

Mechanical Behaviour of Natural Fibre Reinforced Epoxy Composites

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ABSTRACT: Composite materials placed a predominant role in many of the conventional materials. Fibre reinforced plastics have gained recognition as structural material. Reinforcement with natural fibre in composites has recently gained attention due to low cost, easy availability, low density, easy of separation, biodegradability, and recyclable in nature. Fibre reinforced plastics can replace steel in chemical, marine and transport industries. The present work describes the development and characterization of mechanical properties of natural fibre based polymer composites consists of Cordia Dichotoma as reinforcement and Epoxy resin as matrix. Experiments carried out to develop the composites and different weight fraction natural fibre. The fabrication is done by Hand lay-up technique with the extracts of the natural fibre and the matrix material. The laminates was done by using different Fibre-Epoxy weight ratio.

From the results obtained, it shows that the composition of 20gms fibre, the mechanical properties obtained were best among the examined compositions.

KEYWORDS: composites, Natural Fibres, Epoxy, UTM Machine, Chemical Resistance test, and Hardness.

I. INTRODUCTION

Composite is combination of two or more materials (mixed or bonded) on a macroscale. Composite is self-possessed of reinforcement (fibres, particles, flakes, and fillers) embedded in a matrix (polymers, ceramics, and metals). Composites plays a very important role in present days. These composites can be fabricate easily compare with others. The main advantage of the composites can be having the high stiffness and strength and also possess better mechanical properties. And also cost effective ness. FRP can be played by the main role of the composite preparation. In this FRP having high strength weight ratio and it can be used in the replacement of construction materials aluminium and steel weight reduction of about 60%. In this work the natural fibre Indian cherry (Cordia Dichotoma) is reinforced with epoxy resin matrix. The common name of the natural fibre is Indian cherry, blue berry, pink pearl and bird lime tree. And the preparing specimens are considered as (5, 10, 15, and 20 grams) of Cordia Dichotoma.

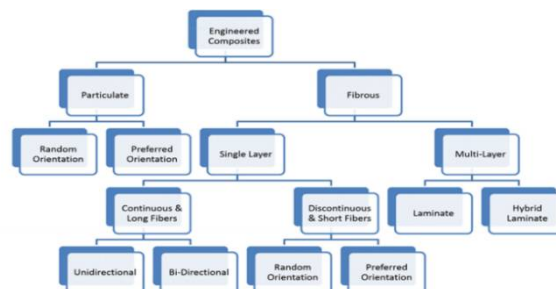


Fig.1. classification of composites

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II. NATURAL FIBRE REINFORCEMENT

Natural fibres are easily available at very low cost. The term “Natural Fibre” covers a broad range of vegetable, animal and mineral fibres. However in the composite industry, it is usually refers to wood fibre and agro based bast, leaf, seed, and stem fibres. These fibres often contribute greatly to the structural performance of plant and, when used in plastic composites, can provide significant reinforcement.

Natural fibres include those made from plant, animal and mineral sources. Natural fibres can be classified according to their origin as animal fibre, mineral fibre, and plant fibre. Fig.2 shows the classification of natural fibres.

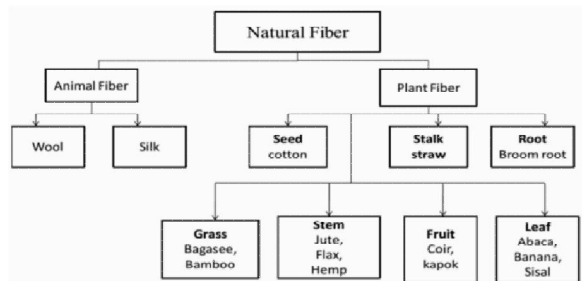


Fig.2. classification of natural fibre

III. FABRICATION OF COMPOSITES

HAND LAY-UP MOULDING

Hand lay-up moulding is the method of preparing fabrics made of reinforcement and pouring the matrix resin layer by layer until the desired thickness is obtained. This is the best method for labour consuming composite processing method. Most of the aerospace composite products are prepared by this method. The fibres Cordia Dichotoma are collected from Nallamala forest, Andhra Pradesh.

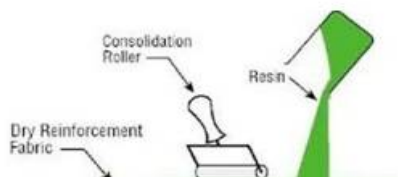


Fig.3. hand lay-up Technique

IV. MATERIAL

Particulars of the composite preparation:

Entities	Particulars
Matrix	Epoxy resin LY556 which is a thermosetting plastics
Reinforcement	Cordia Dichotoma
Hardener	HY 951
Processing Technique	Hand Lay-up compression under room temperature with natural curing.
Mixing Ratio	100% Natural Fibre

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PREPARATION OF MOULD

For making of the mould with the glass plate having to prepare the dimensions are 200mm x 200mm x 3mm mould (length x width x thickness)

V. EXPERIMENTAL WORK

Testing of Mechanical Properties

Tensile Test: The tensile test was carried out using Universal Testing Machine (UTM). The specimen is prepared according to an ASTM D638-03 standard. The tension test is generally performed on flat or round specimens. The various mechanical properties such as ultimate breaking load, displacement at maximum force and ultimate stress were determined and tabulated in below.



Fig.4. Tensile test specimens

Table1. Tensile Test Results of the selected specimens

S.No	% of fibre (gms)	$F_{max}(N)$	Tensile Strength (Mpa)	Tensile Modulus (Mpa)
1	5	409.72	13.66	1705.44
2	10	511.28	17.19	2310.77
3	15	646.32	22.70	2610.60
4	20	702.32	23.41	3415.04

Flexural Test: The flexural test is carried out using universal testing machine. The test specimen was prepared according to ASTM D 790-03 standard. The specimens were tested at a cross head speed of 5 mm/min, at a temperature 22°C and humidity 50%. The important mechanical properties such as ultimate breaking load, displacement at maximum force and ultimate stress were determined and tabulated in below.



Fig.5. Flexural test specimens

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Table.2. Flexural test results of the specimens

S.No	% of Fibre (gms)	Maximum load (KN)	Maximum Stress (MPa)	Flexural Modulus (MPa)
1	5	0.9	47.23	3914.96
2	10	0.09	52.59	3942.27
3	15	0.19	102.88	8327.52
4	20	0.19	103.48	9466.64

Hardness test: the hardness test was conducted by the Rockwell hardness tester and used for the testing hardness of the composites as per the ASTM D 785. Which is especially used for plastic materials, Bakelite and vulcanized rubber. The indenter chosen is of diamond. A load of 60 kg was used for the test.

Table.3. Hardness Test Results of the specimens

S.No.	Fibre Weight ratio % (grams)	Hardness values
1	5	10
2	10	14
3	15	21
4	20	23

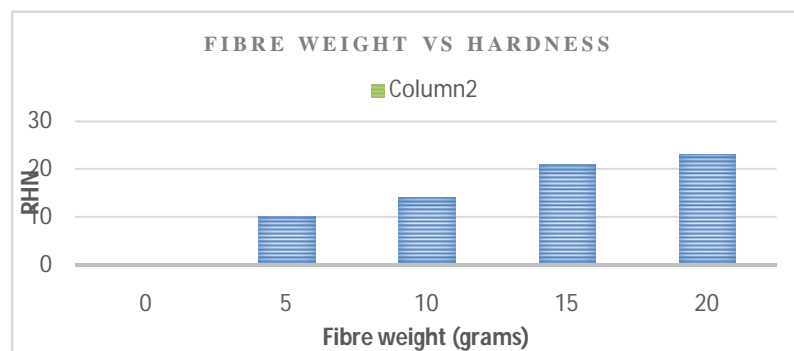


Fig.6. Rockwell Hardness Test results

From the above graph it can be observed that the composite material is showing hardness 5% having less hardness compared with 20% because of increase of weight % it will increase the hardness.

Chemical Test: The chemical resistance test of the composites was studied as per ASTM D standard 543-87 Method. The chemicals mainly acids is concentrated hydrochloric acid, concentrated nitric acid, acetic acid, the alkalis namely aqueous solutions of sodium hydroxide, sodium carbonate, and solvents-benzene, carbon tetra chloride and Water were selected.

Change in Weight of Cardia Dichotoma fibre reinforced Epoxy composite immersion in chemical reagents for 24 hours.

$$W = \frac{w_2 - w_1}{w_1}$$

W = weight (%) of final sample

W₂ = weight of treated sample

W₁ = weight of untreated sample.

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Table.4. Before weights of the untreated fibre chemical resistance test

Name of the Fibre	Specimen 1 (grams)	Specimen 2 (grams)	Specimen 3 (grams)	Specimen 4 (grams)	Specimen 5 (grams)	Specimen 6 (grams)	Specimen 7 (grams)	Specimen 8 (grams)
Cordia Dichotoma	0.20	0.21	0.23	0.25	0.26	0.28	0.29	0.32

Table.5. After weights of the treated fibre chemical resistance test

Fibre weighting	Specimen 1 (grams)	Specimen 2 (grams)	Specimen 3 (grams)	Specimen 4 (grams)	Specimen 5 (grams)	Specimen 6 (grams)	Specimen 7 (grams)	Specimen 8 (grams)
After Weights	0.23	0.25	0.32	0.32	0.31	0.32	0.33	0.37

Table.6. Values of chemical Resistance Testing of Cordia Dichotoma

Chemicals	W ₁	W ₂	$W = \frac{w_2 - w_1}{w_1}$
40% nitric acid	0.20	0.23	+0.1500
10% Hydrochloric acid	0.21	0.25	+0.1904
8% Acetic acid	0.23	0.32	+0.3913
10% Sodium Hydroxide	0.25	0.32	+0.2806
20% Sodium Carbonate	0.26	0.31	+0.1923
Benzene	0.28	0.32	+0.1428
Carbon Tetrachloride	0.29	0.33	+0.1379
Water	0.32	0.37	+0.1562

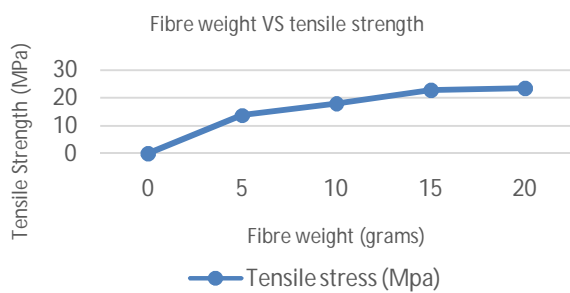
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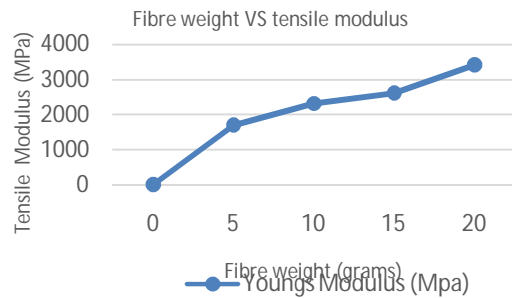
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VI. RESULTS AND DISCUSSIONS

I. EXPERIMENTAL WORK IN TENSILE TEST:

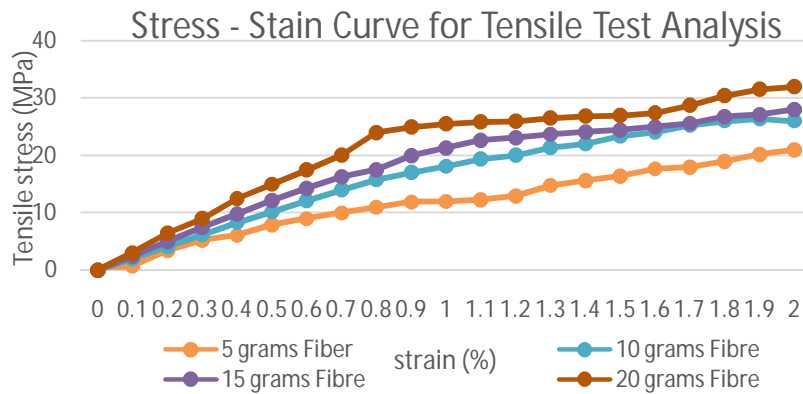


7 (a)



7 (b)

The effect of fibre volume percentage on Tensile strength and Tensile modulus is shown in Fig. 7(a), 7 (b). It is seen that the tensile strength increases with introduction of fibre i.e. from 13.66 MPa to 23.41 MPa. This is because of the strength provided by the Cordia Dichotoma into the matrix. The tensile modulus also increases as per the increase in fibre weight i.e. from 1705.44 MPa to 3415.04 MPa. And the graph 7(c) shows the different fibre weight ratios.



7 (c)

Fig.7. Tensile Test Results (a) Fibre weight ratio VS Tensile Stress (b) Fibre weight ratio VS Tensile Modulus (c) Tensile Stress – Stain Curve analysis.

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2. EXPERIMENTAL WORK IN FLEXURAL TEST:

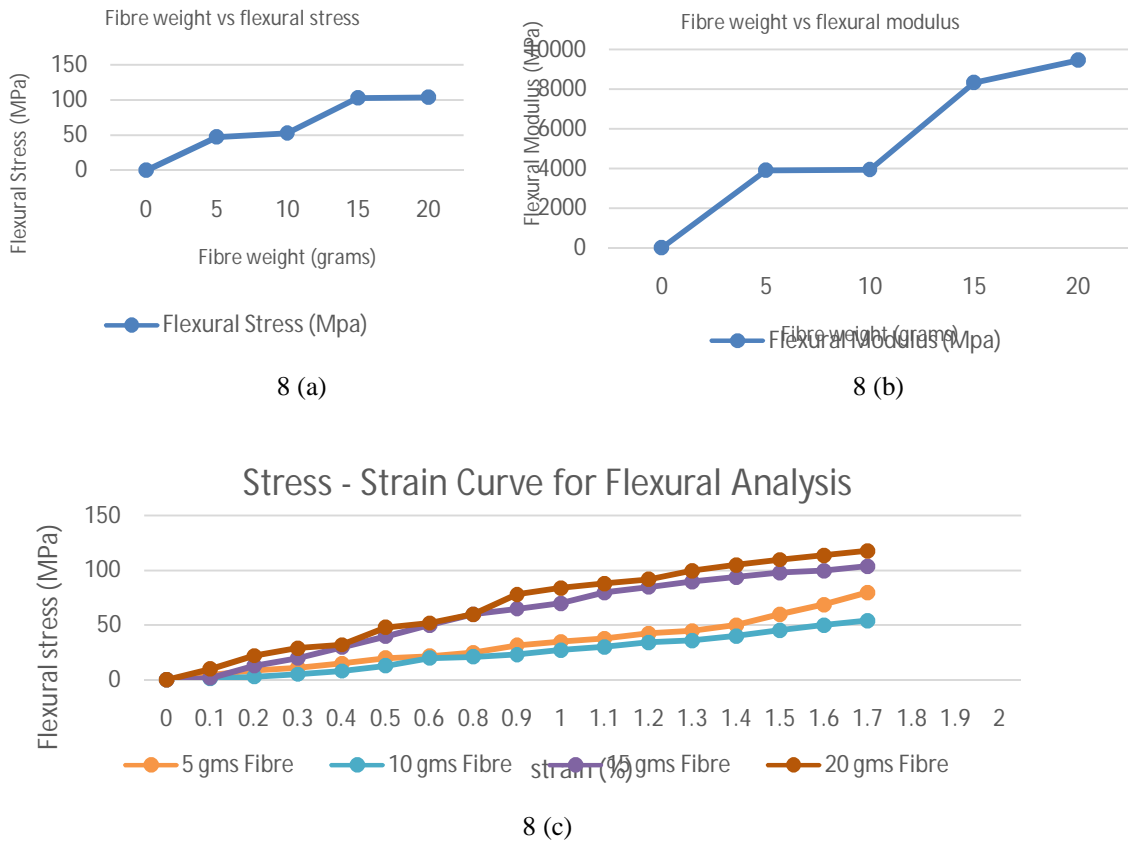


Fig.8. Flexural Test Results (a) Fibre weight ratio VS Flexural Stress (b) Fibre weight ratio VS Flexural Modulus (c) Flexural Stress – Statin Curve analysis

The effect of fibre volume percentage on Flexural strength and Flexural modulus is shown in fig. 8(a), 8(b) it is seen that the Flexural strength increases with introduction of fibre i.e. from 47.23 MPa to 107.48 MPa. This is because of the strength provided by the Cordia Dichotoma into the matrix. The Flexural modulus is also increases as per the increase in fibre weight i.e. from 3914.96 MPa to 9664.64 MPa. And the graph 8(c) shows the different fibre weight ratios.

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VII. CONCLUSION

Composite materials is an across-the-board scope of good-looking aspects like the relatively high Tensile strength, Flexural strength, Impact strength, good adaptability in low density and corrosion resistance. Composite materials have good mechanical, chemical, and electrical properties. The resulting can be concluded based on the study of Natural Reinforcement Composites for Mechanical properties and Chemical Resistance.

1. This work shows the successful fabrication of Cordia Dichotoma fibre reinforced epoxy composites with different fibre weights is possible by simple Hand lay-up technique. And the tests were conducted by using the Universal Testing Machine (UTM).
2. It has been noticed that the mechanical properties of composites such as tensile strength, flexural strength, and impact strength of composites are greatly influenced by the fibre weights.
3. Maximum Tensile strength is obtained at 20 gm and Maximum flexural strength is obtained at 20 gm weight of Cordia Dichotoma fibre.
4. It is observed that the tensile, flexural, hardness properties increases, with increasing the fibre weight ratio.
5. The effect of alkali treatment of Cordia Dichotoma were studied. The composites with alkalis were found to exhibit good resistant to some acids, alkalis and solvents. As the weights increase after chemical resistance test, density also increases which indicates better strength for the fibres.

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