SYNTHESIS AND ANALYSE THE PHYSICAL PROPERTIES OF SUGARCANE BAGASSE GLASSFIBER EPOXY COMPOSITES

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Abstract - *The composites are used widely in the production field and it is made of many natural and artificial materials to. Now the glass fibre are used in many places they are very flexible in manufacturing a components to design the required shape and size. So that in addition to develop the strength and quality a naturally available fibre are used, here we used sugarcane bagasse are matrix material and glassfibre as reinforcement, it has been made by the compression moulding machine and tested their mechanical properties such as tensile, flexural, impact and hardness of the materials and thus the properities where analyse and study of the material properties were analyzed.*

Key Words: Sugarcane bagasse fiber, Glass fiber, epoxy resin

1. INTRODUCTION

Composites materials are combination of two or more chemically distinct materials, with a distinct interface separating the components, created to obtain properties that cannot be achieved by any of the components acting alone composites are combinations of two materials in which one of the materials called the reinforcing phase, is in the form of fibres, sheets, or particles, and is embedded in the other materials called the matrix phase. The reinforcing material and the matrix material can be metal, ceramic, or polymer. Typically, reinforcing materials are strong with low densities while the matrix is usually a ductile, or tough, material. If the composite is designed and fabricated correctly, it combines the strength of the reinforcement with the toughness of the matrix to achieve a combination of desirable properties not available in any single conventional material. Recently there has been a greater inclination towards natural fiber reinforced plastic composites because these are environmental friendly and cost effective to synthetic fiber reinforced composites. Additionally, Natural fibers have lot of advantages over traditional fibers in terms of low cost, low density, biodegradable and easily processed [1-5]. The conventional material such as glass, carbon and boron fibers are quite expensive and the use of fiber like carbon or boron is justified only in aerospace application [5]. Therefore it is meaningful to explore the possibility of using cheaper materials such as natural fiber as reinforcement. Various aspects of hybrid fiber based polymer composites has studied by various investigators. Rafiquzzaman et.al [6] investigated the mechanical performance of sugarcane bagasse-glass fiber based polymer composite. Results indicated that sugarcane bagasse fiber can be a very potential candidate in making of composites, especially for partial replacement of high-cost glass fibers for low load bearing applications. Jawaid et al [7] studied the mechanical behavior of hybrid composites based on sugarcane bagasse and oil palm fiber. It has been found that the use of hybrid system was effective in increasing the tensile and dynamic mechanical properties of the oil palm-epoxy composite because of enhanced fiber/matrix interface bonding. Verma et al [8] examined the mechanical properties of glass/sugarcane bagasse hybrid composites. The sugarcane bagasse fabrics were modified by treatment with different chemicals. It has been observed that titanate treatment of sugarcane bagasse fabric results in enhanced performance characteristics and mechanical properties of hybrid composites. Ashmed et al [9] investigated the elastic properties and notch sensitivity of untreated woven sugarcane bagasse and sugarcane bagasse-glass fabric reinforced polyester hybrid composites, analytically and experimentally. The sugarcane bagasse composites exhibited higher notch sensitivity than sugarcane bagasse–glass hybrid composites. Dixit et al [10] reported a remarkable improvement in the tensile and flexural properties of hybrid composites compared to the un-hybrid composites. It was also found that the hybrid composite offers better water absorption resistance. Ahmed et al [11] experimentally investigated the effect of stacking sequence on mechanical properties of woven sugarcane bagasse and glass fabric reinforced polyester hybrid composites. The layering sequence has larger effect on the flexural and inter-laminar shear properties than tensile properties. On comparing the overall properties of the laminates it was concluded that the hybrid laminates with two extreme glass plies on both side has the optimum combination with a good balance between the properties and the cost. Thew and Liao [12] informed that mechanical properties of bamboo/glass fiber reinforced hybrid composites depends on fiber length, fiber weight ratio and adhesion characteristics between the matrix and the fiber. Experimental investigation carried out by Mishra et al [13] depicts that addition of quite small amount of glass fiber to the pineapple leaf fiber and sisal fiber-reinforced polyester matrix improves the mechanical properties of the resulting composites. The study also reported that the water absorption tendency of composites decreased because of hybridization and treatment of bio fibers. Pandya et al [14] found that on placing glass fabric layers in the exterior and carbon fabric layers in the interior of the hybrid composites gives higher tensile strength and ultimate tensile strain than hybrid composites with carbon fabric layers in the exterior and glass fabric layers in the interior. Sreekala et al [15] concluded that incorporation of small volume fraction of glass fiber in composites results in enhanced tensile and flexural properties. Velmurugan et.al [16] studied the tensile, shear, impact and flexural properties of the palmyra/glass fiber hybrid composites. The properties of the hybrid were found to be increasing continuously with the addition of glass fiber. D. Maldas et al (1990) [17] studied the effect of thermoplastics (e.g. polyvinyl chloride and polystyrene), as well as a coupling agent — poly and bagasse lignin, on the mechanical properties of particle boards of sugarcane bagasse. The mechanical properties of bagasse particle boards were compared to those of hardwood aspen fiber particle boards, delignified bagasse particle boards, as well as those of composites made from bagasse, polymers and coupling agents. Particle boards of bagasse comprising both thermoplastics and a coupling agent offer superior properties compared to those made of only thermoplastic or a coupling agent. The extent of improvement in the mechanical properties of particle boards depended on the concentration of polymers and the coupling agent; nature of the fiber, polymer and coupling agent; composition of PMPPIC and bagasse; as well as lignin content of the bagasse. Moreover, the mechanical properties and dimensional stability of coupling agent-treated particle boards are superior to non-treated ones. Monteiro S.N. et al (1998) studied [18] the possible uses of bagasse waste as reinforcement in polyester matrix composites. Preliminary results have attested this possibility. Composites with homogeneous microstructures could be fabricated and the levels of their mechanical properties enable them to have practical applications similar to the ones normally associated with wooden agglomerates. Future developments are expected to increase the performance and competitiveness of these composites as compared to those of other materials in the same structural class. Vazquez A. et al (1999) reported [19] processing and properties of bagasse fiber-polypropylene composites. Four different chemical treatments of the vegetal fibers were performed in order to improve interface adhesion with the thermoplastic matrix: namely isocyanate, acrylic acid, mercerization and washing with alkaline solution were applied. The effects of the treatment reactions on the chemical structure of the fibers were analysed by infrared spectroscopy. Optical photomicrographs indicate that a highly fibrillated surface is achieved when fibers are mercerized. The effects of the fiber chemical treatment on the tensile properties of the molded composite, produced by different processing routes, were also analysed. It was observed that the tensile strength and the elongation at break of the polypropylene matrix composite decrease with the incorporation of bagasse fibers without treatment. However, isocyanate and mercerization treatments enhance the tensile properties of the composite. Moreover, creep measurements were also carried out on the various composites studied. The best results were obtained on materials with treated fibers. The highest creep activation energy was obtained on the composite with the mercerized fiber. PaivaJ.M.F. et al (2002) confirmed [22] that Lignin, extracted from sugarcane bagasse by the organosolv process, used as a partial substitute of phenol (40 w/w) in resole phenolic matrices. Short sugarcane fibers were used as reinforcement in these polymeric matrices to obtain fiber-reinforced composites. Thermoset polymers (phenolic and lignophenolic) and related composites were obtained by compression molding and characterized by mechanical tests such as impact, Differential Mechanical Thermo analysis (DMTA) and hardness tests. The impact test showed an improvement in the impact strength when sugarcane bagasse was used. The inner part of the fractured samples was analysed by scanning electron microscopy (SEM) and the results indicated adhesion between fibers and matrix, because the fibers are not set free, suggesting they suffered a break during the impact test. The modification of fiber surface (mercerization and esterification) did not lead to an improvement in impact strength. The results as a whole showed that it is feasible to replace part of phenol by lignin in phenolic matrices without loss of properties.Bilba K et al (2003) prepared [23] various bagasse fibre/cement composites, the fibres having a random distribution in the composites. The influence of different parameters on the setting of the composite material has been studied: (1) botanical components of the fibre, (2) thermal or chemical treatment of the fibre, (3) bagasse fibre content and (4) added water percentage. This study shows a retarding effect of lignin on the setting of the composite, for small amount of heat-treated bagasse (200 °C) the behavior of the composite is closely the same as the classical cement or cellulose/cement composite.

2. SPECIMEN PREPARATION

The specimens are prepared by a method called compression moulding as seen in Figures 1, SBGFC (Glassfibre as reinforcements). All the specimens have a thickness of 4 mm. The sugarcane bagasse and glassfibre in the form of strands.

The SBGFC hybrid composite has a total of 2 layers, comprising of glassfibre and sugarcane bagasse in particulate fiber layers. The aluminium foils/ wire mesh and banana fibers are used alternatively. The binding agent was used as a combination of epoxy resin-type LY556 and hardener-type HY951 in the ratio 10:1. While preparing SBGFC 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

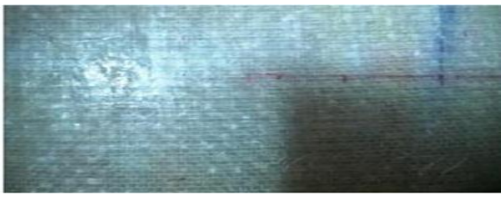

Fig -3 Final fabricated SBGFC

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 GPRP, the second group is SBGFC. 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 SBGFC with notched glassfibre 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)

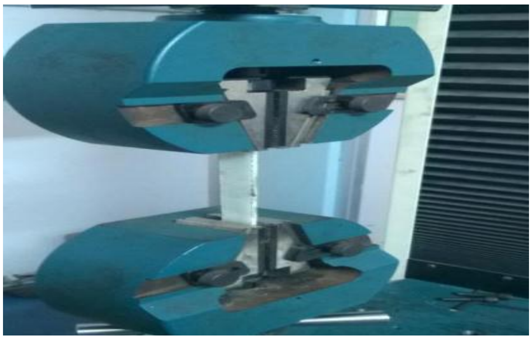

Figure 5. Tensile testing of the specimen.

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, the SBGFC. 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

3.5Results 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	SBGFC	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 9

Figure 9. . SBGFC 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 SBGFC 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 SBGFC 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	SBGFC	136.13 KN

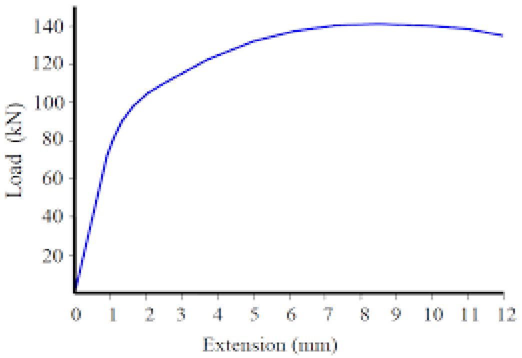

Figure 10. Load vs. displacement graphs for tensile test.

Impact Test

The impact energies (in Joules) of the hybrids and the standard SBGFC were plotted It is inferred that presence of sugarcane bagasse and glassfibers 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	SBGFC	189.65 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 glass fibre 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	7.1	31.55

4. CONCLUSION

From the investigation conducted on sugarcane bagasse-Glassfibre Composites, it has been observed that: The SBGFC (with Al wire mesh) composite has the highest flexural strength. Also, with the other two composite types. It has higher toughness value than the standard GFRP. SBGFC 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 glassfibre as reinforcements in composites influences its mechanical properties, contributing towards a higher flexibility, ductility, impact and tensile properties.

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