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Mechanical Characterization of Treated Bamboo Natural Fiber Composite

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Abstract

Fiber reinforced polymer composites have many applications as a class of structural materials because of the case of fabrication, relatively low cost of production. The fiber which serves as a reinforcement in reinforced plastics may be synthetic or natural. An investigation has been carried out to make use of bamboo fiber which is a natural fiber abundantly available in India. The objective of the present work is to study the effect of fiber loading and mechanical behavior of bamboo fiber reinforced epoxy composites. This paper shows the evaluation of tensile strength, flexural strength and surface hardness of the bamboo-epoxy composite. It also concludes the effect of fiber loading on tensile strength, flexural strength and surface hardness of the bamboo-epoxy composite.

Keywords: Tensile Strength, Flexural Strength, Surface Hardness, Hand Lay-up Technique, Fiber Loading, Bamboo Fiber.

Introduction:

When two or more materials with different properties are combined together, they form a composite material [1]. “Composites are multifunctional material systems that provide characteristics not obtainable from any discrete material. They are cohesive structures made by physically combining two or more compatible materials, different in composition and characteristics and sometimes in form” [2]. “The composites are compound materials which differ from alloys by the fact that the individual components retain their characteristics but are so incorporated into the composite as to take advantage only of their attributes and not of their short comings”, in order to obtain improved materials [3].

This paper shows the behavior of mechanical properties under fiber loading. Test specimens are prepared by hand lay-up method using bamboo as natural fiber

reinforcement in polymer matrix using epoxy resin and hardener (DERAKANE 411-350 epoxy vinyl ester). Natural bamboo fibers were treated by sodium hydroxide to remove moisture. Fiber composite sheets were prepared and then cut into desired shape and dimensions.

Literature Review:

Tingju Lu, et al., 2013, this paper shows an effect of surface modification of bamboo cellulose fibers on mechanical properties of cellulose/epoxy composites [4]. Yanjun Li, et al., 2013, this research paper demonstrates thermal decomposition properties of bamboo and high density polyethylene composite with heat treated bamboo fiber [5]. Netra L. Bhandari, et al, 2012, this paper shows the analysis of morphological and mechanical behaviours of bamboo flour reinforced polypropylene composites [6]. Prity Aniva Xess, 2012, this research shows the erosion wear behaviour of bamboo fiber based hybrid composites. It involves the study of the physical, mechanical, dynamic mechanical and erosion wear behaviour of the composites [7]. Suyash Sahay, 2012, this report presents a study on the effect of chemical treatment on the mechanical behaviour of bamboo-glass fiber reinforced epoxy based hybrid composites [8]. Sanjay K. Chattopadhyay, et al., 2011, this research paper shows the mechanical, thermal, and morphological properties of bamboo fiber reinforced polypropylene composites [9]. A. V. Ratna Prasad, et al., 2011, this paper shows the mechanical properties of natural Fiber reinforced polyester composites: Jowar, sisal and bamboo [10]. V. Kumar, et al., 2011, it gives the Impedance-spectroscopy analysis of oriented and mercerized bamboo fiber-reinforced epoxy composite [11].

Preparation of Specimens:

Specimens for tensile, flexural and hardness testing were prepared in polymer matrix composites along with bamboo natural fiber. Following table 1 shows the composition of various samples prepared.

Table 1: Sample Composition

Designation	Composition	No. of Samples
B	Pure Epoxy	5+5+5 = 15
B1	Epoxy (95%) + Bamboo Fiber (5%)	5+5+5 = 15
B2	Epoxy (90%) + Bamboo Fiber (10%)	5+5+5 = 15
B3	Epoxy (80%) + Bamboo Fiber (20%)	5+5+5 = 15
B4	Epoxy (75%) + Bamboo Fiber (25%)	5+5+5 = 15
B5	Epoxy (70%) + Bamboo Fiber (30%)	5+5+5 = 15

Characterization of Mechanical Properties:

Tensile and flexural tests are carried out on Instron 3382, 1.0kN Universal Testing Machine at a temperature of 23±2˚C, and with relative humidity of 38±5%. Testing

procedures is carried out in ASTM D638 for tensile tests and ASTM D790 for flexural tests. Rockwell Hardness test is carried out in accordance with ASTM D785. Summary of the entire test to be performed is shown in the Table 2.

Table 2: Summary of tests

Testing	Machine Used	Working Variables	No of Specimen Tested	Standard Used
Tensile	Instron 3382, 1.0kN UTM	Load cell = 500KN Rate = 6mm/min	5×6 = 30	ASTM D638
Flexural	Instron 3382, 1.0kN UTM	Load cell = 500KN Rate =1.32mm/min	5×6 = 30	ASTM D790
Hardness	Rockwell hardness tester, PSI New Delhi	Ball indentor size = ¼ inch	5×6 = 30	ASTM D785

Results:
The properties of bamboo fiber reinforced epoxy composites with different fiber loading under this investigation are presented in table 3.

Table 3: Mechanical characteristics of composites

Sr. No.	Fiber Content (%)	Orientation (degree)	Tensile Strength (MPa)	Flexural Strength (MPa)	Hardness (HRL)
1	0%	-	18.16	19.03	46
2	5%	Random	26.22	27.88	49
3	10%	Random	37.98	37.48	56
4	20%	Random	45.28	43.82	62
5	*25%*	*Random*	*53.61*	*51.47*	*67*
6	30%	Random	46.91	48.15	68

Effect of fiber loading on tensile strength:
Following figure 1 shows the effect of fiber loading on tensile strength of bamboo fiber composite material.

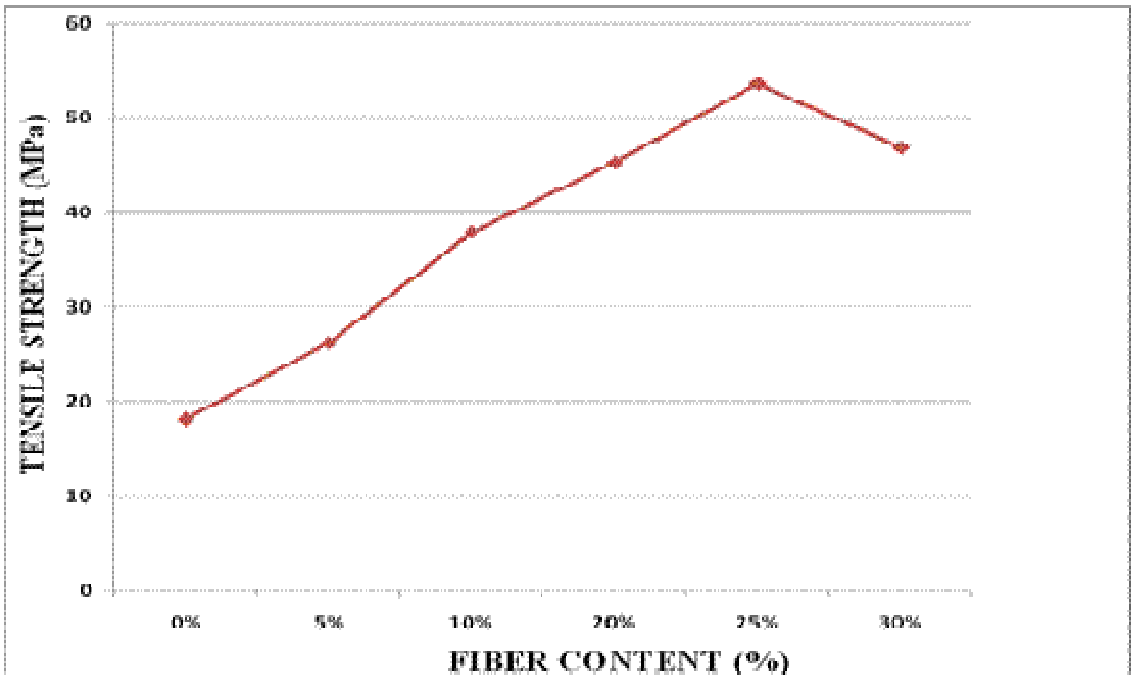

Figure 1: Effect of fiber loading on tensile strength of composite

Effect of fiber loading on flexural strength of composite:
Following figure 2 shows the effect of fiber loading on flexural strength of bamboo fiber composite material.

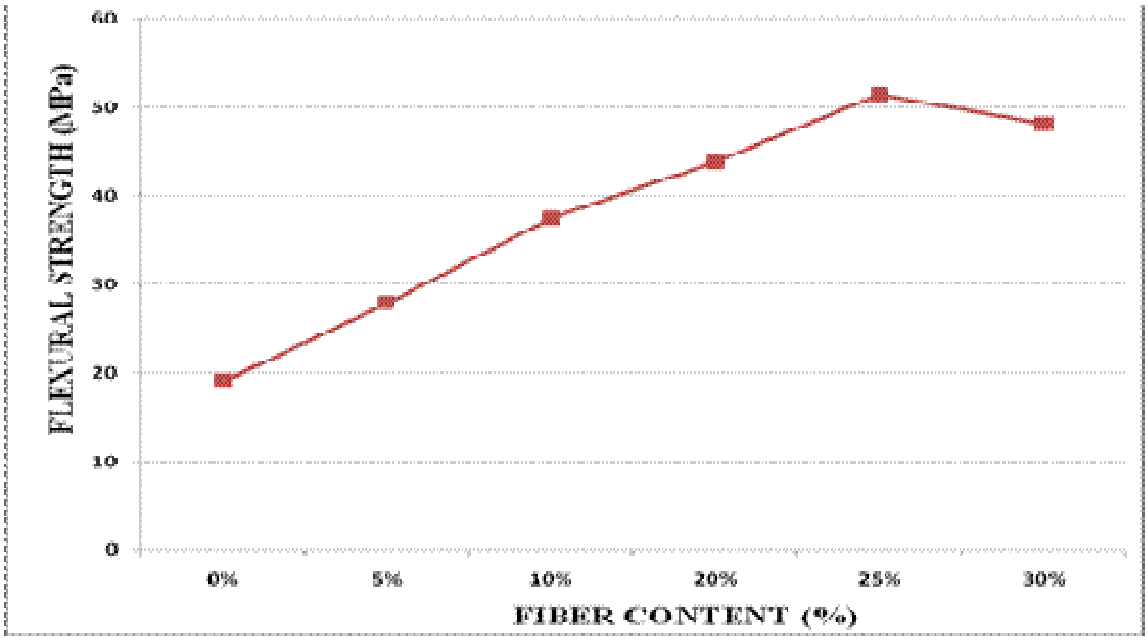

Figure 2: Effect of fiber loading on flexural strength of composite

Effect of fiber loading on surface hardness of composite:
Following figure 3 shows the effect of fiber loading on surface hardness of bamboo fiber composite material.

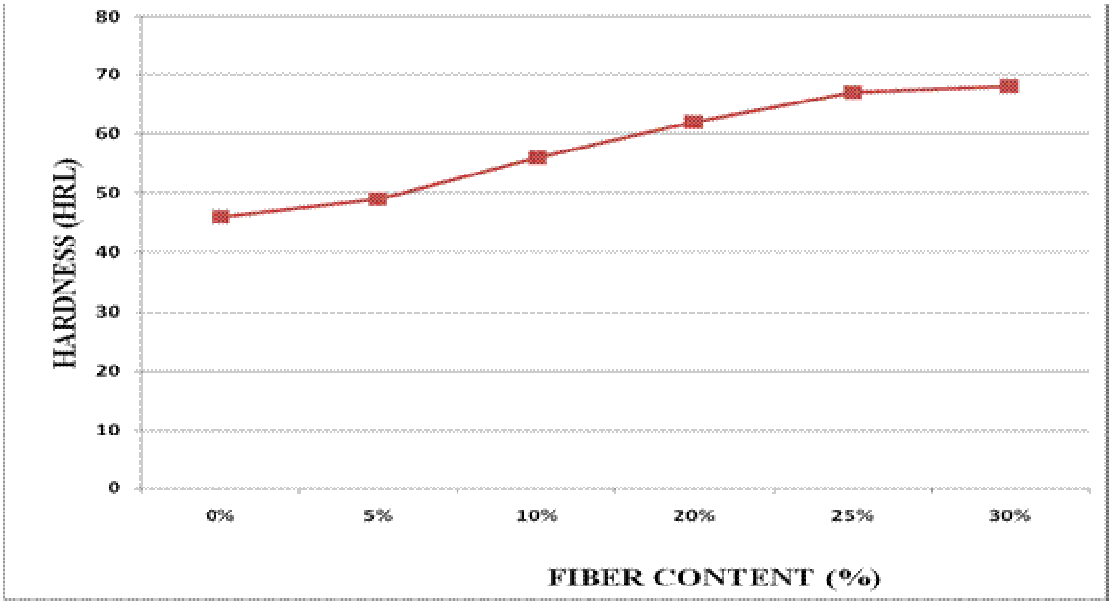

Figure 3: Effect of fiber loading on surface hardness of composite

Conclusion:
The experimental investigation on the effect of fiber loading on mechanical behavior of short bamboo fiber reinforced epoxy composites leads to the following conclusions obtained from this study are as follows:

1. The present study shows that the tensile strength of bamboo-epoxy composite increases to the certain level of fiber loading and then starts decreasing on further fiber loading. The maximum value of tensile strength is obtained at 25wt% of fiber loading.
2. The current study reveals that the flexural strength of bamboo-epoxy composite increases to the certain level of fiber loading and then starts decreasing on further fiber loading. The maximum value of flexural strength is obtained at 25wt% of fiber loading.
3. It also shows that the micro surface hardness of bamboo-epoxy composite improves till 25wt% of fiber loading and after that the hardness is nearly constant.

References:

[1] Herakovich C.T., (1998). Mechanics of fibrous composites. New York: Wiley; p. 1-27.

[2] Jartiz, A.E., Design 1965, pp. 18.
[3] Berghezan, A. Nucleus, 8(5), 1966, (Nucleus A. Editeur, 1, rhe, Chalgrin, Paris 16(e).
[4] Tingju Lu, Man Jiang, Zhongguo Jiang, David Hui, Zeyong Wang, Zuowan Zhou, Effect of surface modification of bamboo cellulose fibers on mechanical properties of cellulose/epoxy composites, Composites Part B: Engineering, Volume 51, August 2013, Pages 28-34.
[5] Yanjun Li, Lanxing Du, Chi Kai, Runzhou Huang, Qinglin Wu, Bamboo and high density polyethylene composite with heat-treated bamboo fiber: Thermal decomposition properties, Volume 8, Issue 1, 2013.
[6] Netra L. Bhandari, Sabu Thomas, Chapal K. Das and Rameshwar Adhikari, Analysis of morphological and mechanical behaviours of bamboo flour reinforced polypropylene composites, Nepal Journal of Science and Technology Vol. 13, No. 1 (2012) 95-100.
[7] Prity Aniva Xess, Erosion wear behaviour of bamboo fiber based hybrid composites, M. Tech. Thesis submitted to National Institute of Technology, Rourkela, 2012.
[8] Suyash Sahay, A study on the effect of chemical treatment on the mechanical behaviour of Bamboo-Glass Fiber Reinforced Epoxy based hybrid composites, National Institute of Technology, Rourkela, 2012.
[9] Sanjay K. Chattopadhyay, R. K. Khandal, Ramagopal Uppaluri, Aloke K. Ghoshal, Bamboo fiber reinforced polypropylene composites and their mechanical, thermal, and morphological properties, Journal of Applied Polymer Science, Volume 119, Issue 3, Pages 1619-1626, 5 February 2011.
[10] A. V. Ratna Prasad, K. Mohan Rao, Mechanical properties of natural fiber reinforced polyster composites: Jowar, Sisal and Bamboo, Materials & Design, Volume 32, Issue 8-9, September 2011, Pages 4658-4663.
[11] V. Kumar, Pradeep K. Kushwaha, Rakesh Kumar, Impedance-spectroscopy analysis of oriented and mercerized bamboo fiber-reinforced epoxy composite, Journal of Materials Science, May 2011, Volume 46, Issue 10, pp 3445-3451.