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Investigation on Properties of Luffa and Coir Reinforced Polymer Composites

K Ramachandra Raju, G Senthil Kumar,M Ragul, M.Rajarajachozhan, SSandeep
Department of Mechanical Engineering, Bannari Amman Institute of Technology,
Sathyamangalam 638 401, Tamilnadu, India
E-mail id: ragulm.me16@bitsathy.ac.in, sandeep.me16@bitsathy.ac.in

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Abstract:

Improvement in the usage of the materials which are not suitable for the environment and harmful to the living beings, many of the researchers turned their vision towards the natural products. Although lot of synthetic fibers were available in our surroundings with sufficient mechanical and physical properties such as high flexibility with good strength, heat and chemical resistant, we stepped our project related to natural fibers. Nowadays, Natural fibers are the replacement of synthetic fibers in various fields because of their properties similar to the synthetic fibers and is efficiently low cost and nontoxic to the environment. In our paper we choose two natural fibers luffa and coir fibers which have been randomly oriented with the high strength and low shrinkage and biodegradable epoxy resin were accomplished in different form due to their particle size, short fibers and long fibers. Present work famous that mechanical properties such as tensile strength, hardness, longevity take a look at of the epoxy resin increases to great quantity while it get reinforced with the fiber. The main purpose of the project is to improve the usage of the natural products over the synthetic fibers to make the product as an ecofriendly to the environment.

Keywords—**Coir fiber, Luffa fiber, Hand lay-up method, Chemical treatment**.

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I.INTRODUCTION

Nowadays the interest of the researchers move towards the natural fibers because of its fabulous features. Due to the increased damage to the environment due to the harmful products and improper awareness about the synthetic fibers many of the industries should prefer it for their welfare and to satisfy their need of their consumers. To overcome this, many researchers implemented their work in the field of natural fibers. Natural fibers were considered as the better reinforcement with the thermoplastic and thermosetting plastic materials when it gets reinforced with the two fibers and the biodegradable epoxy resin. Many of the researchers did their concentration in the composite material. The composite material refers to the combination of two or more material. In our research work, we took about the brief study in the Luffa and Coir natural fibers as a reinforcement and epoxy resin and hardener as a matrix.

Due to the fabulous features of the natural fibers such as high elasticity, good strength, high stiffness, low weight and cheaper cost, we chose the two easily available fibers – Luffa fiber and coir fibers.Luffa fibers extraction is very simple compared to the other natural fibers. The ripened *Luffa acutangula* fruits have been collected from the nearby villages and get dried. *Luffa acutangula*consists of two layers, one is the inner

fiber material and other is the outer yellow core. The outer core gets washed in the sunlight to remove the impurities. The inner fiber gets removed and subjected to reinforcement.

Coir is one of the most important by-product of the coconut. Coir gets extracted from the outer husk of the coconut. The coir fiber is relatively low cost and not harmful to the environment and it provides a huge resistant over salt water.

Bhanu k. Goriparthiet al (2012) [1]investigated the jute fiber and made the discussions with the co-authors about the surface treatment properties and mechanical properties of the especial jute fiber. Their main focus is to improve the adhesion character of the jute fiber. They used the polylactide for the reason. In their work they used the treated jute fiber with the unidirectional composites by the hot-pressing method. The mechanical properties such as tensile test, flexural test gets improved and the result obtained in the Izod test gets reduced. As a result, wear resistance of the jute fiber is sensitive to the adhesion.

Sulawankaewkuk et al (2013) [2]discussed about the physical properties of the sisal fiber and its fiber content and the interfacial modifications of the fiber. They keep on testing about the mechanical, morphological, thermal and the water absorption characters of the Sisal fiber. They characterized the fiber based on fiber content into the 10, 20, 30 weight percentage. With improving the fiber content, modulus and tensile strength, water absorption qualities get improved and the impact strength and elongation gets decreased.

Hari Om Mayuraet al (2015)[3]investigated their research work on the short sisal fiber with the epoxy resin and they done detailed study about the mechanical properties of the Sisal fiber. Their main motto is to use the natural fiber for their fabulous feature such as low density, low cost and special mechanical features. The fibers gets classified based upon the fiber length such as 5, 10, 15 and 20 mm but 30 percent constant fiber content. The result obtained by them is that the tensile strength was not improved but the flexural strength gets improved.

R.Panneerdhass et al (2014)[4] discussedabout the Mechanical properties of Luffa fiber and Groundnut reinforcement with the Epoxy Polymer hybrid composites. Luffa fiber and Groundnut fiber had been developed by using the Hand layup method and both the fibers are treated equally at the percentage of 1:1. By using the both fibers they discussed about the Tensile, Compressive, Flexural and the Impact strength of it. As a result, the effect of mechanical properties was obtained at 40 percent of fiber volume fraction of treated fiber composites.

From all of the above discussions made by the scientists we have planned to use both the Luffa and Coir fibers gets reinforced with the epoxy polymer composites. Here we use Luffa and Coir reinforcement as a matrix and epoxy as a resin. Hand lay-up method is used for our work because we use the hybrid fibers. We analyze the mechanical properties such as tensile test, impact test and toughness test and compared with the previous work with the scientists and the result will be declared.

II. EXPERIMENTAL PROCEDURE

This chapter explains the process underwent during the fibreextraction, chemical treatment, testing and fabrication of specimen.

A.Fiber Extraction Process

The extraction method of Luffa fibers is carried out carefully with proper care. The Luffa leafs are is obtained from the *Luffa cylindrica*plant and prepared into bundle bags. The fibre is treated with 2% NaOH solution and allowed to dry in sunlight for 2-3 hours. For cutting the luffa fibre as per required dimensions a wire hack saw blade is used. The pre-treated luffa fiber filament is obtained at into 3-6cm of fiber lengthwise. Luffa fiber mat and chopped random luffa fiber material is prepared with the help of mould.

For the withdrawal of coir fiber, initially the coconut husk is obtained from the coconut fruit. When the extraction is completed at a certain degree, the fibers are allowed to dry at 70°C to 80°C at direct contact with sunlight or by using a drying oven.

Fig. 1 Luffa fiber

Fig. 2 Extraction of coir fiber

III. FABRICATION OF COMPOSITE:

B. Die Making

The primary step involved is the fabrication of the die. The tooling process required in this molding process is quite similar to that of stamping dies. The stamping dies needs external force but molding does not need any is the key difference between them. In plastic molding, two necessary components units are carefully designed in a way that, when the two units are brought together, they make up a system of closed cavities linked to a central orifice. Liquid plastic is fed through the orifice or into the cavities, or molds, depending upon the shape of the mold. Then the plastic is allowed to solidify, then the molds are opened and the finished parts are ejected from the mold.

C. Material preparation:

Coir fiber and Luffa fiber knitted fabric is used in this study. To achieve a proper mixing of the epoxy resin and its hardener they are incorporated at the volume fraction of 2:1 and are blended thoroughly. To prevent the sticking of fibers with the mould a release agent (mansion polish) is commonly used. It is decided to use the most commonly employed method in cleaning the natural fibers. Initially, the cleaning of fiber surfaces is done by the stilled water and later subjected to alkaline treatment (NaOH or KOH). Generally a 5% concentrated alkali is used. First the extracted fibers are washed with fresh water thoroughly. Then fibers are submerged in the caustic Sodium Hydroxide (NaOH) solution for 8 hours to remove any moisture presence.

A flow of fresh water is used to clean the fibers to remove any unwanted presence of the NaOH present in the fiber surface. The alkali treated fibers are allowed to be neutralized by dilute acetic acid (CH_3COOH) solution and finally water is used to wash the fibers. Then the wet fibers were allowed to dry in the absence of humidity for 10 to 12 hoursat a room temperature of 25^{o}C.

D. Hand layup process

Hand layup method is one of the simple PMC processing technique. For manufacture of composite parts the hand layup is one of the preferred and simplermethods. This wet layup process is used for processing versatile continuous fiber reinforced composites. The process involves the combination of multiple layers of unidirectional or woven composite materials to produce an advanced material which is capable of exhibiting desirable properties. The layup process is generally proceeded out using the help of hand held rollers or brushes.

Thecoir and luffa fiber are taken as the reinforcement particles in this study .The mould made of wood is used for the fabrication of the composite materials. The luffa and coir fiber particles are mixed with epoxy resin by means of simple mechanical stirring process. This mixture of fibre and resin is poured into various shaped

moulds, depending upon the various testing conditions. The composite materials of different volume fraction composition is prepared for testing procedures. Two part epoxy resin compounds are kept in two separate A - B containers. Part A is the epoxy resin and the Part B is the polyamine hardener. After the curing process of gel coat has been complete, a roll stock ofluffa and the coir fibers areplaced over the mold.

IV. TESTING STANDARDS

E. Tensile Testing

Tensile testing is otherwise known as the tension testing. The tensile test is used in the field of fundamental materials science and engineering test in which a product sample is subjected to a controlled tension until failure of the sample occurs. Universal testing machine (UTM) otherwise known as universal tester is used to investigate the tensile and compressive properties of the given test specimen by applying tensile, compressive or transverse stresses. This test method is used to determine yield strength, maximum tensile strength, elongation percentile of the material, ductility, strain-hardening characteristics, elastic modulus and Poisson's ratio and draw the stress – strain curve. The Standard testing method is ASTM A370-2018is used for performing thetensile test on the polymer matrix composites.The dimensions of the test sample are 175 mm initial gauge length, 25 mm width and having 8 mm thickness.FIE Make Universal Testing Machine, UNITEK-9450 is used for performing the tensile test and the results of the Tension Test are tabulated as shown in the table no.1. Tensile sample used in this test is shown in figure no 3.

Fig. 3 Tensile test sample

TABLE I
TENSILE TEST

Sample	Elongation %	Tensile Strength (MPa)	Tensile Modulus (GPa)
1	3.2	183	4.2
2	4.5	175	3.8
3	2.5	188	6.5

F. Hardness test

Hardness testis carried out to find the hardness of the test sample. Hardness is defined as the resistance of the material to indentation and it is measured by determining the permanent depth of indentation. It is seen that hardness is an empirical test rather than being a material property.For finding the hardness of our test specimen, the Micro-hardness test is carried out in the ASTM standard E92-2016, which is achieved with the Vickers hardness test. The results are tabulated as shown in table no 2.The sample used in this test is shown in figure no 4.

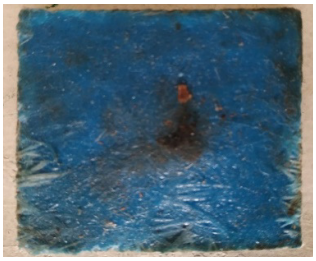

Fig. 4 Hardness test sample

TABLE II
HARDNESS TEST

Sample	Hardness value (HV)		
	Trial 1	Trial 2	Average
1	124	120	122
2	110	110	110
3	90	94	92

G. Impact test

We mainly focused on the three main mechanical properties, one of the most important test is the Impact test. Impact test is used to analyze the dynamic tear of the work tool when the load gets applied.

Charpy impact Test is otherwise known as V-notch Charpy Test. This test is carried out to find the amount of brittle fracture absorbed by a material while testing. This test is also used as an indicator to determine the several suitable temperatures. The Charpy test is similar to the impact test. The specimen used for charpy test has the dimensions of 55mm*10mm*10mm. The specimen consists of V-notch of about 45 degrees at the room temperature of 25^0 C. To perform the test, the pendulum set at the preferred height is allowed to hit on the test sample and the notched sample is thrown away. As from the results, we find out the fracture of the material.The results are tabulated as shown in table no 3.The sample used in this test is shown in figure no 5.

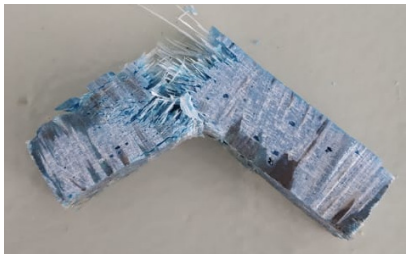

Fig. 5 Hardness test sample

TABLE III
IMPACT TEST

Trial no.	Room temperature (^{0}C)	Charpy Impact value(J)		
		Sample 1	Sample 2	Average
1	25	108	118	113
2	25	114	110	112
3	25	114	108	111

V. CONCLUSION

As a view of a traditional strategy, we get shifted our work to the natural fiber from the synthetic fiber. Although lot of natural fibers were available we used only Luffa and Coir fiber because we wish to done our job on the new combination of fibers. Natural fibers were mostly preferable than the synthetic fibers because of its fantastic performance in all the areas such as high strength, low cost, good mechanical properties, easily available and most importantly eco-friendly to the environment. We preferred only hand lay-up method other than the new technologies because of the new combination of fibers is used. The reinforcement matrix of the Luffa and Coir fiber with the composition of epoxy resin and hardener provides a significant result while compared to the existing work by the previous scientists. As a result, we have reviewed the mechanical properties such as tensile, impact and the hardness properties of Luffa and Coir reinforced Polymer matrix composites.

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