Analysis of Hybrid Natural Fiber Composite for Bio-Medical Application

T.Gopalakrishnan [1], J J Jayakanth [2], C.Gnanavel [3], R. Sridhar [4]
[1, 2, 3, 4] Assistant Professor, Department of Mechanical Engineering, VISTAS, Chennai, Tamil Nadu, India.

Abstract – Composite materials have occupied major part in current era due to its light weight, good stiffness, high specific strength etc. The need to pursue an environmentally safer future has prompted the researchers to look beyond the artificial or synthetic fiber based composites and thought about the hybrid composite. The hybrid composite is obtained by compounding the natural fiber with artificial or synthetic fibers in the reinforcement phase. For the current work the natural fibers of banana and jute fibers are combined with glass fibers for various volume fractions. The banana/ glass fiber with epoxy and jute/ glass fiber are analyzed. The fabrication of different sequence of composite in various volume fractions (30%, 40%, and 50%) is done by handy layup technique. The mechanical properties of all different composites are tested and the results are tabulated. From the result the better composite material is selected for the biomedical application. In the current project the bone plate are fabricated with the help of various structural patterns because natural fibers have the advantage that they are renewable resources, high strength, stiffness, acoustic isolation and low cost.

Index Terms – Natural fibers, hybrid composite, composite bone plate, banana and jute fiber.

1. INTRODUCTION

Orthopedic surgeons have been utilizing metallic plates for the fixation of bone fractures. These metallic plates composed of titanium, stainless steel, cobalt chrome and zirconium. It has the several disadvantages like metal incompatibility, corrosion, magnetism effect, and anode-cathode reactions [14]. A composite is coalescence of two materials in which one of the materials, called the reinforcing phase, is in the form of fibers, sheets, or particles, and is embedded in the other materials called the matrix phase [5]. Glass fiber additionally called fiberglass. It is material made from astronomically fine fibers of glass Fiberglass is a lightweight, prodigiously vigorous, and robust material [16]. Until now two types of fiber have been available to human society. Natural fibers that have subsisted and artificial fiber [17]. Natural fiber reinforced polymer composite materials which are less rigid than metals may be good alternatives because of properties more proximate to bone mechanical properties [12]. Hybrid composites are more advanced composites as compared to conventional FRP composites. Hybrids can have more than one reinforcing phase and a single matrix phase or single reinforcing phase with multiple matrix phases or multiple reinforcing and multiple matrix phases. They have better flexibility as compared to other fiber reinforced composites.

2. MATERIAL AND METHODS

2.1 Fibers

The fibers used for the fabrication of the composites are Glass fiber and Natural fiber.

2.2 Glass Fiber

In glass fibre reinforced plastic material consisting of various grams per square meter and various thickness (30 gsm to 1000gsm). eg

- 225 gsm
- 300 gsm
- 450 gsm
- 600 gsm

In current work select the following type of gsm

- 600 gsm (woven fiber)

In the woven fiber is high strength compare to the other type of gsm.

2.3 Woven fiber (600 gsm)

Glass fiber woven roving is made by fiberglass direct roving, Good electrical insulation and mechanical properties, high strength. Glass fiber Woven roving offers the widest range and the best control over thickness, weight and strength of all forms of fiberglass textiles. This offers the materials engineer a wide choice of controlled fabric properties to satisfy design needs and objectives.

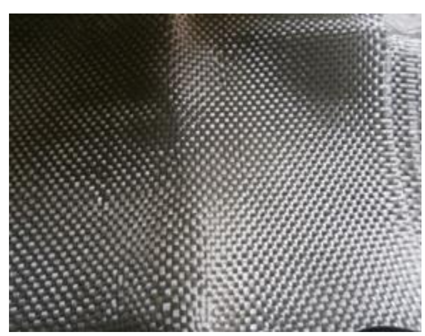


Figure. 1 Woven fiber 600 gsm

2.4 Banana Fiber

Banana fiber, a lingo-cellulosic fiber, obtained from the pseudo-stem of banana plant (Musa sepientum), is a bast fiber with relatively good mechanical properties. The pseudo-stem is a clustered, cylindrical aggregation of leaf stalk bases. Banana fiber at present is a waste product of banana cultivation and either not congruously utilized or partially done so. The extraction of fiber from the pseudo stem is not a mundane practice and much of the stem is not utilized for engenderment of fibers. The buyers for banana fibers are erratic and there is no systematic way to extract the fibers conventionally.

Figure. 2 Banana fiber

2.5 Jute fiber

Jute is kenned as the 'Golden Fibre' due to its golden brown colour and its paramountcy. In terms of utilization, engenderment and ecumenical consumption, jute is second only to cotton. It is the fibre used to make hessian sacks and garden twine. Jute is environmentally amicable as well as being one of the most affordable fibres; jute plants are facile to grow, have a high yield per acre and, unlike cotton, have little desideratum for pesticides and fertilizers. Jute is a bastfibre, like flax and hemp, and the stems are processed in a kindred way.

Figure. 3 Jute fiber

2.6 Matrix

Epoxy is a thermosetting polymer that remedies (polymerizes and cross links) when commixed with a hardener. Epoxy resin of the grade LY-556 and the hardener used was HY-951. The matrix material was yare with a cumulation of epoxy and hardener HY-951 at a ratio of 10:1.

Figure.4 Epoxy and Hardener.

2.7 Chemical Treatment

The fibers are powdered. Then the fibers are cleaned customarily in clean running dihydrogen monoxide and dried. A glass beaker is taken and 6% NaOH is integrated and 80% of distilled dihydrogen monoxide is integrated and a solution is made. After adequate drying of the fibers in mundane shading for 2 to 3 hours, the fibers are taken and soused in the prepared NaOH solution. Sousing is carried out for different time intervals depending upon the vigor of fiber required. In this study, the fibers are soused in the solution for three hours. After the fibers are taken out and washed in running dihydrogen monoxide, these are dried for another 2 hours.

2.8 Fabrication process

Figure. (a) Cutting of long Fibers to required Length. (b) Required length of fibers for fabrication.(c) Weighing of Fibers to Fabricate.(d) Weighing of resin and hardner.

(e) Applying Epoxy Resin, Hardener. (f) Applying Epoxy Resin, Hardener & Fiber layer by layer. (g) Full length Fabricated Plate.

3. EXPERIMENTAL PROCESS

3.1 Samples of desired Dimension

A Wire Hacksaw blade was habituated to cut each laminate into more minuscule pieces, for Tensile test specimens were made according to the ASTM D-3039 size of (250x25x2.5) mm to quantify the tensile properties.

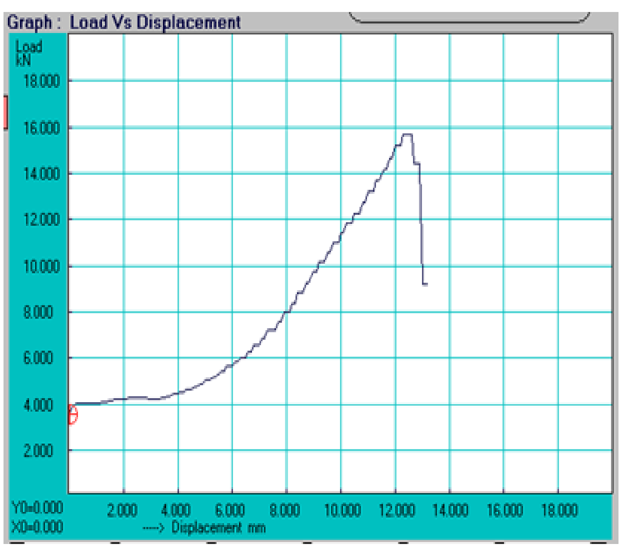
3.2 Tensile test

A tensile test, additionally kenned as tension test, is probably the most fundamental type of mechanical test you can perform on material. Tensile tests are simple, relatively inexpensive, and plenarily standardized. By pulling on something, you will very expeditiously determine how the material will react to forces being applied in tension. As the material is being pulled, you will find its vigor along with how much it will elongate.

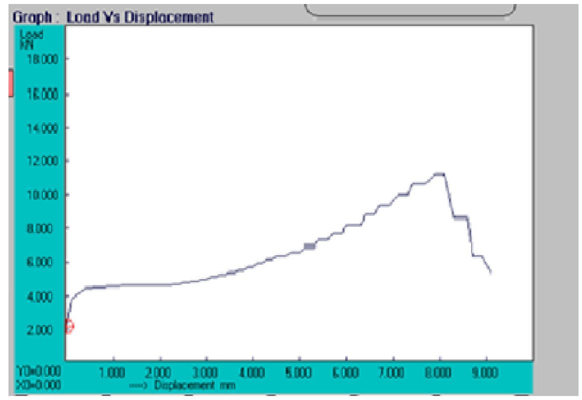
4. RESULTS AND DISCUSSION

4.1 Tensile Test Results For Jute fiber

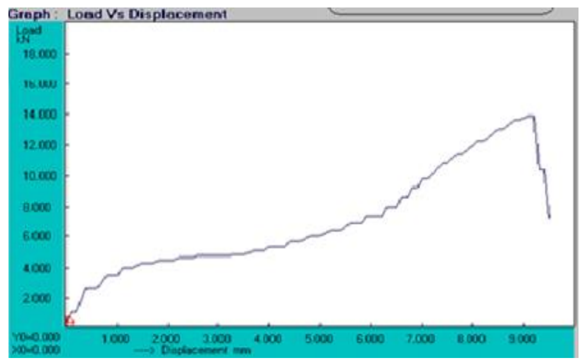
Fiber	%	Density (gm/cm2)	Ultimate Stress (kN/mm2)	Yield Stress (kN/mm2)
Jute	30	1.46	0.105	0.046
	40	1.46	0.113	0.105
	50	1.46	0.139	0.036



Graph.1 Tensile test 30% jute fiber.



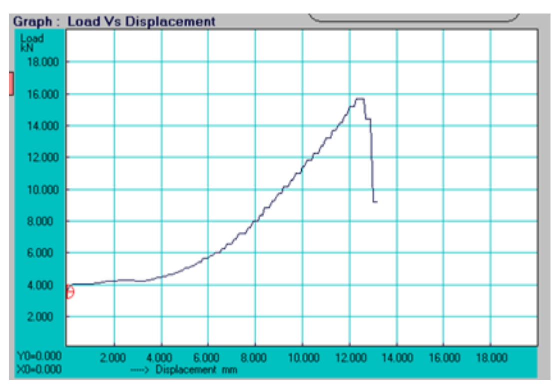
Graph.2 Tensile test 40% jute fiber.



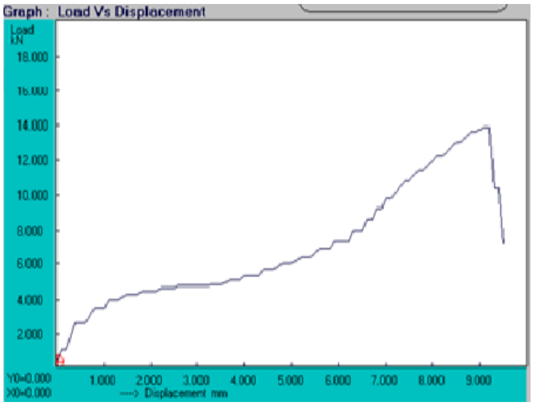
Graph.3 Tensile test 50% jute fiber.

4.2 Tensile Test Results For Banana fiber

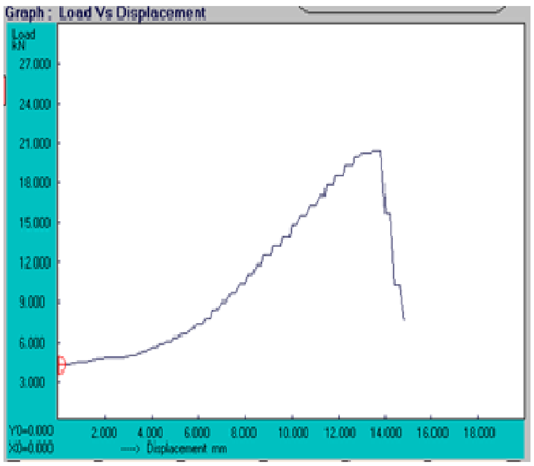
Fiber	%	Density (gm/cm2)	Ultimate Stress (kN/mm2)	Yield Stress (kN/mm2)
Banana	30	1.426	0.139	0.139
	40	1.426	0.163	0.169
	50	1.426	0.204	0.204



Graph.4 Tensile test 30% banana fiber.



Graph.5 Tensile test 40% banana fiber.



Graph.6 Tensile test 50% banana fiber.

5. CONCLUSION

The project work presents the study and testing of hybrid natural fibers composite. Based on the result following conclusions are shown, From the Tensile Experimental test results it is found that 30%, 40% and 50% HNFC will match the Femur bone tensile property anyhow from this results we suggest 50% HNFC is the best material which is having high Tensile strength, high Density when compare to 30% & 40% HNFC.

From the Compression Experimental test results it is found that 30%, 40% and 50% HNFC will match the Femur bone Compression property anyhow from this results we suggest 50% HNFC is the best material which is having high Compressive strength, high Density when compare to 30% & 40% HNFC.

From the Impact Experimental test results it is found that 30%, 40% and 50% HNFPCM will match the Femur bone Impact property anyhow from this results we suggest 50% HNFPCM is the best material which is having high Impact strength compare to 30% & 40% HNFPCM.

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