JOURNAL OF ADVANCEMENT IN
ENGINEERING AND TECHNOLOGY

Journal homepage: http://scienceq.org/Journals/JAET.php

Research Article Open Access

Bamboo Fiber Based Polymer Composites Synthesis Mechanical Characterization

M.Ramarao[1], A.Ravi Kiran[2] ,G.Mallikharjuna[3], B.Jamal Vali[4], J.V.Mohanachari[5]

[1]Dept. of Mechanical Engg.,JNTU University,Ananthapuramu ,Andhra Predesh,INDIA
[2]Dept of Mechanical Engg .CV Raman Engineering College ,Andhra Predesh,INDIA
[3] Dept of Mechanical Engg,Bheema Institute Of Technology,Adoni Andhra Predesh,INDIA
[4]Dept. of Mechanical Engg., Vasavi Polytechnic College ,Banaganapalle, Andhra Predesh,INDIA
[5]Dept. of Mechanical Engg.,JNTU University,Ananthapuramu, Andhra Predesh,INDIA

*Corresponding author: J.V.Mohanachari, E-mail: mohan.chary320@gmail.com

Received: December 12, 2017, Accepted: January 10, 2018, Published: January 10, 2018.

ABSTRACT

Now-a-Days dynamic world can't predict its development without bringing the concept of advances in material composition. So many Investigators are focussing their on in this field to achieve the desired standards. Fiber which is reinforced naturally in polymer composite gives a Greater tendency to replace the composite made up of synthetic fiber. This is primarily because of the advantages like light weight, non-toxic, non-abrasive, easy availability, low cost, and biodegradable properties. The synthetic fibers have higher end of mechanical properties like tensile strength and tensile modulus however the specific mechanical properties like specific tensile modulus and other specific properties (properties/specific gravity) of natural fiber gives a satisfying result for composites as compared to synthetic fiber based composites. The objective of the present study is to investigate the mechanical behaviour of short bamboo fiber reinforced epoxy based composites. Bamboo fibers with different length and contents are reinforced in epoxy resin to fabricate composite materials. The effect of fiber length and content on the mechanical behaviour of composites is studied.

Keywords: *Bamboo sticks, Epoxy Resin, Tensile test, Izod Impact Test, flexural test.*

INTRODUCTION

Composite material is the combination of two or more materials which give sbetter resukts when compared to individual. based on matric composites are classified into several types such as metal matrix composites, polymer matrix composites and ceramic matrix composites etc. In fiber reinforced polymer composite, the fiber used may be of different size [1]. Depending upon the application and the type of property to be imparted to the composite, size of fibers is accordingly determined. In fiber reinforced polymer composite, the reinforcing can be either of fibrous or can be non-fibrous. If the fiber used in the composite is derived from the natural resources like animals or plants, then the fiber is said to be natural fiber and the composite is said to be natural fiber reinforced polymer composite. Many a times, it does happen that the mechanical behaviour of a NFPCs do not gives a convincing result and have shown inconsistent values in many cases [2-5]. Lack of sufficient data for such fibers and their irregular characteristics are the prime reason behind this. On the other hand, there are several issues related to the natural fiber which wills to bring a full stop to the research going on in this field. But even though researchers have shown their benchmark contribution to this challenge and have become successful at many steps. The biggest challenge with the use of natural fiber is that these fibers are hydrophilic in nature i.e. they are moisture loving while many polymers are hydrophobic (moisture hating). Hence it has always been source of hindrance offered by natural fiber against its proper adherence with the matrix composite.

The mechanical behavior of the NFPCs are mostly influenced by the large number of parameters like volume fraction of fibers, fibers length, fibers aspect ratio, fiber-matrix adhesion, fiber orientation, and stress transfer at the interface. Hence to improve the overall mechanical behaviour of the composites, the properties of matrix and fibers have to be improved first. Several investigations have been made on various natural fibers such as hemp, kenaf, flax, jute and bamboo to study the effect of these fibers on the mechanical and physical strength of composite materials [6-9]. Better the bonding at the interface between the fibers and the matrices better is the mechanical behaviour of the composite. Since the load can be easily transfer to the fibers by the matrix [10]. It has been reported by few investigators that the mechanical properties of the composites get improved with increment in interfacial strength [11-13]. Bamboo finds its application in composite materials in several forms. These forms range from short bamboo fiber to long strips including the whole bamboo. Researchers have expanded their interest in the product development by using the usage of raw materials like bamboo fibre which is stronger as well as can be utilized in generating high end quality sustainable industrial products [14]. The impact strength of a composite when reinforced with a short bamboo fiber has been studied by several investigators for different fiber length and fiber content and optimum property has been reported [15].

Studies on characterised short sisal and coconut fibers composites as well as sisal fabric composites using compact tension specimens have been made. It was found that increasing fiber content increased fracture toughness of the composites [16]. Reinforcement of matrix with these short natural fibers increases the fracture toughness of the composites significantly [17]. Three different types of natural fibers coir, sugarcane bagasse and banana fibers were studied and it was found that all of these composites have their fracture toughness increased. Coir and sugarcane bagasse fibers reinforcement improved the fracture toughness by 15.7%, and 17.8% respectively. Polyester

reinforced
with short bamboo fibers ranging from 10 to 50, 30 to 50 and 30 to 60 vol% at increments of 10 vol% for bamboo fibers at 4, 7 and 10mm length respectively was studied. The increment in fiber content deteriorates the fracture toughness at 4mm of fiber length. Positive effect of fiber reinforcement was observed for 7 and 10mm fibers length. The optimum fiber content is found to be at 40 vol% for 7mm fiber and 50 vol% for 10mm fiber. The highest fracture toughness was achieved at 10 mm/ 50 vol% fiber reinforced composite, with 340 % of improvement compared to neat polyester [15].

The effect of short fiber on mechanical behaviour of composite has been studied by few investigators. The effect of chemical treatment on mechanical behaviour of banana fiber reinforced polyester composites has been studied and reported that the mechanical properties of different alkali treated banana fiber composites showed improved fiber matrix interactions [18]. Short sisal fiber reinforced with LDPE has been studied and it was shown that the tensile properties of the sisal-LDPE composites was enhanced [19]. Chemically treated natural fiber reinforced thermoplastic composites offered enhanced mechanical and physical properties under extreme conditions. Tensile properties such as tensile strength and tensile modulus of chemically treated short sisal fiber reinforced composites with different fiber loading has been studied [20]. Jute fibers are found to be very good in enhancing the fiber matrix adhesion and thus mechanical properties in jute fiber reinforced PP composites [21]. Impact behaviour of natural fiber reinforced polymer composites has been studied by few investigators [22-23]. Physical and mechanical properties of sisal fiber reinforced epoxy composites were reported by Bisanda and Ansell [24]. Yang et al. [25-26] have studied mechanical properties and morphology of thermoplastic polymer composites filled with rice husk flour.

3. PREPARATION OF THE COMPOSITES:

Dry bamboo fibers were bought from the local market, Tadipatri in the form of long strip with an average width of about 10mm. The fibers were then further left to be died for a week. After a week, the fibers of three different lengths i.e. 4mm, 7mm and 10mm and a width of approx. 3mm were cut manually. Epoxy Resin and the hardener (HY 951) were supplied by Ciba Geigy India Ltd. A wooden mould having a dimension of 200 × 200 × 40 mm3 was used for composite fabrication. Composites with three different wt.% (10wt.%, , 20wt.% and 30wt.% of fiber with length of 4mm, 7mm and 10mm was taken for the composite fabrication. The weighed epoxy and hardener is first manually stirred with a glass rod followed with an addition of weighed fiber. The fiber and epoxy resin is thoroughly stirred to make sure there is no air bubble trapped in the mixture. The mixture was then poured on a relieving sheet which was already placed in a mould. The mixture was uniformly distributed over the inner surface of the mould and then closed by another relieving sheet on its top. The mould was then closed and a constant dead load of 50 kg was put on the mould for the purpose of curing to enhance the mixture to take the desired shape of mould. The load was left for 24 hours and then released. The composite thus obtained was further allowed to be cured in air for another 24 hours.

Table 1: Composition and designation of fiber reinforced composites

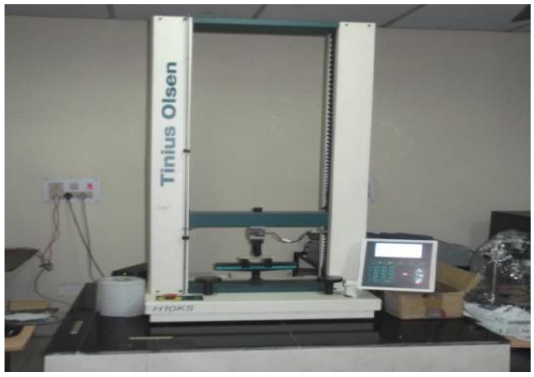
Type	Composition
CASE-1	Epoxy(85wt%)+ Short bamboo fiber of length 6mm (15wt%)
CASE-2	Epoxy(70wt%)+ Short bamboo fiber of length 6mm (30wt%)
CASE-3	Epoxy(55wt%)+ Short bamboo fiber of length 6mm (45wt%)
CASE-4	Epoxy(85wt%)+ Short bamboo fiber of length 8mm (15wt%)
CASE-5	Epoxy(70wt%)+ Short bamboo fiber of length 8mm (30wt%)
CASE-6	Epoxy(55wt%)+ Short bamboo fiber of length 8mm (45wt%)
CASE-7	Epoxy(85wt%)+ Short bamboo fiber of length 12mm (15wt%)
CASE-8	Epoxy(70wt%)+ Short bamboo fiber of length 12mm (30wt%)
CASE-9	Epoxy(55wt%)+ Short bamboo fiber of length 12mm (45wt%)

3.1. polymer matrix composite

4. EXPERIMENTATION

After the fabrication of bamboo reinforced epoxy based polymer composite, the sample of appropriate dimension were prepared to carry out various tests like tensile strength test, flexural strength test, micro hardness test and Impact test under ASTM standards. The tensile strength and flexural strength test were carried out using instrument TINIUS OLSEN H10KS (Figure 3.2). Both of these tests are carried out on flat specimen. A uniaxial load is applied to the specimen in both the direction of the specimen, finally leading to the failure of the specimen after ultimate stress. The ASTM standard test method for tensile properties of composites has the designation D 3039-76**.** Micro hardness test

was carried out by using the instrument named LECO hardness tester. The test is commonly known as Vicker's Micro hardness test. The specimen used in this case is also of flat shape. A diamond indenter of right pyramid shape with a square base and an angle of 1360 between two opposite faces are forced into the material under a load, F kgf. After indentations (rhombus shape) produced by the indenter on the specimen, both the diagonals are measured and hardness value is thus calculated. The load considered in the present study is 0.1 kgf. Impact
strength of a material is defined as the property of a material by virtue of which the material opposes it fracture under stress applied at high speed. Impact strength of a polymer composite material is entirely related to its toughness as a whole.



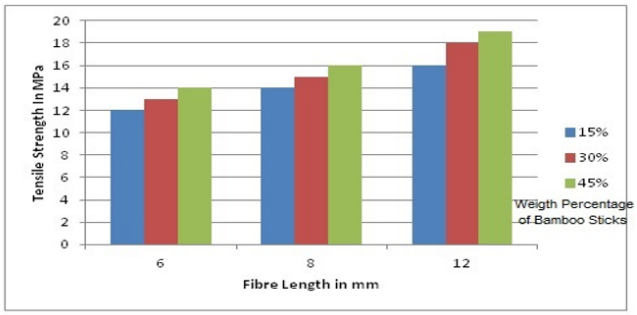
4.1Experimental setup for tensile strength

4.2. Rockwell hardness Tester

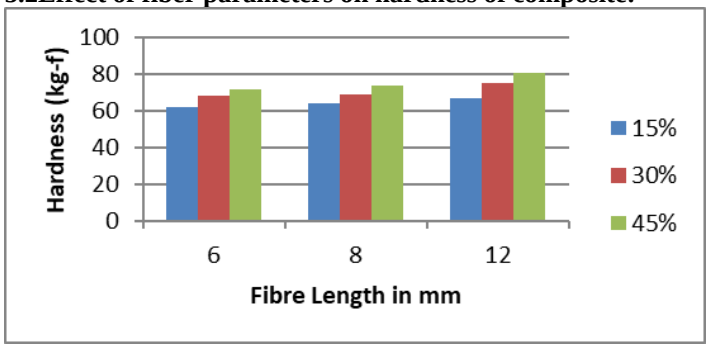
5 RESULTS AND DISUSSIONS:

Mechanical properties of bamboo reinforced epoxy based composites such as tensile strength, flexural strength, impact strength and hardness number with their varying composition are tabulated below.

5.1. Effect of fiber parameters on tensile strength of composites



5.2Effect of fiber parameters on hardness of composite:



6 CONCLUSION

Short bamboo fiber reinforced epoxy based polymer composite was fabricated and its mechanical characterization was studied. The conclusions obtained from this experimental investigation are as follows:

1. The required epoxy based bamboo fiber reinforced polymer matrix composites were prepared successfully.
2. Tensile strength, and hardness are greatly affected by the size of the fibers used.
3. The present study reveals that, tensile strength and hardness increases with increasing content of fiber in composite materials.

REFERENCES

1. Suhaily S.S, Khalil H.P.S.A, Nadirah W.O.W & Jawaid M, "Bamboo Based Biocomposites Material, Design and Applications"; pp. 492.
2. Xiao, Y, & Ma, J. Fire Simulation Test and Analysis of Laminated Bamboo Frame Building. Construction and Building Materials. (2012). , 34(0), 257-66.
3. Torres F.G., Diaz R.M., Morphological characterisation of natural fibre reinforced thermoplastics (NFRTP) processed by extrusion, compression and rotational moulding, Polymers and Polymer Composites 12 (8) (2004) pp-705–718.
4. Torres F.G., Aguirre M., Rotational moulding and powder processing of natural fibre reinforced thermoplastics, International Polymer Processing 18 (2) (2003) pp- 204–210.
5. Torres F.G., Ochoa B., Machicao E., Single screw extrusion of natural fibre reinforced thermoplastics (NFRTP), International Polymer Processing 18 (1) (2003) pp- 33–40.
6. Satyanarayana K. G, Sukumaran K, Mukherjee P. S, Pavithran C and Pillai S. G. K, "Natural Fiber-Polymer Composites", Cement and Concrete Composites, 12(2), 1990, pp. 117-136.
7. Satyanarayana K. G, Sukumaran K, Kulkarni A. G, Pillai S. G. K, and Rohatgi P. K, "Fabrication and Properties of Natural Fiber-Reinforced Polyester Composites", Composites, 17(4), 1986, pp. 329-333.
8. Mansur M .A and Aziz M. A, "Study of Bamboo-Mesh Reinforced Cement Composites" Int. Cement Composites and Lightweight Concrete, 5(3), 1983, pp. 165-171.
9. Lundquist L, Marque B, Hagstrand P. O, Leterrier Y and Månson J. A. E, "Novel Pulp Fiber Reinforced Thermoplastic Composites", Composites Science and Technology, 63(1), 2003, pp. 137-152.
10. Karnani R., Krishnan M., and Narayan R, "Biofiber –reinforced polypropylene composites" Polymer. Engineering and Science, vol 37, (1997)pp- 476.
11. Gassan J. and Bledzki A.K., "Alkali treatment of jute fibers:relationship between structure and mechanical properties" Journal of applied polymer science, (1999).vol 71, pp- 623-629.
12. George J, Bhagawan S.S, and Thomas S, (1998) "Improved interaction in chemically modified pineapple leaf fiber reinforced polyethylene composites" Composite. Interface.5, 201.

13. Bataille P, Richard L, and Sapieha S., "Effect of cellulose fibers in polypropylene composites" Polymer Composite, vol 10, (1989). pp - 103-108.
14. Khalil H.P.S.A, Bhat I.U.H, Jawaid M, Zaidon A, Hermawan D, Hadi Y.S, Materials and Design, sc 42, (2012): pp. 353-368.
15. Wong K.J, Zahi S, Low K.O, Lim C.C, Materials and Designs, Fracture characterization of short bamboo fiber reinforced polyester composites, Sc.,31 (2010): pp. 4147-4154
16. Silva RV, Spinelli D, Bose Filho WW, Carlo Neto S, Chierice GO, Tarpani JR, Fracture toughness of natural fibers/castor oil polyurethane composites, compos Sci technol 2006:66 (10): 1328-1335.
17. Biswas S, Debnath K, Patnaik A, Mechanical Behaviour of Short Bamboo Fiber Reinforced Epoxy Composites Filled with Alumina Particulate.
18. Pothan L.A., George C.N., Jacob M., and Thomas S., "Effect of chemical modification on the mechanical and electrical properties of Banana fiber polyster composite" Journal of Composite Material , Vol 41, (2007). pp-2371- 2386.
19. Joseph K. and Thomas S., "Dynamic mechanical properties of short sisal fibres reinforced low density polyethylene composite"journal of reinforced plastic and composites , 12(2) , (1993).pp-139-155.
20. Frederick TW, Norman W (2004) Natural fibers plastics and composites. Kluwer Academic Publishers, New York.
21. Liu X.Y. and Dai G.C. "Surface modification and micromechanical properties of jute fiber mat reinforced polypropylene composites" Express Polymer. Letters, vol 1, No.5 (2007) pp 299-307.
22. Wang B., Panigrahi S., Tabil L., and Crerar W, "Pre-treatment of flax fiber for use in rotationally molded biocomposites". Journal of reinforced plastic and composites., 26, (2007). pp 447-463.
23. E.S. Rodriguez, P. Stefani, and A. Vazquez, "Effects of fiber alkali Treatment on the resin transfer moulding processing and mechanical properties of jute – vinylester composites" Journal of Composite Materials vol 41, (2007).pp1729 -1741.
24. Bisanda E. T. N. and Ansell M. P. "The effect of silane treatment on the mechanical and physical properties of sisal –epoxy composites" composites science and technology , volume 41 ,Issue 2 ,1991,pp 165-178.
25. Yang, H.S., Kim, H.J., Lee, B.J. and Hawng, T.S. 2004. "Rice husk flour filled polypropylene composites; mechanical and morphological study". Composite structure. 63: pp 305-312.
26. Yang, H.S., Kim, H.J., Lee, B.J. and Hawng, T.S. 2007. "Effect of compatibilizing agent on rice husk flour reinforced polypropylene composites". Composite structure 77: pp 45-55.
27. Khanam P. Noorunnisa , Khalil H. P. S.Abdul , Jawaid M. , Reddy G. Ramachandra , Narayana C. Surya , Naidu S. Venkata, "Sisal/Carbon Fibre Reinforced HybridComposites: Tensile, Flexural and Chemical Resistance Properties" journal of polymer and the environment (2010) pp 727-733.
28. Ismail H., Edyham M.R. and Wirjosentono B., (2002). Bamboo fibre filled natural rubber composites: the effects of filler loading and bonding agent, Polym Test, vol. 21, pp. 139–144.
29. Yao W. and Li Z., (2003). Flexural behavior of bamboo-fiber-reinforced mortar laminates," Cem Concr Res, vol. 33, pp. 15–19.
30. Zhao Q., Tao J., Yam R.C.M., Mok A.C.K., Li R.K.Y., and Song C., (2008). Biodegradation behavior of polycaprolactone/rice husk eco-composites in simulated soil medium, Polym Degrad Stab, vol. 93, no. 8, pp. 1571–1576.
31. Yang H.S., Kim H.J., Son J., Park H.J., Lee B.J., and Hwang T.S., (2004). Rice-husk flour filled polypropylene composites; mechanical and morphological study, Compos Struct, vol. 63, no. 3–4, pp. 305–312.

Citation: J.V.Mohanachari *et al.* (2018). Bamboo Fiber Based Polymer Composites Synthesis Mechanical Characterization, J. of Advancement in Engineering and Technology, V6I1.01. DOI: 10.5281/zenodo.1163658.