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Experimental Studies on Mechanical Behaviour of Banana Fibre Reinforced Epoxy Composite

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Abstract **- The importance of natural fibre composites is increasing in automobile and plastic lumber and also in cosmetic applications. Natural fibres such as jute, banana, coir, palm, sisal, cellulose etc. are recycled as an additional to synthetic fibres e.g. Carbon glass etc. These fibres are useful to the synthetic fibres because of having renewable character, cost, acceptable specific strength properties, low enhanced energy recovery and biodegradability. The natural fiber composites provide better mechanical properties which have low specific mass for the essential of producing structural materials as housing, aerospace, automobiles, industries etc. natural fibers are also combined with other natural materials to obtain better mechanical properties. Banana fibre reinforced epoxy composites were ready for unlike weight content of fibres by using hand layup moulding method. Biological fibre-reinforced composite has the potential to improve its mechanical properties for a wide range of latent application. The properties of some natural fibres have been investigated and the reported results showed promising utilization of some of them as an alternative to glass fibre in many applications. In this present work treated banana fibers are used as the reinforcing material.**

Keywords: Composites, Banana fiber, Epoxy, Mechanical properties.

I. INTRODUCTION

1. Natural Fiber: A composite material is a material which is produced from two or more constituent materials. These constituent materials have notably dissimilar chemical or physical properties and are merged to create a material with properties unlike the individual elements. Within the finished structure, the individual elements remain separate and distinct, distinguishing composites from mixtures and solid solutions. Mixture of two or more constituent materials with dissimilar physical or chemical properties. When combined, they produce a material with characteristics different from their original properties. [6]] the two main components within a composite are the matrix and fibre. The main purpose of natural fiber composite is because of its Wight saving is major parameter compared to conventional materials. While composites are lighter they can also be stronger than other materials, for example, reinforced carbon-fibre can be up to five times stronger than 1020 grade steel and only one fifth of the weight, making it perfect for structural purposes. Additional advantage of using a composite over a conventional type of material is the chemical and thermal resistance and electrical insulation properties. Fibre reinforced composites, such as fibre reinforced plastic, are finding increasing use in this project and manufacture of final products for commercialization. Various conventional materials.

The properties which are obtained from natural fiber composite are more than other conventional material composites. [4] Examples of Composite Uses in electric circuits, Infrastructure, Aerospace structure and in Pipes and tanks etc. The outstanding mechanical properties and low specific mass form the basis of the increasing volume of structural applications. With reference to the environment aspects, it would be very interesting if natural fibres could be used instead of glass fibres as reinforcement in some structural applications. The properties of the composites are strongly influenced by the fibre length. The attraction in utilizing natural fiber, for example, distinctive wood fiber and plant fiber as support in plastics has expanded drastically throughout last few years. In recent industrial applications the natural fibers as reinforcement in plastic has rapid increase in application. [6] They are renewable raw materials and have relatively high strength and stiffness. About the ecological viewpoints if natural fibers might be utilized rather than glass fibers as protection in some structural provisions it might be extremely intriguing Natural fibres have many advantages likened to glass fibres, for example they have low density, are recyclable and biodegradable. Additionally, their low-density values permit producing composites that combine good mechanical properties with a low specific mass. In tropical countries like Malaysia, fibrous plants are available in plenty and some of them like banana are agricultural crops. Banana fibre at present is a waste product of banana cultivation.

Hence, without any additional cost input, banana fibre can be obtained for industrial purposes. Banana fibre is found to be good reinforcement in polyester resin. [3] The use of

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natural fiber rather than conventional materials is because it has low thickness low specific weight and recyclable Also, they are crude materials and have generally great mechanical properties and stiffness.

Natural fibers are classified on the basis of the origin of source, into three types

1) Plant Fibers
2) Mineral Fibers
3) Animal Fibers

Plant Fibers: The plant fibers selection based on its cellulose content .i.e. percentage of cellulose examples, flax, cotton, jute, bamboo, ramie, coir hemp, and sisal. Fruit fibers are the fibers usually are obtained from the fruit of the plant, e.g., banana fiber and coconut fiber. Likewise, stalk fiber are the fibers which are obtain from the stalks (rice straws, bamboo, wheat and barley). And Skin fibers are those fibers which are obtained after the skin adjacent the stem of the plant. Leaf fibers are the fibers which are obtain from the leaves (agave and sisal).

The natural fibers are used in various applications. The classification of fibers is: Seed fibers are those which obtain from the seed e.g., cotton and Kapok. These fibers having better tensile properties than the other fibers. Because of this reason these fibers are used in many applications such as packaging, paper and fabric.

Mineral Fibers: These fibers are obtained from minerals. These are naturally happening fiber or somewhat changed fiber: Asbestos is the main characteristically trendy mineral fiber. It has different classifications they are taking after the Variations in mineral fiber are the serpentine, amphiboles and anthophyllite. The Ceramic filaments are glass fiber, aluminum oxide and boron carbide. Metal filaments join aluminum strands.

Animal Fibers: Animal hair are the strands got from creatures e.g., Sheep's downy, goat hair, horse hair, alpaca hair, and so forth. Animal fiber by and large comprises of proteins; cases, silk, alpaca, mohair, downy. Silk fiber is the filaments met from dry saliva of bugs or creepy crawlies throughout the time of planning of cocoons. Avian strands are the fiber from fowls. Composites of natural fiber used for drives of structural, but typically with artificial thermoset matrix which of course bound the environmental benefits. Now natural fiber composites application is usually found in building and automotive industry and the place where dimensional fidelity under moist and high thermal conditions and load bearing capacity are of importance. Natural fibers like cotton, sisal, jute, abaca, pineapple and coir have already been studied like a reinforcement and filler in composites.

Among many natural fibers, banana fiber is considered as a potential reinforced in polymer composites due to its many advantages such as easy availability, low cost, similar strength properties etc. Generally, natural fibers are consisting of cellulose, lignin, pectin etc.

Table 1: Properties of Banana fibers [4]

Properties	Range
Cellulose (%)	63-64
Micro febrile angle	11
Hemi cellulose (%)	6-9
Lignin (%)	5-10
Moisture content (%)	10-11
Density (kg/m^3)	1350
Lumen size (mm)	5
Tensile strength (MPa)	529-914
Young's modulus (GPa)	27-32

2. Epoxy Resin: Lapox L12 is a liquid, unmodified epoxy resin of medium viscosity which can be used with various hardeners for making glass fibre reinforced composites. The choice of hardener depends on the processing method to be used and on the properties required of the cured composite. Hardener K6 is a low viscosity room temperature curing liquid hardener. It is commonly employed for hand lay-up applications. Being rather reactive, it gives a short pot life and rapid cure at normal ambient temperatures. Laminates can be subjected to operating temperatures of 100^0 C.

Figure 1: Epoxy Risen

II. METHODOLOGY

The steps required to prepare material and the methodology to prepare the specimen as follows,

- Banana fiber
- Epoxy
- Hardener

All the steps for the preparation of non-woven banana fiber reinforced epoxy composites are

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- Extracting the natural banana fiber
- Retreating the dried banana fibre
- Mould Preparation
- Epoxy and hardener are mixed with a ratio of [10 :1]
- Preparation of the specimen
- Tensile and Bending testing.[1]

III. EXPERIMENTAL WORK

3.1 Extracting the natural banana fibre

The extraction of banana fiber is done. From the fully grown trunk after the fruit has been plunked in order to avoid the fruits becoming wasted. Then, the banana trunks are placed under the sunlight to remove its moisture content at least for two weeks. After the banana trunks are dried, they are soaked in the water for another two weeks. The banana fibers are need to be soaked in water two weeks because it will be helpful in thinning the dried banana fiber so it's important step to be soaked in water. And there after again the fibers are kept to dry under sunlight for 24hrs.

Figure 2: Extracting the natural banana fibre [1]

3.2 Retreating the dried banana fibre

After banana fibres were fully dried, they must be cut horizontally in order to get the average width of fibre between 10 and 15 mm. The longest and the shortest fibre are 137 and 77 cm in length, respectively as shown in figure 3.

Figure 3: Retreating the dried banana fibre

3.3 Mould preparation

Instead of using mould as a mild steel, here we have used glass sheet as a mould as shown in figure 4. Initially a removing agent is applied on the glass sheet for the easy removal of the composite as shown in figure 4.

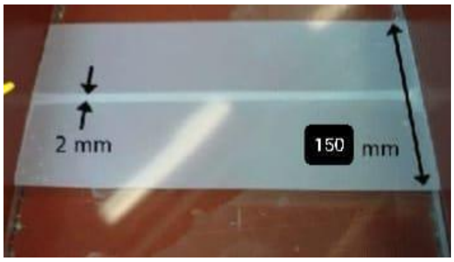

Figure 4: Mould preparation

3.4 Epoxy and hardener are mixed with a ratio of [10:1]

The composites are fabricated by hand lay-up technique. The required mixture of Lapox L12 resin and hardener K6 was made by mixing them in (10:1) ratio in a beaker while stirring the mixture by a rod, taking into care that no air should be entrapped inside the solution. The mixture was applied on to the fibre, keeping in measuring the requirements of various testing condition and characterization standards as shown in figure 5.

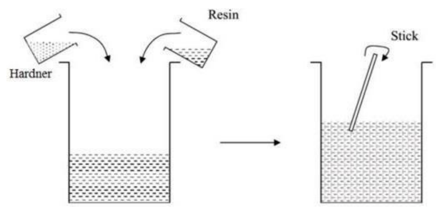

Figure 5: Epoxy and hardener are mixed with a ratio of [10:1]

3.5 Specimen preparation

- Before the fiber is laid on the glass sheet, the glass sheet is applied by a removing agent called grease or waste oil in order to remove fabricated layer of composite.
- Then the first layer of fibers are cut and placed on a glass sheet of equal size.
- In a 500ml beaker the epoxy and hardener are mixed in the ratio of 10:1 and stirred continuously.
- Using a special brush, the epoxy mixture is laid up uniformly for the first layer on to the mould.
- The second layer of banana fibre is then applied.
- Another layer of epoxy is uniformly applied on the banana fibre.
- Then the composite is closed by a glass sheet and a load is applied on that in order to get uniform distribution of epoxy mixture on the fiber and the composite material was pressed uniformly for 24 hr for curing.

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- After the composite fibres are fully dry, then the glass sheet is separated.
- The composite fibres are cut to specimen sizes ready for testing as shown in figure 6.

Figure 6: Specimen preparation

Figure 7: Specimen for tensile test

IV. TENSILE TEST

Fabricated composite was cut to get the desired dimension of specimen for mechanical testing. For the tensile test, the specimen size was 30mm width, 250mm of length, 8mm thickness and gauge length was 170 mm. Tensile strength was tested in UTM Machine. The specimen with desired dimension was fixed in the grips of the UTM Machine. The experimental set up for tensile test is shown in Figure 8.

Figure 8: Experimental set up for tensile test

Figure 9: Specimen after tensile test

V. BENDING TEST

Bending tests are conducted by placing a length of material across a span and pushing down along the span to bend the material until its failure. Specimen dimension for bending test was 130 mm × 30 mm × 9 mm and the same UTM Machine was used for bending test. The experimental test set up for bending test is as shown in Figure 10.

Figure 10: Experimental set up for bending test

VI. RESULTS AND DISCUSSIONS

6.1 Tensile Test

Mechanical properties of composites such as bending strength, tensile strength, has been investigated for the percentage weight of fiber 27% and percentage weight of matrix i.e. 73%. Tensile test the mechanical properties of the composite are mainly depending on many factors such as fiber content and length. In tensile test the following result was obtained.

Test Type	Tensile
Max Displacement	8.37 mm
Elongation	4.92%
Ultimate load	10.780 kN
Yield load	8.590 kN
Yield Stress	0.036 kN/mm^2
Ultimate Stress	0.045 kN/mm^2

The Load vs Displacement graph is shown in below that shows as the load increases displacement also increases.

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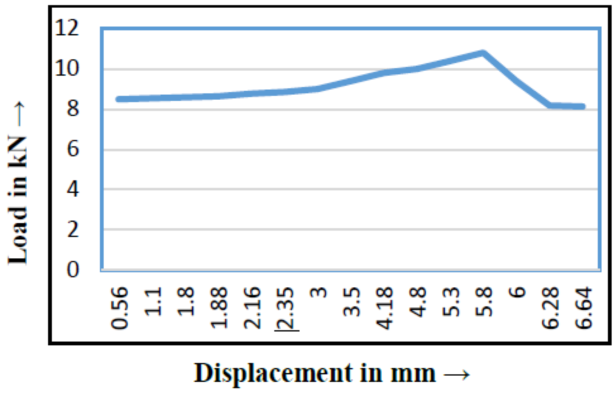
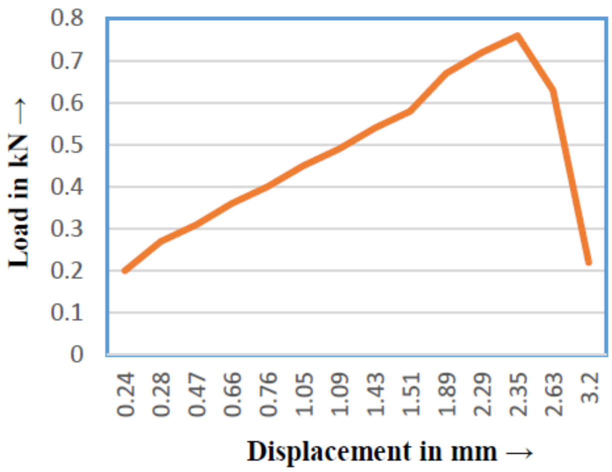


6.2 Bending Test

The mechanical properties of the composite are mainly depending on many factors such as fiber content and length. In bending test the following result was obtained.

Test Type	Compression
Ultimate Load	0.760 kN
Displacement at Fm	2.33 mm
Max Displacement	4.28 mm
Elongation	3.89 %
Compressive Strength	0.003 kN/mm^2

The Load vs Displacement graph for bending test is as shown below.



VII. CONCLUSION

The Fabrication of Banana Fiber based Epoxy composite processed by hand lay-up method. By this project we came to know the mechanical strength of the banana fiber when it is mixed with the Epoxy and Hardener with a ratio of 10:1 and that of percentage weight of fiber and matrix is 27% and 73% respectively, To know the various mechanical properties of the Banana Fiber we have conducted Tests such as Tensile and Bending Test.

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