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Comparisons of Tensile Strength of Bamboo Fiber and Glass Fibre Epoxy Composite

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Abstract – One of the first building materials used by mankind was Bamboo. In Asia, bamboo is very usual for scaffolding, bridges, housing and some additional temporary structure. In numerous exaggeratedly populated provinces of the tropics, particular bamboo supply which is the only appropriate material that has been adequately inexpensive as well as abundant to encounter the widespread need for reasonable housing. This research work comprises the physical and mechanical properties tests of Bamboo for its usage in structural need in construction Industries and Structural Design Area. Bamboo fiber reinforced by polymer composites consists of moderate mechanical properties but their properties could be hugely improved by integration of synthetic fibers or by the treatment of fiber in the alkali medium.

Keywords: Bamboo Fiber, Metal Matrix, Silicon Carbide, Rockwell Hardness, Tensile Strength.

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I. INTRODUCTION

Composite material could be explained as the material comprised of just two or may be more than two separate materials on macro scale along with unlike properties to create a fresh material having properties which are completely poles apart from each of the constituents. The prime phase of a composite material is prominently called as a matrix with a constant character. In the slightly different words, matrix is a material which plays the role of a binder and holds together the fibers in the required position in that way transmitting the external load to reinforcement. These matrixes have been pondered for being less hard as well as more ductile [1]. The composite material comprises of a matrix and a fiber added with some filler material. The reinforced material might be synthetic or else natural fibers. In today's increasing demand of environmental security, various natural fibers reinforced polymer composites (NFPCs) have been fetched into the aggressive market [2]. NFPCs present a broad range of pros over composites of synthetic fiber. Such pros contain high strength at elevated temperatures, high strength to weight ratio, elevated toughness and high creep resistances.

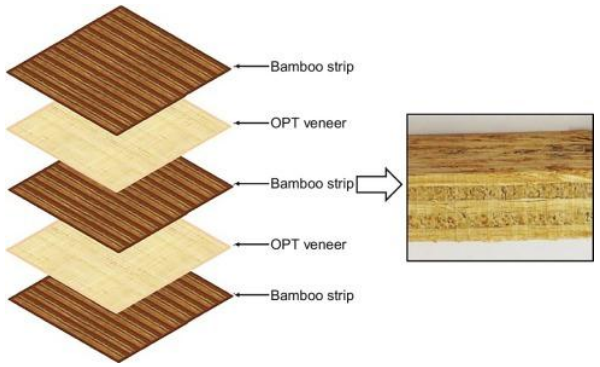

Fig. 1 Bamboo fiber

II. LITERATURE REVIEW

(Raja and Retnam, 2019) [3] Polymer matrix composites (PMCs) are broadly being utilized in aerospace structures, automotive parts, boat hulls, etc. From the time when the advancement of PMCs, a single fibre composite drops back the adding up of just one, may be more than one fibres made to be a hybrid composite that could be utilized for augmenting their mechanical properties. Hybrid bamboo/glass fibres as the substitution for polyester composites are made-up with ±60◦ orientation, also coconut shell powder in micro along with nanosized particles have been adjoined as the filler materials. Mechanical properties for example tensile, flexural, impact strength, hardness number, and fatigue behavior were inspected. The

fractured surfaces of the composites have been noticed through scanning electron microscopy analysis. The test outcomes uncover that the bamboo fibres in mixture with glass fibres display an improvement in their mechanical properties like stiffness and strength, and have been appropriate for aerospace applications.

(Zhang *et al.*, 2018) [4] Bamboo fibers determine huge potential as the reinforcement phase in composite materials. This study with the intention of finding appropriate NaOH concentration for bamboo fiber treatment, bamboo fibers have been treated with 2 wt.%, 6 wt.% and 10 wt.% NaOH solutions for 12 h, correspondingly. We resolved that 6 wt. % NaOH treated bamboo fibers are best to fabricate bamboo fiber composites through single fiber tensile test, single fiber pull-out test, (FTIR), along with scanning electron microscopy (SEM). The tiny length bamboo fibers treated with 6 wt. % NaOH solutions have been well spread in the epoxy matrix through a fresh preparation approach. In this work, the effect of fiber particles and the length of fiber on the properties of reinforced bamboo fiber epoxy composite are studied. The results show that the fracture toughness and flexural modulus of fiber and fiber composites are amplified with the fiber and content. Though, for every sample, composites displayed very minimum difference on the flexural strength. The fracture surfaces of the composites have been noticed by SEM, uncovering that fiber breakage, matrix cracking, deboning, along with fiber pull out have been major failure types. Additionally, thermo gravimetric analysis (TGA) has been carried out to inspect the thermal behaviour of bamboo fibers along with composites.

(Reddy *et al.*, 2018) [5] Focused on bamboo's mechanical properties fabric with Alumina made as a filler material in polyester composites. As the non-biodegradable resources continuously becoming plentiful and rising as a chief danger to our environment. The necessity of biodegradable resources is enhanced and therefore natural fiber reinforced polymer composites have seemed one of the cost-effective and environmentally friendly substitute for synthetic fiber reinforced composites. Therefore, in the past few years, the key industries for example construction, packing and automobile is showing a deep attention in the growth of natural fiber reinforced composites. Therefore the current work aim towards manufacturing natural fiber reinforced polymer composite through usage of Bamboo fabric as the natural fiber, polyester as the resin and through usage of alumina to be the filler material at different ratios, that is, 0%, 5%, 10%, 15% as well as 20%. The filler has been used in several ratios to discover disparities in the properties. Next later the tensile as well as the flexural tests have been performed to discover the mechanical properties. After this, we found that the composite along with the bamboo fabric as well as the polyester with alumina filler of 15% is the maximum tensile as well as the transverse strength.

(Roslan, Rasid and Hassan, 2018) [6] Bamboo has importantly concern of researchers because of its pros over synthetic polymers. It has been completely renewable, environmentally-friendly, non-toxic, economic, non-abrasive and completely recyclable. This research work concise an outline of the bamboo, fiber extraction and mechanical behavior of bamboo reinforced composites. Several studies performed and showed that mechanical properties of bamboo fibers reinforced polymer composites have been brilliant and capable for being utilized in high-tech applications. Such properties of the laminate have been affected through the fiber loading, fibre orientation, physical and inter laminar adhesion amongst fibre and matrix. On contrary, the attendance of chemical constituents such as cellulose, lignin, hemicellulose and wax substances in natural fibres preventing them from strongly tying with polymer resin, therefore, led to poor mechanical properties for composites. Many approaches have been made to tackle this issue through usage of the chemical treatment.

(Tripathi and Yadav, 2017) [7] When two or more than two materials have been prearranged in the form of layer through usage of any tying element that mixture is the composite material. Here the bamboo glass fiber hybrid composite joining material has been the epoxy resin and woven form of E-glass fibre has been taken into use. A layer of slender bamboo fibre matrix is caught into concern in such experimental study. Through usage of hand layup approach ready a bamboo/glass fibre composite sheet. In this sheet layer of glass fibre in woven form & layer of thin bamboo fibre have been used. As per ASTM standard, specimen have been prepared & tailed by flexural test, tensile test & hardness test. It has been noticed that bamboo/glass fibre laminates did influence mechanical properties.

(Torabi *et al.*, 2016) [8] Sliding wear behaviour that bamboo (Phyllostachys pubescens) shows have been inspected in the cases involving dry friction. The bamboo's wear volume has been an operation done by sliding velocity, the perpendicular load as well as the relative orientation of bamboo fibres regarding the friction surface. Also tribological properties of the Bamboo Fiber Reinforced Friction Materials (BFRFMs) have been tested over a persistent speed friction tester. The outcomes presented that the wear volume enhanced along with the amplified sliding velocity and normal load. The normal-oriented specimens (N-type) displayed sound wear resistance if compared to the parallel-oriented ones (PS and PI-type), whereas the outside surface layer (PS -type) displayed sound resistance in competition to the inner later (PI-typ). The friction coefficient of BFRFMs (reinforced with 3 wt.%, 6 wt.% and 9 wt.% bamboo fibers) have

been greater than those of the non-bamboo fiber reinforced friction material along with alike ingredients mingled with as well as the process conditions throughout the temperature-enhancing process. The friction coefficients of the specimens containing 3 wt.% bamboo fibers have been greater than for other specimens. The wear rate of BFRFMs enhanced as the increase of test temperature, and the wear rates of specimens containing 3 wt.% bamboo fibers have been lesser than that of other specimens.

(Banga, Singh and Choudhary, 2015) [9] In this study, experimental research is performed to study the influence of bamboo fibres at distinct weight percentages (20, 30 and 40) for modifying epoxy resin. Tests have been led on 100 kN servo hydraulic universal testing machine in displacement mode of control, digital Rockwell hardness testing machine as well as impact testing machine. Modifying epoxy resin by bamboo fibres along with enhanced mechanical properties have been major aim of this work. Bamboo fibres at different wt% (20, 30 and 40) have been filled in epoxy resin and the influence of mixing bamboo fibres on mechanical as well as physical properties has been studied. Based on mechanical testing results, it is found that 30 wt% of bamboo fibre mixed epoxy is delivering optimum mechanical properties. The adding of bamboo fibres has enhanced tensile, flexural and impact properties in case of epoxy resin and amplified water absorption of the material. Based on overall study the epoxy reformed with 30% of bamboo fibre has been found to be improved than other amalgamations.

(Screenivasulu and Reddy, 2014) [10] As the demand of modern technology are suspending day by day, the demands for modern material are very high and unusual; such as, mechanical properties, chemical properties etc. The demand, high strength to weight ratio, high stiffness, high corrosion resistance materials, high fatigue strength with high dimensional stability etc. These unusual demands of material properties cannot be easy to fulfill. Such demands can't be achieved through the conventional metal alloys. Polymeric materials reinforced along with synthetic fiber which can be glass, carbon and aramid deliver benefits of great stiffness and strength to weight ratio in comparison to conventional construction materials, namely wood, concrete, and steel. In spite of such benefits the well-known use of synthetic fiber–reinforced polymer composite has trend to wane because of their high primary costs, their usage in non-efficient structural forms and most significantly their undesirable environmental impact. This study makes an effort to make an exploration of the potential utilization of short bamboo fiber reinforced polyester composites. Consequently, the current project work has been to assess the mechanical properties namely Tensile strength (TS), Flexural strength (FS) of short bamboo fiber reinforced composites with and without Alumina (Al2O3) as a reinforced material.

(Ochi, 2014) [11] In this research work, mechanical properties of long bamboo fiber and bamboo powder composites are discussed. As a plastic material can easily press-molded, bamboo fiber and its powder can also be hot press-molded. Thus, because of similarity with plastic of bamboo fiber composites, it can replace plastic products and would decrease the environmental impact of plastic use. In this research work, by using bamboo fiber bundles and bamboo powder a molded uni-directional long fiber reinforced composite is produced. Tensile and flexural properties of the composite were tested. The results were show that, by increasing fiber content in the composite, the tensile and flexural strength of bamboo fiber were increased. And it also examined that, with the increase of molding temperature after 180oC, both strengths (tensile and flexural) were decreased. The best tensile and flexural strength of composite of bamboo fiber and powder recorded is 169.9 Mpa and 221.1 Mpa respectively.

III. MATERIAL AND METHODOLOGY

Preparation of Materials Material

To enhance the properties of bamboo fibre, a matrix is prepared. According to the size of the moldings box 19 × 165mm, the bamboo fibres were woven by using a weaving machine after they are dried off. Composite fabrication is done by the help of woven glass fiber. The source of matrix is Polyester resin; methyl ethyl ketone peroxide and cobalt napthenate was used for the catalyst and oxidizer.

Manufacturing and testing

Molding box recommended dimensions size is 350mm×330mm×20mm is prepared with wax and wood, in order to avoid sickness between composite and mould. Seven different types of plates were manufactured with pure bamboo reinforced with polyester matrix. And the other matrix is of bamboo reinforced with E-glass fiber with micro- and Nano coconut shell powder reinforced polyester combinations. For developing samples of composites various methods were implemented for the compression molding process. Resin was expanded with various amount of cobalt naphthnate as the oxidizer and use of catalysts for example methyl ethyl ketone.

In order to remove the porosity of prepared specimen, a dead load is placed on the prepared laminated body for removing air bubbles.

Mechanical Testing

As per the ASTM standards, the specimen was cut into two pieces, bamboo and PMC composite and then the experiments will performed. For attaining the orientation of angle angles, appropriate angles are settled. And similarly by employing a milling

cutter with 60^{o} fiber orientation, so the plate was cut into definite angles. And the cutting of the specimen will be performed on the basis of ASTM D 638 standards. Further for the testing purpose, computerized universal testing machine is used, for the tensile strength of developed fiber reinforced plastic composites along with bamboo. Samples which were secured in the UTM with the specifications of 5mm gauge length and 2 mm min−1 cross head speeds were tested and the tested specimens.

With the specimen standardized as ASTM D 790, flexural examination was conducted on a computerized UTM machine with distinctive accessories.

Test is performed on the specimens with a 15 kN UTM machine. The strain rate is applied on the specimen is 5 mm/min.

Fig. 1: Specimen after Tensile Test Flexural

Flexural Test

In bending, the material's tensile strength shows the stress of the outer top fiber for a testes specimen at a point of failure. Flexural strength strength was calculated by the help of supporting three point bending equipment. In the basic test, flexural strength shows in Mpa,

$$\text{Flexural test} = \frac{3lp}{2bd2}$$

Where,

P = the load applied to a sample of test, in Newton

l = specimen length in mm

b = specimen width in mm

d = specimen thickness in mm

IV. RESULTS & DISCUSSION

The strip which is used in the test is with thickness of 0.7 mm. And the fraction of composite with bamboo fiber of 0.3. The tensile test is performed on the strip of bamboo.

Theoretical value of modulus of elasticity of BREC was calculated by using the formula Ec = Ef Vf + Em (1 – Vf)

The tensile test is performed with 10kN on UTM machine.

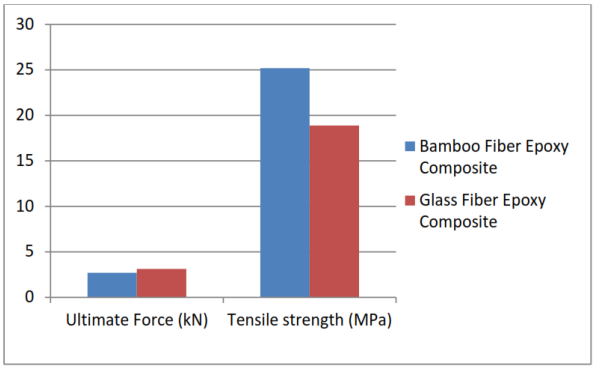

Fig. 2 Comparison of ultimate force and tensile strength

Table 1 Composite Properties

Specimen	Ultimate Force (kN)	Tensile strength (MPa)
Bamboo Fiber Epoxy Composite	2.7	25.171
Glass Fiber Epoxy Composite	3.12	18.87

Table 2 Result

Property	Values
Volume fraction of composite	0.3
Modulus of elasticity of fiber	2685 Mpa
Modulus of elasticity of epoxy	3407 Mpa
Analytical modulus of BREC	3892 Mpa

V. CONCLUSION

It is seen that, tensile strength and flexural properties of glass fiber and bamboo composites is preferable for the extreame high flexibility and it can be concluded that by solving and finding a results of tensile strength and flexural strength, it will be resulted that the mechanical properties considerably influence with the use of bamboo and glass fiber in a layer manner. From the tensile strength test it is resulted that the tensile strength of composite is 25.171 Mpa at 2.7 kN. It is also concluded from the above study that on increasing the volume of fiber the tensile strength of composite will increase. And the modulus of elasticity of fiber is achieved 2685 Mpa, modulus of elasticity of epoxy is 3407 Mpa and analytical modulus of BREC is 3892 Mpa.

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