Tensile and Flexural Properties of Luffa Fiber Reinforced Composite Material

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Abstract— **Interest in natural fibers as composite reinforcements has grown in recent years. A survey of recent literature shows a significant increase in the number of articles and patents relating to the use of natural fibers. Natural fibers are reported to have advantages of lower cost and better stiffness per unit weight compared to glass. For environmental concern on synthetic fibers (such as glass, carbon, and ceramic fiber.etc), natural fibers such as banana, jute, coir, hemp, etc., are widely used. In this paper, the untreated luffa fiber reinforced epoxy resin matrix composites have been developed by hand lay-up technique with varying process parameters, such as different type of luffa fibers (discontinuous fiber mat and chopped single fibers) and with different volume fraction of fibers (30%, 40% and 50% by weight).The developed luffa fiber reinforced composites were then characterized by tensile and flexural test. The results are taken and graphically represented.**

Keywords— ***Luffa fiber mat, Chopped single Luffa fibers, Epoxy resin, Hand lay-up method, Volume fraction of fibers, Orientation.***

1. INTRODUCTION

Many modern technologies require material, with unusual combinations, which exhibits superior properties then the individuals. Composites have concerned considerable importance as a potential operational material. Low cost, light weights, high specific modulus, renewability and biodegradability are the most basic & common attractive features of composites that make them useful for industrial applications [5]. With low cost, high specific mechanical properties natural fiber signifies a worthy renewable and biodegradable substitute to the most common synthetic reinforcement. Composites have already proven their worth as weight-saving materials, the current challenge is to make them cost effective [5]. Now it is focused on to produce economically attractive composite components has resulted in several innovative manufacturing techniques currently being used in the composites industry.

Fibre reinforced composite is one such material, which has revolutionized the concept of high strength. Most of the natural composite materials grows from the forest and agriculture. Luffa-cylindrica locally called as “sponge-gourd” is one such natural resource whose potential as fiber reinforcement in polymer composite has not been explored till date for tribological applications [4].

It has a ligneous netting system in which the fibrous cords are disposed in a multidirectional array forming a natural mat. This fibrous vascular system is composed of fibrils glued together with natural resinous materials of plant tissue. It contains 62% cellulose, 20% hemicellulose and 11.2% lignin [7]. The fruit of the sponge-gourd (L. cylindrica) plant with fruit which is of the Curcubitacea family. It has a thick peel and the sponge-gourd, which has a multidirectional array of fibers comprising a natural mat, presents an inner fiber core. Composite materials are formed by a combination of two or more distinct materials. The combination results in superior properties not exhibited by the individual materials. Many composite materials are composed of just two phases one is termed as matrix phase, which is continuous and surrounds the other phase often called the dispersed phase. The matrix phase binds the fibres together and acts as medium by which an externally applied stress is transmitted and distributed to the fibers. Only a very small portion of an applied load is sustained by the matrix phase and major portion of is sustained by the fibres. The fibres are basically two types they are natural and synthetic fibers. Cotton, Jute and Sisal are some examples for Natural Fibres and Glass, some of the examples for Synthetic Fibres are carbon and Nylon [4]. The Natural fibres are renewable [1] and cheaper but their mechanical properties are much lower than the synthetic fibers. The synthetic fibres exhibit good mechanical properties but they are costlier and non renewable [2].

This paper examines the tensile and flexural properties of the luffa fiber mat and chopped fibre. There has been a lot of research work on different combination of natural fiber with polymer matrix composites. Few researches are going on the combination of luffa /epoxy based composites, which individually has gained lot of attraction for industries. Keeping this in view the present work has been under taken to develop a polymer matrix composite (epoxy resin) using luffa fiber as reinforcement and to study its tensile and flexural properties [6].

2. MATERIALS AND METHODS

2.1 Materials

Luffa fiber is used in this study is L.Cylindrical type and it is a lingo-cellulose material. A room temperature-cured semi flexible epoxy resin as matrix (LY556) and HY951 as hardener were used in the study.

2.2 Preparation of Fibres for fabrication

A wire hack saw is used to cut the Luffa fibres as per required dimensions to experiment. The untreated luffa fiber mat is cut into 6cm of fiber length. The untreated chopped random luffa fiber material is cut into 3 to 6mm of fiber length. Luffa fiber mat and chopped random luffa fiber material is prepared with the help of mould.

Fig. 1 Sponge-gourd (L-cylindrica) Plant

2.3 Orientation of fibers in the mould

Orientation is termed as the alignment of fiber in the mould along with the resin mix. There are many type of alignment methods, they are random, longitudinal axis, transverse axis and woven fiber of both orientations. The discontinuous (chopped) fiber mat has oriented in longitudinal axis and discontinuous single fiber materials are in random orientation.

2.4 Volume Fraction of Fibers

To obtain the highest value of the strength of composites it has been analyzed for various volume fractions (30%, 40% and 50%) of the fibers to the matrix materials. The untreated fibers are taken with required volume fractions laid in the mould of same size 300 X 300 X 3 mm and care is taken that fibers are pressed to form the size of the mould. Then the top mould is closed and bolts are tighten. Then the mould is transferred to compression press and placed under pressure for about an hour such that it compresses and forms a thin laminate shape.

2.5 Fabrication of material by Hand lay-up Method

A weight press is needed for the Hand lay-up method. The base plate was cleared of rust by scrubbing with an abrasive paper. Then the surface was allowed to dry after cleaning it with a thinner solution. After drying, the surface was coated with mansion wax. The surface was given a few minutes to get it set for the mold lay-up. The company codes for the epoxy semi polymerized resin and the Hardener/Curing agent are LY556 and HY951 respectively.

Fig. 2 Luffa fiber mat

They were mixed in the proportion of 10:1 (LY556 & HY 951). The curing time or the pot life, which was how it was usually notified in the laboratory charts, is usually 20 minutes once mixed. Things should be taken care of so that the resin does not cure in the curing pot itself. A constant watch over the blend in the pot was made with the aid of a stop clock. A plate of dimensions 300 x 300 x 3 mm was fabricated by this process. A beaker is taken and the resin is about 320 to 350 grams which is nearly equals to the volume of the mould, is poured on to it. And next step hardener is added to the resin in about 10% of the resin by quantity. The resin mix is thoroughly mixed in the beaker such that the resin and hardener get dissolved fully.

When the resin mix is ready, it is poured on the mould such that it fills up initial base area fully. Then the prepare fiber laminate is taken and placed on to the mould again. The balance resin is poured on the fiber kept on the mould and care is taken such that the fiber material is entirely soaked in the resin and the top plate is closed and bolts are tightened.

2.6 Experimental Procedure

Tensile test was carried out on the UTM machine in accordance with ASTM D 3039-76 standard to find the tensile properties of 30, 40, 50% volume fraction of fiber. And for the flexural test three point bend test was carried out in an UTM machine in accordance with ASTM standard to measure the flexural strength of the composites. The span length was 70mm. The experiment was conducted on samples of luffa fiber mat and as well on chopped luffa fibers combinations and the results are taken and are mentioned in the below table. All the specimens (composites) were of rectangular shape having dimension of 300 X 300 X 3mm.

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3. RESULTS AND DISCUSSION

Table. 1 Tensile and flexural strength properties of the luffa composite material for different volume of the fraction of fibers.

Sample	Volume fraction of fiber %	Type of reinforcement	Tensile strength N/mm^2	Tensile modulus KN/mm^2	Flexural Strength N/mm^2
1	30	Luffa fiber mat	9.5	4.76	38.57
2		Chopped Luffa fibers	13.5	4.53	25.95
3	40	Luffa fiber mat	19.5	3.48	62.49
4		Chopped Luffa fibers	13.65	7.58	31.67
5	50	Luffa fiber mat	14.45	4.65	46.82
6		Chopped Luffa fibers	15.75	6.3	34.63

4. COMPARISON OF MECHANICAL PROPERTIES

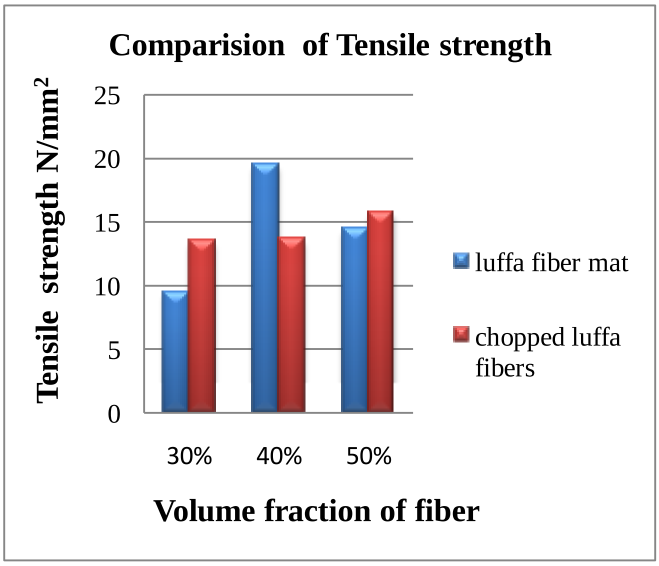

Fig. 3 Comparison of tensile strength with different volume fraction of fibers.

Tensile strength of luffa fiber mat reinforced composite materials is first increases and then decreases with increases of volume fraction of fibers. Tensile strength of chopped luffa fiber reinforced composite materials is increases with increases of volume fraction of fibers. The highest value of tensile strength is 19.5 N/mm^2 at 40% volume fraction of fibers.

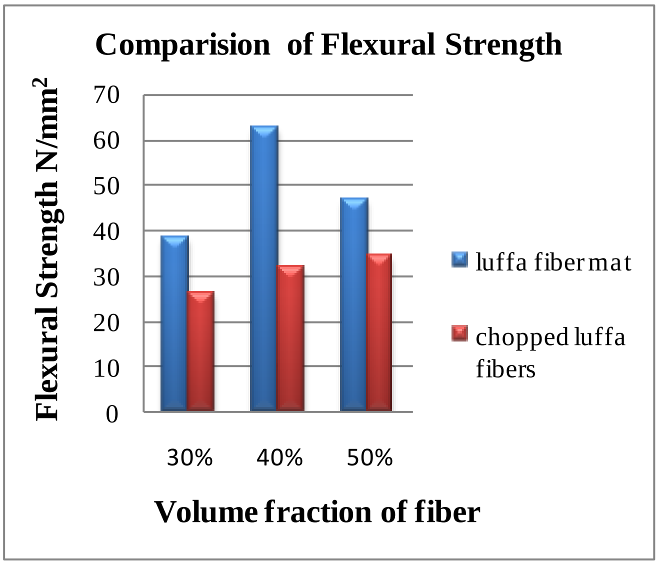

Fig. 4 Comparison of flexural strength with different volume fraction of fibers.

Flexural strength of luffa fiber mat reinforced composite materials is first increases and then decreases with increases of volume fraction of fibers. The highest value of tensile strength is 62.49 N/mm^2 at 40% volume fraction of fiber. Flexural strength of chopped random luffa fiber reinforced composite material increases with increases of volume fraction of fibers. The highest value of flexural strength is 19.5 N/mm^2 at 50% volume fraction of fibers.

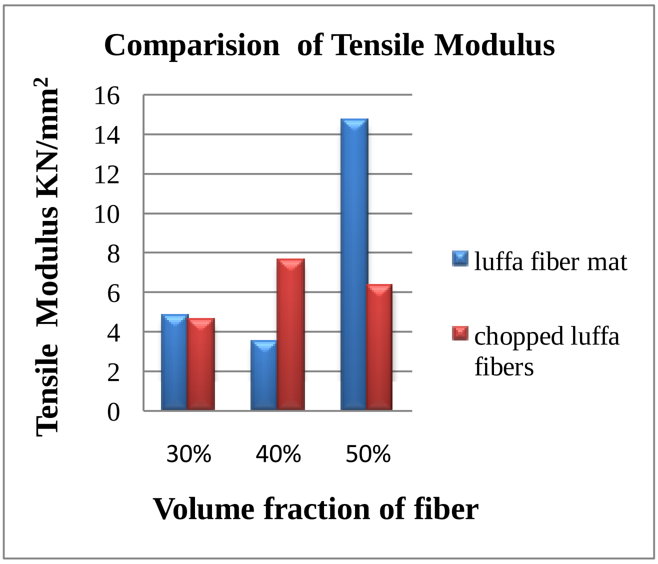

Fig. 5 Comparison of tensile Modulus with different volume fraction of fibers.

5. CONCLUSION

Natural fiber can be a potential candidate in making of composites, especially for partial replacement of high cost glass fibers for load bearing application. From the point of view of wood substitution, natural fiber composites boards could offer an excellent eco-friendly solution as wood substitutes. From the results, when luffa fibers are used with reinforcement in epoxy resin matrix, it has been observed that the highest value of tensile strength is obtained at 40% volume fraction of fiber and its strength at 50%. And maximum flexural strength was also obtained in luffa fiber mat reinforced composite materials at 40% volume fraction of fibers when compared to other volume fractions. When compared with chopped luffa fibers, luffa fiber mat has maximum strength. Decrease in flexural strength and tensile strength may be due to insufficient matrix material. Possibility of using these types of composites is where ever required a light weight such as in building and construction industry and as well as storage devices.

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