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# A COMPARATIVE STUDY OF MECHANICAL AND PHYSICAL PROPERTIES OF POLYMER MATRIX COMPOSITE REINFORCED WITH BAMBOO AND JUTE

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**Abstract -** *Natural fiber possesses superior properties like low density, stiffness, lightweight and better mechanical properties made the composites a preferred choice for the various applications for various load conditions. Apart from this environmentally friendly, biodegradability and sustainability are the major considerations for the selection of natural fiber composites as compared to conventional synthetic fiber based composites. An extensive range of different natural fibers has been used for reinforcement until now. This paper deals with the comparison of the properties of a polymer matrix reinforced with Bamboo and Jute. Composites were compared for their mechanical properties such as tensile strength, flexural strength, impact strength, and hardness.*

***Key Words***: Bamboo Composites, BcFc, Jute Composites, Micro fibrils.

## 1. INTRODUCTION

Composites materials with light-weight, high strength-to-weight ratio, and stiffness properties are replacing conventional materials like metals, woods, etc. Good Mechanical and Tribological responses of polymer-based composites also support for their application in different areas [1, 2]. The abundant availability of natural fibers such as jute, coir, sisal, pineapple, ramie, bamboo, banana, etc., has given an impetus to the development of natural fiber composites. Composite boards have been used in the development of panel and doors to fulfill the low-cost housing needs. Recent research [3, 4] indicates that natural fibers can very well be used as reinforcement replacing for expensive glass fibers in polymer composites. The study of natural fiber reinforcement is due to its abundant availability in a wide variety [5- 12]. The composites can be prepared with desired properties by orienting the fibers according to the application. The composites are comparatively cheaper to manufacture and there are various manufacturing processes available for the composites. The mechanical properties were evaluated such as flexural strength, tensile strength, impact strength, and tensile modulus, elongation at break, flexural modulus, and hardness of the composites [13].

Bamboo is one of the grassy plants that always gain most manufacturers' attention due to several advantages such as ease of growth in diverse climates, which make it durability and low-cost material when compared to others [14]. As a fiber, the overall mechanical properties of bamboo are comparable to or even better than those of wood. Good interfacial bonding between fibers and matrices leads to better mechanical behavior of the composite. Since the load can be easily transferred to the fibers by the matrix [15]. Chemically treated natural fiber reinforced thermoplastic composites offered enhanced mechanical and physical properties under extreme conditions.

Due to the immense scope in the field of composites the need to find an alternative to the glass fiber reinforced composites is imminent due to its non-biodegrading property. Recent research [16, 17] indicates that natural fibers can very well be used as reinforcement replacing the expensive glass fibers in polymer composites.

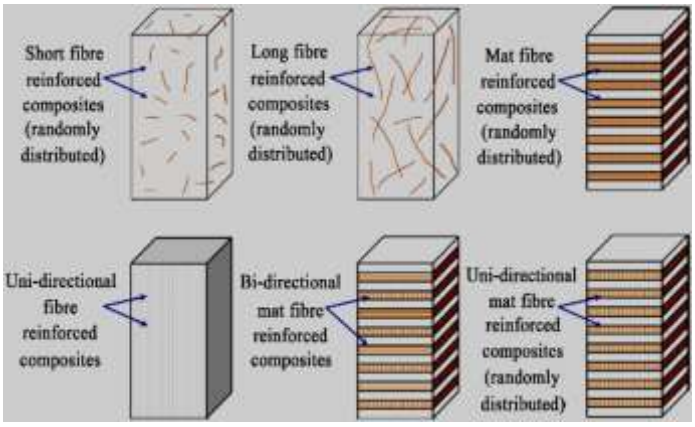


**Fig -1** Different type of fiber orientation used for laminate manufacturing [18]

There is a number of aspects that effects the performance of composites are the following; (a) orientation of fiber, (b) strength of fibers, (c) physical properties of fibers, (d) interfacial adhesion property of fibers and many more [18- 23].The use of natural fibers is improved remarkably due to the fact that the field of application is improved day by day, especially in the automotive industries. Nowadays, natural fiber composites have gained increasing interest due to their eco-friendly properties

### 1.1 Mechanical properties of Polymer-based matrix composite reinforced with Bamboo/ Jute:

Few investigators have studied the effect of short natural fiber on the mechanical behavior of composite. The mechanical properties mainly provided by the cellulose content, which is influenced by many factors such as fibers volume fraction, fiber length, fiber aspect ratio, fiber-matrix adhesion or fiber orientation [24].The et. al. [25], in 2000, found that the mechanical properties of the bamboo-glass fiber reinforced polypropylene hybrid composites depend on fiber weight ratios, fiber length, and adhesion characteristics between the fibers and the matrix. For this, they use bamboo fibers of 3mm and 6mm sizes. Compression moulding method was used to develop the composite with 10% to 40% bamboo fiber. They observed that using bamboo fiber from 10 to 30% increased the average tensile strength, and it was dropped by 16% at 40% (by weight) fiber content compared to the case of 10% (by weight) fiber content. However, compatibilizer agent is not enough to utilize the performance of mechanical properties of bamboo/ E-glass/ polypropylene hybrid composite, although the improvement in the mechanical properties due to hybridization [26].

Some researchers in 2004 work on the tensile strength of improved bamboo fiber eco-composite BFECand bamboo fiber cotton eco-composite BFcEC [27]. They used steam explosion technique to extract bamboo fibers. They found that tensile strength and Young modulus of the BFcEC increased from 15 to 390% respectively. It reveals that the elastic modulus of BFEC increased about 2.6 times higher than of neat MAPP/ PP. The tensile strength of BFRP is slightly lower than that of the PP samples, enhancement is found by the inclusion of glass fiber with 3 % MAPP. It also showed that the BGRP has better fatigue resistance than the BFRP composites at all load levels. Thus, it shows the improvement in mechanical properties due to hybridization.

Samal et. al., [28] made comparisons between the BGRP and the virgin polypropylene. They showed that the composites prepared at 30% fiber loading with 2% MAPP concentration showed optimum mechanical performance. As compared to the virgin polypropylene, at a glass fiber: bamboo concentration of 15:15, the tensile strength, flexural strength, and the impact strength increased by around 69%, 86% and 83% respectively Priyadarshini Tapas et al. [32] studied the physical and mechanical properties of $Al_2O_3$ filled jute fiber reinforced epoxy composites. Jute and $Al_2O_3$ taken as reinforcement and epoxy as matrix. They observed that Hardness, strength, flexural and tensile modulus increased with increase in the fiber and filler and inter laminar shear strength increased only by increasing fiber and decreased in addition of filler on composites.

M. Ramesh et al. [33] also observed that the addition of glass fiber into jute fiber composite resulted in maximum tensile strength. In the same way they have observed that jute and sisal mixture composites sample is capable having maximum flexural strength and maximum impact strength was obtained for the sisal fiber composite.

Gopinath et al. [34] observed that mechanical behavior of jute fiber in polyester and epoxy matrices and the results showed that jute-polyester processing time is far lesser as compared to jute-epoxy laminate.

Tensile strength and impact strength of the composites also found to be increasing with an increase in the loading of bamboo microfibrils, reached an optimum and thereafter decreased with further increase in microfibril loading [29].Tensile properties of Bamboo and Jute found by the researchers can be tabulated as follows:

**Table -1: Comparison of Tensile properties of Bamboo [30] and Jute [31]**

| Comparison of Tensile properties of Bamboo [30] and Jute [31] | | |
|---|---|---|
| Fiber | Tensile Strength (MPa) | Young Modulas(GPa) |
| Bamboo(Steam Explosion) | 615-852 | 35.45 |
| Jute | 393-773 | 26.5 |

## 2. EFFECT OF PROCESS PARAMETERS ON MECHANICAL CHARACTERISTICS OF POLYMER MATRIX COMPOSITE REINFORCED WITH BAMBOO/ JUTE

Researchers study the effect of weight percentage of jute fiber reinforced in polymer-based composites. They found that mechanical properties enhanced as the jute weight percentage increased up to 40% [35].

D. Dash et al. [36] reported the mechanical properties of composites such as tensile strength and compressive strength of natural fiber composite and compare with the data for glass/epoxy composites. They found that bamboo composite laminates having higher tensile strength and stiffness than jute composite laminates, but not at par the glass fiber reinforced composite. However, Compressive test shows that compressive strength and modulus of jute composite is higher than bamboo composite but less than glass composite. They also studied the effect of fiber orientation angle. They found that the fiber orientation of $0^o$ provides higher strength and modulus than the $45^o$ direction of fiber orientation. The mechanical property also depends upon the individual material property.

Mohanachari et.al. [37], Specify that fabricate the short bamboo fiber reinforced epoxy based polymer composite. They found that tensile strength and hardness increases with increasing content of fiber in composite materials.

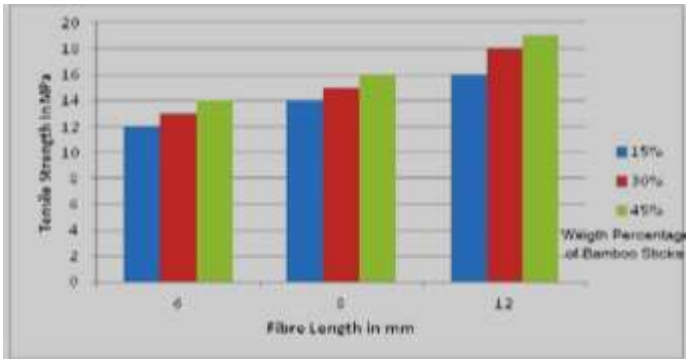


**Fig -2**: Effect of fiber parameters on tensile strength [35]

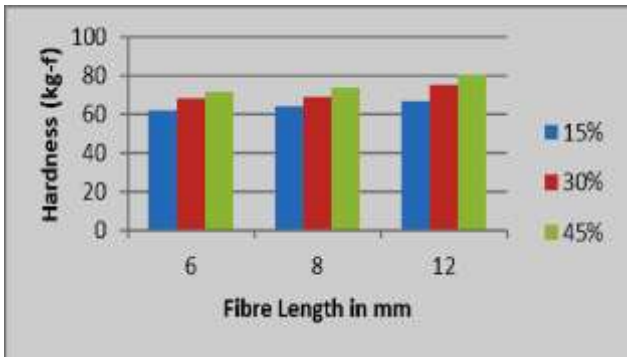


**Fig -3**: Effect of fiber parameters on Hardness of composites [35]

A number of layers and fiber directions also affect the mechanical behavior of composites. It was observed that the mechanical behavior of laminated has improved by increasing the number of layers [38]. Composite, the 5 layers show the maximal properties. The composites at $0^o$ fiber direction and $0^\circ$ cutting direction revel high mechanical properties than the other cases. Suppression of hydrolysis is necessary to improve the overall performance of jute/polylactic acid composites. Addition of jute fiber increased the modulus but lowered the absolute tensile strength of the composites [39].

## 3. CONCLUSIONS

Natural fibers are rapidly growing in term of their industrial application as well as fundamental research. Natural fibers are completely or partially recyclable and biodegradable. It is comparatively economical and eco-friendly. Various researches show that with the help of chemical treatment, we can get desired properties.

It is further concluded that Bamboo fibers, when reinforced in polymers, revealed the good physical, mechanical as well as thermal properties. Mechanical and structural properties of bamboo fibers are also affected by the source, position, species, and age, which further conclude its final properties.

As regards Jute Fibers, which are nowadays not only limited for the textile application, on account of latest and future technologies like; after its reinforcement with polymers, it can replace various materials in the field of building structures, furniture etc. The physical, mechanical and thermal characteristics of jute-based composites depend upon fabrication techniques, fiber orientation, and fiber weight ratio.

Apart above, the fact that the composites have a few disservices, with this foundation, it is certain that the composite is the most needed innovation in the quickly developing current pattern. However, a plethora of innovations had suggested various procedures for the fabrication of polymer-reinforced composites. Also, diverse methods are used to enhance the strength of composites with the aid of various chemical treatments. Varying fiber fraction is also enhancing fiber orientations so as to eliminate the moisture, led to recuperate the fiber/matrix interface leading to improvement in its physical strength.

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