Investigation of Thermo Mechanical Properties of Natural Waste Based Hybrid Composites

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Abstract

As we all know that India is known for its agricultural products rather than its industrial goods. Farmers produce crops and they pet several animals. The waste produced from their animals and crops are utilized by them to some extent but due to unawareness a lot of material goes on waste. Some of these wastes are Bagasse fiber and chicken feather. Also these alternate materials are environment friendly as well as biodegradable. In poultry industry, chicken feather is waste material but, it posses high toughness and insulation and is also used as good reinforcing material in polymer matrix composite due to low density, low cost and high aspect. Bagasse having high tensile strength contains about 40% cellulose, 30% hemicelluloses, and 15% lignin which are modified by creating quiononesin lignin portion of the fiber and reacting with the furfural alcohol to increase their adhesiveness. Short Natural fibers like chicken and long fibers like bagasse were used in hybrid combination and the fiber weight fraction of 5%, 55% and 40% were used for the fabrication of the composite in epoxy Resin. This composite is manufactured using hand layup process. Mechanical properties of composite are determined through hardness and impact tests. Water absorption tests were conducted by immersing specimen in a water bath at room temperature for different time durations.

1. INTRODUCTION

Due to the low cost of the alternate materials the present era is focusing on these materials. Some other properties represented by these alternate materials are their machinability and their variety applications. Also, these alternate materials shows similar properties to that of the artificial material These alternate materials have better properties than their parent material in all aspect. Natural fibers such as bagasse, coconut coir, sisal, pineapple leaf fiber, animal hair, chicken feather etc as reinforced material in the composite when compared to the other manmade fiber, the natural fiber based composite present their advanced properties with their bio degradability. So, we can say that natural fiber based hybrid composites are environment friendly and biodegradable as these material now emerging as the potential alternate hybrid in engineering composite. Polymers are used in every place of society such as automotive, civil engineering medical equipment etc. Polymers are easily shaped by extrusion, injection molding, vacuum forming or foaming. It is durable, environmentally resistant, tough and light. Here bagasse as a natural fiber and chicken feather used in practical form

reinforced in polymer. Sugarcane bagasse extracted from the sugarcane. In sugar industry, bagasse having high tensile strength, contains about *40*% cellulose, 30% hemicelluloses, and 15% lignin which are modified by creating *quionones* in lignin portion of the fiber and reacting with the furfural alcohol to increase their *adhesiveness*. Chicken feathers, having good thermal resistance are made from protein keratin. There are two forms of microcrystalline keratin in the feathers. The chicken feather posses *toughness* and insulation. Both chicken feather and bagasse are going to be wasted in million of tones. Bagasse is used in furness and chicken feather is used rarely in textile industry. Here these two natural fibers used with epoxy thermoset polymer for making hybrid composite. Epoxy is a themoset polymer which is widely used for making composite material because of is easy availability and curing in normal temperature and pressure with 55% humidity.

2. FABRICATION

Fabrication of composite materials is accomplished by a wide variety of techniques, including:

- Vacuum Bag Molding
- Woodworking Application
- Pressure Bag Melding
- Autoclave Moulding
- Resin Transfer Moulding (RTM)
- Hand Layup Technique

Composite fabrication usually involves wetting, mixing or saturating the reinforcement with the matrix, and then causing the matrix to bind together (with heat or a chemical reaction) into a rigid structure. The operation is usually done in an open or closed forming mould, but, the order and ways of introducing the ingredients varies considerably. Hand Lay-up/ Spray up is one of the cheapest and most common processes for making fiber composite products.

2.1 Sugarcane Bagasse

The main chemical constituents of bagasse are hemi cellulose and lignin. Hemi cellulose and cellulose are present in the form of holocellulose in bagasse, which contributes more than 70 % of the total chemical constituent present in bagasse. Another important chemical constituent present in bagasse is lignin. Lignin acts as a binder for the cellulose fibers and also behaves as an energy storage system.

Fig.1: Sugarcane

Fig.2: Clean Bagasse

2.2 Chicken Feather

The mechanical performance of feathers were therefore, controlled more by shape than by material properties The fracture toughness of β-keratin has proved to be very high, around 10 kJm. The mechanical properties of feather fiber are related to the structure of keratin. Moving from calms to tip, the keratin molecules become more aligned than at the bird's skin before returning to a state of higher disorder towards the rachis tip.

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Fig.3: Chicken Feather

2.3 Treatment of Fiber

Bagasse after extraction of sugarcane juice bagasse fiber is cleaned in fresh boiled water then dried in the sun is rays.

Fig.4: Dry Bagasse

The chicken feather fiber is collected from the local area and is washed several times with water and then is soaked in 5% NaOH concentrated water for 30 minutes. The soaked chicken feather is then washed with detergent water followed by pure water then is dried in the suns rays. A clean chicken fiber, free from dirt and impurities, is obtain.

Fig.5: Chopped Chicken Feather

A matrix comprising AY-105 epoxy resin and HY-951 hardener. The Ratio of epoxy (AY-105) and hardener (HY-951) is 10:8 as per manufactures. %. Using a Mould of Dimension 650×450×10 mm^3 for composite preparation by Hand Layup technique. Wax is applied on the inner faces of mould to prevent bonding of matrix with the mould surfaces. For the 450x300x100 mm^3 composite sheets two wooden beet frame was prepared of 5mm thickness each. Prepare Bagasse fibre +Chicken feather epoxy resin mixture by the percent of weight 14% bagasse, 2% of chicken feather and remaining 84% of epoxy system. So there was mixture of 1400gm epoxy system (800gm epoxy + 640gm hardener) and 20gm of chicken feather was prepared. Bagasse was reinforced longitudinally between these mixtures. So, there a desired dimension of sheet is (450x300x10 mm^3) prepared.

Fig.6: Mould

Fig.7: Bagasse/Chicken Hybrid Composite Sheet

3. SPECIMEN PREPARATION

Impact specimen was cut as per ASTM D256 as shown in figure 8. Three specimen were cut of each test in order to obtain an average value.

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Fig.8 : Impact Specimen

4. TESTING AND RESULT

4.1 Impact Test

To obtain the impact strength of Bagasse fiber & Chicken feather composite material Izod test is performed as per standard ASTM D256. The mean value impact strength of this composite material is found to be *64* J/m. Which shows better impact strength than plain epoxy sheet and natural fiber reinforced composite.

Fig.9 : Impact Test

4.2 Hardness Test

Hardness test is performed on Digitally hardness testing machine with model RBHT, M scale, 100 kgf load capacity, 1/4'' ball indenter .The hardness of bagasse fiber & chicken feather composite *62.70* (Mean Value) is more than hardness value of natural fibers composite.

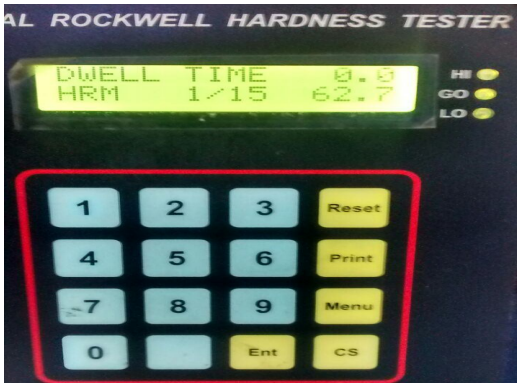

Fig.10 : Hardness Test

4.2 *Water Absorption Test*

Water absorption test conducted in which specimen is immerged in for 24 hours at room temperature under normal condition and with each 4hours, their weight is measured. Since, the epoxy do not make hydrogen bond, so there is less possibility to increase their weight, but natural fiber absorbs some amount of water initially and after some hours, it is in variant in weight.

Initial weight of specimen was 20gms and after 24 hours, it reached to a weight of 20.70gms. After that, the specimen weight shows that there is no increase in weight.

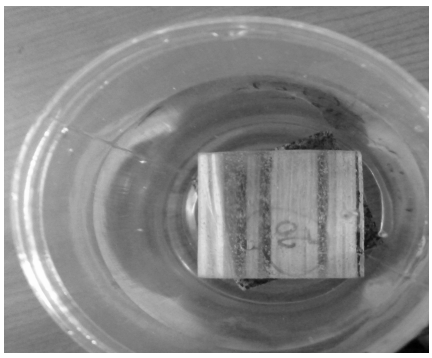

Fig.9: Specimen Dipped in Beaker

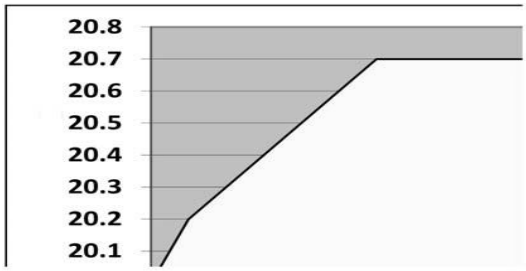

Fig.10: Water Absorption Test

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5. CONCLUSIONS

- There is improvement in Izod impact strength of composite by adding sugarcane Bagasse fibre and Chicken feather 64(J/m) as compared to the epoxy resin.
- The hardness (62.70) of composite sheet which is made by composite reinforcement method is better as compared to particulate reinforcement.
- The composite absorbed only 0.70 gms water in 24 hours and got saturated.

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