Investigative Studies on the Mechanical Behaviour of Banana Fiber Sugarcane Bagasse Powder Reinforced Polymer Composites

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Abstract- *Natural fiber reinforced polymer composites are being worked upon for various engineering applications. Various natural fibers such as jute, sisal, palm, coir and banana are used as reinforcements. The attempt has been made in this work by using banana fibers and sugarcane bagasse powder as reinforcement in epoxy resin matrix and to evaluate the mechanical behavior of this composite. Weight fraction of fiber and matrix was kept at 30%-70% specimens prepared according to the ASTM standards and Conducted different tests. From the results it was found that, the mechanical properties increasing of sugarcane powder percentage specimen get good mechanical properties.*

Keywords- Banana fiber, sugarcane powder, epoxy resin, mechanical properties.

I. INTRODUCTION

The use of natural filler for the reinforcement of the composites has received increasing attention both by the academic sector and the industry. Currently, many types of natural fillers have been investigated to be used in the industry including flax, hemp, wood, wheat, barley, and oats. They are now fast involving as potential alternatives to inorganic or synthetic materials for various applications as building materials and automotive components.

Polymer composite materials are currently widely used in many industrial areas in light-weight and high strength requirements. However, compared with synthetic fibers, the advantages of using natural fibers in composites are their low cost, low density, biodegradability, renewability, and recyclability. Some of the problems associated with untreated natural fiber-reinforced matrix composites include poor interfacial adhesion between the cellulose fibers and the resin matrix. All plant-derived cellulose fibers are polar and hydrophilic in nature, mainly as a consequence of their chemical structure. Natural fibers have a good potential for chemical treatment due to presence of hydroxyl groups in lignin and cellulose. Reaction of hydroxyl groups can change the surface energy and the polarity of the natural fibers. In this project, composites are prepared by sugarcane bagasse powder, chopped banana fibers and epoxy resin. In this study, the effect of treated banana fibers on the mechanical properties polymer composites is investigated.

II. MATERIALS AND METHOD

A. MATERIALS

The materials which have been used in the present work are shown below. Composites were prepared for two material combinations. The chosen composite includes the following materials.

- **Matrix Material**

Epoxy resin: Epoxy resin is widely used in industrial application because of their high strength and mechanical adhesiveness characteristic. It is also good solvent and have good chemical resistant over a wide range of temperature. Atul Ltd. Lapox L – 12 is used in the present investigation. The properties and curing details of epoxy resin and hardener K – 6 is used as curing agent. In the present investigation percentage of weight has been used in all materials developed. The weight percentage of hardener used in the present investigation is in the ratio of 10:1.

- **Reinforcements**

Reinforcing agents are added to the resin to improve the mechanical properties and failure rates of the material.

- o **Banana fiber:** Banana fiber obtained from the stem of banana plant is a fiber with relatively good mechanical properties. The extraction of the natural fiber from the plant requires certain care to avoid damage. In the present experiments, initially the banana plant sections were cut from the main stem of the plant and then rolled lightly to remove the excess moisture. Impurities in the rolled fiber such as pigments, broken fiber, coating of cellulose etc. were removed manually by means of comb, and then the fiber were cleaned and dried. The length of the banana fiber is taken as 10mm.

- **Sugarcane powder:** The preparation of sugarcane Powder begins after crushing the sugarcane stalk and extracting the sucrose. Then bagasse fiber was repeatedly washed with water and the sugarcane fiber are separated from undesirable foreign matter and shifted manually from fiber bundles that fibers are chopped then we use the grind mill to get a powder form after that finally sieves in 300 micron.
- **Chemical Treatment**
    - The fibers are cut to the required size of 10mm, then the fibers are cleaned normally in clean running water and dried.
    - A glass beaker is taken and 6% NaOH is added and 80% of distilled water is added and a solution is made.
    - After adequate drying of the fibers in normal shading for 2 to 3 hours the fibers are taken and soaked in the prepared NaOH solution (3hours).
    - Soaking is carried out for different time intervals depending upon the strength of fiber required followed by fabrication process.

B. SPECIMEN PREPERATION

The composites which are prepared initially were marked for required dimensions and then are cut to the markings using a wire saw. The cut edges of composites were then rubbed against emery paper in order to bring them to the exact size. Different test requires specimens of different dimensions. The specimens were prepared according to ASTM standards. The test specimen along with specimen dimension and standards for different tests are discussed below.

Tensile Test Specimens: Tensile test specimens were prepared according to ASTM D3036 standard. The specimen used is a rectangular bar of length 220mm, width 25mm and thickness 6mm.

Compression Test Specimens: Compression test specimens were prepared according to ASTM D695 standard. The specimen used is a rectangular bar of length 25.4mm, width 12.7mm and thickness 12.7mm.

Flexural Test Specimens: Flexural test specimens were prepared according to ASTM D790 standard. The specimen used is a rectangular bar of 130mm length, 25mm width and 6.5mm thickness.

Impact Test Specimens: Impact test specimens were prepared according to ASTM D256 standard. The specimen used is a rectangular bar of 63.5mm length, 12.7mm width and 12.7mm thickness.

Hardness Test Specimens: Hardness test specimens were prepared according to ASTM D785 standard. The specimen used is a rectangular bar of 10mm length, 10mm width and 6mm thickness.

C. METHODOLOGY

- Specimens are prepared as per ASTM standards for the tests to be conducted.
- The inner surface of the mold was initially smeared with a releasing agent to prevent the composites from sticking on to the mold wall
- Sugarcane bagasse powder, banana fiber (in chopped form) with Epoxy and hardener were mixed in a container and stirred well for 5 – 7 minutes
- The prepared mixture is poured in to the prepared moulds
- The samples so prepared are kept for drying for a duration of 24 hours at room temperature
- After drying the samples are cut in accordance with ASTM standards.

III. RESULTS AND DISCUSSIONS

The tensile, compressive, and flexural tests were carried out by using UTM machine, and Charpy impact test machine for impact test, and Vickers hardness test machine for finding the hardness value. The polymer composite specimens were prepared according to the ASTM standards for each test. Three different fibers contents by weight were used namely 10%, 15%, 20%.

1. TENSILE STRENGTH OF COMPOSITES

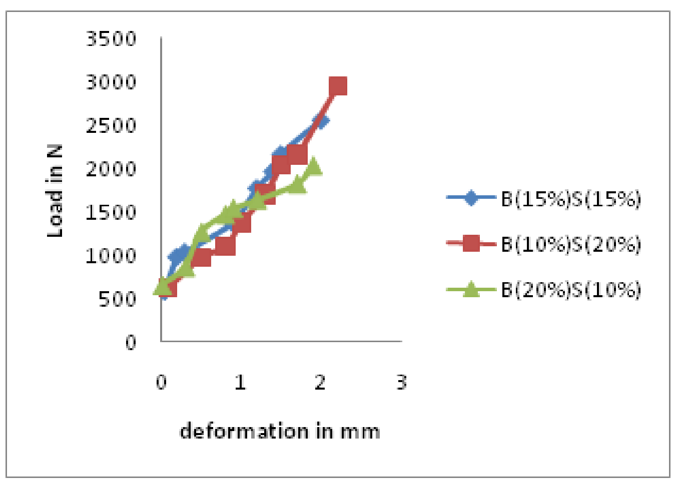

Fig. 1 The tensile strength effect of treated filler content on polymer composites

The Fig. 1 shows the effect of treated filler content on the tensile strength of the all combination of composites, it is evident that as load increases deformation increases. The bio-flour materials are mainly composed of a complex network of three polymers: cellulose, hemicelluloses and lignin. The lignin not only holds the bio – flour together but also acts as a stiffening agent for the cellulose molecules within bio – flour cell wall. Therefore, the lignin and cellulose content of sugarcane bagasse have increases the tensile strength.

2. COMPRESSIVE STRENGTH OF COMPOSITES

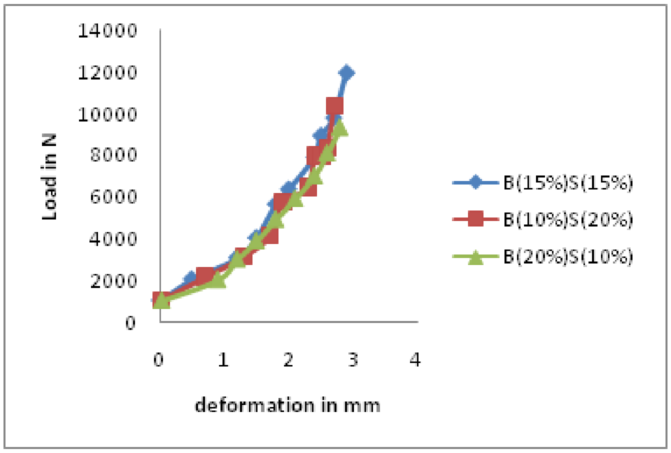

Fig. 2 Influence of treated filler content on the compressive strength of polymer composites

Fig. 2 shows the relation between the load and deformation for treated different combination composites under compressive test. It can be clearly observed that load bearing capacity of treated 20% banana fiber and 10% sugarcane powder filler content is very less compare to the other two filler content composites. But the 15% banana fiber and 15% sugarcane powder filler content shows the more load absorbing capacity than other two filler content composites.

3. FLEXURAL STRENGTH OF COMPOSITES

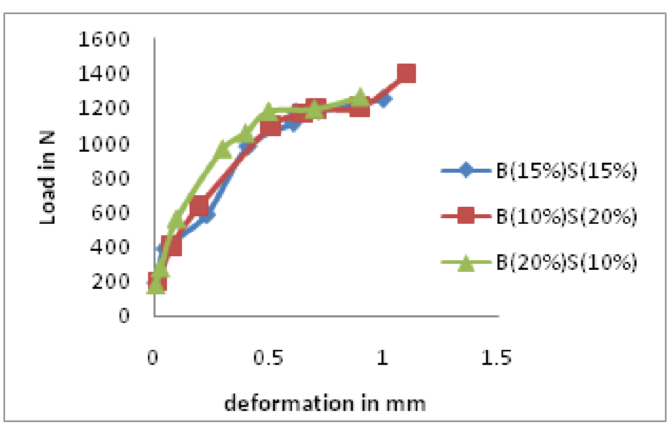

Fig. 3 Flexural Strength versus Deformation for treated filler content

Fig 3 shows the flexural strength for treated content different combination composites. can be clearly seen that the 10% banana fiber and 20% sugarcane powder filler content composites are having highest resistance to deformation. This due to the highest resistance to deformation is more in 20% filler content, the transferred highest resistance to deformation by the filler and then it transferred to the matrix material So that it avoids the initiation of the crack in early stage. It clearly indicates that addition of sugarcane powder filler improves the load bearing capacity of the composites. And it shows linearity indeformation as load increases compare to the other content composites. The composite with 20% banana fiber 10% sugarcane powder content is exhibit low flexural strength. this is due to insufficient filler content compare to other composite. For treated maximum fluxural streangth 1395 N at deformation 1.1 mm.

4. IMPACT STRENGTH OF COMPOSITES

Table no.1 treated and Un-treated Impact Strength of Composites

Sl no.	Composition content	Impact strength (N)
1	B(15%)S(15%)	0.6
2	B(10%)S(20%)	1.9
3	B(20%)S(10%)	1.7

From the table it clearly gives the comparable results of impact strength for treated filler content with different combination composites. specimen 20% sugarcane powder and 10% banana fiber content is having the more capacity energy absorption compare other different content due to in treated filler content the adhesive property between filler and matrix material is more that leads to improve the mechanical properties.

5. HARDNESS OF COMPOSITES

Table no.2 treated and Un-treated hardness value of Composites

Sl no.	Composition content	Hardness (Vickers)value
1	B (15%) S (15%)	45.1
2	B (10%) S (20%)	49.6
3	B (20%) S (10%)	44.2

From the table clearly gives the comparable results of hardness value of treated 20% sugarcane powder and 10% banana fiber content is having the more hardness value compare other different content this is due to alkali treatment improves the adhesive characteristics of sugarcane bagasse powder filler content surface by removing hemicelluloses and lignin.

IV. CONCLUSIONS

- The banana fiber and sugarcane powder was successfully used to fabricate the hybrid natural composites with 30% fiber and 70% resin. So it has been known that they have higher tensile strength, compressive strength, flexural strength and hardness value compared to commercial nuwood.
- The amount of sugarcane powder content positively affects the tensile strength of composites. The specimen B10%-S20% found to have a greater tensile strength of 2939 N
- The compressive strength of the specimen with composition B15%-S15% shown greater value of 11956 N compared to other two composites
- The flexural strength of composites increases with increase in the amount of sugarcane powder content. The specimen with B10%-S20% was found to have more flexural strength of 1395 N
- The composite specimen with B10%-S20% composition found to possess higher impact strength of 1.9 N compared to B15%-S15% and B20%-S10% composition specimen
- The specimen with composition B10%-S20% found to have a greater hardness value of 49 HV/0.01 compared to B15%-S15% and B10%-S20% composition specimens.

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