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Analysis of Hybrid Natural Fibers Composite For Bio-Medical Application

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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 combining the natural fiber with artificial or synthetic fibers in the reinforcement phase. For the current work the natural fibers of banana and jute are mixed with glass fiber for various volume fractions. The following combination sequences are going to be tested banana/ glass fiber with epoxy, jute/ glass fiber with epoxy. Two different types of glass fibers (randomly oriented and plain woven fibers) are considered. The fabrication of all types of composite is done by handy lay-up technique. The mechanical properties like hardness and water absorption are tested and the results are tabulated. From the result the better composite material is selected for the biomedical application and the prototype of bone plate are fabricated with the help of various structural patterns.

KEYWORDS

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

Introduction

Orthopedic surgeons have been using metallic plates for the fixation of bone fractures. These metallic plates made of titanium, stainless steel, cobalt chrome and zirconium. It has the several disadvantages like metal incompatibility, corrosion, magnetism effect, and anode-cathode reactions. The natural fiber reinforced polymer (NFRP) overcomes these problems which are arising by metallic materials. An NFRP composite material uses pure natural fibers and polymers that are less rigid than metals. Composites material comprise of reinforcement and matrix. Reinforcement is a strong load carrying material which provides strength and low rigidity and helping to support structural load. The matrix maintains the position and orientation of the reinforcement. Composite material provides better mechanical properties compared to single conventional materials.

The natural fibers such as Banana and Jute have to be used as a replacement for reinforcement materials in composites. These fibers have low density, high toughness, reducing tool wear, ease of separation, low energy of fabrication, impact resistance and flexibility. The main advantages of natural fibers are biocompatibility and biodegradable. The bio epoxy resin Grade LY 556 and Hardener HY 951 used as matrix because of their higher adhesion and less

shrinkage. Strength and stiffness of fiber composites depend on fiber concentration, fiber aspect ratios, fiber matrix adhesion, as well as fiber Orientation [10].

METHODOLOGY

Hybrid composite method

A composite material in which two or more high-performance reinforcements are combined. The aim is to combine the properties of the composing materials into an average property or even to create new or improved properties. Hybridization is the process of incorporating different synthetic fibers with natural fibers to yield better strength, stiffness, a high strength-to-weight ratio, and other mechanical properties.The natural fiber (30%, 40%, and 50%), glass fiber, and resin are combined into the different volume ratios. [9].

Materials used

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 controlledfabric properties to satisfy design needs and objectives [13].

Figure 1 Woven fiber 600 gsm

Banana Fiber

Banana fiber, a lingo-cellulosic fiber, obtained from the pseudo-stem of banana plant (Musa sepientum), is a bastfiber 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 properly utilized or partially done so. The extraction of fiber from the pseudo stem is not a common practice and much of the stem is not used for production of fibers. The buyers for banana fibers are erratic and there is no systematic way to extract the fibers regularly. Useful applications of such fibers would regularize the demand which would be reflected in a fall of the prices [13].

Figure 2Banana fiber

Jute fiber :

Jute is known as the 'Golden Fibre' due to its golden brown colour and its importance. In terms of usage, production and global consumption, jute is second only to cotton. It is the fibre used to make hessian sacks and garden twine. Jute is environmentally friendly as well as being one of the most affordable fibres; jute plants are easy to grow, have a high yield per acre and, unlike cotton, have little need for pesticides and fertilizers. Jute is a bastfibre, like flax and hemp, and the stems are processed in a similar way[13].

Figure 3 Jute fiber

Epoxy resin LY556 :

In this project we are choose the Epoxy resin (Araldite LY 556) made by CIBA GUGYE Limited, having the following outstanding properties has been used.

Excellent adhesion to different materials.Great strength, toughness resistance.Excellent resistance to chemical attack and to moisture.Excellent mechanical and electrical properties.Odorless, tasteless and completely nontoxic.Negligibleshrinkage[8].

Figure 4 Epoxy resin

Hardner:

In the present work Hardener (araldite) HY 951 is used. This has a viscosity of 10-20 poise at 250C. The resin to hardener ratio is 10:1.

Figure 5Hardner

(a)

(b)

(c)

(d)

(e) (f)

(g)

Figure 6 (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.

EXPERIMENTAL DETAILS

A Wire Hacksaw blade was used to cut each laminate into smaller pieces, for Water absorption specimens were made according to the ASTM D-570 to measure the water absorption properties, for hardness test specimens were made according to the ASTM D-785 size of 25 mm diameter and 20 mm length to measure the hardness strength.
Water absorption gives an idea of strength of aggregate. Aggregates having more water absorption are more porous in natural and are generally considered unsuitable unless they are found to be acceptable based on strength, impact and hardness tests.

Test procedure

Water absorption is used to determine the amount of water absorbed under specified conditions. Initially the Composite materials were dried in an air oven at 50 °C. Then these conditioned

materials were immersed in distilled water, acid solution at 30 °C for about 24 hours. The material were removed from water and wiped with filter paper to remove surface water and weighed with digital balance of 0.01 mg resolution. The weighing was done within 30 secs in order to avoid the error due to evaporation. The test was carried out according to ASTM D570 to find out the swelling of specimen.

Test material image

(a) (b) (c)

(d)

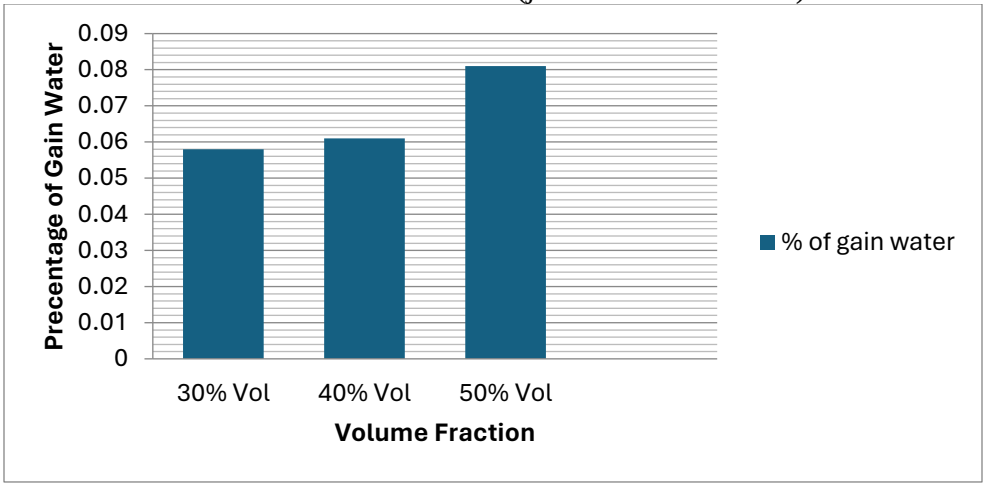
Figure 7 Water absorption test material image
(a) Banana fiber material (b) Jute fiber material (c) Immersed in distilled water (jute and banana fiber) (d) Weighing machine.

TABULATION FOR WATER ABSORPTION TEST

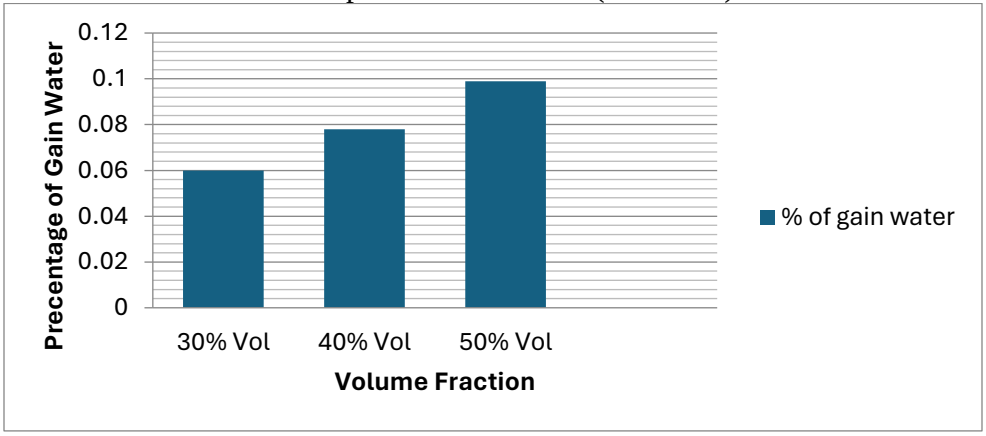
Hybrid natural fiber	Different volume fraction for natural fiber in %	Mass before test (g)	Mass after test (g)	(%) gain of water
Jute	50	6.853	6.857	0.058
	40	6.531	6.535	0.061
	30	6.121	6.126	0.081

Banana	50	6.624	6.628	0.06
	40	6.378	6.383	0.078
	30	6.003	6.009	0.099

Table 1 Gain of water (jute and banana fiber) %



Graph 1 Gain of water (Jute fiber) %



Graph 2 Gain of water (Banana fiber) %

HARDNESS TEST

In current project we are using Brinell hardness test and results are tabulated. Hardness of the three separate specimens and three reinforced composite material is determined by using Brinell Hardness Testing Machine. The specimen size used here is a circular rod of length of 65mm and the diameter of 35mm. The specifications of the machine are ball intender of diameter 20mm and the maximum load of 4000N.

Test material image

(a) b) (c)

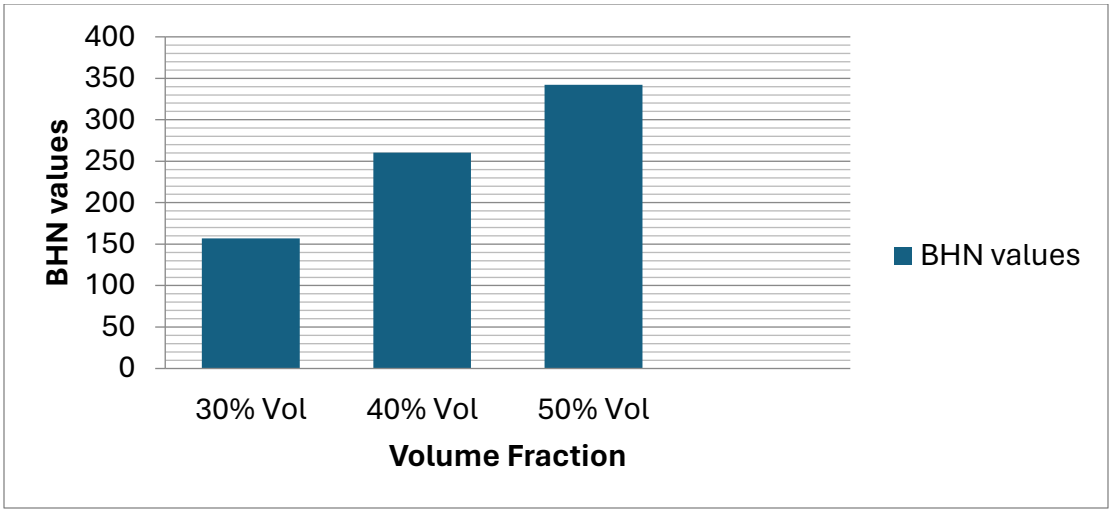
Figure 8 Hardness test material image

(a) Jute fiber testing material (b) Banana fiber testing material (c) Using microscope find the diameter.

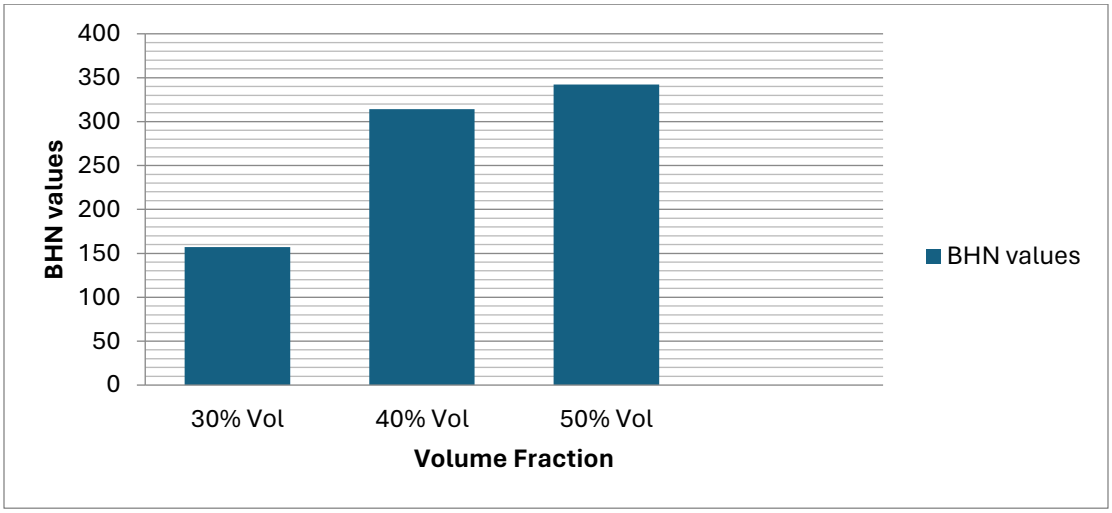
TABULATION FOR HARDNESS TEST

Hybrid natural fiber	Different volume fraction (%)	Load (P) (Newton)	Ball diameter (D)mm	Diameter of the Indentation (d)mm	BHN
Banana	50	2500	5	1	42.33
	40	2500	5	3	60.48
	30	2500	5	4	57.07
Jute	50	2500	5	1	42.33
	40	2500	5	2	14.15
	30	2500	5	4	57.07

Table 2 Hardness of Jute and banana fiber.



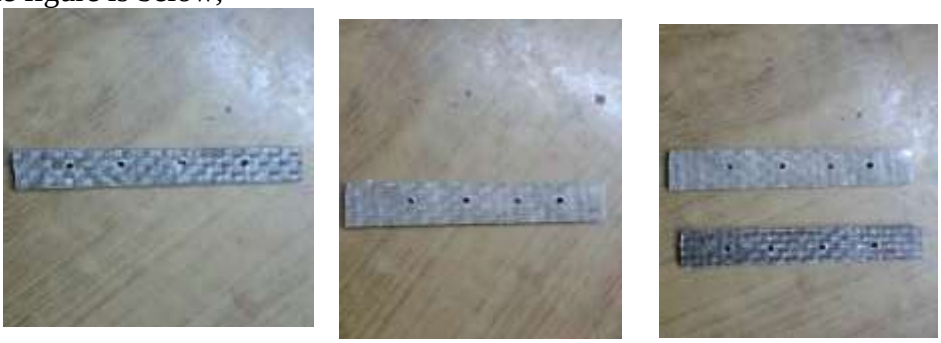
Graph 3 Banana fiber BHN value.



Graph 4 Jute fiber BHN value.

BONE PLATE PROTOTYPE

In current work the natural fibers of banana and jute are mixed with glass fiber for various volume fractions. The following combination sequences are going to be tested banana/ glass fiber with epoxy, jute/ glass fiber with epoxy. Two different types of glass fibers (randomly oriented and plain woven fibers) are considered. The fabrication of all types of composite is done by handy lay-up technique. The phase (I) results tensile, compression and impact property anyhow from this results we suggest 50% HNFC is the best material which is having high Tensile strength, Compressive and Impact strength, high Density when compare to 30% & 40% HNFC.
In current phase (II) work is the mechanical properties like hardness and water absorption are tested and the results are tabulated.
The best material of the 50% HNFC (Jute and Banana) fiber prototype model is fabricated and show the figure is below,



(a) (b) (c)

Figure 9 Bone plate prototype model.

(a) Jute fiber prototype model. b) Banana fiber prototype model. (c) Both Jute and Banana fiber prototype model.

The bone plate model and dimensions are below:

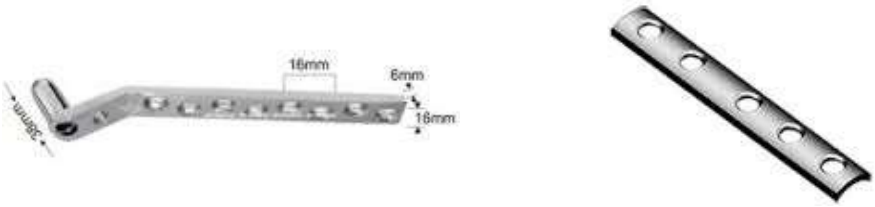


Figure 10 Bone plate

Results and Discussion

WATER ABSORPTION RESULT

Jute fiber results

From this Experimental Result (30% jute fiber) concluded that the Specimen having (%) gain of water of 0.081 %.
From this Experimental Result (40% jute fiber) concluded that the Specimen having (%) gain of water of 0.061 %.
From this Experimental Result (50% jute fiber) concluded that the Specimen having (%) gain of water of 0.058 %.

Banana fiber results

From this Experimental Result (30% banana fiber) concluded that the Specimen having (%) gain of water of 0.099 %.
From this Experimental Result (40% banana fiber) concluded that the Specimen having (%) gain of water of 0.078 %.
From this Experimental Result (50% banana fiber) concluded that the Specimen having (%) gain of water of 0.06 %.

HARDNESS TEST RESULT

Jute fiber results

From this Experimental Result (30% jute fiber) concluded that have Hardness Strength BHN value 157.0.
From this Experimental Result (40% jute fiber) concluded that have Hardness Strength BHN value 314.15.
From this Experimental Result (50% jute fiber) concluded that have Hardness Strength BHN value 342.33.

. Banana fiber results

From this Experimental Result (30% banana fiber) concluded that have Hardness Strength BHN value 157.07
From this Experimental Result (40% banana fiber) concluded that have Hardness Strength BHN value 260.48
From this Experimental Result (50% banana fiber) concluded that have Hardness StrengthBHN value 342.33.

Conclusions

The project work presents the study and testing of hybrid natural fibers composite. based on the following conclusions are shown:

From the Water absorption Experimental test results it is found that 30%, 40% and 50% HNFC. The 50% HNFC is the best material which is having high strength, high Density when compare to 30% & 40% HNFC.
From the Hardness Experimental test results it is found that 30%, 40% and 50% HNFC. The 50% HNFCis the best material which is having high Hardness strength, high Density when compare to 30% & 40% HNFC.

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