IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X
PP. 07-11
www.iosrjournals.org

Tensile Testing of Bamboo Fiber Reinforced Epoxy Composite

R. S. Wani, R. R. Shitole
(Department of Mechanical Engineering, Vishwakarma Institute of Technology, S. P. Pune University, India)

Abstract: *In day to day life, various components are made up of plastics and metals. But these materials create environmental problems. Components made from metals are heavy. Hence, alternative materials for these materials with enhanced desired properties are required Composites have various desired properties such as strength, stiffness, corrosion resistance, etc. From thousand years, humans have used composites for various applications because of their enhanced properties. In the present work, composites were prepared with unidirectional bamboo fiber reinforced with epoxy resin. Experimental analysis of composite made from bamboo fiber and epoxy material has been carried out to study the tensile strength of the composite. Tensile test of the composite is carried out on the 10KN universal testing machine and results were obtained.*

Keywords: *Bamboo Composite, Bamboo Fiber, Modulus of Elasticity of Composite, Tensile Strength, Bamboo Epoxy reinforced Composite*

I. Introduction

In today's world plastic is widely used in every sector. Also most of the parts are made from the petroleum based product. The petroleum based products and plastic based products are creating environment problems. Because of this situation, it is essential to find out substitute materials which have comparable mechanical and thermal properties as compared to the conventional materials.

Composite materials are light in weight but they have high strength. Because of higher specific strength stiffness and fatigue characteristics, natural fiber composites are good alternatives for the conventional plastic, metal and petroleum based materials. Various composites are made from carbon, graphite and glass. Because these composites has better mechanical properties as compared to other composites. Also these composites are easy to manufacture. Hence because of the advantages, these composites are investigated widely. But there are few disadvantages. These fibers do not degrade and hence they create environmental problems. Because of these disadvantages, scientists are researching to replace these fibers by natural fibers [1].

India is bestowed by large availability of natural fiber such as bamboo, jute, banana, coir, etc .Bamboo has good overall mechanical properties as compared to wood. Bamboo becomes mature in 3-4 years. Also bamboo root grows the new sprouts even after cutting of bamboo, hence once bamboo is planted, it does not need to be planted again [2].

Various composite materials are made from natural fibers. Since natural fibers are renewable, composites made from natural fibers lead to low cost of components [3]. Initial cost of synthetic fibers is very high as compared to natural fibers, also synthetic fibers create the environmental problems [4]. Due to higher cost of conventional raw materials, scientists are researching the composites made from natural fibers such as bamboo, jute, coir, banana, etc [5]. This paper reports the evaluation of mechanical properties of composite like tensile strength. Bamboo strips are used as a reinforcing material in the composite.

II. Material And Methodology

Composite is a material which is composed of two or more material at a microscopic scale and has chemically distinct phases.

2.1Fiber: Fiber is a reinforcing material of the composite. Its role is to increase the mechanical properties of the composite. Fiber is stronger and harder as compared to matrix material. Fibers are discontinuous unlike matrix. In the present work, short bamboo strips are used as a fiber material. They were arranged from the local market. Bamboo has better strength along axial (fiber) direction as compared to transverse direction of the fiber.

DOI: 10.9790/1684-17010050711

Fig 1. Bamboo Fiber

2.2 Matrix: Matrix is a material which holds the fibers together. It protects the fibers from environment and abrasion with each other. Matrix distributes the loads evenly between the fibers. It helps to maintain the distribution of fibers and provides better finish to final product. In the experiment epoxy resin is used as a matrix material. Modulus of elasticity of epoxy resin is 3700 MPa.

2.2.1 Hardener: Hardener is used to cure the epoxy resin. Generally, it is mixed with epoxy resin at normal atmospheric temperature. Epoxy resin is cured by mixing it with hardener in equal amounts. Hardener is available in liquid form. When epoxy resin and hardener are mixed together, chemical reaction takes place and because of which, mixture starts to harden.

2.3 Preparation of Composite: Composite laminate was prepared by conventional hand lay-up method. The mould frame was made from steel angle sections having dimensions 350mm×330mm×20mm which was laid on top plastic sheet and artificial clay was used to seal the space between them to prevent leakage of resin material out of the mould. One layer of fiber strips was laid down in the mould and they were coated with epoxy resin mixed with hardener. On top of which, another layer of fiber strips were laid down and process was repeated until the required thickness of the composite was achieved. A dead weight of 10 Kg was placed on the prepared laminate so as to remove any porosity or air bubbles.

Fig 2. Composite Lamina

2.4 Preparation of Specimens: Water jet machining was used to prepare the specimen. The specimens were created according to ASTM D638-02a standard [7].

DOI: 10.9790/1684-17010050711

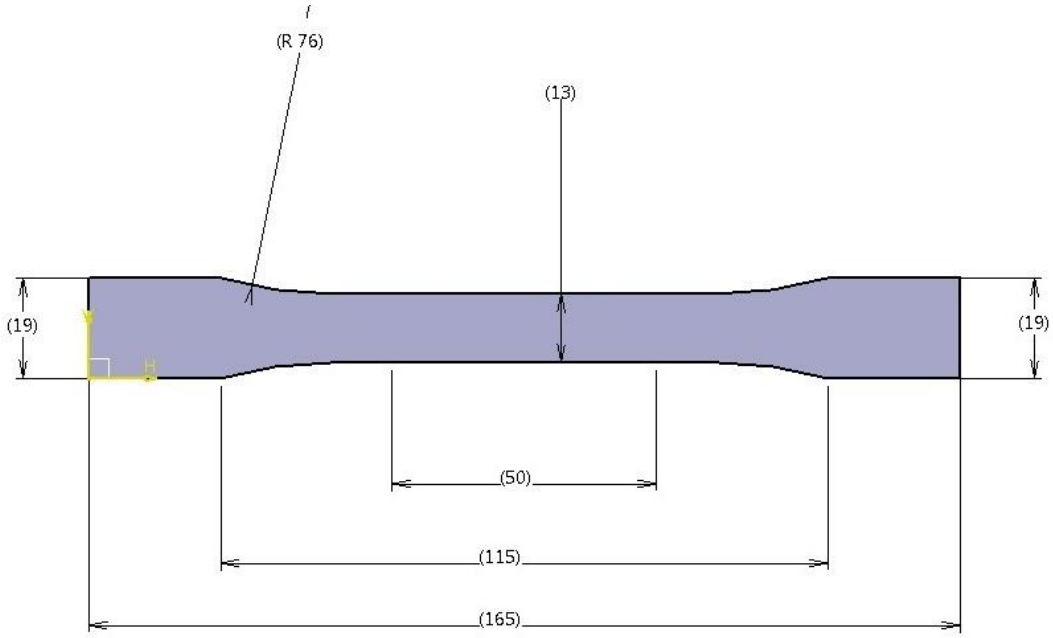

Fig 3 Drawing according to ASTM D638-02a Standard

Fig 4. Test Specimen

III. Testing Of Composite

Tensile tests of the specimens were carried on 10kN universal testing machine. These specimens were loaded at the strain rate of 10mm/min. These tensile tests were carried at Praj Metallurgical testing laboratory in Pune.

IV. Results And Tables

The thickness of bamboo strips used was 0.4mm. Three layers of bamboo strips were used in the composite. Volume fraction of bamboo fibers was found out to be 0.2. The tensile strength of bamboo fiber strips in the fiber direction is 230 MPa. Modulus of elasticity of bamboo fibers is 2480.26 MPa. The tensile strength of bamboo reinforced epoxy composite was found out to be 26.417 MPa.

Theoretical value of modulus of elasticity of BREC was calculated by using the formula $E_c = E_f V_f + E_m (1 – V_f)$

Modulus of elasticity of BREC was calculated analytically with the help of above formula and the value was found out to be 3456.052 MPa. Modulus of elasticity of BREC was calculated experimentally with the help of graph and it was found out to be 2934.5122 MPa.

DOI: 10.9790/1684-17010050711

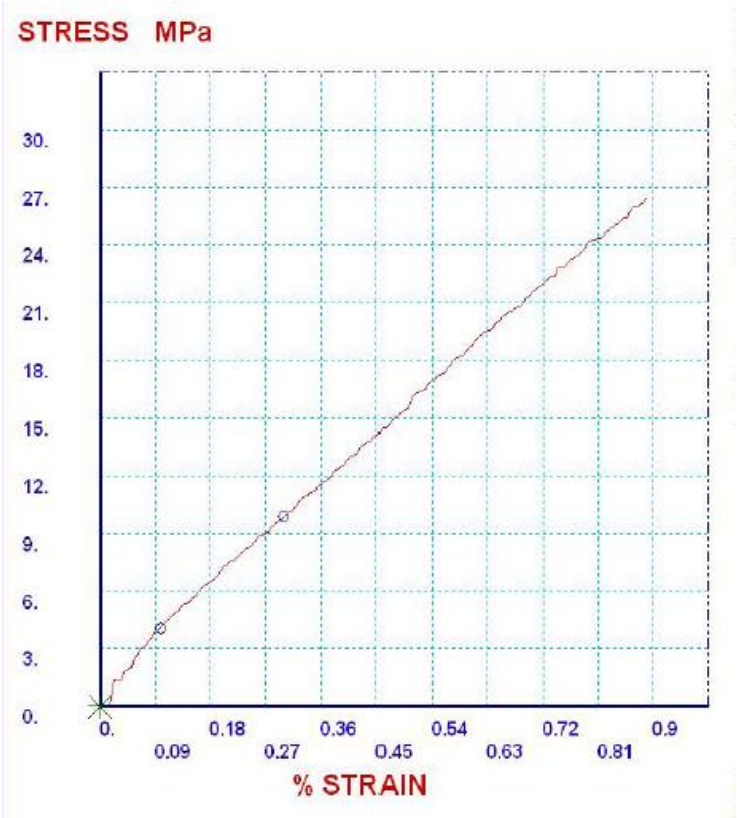

Fig. 5 Stress Vs Strain Graph of BERC

Tensile strength of BERC specimen was carried out on 10KN universal testing machine from which above graph of stress and strain was obtained. From this graph, two yield points were choosen and the modulus of elasticity of BERC was obtained.

Table 1. Experimental properties of composite

Specimen	Ultimate Force (kN)	Tensile strength(MPa)
Bamboo Fiber Epoxy Composite	2.4	26.417
Glass Fiber Epoxy Composite [6]	2.125	16.87

Table 2.Result

Property	Values
Volume fraction of composite	0.2
Modulus of elasticity of fiber	2480 MPa
Modulus of elasticity of epoxy	3700 MPa
Analytical modulus of BREC	3456 MPa

V. Conclusion

From this work, following conclusions are derived

1) Experiment was carried out on bamboo epoxy reinforced composite and it is found that its tensile strength is 26.417 MPa at 2.4 kN.
2) From the above discussion, it is clear that volume fraction is the deciding factor to achieve desired properties of the composite.
3) In the above experiment, the volume fraction of fiber was only 20%, but still the composite carries sufficient amount of load.
4) By increasing the volume fraction of fiber it is possible to increase the tensile property of composite.
5) It is assumed that, composite is free of voids. But in reality, there are few voids present in the composite. Hence theoretically calculated value of modulus of elasticity is greater than the practically calculated value. In this case, theoretical Modulus of elasticity is 3456 MPa, while practical Modulus of elasticity is 2930 MPa. Percentage error is less than 15% between theoretical and practical value.

 DOI: 10.9790/1684-17010050711

6) When compared with the glass epoxy reinforced composite it is found that bamboo composite can sustain more load than glass epoxy composite, so it is possible to replace glass fiber with bamboo fiber.
7) Also, by simple hand lay-up method it is possible to make composite very easily as compared to the other expensive methods.

References

[1] Parnia Zakikhani, R. Zahari, M.T.H. Sultan, D,L. Majjid, Extraction and preparation of bamboo fiber-reinforce composites, *Materials and design 63 (2014) 820-828.*
[2] S.A.H. Roslan, Z.A. Rasid, M.Z. Hassan, The natural fiber composites based on bamboo fibers; A review, *ARPN journal of engineering and applied science, Vol. 10, No. 15, Aug 2015.*
[3] Kannan Rassiah, M.M.H Megat Ahmad, A review on mechanical properties of bamboo fiber reinforced polymer composite, *Australian journal of basic and applied science, 7(8): 247-253,2013.*
[4] S. Sreenivasusu, Dr. A Chennakeshava Reddy, Mechanical properties evaluation of bamboo fiber reinforced composite material,, *International journal of engineering research, Vol.3, 187-194,march 2014.*
[5] Honey Banga, V.K. Singh, Sushil Kumar Choudhary, fabrication and study of mechanical properties of bamboo fiber reinforced bio-composite, *Innovative system design and engineering, Vol. 6, No.1, 2015.*
[6] Amit Kumar Tanwer, Mechanical properties testing of uni-directional and bi-directional glass fiber reinforced epoxy based composites, *International journal of research in advent technology, Vol. 2, No. 11, Nov 2014.*
[7] ASTM D638-02a Standard.
[8] Material Science advanced topics by S. Siti Suhaily, H.P.S. Abdul Khalil, W.O. Wan Nadirah and M. Jawaid.

 DOI: 10.9790/1684-17010050711