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Mechanical Behaviour of Banana flax Fiber Reinforced Soy Resin Composites

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ABSTRACT: *Now-a-days, natural fiber reinforced polymer composites are increasingly being, used for varieties of engineering applications due to their many advantages. Among natural fibers, both banana and flax fibers are used for many such applications due to its availability.The attractive advantages of natural fibers are their low cost, light weight, renewability, biodegradability, short growth cycle and high availability. The objective of the present research work to study the mechanical behavior of banana –flax fiber reinforced with soya resin based composites. Samples of banana, flax and banana-flax fiber composites were prepared by using hand layup method .Samples were cut in flat bar shape specimens from the manufactured laminate according to Tensile Testing standards which is to be performed under Universal testing machine (UTM),Tensile strength of laminates are observed. Finally, the Scanning Electron Microscopy (SEM) of fractured surfaces has been done to study their surface Morphology.*

Keywords: *Natural fibers, Natural composites, biodegradable, packaging material.*

I. INTRODUCTION

Composites are materials consisting of two or more chemically distinct constituents, on a macro-scale, having a distinct interface separating them. One or more discontinuous phases are, therefore, embedded in a continuous phase to form a composite[1]. With the growing global energy crisis and ecological risks, natural fibers reinforced polymer composites have attracted more research interests due to their potential of serving as alternative for artificial fiber composites [2-3]. Advantages of natural fibers over synthetic fibers include low density, high availability, low cost, recyclability and biodegradability [4-5]. A great deal of work has been done on the polymer composites reinforced with different types of natural fibers such as jute, banana, coir, wood fiber palm, flax and kenaf etc. [6]. Among them, both Banana and flax fibers are extensively used now-a-days in many industrial applications. Banana fiber is a natural fiber extracted from the husk of banana cultivation. It is a fiber which is highly available in India [9]. Flax fiber has many advantages like low cost, low density, versatile, high stiffness, renewability, waterproof, biodegradability and high degree of flexibility during processing [7]. Compare to other natural fibers, this fiber has remarkable interest in many industries due to its high hardness and hard-wearing quality, not toxic, good acoustic resistance, resistant to microbial and fungi degradation, and not easily combustible.

II. EXPERIMENTATION

Extraction Process of Flax Fiber:

Flax fiber is extracted from the bast beneath the surface of the stem of the flax plant. Flax fiber is soft, lustrous, and flexible; bundles of fiber have the appearance of blonde hair, hence the description "flaxen" hair. It is stronger than cotton fiber, but less elastic. Flax fiber is extracted from the skin of the stem of the flax plant. Its long fibers, ranging from 45 to 140 cms long, make it easy to spin and weave. When it is spun into yarn, it is sometimes blended with other staple fibers. Fabrics that are comprised of 100 per cent flax fibers or yarns are known as linen. Where flax is used with other fibers, the percentage of each is usually stated.

Extraction Process of Banana Fiber??

The banana fiber is obtained from banana plant. These fibers are waste product of banana cultivation, therefore with less cost these fibers can be obtained for many applications.Initially, extracted banana fiber is to be sun dried and then dried in oven to remove moisture present in the fiber. Initially, the banana plant sections were cut from the main stem of the plant. The outer sheath from the banana stem is first peeled off, the inner layers are flattened and fibers are stripped off either manually or through machines. A special machine was designed i.e., Raspador Machine In this process the fiber is extracted from the stem sheaths which is inserted one by one into machine. This machine removes non-fibrous tissues and the coherent material from the fiber bundle present in the sheath and gives the fine fiber as output. The fine fiber which is extracted is in shiny appearance and it depends on extraction and spinning process.

NaOH Solution Preparation:
Before making 1 N solution of NaOH, Initially NaOH pellets are required.

- Equivalent weight of NaOH is to be known, to make 1 N solution of NaOH which is calculated by dividing Molecular weight by 1, i.e., 40 divided by 1= 40. So the equivalent weight of NaOH is 40. To make 1 N solution, dissolve 40.00 g of sodium hydroxide in water to make volume 1 liter. For a 0.1 N solution, 4.00 g of NaOH per liter is needed.
- After preparing solution of NaOH, Weight of fiber individually is to be measured for soaking and based on the weight, solution is to be prepared.
-

Before Soaking After Soaking Drying for 2 weeks

Soy Powder Adhesive Preparation Process:
Soy-based adhesive preparation was made by 40 grams of soy powder which is to be dissolved in 160 mL of distilled water in a necked flask and stirred for 40 min in a 35^{0}C water bath. . After that, 2 drops of vinegar was added to slurry, and incubated at 54 ◦C for 20 min. Finally, and 2 drops of glycerin was added to the slurry and stirred continuously for 10 min to obtain the soy-based adhesive.

Steps involved in preparing of laminates:
Initially, fibers were chopped to required fiber length. The extracted fine fibers is to be soaked in prepared NaOH Solution for 24 hours and then to be dried. Required quantity of the fiber were soaked in the prepared sodium hydroxide (NaOH) solution to remove impurities like wax and pectin. After Soaking for 24 hours**,** the fibers were then washed with tap water and finally washed thoroughly with distilled water. Then the fibers were to be dried in air for 1-2 weeks. Three Samples i.e., banana fiber, flax fiber and banana-flax fiber is to be prepared each of 3mm Thickness. Take a single layer of PVC sheet and apply prepared soy based adhesive mixture uniformly on the PVC sheet. Place equal amount of banana fiber on the PVC sheet and coat soy adhesive on the fiber uniformly with brush or manually. Same process is to be repeated for preparing of laminate of 3mm thickness. Place it in open air for curing and Banana fiber laminate is formed. i.e., **Sample-I.** Again repeat steps from 8 to 10 to obtain flax fiber laminate 3mm thickness on PVC sheet and Considered s Flax Fiber laminate i.e., **sample-II**. Repeat same steps again to obtain banana-flax fiber laminate and consider it as Banana-Flax laminate i.e., **Sample-III**

Sample-I **Sample-II** **Sample-III**

Tensile Test:

Tensile testing of the composite samples is done as per ASTM D3039-76 test Standards. Generally the tensile test is performed on flat specimens .A uniaxial load was applied through the ends.Samples were cut in flat bar shape specimens from the manufactured laminate according to Tensile Testing standards which is to be performed under Universal testing machine (UTM).The test is conducted both in X-axis and Y-axis. Three samples are to be cut in flat bar shape both in X-direction and Y-direction.The test is repeated two times in on each composite type and the mean value is considered.

Three Tensile Testing Samples are cut in both X and Y- direction

Scanning electron microscopy (SEM):

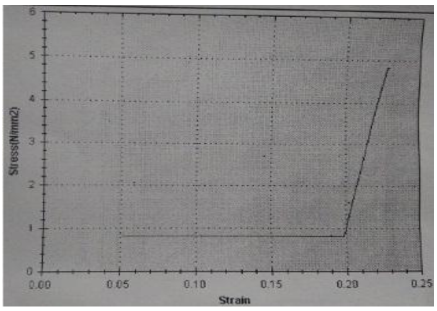
The morphological characterization of the composite surface is done in scanning electron microscope .The samples are cleaned carefully, air-dried and are coated with 100 Å thick platinum in JEOL sputter ion coater and observed SEM at 20 kV. Likewise all the three samples with silver paste are mounted on stubs.The fracture morphology of the surface of the composites after tensile test was observed by means of SEM

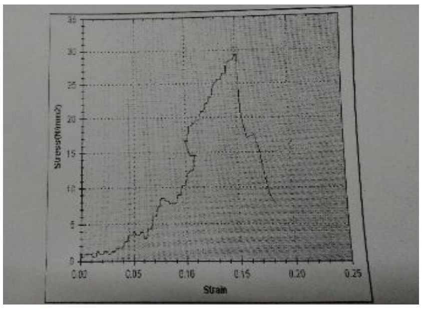
III. RESULTS AND DISCUSSIONS

Tensile Strength of Composites:

Flat Shape Samples	Input Parameters												Output Parameters			
	Specimen Width Mm		Specimen Thickness Mm		Initial Gauge Length Mm		Pre Load Value Kn		Maxmload Kn		Max Elongation Mm		Load At Peak Kn		Tensile Strength N/Mm^2	
Banana	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y
	25.15	23.78	1.48	2.97	50	50	0	0	600	600	250	250	0.18	2.07	4.836	29.309
Flax	26.71	24.92	2.42	2.71	50	50	0	0	600	600	250	250	0.12	4.08	1.856	60.415
Banana-Flax	25.15		1.48		50	50	0	0	600	600	250	250	0.18	5.58	4.836	38.364

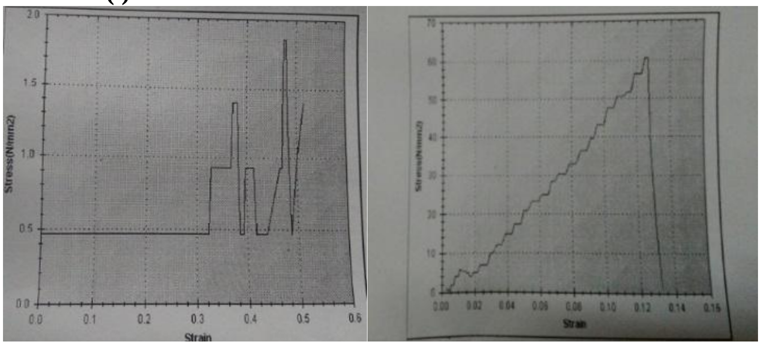
Tensile strength is the most important property of any material. The effect of tensile strength of three samples in X and Y directions are shown in stress vs strain graphs (i), (ii), (iii)respectively. From the table above, it is evident that the value of tensile strength of three samples in Y-Direction is more as compared to samples in X-direction.





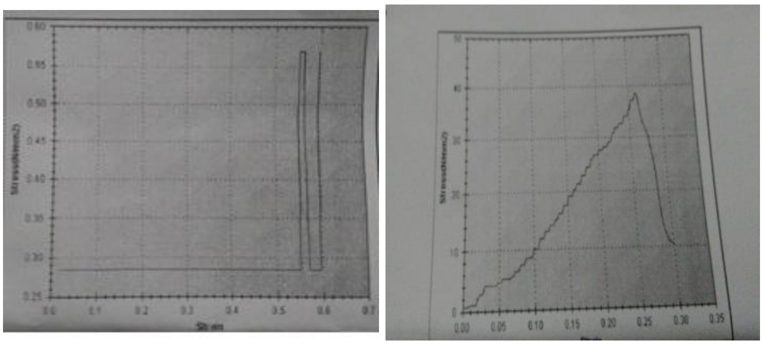
X-Direction **Y-Direction**

(i) Stress vs Strain of Banana Fiber Laminate



X-Direction Y-Direction

(ii) Stress vs Strain of Flax Fiber Laminate

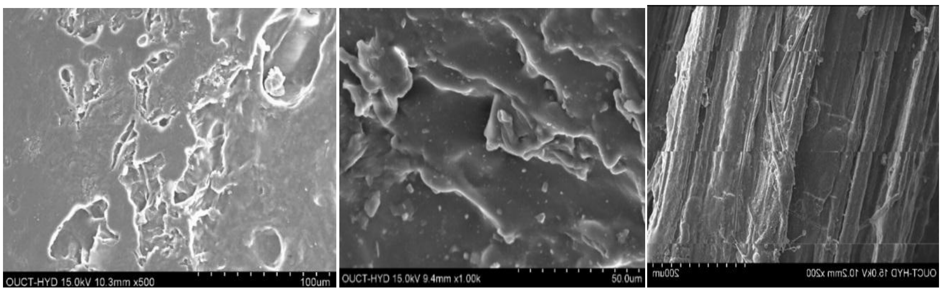


X-Direction Y-Direction

(iii) Stress vs Strain of Banana-Flax Fiber Laminate

Surface morphology of the Composites:

The fracture surfaces study of banana, flax and banana-flax fiber reinforced soy based compositeafter the tensile test has been shown in Figure (i), (ii), (iii) respectively. From the Figure it can be seen that the fibers are detached from the resin surface due to poor interfacial bonding. The surface of the fiber is not smooth indicating that the compatibility between fibers and epoxy matrices is poor.



(i) (ii) (iii)

Scanning electron micrographs of Banana, Flax and Banana-Flax fiber reinforced soy composite specimens after tensile testing

IV. CONCLUSION

The experimental investigation on the effect of surface treatment on mechanical of Banana-Flax fiber reinforced soy composites leads to the following conclusions obtained from this study are as follows:

1. From the results it has been concluded that the surface treatment has significant effect on the mechanical behavior of composites. The tensile strength of three samples in Y-direction is maximum when compared to other samples in X-direction.

2. The fracture surfaces study of banana -flax fiber reinforced soy composite after the tensile test has been done. From this study it has been concluded that the poor interfacial bonding is responsible for low mechanical properties. Banana –Flax composites have good interfacial bonding when compared to individual composites.

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