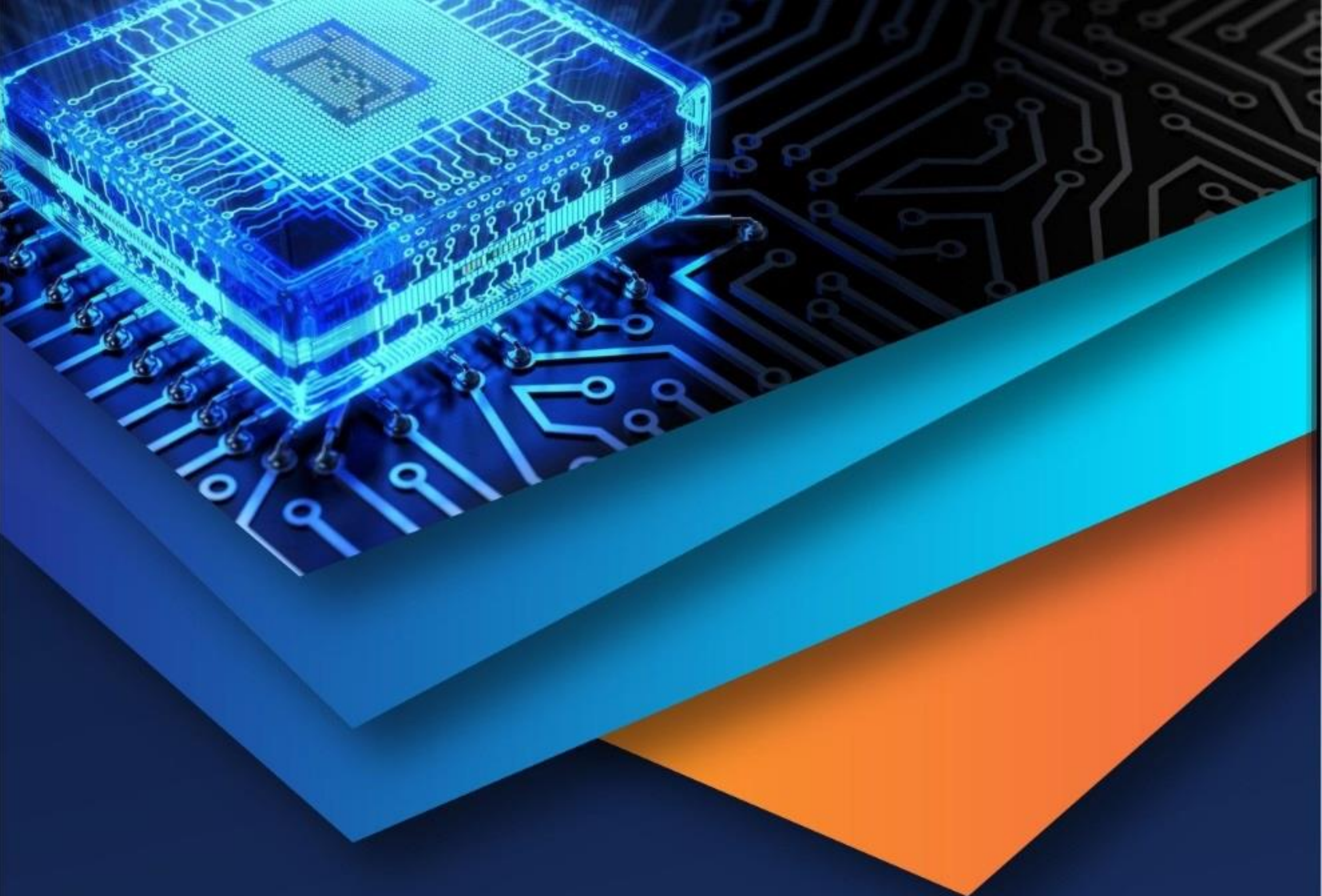

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