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EXPERIMENTAL STUDY ON MECHANICAL PROPERTIES OF FICUS BENGHALENSIS WITH GYPSUM POLYMER HYBRID FIBER COMPOSITES

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KEYWORDS: Ficus - benghalensis, gypsum powder, water absorption, epoxy resin, mechanical properties.

ABSTRACT
Now a day, Natural fibers have attracted the researchers for their ease of availability, high tensile strength, low thermal expansion, high strength to weight ratio, low cost and bio-degradability. The present work aims at developing hybrid natural fibers based ceramics composite material. The attractive features of jute, sisal, aleovera, bagasse and banana have been been replaced the natural fibers like their low cost, high strength low thermal expansion, high strength to weight ratio, renewability and biodegradability. The experimental study aims at learning the tensile, impact, flexural and water absorption behavior of ficus - benghalensis with gypsum polymer hybrid natural fibers. The study has been carried out in view of high lighting advantages of natural fibers over synthetic fibers. Different percentage of polyester resin and gypsum powder is used as a Matrix and Banyan tree fiber is used as reinforced material. Material properties of the composite has been studied with the help of different percentage weight ratios of gypsum and it was found 4% of gypsum powder has maximum tensile, flexural strength, energy but less water is absorbed in 14% composition.

INTRODUCTION
A composite is combination of two materials in which one of the materials, called the reinforcing phase. The reinforcing material and the matrix material can be metal, ceramic, or polymer. Composites typically have a fiber or particle phase that is stiffer and stronger than the continuous matrix phase and serve as the principal load carrying members. The matrix acts as a load transfer medium between, and in less ideal cases where the loads are complex, the matrix may even have to bear loads transverse to the fiber axis. The matrix is more ductile than the and thus acts as a source of composite toughness. The matrix also serves to protect them from environmental damage before, during and after composite processing. When designed properly, the new combined material exhibits better strength than would each individual material. Composites are used not only for their structural properties, but also for electrical, thermal, tribological and environmental applications.

Productions of synthetic fibers, followed by weave, mat and prepreg manufacture, are based on machinery and high investments. The production of natural fibers however, can be carried out by manpower and traditional methods.

MATERIALS AND METHODS
Raw Materials
Ficus benghalensis fiber.

Figure 1.1- Ficus benghalensis fiber

The properties of natural fibers can vary depending on the source, age and separating techniques of the fibers. Ficus benghalensis, an annual fiber plant, has been found to be an important source of fibers for a number of applications since good olden days. The banyan fiber has high potential as a reinforcing fiber in polymer composites.

Epoxy Resin

Epoxy resins are the most commonly used thermoset plastic in polymer matrix composites. Mechanical properties of epoxy resin are Density of 1.1-1.4kg/m, Elastic modules of 3-6GPa, Tensile strength of 35-100 MPa, Elongation at break of 1-6%, Water absorption (24h) 0.1-0.4%, Izod Impact (Notched) 0.3J/cm and Compressive Strength 100-200MPa.

TriethyleneTetramine (TETA)

TriethyleneTetramine, abbreviated TETA and trien, is an organic compound with the formula $[CH_2NHCH_2CH_2NH_2]_2$. This oily liquid is colorless but, like many amines, assumes a yellowish color due to impurities resulting from air oxidation. It is soluble in polar solvents and exhibits the reactivity typical for amines. The branched isomer and piperazine derivatives also comprise commercial samples of TETA.

Fabrication of Composite Fiber

Alkaline Treatment

Alkaline treatment or mercerization is one of the most used chemical treatments of natural when used to reinforce thermoplastics and thermoset. The important modification done by alkaline treatment is the disruption of hydrogen bonding in the network structure, thereby increasing surface roughness. This treatment removes a certain amount of lignin, wax and oils covering the external surface of the fiber cell wall, depolymerizes cellulose and exposes the short length crystallites. Addition of aqueous sodium hydroxide (NaOH) to natural fiber promotes the ionization of the hydroxyl group to the alkoxide.

Fiber – OH + NaOH → Fiber – O – Na +H2O

Figure 2.1 - Alkaline Treatment of Natural Fiber

Calculation of mixture preparation

For the preparation of the composite we calculate the percentage of polymer and hardener required from the table we come to know about the amounts accurately. The Epoxy and hardener were mixed by using glass rod in a bowl based on volume. Care was taken to avoid formation of bubbles. Because the air bubbles were trapped in matrix may result failure in the material. The subsequent fabrication process consisted of putting a releasing film on the mould surface. It was left for 8 hrs to allow sufficient time for curing and subsequent hardening.

Sample Number	*Ficus benghalensis Fiber(gm)*	*Epoxy resin (gm)*	*TETA (gm)*	*Gypsum Powder (gm)*
1	90	240	24	0
2	90	240	24	6
3	90	240	24	12
4	90	240	24	18
5	90	240	24	24
6	90	240	24	30
7	90	240	24	36
8	90	240	24	42

Table 2.1 - Concentration of sample preparation

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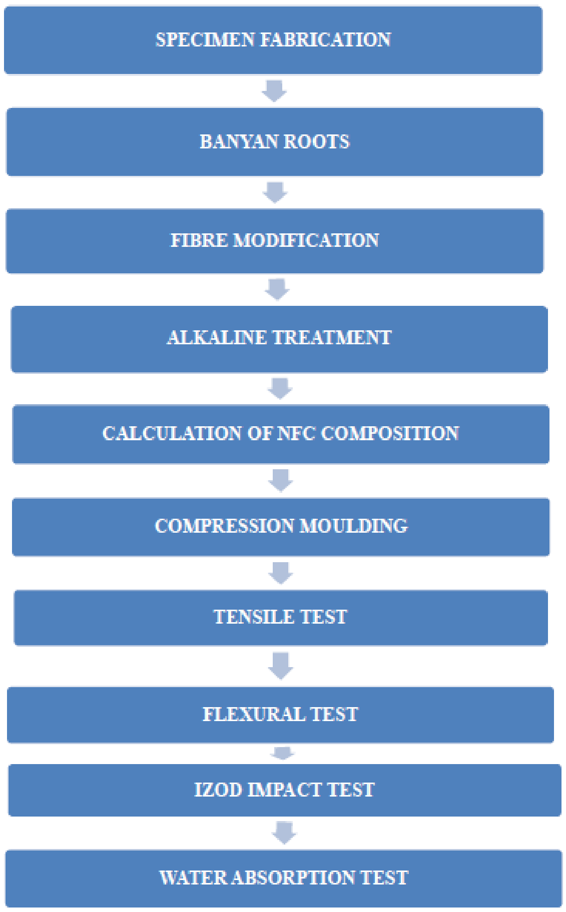
Polymer-Hardener Mixture Preparation

For the making of good composite the measurement of the samples should be accurate and the mixture should be very uniform. We take accurate amount of polymer which we have calculated earlier and 10% of its hardener. Then this mixture is stirred thoroughly till it becomes a bit warm. Bit extra amount of hardener is taken for the wastage in the process. Hardener should be taken in minute because little extra amount of hardener can spoil the composite.

Work Methodology



EXPERIMENT PROCEDURE

Cutting of test specimen to as per ASTM Standards

A wire hacksaw blade was used to cut each laminate into smaller pieces, for various experiments:

- Tensile test- Sample was cut into dog bone shape 165x30x3 mm (ASTM D638-3).
- Flexural test specimen was cut into 130*13*3 (ASTM D 790)
- Impact test specimen was cut into 66*13*3 (ASTM D 256)
- Water absorption test was cut into 20*20 mm.




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Figure 4.1- UTM machine Sample loaded condition for tensile testing

Figure 4.3 - UTM machine loaded condition for flexural testing

Figure 4.5- Izod impact testing machine

Figure 4.7 - Water absorption test.

$W = ((M_2 - M_1) / M_1) \times 100$

M_2 is the weight of the wet sample at the Time t; and M1 is the initial weight of the sample.

Figure 4.2 - Tensile test specimen after test

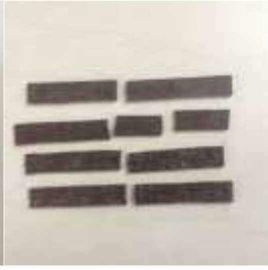


Figure 4.4 - Flexural test specimen after test

Figure 4.6 - Impact test specimen after test

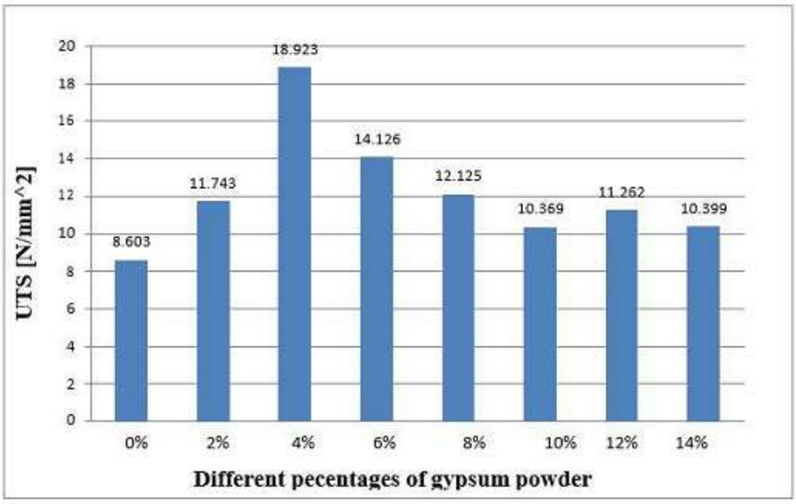
RESULT AND DISCUSSION

Tensile Test

Sample No.	CS Area [mm²]	Peak Load [N]	% Elongation	UTS [N/mm²]
1	39.00	335.728	0.980	8.603
2	39.00	458.107	.0973	11.743
3	39.00	738.065	20540	18.923
4	39.00	550.930	2.420	14.126
5	39.00	472.705	2.720	12.125
6	39.00	404.594	1.640	10.369
7	39.00	439.213	2.420	11.262
8	39.00	405.712	2.820	10.399

Table 5.1 - Tensile Test Results

We have plotted stress vs strain graphs for every sample which vary gypsum percentages 0% 2% 4% 6% 8% 10% 12% 14% and we have kept fiber and resin weight constant.



Graph 1 – Bar graph comparison of UTS Vs Different % of Gypsum

By comparing the graph we can conclude that sample 3 of 6% of gypsum is the best Suitable specimen.

Flexural Test

Sample No.	CS Area [mm²]	Peak Load [N]	Flexural Strength (Mpa)	Flexural Modulus (Gpa)
1	39.00	20.709	16.727	1286.210

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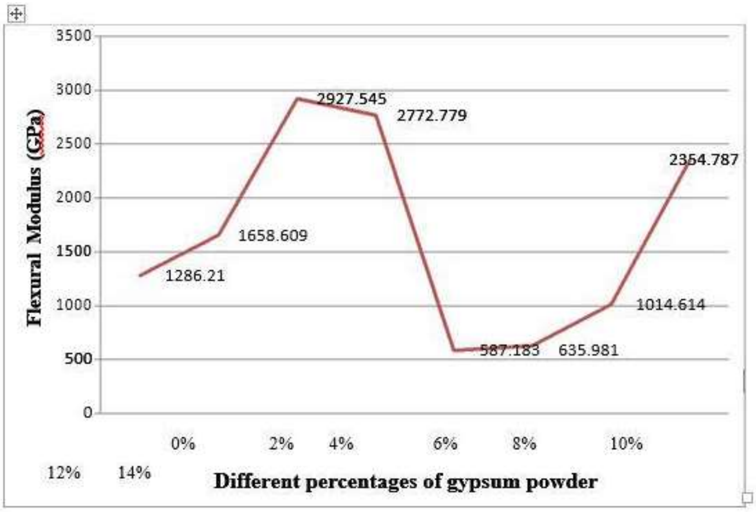
2	39.00	36.758	29.689	1658.609
3	39.00	55.682	44.973	2927.545
4	39.00	62.117	50.171	2772.779
5	39.00	45.175	36.488	587.183
6	39.00	50.522	40.806	635.981
7	39.00	26.703	21.568	1014.614
8	39.00	47.147	38.080	2354.787

Table 6.1 - Flexural Test Results

We have plotted load Vs length for every sample which vary gypsum percentages 0%, 2% , 4% , 6%, 8% , 10% , 12% , 14% and we have kept fiber and resin weight constant.



Graph 2 – Line graph comparison of Flexural Modulus Vs Different % of Gypsum

By comparing the graph we can conclude that sample 3 of 6% of gypsum is the best suitable specimen.

Izod Impact test

Sample No.	**Izod Impact Value for 3 mm Thick Specimen in J**
1	**0.50**
2	**0.35**
3	**0.75**
4	**0.30**
5	**0.30**
6	**0.25**
7	**0.25**
8	**0.20**

Table 7.1 - Izod Impact test results

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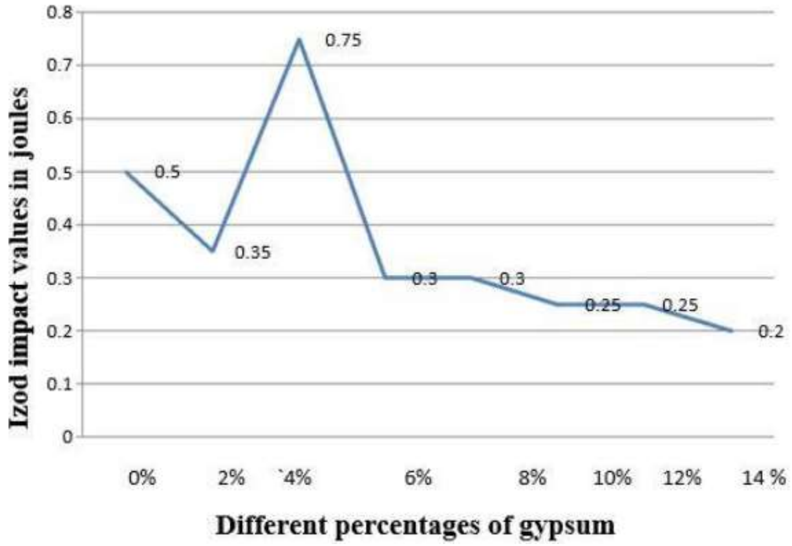
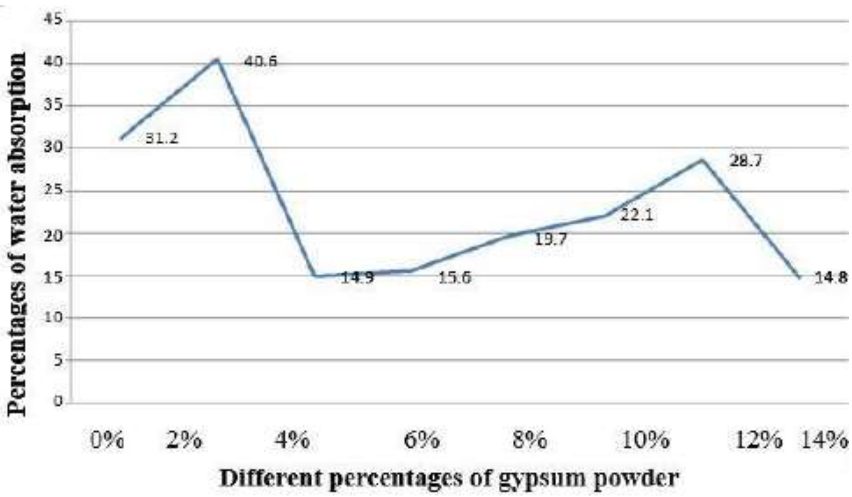


Graph 3 – Line graph comparison of Izod Impact Value (J) Vs Different % of Gypsum

Water absorption test results

Sample No.	Weight before test in gms (M2)	Weight after test in gms (M1)	% of water absorption
1	1.09	1.43	31.2
2	1.06	1.49	40.6
3	1.14	1.31	14.9
4	0.96	1.11	15.6
5	1.27	1.52	19.7
6	1.04	1.37	22.1
7	1.22	1.57	28.7
8	1.08	1.24	14.8

Table 8.1 - Water absorption test results



Graph 4– Line graph comparison of Water absorption Vs Different % of Gypsum

Now by comparing the results water absorption varies from 14.8% to 40.6%. The least water absorption content is 14% of gypsum powder with 14.8 percent highest water absorption content is 2% of gypsum powder with 40.9 percent.

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CONCLUSION

These technologies offer a way of light weighting and high strength of automotive components. In the view of fuel economy the natural fiber are given extreme output. The crushed medium density of hybrid natural fiber ficus - benghalensis is help to fabricate of large composite components. This study has been found that sample no. 3 – 4% (12gms weight) of gypsum powder, (90gms weight) ficus – benghalensis and (240gms weight)of epoxy resin hybrid natural fiber reinforced polymer composition attain the maximum tensile strength (18.923 N/mm2), maximum flexural strength (2927.545 GPa) and maximum izod impact value (0.75J). Whereas, 14% (42gms weight) of gypsum powder, (90gms weight) ficus – benghalensis and (240gms weight) of epoxy resin hybrid natural fiber reinforced polymer composition absorbed the less amount of water content (14.8%).

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