SYNTHESIS AND ANALYSE THE PHYSICAL PROPERTIES OF SUGARCANE BAGASSE COCONUT COIR EPOXY COMPOSITES

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Abstract - *The present experimental study aims at learning the mechanical behavior of hybrid natural fiber composites. Samples of coconut coir-sugarcane Bagasse-Epoxy hybrids were manufactured using compression moulding method where the stacking of plies was alternate and the weight fraction of fibre and matrix was kept at 40%-60%.Specimens were cut from the fabricated laminate according to the ASTM standards for different experiments. For Tensile test & flexural test samples were cut in Dog-bone shape and flat bar shape respectively. After that experiment is performed under Universal testing machine (UTM) flexural strength & Tensile strength were observed and compared to base values of epoxy polymer to perceive the change in strength. Hardeness properties for their brittleness*

Key Words: Sugarcane bagasse fiber, Coconut coir, epoxy resin

1.INTRODUCTION

A composite is a material made by combining two or more dissimilar materials in such a way that the resultant material is endowed with properties superior to any of its parental ones. Fiber-reinforced composites, owing to their superior properties, are usually applied in different fields like defense, aerospace, engineering applications, sports goods, etc. Nowadays, natural fiber composites have gained increasing interest due to their eco-friendly properties. A lot of work has been done by researchers based on these natural fibers. Natural fibers such as jute, sisal, silk and coir are inexpensive, abundant and renewable, lightweight, with low density, high toughness, and biodegradable. Natural fibres such as jute have the potential to be used as a replacement for traditional reinforcement materials in composites for applications which requires high strength to weight ratio and further weight reduction. Bagasse fiber has lowest density so able to reduce the weight of the composite upto very less. So by using these fibers (jute, bagasse, and lantana camara) the composite developed is cost effective and perfect utilization of waste product. Natural fiber reinforced polymer composites have raised great attentions and interests among materials scientists and engineers in recent years due to the considerations of developing an environmental friendly material and partly replacing currently used glass or carbon fibers in fiber reinforced composites. They are high specific strength and modulus materials, low prices, recyclable, easy available in some countries, etc. Li et al. [5] conducted a research to study the mechanical properties, especially interfacial performances of the composites based on natural fibers due to the poor interfacial bonding between the hydrophilic natural fibers and the hydrophobic polymer matrices. Two types of fiber surface treatment methods, namely chemical bonding and oxidization were used to improve the interfacial bonding properties of natural fiber reinforced polymeric composites. Interfacial properties were evaluated and analyzed by single fiber pull-out test and the theoretical model. The interfacial shear strength (IFSS) was obtained by the statistical parameters. The results were compared with those obtained by traditional ways. Based on this study, an improved method which could more accurately evaluate the interfacial properties between natural fiber and polymeric matrices was proposed. Joshi et al. [6] compared life cycle environmental performance of natural fiber composites with glass fiber reinforced composites and found that natural fiber composites are environmentally superior in the specific applications studied. Natural fiber composites are likely to be environmentally superior to glass fiber composites in most cases for the following reasons: (1) natural fiber production has lower environmental impacts compared to glass fiber production; (2) natural fiber composites have higher fiber content for equivalent performance, 16 reducing more polluting base polymer content; (3) the light-weight natural fiber composites improve fuel efficiency and reduce emissions in the use phase of the component, especially in auto applications; and (4) end of life incineration of natural fibers results in recovered energy and carbon credits. Rana et al. [7] in their work showed that the use of compatibilizer in jute fibers increases its mechanical properties. At 60% by weight of fiber loading, the use of the compatibilizer improved the flexural strength as high as 100%, tensile strength to 120%, and impact strength by 175%.Shah and Lakkad [8] tries to compare the mechanical properties of jute-reinforces and glass-reinforced and the results shows that the jute fibers, when introduced into the resin matrix as reinforcement, considerably improve the mechanical properties, but the improvement is much lower than that obtained by introduction of glass and other high performance fibers. Hence, the jute fibers can be used as a reinforcement where modest strength and modulus are required. Another potential use for the jute fibers is that, it can be used as a „filler" fiber, replacing the glass as well as the resin in a filament wound component. The main problem of the present work has been that it is difficult to introduce a large quantity of jute fibers into the JRP laminates because the jute fibers, unlike glass fibers, soak up large amount of resin. This problem is partly overcome when „hybridsing" with glass fibers is carried out. Ray et al. [9] in their work, Jute fibres were subjected to alkali treatment with 5% NaOH solution for 0, 2, 4, 6 and 8 h at 300C. It was found that improvement in properties both for fibres and reinforced composites. The fibres after treatment were finer, having less hemicellulose content, increased crystallinity, reduced amount of defects resulting in superior bonding with the vinylester resin. As fibres, the improvements in properties were predominant around 6–8 h treatment whereas as composites, it was maximum when reinforced with 4 h-treated fibres at 35% fibre loadings. 17 The modulus of the jute fibres improved by 12, 68 and 79% after 4, 6 and 8 h of treatment, respectively. The tenacity of the fibres improved by 46% after 6 and 8 h treatment and the% breaking strain was reduced by 23% after 8 h treatment. For 35% composites with 4 h-treated fibres, the flexural strength improved from 199.1 to 238.9 MPa by 20%, modulus improved from 11.89 to 14.69 GPa by 23% and laminar shear strength increased from 0.238 to 0.283 MPa by 19%. On plotting different values of slopes obtained from the rates of improvement of flexural strength and modulus, against NaOH treatment time, two different failure modes were apparent before and after 4 h of NaOH treatmentSaha et al. [10] in their paper, jute fibers were treated with alkali(NAOH) solution and physic-chemical properties of jute fibers was investigated. The treatments were applied under ambient and elevated temperatures and high pressure steaming conditions. The results indicated that the uniaxial tensile strength increased by up to 65% for alkali-steam treatment. The treatments without steaming were not as effective. Physico-chemical characterization of fibers showed that the increase in tensile strength was due to the removal of non-cellulosic matters like lignin, pectin and hemicellulose. Gassan and Bledzki [11] used the coupling methods to improve the properties of composites. Composites have high level of moisture absorption, poor wettability, and insufficient adhesion between untreated fibers and the polymer matrix leads to debonding with age. To improve the properties of the composites, the natural reinforcing fibers can be modified coupling methods. The coupling agents have chemical groups which can react with fiber or polymer and thus improve the interfacial adhesion. This paper concerns with the use of MAH-PP copolymers as coupling agents in jutepropylene composites. It is found that the flexural strength was increased by 40% and flexural modulus by 90%. SEM investigation showed the improved fiber-matrix adhesion which was due to the chemical bonds between fiber and matrix provided by the coupling agent. Monteiro SN. Rodriquez et al. [12] tries to use the sugar cane bagasse waste as reinforcement to polymeric resins for fabrication of low cost composites. They reported that composites with homogeneous microstructures could be fabricated and mechanical properties similar to wooden agglomerates can be achieved. Hassan et al. [13,14] have converted the bagasse into a thermo formable material through esterification of the fiber matrix. The dimensional stability and mechanical properties of the composites prepared from the esterified fibers were reported in this work. 18 BC Ray [15] used 3-point flexural test to qualitatively assess such effects for 55, 60 and 65 weight percentages of E-glass fibers reinforced epoxy composites during cryogenic and after thawing conditions. The specimens were tested at a range of 0.5 mm/min to 500 mm/min crosshead speed to evaluate the sensitivity of mechanical response during loading at ambient and sub-ambient (- 80°C temperature). These shear strength values are compared with the testing data of as-cured samples. After reviewing the existing literature available on natural fiber composites, particularly natural fibers (jute, bagasse and lantana camara) composites put efforts to understand the basic needs of the growing composite industry. The conclusions drawn from this is that, the success of combining vegetable natural fibers with polymer matrices results in the improvement of mechanical properties of the composites compared with the matrix materials. These composite fibers are cheap and nontoxic, can be obtained from renewable sources, and are easily recyclable. Moreover, despite their low strength, they can lead to composites with high specific strengths because of their low density.

Therefore, the aim of this research work is finding new alternative of sports equipment (skateboard) application in prospects of long-lasting and economic concern as well as better physical or mechanical properties. The present work focused on the fabrication of sugarcane bagasse - coconut coir based skateboard by using hand layup method. Later the mechanical performances of these composite have been investigated experimentally

2. SPECIMEN PREPARATION

The specimens are prepared by a method called compression moulding as seen in Figures 1, SBCCC (particulate composites). All the specimens have a thickness of 4 mm. The sugarcane bagasse and coconut coir in the form of strands.

The SBCCC hybrid composite has a total of 2 layers, comprising of glassfibre and sugarcane bagasse in particulate fiber layers.. The binding agent was used as a combination of epoxy resin-type LY556 and hardener-type HY951 in the ratio 10:1. While preparing SBCCC with glassfibre, circular notches are punched in the foil to enhance bonding between the immediately adjacent layers as seen in Figure 3.

After fabrication, the specimens are cut according to ASTM standards for further mechanical testing as follows.

Fig 1. Initial materials

Fig 2. Compression machine process

Fig -3 Final fabricated SBCCC

3. Mechanical Testing

After the specimens are cut in accordance to ASTM standards, (Table 1) they are subjected to mechanical tests.

Table -1: ASTM standards for specimen cutting

SL NO	TEST	SPECIMEN DIMENSION (l x b) in mm
1	Tensile	175 x 25 (ASTM D3039)
2	Flexural	125 x 25 (ASTM D790)
3	Impact test	60 x 60 (ASTM D3029)
4	Hardness	55 x 25

3.1 Flexural Test

A total of 6 Specimens are prepared for the test. These specimens have been separated into three different groups, each consisting two specimens (Figure 4). The first two specimens are normal SBCCC. The 3-point bending test fixtures were then fitted in the UTM machine. The specimens were then loaded turn by turn, so that a span length of 100 mm was maintained for each specimen. The feed rate was set as 1 mm/sec. For each specimen, the bending test was done while the data was interpolated simultaneously in the 'Horizon' software. 'Force' and 'Position' were the two primary data variables collected as output, using which, Load vs. Deflection curves were plotted. The data was collected, the values of flexural stress and strain were estimated and the graphs were plotted

Figure 4. Flexural testing of the specimen.

3.2 Tensile Test

A total of 4 Specimens are prepared for the test. These specimens have been separated into two different groups, each consisting two specimens as follows (Figure 5). The specimens is SBCCC with notched aluminium wire mesh reinforcement,

The tensile test fixtures were then fitted in the UTM machine. The specimens were then loaded turn by turn, such that a span length of 100 mm was maintained for each specimen. The feed rate was set as 2 mm/sec. For each specimen, the tensile test was done while the data was interpolated simultaneously in the 'Horizon' software. 'Force' and 'Position' were the two primary data variables collected as output, using which, Load vs. Deflection curves were plotted (Figure 6)

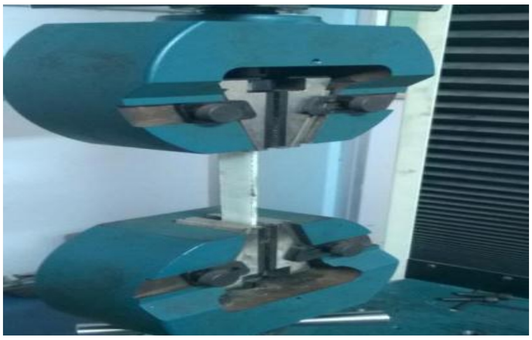

Figure 5. Tensile testing of the specimen.

3.3 Impact Test

A total of 4 Specimens are prepared for the test. These specimens have been separated into three different groups, each consisting two specimens as follows (Figure 7). The first two specimens are normal GPRP, the second group is SBCCC. Factories Plus - Drop Impact Tester was used for this purpose. The specimen size was fixed as 60 x 60 mm, and the drop speed was set as 3 m/s for all the specimen. Peak force', 'Impact Energy', 'Total Deformation' were some of the variables collected as output, using which graphs were plotted (Figure 8).

Figure 6. Impact testing of the specimen

3.4 Hardness Test

The hardness of both the specimens – GFARP and the hybrid were estimated using Brinell hardness tester (Figure 9) with a ball-indenter diameter of 10 mm. A load of 2000 kg was applied to the specimen to be tested. Each specimen was indented twice, the diameters measured, hardness values (BHN number) estimated for each, and a mean value arrived at.

Thus, a total of four mechanical tests were performed according to ASTM standards and the respective mechanical properties determined.

Figure 7. Hardness testing of the specimen

3.5 Results and Discussion

The mechanical properties were determined from the values of the various variables obtained as a result of the tests that were conducted. The data was interpolated to plot graphs and perform comparative studies

Flexural Test

The 'Load ' vs. 'Displacement' graph was plotted from the 'Force' and 'Position' values obtained as outputs of the flexural test (Figure 8).

The three types of graphs were plotted together as follows: The values obtained were tabulated to do a comparative flexural study (Table 2).

Table 2. flexural test result

SL NO	SAMPLE ID	ULTIMATE LOAD (KN)
1	SBCCC	76.78 MPa

It has been observed from the graphs of the GABGRP hybrid that there is a resistance to load even after the breakage of the first layer of glass fibred. The reinforcements, especially aluminium, being ductile in nature, thus resist the fracture to some extent. Also the usage of wire mesh as reinforcement exponentially increases the capacity of the hybrid composite to withstand a larger load. It was also observed that the replacement of Al foils by Al wire mesh negated the de-lamination effect observed otherwise. It was observed that de-lamination in the case of GABGRP with Al foil reinforcement occurs due to improper bonding between the smooth surface of the foil and its adjacent glass fiber layer Figure 10.

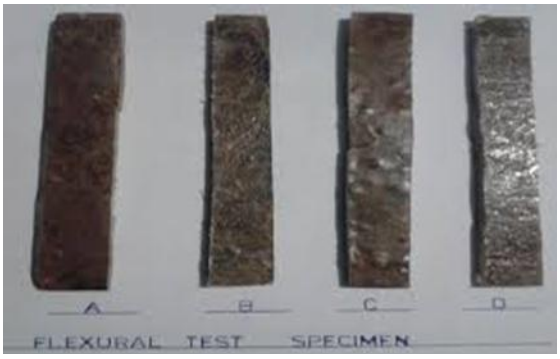

Figure 9. SBCCC hybrid after flexural test

Tensile Test

The 'Load ' vs. 'Displacement' graph was plotted from the 'Force' and 'Position' values obtained as outputs of the flexural test (figure 8). The three types of graphs were plotted together and a comparative tensile study is done (Table 3).

It is inferred that due to the presence of notches in the aluminium foil, the load-withstanding capacity of the foil reinforced SBCCC hybrid increases (Figure 10). This is due to greater bonding between the adjacent layers of the notched foil. And by replacing the foils with wire meshes, the load-withstanding capacity of the hybrid increases drastically. Here too, it is observed that the wire mesh inclusion in the SBCCC hybrid composite prevents de-lamination of the specimen unlike the case of GAGRP-Al foil hybrid, where a considerable amount of de-lamination is observed.

Table 3. Tensile test result

SL NO	SAMPLE ID	ULTIMATE LOAD (KN)
1	SBCCC	126.13 KN

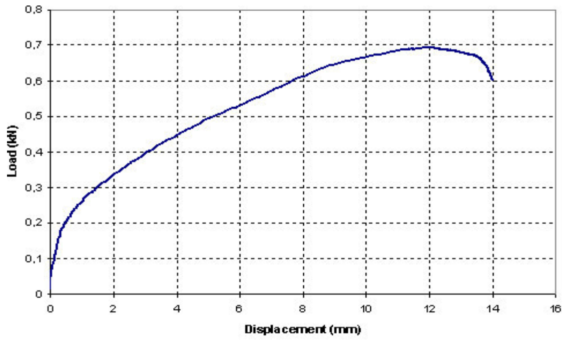

Figure 10. Load vs. displacement graphs for tensile test.

Impact Test

The impact energies (in Joules) of the hybrids and the standard GFARP were plotted It is inferred that presence of Al wire mesh and banana fibers in the hybrid composite increases its impact energy and hence its toughness Table 4.

Table 4. Impact energy chart

SL NO	SAMPLE ID	IMPACT ENERGY (J)
1	SBCCC	166.25 J/m2

Hardness Test

Using the values of the diameter of indentation in each specimen after hardness testing, the respective RH numbers were found out Thus, it is inferred that the inclusion of Aluminium and SUGARCANE BAGASSE makes the composite less hard. Being less hard, the hybrid composites are less brittle and more ductile (Table 5).

Table 5. Hardness test result

SL NO	AVERAGE DIA(in mm)	BHN DIA (in mm)
1	6.1	26.55

4. CONCLUSION

From the investigation conducted on sugarcane bagasse-Glassfibre Composites, it has been observed that: The SBCCC composite has the highest flexural strength. It has higher toughness value than the standard NFRP. SBCCC also exhibits a lower hardness value, which shows that it is less brittle. Thus, it is inferred that the inclusion of Sugarcane bagasse fibers and coconut coir as reinforcements in composites influences its mechanical properties, contributing towards a higher flexibility, ductility, impact and tensile properties.

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