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Mechanical Properties of Epoxy Resin Matrix Composites made of Jute Fiber, bagasse and glass fiber

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Abstract:

Currently engineers are looking for recycling of the waste materials for varying uses that are easily biodegradable as well as maintain sustainability to protect our environment. Other way the problem of handling waste material is also solved as it is being reused. Recycling of the waste materials are the key considerations at the face of material scientist. Nowadays natural fiber composites are preferred over conventional synthetic fiber composites in many industrial applications. In this study jute fiber, bagasse, banana fiber and glass fiber reinforced composites bonded with epoxy resin were prepared using hand lay-up technique to compare their mechanical properties. For this purpose, an open type wooden mould was used. The density of Composite made of Bagasse and Banana fiber are measured as o.398gm/Cm^3 and 0.352ge/Cm^3 and densification of bagasse fiber composite is more as compare to the composite made of banana fiber. The value of tensile test clearly describing that the composite made of bagasse is capable to bear more load than the composite made of banana fibe. Tensile strength of bagasse fiber composite is 70% higher than the composite made of Banana fiber. Though there is no much difference are observed for the value of hardness as well as in Compressive strength values of both the composites. It indicates the stress bearing capacity of banana composite is very lesser than bagasse composites.

1.Introduction

Composite is a product made up of two or more different types of materials that are combined together to form something totally different than that of the original constituents (M K Manik et al.2019). Structure of composite material is shown in

fig.1.1.
Fig.1.1 composite made of different materials at workshop of L D C Institute of Technical studies

Composite consist of outer cover generally called as matrix, mostly it protect the inner strengthening part of the composite called as fiber. Natural composites exist in both animals and plants. Wood is one of the best examples of natural composite – it is made from long cellulose fibers and much weaker matrix substance called lignin. Cellulose is also found in cotton, but without the lignin matrix, which cannot be bound together for strengthening. The bone in the human body is also a good example of natural composite. Composites can be made naturally or synthetic. Wood is a natural composite whereas plywood is made of sawdust and ply, a man-made composite that combines natural and synthetic materials. Fig.2 shows the different raw materials by which composites are to be made in the workshop of LDC Institute of Technical Studies, Soraon Prayagraj, India.

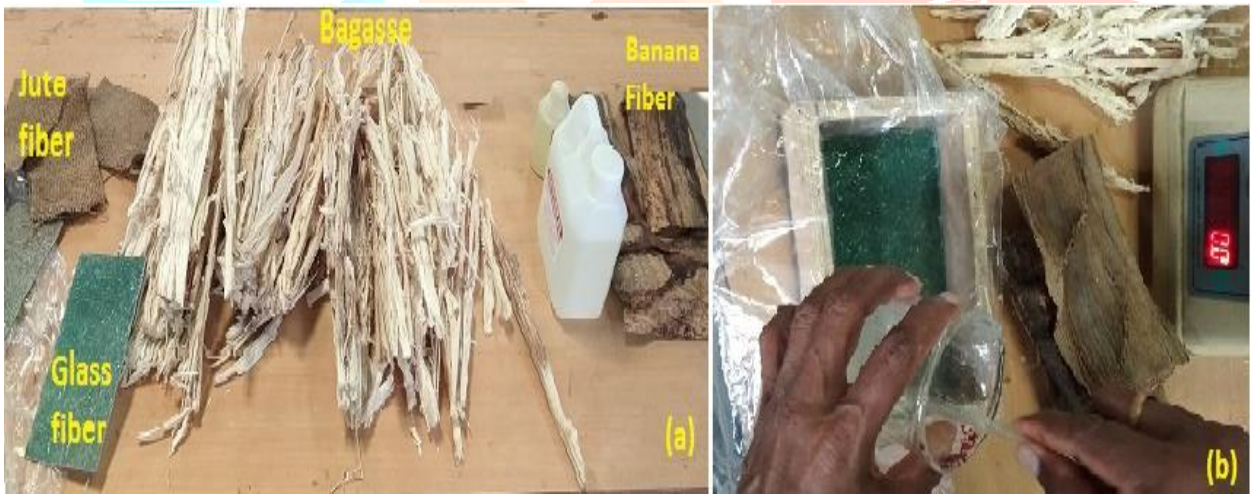

Fig. 2 (a) The collection of different waste raw materials and in (b) initial step up for formation of omposite in hand layout method.

In last few years, due to an environmental awareness the attention has been given to use the natural fiber composites in many industrial applications. Considering ecological balance and to safeguard from global warming a substantial interest has been generated to use natural materials for manufacture green products and reduce carbon dioxide emissions by all possible ways [1]. Environmental protection regulation act presently emphasizes to recycle the waste materials for common uses and the researcher is looking for environmental friendly composite materials. At present it was observed that plant fibers are very eye-catching for composite materials for the following characteristic such as biodegradability, availability in

abundance, renewability, high specific strength, low cost, and many more. But there are some weaknesses such as incompatibility with some polymer matrix, the tendency to form aggregates during processing, and poor resistance to moisture absorption which reduce considerably the mechanical properties of the natural fibers reinforced composite materials [2]. Literature prevails that out of all the natural fibers, jute fiber shows its good mechanical properties compared with other natural fibers, such as sisal, coir, and ramie [2]. A large many authors have reported that the jute fiber composites from different aspects, for example, mechanical properties [3], physical properties [4] and chemical properties, the effect of fiber treatments on mechanical properties [5], and dynamic mechanical properties [6] and so on.

Properties	Composite made of Bagasse	Composite made of Banana fiber
Length(mm)	192	192
Breadth(mm)	110	110
Weight on gm.	336.31	297.09

It is viewed that in most cases natural fibers possess comparatively good mechanical properties, their poor wet capacity, inbuilt variability, and poor adhesion with many polymer matrices lead to composites whose mechanical properties are low as compared to synthetic fiber composites. However these problems can be solved by a proper combination of reinforcements [7] or by physical and chemical treatments of the fibers [8].

The manufacturing processes of various natural composites are very unique for different fibers and foe different combinations of raw materials. Machine lay-out and hand lay-up technique is the oldest and common technique for manufacturing fibers reinforced composites. This is due to the good mechanical properties particularly for fatigue properties which can be obtained by this method [9].

2. The raw materials for composite and process of Preparation

The different raw materials such as old/useless glass fiber, Bagasse, Banana fiber, rejected gunny bag made of jute and fine cloth of polyethylene and Epoxy resin as hardeners has been collected from the different source/ local area. Initially all the different fibers, were made fine by manual segregation and there after all these materials are cleaned thoroughly. Fibers were arranged in the form of layers so that these layers can be placed one by one with the combination of layers of resin. All these types of fibers were arranged and kept separately for making their own layered composites. Initially the weight percentage of fiber to resin was maintained to 7:4. The weighted resin was applied over the fiber putting the fiber layer by layers. All the fibers are measured separately to maintain the proper ratio of materials to resin in definite proportion, after applying resin over one layer of fiber a soft roller was repeatedly rolled to make surface even for next layer, in this way repeated layers of composite was prepared. After the initial preparation of composite in the mold, a dead weight of 2.5 kg was placed overnight over the composite to remove trapped air/gases from green sample and to get a uniform solid structure. The detail of application of preparation of mould, weighing of different raw materials, and initial preparation of composite fiber is shown in fig3.

Fig.3 (a) preparation of wooden mould,(b) weighing machine for measuring different raw materials used in composites and in (c) initial set up for composites is shown.

3. Result and Discussion

Result of the density of the composites are plotted in fig.3.1 and the test result has been show that the density of bagasse fiber composite is more as compare to the composite made of banana fiber . The value of the density of Composite made of Bagasse and Banana fiber are recorded as o.398gm/Cm^3 and 0.352ge/Cm^3 respectively. Based on the value, the density of bagasse composite is recorded as approximately 15% higher than the density of banana fiber composite.,

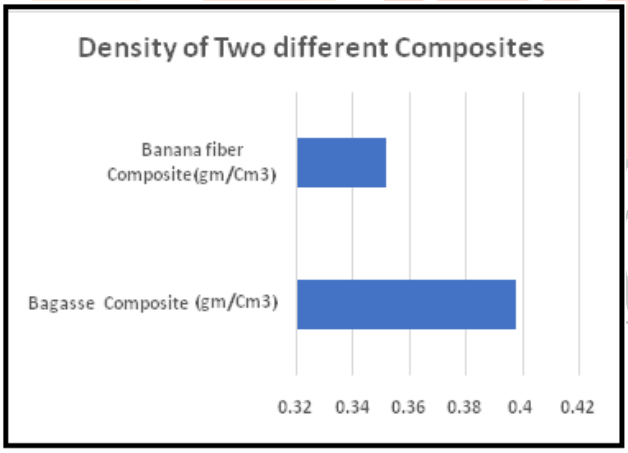

Fig. 3.1 Density of two different composites are shown

3.1 Hardness, Tensile, Shear and Compressive Strength Test

The tensile test for both the composites was performed with the help of UTM in material testing laboratory of LDC Institute of Technical Studies at Soraon Prayagraj. The test samples as shown in fig.3.4 (b) were initially prepared as per stander procedure and the test has been carried out as shown in fig.3.2 (c).

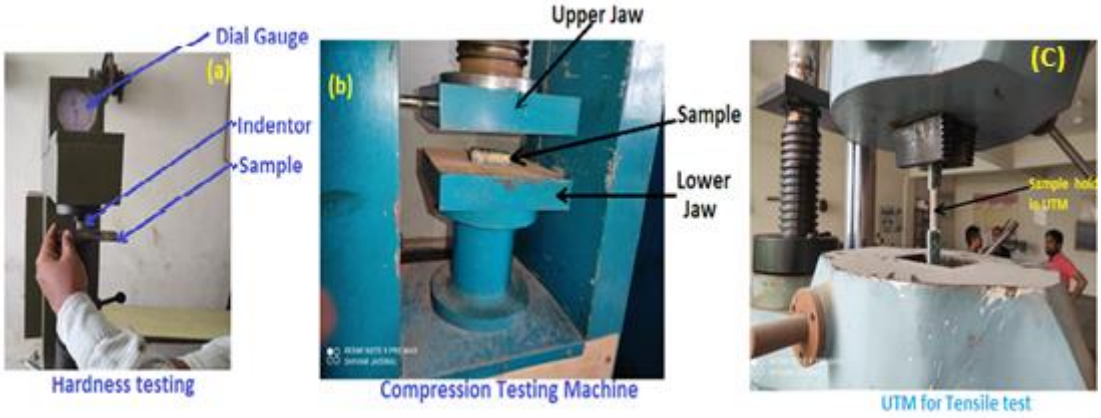

Fig. 3.2 The tensile test of the sample has done in UTM and holding of the sample as shown.

Samples were positioned by a specially designed mounting in the machine between the upper and lower cross bar of UTM as shown in the fig.3.2 (c). The result represents that the value of tensile strength of banana fiber composite is lesser as compare to Bagasse fiber composite. A very little difference is observed between the results of compressive strength of two different composites. The value of tensile test clearly describing that the composite made of bagasse is capable to bear more load than the composite made of banana fiber. The strength of tensile strength of bagasse fiber composite is 70% higher than the composite made of Banana fiber. Similarly the shear strength result also follows the similar trends in both composites. When the value of shear strength for bagasse composite is recorded as 198MPa that time the same is viewed 108Mpa for banana composite. Though there is no much differences are observed for the value of hardness as well as in Compressive strength values of both the coposites. It indicates the stress bearing capacity of banana composite is very lesser than bagasse composites.

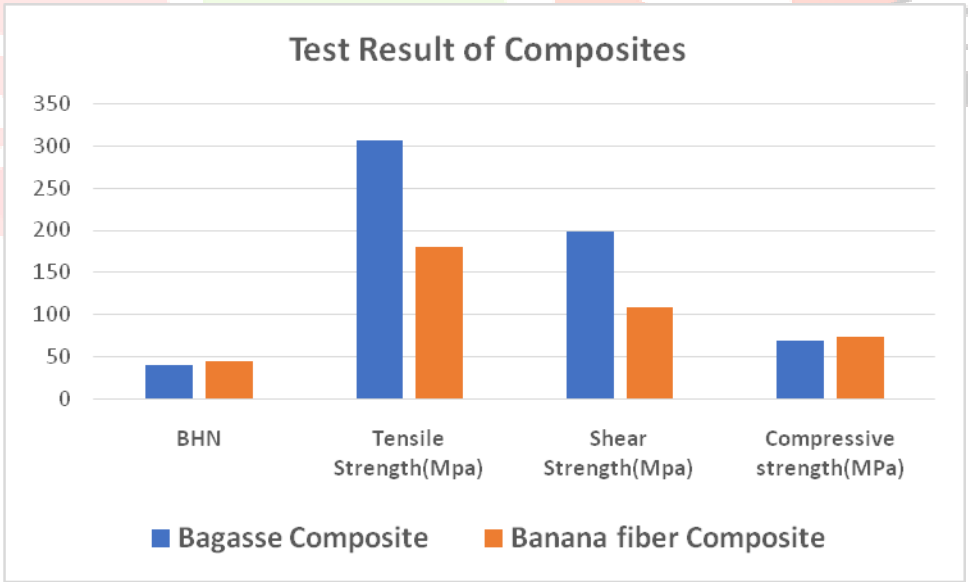

Fig. 3.3 The result of Brinell hardness number, tensile, compressive and shear strength of the sample has plotted as shown.

3.3 Tests for Toughness

The samples for Izod and Charpy tests were prepared from the material of two different composites as per standard procedure and the size of the samples were taken as **75 x 10 x 10** for Izod test and **125 x 10 x 10** for Charpy test. Also a cut mark at the defined

distance was made to perform the experiment as per material testing standards. Charpy and Izod test procedure are shown in fig. 3.4(a).

Fig. 3.4 (a) shows the sample of Izod and Chary test and in (b)demonstrate the sample of UTM test.

To perform Izod and Charpy tests the machine was operated repeatedly with the other different sample and find out the error in the initial reading and this error is subtracted to find the accuracy of the result. There after the sample was positioned as per procedure and the test had been done.

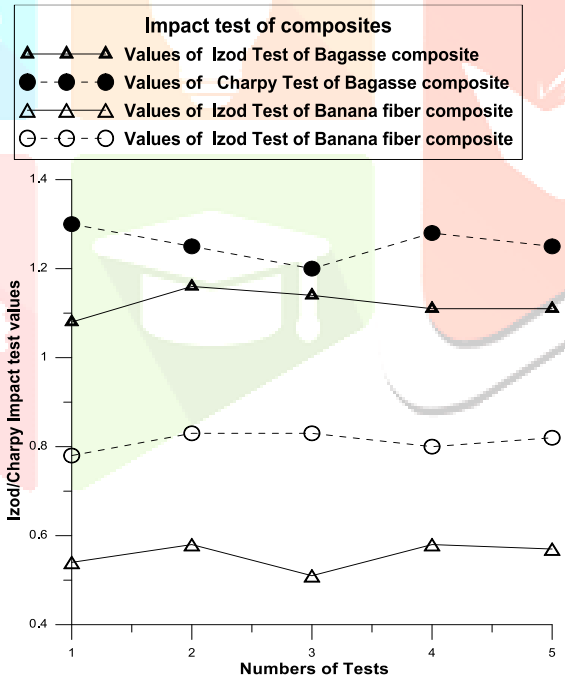

Fig. 3.5 (a) shows the comparison result of numbers of Izod and Chary tests that has been conducted in samples of two different composites.

The reading of the test result was noted down and plotted for comparison in fig.3.5. Just after the Izod test, the set up of the impact test machine was changed to conduct the Charpy test. Set up with knocking hammer was also altered to conduct the test as

per norms and again the error was found out to govern the accuracy of the result. The energy absorbed in Izod test is somewhere lesser as compare to energy absorbed in Charpy test that has been conducted for both the samples.

. The value of energy absorbed in Izod and Charpy test for Bagasse composite is approximately 100 and 78% respectfully than composite of banana fiber. The plot also clearly indicates that the energy gap of Izod and Charpy test result of banana fiber is more that the energy gap of Izod and Charpy result of Bagasse composite.

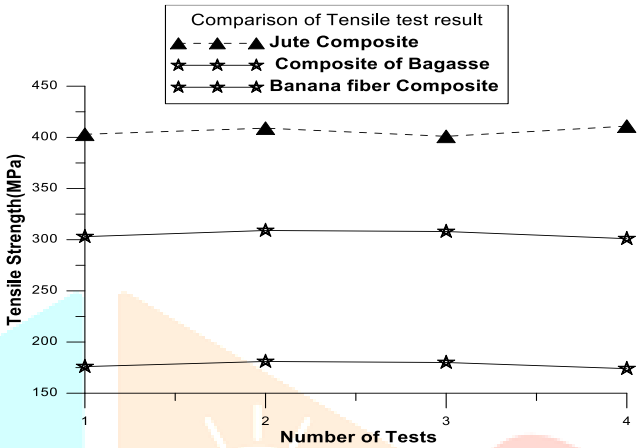

Fig. 3.6 (a) shows the comparison result of Izod and Chary tests of Bagasse and Banana fiber Composites with Jute fiber composite

The composites made of bagasse and Banana fiber are both studied in details and the mechanical properties of both the composites are viewed, the results depicted that the composite made of bagasse is comparatively more superior than that of composite made of banana fiber. The tensile test result of the composite finally compare with the composite made of Jute fiber of previously examined by the author. Here the result clearly viewed that the composite made of Jute fiber is the most superior than both bagasse and banana fiber composites as shown in fig. 3.6 in terms of tensile test and other results.

4. Conclusion

At present a huge amount of research has been done to find out the mechanical and physical behavior of natural fiber composites that are highly demanded in automotive industry and house hold requirements because of it's light weight to strength ratio. It is very impressive due to sustainability as well as environment friendly materials. In present time natural fiber composites are widely used for interior parts such as dashboards, plywood, door panels, seat cushions, parcel shelves and backrests but its external applications are limited. In the present study the author find out the two different composites of mainly bagasse and Banana fiber as major materials an d the test result shows the following conclusions are listed below:

- The density of Composite made of Bagasse and Banana fiber are measured as o.398gm/Cm^3 and 0.352ge/Cm^3 and densification of bagasse fiber composite is more as compare to the composite made of banana fiber.
- The value of tensile test clearly describing that the composite made of bagasse is capable to bear more load than the composite made of banana fiber.
- The strength of tensile strength of bagasse fiber composite is 70% higher than the composite made of Banana fiber. Similarly the shear strength result also follows the similar trends in both composites.
- Though there is no much difference are observed for the value of hardness as well as in Compressive strength values of both the composites. It indicates the stress bearing capacity of banana composite is very lesser than bagasse composites.
- The energy absorbed in Izod test is somewhere lesser as compare to energy absorbed in charpy test that has been conducted for both the samples. The value of energy absorbed in Izod and Charpy test for Bagasse composite is approximately 100 and 78% respectfully than composite of banana fiber.
- The plot also clearly indicates that the energy gap of Izod and Charpy test result of banana fiber is more that the energy gap of Izod and Charpy result of Bagasse composite.
- The tensile test result of the composite finally compare with the composite made of Jute fiber of previously examined by the author. Here the result clearly viewed that the composite made of Jute fiber is the most superior than both bagasse and banana fiber composites.

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