Fabrication & Evaluation of Mechanical Properties of Bagasse Fiber Reinforced Natural Composites

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Abstract- *In the present work, the natural compounds based on sugar cane bagasse. This study was focused to observe the mechanical properties of sugarcane fiber. The sugarcane fibers used in fabricating a composite material was untreated and surface treated with NaOH and HCl. The fibers have been pretreated with 4% of NaOH and 3% of HCl solution and then it has been allowed to dry for 24 hours. After the treatment the composites has been fabricated. The mechanical properties have been evaluated for the prepared composite material and then the results are discussed.*

I. INTRODUCTION

Composite materials are also called composition materials or shortened to composites. Composite materials are materials made from two or more constituents' materials with significantly different physical or chemical properties. When we combined these materials, produce a material with different characteristics from the individual components. Composites are materials that comprise strong load carrying material is known as reinforcement and imbedded in weaker materials is known as matrix. Reinforcement provides stiffness and strength, helping to support structural load. Bagasse is bio product of sugar cane fiber which is left after the juice has been extracted from the sugar cane.

Bagasse fibers are natural fiber products and it biodegrades in 25-65 days. Bagasse fibers are the bast fiber like as banana fibers. It consists of water, fibers and small amounts of soluble solids. Percent contribution of each of these components change according to the maturity variety, harvesting and the efficiency of the crushing plant. For each 10 tons of sugarcanes crushed, a sugar factory produced nearly 3 tons of wet bagasse. Bagasse is mainly used as a burning raw material in the sugar cane mill furnaces. Bagasses have low caloric power, which makes this a low efficiency process. Approximately 9% of bagasse is used in alcohol (ethanol) production. Ethanol is not a good replacement for the fossil fuels, but it is an environmentally friendly fuel. Ethanol is a very versatile chemical raw material from which a variety of chemicals can be produced. There exist an excellent opportunity in fabricating bagasse based composites towards a wide array of applications in building and construction such boards and blocks as reconstituted wood, pulp, flooring tiles etc. These pulps are suited for generic printing and writing paper as well as tissue product but it is widely used for boxes and newspaper production. Bagasse fibers are short they result in paper with enhanced printing quality and also improved paper porosity.

Fig.1. Bagasse Fiber

II. LITERATURE REVIEW

Abbassi et al. [1] investigated the effect of alkali treatment on alfa fiber reinforced polypropylene composites. They found that the alkali treatment significantly increases the youngs moduli and tensile strength of the composites.

Hassan et al. [2] examined the morphology and mechanical properties of carbonized waste maize stalk reinforced polyester composites. The addition of carbonized waste maize stalk ash content increases the tensile strength, tensile modulus, compressive strength except the impact strength.

Andressa et al. [3] studied the mechanical and thermal properties of sisal/phenolic composites. The tensile and flexural strength are found to be 25.0 MPa and 11.0 MPa respectively. It has been proposed that these properties are sufficient to replace the timber in structural applications.

Daniella et al. [4] have used pre-treated and modified residues from sugarcane bagasse fibers to prepare natural composites based on the high-density polyethylene matrix (HDPE). The results show that the unmodified sugarcane bagasse forms agglomerations which significantly affect the mechanical strength properties whereas the modified sugarcane bagasse improves the strength properties through the formation of strong sugarcane bagasse/HDPE interfaces.

Uthayakumar et al. [5] investigated the influence of redmud on the mechanical, vibrational and chemical resistance properties of banana fiber reinforced polyester composites. They found that the addition of redmud improves the mechanical properties compared to the neat banana fiber reinforced polyester composites. Water absorption characteristics of acid treated and untreated Napier grass fiber reinforced polyester composites have been evaluated by Haameem et al. [6]. This study finds that the treated Napier grass fiber composite absorbs less percentage of water when compared to the untreated fiber composite which helps to improve the bonding between the fiber and the matrix. A significant loss of the tensile and flexural properties in the untreated composite is due to the impairment of the fiber/matrix bonding through water absorption.

III. EXPERIMENTAL PROCEDURE

MATERIALS AND METHODS:

The materials used for the preparation of composites are sugarcane fiber, polyester resin, MEKP as a catalyst and cobalt naphthanate as an accelerator. NaOH and HCl are used for fiber surface treatments.

Preparation of the material: The sugar cane sachet was collected and then dried in the sun for 2 days to eliminate the moisture present in it. Then the sugarcane fibers are manually separated and cut into the dimensions of 250mm in length. Once the fiber has been prepared, it has undergone surface treatments. The base treatment has been carried out with the 4% NaOH solution. The fiber is placed in the 4% NaOH solution for 1 hour, removed and washed in distilled water. Then it has been left to dry for 24 hours at room temperature. Similarly, the fiber was treated with a 3% HCl solution for 1 hour, washed in distilled water, and dried at room temperature for 24 hours. Sugarcane fiber has been observed to turn yellowish when treated with a NaOH solution for 1 hour. Then, in the case of sugarcane fiber treated with HCl, no color change is identified. The sugarcane fibers before and after surface treatment are shown in Figure 2 (a) and (b).

Fig.2. (a) (b)

FABRICATION OF COMPOSITES:

The pretreated fibers are then used to make a composite material. The composite material was prepared to a size of 250mm x 100mm using the manual placement method. The mold made of 250 x 100 mm rectangular mild steel plates. Here, the one-way sugarcane bagasse is used to make the composite material. To prevent the matrix from sticking to the mold, wax is applied to the inside of the mold. Then the polyester resin mixture has been poured into the mold and sugar cane fiber has been placed. The fiber is placed in such a way that there is no gap between the fibers. Resin and hardener are added and poured into the mold onto the fiber. After the resin is applied, the wooden slab is laid to provide even distribution of the applied load. The weight of around 50 kg is placed on the wooden slab that was already in the mold on the composite and has been allowed to cure for 24 hours. After 24 hours the weight was taken and without damaging the laminates they are taken with care. In accordance with ASTM standards, samples are cut for testing. The different samples that are chemically treated are shown in table 1. The manufacturing process from the raw material to the final product and the preparation of the sample from the manufactured composite is clearly explained in the following Figures 3 and 4.

Fig.3. Flowchart for fabrication process

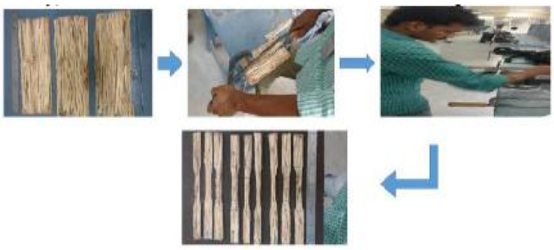

Fig.4. Flowchart for specimen preparation

Table.1. MECHANICAL PROPERTIES

Tensile Strength (Mpa)	180 - 290
Young's Modulus (Gpa)	15 - 19
Failure Strain (%)	1 - 5
Density (Kg/m3)	720 - 880

Table.2.CHEMICAL COMPOSITION OF BAGASSE FIBERS

Cellulose (%)	45-55
Lignin (%)	18-24
Pectin (%)	0.6-0.8
Ash (%)	1-4
Extractives (%)	1.5-9
Hemi cellulose (%)	20-25

IV. RESULTS AND DISCUSSION

The tensile results obtained for the three types of sugarcane bagasse composites of untreated, HCl treated and NaOH treated. These results are briefly discussed in the following passages.

Tensile test: The tensile tests have been performed on the untreated, HCl treated & NaOH treated sugarcane bagasse fiber composites. The sample piece has been fabricated manually as per the ASTM standard D3039. Comparing all the three tensile tests such as Untreated, HCl and NaOH, NaOH treated composites giving the better tensile results. It is also observed that breaking occurs nearly at middle of the entire specimen.

Fig.5. Specimen after tensile test

Table.3. Tensile results of sugarcane composites:

Test	Untreated Sugarcane composites	HCl treated Sugarcane composites	NaOH treated Sugarcane composites
Tensile strength (MPa)	9.7	23.82	45.5
Load at breaking point (KN)	0.4	2.1	2.4
Breaking strength (MPa)	2.4	8.2	20
Yield stress (MPa)	7.5	8.5	20.5

Fig.6. Tensile properties of untreated sugarcane bagasse composite

Fig7. Tensile properties of HCL treated sugarcane bagasse composite

Fig.8. Tensile properties of NAOH treated sugarcane bagasse composite

From the above Figures 6, 7 & 8 it is observed that the untreated sugarcane fiber composite providing least tensile strength when comparing surface treated composites. Surface treated composites providing improved tensile results, among surface treated composites NaOH treated composites providing improved tensile properties when compared to HCl treated composites. From this it is observed that NaOH surface treatment to sugarcane bagasse fiber provides better tensile properties.

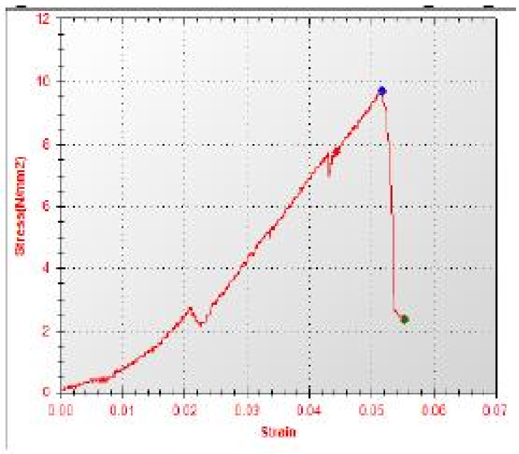

Fig.9. Stress vs strain graph of Untreated Sugarcane fiber composite

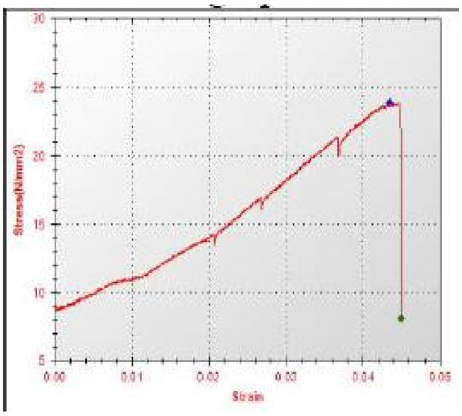

Fig.10. Stress vs strain graph of HCl treated Sugarcane fiber composite

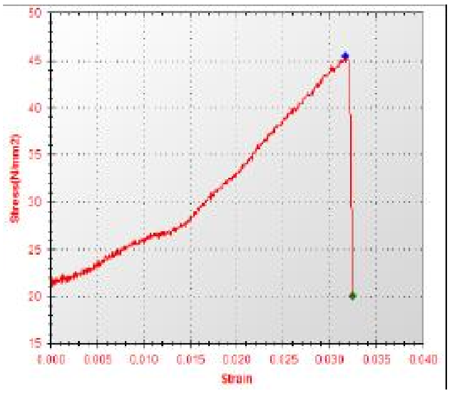

Fig.11. Stress vs strain graph of NAOH treated Sugarcane fiber composite

V. CONCLUSION

Natural fibers created a great impact in a modern era due to its abundant availability in better economical investment, low density and manufacturing cost for natural fiber composites is very much low compared to other manmade fibers. These factors head the natural fiber for better fuel economy due to low density in an automotive sectors and it also reduce most of the manufacturing cost for same desirable properties provided by other materials.

From this work it is observed that sugarcane fiber with NaOH treated composites provides the better tensile results when comparing to Untreated & HCl treated sugarcane fiber composites. The surface treatment with NaOH is improving the mechanical properties, so the sugarcane bagasse with various proportions of NaOH treatment is suggested to find the best proportion of NaOH for sugarcane bagasse.

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