Analysis of Bamboo Fibre Composite with Polyester and Epoxy Resin

M. Ramachandran, Sahas Bansal, Vishal Fegade, Pramod Raichurkar
MPSTME, SVKM NMIMS University, Dhule, Maharashtra, India.
sweetestchandran@gmail.com

Abstract

Usage of natural fibers in reinforced plastic material with natural fibers as a composite had a positive approach for the development of green composites in our day to day life. The paper deals with the study of woven bamboo natural fiber with polyester resin having 0/90 degree orientation and the bamboo natural fiber (2-4 mm length) with epoxy resin having random orientation. Tensile test was conducted on bamboo polyester resin composite whereas for bamboo epoxy resin composite, IZOD test, CHARPHY test, FTIR test and Hardness test were conducted. Both the composites i.e. Bamboo polyester resin composite and bamboo epoxy resin composite shows significant results as compared to manmade fiber composites.

Keywords: Tensile Strength, Composites, Bamboo fiber, Impact Test

I. Introduction

Polymeric composites degradation behavior upon exposure to environment conditions such as humidity and temperature is one of the most important problems occurred. The natural FRP composites are lightweight, strong and biodegradable. The bamboo fiber have excellent property like High tensile strength, High strength to weight ratio, Low cost when compare with synthetic fiber, easily available, Ecofriendly nature, etc. In the fiber percentage moisture present with respect to weight varies from 9.16 to 10.14 at normal atmospheric condition. Various researchers and scientists focused on bamboo fiber for using in reinforced plastic composites. For sample A, the woven bamboo was cut into 100 by 100 cm sq. and soaked in 5% NaOH solution at normal room temperature for 4 hours. The treated woven bamboo was perfectly cleaned in water and excess water was dried. For sample B, the raw bamboo fiber was cut into 2-4 mm of length, mixed with epoxy resin and kept for duration of 12 hours. Two samples were prepared named Sample A and Sample B. Table 1 shows the orientation, composition and volume of sample A and B.

Table 1. Compositions of sample A and B

SAMPLES	ORIENTATION	COMPOSITION	VOLUME (%)
A	0/90	Polyester Resin Bamboo Fiber	70% 30%
B	Random	Epoxy Resin Bamboo Fiber	90% 10%

II. Specimen preparation

The sample A was fabricated by adding polyester resin with hardener (ratio 10:1). This matrix solution was poured evenly over the woven bamboo fiber. The procedure was continued for five layers of woven. In order to trap the air bubbles, the specimen was pressed in the **hydraulic press**. The sample B was prepared by wet layer forming process or hand layup molding process. This process includes first wax coating provided to prevent the fiber reinforced plastic stick on the surface of the forming tool then the matrix which is placed on the forming tool. Both the glass reinforced fiber layer and coal ash in an open molding process. Using matrix, glass fiber and coal ash are taken in combination (90/10) named B. Then it is saturated with the epoxy wet resin by pouring on the reinforced fiber layer. Further the addition of fiber layer is provided to get the required thickness of the fiber reinforced plastic.

III. Tensile Test

Tensile strength is a measurement of the force required to pull something such as rope, wire, or a structural beam to the point where it breaks and therefore tensile properties indicate how the material will react to forces being applied in tension. Tensile tests are used to determine the modulus of elasticity, elastic limit, elongation, proportional limit, and reduction in area, tensile strength, yield point, yield strength and other tensile properties. Table 2 shows the tensile test of bamboo polyester resin composite.

Table 2. Tensile Test of Bamboo polyester resin composite.

COMPOSITE	Tensile Test
Bamboo composite (Polyester Resin)	21.22 N/mm^2

IV. FTIR Test

FTIR stands for **F**ourier **T**ransform **I**nfra-**R**ed. IR radiation is passed through a sample andsome of the radiation is absorbed by work piece.The resulting spectrum represents the molecular absorption and transmission, creating molecular fingerprint of the sample. FTIR gives information about unknown metals, determine quality or consistency of a sample, determine amount of mixture in sample and an excellent tool for quantitative analysis.

From bamboo fibre FTIR test (Figure 1), the graph shows 1 Alcohol/Phenol OH stretch, 1 Alkyl CH stretch, 2 Amide CO stretch, 2 Aromatic CH bending functional groups. From bamboo epoxy resin composite FTIR test (Figure 2), the graph shows the same functional groups as that of bamboo fibre FTIR test along with one extra Alkyl CH stretch.

Figure 1. Bamboo Fiber FTIR test result graph

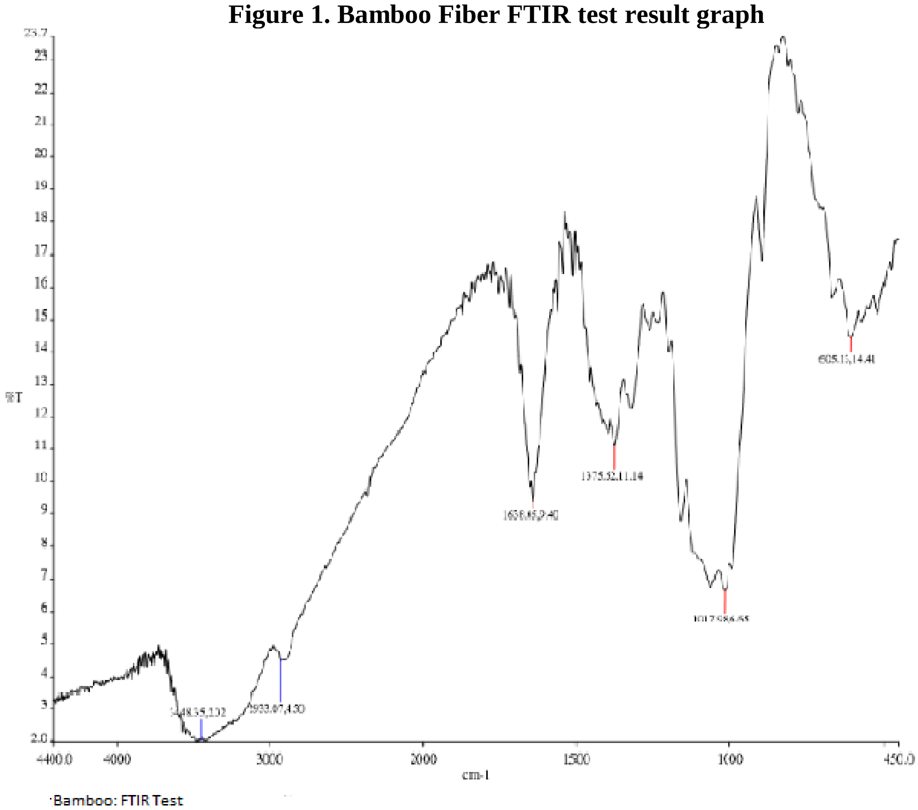
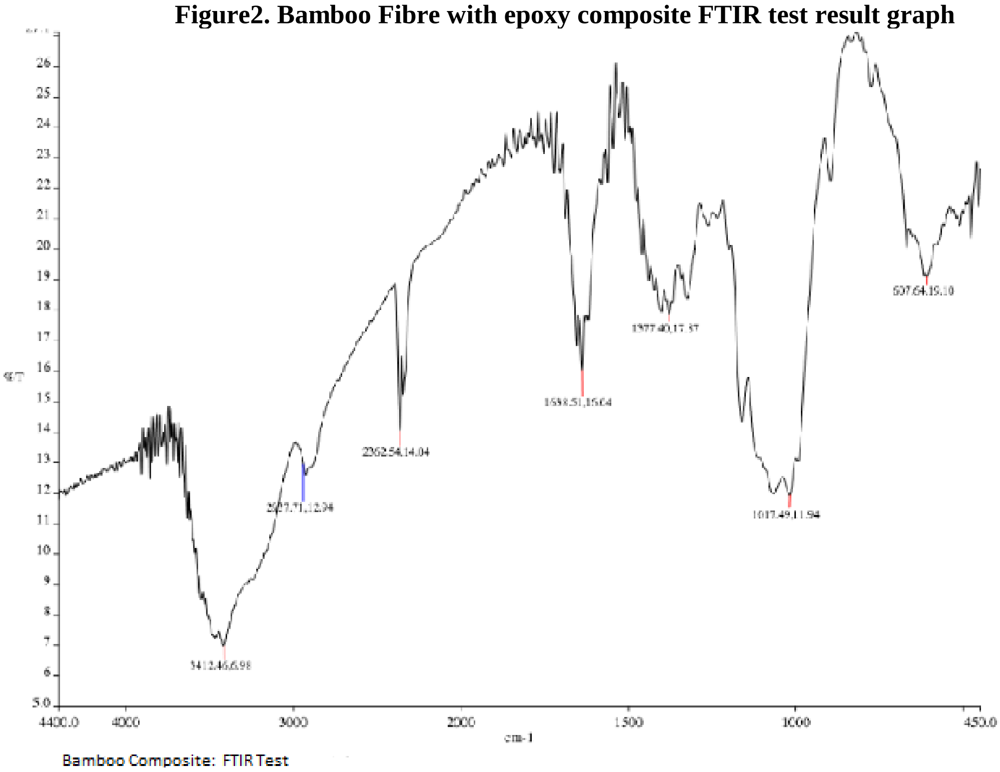


Figure2. Bamboo Fibre with epoxy composite FTIR test result graph

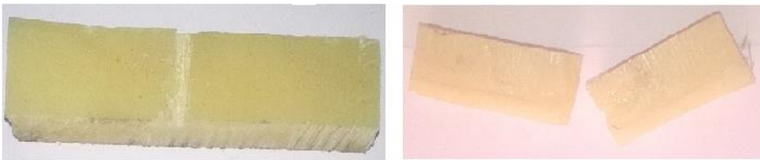


V. Impact Test

Impact Test consists of IZOD and CHARPHY test. IZOD test is for determining the impact resistance of materials. An arm held at a specific height (constant potential energy) is released. The arm hits the sample. The specimen either breaks or the weight rests on the specimen. From the energy absorbed by the sample, its impact energy is determined. A notched sample is generally used to determine impact energy and notch sensitivity. Table 3 shows the IZOD test of bamboo epoxy resin composite.

Figure 3. IZOD test specimen before and after break

BAMBOO EPOXY SPECIMEN: IZOD TEST

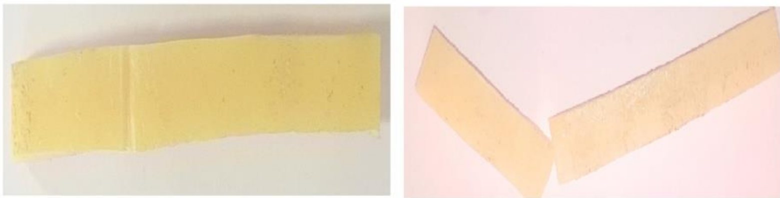


BEFORE BREAK AFTER BREAK

CHARPHY test is standardized high strain-rate test which determines the amount of energy absorbed by a material during fracture.It is widely applied in industry, since it is easy to prepare and conduct and results can be obtained quickly and cheaply. The test became known as the Charpy test in the early 1900s due to the technical contributions and standardization efforts byGeorges Charphy. Today it is utilized in many industries for testing materials, for example the construction of pressure vessels and bridges to determine how storms will affect the materials used. Table 3 shows the CHARPHY test of bamboo epoxy resin composite.

Figure 4. CHARPHY test specimen before and after break

BAMBOO EPOXY SPECIMEN: CHARPHY TEST



BEFORE BREAK AFTER BREAK

Table 3. Impact test of Bamboo epoxy resin composite.

COMPOSITE	IZOD TEST	CHARPHY TEST
Bamboo Composite (Epoxy Resin)	2 Joules	3 Joules

VI. Rockwell Hardness Test

The Rockwell method measures the permanent depth of indentation produced by a force/load on an indenter. First, a preliminary test force (commonly referred to as preload or minor load) is applied to a sample using a diamond indenter. This load represents the zero or reference position that breaks through the surface to reduce the effects of surface finish. After the preload, an additional load, call the major load, is applied to reach the total required test load. This force is held for a predetermined amount of time (dwell time) to allow for elastic recovery. This major load is then released and the final position is measured against the position derived from the preload, the indentation depth variance between the preload value and major load value. This distance is converted to a hardness number. Table 4 shows the hardness of bamboo epoxy resin composite.

Table 4. Hardness test of Bamboo epoxy resin composite

COMPOSITE	HARDNESS (RHN)
Bamboo Composite (Epoxy Resin)	20

VII. Conclusion

Tensile properties of bamboo polyester resin composite and FTIR test, impact test and hardness test of bamboo epoxy resin composite showed significant results. According to the FTIR results, the functional groups of bamboo fiber and bamboo epoxy resin composite are same except one extra alkyl CH stretch functional group in bamboo epoxy composite which indicates better compatibility between them. In future, we are going to carry out tests with various compositions and orientations of bamboo polyester resin composite and bamboo epoxy resin composite.

References

[1]. R. Petrucci , C. Santulli , D. Puglia , E. Nisini , F. Sarasini , J. Tirillò , L. Torre , G. Minak , J.M. Kenny, Impact and post-impact damage characterisation of hybrid composite laminates based on basalt fibres in combination with flax, hemp and glass fibres manufactured by vacuum infusion, Composites: Part B 69 (2015) 507–515.
[2]. Rakshit Agarwal, M. Ramachandran, Stanly Jones Retnam, Tensile Properties of Reinforced Plastic Material Composites with Natural Fiber and Filler Material, ARPN Journal of Engineering and Applied Sciences, Vol.

10, No. 5, 2015, pp. 2217-2220.
[3]. Priyanka, Sanjay Palsule , Banana fiber/chemically functionalized polypropylene composites within situ fiber/ matrix interfacial adhesion by Palsule process, Composite Interfaces, 2013, Vol.20, No.5, 309–329.
[4]. M. Ramachandran, Application of Natural Fibres in Terry Towel Manufacturing, International Journal on Textile Engineering and Processes, Vol 1, Issue 1, 2015, pp. 87-91.
[5]. C. Elanchezhian, B.Vijaya Ramnath, KaosikR., NellaiappanT.K, SanthoshKumar.K, Kavirajan .P, Sughan M.U, Evaluation of mechanical properties of kenaf based hybrid composite for automotive components replacement,Vol.10, No.13, 2015.
[6]. Malvika Sharma, M. Ramachandran, Development and characterization of fibre reinforced material based on potato starch and jute fibre, International Journal of Applied Engineering Research. Vol 10, No. 11 (2015) pp. 10324-10327.
[7]. G. Caprino, L. Carrino, M. Durante, A. Langella, V. Lopresto , Low impact behavior of hemp fibre reinforced epoxy composites; Composite Structures 133 (2015) 892–901.
[8]. D. Bino prince raja, B. Stanly Jones Retnam, M. Ramachandran, Analysis of mechanical properties of glass and carbon fiber reinforced polymer material, International Journal of Applied Engineering Research. Vol 10, No 11 (2015) pp. 10387-10391.
[9]. Sudha J, HarishKumar Padmakumar, Ranjani R, Sheela Ramani G, Naviyarasan M, Comparative Study of Impact Properties of Coir & Aloe Vera Based Composites With GFRP, Vol 10, No 8 (2015) pp.20517-20528.
[10]. M Aniber Benin, B. Stanly Jones Retnam, M. Ramachandran, Comparative study of tensile properties on Thermoplastic & Thermosetting polymer composites, International Journal of Applied Engineering Research. Vol 10, No 11 (2015) pp. 10109-10113.
[11]. K. HariRam, R. Edwin Raj, Mechanical Property Evaluation of Sisal Glass Fiber Reinforced Epoxy Polymer Composites, IJAER, Vol 10, No3 (2015) pp.6951-6962.
[12]. P. Pradeep, J. Edwin Raja Dhas, M. Ramachandran, Mechanical Characterization of jute fiber over glass and carbon fiber reinforced polymer composites, International Journal of Applied Engineering Research. Vol 10, No 11 (2015) pp. 10392-10396.
[13]. Microstructure, flexural properties and durability of coir fibre reinforced concrete beams externally strengthened with flax FRP composites; Libo Yan, Shen Su , Nawawi Chouw ; 2015 Elsevier
[14]. Pramod Raichurkar, Updeep Singh, Tushar Patil, M. Ramachandran, Cotton Weaving - A New Business opportunities and diversification in Cotton weaving, International Journal on Textile Engineering and Processes, Vol 1, Issue 2, April 2015, pp. 11-15.
[15]. K.Kanny, MohanT.P., Surface treatment of sisal fiber composites for improved moisture and fatigue properties, Composite Interfaces Vol.20,No.9,783–797.
[16]. Alex. S, Stanly Johns Retnam, M. Ramachandran, A review on Biodegradability of Hybrid Bamboo/Glass fiber polymer composites, International Journal of Applied Engineering Research.Vol 10, No 11 (2015) pp. 10565-10569.
[17]. Nadezda Stevulova, Julia Cigasova, Pavol Purcz, Ivana Schwarzova, Frantisek Kacik, Anton Geffert, Water Absorption Behavior of Hemp Hurds Composites, *Materials* 2015,*8*,2243-2257.
[18]. Anshu Anjali Singh and Sanjay Palsule, Jute fiber reinforced chemically functionalized high density polyethylene (JF/CF HDPE)composites within situ fiber/ matrix interfacial adhesion by Palsule Process, Composite Interfaces, 2013, Vol.20, No.8, 553–573
[19]. Tara Sen, H.N., Jagannatha Reddy; T. Sen, H.N. Jagannatha Reddy, Strengthening of RC beams in flexure using natural jute fibre textile reinforced composite system and its comparative study with CFRP and GFRP strengthening systems, International Journal of Sustainable Built Environment 2 (2013) 41–55.