



Effect on Mechanical Properties for Jute, Coir and Bamboo Natural Fiber Reinforced Epoxy based Composites

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Abstract: Jute, Coir and Bamboo Natural Fiber composites are considered to have potential use as a reinforcing material in epoxy polymer based composites because of their good strength, stiffness etc. In present study, mechanical properties for these natural fiber composites were evaluated. Here, these natural fibers are the fiber reinforcement and epoxy polymer resin as a matrix material. Composite were prepared with different longitudinal (Unidirectional) natural fiber reinforced with epoxy based polymer. Mechanical test i.e. tensile test were performed on UTM machine and the results are reported. The result showed tensile and compressive strength of different unidirectional natural fiber reinforced epoxy polymer composites and presented the conclusion.

Keywords: Coir Fiber; Jute fiber; Bamboo fiber; Epoxy polymer resin; Tension; UTM

I. Introduction

The physical and mechanical characteristics of composites can be modified by adding a filler phase to the matrix body during the composite preparation. The incorporation of filler in composites is to improve its mechanical properties and to reduce its cost. Therefore, the use of inorganic filler in composites is gaining popularity in the composite world. The bio fibers have gained popularity as reinforcement due to their eco-friendly nature and good mechanical properties. They offer a potential alternative to glass, carbon and other synthetic fibers used for the manufacturing of composites. The potential of natural fibers such as bamboo, coir and jute as reinforcement in composites [3].

As thermoplastic resins need a processing temperature which is higher than natural fiber so they cannot be used for natural fibers composites, where as thermosetting resins can cure in room temperature and they are used widely in natural fiber composite. Epoxy can present better properties as a matrix and such type of composites are nature friendly and cost effective [3].

With the above background, the aim of present research is that to prepare natural fiber based epoxy composite and investigate the best natural fiber composite among them for different mechanical properties (i.e. Tensile strength and compressive strength) by testing of prepared sample of coir, jute and bamboo fiber epoxy composites on UTM.

So here, three type of sample are being tested, First from Jute, second from coir and third from bamboo epoxy based composite. Although weight percentage of natural fiber in each sample is same and fiber orientation is longitudinal. Here after research, concluded that which natural fiber based epoxy composite will be better for different mechanical properties.

II. Experiment

A. Elements and Specifications of Composites

Natural Fiber

Natural fibers have recently attracted the attention of scientists and technologists because of the advantages that these fibers provide over conventional reinforcement materials, and the development of natural fiber composites has been a subject of interest for the past few years. These natural fibers are low-cost fibers with low density and high specific properties. These are biodegradable and nonabrasive, unlike other reinforcing fibers. Also, they are readily available and their specific properties are comparable to those of other fibers used for reinforcements. However, certain drawbacks such as incompatibility with the hydrophobic polymer matrix, the tendency to form aggregates during processing, and poor resistance to moisture greatly reduce the potential of natural fibers to be

used as reinforcement in polymers. In this article, we shall review the reported work on various aspects of natural fiber reinforced composites and address some of the basic issues in development of such composites. [7]

Fig.1 Jute Fiber



Fig.2 Bamboo Fiber



Fig.3 Coconut coir Fiber



There are a number of reinforcement materials and the selection is done depending upon the properties to be imparted to the end product. Major Natural fibres are used as reinforcement materials such as Jute, coir and bamboo. Natural fibers for reinforcement are available in several forms like fibres, rovings, chopped strands, yarn and mats. A particular form is chosen depending on the moulding methods and properties to be imparted to end products.

Table 1 Mechanical properties of natural fibers

S.No.	Natural Fiber	Tensile Strength (MPa)	Density (gm/cm ³)
1	Bamboo -	140-230	0.6-1.1
2	Jute	393-773	1.3
3	Coconut coir	175	1.2

Unidirectional Tapes of Natural Fibers

Unidirectional tapes have been the standard within the aerospace industry for many years, and the fiber is typically impregnated with thermosetting resins. Tape products have high strength in the fiber direction and virtually no strength across the fibers. The fibers are held in place by the resin. Tapes have a higher strength than woven fabrics [9]. Element of Polymer composite are **Natural fiber, hardener, Epoxy Resin, Releasing agent.**

Compositions of Composite Material

Compositions of composite material for preparation of sample for Testing are show in table No.2

Table 2 Composition of composite material (By Weight)

S.No.	Material for composition	Specification	Mix ratio by weight
1	Epoxy Resin	Araldite-AW-106	1 Liter
2	Hardener	HV-953	0.75 Liter
3.	Natural fiber		85 gm per specimen

B. Fabrication of Composite Material

The fabrication of the polymer matrix composite was done at room temperature. The required ingredients of resin and hardener were mixed thoroughly in beaker as shown fig.6 and the mixture so made was transferred to mould cavity of the mould and the mould tightened with the help of nuts & bolts.

Preparation of mixture for composite

The required mixture of resin & hardener were made by mixing them in (10:7.5) parts in a beaker by stirring the mixture in a beaker by a rod taking into care that no air should be entrapped inside the solution.

Mould Fabrication

Two wooden moulds of size 310 X 185 X 10 (mm) were used for casting of polymer matrix composite slabs. The moulds made of pressed wood. The mould comprises of two plates one top & other bottom & third rectangular mould cavity inside. After that by placing the three pieces together drill the holes & then it has to be tightened by nuts & bolts as shown in fig.7. Each mould has four samples each sample has size of 300 X40 X10 mm.

Fig. 6 mixing of resin and hardener



Fig.7 Mould Assembly



Casting of sample

The dough prepared was transferred to mould cavity by care that the mould cavity should be thoroughly filled. Leveling was done to uniformly fill the cavity.

Curing Period

Curing was done at room temperature for approx. 48 hrs. After curing the mould was opened slab taken out of the mould and cleaned.

C. Material Properties Testing Of Composite Material

Compression & Tensile tests were carried out using Universal Tensile testing machine & Tensile testing machine respectively for natural fiber reinforced epoxy resin based polymer composite samples. Each test have two sample from Jute, bamboo and coir fiber reinforced epoxy resin based polymer composite materials so total Twelve samples are required for testing

Fig. 8 Prepared Samples (from left; Jute, bamboo and coconut fibers based composite)



Tension and Compression Test

The values of Tensile and Compression strength of specimen Composite material with different natural fiber are given in Table 3. Compression Test was carried out on UTM as shown in fig.9. The tensile test on unidirectional natural fiber samples were performed on two specimens of each prepared Composites material.

Fig.9 Compression test on samples



Table 3 Result from Tensile and compression test with average of value from two samples

SPECIMEN	TENSILE STRENGTH, (MPa)	COMPRESSIVE STRENGTH, (MPa)
Jute Fiber composite	9.155	31.28
Bamboo fiber composite	13.05	35.42
Coconut coir fiber composite	3.208	25.41

III. Results and Discussion

Fabricated materials of compositions of epoxy resin, Hardener with different natural fiber of jute, coir or bamboo system have been tested on Universal Testing Machine for find out the value of tensile strength, Compressive strength. The tensile test & Compression test in longitudinal direction was performed on four specimens of each prepared composites material. It may be noted that the test was successful because in the all tested specimens the fracture occurred in the middle of the specimen. The calculated values of the Tensile and Compressive strength and its corresponding value are given in Table 3.

Result shows in fig. 10, the value of Compressive strength in case of bamboo natural fiber composite is more than other natural fiber based polymer composites. Result shows in fig. 11, shows that the value of Tensile strength in tensile test is greater in bamboo natural fiber reinforced epoxy based polymer composites than other natural fiber composites taken in research.

Fig. 10 values of compressive strength

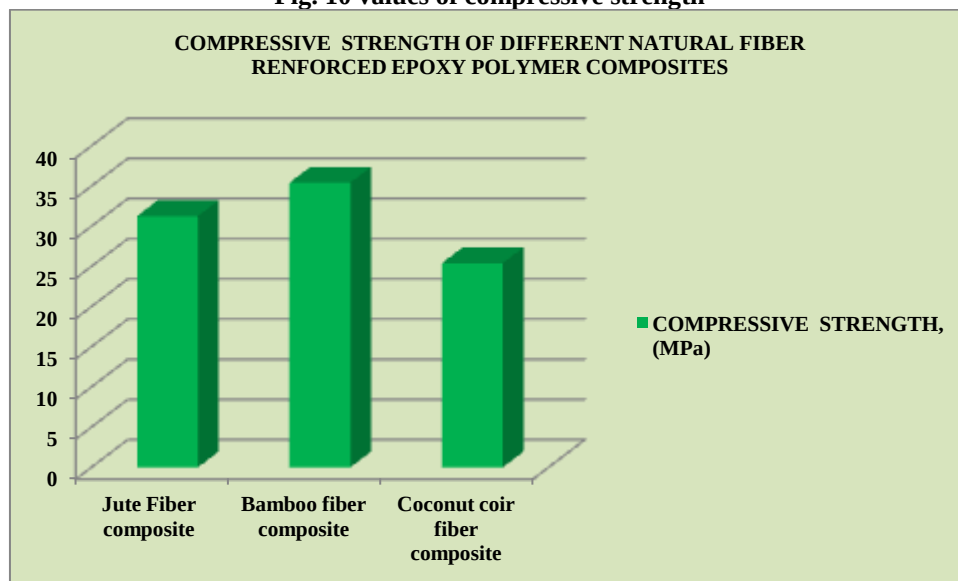
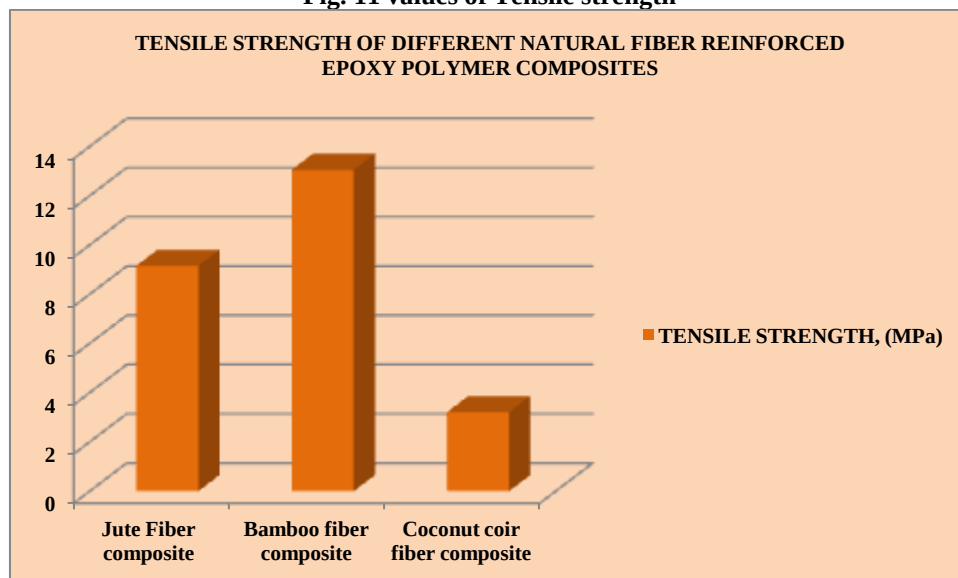


Fig. 11 values of Tensile strength



IV. Conclusion

In all the testing of properties of material as compression and tension on samples of uni-directional natural fiber (Jute, Bamboo and coir) reinforced epoxy resin based polymer composites, following points have been concluded.

- Bamboo natural fiber reinforced epoxy based polymer composites have more tensile and compressive strength than Coir and Jute based composites.
- Jute fiber based composite is better than coir fiber based composites in both the test.
- In tensile test all the natural fiber have almost same value but in compression test coir fiber based composite have less strength than others.
- Compressive Strength of all natural fiber composites are greater than tensile strength.
- Fiber lengths, orientation, concentration, dispersion, aspect ratio, selection of matrix, and chemistry of the matrix need to be investigated thoroughly.

V. References

- [1] F.C.Campbell, *Structural Composite materials* (ASM International, 2010)
- [2] Girisha C., Sanjeevamurthy and Rangasrinivas G., Tensile properties of natural fiber –reinforced epoxy hybrid composites, *International journal of modern engineering research (IJMER)*, vol.2, Issue-2, March-April 2012, pp 471-474 (ISSN:2249-6645).
- [3] Jena H., Kumar M. and Pradhan A.K., Study the Impact property of laminated Bamboo-fiber composite filled with cenosphere, *International Journal of environmental science and development*, Vol.3, No.5, Oct 2012, PP 456-459.
- [4] Malhotra N., Sheikh K. and Rani S., A review on mechanical characterization of natural fiber reinforced polymer composites, *Journal of engineering research & Studies*, vol.III, Issue-I, January –March -2013, pp 75-80 (E-ISSN 0976-7916)
- [5] Okubo K., Fujii T. and Yamamoto Y., Development of bamboo –based polymer composites and their mechanical properties, *Composites Part A: applied science and manufacturing*, 35, 2004, pp 377-383.
- [6] Rassiah K. and Ahmad M.M.H.M., A review on mechanical properties of Bamboo fiber reinforced polymer composites, *Australian Journal of Basic and applied sciences*, 7(8), 2013, pp 247-253, ISSN: 1991-8178.
- [7] Saheh D.N. and Jog J.P., Natural Fiber polymer composites: A review , *Advances in polymer Technology*, vol.18, No.4, 1999, PP 351-363
- [8] Srinivas C.V. and Bharath K.N., Impact and Hardness properties of areca fiber epoxy reinforced composites, *J.Mater. Environ. Sci.*, Vol.2, No.4, 2011, pp 351-356.
- [9] Tanwer A.K., Mechanical Properties Testing of Uni-directional and Bi-directional Glass Fibre Reinforced Epoxy based Composites., *International Journal of Research in Advent Technology*, Vol.2, No.11, 2014, pp 34-39.

VI. Acknowledgments

The author acknowledges the support extended by administration of Roorkee Institute of Technology, Roorkee for providing test facilities for the research. Further, author is thankful to the lab staff of Department of mechanical engineering, Roorkee Institute of Technology, Roorkee for their assistance and help during research work.