STUDY OF MECHANICAL PROPERTIES OF NATURAL FIBER HYBRID POLYMER COMPOSITES

Ashhab Jamal[1], Ambreen Bano[2], Sumita Chaturvedi[3]

[1]*Department of Mechanical Engineering, Integral university, Lucknow, 226026, India*
[2]*Department of Biosciences, Integral university, Lucknow, 226026, India*
[3]*Department of Mechanical Engineering, Integral university, Lucknow, 226026, India*

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Abstract - *In present times, there is an increase attention has been made on the use of renewable resources, specially of plant origin, keeping in view the ecological concerns as well as renewability. As natural fibers are renewable resources in many developing countries of the world as they are cheaper, have no health hazards and provide a solution to environmental pollution by finding new uses for the waste materials. The mixing of reinforcements to prepare hybrid composites is attractive as it allows the designing of composites with mechanical performance to meet the need of the product. The advantage of replacing synthetic fibers for natural ones, is that they are eco friendly. Various combinations of different types of synthetic and natural fibers are used to meet design requirements in many different application. In this present study, mechanical properties the effect of untreated and alkaline treated (5% NaOH) sisal and bamboo fiber composite has been studied. The fiber length and fiber content increases in sisal and bamboo fiber composites there is an increase the mechanical properties. The alkaline treated sisal and bamboo fiber composite has showed a remarkable increase tensile, flexural and impact strength as compared to that of untreated.*

Keywords: Fiber Reinforced Polymer Composite, sisal fiber, bamboo fiber, Epoxy

1. INTRODUCTION

In Present-day research the field of polymer science and technology has been focused on the developing papers, plastics, textile fibers, adhesives, composites, blends, and many other industrial product from renewable resources, mostly the abundantly available are agro-waste and lignocellulosic materials. New materials and composites that have both environmental and economic benefits are being considered for application in the automotive, furniture, building, and packaging industries.

A composite is a heterogeneous material created which is created by the assembly of two or more components, reinforcing agent and a compatible matrix binder in order to achieve specific characteristics and properties. Conventional material used in engineering application are usually homogeneous in nature. They are being replaced by composite materials that are heterogeneous in nature, so as to achieve improved mechanical properties such as stiffness, high specific strength and toughness. Composite materials constitute of reinforcement materials which have high load carrying strength embedded in matrix materials that are relatively weaker [1].

Since ancient times fiber-reinforced construction materials have been known as fiber reinforced composites have a low specific gravity, high strength, weight and excellent weather ability, chemical resistance, versatility of product design and ease of fabrication and consequently possess a distinct advantage over conventional materials.

Today, fiber reinforced composites has been emerged as a major class of structural materials with an increasing application in weight critical components for the industry, particularly the marine, aerospace, and automotive sectors [2].

Now days, fibers are used as reinforcement fillers for the thermoplastic and thermosetting matrices to prepare the composites, which are known as Fiber Reinforced Polymers (FRP). Thermoplastics for example Polystyrene, Polyethylene, Polyamides, Nylons, Polypropylene and thermosetting plastics such as Phenolic epoxy resins, Polyester are used as matrix materials.

Synthetic and natural polymer fibers are also used to a limited extent. Fibers are very attractive and effective reinforcement materials. A great majority of materials are stronger and stiffer in the fibrous form than as bulk material.

The natural fiber reinforced polymer composites form new class of materials which seem to have good potential in future as a substitute for scarce wood as well as wood based materials in structural applications. As fibers are obtained from the various parts of the plants are known as plant fibers. These fibers are classified into three major categories depending upon the part of the plant from which fiber are extracted [2, 3].

- Bast or Stem fibers (jute, banana etc.)
- Leaf fibers (sisal, pineapple, etc.)
- Fruit fibers (cotton, coir, etc.)

Natural fiber reinforced polymer composites

Sisal fiber

Sisal fiber is a hard fiber that has been extracted from the leaves of the sisal plant (Agava sisalana). Sisal fiber is one of the four most widely used natural fibers as well as it is half of the total production of textile fibers. The main reason for this is due to the ease of cultivation of the sisal plants and which have short renewal times [4].

Sisal fibers have both the properties of crystalline and non-crystalline components when they are subjected to tension are expected to undergo deformation as in the case of banana fiber. As the applied stress initially is shared between crystalline and non-crystalline components in fibrous composites and the extent to which the fiber resists deformation in this low strain region is called initial modulus of the fiber [5].

Bamboo Fiber

Bamboo plants are giant, fast-growing grasses with woody stem having various characteristics regarding growth habit, temperature tolerance, size, sun tolerance, and soil moisture requirements [6, 7]. It has been examined as a source of best fiber and cellulose via pulping by several researchers. The major advantage of using these fibers is its vast abundance as a natural resource in the Asia and Middle and South America [8].

Due to its high strength-weight ratio, the bamboo fibers are often referred to natural glass fiber, and it is an alternative to steel in tensile loading application as its tensile strength is high and reaches 370 Mpa [9]. A bamboo fiber has been emerged as a purposeful tool which is extensively utilized in composite industries [10].

Present studies have shown that fabrication of the environmental friendly composites from bamboo fibers for ecological purposes has very useful mechanical properties [11].

It has also been studied that there is a presence of specific strength in bamboo fibers which is more than the strength obtained from conventional glass fibers. [12, 13].

Experimental procedure

Specimen Preparation

Sisal fiber is collected from Bihar, whereas bamboo fiber and epoxy polymer was collected from online purchase. The mould used in this work is made of teak wood of dimension 250*250*3 mm with eight beadings. The casting of the composite material is made in this mold by hand lay-up process. Fibers of different lengths (10, 15 and 20 cm) and weight percentages (10, 15 and 20) was mixed with epoxy for the initial preparation of composites. The fibers (Sisal and bamboo) are laid uniformly over the mould before application of any releasing agent. After arranging the fibers uniformly, they are compressed for 30 min in the mold. The compressed form of fibers (sisal and bamboo) is removed from the mould.

Un-treated Bamboo/Sisal Fibers

The fibers are then washed with tap water and distilled water for several times until all the dirt has been removed. The short bamboo and sisal fibers then dried at room temperature (33° C) for 24 h which was followed by oven drying at room temperature for 24 h.

Sodium Hydroxide Treatment of Bamboo/Sisal Fibers

For this, short sisal and bamboo fibers and are soaked in a 5% NaOH solution at 37º *C*. The fibers are kept immersed in the NaOH (alkali) solution for 24 h. The fibers are then washed with tap water and then distilled water to remove every trace of NaOH solution to the fiber surface and then it was neutralize with dilute acetic acid at three times. The short bamboo and sisal fibers then dried at 37° C for 24 h.

The tensile, flexural and impact properties of untreated and treated (NaOH absorption) characteristics are tested on sisal and bamboo composite material. Primarily, optimum fiber length and weight percentage was determined in the case of sisal and bamboo fiber composites.

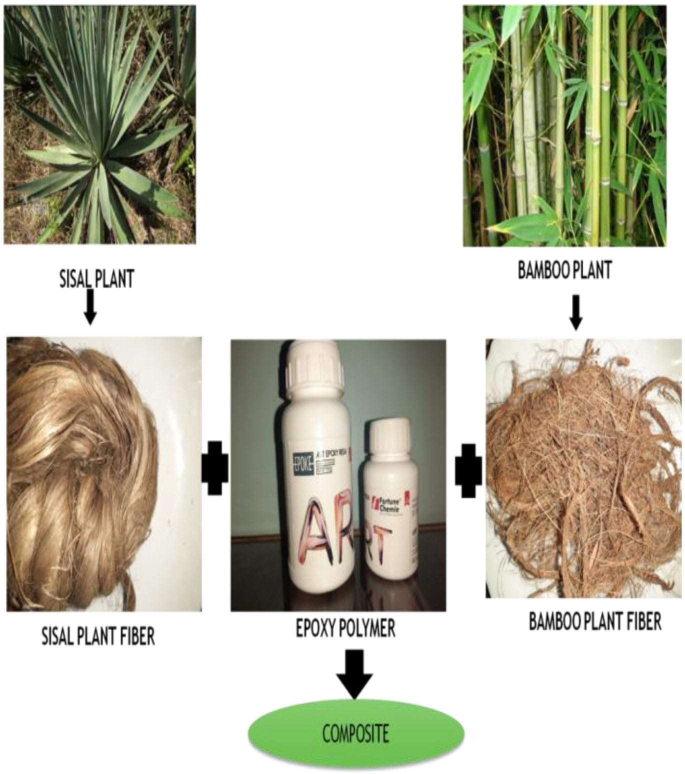


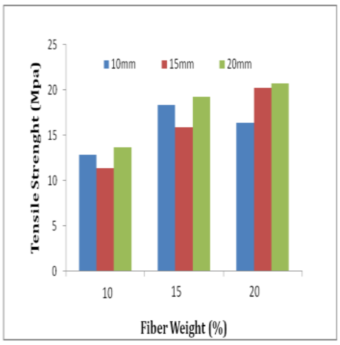
Figure 1: Represents the procedure of making Sisal and Bamboo Epoxy Composite

RESULTS

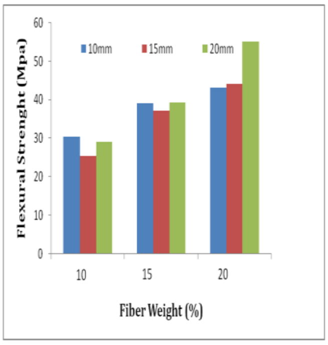
After the fabrication, the test specimens are subjected to different mechanical tests as per ASTM standard. The tensile test was carried out according to ASTM D638. The hybrid composite specimens were subjected to tensile test at Universal Testing Machine. The Flexural test was carried out according to ASTM D790, Flexural Test was also carried out in Universal Testing Machine. The impact strength of the composite samples was carried out according to ASTM D7136.

Fiber length (cm)	Fiber weight (%)
10	10
	15
	20
15	10
	15
	20
20	10
	15
	20

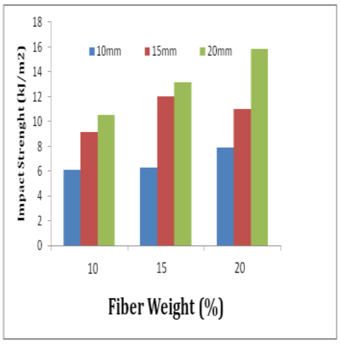
Table 1: Effects of fiber length and weight percentage



Graph 1: Effect of fiber length and weight percentage of tensile properties of sisal/ bamboo composites



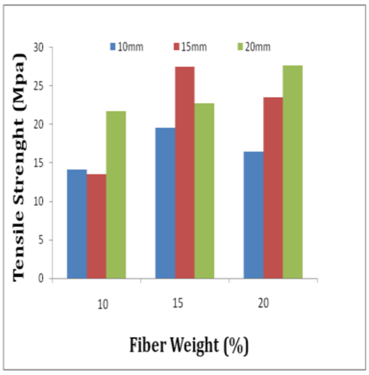
Graph 2: Effect of fiber length and weight percentage of flexural properties of sisal/bamboo composites



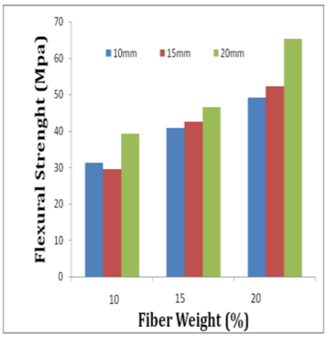
Graph 3: Effect of fiber length and weight percentage on impact properties of sisal/bamboo composites

Fiber length (cm)	Fiber weight (%)
10	10
	15
	20
15	10
	15
	20
20	10
	15
	20

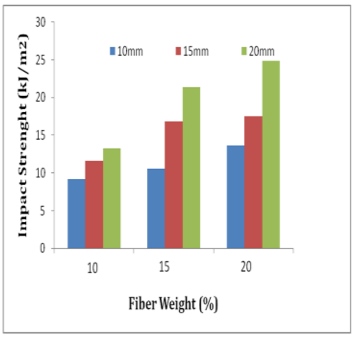
Table 2: Effects of fiber length and weight percentage on mechanical properties of treated sisal/Bamboo composite



Graph 4: Effect of NaOH treated fiber length and weight percentage of tensile properties of sisal/ bamboo composites



Graph 5: Effect of NaOH treated fiber length and weight percentage of flexural properties of sisal/bamboo composites



Graph 3: Effect of NaOH treated fiber length and weight percentage on impact properties of sisal/bamboo composites

3. CONCLUSION

In this study, the effect of untreated and treated (5% NaOH) sisal and bamboo fiber composite has been studied on the basis of mechanical properties including tensile, flexural and impact strength. The study indicated that the increase in the fiber length as well as fiber content in sisal and bamboo fiber composites results in increasing the mechanical properties. The sisal and bamboo fiber composite prepared with the 5%NaOH alkaline (treated) bamboo and sisal fibers showed a remarkable increase in all mechanical strength properties such as tensile, flexural and impact strength. By increasing the length and concentration of treated bamboo fiber concentration in the hybrid composite, the tensile, flexural and Impact strength may be improved.

ACKNOWLEDGEMENT

I would like to acknowledge the Department of Mechanical Engineering of Integral University, Lucknow, U.P. for their full support to conduct this work.

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BIOGRAPHIES

Ashhab Jamal, M. Tech in Mechanical Engineering with specialization in Production and Industrial Engineering from Integral University, Lucknow, Uttar Pradesh.