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Analysis of Ficus Benghalensis Aerial Roots Fibre for Composite Application

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***Abstract*: When compared to composite composites made entirely of synthetic components, natural fibers are more affordable and more plentiful. The goal of this work is to forecast the compressive and tensile characteristics of natural fiber-reinforced composite materials. The results were compared. The hand-lay-up procedure was utilized in this inquiry to manufacture the composite of the aerial roots of banyan trees. In accordance with ASTM D 638 guidelines, specimens for the tensile test were sliced from the manufactured laminate. Following that, the experiment is run on a universal testing machine (UTM). Tensile and compressive characteristics of the composite material were addressed based on test results. Due to its many advantages, including low cost, low density, high strength and stiffness to weight ratio, low energy consumption, low pollutant emissions, and biodegradable materials, banyan tree aerial roots are widely used in a variety of engineering applications and as a suitable alternative material.**

***Keywords*: NFRC, Ficus Benghalensis aerial roots, hand-lay-up method, tensile & compressive properties, ecofriendly.**

1. Introduction

Composite materials are gaining a lot of attention these days, both in terms of applications and research. Higher specific qualities, such as tensile, impact, and flexural strengths, stiffness, and fatigue characteristics, provide composite materials an edge over other traditional materials and allow for more adaptable structural design. Their numerous benefits have led to their extensive use in the aerospace sector, as well as in a wide range of commercial mechanical engineering applications, including internal combustion engines, cars, train coaches, thermal control and electronic packaging, flywheels, drive shafts, tanks, brakes, pressure vessels, and other mechanical components; process industry equipment that needs to be resistant to high-temperature corrosion, oxidation, and wear; and dimensionally stable components. underwater constructions, biomedical gadgets, and sports and recreation equipment. According to its definition, a composite material is one that has two or more unique elements, each of which has a separate interface and exhibits considerably different macroscopic behaviour. None of the components by themselves can adequately capture its qualities. Constituent materials are the discrete parts that make up a composite material. An embedded discontinuous phase or phases embedded in a continuous phase is the typical configuration of a composite's components. The matrix is the continuous phase, while the discontinuous phase is known as the reinforcement. Most of a composite's mass is often found in the matrix phase. By keeping the reinforcing components in their proper places, the matrix material envelops and supports them.

The methods of open mold fabrication,

- Hand lay-up
- Spray-up method
- Tape Lay-up

A. Hand lay-up

The Hand Lay-up procedure is the most often used kind of Open Molding. The following procedures are part of the labour-intensive, sluggish, manual Hand Lay-up process. Releasing the Mold from the surface is achieved by applying a coating of release anti-adhesive chemical on the mold. Application of gel coating forms the part's principal surface layer. Tissue reinforcement with tiny fibers is put on top. Reinforcing fibers in the form of chopped strands, roving's, or woven fabric are placed in layers together with liquid matrix resin. Rolling or brushing the resin mixture on is an option. (Usually at room temperature) The component is cured. Part is taken out of the surface of the mold. Two drawbacks of the Hand Lay-up process are that the composites have poor densification (caught air bubbles) and a low concentration of reinforcing phase (up to 30%).

B. Spray-up method

Two distinct sprays are used in the Spray-up process to apply chopped reinforcing fibers and liquid resin matrix to the mold surface. The fibers are cut into 1-2 (25–50 mm) length segments, and an air jet is used to spray both the resin and the reinforcing phase at a specified ratio. Although the Spray-up process may quickly build a homogeneous composite coating, it cannot employ continuous reinforcing fibers, hence the material's mechanical qualities are only mild.

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Fig. 1. Banyan Tree (or) Ficus benghalensis

C. *Tape-lay up*

Using this technique, a tape application robot applies layers of prep reparation (a reinforcing phase soaked by liquid resin) tape to the mold surface.

2. Methods and Methodology

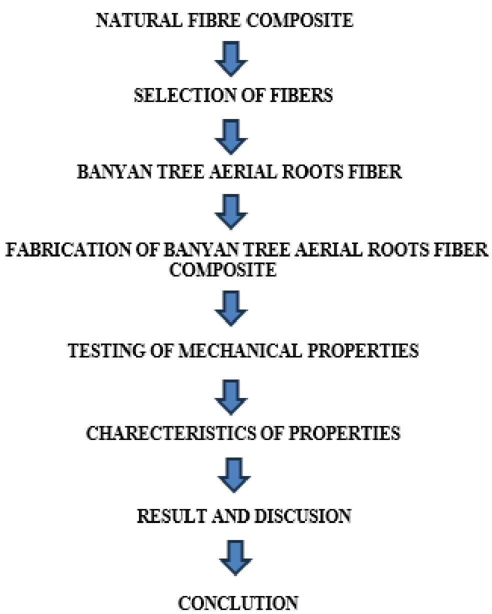

Fig. 2. Methodology

A. *Selection of Material*

This section explains the specifics of the composites' production as well as the experimental methods used to characterize their mechanical properties. Aerial roots are the basic elements employed in this work.

B. *Banayan tree aerial root fibre:*

The surrounding environment has been used to extract the aerial roots of the banyan tree. which is found in the state of Tamil Nadu. The Fig. 1 depicts the Banyan tree.

After gathering the tree's aerial roots, they should be removed. Then, using a sickle, carefully force the banyan tree's aerial roots. These are then soaked in a pail of regular water and allowed to retank for two to three days. Gloves are used to remove the biological waste from the bucket's top when the soaking procedure is complete. The outer covering of the roots should be scraped off with a knife or nail, and the roots should be divided in half until they reach the precise proportions required to produce fiber. A towel is used to thoroughly clean these damp fibers. This fiber must be cut into 25mm pieces after being cleaned and sun dried for a day.

Fig. 3. Banyan tree roots

C. *Selection of Polyester Resin*

Referred to several times, polymers are usually considered to be an effective fiber binder. Polymer has been the preferred binder for these fibers due to its cheaper cost and higher carry availability. Easy molding, improved handling, and improved flow characteristics are some of the benefits of using unsaturated polyester. Simple manufacturing and improved blend in of Polyester prompts them to use it. Our primary goal of creating a low weight composite is further enhanced by their low density of 2.02g/cc.

1) *Physical Property*

Density :2.02 g/cc

2) *Mechanical properties*

Ball indentation hardness: 350MPa
Flexural modulus: 14 GPa
Flexural strength: 105 MPa
Compressive strength: 170MPa

3) *Thermal properties*

Temperature: 200C temperature at 8 MPa: 210 ºC
Shrinkage: 0.01 %

D. *Materials for Fabrication*

Fig. 4. Polyester Resin (Matrix)

Fig. 5. Catalyst (Cobaltoctate)

Fig. 6. Accelerator (Methyl Ethyl Ketone)

E. *Hand Lay Up Method*

The natural fiber reinforced polymer composite was prepared using the hand layup technique. A mild steel mold measuring 230x270x10 mm was used for the tensile and flexural tests, and a second mild steel mold with the same dimensions was used for the compressive test. Although this method is the least expensive to produce, it has certain drawbacks, including a lengthy curing period and a low production rate. In addition, the worker's skill level affects the quality of the composite. After equally distributing the fibers inside the mold, promoter and catalyst were combined with thermosetting resin. The whole surface of the mold is coated with mold release agent. The fiber stacking procedure is wrapped using a brush or roller.

The necessary thickness is constructed by layering the fibers that have been impregnated with resin. Curing is the process of waiting for a room-temperature, generally forming thermosetting polymer bond network.

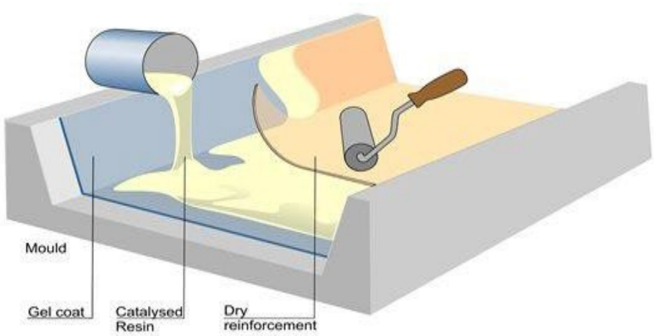

Fig. 7. Hand layup method

Before Mold After Mold

Fig. 8. Molding plate

F. *Fabricated Composite Images*

Fig. 9. Banyan tree aerial roots fiber composites

3. Result and Discussion

A. *Tensile Strength Test*

Table 1 shows that the readings of the three specimens are tested and readings are noted. As a result of the compression test, 1st specimen yields the tensile strength of about 34.244 N/mm^2. 2nd and 3rd specimen yields compression strength of about 34.677 & 34.720 N/mm^2. As an average these specimen yields compression strength of about 34.677 N/mm^2.

Table 1
Tensile strength test

Sample No.	CS Area [mm^2]	Peak Load [N]	%Elongation	UTS [N/mm^2]
1	90.000	1869.231	2.560	34.244
2	90.000	1869.231	2.769	34.677
3	90.000	1869.231	2.967	34.720
Average	90.000	1869.231	**2.769**	**34.677**

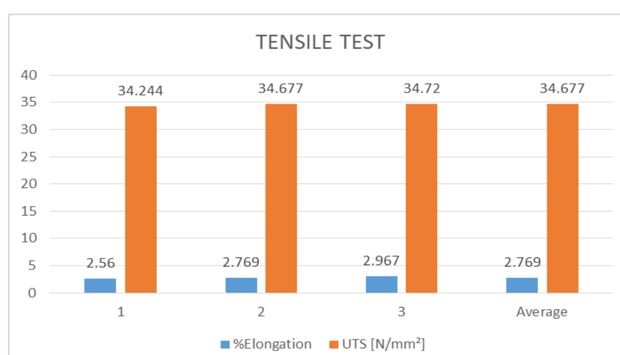

Fig. 10. Tensile test

B. Impact Strength Test

Table 2 shows that the reading of the Banyan Tree Aerial Roots Fiber specimen which undergone Impact test three specimens are tested and noted, 1st specimen yields the impact strength of about 21.6J. 2nd and 3rd specimen yields impact strength of about 21.8 & 21.9 J. As an average these specimen yields impact strength of about 21.8 J.

Table 2
Impact strength test

S No	Sample Number	Izod Impact value in (J)
01	Sample 1	21.6
02	Sample 2	21.8
03	Sample 3	21.9
	Average	21.8

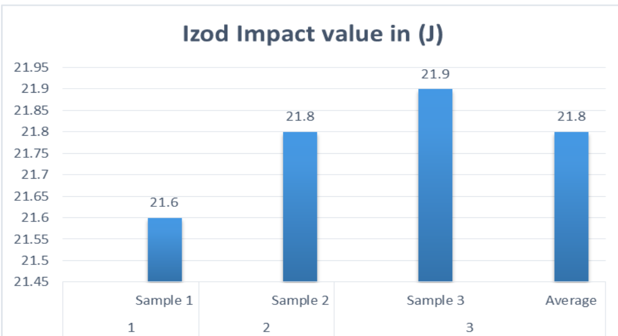

Fig. 11. Impact test

C. Flexural Strength Test

Table3
Flexural strength test

Fiber ratio	CS Area [mm²]	Peak Load [N]	Flexural Strength (MPa)	Flexural Modulus (GPa)
Sample 1	50.000	98.436	78.437	1548.527
Sample 2	50.000	100.789	79.524	1598.512
Sample 3	50.000	104.850	88.957	1648.524

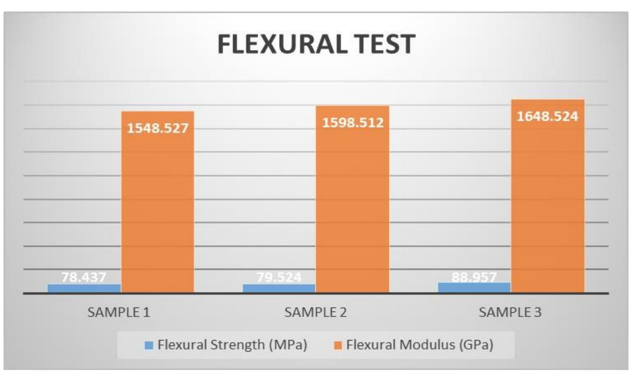

Fig. 12. Flexural test

Table 3 shows that the readings of the three Samples are tested differed radio and readings are noted. As a result of the flexural test, 1st Sample yields the flexural strength of about 78.437Mpa. 2nd and 3rd Sample yields flexural strength of about 79.524 & 88.957Mpa. The Banyan Tree Aerial Roots Fiber average these specimen yields flexural strength of about 88.957 MPa.

4. Conclusion

In this experiment, composites made of fiber particles from banyan tree aerial roots were effectively created. Here, the mechanical characteristics of the composite tensile, compressive, and flexural have been examined and described. From this investigation, the following findings have been made. This work demonstrates the effective creation of reinforced composites from maize fibers and the aerial roots of banana trees using a straightforward hand lay-up technique. Composite samples are useful for analyzing tensile and other mechanical characteristics. Information on the fiber from the aerial roots of banyan trees' potential as a source of reinforcement for polymer matrix composites has been provided. In order to achieve comparable performance, NFR composites need a larger fiber content, which uses less of the more polluting base polymer.

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