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Bending, Tensile and Water Absorption Test of Corn Husk and Glass Fibre Reinforced Composite for Different Composition

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Abstract

Now a day, there is a huge trend in research and development of bio-based products which have a wide variety of replacement for naturally existing materials. The current research intends to determine the qualities of a composite laminate material consisting of maize husk and glass fibre. The composite is created by alternately overlaying glass fibre cloths on corn husk fibre layers. The required composition and thickness are achieved by calculation of number of the layer of each fibres. The epoxy resin and hardener by weight is mixed in the ratio 10:1 respectively. It is poured between the layers of the composite to generate adhesion. Hand lay-up technique is adopted in manufacturing of the material and the material is pressed for certain duration using nut and bolt template assembly allowing it for natural curing. The composite is being tested for bending, tensile and water absorption tests according to standards.

Keywords: *Bending Test, Corn Husk, Glass Fibre, Hand Lay-Up, Natural Composites, Tensile Test, Water Absorption Test*

1.0 Introduction

Now a days, the synthesis of composite materials using naturally occurring materials are in much focus because of their unique properties. Corn husk is one of the such lignocellulose waste whose fibre has the same properties similar to the wood[1]. Since it is a waste, they are used as the reinforcement in polymer composite[2]. The aim of this work is to study and evaluate the suitability of using composite made up of corn husk fibres and glass fibre cloth with polymer resin and evaluation of its bending, tensile and water absorption properties without any treatment for both glass fibre and corn husk fibres and to investigate the influence of fibre components using indigenously available natural fibres[3]. The maize wastes and glass fibre cloth is used to develop a composite which can be used for various engineering applications[4]. Presently, alloy composites have also found diversity of applications within the mining industry[5]. Several raw materials are used in different sectors such as domestic, agriculture and industry leading to high economic interest to recover valuable minerals and to process them and convert them into merchandisable products[5].

2.0 Materials and Methodology

The dried corn husk is been grinded to required size and the mixture of Epoxy resin (LY556) and Hardner (K6)

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is been weighed in te proportion 10:1 by weight and the mixture is prepared. Required proportion of corn husk and 7 mill glass fibre cloth is taken by the calculation of volumetric ratio. Laminar composite of corn husk and glass fibre is prepared by alternate layers of these filler fibres using Epoxy resin and hardner mixture as matrix. The material is left for natural post curing in the template itself for about 2 hours[3].

3.0 Testing

3.1 Bending / Flexure Test

Bending (Flexure) tests have been performed on bending test specimens that have been exposed to an external force. The force is delivered perpendicular to the specimen's longitudinal axis. Typically, there are three sites of loading: the specimens were loaded in the center of the spam, with the load applied to the top surface of the specimen, and the support was rounded. Loading was maintained at a uniform rate through a loading block. The test has been conducted according to ASTM D790. The specimen used is a rectangular of size 235 x 25 x 6 mm. which is having Span length, L = 165 mm, breadth, h = 25 m and depth, b = 12 mm[7] (Figure 1).

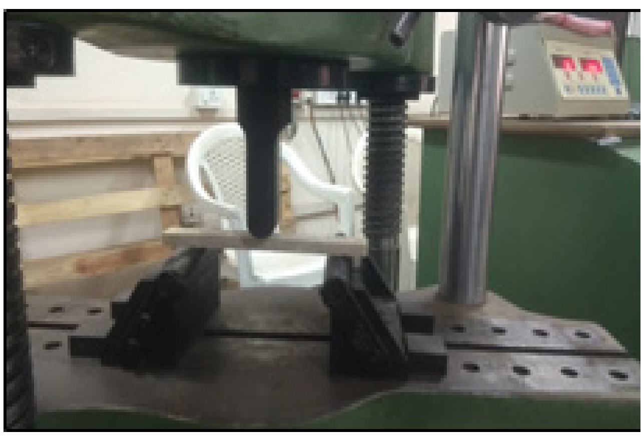

Figure 1. 3 Point bending test.

3.2 Tensile Test

Tensile test specimens and the test is conducted according to ASTM D3039. The dimensional view of the specimen is shown in Figure 2. The specimen used is a rectangular of size 250x25x4 mm. Span length of the specimen

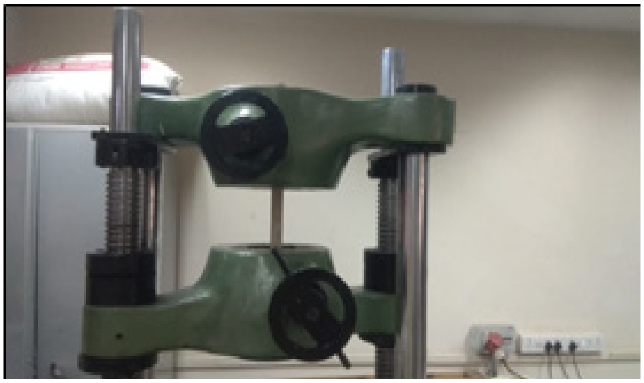

Figure 2. Tensile test.

is 200 mm and the gauge length, L_0 of the specimen is 150 mm[7].

3.3 Water Absorption Test

This test is been conducted according to ASTM D570 by measuring initial and final weights after water treatment for specimens. It calculates the overall water retention capacity of the glass fibre and corn husk composite material over time. The testing is very essential to determine the property of material when used for external applications[8].

Percent Water Absorption = [(Wet weight - Dry weight) / Dry weight] * 100

This test is done in two ways,

- Cold water soaking test
- Hot water boiling test

3.3.1 Cold Water Soaking Test

The test specimens are soaked in RO distilled normal water for 24 hours at room temperature by placing

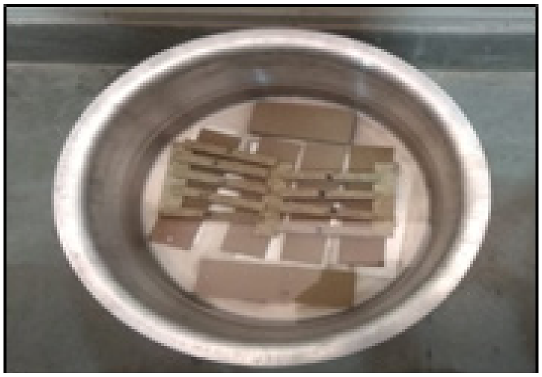

Figure 3. Cold water soaking test.

them on the supports. The average room temperature is 27^0C. Initial weight before soaking and final weight after removing from soaking is measured and percentage water absorbed is calculated by basic formula (Figure 3).

3.3.2 Hot Water Boiling Test

The specimens are placed in boiling water and is to be boiled for about 1.5 hours. The duration is counted as soon as the water starts to boil and after 1.5 hours of boiling in distilled RO water. The test is mainly done to check whether the material gets delaminated since normally epoxy coatings get delaminated at higher temperatures (Figure 4).

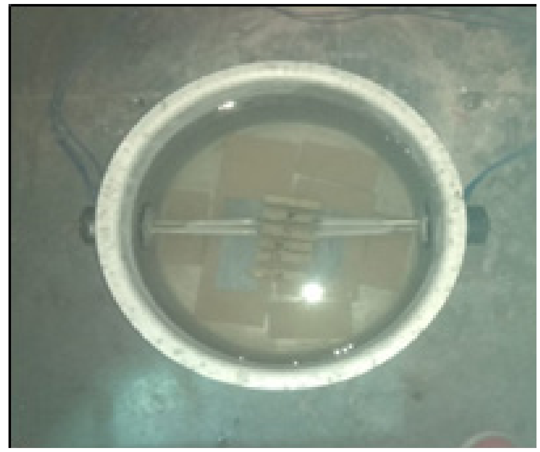

Figure 4. Hot water soaking test.

4.0 Results and Discussion

4.1 Bending Test

The bending test according to the ASTM is conducted on UTM Model UTN/E-40, capacity OF 0-40kN. The obtained values are plotted in the graph of Force v/s Displacement for all the 3 variants of the specimens and is indicated in Figure 5. The flexural modulus is calculated using the yield values obtained for each of the specimen variants[7]. The irregular stepped variation in the graph

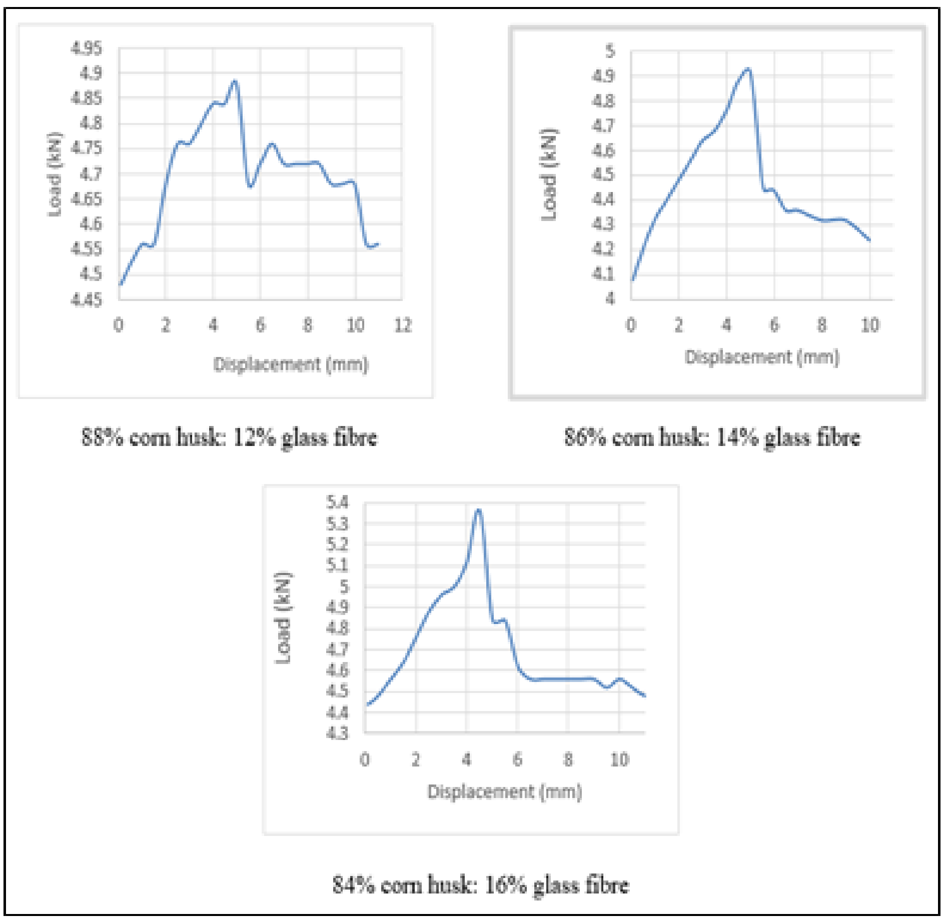

Figure 5. Load(kN) v/s Displacement(mm) – Bending test.

Table 1. Bending test result

Composition (CH : GF)	Ultimate load (kN)	Flexure modulus (MPa)
88 : 12	4.84	3118.13
86 : 14	4.92	5778.88
84 : 16	5.24	6758.96

represents the breakage of each ply since it is a laminated composite. As the observation from the 3 variants results, it is found that Ultimate load and Flexure modulus increases as the glass fibre content increases. Bending takes place according to the laminated layers and material does not get completely failed until the last layer breaks down and hence life of the material is extended to a great extent.

4.2 Tensile Test

In the similar way to the bending test, the tensile test is carried out in the same UTM by the application of axial force. Stress v/s Strain is plotted for each composition of the specimen. From the graph yield stress is founded out and the Elastic modulus is calculated[9]. As per the observation of the comparison results obtained among

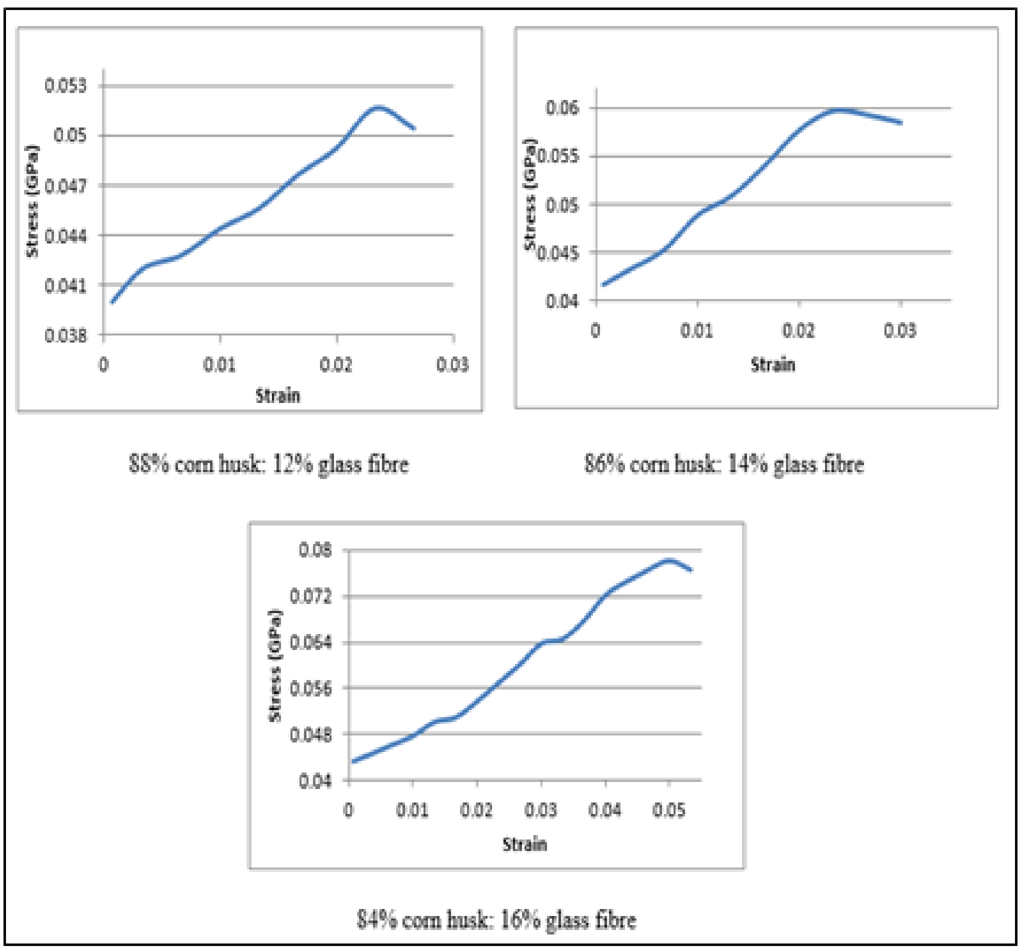

Figure 6. Stress (GPa) v/s Strain – Tensile test.

Table 2. Tensile test result

Composition (CH : GF)	Yeild stress (MPa)	Young's modulus (MPa)
88 : 12	42	750
86 : 14	43.2	600
84 : 16	46	470

Table 3. Water absorption test result

Composition (CH : GF)	Cold water soaking test % water absorption in 24 hrs	Hot water boiling test % water absorption in 1.5 hrs
88 : 12	4.517725	4.4132
86 : 14	3.693565	3.9492
84 : 16	3.57215	3.68215

the 3 variants, the maximum load increases as the glass fibre layers are increased and the deflection will also be more if glass fibre content is more. Young's modulus decreases as the glass fibre content decreases since corn husk is known for its tensile strength.

4.3 Water Absorption Test

The percentage of water absorption during both the hot and cold water is been tabulated by taking the average of all the same composition of specimens[8]. Using both methods of water absorption test, it is observed that as the glass fibre content increases, the percentage water absorbed gradually decreases. This shows that corn husk absorbs more water. But eventually the material losses water within some time and all the composition reaches almost same retained water content.

5.0 Conclusion

Corn husk fibre reinforced composite can replace wood in most of the commercial applications if specifically designed machineries are used to develop this composite. This project also helps in disposal of agro wastes which otherwise will be burnt, in addition to this if it is used in commercial applications it will help farmers to generate additional income from the wastes. To evaluate the mechanical properties tensile, impact and bending tests were conducted. The tensile and bending tests results shows that composites have excellent ductility even though the ultimate tensile strength is less. Hence this composite can be used in lighter applications such as tables, cardboards, partitions, etc. The bending test result shows that it has moderate strength hence can be used in applications such as false roofing, windows, etc., where lesser loads will be acting. Since the water does not get retained after absorption, it can be used for external applications also. Thus, the proper use of these waste materials will evolve the cheap engineering materials with huge application and also helps in waste management.

6.0 References

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