Characterization of Jute Frp Composite for Structural and Electrical Applications

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Abstract: The bio-based FRP composites are fast growing in industrial applications and fundamental research. Bio based fibers have been proved to be better alternative to synthetic fiber in automobiles, railway coaches and aerospace applications. Polymers are finding wide applications in our daily life due to their exclusive properties such as higher strength to weight ratio, lightness, economy, chemical resistance etc. Polymer composites are materials with many outstanding properties and in order to make them biodegradable or partially biodegradable, lot of efforts have been made to use bio based fibers as reinforcement. But the performance of these bio based composites depends on the properties of the reinforcing fibers and the bonding between the matrix and the fibers. The current research focuses on jute fiber reinforced polymer matrix composites that can be used for structural and electrical applications. In this work sawdust and wheat flour are used as filler material. Four samples of different compositions and fillers are developed by means of hand layup process. The investigation of tensile strength, flexural strength and impact energy are considered/taken up in present work. Surface morphology of composites have also been studied.

Keywors: LapoxL12, saw dust, hemicelluloses, flexural test.

I. INTRODUCTION

Every year, farmers harvest around 35 million tones of common strands from an extensive variety of plants and creatures. Over the past 50 years, natural fibers have been uprooted in our apparel, family unit decorations, enterprises and farming by man-made strands. Because of the expanding ecological mindfulness, normal fiber composites are winding up. The materials which are strong, solid, lightweight, and with great mechanical properties, that are essentially superior to those of conventional materials are filling the developing interest for characteristic fiber in different businesses, for example, car, building, and development.

The primary reason for this research is to convert a bio waste into a Useful Product and to boost the speed of market presentation of bio based/natural fiber composites based on the fibers. A definitive point is to increment on the planet market of common fiber composites and its items. Therefore the present work will spotlight on fibers that are directly important to use the fiber for basic structural and electrical applications. The present work aims to use the natural fibers like jute fibre along with sawdust/wheat flour to develop new composites. Chemical treatment of fibres is done to take out the unwanted contents like wax, hemicelluloses, etc. Tensile, bending and impact tests are to be conducted according to ASTM standards respectively to know the strengths of the given natural fiber composites. Microstructure Analysis is also carried out to study the surface morphology by SU3500 SEM.

II. MATERIALS AND METHODS

The following materials are selected for the composite preparations based on literature survey Jute fibre, Lapox L-12 resin and K6 hardener, Saw dust, Wheat flour.

JUTE FIBRE

Fig:1 Jute Fibre

Jute fibre shown in fig.1 is a long, delicate, gleaming vegetable fiber that can be spun into coarse, solid strings. It is derived fundamentally from plants in the sort Corchorus.

The filaments are first separated by retting. The retting procedure comprises of packing jute stems together and submerging them in moderate running water. There are two kinds of retting: stem and ribbon. The moderate viscosity epoxy resin LAPOX L-12 along with the room temperature curing hardner was selected for the experiment.

LAPOX L-12 AND HARDENER K-6

Fig.2 Lapox-L12

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K-6 hardener is a room–temperature curing agent with low viscosity. It is usually used for hand layup applications. Being rather reactive, it gives a short pot-life cures rapidly at normal ambient temperatures. Resin L-12 and hardener K-6 have a shelf life of 24 months if stored away from heat and humidity in its original container. Tensile strength of neatly cured system is 55-70 MPa and flexural strength of neatly cured system is 120-140 MPa.

PROPERTY	TEMP	TEST SETUP	VALUES
Appearance	-	-	Pale yellow
Density	25 °C	ISO 1183	0.95-1.1gm/cm^3
Viscosity	25 °C	ASTM D2196	5-15 Mpa

Table.1 Properties of Hardner

III. SAWDUST

Sawdust is a waste or outcome of carpentry work during, sawing, processing, planing, directing, penetrating and sanding. It is made of fine wood particles.

Fig.3 Saw dust

Sawdust has other uses, including filling in as a mulch, as a contrasting alternative to mud feline litter, or as fuel. Until the approach of refrigeration, it was regularly utilized as a part of ice houses to keep ice solidified during at any point of time in an year.

The examination on bio based strands to be utilized to make new composite for auxiliary and electrical applications is as yet being conveyed. The previously mentioned strands are chosen in various research applications.

IV. WHEAT FLOUR

Fig.4 Wheat flour

Wheat flour is produced using crushing of wheat utilized for human utilization. Wheat assortments are called soft. If gluten content is low are called "hard" or "solid" on the off chance that they have high gluten content. Soft flour is relatively low in gluten and in this way brings about a roll with a better, brittle surface.

Alkali treatment is the simplest method of chemical treatment of fibers and improves the mechanical properties of composites. The treatment provides finer fabric, increase crystallinity, reduction in amount of defects, superior bonding and reduced moisture absorption.

The fibres washed with fresh water to remove the residual NaOH sticking to the fibre surface. The fibers were then dried in open air. Removal of lignin, hemicellulose, silica and pith from the fiber to have better impregnation and improve fiber surface roughness for better interaction are the major objectives of fiber chemical treatment.

V. MOULD SPECIFICATIONS

A mould made up of galvanized steel plate of dimension (250 X 250 X 10 mm) is prepared. Casting of the composite is carried out in this mould by hand layup process. Then the specimens are cut from the prepared casting as per ASTM Standards.

Fig.5 Mould

VI. SPECIMEN PREPARATION

Prepared composite were machined by means of water jet cutting. Specimens were then prepared as per ASTM standards. In the present work three tests are conducted i.e. Tensile, Flexural and impact.

VII. EXPERIMENTAL DETAILS

1. TENSILE TEST

Tensile test was conducted to predict how the preapared composite will behave in their intended applications. The specimen were tested according to ASTM D 638-03 in universal testing machine (UTM). The geometry of the specimen shown in Fig. 6

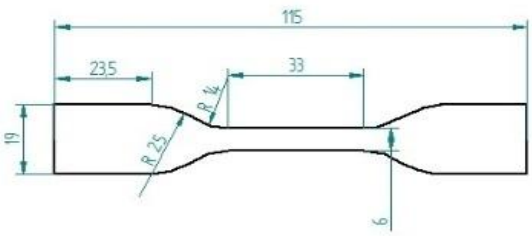

Fig. 6 Tensile test specimen

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2. FLEXURAL TEST

Flexural test is most commonly used mechanical test. In this test material properties can be determined by measuring the force required to bend the specimen to point where it breaks. Flexural test was conducted to predict the prepared materials ability to withstand bending or flexural forces. The specimen were tested according to ASTM D 790-07 in universal testing machine (UTM). The sketch of standard test specimen is shown below.

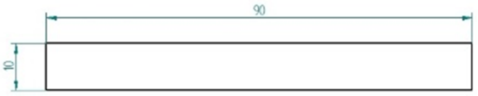

Fig.7 Standard flexural test specimen

3. IMPACT TEST

Impact test was conducted to find pepared materials ability to resist or hold high rate loading. The Figure 8 shows charpy impact test specimen used to obtain the impact properties. The specimen were tested according to ASTM D 256-06.

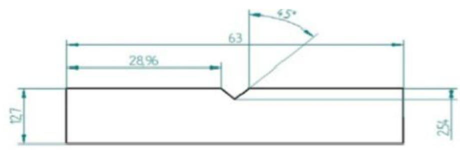

Fig.8 Standard Charpy test specimen

VIII. SCANNING ELECTRON MICROSCOPY

Surface morphology of the composite specimen is carried out on SU3500 SEM. In this work surface morphology of four different samples is studied. And also the fractured surfaces are compared with non fractured surfaces. First the samples to be scanned are prepared and fixed to placing plate by the help of gum tape. Then the plate is placed in gold coating unit for 2-3 minutes so that the surface are gold coated. This is to get clear 3d image of surface. After that the plate is instantly place inside the scanning electron microscope for the study.

IX. RESULTS AND DISCUSSION

4. TENSILE TEST

The tensile test was conducted as per ASTM D638-03 on universal testing machine of capacity 0-20 tons at the rate of loading of 5mm/min. the ultimate tensile strength values are given in table below.

Table.2 Test results

Composition	UTS(MPa)
25 % fibers, 75% Resin	51.84
25%Fiber,70%Resin ,5%Saw Dust	63.67
25%Fiber,70%Resin, 5% wheat flour	62.85
25% Fiber,70%Resin, 5% of both filler	84.46

6. FLEXURAL TEST

The flexural test was conducted as per ASTM D790-07 on universal testing machine of capacity 0-60 tons at rate of loading of 1.3mm/min. The ultimate flexural strength values for different combinations are shown in graph.

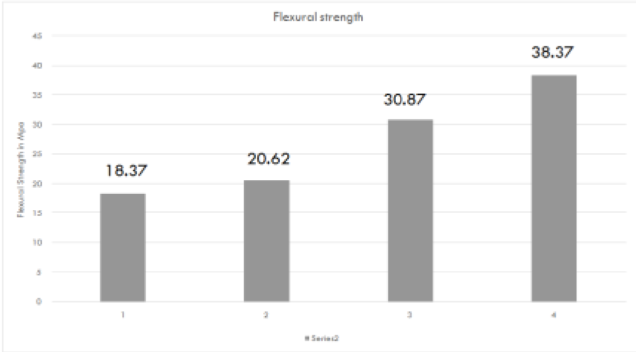

Fig.9 Flexural test results

5. IMPACT TEST

The impact test was carried as per ASTM D256-06 using impact testing machine of capacity 0-360 J. The absorbed load values are shown in Fig.

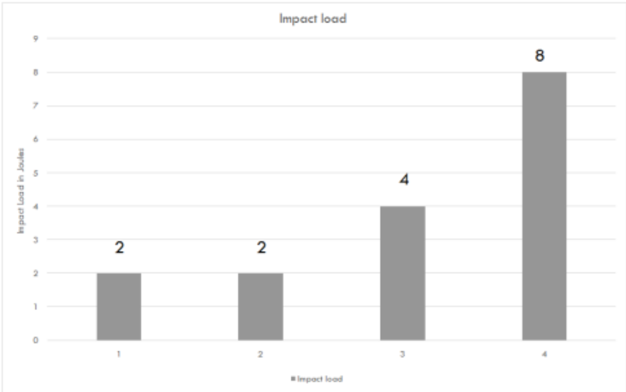

Fig. 10 Impact test results

X. SCANNING ELECTRON MICROSCOPE STUDY

Microstructure analysis was carried out to study the surface morphology of the composite specimen by SU3500 SEM.

The images were taken for without fractured and fractured composites and the images were analysed for better reduction and the reasons for failure and in turn reduction in strength.

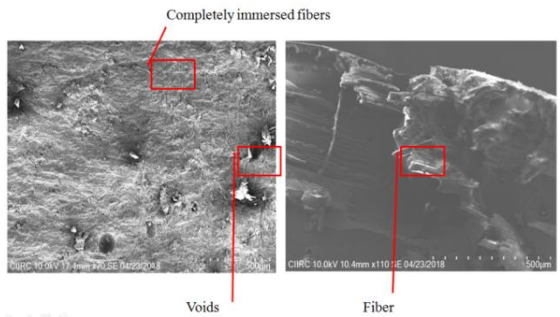

Fig.11 SEM Images for specimen-1

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The SEM images above shows the adhesion between the fibres and matrix. The above images are of sample with composition of 25 % Fibers and 75% Resin. Figure (a) shows image of surface without any fracture. There are some voids seen in image which are caused because of manually stirred resin mixture and it also may be caused because of random orientation of fibers. This sample contains more of resin therefore fibers are completely immersed and are not that clearly out in surface.

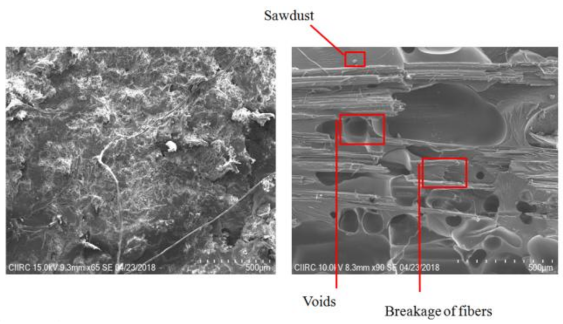

Fig12. SEM images for specimen 2

The above images are of sample with composition of 25 % Fibers, 70% Resin, 5% sawdust. Figure (a) shows image of surface without any fracture. This image is taken in magnification of 65x to show the change in surface due to presence of sawdust. This is due to bonding of sawdust with resin during stirring process.

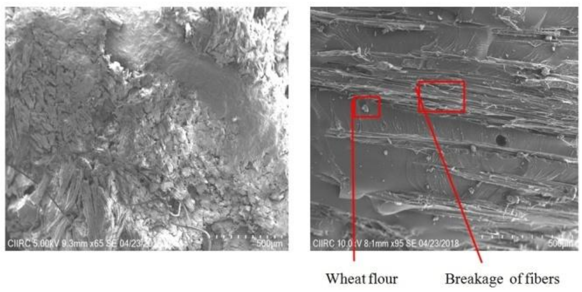

Fig.13 SEM images for specimen 3

The above images are of sample with composition of 25 % Fibers, 70% Resin, 5% wheat flour. Figure (a) shows image of surface without any fracture. The filler material used in this sample is wheat flour which is really soft and has ability to bond and immerse completely in resin. Therefore we can see that surface of the sample without any fracture is more even and filler material is completely filler everywhere.

XI. CONCLUSIONS

- It is seen that mechanical properties of composites are increased with addition of natural fillers.
- Tensile strength for composites is found to be increasing with addition of sawdust and wheat flour.
- Flexural strength for composites is found to be increasing with addition of sawdust and wheat flour.
- The energy absorbed by the composites increased with addition of wheat flour.
- Overall the composite with both sawdust and wheatflour filler is found to be having high mechanical properties.
- SEM images prove that the composite with both filler has strong bonding between resin and fibers and it also shows that the fibers are completely immersed within resin.

REFERENCES

1. Dr P V Senthiil, AakashSirssht, “Studies on Material and Mechanical Properties of Natural Fiber Reinforced Composites”, The International Journal Of Engineering And Science (IJES) Volume 3Issue, 11,2014
2. AjithGopinatha, SenthilKumar.Mb, Elayaperumal, Experimental Investigations on Mechanical PropertiesOf Jute Fiber Reinforced Composites with Polyester and Epoxy Resin Matrices. 12th global congress on manufacturing and management, gcmm 2014
3. M. Ramesha, Sri AnandaAtreyaa, U. S. Aswina, H. Eashwara, C. Deepa, Processing and Mechanical Property Evaluation of Banana Fiber Reinforced Polymer Composites. 12th global congress on manufacturing and management, gcmm 2014
4. Moorthy M. Nair1, K. ShambhaviKamath, NagarajShetty, Study on Tensile and Hardness behavior of Sawdust Impregnated on Short Coir Fiber Reinforced Epoxy Composite. Indian Journal of Advances in Chemical Science S1 (2016) 118-121
5. SubhankarBiswasa, SweetyShahinura, MahbubHasana and QumrulAhsan, Physical, Mechanical and Thermal Properties of Jute and Bamboo Fiber Reinforced Unidirectional Epoxy Composites. 6th BSME International Conference on Thermal Engineering (ICTE 2014)
6. Vivek Mishra, SandhyaraniBiswas, Physical and Mechanical Properties of Bi-directional Jute Fiber epoxy Composites. Chemical, Civil and Mechanical Engineering Tracks of 3rd Nirma University International Conference on Engineering.
7. D. Chandramohan, John Presin Kumar, Experimental data on the properties of natural fiber particle reinforced polymer composite material.
8. J.F.Horta, F.J.Simões, A.Mateus, Study of Wood-Plastic Composites with reused High Density Polyethylene and Wood Sawdust. International Conference on Sustainable and Intelligent Manufacturing, RESIM 2016, 14-17 December 2016, Leiria, Portugal.
9. Md. RashnalHossain, Md. AminulIslama, Aart Van Vuureab, IgnaasVerpoest, Tensile behavior of environment friendly jute epoxy laminated composite. 5th BSME International Conference on Thermal Engineering.
10. EmadOmrani, Pradeep L. Menezes, Pradeep K. Rohatgi, State of the art on tribological behavior of polymer matrix composites reinforced with natural fibers in the green materials world.
11. TakianFakhrul, M.A.Islam, Degradation behavior of natural fiber reinforced polymer matrix composites. 5th BSME International Conference on Thermal Engineering.