

Experimental Investigation of Tensile Properties of Bamboo Reinforced Epoxy Composites

Ajitnath P¹, Syed Abbas Ali², Altaf Hussain Bagwan³, Mohammad Shakir M Attar⁴,

M. Tech. Student, Department of Mechanical Engineering, SECAB IET, Vijaypur, Karnataka, India¹

Associate Professor, Department of Mechanical Engineering, SECAB IET, Vijaypur, Karnataka, India²

Assistant Professor, Department of Mechanical Engineering, SECAB IET, Vijaypur, Karnataka, India²

ABSTRACT: Bamboo is the one of naturally available material which can be used in composites. Bamboo fibre have tremendous properties like high tensile strength, less water absorption capacity there by less swelling, easily available in less price compared to other fibres more importantly it is renewable source of fibres. In this work, composite material has been developed with the use of natural fibres and renewable source of fibres and investigated the tensile properties of bamboo reinforced epoxy composite for different orientations. It is observed that bamboo fibres have direct effect on tensile strength and tensile strength is more when it is loaded along the length of fiber and it becomes weak when it is loaded perpendicular to the length of fiber and thus one can say that fibres are direction oriented. Further, the tensile strength increased as the fiber diameter increases.

KEYWORDS: Bamboo Fibre, High Strength, Composite Materials, Tensile Strength.

I. INTRODUCTION

Composite material made up of two or more chemically different materials, on a macro-scale, having a different separating interface between them. One or more discontinuous phases are embedded in a continuous phase to form a composite. The discontinuous section is typically tougher and stronger than the continual section and is termed the reinforcement, whereas, the continual section is termed as the matrix. A tougher material will offer superior and distinctive mechanical and physical properties as a result of it combines the foremost fascinating properties of its constituents where as suppressing their least fascinating properties. At this time composite materials play a key role in part business, industry and alternative engineering applications as they exhibit outstanding strength to weight and modulus to weight magnitude relation. High performance rigid composites made up of glass, graphite, Kevlar, and carbide fibres in chemical compound matrices are studied extensively owing to their application in part and vehicle technology.

Existing composites available from research and innovation from last several years have growing from automobile bodies glass fiber to aerospace particulate composite. The growing familiarity of composite materials is ever-increasing with varieties of applications. Loose sentence like “materials composed of two or more distinctly identifiable constituents” are used to explain eco friendly composites like timber, organic materials, like tissue surrounding the skeletal system, soil aggregates, minerals and rock.

Composites made of two heterogeneous structures to meet the requirements of predefined function, available with desired properties which give the scope for classification. However new varieties of composites are designed and developed all the time, each with their specific functions like the filled, flake, particulate and laminar composites. The best example of modern-day composite materials is fibres embedded in matrix of another material. When different layers of composite materials gives specific characters of the composite material serves intended function is called laminated composites. Reinforcing materials made to withstand load and serve the predefined functions. Further, even though composites can be distinguished from one other, but no clear prediction can be made. To provide definition, the intension is often shifted to microscopic or macroscopic views.

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For matrix-based composites, the matrix exhibits two important functions. They are binding the fibres and deforming to divide the stresses to all fiber materials when load is applied. The matrixes have the temperature variations, they may be conductors or insulators of electricity and heat, have sensitivity to moisture etc. This gives weight advantages, ease of handling. Solids provide room for stress to incorporate other constituents provide strong bonds for the reinforcing phase are potential matrix materials. In the preparation of composites for structural purpose, few polymers and metals have properties to play the role as matrix materials. These materials resist the loading elastically until the failure point when loaded in tension and compression. The zone of contact between the fiber and the matrix materials is called interface.

Bamboo Fibres:

The uses of chemically prepared industrialized product for composites which are effect the environment in rural area even in small towns when these products are disposed off. In this view it is good practice to use ecological renewable materials like rice husk, fibres of coconut, sisal etc. so Bamboo is the one of naturally available material which can be use in composites. Bamboo fibre have tremendous properties like high tensile strength, less water absorption capacity there by less swelling, easily available in less price compared to other fibres more importantly it is renewable source of fibres.

Bamboo is available abundantly in tropical and subtropical regions. Bamboo fibres have comparable energy required to produce 1m^3 per unit stress in steel or concrete. In production of bamboo fibres requires 50 times less energy than spent in production of steel fibres. The bamboo fibres can attain relatively high tensile strength which is about 370MPa. This is why steel fibres can be replaced by bamboo for composite subjected tensile loading. The ratio of tensile strength to specific weight of steel fibre is six times less than bamboo. The other properties of bamboo fibres like modulus of elasticity and density etc

Bamboos are not trees they are giant grasses. They belong to the family of the Bambusoideae. The bamboos are in the shape of cylindrical shell divided by diaphragms at the nodes in transverse direction.

Bamboos have high strength along axis of the fibres and low strength normal to the axis of fibres respectively. Bamboo is composed of ligneous matrix covers the long and parallel cellulose fibres.



Figure (1) Bamboo fibres

LITERATURE SURVEY:

Different literatures on bamboo reinforced epoxy composites will be discussed carried out previously is bieng discussed in this section.

E.Trujill and L.Osorio (2010), Carried out the research work on improvement of bamboo used polymer composites and its properties. Their study reveals untreated unidirectional bamboo composites show good flexural strength and also, alkali treatment at low concentrations benefits the stiffness of the composite. For Unidirectional (UD) bamboo fibre thermoplastic composites, flexural tests for two different fibre orientations were performed. Material performance was acceptable, but further work is required to improve fibre-matrix interfacial strength also studied the tensile properties for single bamboo fibres at four different span lengths after machine compliance correction, show that the specific E-Modulus can compete with glass fiber. They shown untreated unidirectional bamboo epoxy composites show good

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flexural strength and also, alkali treatment at low concentrations benefits the stiffness of the composite. According to them, flexural stiffness and strength for untreated EBFC were very close to what could be expected based on single fibre properties. This also shows that the interface for untreated bamboo fibres with epoxy is quite good; this was confirmed by a relatively high transverse flexural strength. The significant increase in modulus for TBFC indicates better wetting and increased effectiveness of the fibres, but it is not necessarily an improvement in interfacial bond strength. To obtain the potential of bamboo fibre composites, further work is required to improve the compatibility [5]. Bhat et. al., (2012), discussed about the bamboo fibres reinforced bio composites. The paper gives details of the today's improved developments of bamboo fibre composites. The total opinion of main results presented in literature, looking at the methodology and ultimate properties of bamboo fibres with polymeric matrices and uses in cost effective products and also study is conducted on adhesivewear and friction characteristics of bamboo fibre reinforced epoxy composites and found that wear characteristics of bamboo reinforced epoxy resin composites had good wear resistance. The friction characteristics of bamboo reinforced epoxy composite was increased by about 44% at less sliding velocity of non-parallel direction as compared to the more sliding velocity. The use of bamboo fibre for preparation of bio composites by using emerging technology changes future of new generation. The products properly designed from the bamboo fibre plays predominant role in making new invention to use natural materials. Based on this review of the bamboo fibres can be used for emerging engineered product development for variety of applications. It will be other way for prepare the natural composite it can be specifically used for day to day needs of human for endless applications.

Sandhyarani B (2013), studied the erosion wear characteristics of copper slag reinforced with short bamboo fiber. In this paper author attempted to explore the potential use of bamboo fiber in polymer matrix composites. Due to environmental factors, new ways of using different metal industry slags are being explored in order to protect the environment and to give useful methods for their utilization and disposal. Copper slag is produced as a by-product while smelting and refining of copper. It is having large quantity of various metal oxides; it has all the potential which is required for the good filler material in polymer composites. Hence, this work is carried out towards the erosion wear behavior of copper slag reinforced with short bamboo fiber. It also highlights a methodology of Taguchi's experimental design approach to do the analysis of erosion properties. This study shows the semi-ductile response for all composites irrespective of copper slag content.

II. METHODOLOGY AND MATERIALS

Material required for the preparation of mould box is explained below

Extraction of Fibres

The following steps are followed to extract the fibres

1. Firstly the bamboo samples are collected from black soil area
2. After drying the bamboo samples for two to three days in sunlight then the fibres are extracted.
3. Further fibres are dried to remove out the moisture content in it.
4. Fibres are then weighed in the weighing machine.

Preparation of Mould Box

- Firstly plywood is collected and cut into required dimensions.
- Mould box are prepared according to dimensions.

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Figure2: Extracted fibres



Figure 3:Mould boxes

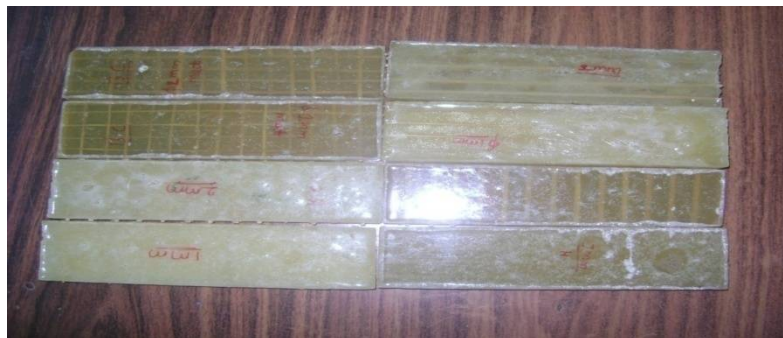


Figure 4: Epoxy reinforced bamboo composite specimens



Figure 5: 1 mm longitudinal specimen.

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Preparation of specimen

- Fibres are arranged in the mould box in longitudinal, lateral, mating (1mm, 2mm, 3mm).are weighed once again.
- Epoxy resin and hardener which acts as reinforcement material are taken in jar. And mixed in the ratio 2:1.
- Mixture is introduced into mould box and filled up to certain desired level.
- Then they are dried for 2 days and removed carefully through mould boxes.

Preparation of 1mm longitudinal specimen

- Fibres of 1mm thickness are arranged in longitudinal direction in mould box, mould box weight with fibres is noted down.
- Specified quantity of epoxy and hardener are taken into jar and mixed well.
- Mixture is introduced into mould box and filled up to certain desired level.
- It is made to dry for 2 days and specimen is obtained. Similarly for 2mm, 3mm longitudinal specimens.

Preparation of 1mm lateral specimen

- Fibres of 1mm thickness are arranged in lateral direction in mould box,mould box weight with fibres is noted down.
- Specified quantity of epoxy and hardener are taken into jar and mixed well.
- Mixture is introduced into mould box and filled up to certain desired level.
- It is made to dry for 2 days and specimen is obtained. Similarly for 2mm, 3mm lateral specimens.

Preparation of 1mm matting specimen

- Fibres of 1mm thickness are arranged in longitudinal & lateral (matt) direction in mould box, mould box weight with fibres is noted down (195.5gms).
- Specified quantity of epoxy and hardener are taken into jar and mixed well.
- Mixture is introduced into mould box and filled up to certain desired level.
- It is made to dry for 2 days and specimen is obtained. Similarly for 2mm matting specimens.



Figure 6:Preparation of 1mm lateral specimen

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Figure 7: Preparation of 1mm matt specimen

Water Absorption Test

This test is carried out to know the water absorption capacity of bamboo fibres.

- Firstly various bamboo samples are collected & weighed independently in digital weighing machine. Bamboo samples of length of 10 and 20 mm.
- Then the bamboo samples are heated (dried) in oven to remove out moisture content in it. Carried out at 70°C about 40 min. Then samples are weighed once again. Bamboo samples of length of 10 and 20 mm.
- Then the samples are further treated with water or bamboo fibres are submerged in water container and maintained it for 3 hours at room temp and removed from it and weighed. Bamboo samples of length of 10 and 20 mm.
- The samples are further tested for submerging it for 5 hours and weighed. Bamboo samples of length of 10 and 20 mm.



Figure 8: Digital weighing machine and soaked fibres in water

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III. RESULTS AND DISCUSSION

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Eight specimens of bamboo reinforced epoxy composites of different diameters ranging from 1mm to 3mm with an interval of 1 mm have been prepared. Further, the longitudinal, lateral and matting arrangement has been done to carry out the tensile test. UTM has been used to carry out the tensile test.

1. **Effect of loading on bamboo fibres longitudinal arrangement:** Figure 9 gives the stress v/s strain diagram for longitudinal arrangement bamboo fibres reinforced with epoxy composites for different diameters of 1mm, 2mm& 3mm. It is observed from the Figure 9 that, stress is increasing as the strain is increasing for different diameters. Further, if the diameter of fiber increases, tensile strength is also increases which intern reveals that there is a definite effect of volume fraction of fibres. The tensile strength is also increases with increase in volume fraction. As the young's modulus decreases maximum deformation increases but the nature of graph remains same.
2. **Effect of loading on bamboo fibres lateral arrangement:** Figure 10 shows the stress v/s strain diagram for lateral arrangement bamboo fibres reinforced with epoxy composites for different diameters of 1mm, 2mm& 3mm. It is observed from the Figure 10 that, stress is increasing as the strain is increasing for different diameters. Further, as the diameter of fiber increases, tensile strength is also increases which intern reveals that there is a definite effect of volume fraction of fibres. As the volume fraction increases, the tensile strength is also increases. As the young's modulus decreases maximum deformation increases but the nature of graph remains same.
3. **Effect of loading on bamboo fibres matting arrangement :** Figure 4.5 shows the stress v/s strain diagram for matting arrangements of bamboo fibres reinforced with epoxy composites for different diameters of 1mm, 2mm& 3mm. It is observed from the Figure 11 that, as the diameter of matting fibre increases tensile strength decreases which in turn reveals that usage of excess fibres in the composites certainly reduces tensile strength of composites.
4. **Effect of loading on bamboo fibres longitudinal, lateral and matting arrangements:** Figure 12 shows the stress v/s strain diagram for diameter of 1mm longitudinal, lateral & matting of bamboo fibres reinforced with epoxy composites in which the loading is done along the length of the composite. The Figure 12 clearly shows that fibres are direction oriented i.e. strength of fibres are more in the direction of loading. However the nature of graph is remains same.

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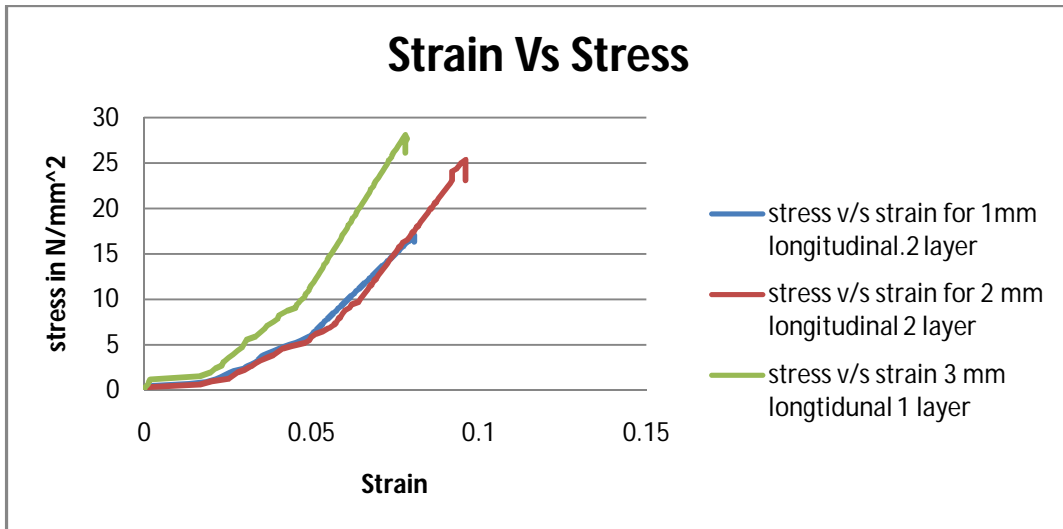


Figure 9:Loading on longitudinal fibres

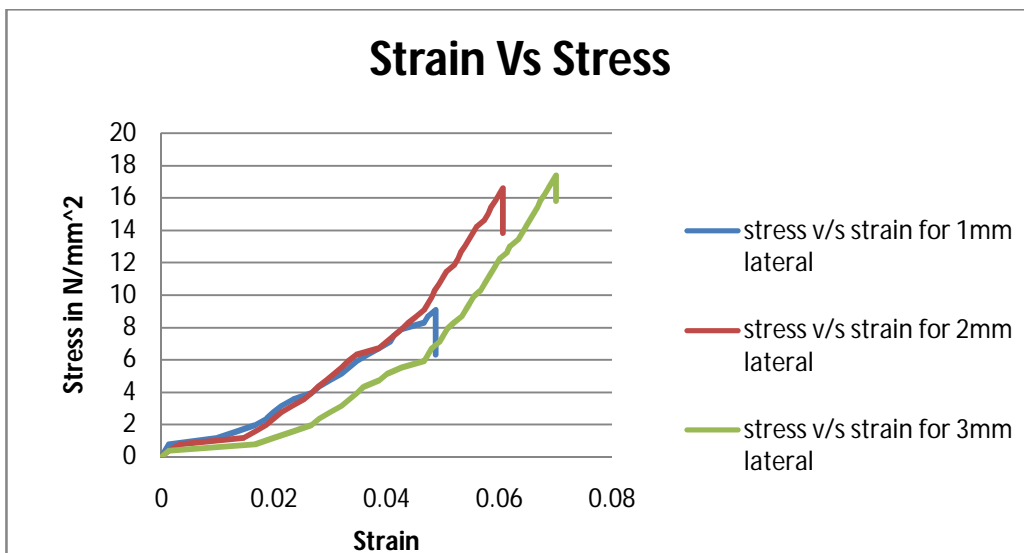


Figure 10 loading on lateral fibres

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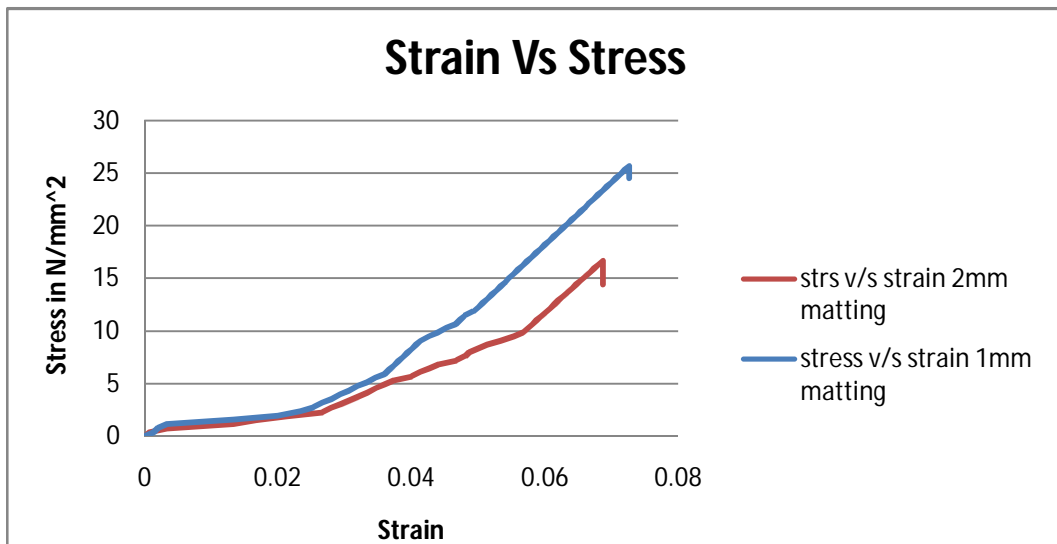


Figure 11: Loading on matted fibres

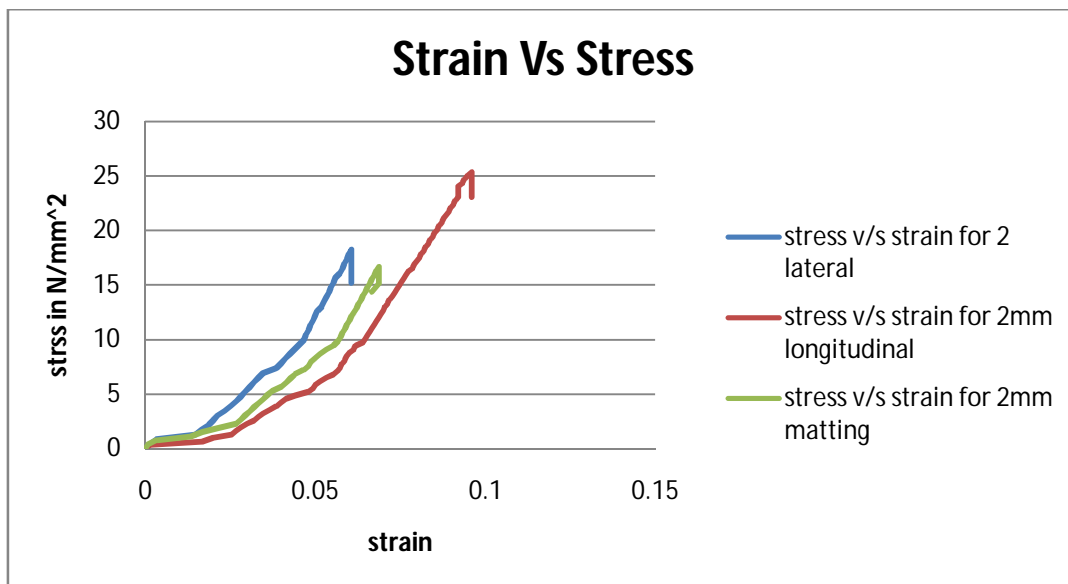


Figure 12: loading on longitudinal, lateral matting fibres

IV. CONCLUDING

The work presented in this report is concerned with experimental investigation of tensile properties of bamboo reinforced epoxy composites. The following conclusions are drawn from the present work are as given below: Bamboo reinforced composites of 1mm, 2mm and 3mm diameters are prepared for longitudinal, lateral and matting arrangements.

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- Water absorption capacity of specimens is evaluated. it is observed that, bamboo fibres are initially absorbs water up to some extent (4-5 hrs.), thereafter, water absorption capacity of fibres ceases.
- The parameters such as tensile strength, tensile modulus and strain elongation are determined. It is observed that bamboo fibres have direct effect on tensile strength and tensile strength is more when it is loaded along the length of fiber and it becomes weak when it is loaded perpendicular to the length of fiber and thus one can say that fibres are direction oriented.
- The tensile strength increased as the fiber diameter increases and the tensile modulus decreased as the diameter of fiber increases. Increase in interaction between fiber/matrix enhances the tensile strength.

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