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Characterization of natural fiber reinforced polymer composites

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ABSTRACT

Natural fiber composite is obtained from nature in the form of leaf, seeds, tree and fruit wastage from these are used for the manufacture of composite materials to deliberately combine to form heterogeneous structures with desired properties. This is also called reinforced polymer composite materials. The natural fiber reinforced polymer composite is rapidly growing both in terms of their industrial applications and fundamental research. Before scientists have created many natural fibers from different materials (coir, hemp, flax, kenaf) they also determined the physical properties of these composite materials. I have created the composite material using the fiber of Palm tree and I have found the mechanical characteristics like tensile strength, hardness, impact strength, water absorption and flexural rigidity of the composite materials. Our material is used to manufacture the automobile body, construction board, insulation board, plywood, flooring, and manufacturing of chair and seat etc. This Palm is in abundant is available it is weightless material and has desired strength, low specific gravity.

Keywords— *Natural fibers (Palm), Epoxy resin, Hardener, Patterns*

1. INTRODUCTION

Composites is a material made from two or more constituent materials with significantly different physical or chemical properties that, when combined, produce a material with characteristics different from the individual components. The individual components remain separate and distinct within the finished structure, differentiating composites from mixtures and solid solutions.

2. MATERIAL PREPARATION

The details of processing of the composites and the experimental procedures followed for their characterization and tri biological evaluation. The raw materials used in this work are:

- Palm tree Fiber
- Epoxy resin

2.1 Preparation of palm fiber

The palm fiber is cut from the palm plant then the green skinny later is removed and the inner yellow layer like fiber thread is taken for the process. We must select a middle-aged plat due to its mechanical characteristics then they are cut down to a length of 30cm then they are treated with water and chemical.

Chemical treatment: The palm fiber is cleaned in cold water for 3 times and then dried in sunlight for 2hrs then it is soaked in chemical containing 80%distilled water and 20%NaOH then dried in sunlight for 3hrs at the end the palm fiber will turn into coffee-like appearance.

Pattern making: Two wooden plates of same dimensions (41.5x59.5x3.5cm) are taken. One of them is a base plate and the other one is the top plate these plates have holes drilled to fix the nuts and bolt. The palm fiber is placed in-between the plates to compress and manufacture the material.

2.2 Preparation of epoxy hardener

In an ml beaker, EPOXY LY is added (60%), hardener 956 (10%) they are stirred of 5mins then Epoxy 178 (30%) is added and stirred for 3mins. This type of resin takes 2-3hrs to dry and settle. The bonding of fiber particles is in the matrix form. The resin properties can be changed by changing the ratio of epoxy and hardener. The setting time of composite is about 3-5 days. Epoxy and hardener have to be mixed in thru ratio of 10:1.

2.3 Fabrication process

The top surface of the base plate and top plate are covers by a plastic sheet and melted wax is poured over the sheet of thickness 1-2mm. After the wax is dried epoxy resin is poured over it. Then the palm fiber is arranged in horizontal Direction of the pattern. Epoxy resin is again poured then the whole bed of the layer is pressed evenly by hand laminating molding method with the help of hand roller. Another layer is created by the same method but the fiber is in a vertical direction then the epoxy resin is poured over it. The thickness of each layer is 25-30mm.

The nuts in the plates are tightened by using a spanner to apply equal force to compress the fiber layer. The force is applied in equal interval of time for every 1hr. After 24hrs the fiber is dried in sunlight to form a reinforced composite. Then the pattern is disassembled to take out the composite.

3. CHARACTERISATION OF COMPOSITES

A composite material consists of two phases. It consists of one or more discontinuous phases embedded in a continuous phase. The discontinuous phase is usually harder and stronger than the continuous phase and is called the "reinforcement" or "reinforcing" material, whereas the continuous phase is termed as the "matrix". The matrix is usually more ductile and less hard. It holds the dispersed phase and shares a load with it. Matrix is composed of any of the three basic material types i.e. polymers, metals or ceramics. The matrix forms the bulk form or the part or product. The secondary phase embedded in the matrix is a discontinuous phase. It is usually harder and stronger than the continuous phase. It serves to strengthen the composites and improves the overall mechanical properties of the matrix. Properties of composites are strongly dependent on the properties of their constituent materials, their distribution and the interaction among them. The composite properties may be the volume fraction sum of the properties of the constituents or the constituents may interact in a synergistic way resulting in improved or better properties. Apart from the nature of the constituent materials, the geometry of the reinforcement (shape, size and size distribution) influences the properties of the composite to a great extent.

Fig. 1: Fabricated composite material

The concentration distribution and orientation of the reinforcement also affect the properties. The shape of the discontinuous phase (which may be spherical, cylindrical, or rectangular Cross-sanctioned prisms or platelets), the size and size distribution (which controls the texture of the material) and volume fraction determine the interfacial area, which plays an important role in determining the extent of the interaction between the reinforcement and the matrix. Concentration, usually measured as volume or weight fraction, determines the contribution of a single constituent to the overall properties of the composites.

It is not only the single most important parameter influencing the properties of the composites but also an easily controllable manufacturing variable used to alter its properties.

4. MATERIAL TESTING

After completing the fabrication process the material is tested in order to study and understand various mechanical/ Physical Properties of the product. Tests such as tensile test, Hardness test, Flexural test, impact test, and water absorption test are conducted and the result is discussed.

4.1 Tensile test

Specimens are placed in the grips of a Universal Test Machine at a specified grip separation and pulled until failure. For ASTM D638 the test speed can be determined by the material specification or time to failure (1 to 10 minutes). A typical test speed for standard test specimens is 2 mm/min (0.05 in/min). An extensometer or strain gauge is used to determine elongation and tensile modulus. Depending upon the reinforcement and type, testing in more than one orientation may be necessary. The specimens are prepared as per standard as shown in figure 2 and test is carried as per standard procedure.

Fig. 2: Specimen prepared for the tensile test

Table 1: Tensile test data

Initial Length in mm	Final Length in mm	Initial Area in mm^2	Final Area in mm^2	% elongation in length	% reduction in area
50	58.5	152.5	122.08	17	19.95
50	59	142.5	116.6	18	22.20
50	56	155.7	122.08	12	21.59

The composite material test result is shown in table 1 and 2 and the graph also plotted below in figure 3. The three samples are taken into the test each sample have different ultimate tensile strength. The outputs are plotted in different graphs that are shown below. Test details are as follows:

Table 2: Tensile test report

Data	Specimen 1	Specimen 2	Specimen 3
Thickness	14.60 mm	12.470 mm	16.80 mm
Width	10.30 mm	10.10 mm	8.70 mm
Area	150.38mm2	128.27mm2	146.16mm2
Gauge length	50.00 mm	50.00 mm	50.00 mm
F max	0.66KN	0.66KN	1.38KN
UTS	4.40MPa	5.18MPa	9.44MPa

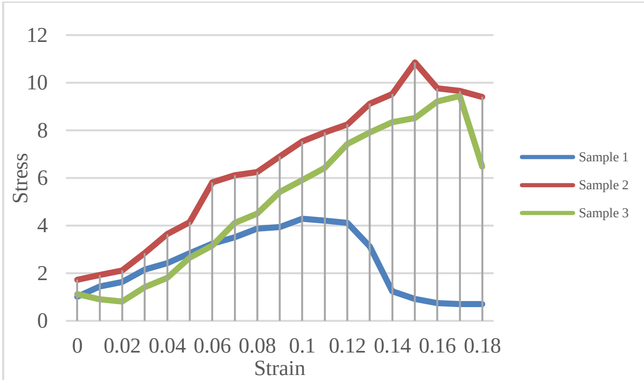

Fig. 3: Stress-Strain graph of the test result

4.2 Hardness test

There are several scales of durometer, used for materials with different properties. The two most common scales, using slightly different measurement systems, are the ASTM D2240 type A and type D scales. The A scale is for softer plastics, while the D scale is for harder ones. However, the ASTM D2240-00 testing standard calls for a total of 12 scales, depending on the intended use; types A, B, C, D, DO, E, M, O, OO, OOO, OOO-S, and R. Each scale results in a value between 0 and 100, with higher values indicating a harder material.

Table 3: Harness test result

S. No.	Durometer	Intending foot 0.1 mm R Tip	Resulting force
1	Type D	Cone 30	61
2	Type D	Cone 30	64
3	Type D	Cone 30	66

4.3 Flexural test result

The flexural test measures the force that required to blend a beam under three points loading situations. That data is often used to select elements for parts that will support the loads without any change in the form in inflection. Flexural modulus is used as an indication of materials stiffness during inflection. Since the physical properties of many elements vary depending on the ambient temperature it is possible to test materials under certain temperatures that simulate the intended end user environment. The prepared specimen for the purpose is shown in figure 4 below.

Fig. 4: Specimen for the flexural test

Table 4: Flexural test result

Load in N	Deflection in mm	Modulus of elasticity in N/mm^2	Flexural rigidity in $N\text{-}mm^2$
340	5.9	27.74	50.135×10^3

4.4 Charpy impact result

In order to find the impact strength of the product, the the specimen is prepared as per the standards are shown in figure 5 and the Charpy test is carried out in impact testing machine.

Fig. 5: Specimen for impact test

Table 5: impact test result

S. No.	Impact strength in J
1	2
2	2
3	2

4.5 Water absorption test

Water absorption is used to find the amount of water absorbed under specified conditions. The effect of absorption of moisture leads to the degradation of fiber-matrix interface region creating poor stress transfer efficiencies resulting in a reduction of mechanical and dimensional properties. Certain factor that affects the water absorption process test is as follows:

1. Type of plastics
2. Additives
3. Temperature and length of exposure.

This test is taken by weighing the composite without any water absorption and with water. The composite is dumped into the water for twelve hours and then the weight is measured and compared with a normal weight of the composite.

Table 6: Absorption test result

Polymer composite material	Mass before the test (gm)	Mass after the test (gm)	(%) gain of water
Palm tree	310	320	3.125

4.6 Density test result

Density is a term used to describe the relationship between the weight of the substance and its size. Density is the physical property of every substance. Every substance has different density it can be measured by different methods. In this method, we calculate the density by a simple formula method. The mass of the composite material is measured and then the volume of the composite is measured. By use this equation to find the density of the composite:

$$\text{Density} = \text{Mass}/\text{Volume}$$

Table 7: Density test result

Polymer composite material	Mass(m) (Kg)	Volume (10^{-4} m^3)	Density, (Kg/m^3)
Palm tree	310	320	3.125

5. CONCLUSION

This work shows that successful fabrication of a Palm tree fiber reinforced epoxy composites by simple hand lay-up technique. Mechanical characteristics of these composites can be successfully analyzed. It found that polymer reinforced Palm tree natural composite is the best natural composites among the various combination. It can be used for manufacturing of automotive seat shells, plywood, automobile body, construction board, insulation board, flooring and manufacturing of chair and seat among the other natural fiber combinations.

6. SCOPE FOR FUTURE WORK

This study leaves wide scope for future investigations. It can be extended to newer composites using other reinforcing phases and the resulting experimental findings can be similarly analyzed.

Characterization of palm tree fiber reinforced epoxy resin composite has been a much less studied area. There is a very wide scope for future scholars to explore this area of research. Many other aspects of this problem like the effect of fiber orientation, loading pattern, wear and structural analysis response of such composites require further investigation.

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