Experimental Investigation on Flexural Properties of Natural Fiber and Synthetic Fiber Composites

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Abstract:-The use of natural fibers in polymer matrices is highly beneficial because the strength and toughness of these composites resulting are greater than those of the unreinforced plastics. The main objective of present work is to investigate the mechanical properties of BANANA fiber polyester resin composites at different weight fractions and carbon fiber polyester resin composites at different weight fractions. Tested specimens of composites were fabricated according to the standards using hand moulding method. The developed composites were then tested to evaluate their Flexural properties. It was found that the increment in fiber content in composites increases the mechanical properties. The mechanical properties of BANANA fiber composites compared with CARBON fiber composites. However, CARBON based composites exhibited better Flexural properties than BANANA based composites.

Keywords:-*BANANA Fiber, CARBON Fiber, Flexural properties, catalyst, Accelerator*

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I. INTRODUCTION

In general fibers are the principal load carrying members while the matrix keeps them at the desired location and orientation, acts as load transfer medium between them and protects them from environmental damage. Combination of fibers with polymers exhibits better mechanical properties than pure polymers. Lignocelluloses natural fibers (jute, flax, hemp, sisal, vakka) are best alternatives to the synthetic reinforcing materials such as glass, carbon, Kevlar etc.

Development of natural fiber composites has been a subject of interest for the past few years [1]-[3]. Now a day's natural fibers play a vital role in many industrial applications because of their recyclability, light weight, non pollution, specific strength properties, easy availability, high toughness, non corrosive nature, low density, good thermal properties,
low cost, reduced tool wear etc, [4].This good environmental friendly feature makes the materials very popular in engineering markets such as automotive and construction industry [5]-[6].
BANANA fiber has lower density as compared to the sisal, jute, coir and bamboo.So BANANA fiber composite is a useful light weight engineering material. The properties of carbon fiber such as high Tensile strength, low weight and low thermal expansion makes it very popular in aerospace, military, motor sports [7].It is also used in compressed gas tanks bicycle industry, especially for high performance racing bikes. Carbon fiber is used some tennis rockets [8].

The carbon reinforced polyester composites are used in very high temperature environments. Natural fiber based thermo set composites are generally higher in strength performance compared to thermoplastic composites. Un saturated polyester resin has been preferred as the matrix material because it is having low shrinkage relatively cheap and also can be molded at room temperature. Thermo sets are decomposing on heating, low strains to failure, definite shelf life, long cure cycles and have lower fabrication temperature [9]. Hence various volume fractions of BANANA and CARBON fibers were combined with an unsaturated polyester resin to produce fiber reinforced polyester composites and their Flexural strength was recorded.

II. Extraction of BANANA Fiber

The fiber is extracted from the plants after the banana had been harvested. The tree was cut as near to the ground as possible. Two or more outer most sheaths are removed and rejected. Intersecting a knife at one end drawing it length wise strips of about 8-10 cm breadth. The TUXICS are scraped and fibers losses the pith. The top layers are removed, washed and immersed in another water retting tank then the fiber is cleaned and dried. The dried fibers are bundled as shown in Figure 1.

 ISSN: 2321-8169
5380 - 5384

Fig 1: Bundle of BANANA fiber

A. Fabrication of composite specimen (Banana):-

Banana fibers of required length for different tests were accurately cut and moulded with a mixture of unsaturated polyester resin. To make the process fast accelerator was added and methyl ethyl ketone peroxide was added as a catalyst. The fibers were aligned parallel in mould with an appropriate amount of polyester resin so that they oriented at 0^0, along the axial direction of the specimen. A compression pressure of 0.05 N/mm^2 was applied on the mould and left for 24 hours to cure. Later these specimens were removed from the mould after solidification and cured again for 2h at 80 ^{0}c. Fabricated specimens are shown in Fig 2.

Fig 2: Fabricated specimens of BANANA fiber

B. Carbon Fiber Fabrication:

A carbon is a long and thin strand of material (0.005-0.010 mm) in diameter. Carbon fibers are composed by using carbon atoms. Carbon atoms are bonded to gether in microscopic crystals. Bundle of carbon fiber is shown in Fig (3).

The crystal alignment makes the fiber incredibly strong for its size. several thousand carbon fibers are twisted to gether to farm a yarn, which may be used by itself or woven into a fabric.

Fig 3: Bundle of CARBON fiber

The carbon fiber spec:TCSEC6K,wt=1.001 was purchased from Tairyfix Carbon fibers. Unsaturated polyester resin of the grade ECMALON 4411 was purchased from Ecmass resins pvt limited, Hyderabad.

III. Fabrication of Carbon Composite Specimen

After cutting the required length of the carbon fiber from the yarn it was introduced into the mould with polyester resin. Polyester is a thermosetting resin with semi fluid form. MEKP (methyl ethyl ketone peroxide) was typically added to polyester resin at ratio 1-3% according to the pot-life, cure speed required and the ambient temperature. The fibers were aligned parallel in the mould so that they oriented at 0^0 along the axial direction of the specimen.
Compression pressure was applied on the mould and left 24 hours to cure. Fabricated specimens of CARBON fiber are shown in Fig (4)

Fig 4: Fabricated specimens of carbon fiber with polyester resin

IV. Characterization of composites:

Flexural test:

The samples were 100mm long, 25mm wide and 3mm thick. In three point bending test, the outer rollers were 64mm apart.(l=64mm) and the sample were tested at strain rate of 1mm/min. The load vs. deflection

ISSN: 2321-8169
5380 - 5384

values of specimen were recorded by using model TMER3 electronic tensometer. The flexural strength and flexural modulus of the composites were calculated by using the derived formulae.

Flexural modulus= $\frac{L^3 m}{4bt^3}$ N/mm^2 (Eq.1)

Flexural strength= $\frac{3PL}{2bt^2}$ N/mm^2 (Eq.2)

Where L=length of the support span (64mm)

b=width

t=thickness

P=peak load

m=slope of the initial straight line portion of the load-deflection curve.

V. RESULTS AND DISCUSSION

A. Flexural properties of BANANA Fiber:

Flexural strength and flexural modulus of banana fiber weight percentages of BANANA composites are shown in table (1)

Table 1: Flexural Properties of Banana composites

BANANA fiber weight percentage	Flexural strength N/mm^2	Flexural modulus N/mm^2
0.4	32.28	1334.02
0.8	52.9	3210.77
1.2	61.44	3108.15
1.6	104.66	7442.9
2	107.52	8995.4

B. Flexural strength:

Figure (5) shows the graph between flexural strength of the BANANA composite at different fiber weight percentages

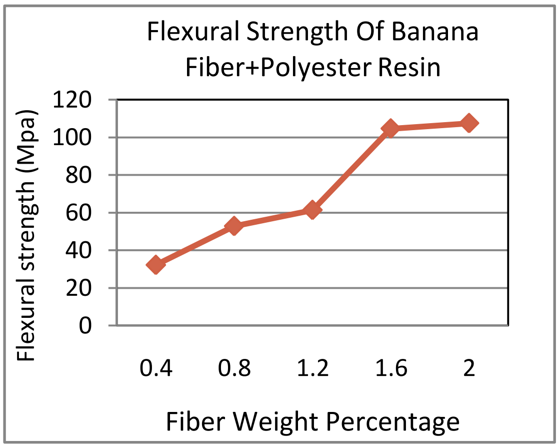

Fig 5: Flexural strength Vs fiber weight percentage

The flexural strength of the composite increased with increased fiber loading. The maximum flexural strength is observed at the maximum fiber weight percentage (2.0%) of fiber. The highest flexural strength is 107.52Mpa where as Flexural strength of pure polyester is 66.96 M.pa. The flexural strength values when compared to pure polyester are 60.57 % higher.

C. Flexural modulus:

Figure (6) illustrates the results of flexural modulus as a function of BANANA fiber loading. From the Fig 6 it is observed that higher fiber concentration demands higher stress for the same deformation Stress increases with the increased fiber weight percentage of the composite.

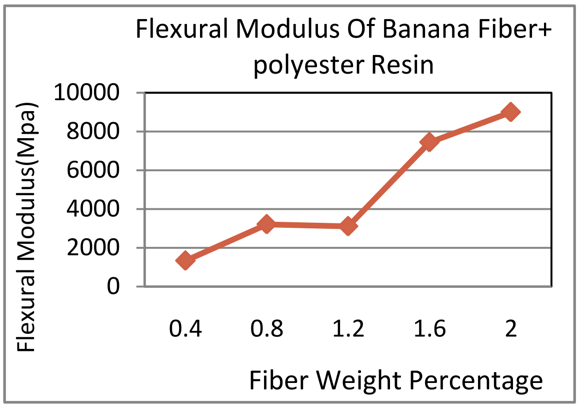

Fig 6: Flexural modulus Vs fiber weight percentage of BANANA

The higher flexural modulus value (8995.4N/mm^2) is observed at 2.0% of fiber weight where as pure polyester exhibited a modulus value 2449.05 Mpa

D. Flexural properties of CARBON fiber

Table 2: Flexural properties of CARBON fiber.

% of carbon fiber	Flexural strength N/mm^2	Flexural Modulus N/mm^2
0.4	32.12	2718.5
0.8	59.98	5687.55
1.2	96.42	9058.53
1.6	111.6	10354.7
2	173.4	18996.7

E. Flexural strength:

The values of flexural strength at different carbon weight percentages are shown in figure (7).

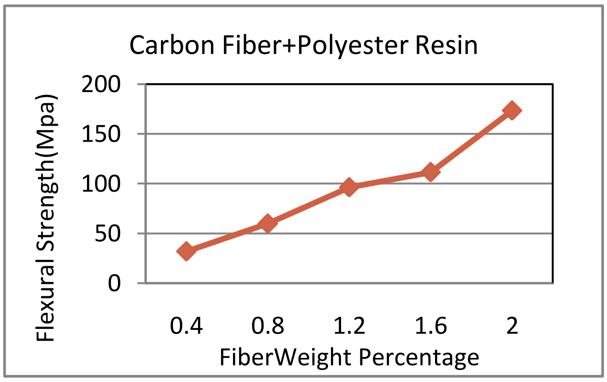

Fig 7: Flexural strength Vs fiber weight percentages.

The higher flexural strength value is observed at the highest carbon weight percentage. Strength increases with increase in fiber weight percentage.

F. Flexural Modulus:

Fig (8) shows the Graph between Flexural modulus of carbon fiber with respect to fiber weight percentage.

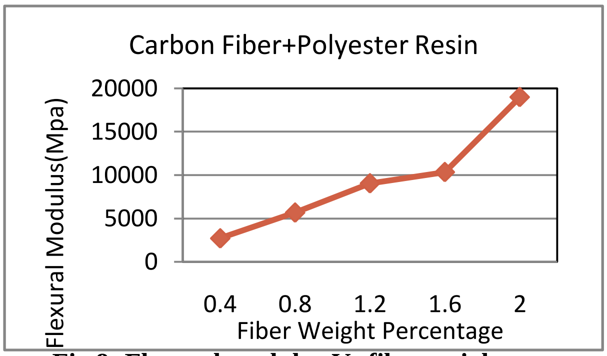

Fig 8: Flexural modulus Vs fiber weight percentage.

Figure (8) depicts the relationship between the flexural modulus and fiber weight percentage.

It is observed a tremendous increment in the flexural modulus values of carbon fiber with polyester resin. As the fiber content increases the modulus values also increased up to mean peak load value 406.6 N at 2.0% of fiber content. The highest value of carbon composite is 18.9 Gpa.

G. Comparison graphs between BANANA and CARBON fiber composites:

From the comparison graphs it is observed that the Flexural properties of Carbon fibers composites are greater than that of the Banana fiber composites at various loads.

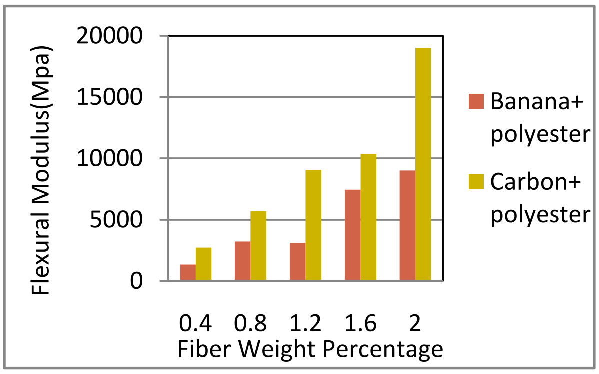

Fig 9: comparison graph between BANANA fiber and CARBON fiber. (Flexural modulus Vs Fiber weight %)

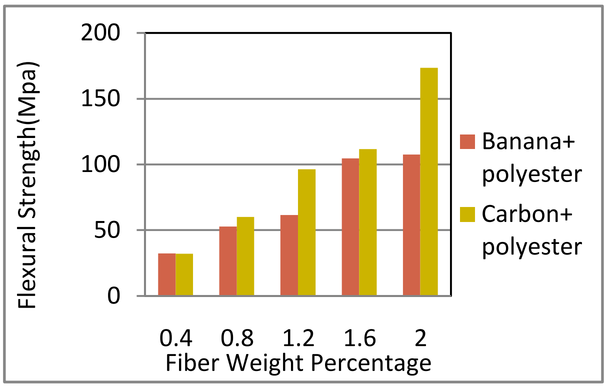

Fig 10: comparison graph between BANANA fiber and CARBON fiber. (Flexural Strength Vs Fiber weight %)

VI. Conclusions

Composite materials are most ideal materials for structural applications where high strength and stiffness to weight ratios are required. Therefore this study focused on the various mechanical properties Banana and Carbon composites at different weight fractions.

From this study it was concluded that increasing of fiber weight percentage in composite increases the mechanical properties. Also the following points are observed from this study.

1. The CARBON fiber incorporation into polyester resin shows the moderate improvement in the Flexural properties.
2. The optimum values of properties of both Banana and Carbon fiber occurred at 2.0% fiber loading.
3. Pure polyester exhibits lower mechanical properties than BANANA incorporated composites

VII. Scope of future work:

In this study only mechanical properties are considered. This work can be extended by considering the metallurgical and thermal properties. Also this work can be extended to different orientation of fibers as well as different fraction.

Acknowledgement:

Author would like to express my deepest sense of gratitude towards my project guide, **Mr. T. Nancharaiah** Head of the Department of Mehanical Engineering, for his essential advices and helping out in grasping the crux of my project.

Author privileged to express our sincere gratitude to the Dr.A.V.Ratna Prasad Principal of V.R.Siddhartha College who have given permission for doing the project in their laboratory.

Special thanks to the laboratory staff Mr. SANKARA RAO who is the skilled technician of the Mechanical Department of Siddhartha College for their timely help.

REFERENCES

[1] A .A.S. Singha and B.Vijay Kumar Thakur(2008),Mechanical Properties of Natural fiber reinforced, polymer composites, Journal of India academy of science,vol:31,789-799.

[2] Bledzki A .K.. Gassian J 1999:Composite reinforced with cellulose based fibres .Progress in polymer science.24,221-274(1999).

[3] Eichhorn S. J Baillie C. A. Zafeiropoulos N., Mwaikambo L.Y., Ansell .P.,Dufresne A., Entiwistle K. M., Herrera-Franco P.J., Escamilla G.C.,Groom L.. Hughes M.,Hill C.,Rials T.G.Wild P.M..2001. Current international research into cellulosic fibres and composites .Journal of Materials Science 36, 2107-2131(2001).

[4] Srikanth G.Nangia S. 2001.Developmetn of natural fiber composites in India in Proceedings of Annual convention and Tracde show, Tampa, USA; 3.6(2001).

[5] Marsh G..2003 .Next step for automotive materials. Materials Today, 6, 36-43(2003).Chen Y., Chiparus O., Sun L., Negulescu I., Parikh D. V .: Calamari T. A.: Natural fibers for automotive non woven composites. Journal of Industrial Textiles, 35, 47-62(2005).

[6] Bledzki A.K.2003: New light construction materials. Przemysl Chemiczny, 82, 548-548(2003)

[7] Bowles and Frimpong, 1991.

[8] Text book of Ammar, 1996

[9] [9]. Text book of Composite Materials written by KAW.