Investigation of Mechanical Properties and Characterization of Hybrid Natural Fibre Polymer Matrix Composites

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Abstract—Over the past decade, the perception of utilizing Natural fiber has come to be more mainstream. Natural fibres are the best substitute with the growing environmental consciousness, which act as an alternative for synthetic fibers due to their promising properties. New cellulosic fibers were identified from banyan bark. This study targets at understanding the components of ficusbenghalensis extracted from the bark of the banyan tree and its mechanical properties. Here, we construct three types of plates. One set of plates is equipped by random orientation process another set of plates by unidirectional orientation and the third plate by orientation of bi-directional tests. The mechanical properties are going to inhibit tensile and impact. The flexural test is directed at these plates. We can select high strength plate among them with the support of those tests’ results, and by comparing those plates.

Keywords: Natural Fibre, Tensile, Flexural and Impact

I. Introduction

Increase the attention of researchers to search for better alternative to synthetic fibers such as glass, carbon and aramids. Referring to environmental aspects in fact, these synthetic fibers have some disadvantages. This difficulty is overcome by good fiber yielding plants which are cost-effective without compromising mechanical properties. The applications of natural fibers are growing in many sectors such as aero-space, automotive, construction, and packaging industries. This is mainly due to their excellent features compared to synthetic fibers, i.e., low cost, low density, cost-effectiveness, high toughness, non-toxic, renewable, recyclable, non-abrasive and biodegradable properties.

Hence, ficusbenghalensis extracted from the banyan tree is used with basalt fibre for making the composite material. The plates of composite materials were made by three methods namely random orientation, unidirectional and bidirectional methods by handlay methods, various tests were taken into the order for identify the mechanical property of the material. Composites are multifunctional material frameworks that give attributes not realistic from any discrete material. The firm structures were made by truly joining at least two perfect materials [1-3]. The composites ought not to be viewed basic as a blend of two materials. In the more extensive essentialness; the blend has its own unmistakable properties. Regarding solidarity to protection from warmth or some other alluring quality, it is better than both of the parts alone or fundamentally not quite the same as both of them [4]. The composites are compound materials which vary from amalgams by the way that the
person parts hold their qualities yet are so fused into the composite as to exploit just of their characteristics and not of their deficiencies”, so as to acquire improved materials [5-7]. The specialist clarifies composite materials as heterogeneous materials comprising of at least two strong stages, which are in cozy contact with one another for a tiny scope. They can be additionally considered as homogeneous materials for a tiny scope as in any segment of it will have the equivalent physical property [8]. The present results of plane bending fatigue experiments conducted on composite plates of orthogonal glass fibers woven and epoxy resin. The set up of plane bending fatigue is described. It is reported that the stratified composite materials have a better fatigue behavior if the angle of fiber direction and the direction of the specimen is lower. Critical numbers of cycles were dependent on the orientation of the reinforcing elements. [9]. The detailed design procedure for the development of the fatigue testing machine for plane bending that can be applied for the testing of composite materials and adhesive joints [10-12].

The objective of the current study of hybrid natural fiber polymer matrix composites is to identify the advantages of natural fibres over synthetic fibres by comparing their properties, comparative strength and the way it can be used replacing the synthetic fibres and as a result the natural fibre shows high strength, low weight and less damage to processing equipments and good relative mechanical properties.

2. Materials and methods

According to the type of reinforcing material composites can be classified as:

A fiber is portrayed by its length being a lot more prominent contrasted with its cross-sectional measurements. The elements of the support decide its ability of contributing its properties to the composite. Strands are compelling in improving the break opposition of the framework since a support having a long measurement demoralizes the development of beginning splits typical to the fortification that may some way or another lead to disappointment, especially with weak grids. Man-made fibers or filaments of non polymeric materials show a lot higher quality along their length since huge defects, which might be available in the mass material, are limited as a result of the little cross-sectional elements of the fiber. On account of polymeric materials, direction of the atomic structure is answerable for high quality and stiffness.

In particulate composites the fortification is of molecule nature. It might be round, cubic, tetragonal, a platelet, or of other customary or unpredictable shape. When all is said in done, particles are not powerful in improving break obstruction but rather they upgrade the solidness of the composite to a restricted degree. Molecule fillers are broadly used to improve the properties of lattice materials, for example, to change the warm and electrical conductivities, improve execution at raised temperatures, diminish grating, increment wear and scraped spot obstruction, improve machinability, increment surface hardness and lessen shrinkage. According to type of matrix material they are classified as Metal Matrix Composites (MMC), Ceramic Matrix Composites (CMC), and Polymer Matrix Composites (PMC)

Higher quality, crack durability and solidness are offered by metal grids. Metal network can withstand raised temperature in destructive condition than polymer composites. Titanium, aluminum and magnesium are the well known grid metals as of now stylish, which are especially helpful for airplane applications. In light of these characteristics metal grid composites are getting looked at for wide scope of utilizations viz. ignition chamber spout (in rocket, space transport), lodgings, tubing, links, heat exchangers, basic individuals and so forth.

Basic fiber fortified composites are made out of filaments and a framework. Filaments are the support and the primary wellspring of solidarity while network sticks all the strands together fit as a fiddle and moves worries between the strengthening filaments. Now and again, filler may be added to smooth the assembling procedure, sway uncommon properties to the composites, and/or decrease the item cost.

Particles utilized for fortifying incorporate earthenware production and glasses, for example, little mineral particles, metal particles, for example, aluminum and indistinct materials, including polymers and carbon dark. Particles are utilized to build the modules of the network and to diminish the
flexibility of the grid. Half breed composites are further developed composites when contrasted with traditional

The enthusiasm for characteristic fiber-strengthened polymer composite materials is quickly becoming both as far as their modern applications and basic examination. They are sustainable, modest, totally or in part recyclable, and biodegradable. Plants, for example, flax, cotton, hemp, jute, sisal, kenaf, pineapple, ramie, bamboo, banana, and so on., just as wood, utilized from days of yore as a wellspring of lignocellulosic filaments, are increasingly more frequently applied as the fortification of composites. Their accessibility, inexhaustibility, low thickness, The natural fiber-containing composites are all the more earth cordial, and are utilized in transportation (autos, railroad mentors, aviation), military applications, building and development businesses (roof framing, parcel sheets), bundling, customer items, and so forth. The characteristic fiber composites can be financially savvy material for following applications are Building and development industry: boards for parcel and bogus roof, segment loads up, divider, floor, window and door jambs, rooftop tiles, versatile or pre-manufactured structures which can be utilized in the midst of common cataclysms, for example, floods, violent winds, earthquakes, etc. Storage gadgets: post-boxes, grain stockpiling storehouses, bio-gas containers, etc. Furniture: seat, table, shower, shower units, etc. Electric gadgets: electrical apparatuses, pipes, etc, Everyday applications: lampshades, bags, helmets, etc, Transportation: vehicle and railroad mentor inside, pontoon, and so on.

3. Experimental Setup:
The composite materials are choosing for the following reasons and application High strength to weight ratio (low density high tensile strength), High creep resistance, High tensile strength and High toughness. The accompanying segment will expand in detail the trial methodology completed over the span of our undertaking work. The means included are 1.Specimen (Fabrication of FRP), 2.By Hand Lay-Up method 3. Laminate into required dimensions, 4.Tensile test and 5. Flexural test (3-Point Bend test)

Raw materials used in this experimental work are:

3.1 Plant material: Ficusbenhalensis , basaltfiber

The Figure 1 shown the Ficusbenhalensis basalt fiber .The properties of the normal filaments can shift contingent upon the source, age and isolating strategies of the strands. Ficusbenhalensis, a yearly fiber plant, has been seen as a significant wellspring of strands for various Applications since great times past. The banyan fiber has high potential as a fortifying fiber in polymer Composites.

3.2 Catalyst: Methyl ethyl ketone peroxide (MEKP) is a natural peroxide, a high dangerous like CH₃)2CO peroxide. MEKP is a lackluster, sleek fluid while CH₃)2CO peroxide is a white powder at STP; MEKP is somewhat less delicate to stun and temperature, and increasingly stable away. Contingent upon the trial conditions, a few unique adducts of methyl ethyl ketone and hydrogen peroxide are known.

The first to be accounted for was a cyclic dimer, C₈H₁₆O₄, in 1906. Later investigations found that a direct dimer is the most pervasive in the blend of items ordinarily acquired, and this is the structure that is normally cited in the industrially accessible material from substance flexibly organizations.
3.3 *Accelerator*: Cobalt octoate is the most dynamic surface drier. Cobalt impacts quick surface drying and is commonly utilized related to assistant driers. It is typically added at 0.05 to 0.4 % dependent on vehicle solids. It is a solid oxidant It is good with all surfaces covering media.

3.4 *Binder*: The universally useful polyester pitch is a brisk relieving unsaturated polyester sap dependent on Orthophthalic crude material for covering reason. It is un-quickened. Appropriate for both hand layup and weapon shower up. The gum offers amazing mechanical properties, effect and water opposition. The glass fibre overlay made with this gum has phenomenal mechanical quality, great unbending nature and remarkable toughness.

4. Test specimens

The Figure 2 shows the edge cut for 150mm*150mm*5mm, here plates were finished by utilizing handlay strategy, where first plate is of arbitrary direction technique and the subsequent plate is by unidirectional and the third plate is by bidirectional strategy.

![Figure 2. Plate (150mm*150mm*5mm)](image)

Plates are heat treated and Tests were taken in omega inspection and analytical laboratory, guindy, Chennai. The following results we got while testing the specimen 1. Tensile test- Sample was cut into dog bone shape 165x30x3 mm (ASTM D638-3). 2. Flexural test specimen was cut into 130*13*3 (ASTM D 790), 3. Impact test specimen was cut into 66*13*3 (ASTM D 256), 4. Water absorption test was cut into 20*20 mm, 5. Tensile test- Sample was cut into dog bone shape 165x30x3 mm (ASTM D638-3), 6. Flexural test specimen was cut into 130*13*3 (ASTM D 790), 7. Impact test specimen was cut into 66*13*3 (ASTM D 256), 8. Water absorption test was cut into 20*20 mm, 9. Tensile test- Sample was cut into dog bone shape 165x30x3 mm (ASTM D638-3), 10. Flexural test specimen was cut into 130*13*3 (ASTM D 790), 11. Impact test specimen was cut into 66*13*3 (ASTM D 256), 12. Water absorption test was cut into 20*20 mm, 13. Tensile test- Sample was cut into dog bone shape 165x30x3 mm (ASTM D638-3), 14. Flexural test specimen was cut into 130*13*3 (ASTM D 790), 15. Impact test specimen was cut into 66*13*3 (ASTM D 256), 16. Water absorption test was cut into 20*20 mm.

4.1 Test specimen

*Specimen 1:*

![Figure 3. Cutting structure of specimen](image)
Figure 3- UTM machine Sample loaded condition for tensile testing Tensile test specimen: Dog bone shape 165*30*3 mm (ASTM 638-3)

Specimen 2:

Figure 4. UTM machine loaded condition for flexural testing

Figure 4 shows the UTM machine loaded condition for flexural testing Flexural test specimen: Specimen was cut into 130*13*3 mm (ASTM D 790)

5. Results and Discussion

5.1 Tensile test

The specimen for tensile test which taken into three modes, it is considering with thickness, width and area

Input data: The details given before testing were taken
(i) Thickness – 7.89mm, Width – 12.58mm and area 99.26 mm², (ii) Thickness – 7.46mm, Width – 12.68mm and area 94.59 mm² and (iii) Thickness – 7.79mm, Width – 12.74mm and area 99.74 mm²

The above mentioned Figure 5 it is observed that the plotted force in Newton vs stroke for the first sample made by random orientation method in which the graph gradually increases when force applied .Where that results in $F_{max} = 1.82 \text{KN}$ and $UTS = 18.34 \text{Mpa}$

The test which carried with same procedure and observed the plotted Force in Newton vs stroke for the second sample made by random orientation method in which the graph gradually increases when force applied. Where that results in available in Figure 6 $F_{max} = 0.75 \text{KN}$ and $UTS = 7.93 \text{Mpa}$. The crushed medium density of hybrid natural fiber Ficus benghalensis is used to fabricate large composite components.
By continuing the procedure for the third sample with plotted Force in Newton vs stroke for the third sample made by random orientation method in which the graph gradually increases when force applied. Where that results in this test we got in Figure 7 is $F_{max} = 2.12$ KN and $UTS = 21.37$ Mpa. It is noted that the tensile strength which have high value in the third sample it’s due to the containing basalt and ficusbenghalensis long fibre has more tensile strength.

5.2 Flexural Test

The specimen for flexural test which taken into three modes, it is considering with thickness, width and area. Input data: The details given before testing were taken (i) Thickness $- 7.72$mm, Width $- 25.05$mm and area $193.39$mm$^2$, (ii) Thickness $- 8.09$mm, Width $- 25.15$mm and area $203.46$mm$^2$ and (iii) Thickness $- 7.77$mm, Width $- 25.60$mm and area $198.91$mm$^2$

The above mentioned graphs for flexural test 1 in Figure 8 is $F_{max} = 0.46$KN and for Test 2 Flexural Test :2 is $F_{max} = 0.19$KN. Input data: The details given before testing were taken Where that results in $F_{max} = 0.37$KN. It is observed that the selected high strength plate among them with the support of those tests' results, and by comparing those plates.

| Sample Id | Tensile Strength In Mpa | Flexural Load In KN | Impact Values In Joules |
|-----------|-------------------------|---------------------|-------------------------|
| 1         | 18.34                   | 0.46                | 2                       |
| 2         | 7.93                    | 0.19                | 4                       |
| 3         | 21.37                   | 0.37                | 4                       |

Table 1 shows the test results by comparing the results sample 3 has more strength in tensile test with, and in flexural test sample 1 has more strength, and In Impact test sample 2 and sample 3 has same strength. In this study has been found that sample 1 containing basalt and ficusbenghalensis long fibre has more tensile strength and sample 1 containing the mixture of ficusbenghalensis and basalt fibre has more flexural strength and while considering impact strength the sample 2 and sample 3 has equal Value of impact strength.
6. Conclusion:

The mechanical properties are going to inhibit tensile and impact. The flexural test is directed at these plates. It is concluded that the technologies offer a way of light weighting and high strength of automotive components and causes less damage to processing equipments. In the view of fuel economy the natural fiber are given extreme output. The crushed medium density of hybrid natural fiber Ficus benghalensis is used to fabricate large composite components. This study has been found that sample 1 containing basalt and ficusbenghalensis long fibre has more tensile strength with value of (21.37Mpa) and sample 1 containing the mixture of ficusbenghalensis and basalt fibre has more flexural strength with value (0.46 KN) and while considering impact strength the sample 2 and sample 3 has equal Value of impact strength.

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