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Experimentation on Hybrid Composite of Banana and E-Glass Fiber

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Abstract - *The natural fiber reinforced polymer composite is a basic material. This can be used to increase the strength to optimize weight and cost of the product. The growing environmental concerns increasing the global warming due to waste management issues, dwindling and fossil resources. Green products are being increasingly promoted for sustainable development. Since these products are environmental friendly ad cost effective there usage might not a disaster to the environment and the bio life. Natural fibers present important advantages such as low density, appropriate stiffness, high renewability and mechanical properties in which these are recyclable and biodegradable. In this project the banana and E-glass fiber reinforced polymer composite was fabricated by using an epoxy resin Lapox-12 (L-12) and used a suitable hardener K-6. This combination can be used to fabricate by hand lay-up process. The fabricated composite can be specified by the according to ASTM standard to finding the mechanical properties for the composite. The result indicates the percentage increase of the weight of banana fiber results to improvements for the mechanical properties. Such as Tensile, Flexural and water absorption test of the composite material. Among the C-1, C-2, C-3 and C-4 composite, the C-4 composite has attained greater mechanical properties: tensile and flexural. But the water absorption capacity is less for the C-4 composite. This is a good character of the E-glass fiber. The combination of hybrid composite can be used for industrial and domestic perpus.*

Key Words: Polymer composite, Banana fiber, E-glass fiber, Epoxy Resin, Mechanical Properties.

1. INTRODUCTION

Natural fibers when compared to synthetic fibers have many properties which are superior to it. The natural fibers are low weight, low density, biodegradable have high specific strength. The hybrid composite of natural fibers revel reduction in the material lost due to the low cost for the using by natural fibers. Natural fiber is a reinforced which has recently attracted the attention of researches. The banana fiber reinforced composite have recently gained importance and the fibers are used for light weight and green composites in agriculture industries. The banana fibers are a lingo cellulosic fiber obtained from the pseudo stem of banana plant and it's a good mechanical properties. These can be used for door panels, room partitions, wall cladding, home appliances, automotive panels, building, construction and electrical housing. . At present the banana fibers is a waste product of banana cultivation, are easily available, and may be reinforced in thermosets and thermoplastics.

In this study, attempts have been made to improve the mechanical properties of the composite by the incorporation of glass fiber, based on the reports of other researches. Composite with different volume fraction of glass have been prepared and analyzed. This paper reports the fabrication of hybrid composites with different weight fraction of E-glass and banana fiber reinforcement with using an Epoxy Resin. Then different tests are conducted according to ASTM standard. The result showed that maximum Tensile strength, Flexural strength and Water absorption for E-glass and banana fibre fabric for the using of maximum percentage of E-glass fiber can be used in the hybrid composite. This combination of hybrid composite can be used for the Industrial and Domestic purposes.

2. MATERIAL AND METHOD

The main constituent of raw materials is used in this experiment for fabrication was banana fibers, glass fibers, epoxy resin lapox-12 (L-12) and the hardener k-6. The banana fibers are collected in the form of thread from Shivamogga (District), Karnataka.

2.1 Fabrication of Material

The composite can be prepared by hand lay-up technique. The required mixture of Epoxy Resin L-12 and hardener k-8 was made by mixing them in (10:1) ratio in a beaker while stirring the mixture by a rod, taking that into care a no air should be entrapped inside the solution. This mixture can be poured into the prepared molds, keeping in assessing the requirement of various testing conditions and characterization standards.

2.2 Mould Preparation

The mild steel mold having dimension of 300*300 mm were prepared and used for casting of polymer matrix composite slabs. The mold comprises two plates on top and bottom. The inner cavity dimensions of the mold 250*250*6 mm.

2.3 Castings of Slabs

Table 1: shows the different composition of composites.

Volume part of composition	Sequence
20% G F + 40% B F+40% E R	C-1
30% G F + 30% B F +40% E R	C-2
40% G F + 20% B F +40% E R	C-3
50% G F + 10% B F +40% E R	C-4

All of the specimens are 0/90 degree orientation and the banana fiber in a linearly increasing percentage indicates the optimum condition on the experiments. Place the banana fibers on 90 degree orientation on the mold cavity prepared. Then pour the mixture of epoxy resin and hardener over the place of banana fiber. A releasing agent can be used on the mold to release the mallex sheets to facilitate easy removal of composite from the mold after curing. Then place the mallex sheet over the resin mixture and the fiber. To apply the pressure on upper side of the mold at room temperature until the matrix is set properly. This setup is left to cure for 24 hours at room temperature. The entrapped air bubbles can be removed by using sliding roller. The prepared composite were cut for testing, conforming to the dimensions of the specimen as per the ASTM standards.

2.4 Sample Preparation

The specimens of suitable dimension are cut using a diamond cutter for mechanical tests as per the ASTM standard. The fabricated slab is as shown in the below fig.2.1

Fig 2.1: banana and glass fiber composite laminate

2.5 Volume Fraction

The estimation of composite is the expansion of volume of fortifying and volume frame work. The creation of composite which can be needed to determine the level of support and lattice. The point of volume or mass of composite is shall so as to discover the volume and framework parts.

Consider the composite of fibers and network vc,vf and vm are the volume of composite. Fiber and lattice separately γc,γf and γm are the composite density.

Fiber and lattice separately presently the characteristics the fiber volume density vf and lattice volume part vm is

VF=vf/vc

VM=vm/vc

Where

VF=volume of fraction

VM=volume of matrix fractiuon

vf=volume of fiber

vc=volume of composite

vm=volume of matrix

Entirely the volume density is

VF+VM=1

vf+vm=vc

3. MECHANICAL PROPERTY TESTING

The mechanical behavior (tensile strength, flexural strength) of the composite was tested by the universal testing machine (UTM).

3.1 Tensile Strength

The tensile test can be done by cutting the composite specimens as per the standard of ASTM: D638. The tensile test is generally performed on flat specimens. The commonly used specimens for tensile test are the dog bone type. The dimension for the tensile specimen is 165*20*6 mm^3 and the gauge length of specimen is 57mm.

Fig 3.1: Tensile test specimen

3.2 Flexural Strength

The flexural test can be done by cutting the composite specimen as per the standard of ASTM: D790. The flexural samples are of 80mm * 15mm * 6mm. The gauge length of the specimen 50mm

Fig3.2: Flexural test specimen

3.3 Water Absorption Test

The photographic view as shown in figure and it is square shape specimen of size 15mm and the thickness 6mm. The ASTM standard guidelines are followed.

Fig3.3: Water absorption Test specimens

4. RESULT AND DISCUSSIONS

4.1 Tensile Properties:

The composite specimens with different fibre combination tests are shown in figure 4.1. The specimen is holder in the grip and the load is applied. The corresponding displacement is noted. The load is applied until the specimen breaks, then the break load, ultimate tensile strength are noted. The specimens are tested on one of the popular testing machine named as Universal Testing Machine (UTM).

Formulae,

Tensile strength = Peak Load /Max Displacement

Strain = Change In Length/Original Length

Tensile modulus = Tensile Strength/Strain

Fig 4.1: Samples for before for after test

The stress and strain is designed for the assurance of extreme rigidity also versatile modulus.

Below the Table 2: shows the results of the tensile test

composites	Max load (KN)	displacement	strain	U T S (MPa)	T M (MPa)
c-1	3.5	2.2	0.278	220.12	791.79
c-2	6.3	2.9	0.357	308.82	865.04
c-3	14.5	3.21	0.39	644.44	1652.4
c-4	18.5	3.54	0.438	1033.3	2359.2

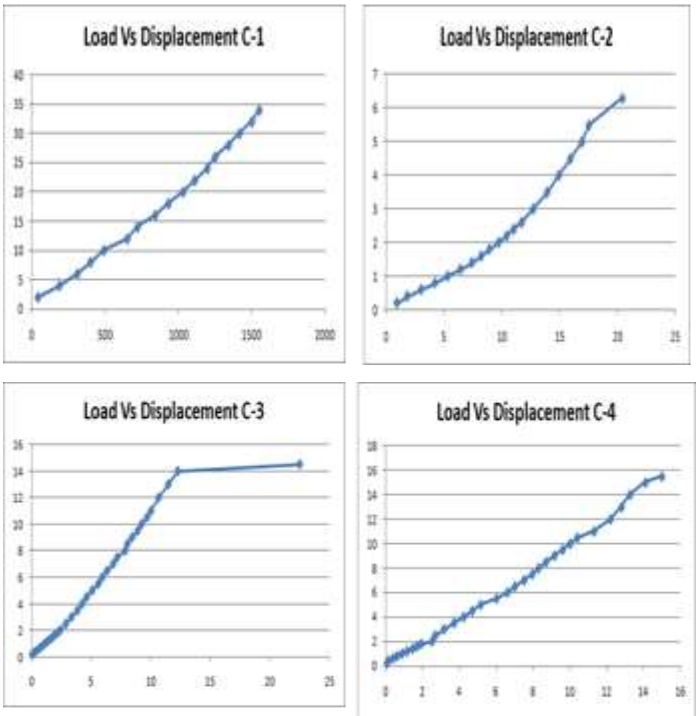

Fig 4.2: Load Vs Disp. of tensile specimens with diff compositions.

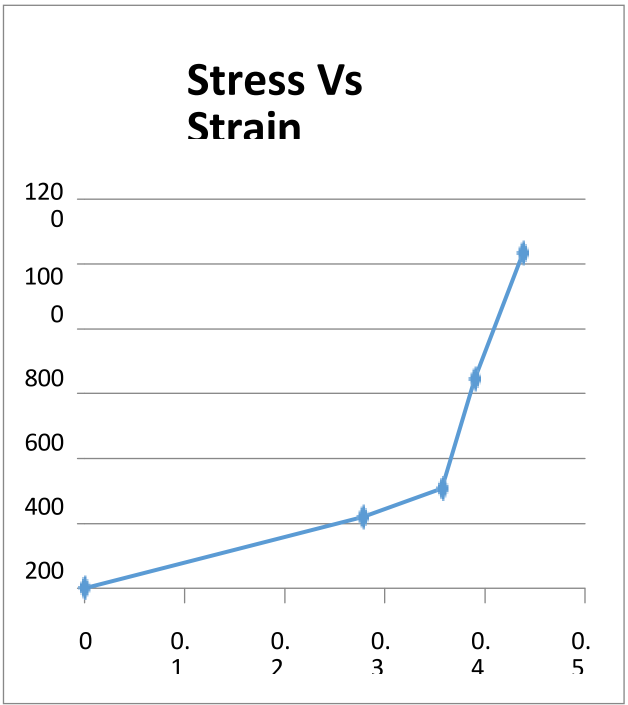

Fig 4.3: Stress Vs Strain curve for tensile test.

Different layering of composites is C-1, C-2, C-3 and C-4. Fig 4.2 represents the various tensile strength values for different composition of banana and E-glass fiber. In composite C-4 gives the highest tensile strength compared to C-1 composite because by using a maximum percentage of E-glass fiber than the banana fiber. The density and strength of the glass fiber is more than banana fiber. The fig.4.3 shows stress strain analysis for all the 4 composites. The graph is suddenly increased by analyzing composites are small percentage to maximum percentage of using E-glass fiber. The initial tensile strength value is 791.79 MPa to maximum tensile strength 2359.2 MPa.

Discussion:

The mechanical behavior of banana fibre and the glass fibre material under elastic load is examined. The outcomes are depicted in table. The elastic properties of banana fibre are strengthened with E- Glass fibre and epoxy resins. The load versus displacement and stress versus strain are shown in the figure 4.2. The tensile strength of C-4 is more that of C-1, C-2 and C-3 composite material.

4.2 Flexural Properties:

The flexural test is done on three point bending setup. Flexural quantity was tried in flexural testing machine. When a load is applied at middle of the specimen it bends and fractures as shown in the figure,

Fig 4.4: Flexural Specimen Loading Position

Formulae:

Flexural strength = $3PL/WT2$

Where,

P= peak load or Max load.

L= Gauge length.

W= width.

T=Thickness.

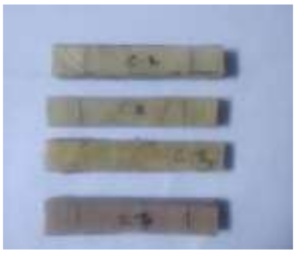

Fig 4.5: Flexural test samples before and after test.

Below table shows the results of composite properties for flexural test. Table 3 shows the results of composite properties for flexural test

comp	Max load (N)	Displacement (mm)	Flexural Strength (MPa)	Youngs Modulus (MPa)	M of resiliance (j/m3)
c-1	223.8	7.34	35.7	102.1	245.46
c-2	404.4	7.88	64.81	323.5	282.82
c-3	563.8	4.07	90.35	440.5	360.83
c-4	653.7	8.13	104.77	983.2	417.35

Below graphs shows the load vs displacement curves for the flexural samples.

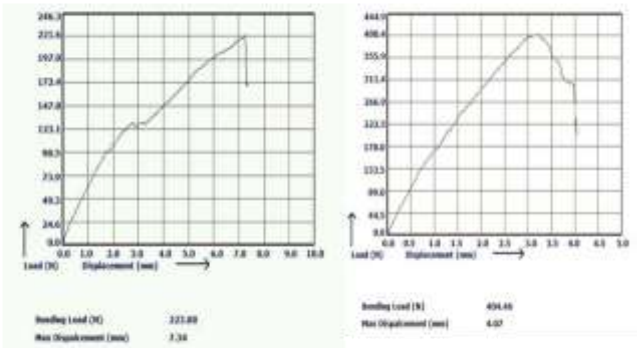

Fig 4.6: Load Vs Displacement for C-1 and C-2

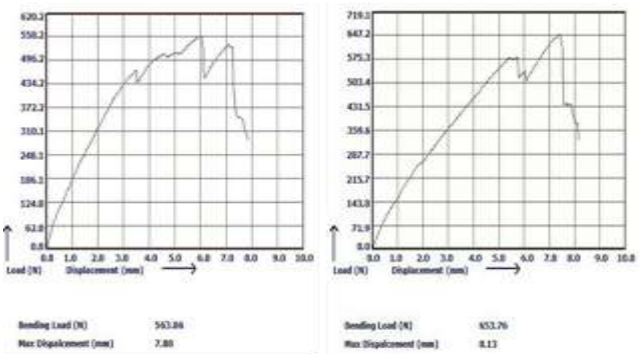

Fig 4.7: Load Vs Displacement for C-3 and C-4

Different layering's of composites are C-1, C-2, C-3 and C-4. Fig 4.5 represents the various flexural strength values for different composition of banana and E-glass fiber. In composite C-4 gives the highest flexural strength compared to C-1 composite because by using a maximum percentage of E-glass fiber than the banana fiber. The density and strength of the glass fiber is more than banana fiber. The above fig. shows the load vs displacement analysis for all the 4 composites. The initial flexural strength value is 35.7 MPa to maximum flexural strength 104.77 MPa.

Discussion:

The mechanical behavior of banana fibre and E-Glass fibre material under flexural load is examined and the outcomes are accounted for underneath separately. The flexural properties of banana fibre strengthened with E-glass fibre and Epoxy resin. The load Vs displacement curve plotted as shown in figure 4.6 and 4.7. The figure shows that bending strength of C-4 composite is more than C-1, C-2 and C-3 of composite material.

4.3 Water Absorption Test:

The composite weight is gain by the absorption of water. The composite was sliced to get the ideal component of sample for mechanical testing. The weight increment of samples by water absorption is taken with ten days of interval for normal water. Once moisture penetrates inside composite material and the fibre tends swell. Therefore interface between fibre and epoxy gets weaken due to water absorption which leads to decrease in mechanical strength of composites. The water absorption of the composite was determined using the relationship below:

Average percentage of water absorption (%) $= W_f - W_i / W_i * 100$

Where, Wi = weight of laminate before immersion

Wf = weight of laminate 10days after immersion

Fig 4.8: Water absorption Test specimens.

Calculation of the composite properties for water absorption test. Table 4 shows the result of Water absorption test

composites	No. of soaking days	Initial weight (Wi in grm)	Final weight (Wf in grm)	Avg. % of water absorption
c-1	2 4 6 8 10	22.5 23.8 24.4 25.1 25.32	23.8 24.4 25.1 25.32 25.5	3.95
c-2	2 4 6 8 10	22.15 22.92 23.45 23.69 23.9	22.92 23.45 23.69 23.9 24.12	2.9
c-3	2 4 6 8 10	21.9 22.5 23.2 23.5 23.8	22.5 23.2 23.5 23.8 23.9	2.69
c-4	2 4 6 8 10	21.2 21.45 21.6 21.7 21.8	21.45 21.6 21.7 21.8 21.82	1.26

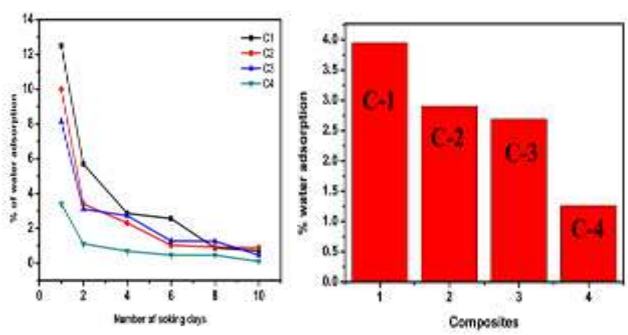

Fig 4.9: A graph representation water absorption capacity

The banana fiber absorbs more water than E-glass fiber. In composite C-1 is the highest water absorption capacity compared to C-4 composite because by using a maximum percentage of banana fiber than the glass fiber. From the test, it is found that the maximum water absorption is observed in composite C-1 which are of maximum percentage of banana fiber while it is minimum in composite C-4 which is maximum percentage of E-glass fiber.

Discussion:

The water adsorption properties of banana fibre with E-glass are explored at room temperature. The water adsorption property of banana fibre, E-glass and epoxy shown in fig 18. The figure demonstrates that of the C1 is more retained than that of C2, C3 and C4 composite material. Therefore, if increases the banana fibre can change moisture absorption compare to E- glass fibre.

5. CONCLUSIONS

The study of mechanical behaviour of banana fibre based hybrid composites indicates to the many conclusions.

1. The fabrication of banana fibre based composites with different compositions of fibre is prepared by hand layup process.
2. From the current experimental results, it has been observed that composition of banana and E-glass fibre has major effects on the mechanical properties: tensile strength and flexural strength of the composite.
3. It has been observed that the better mechanical properties found for C-4 composite with the composition of 50% E-glass, 10% of banana fibre and the 40% of epoxy.
4. Since C-4 (50% E-glass, 10% of banana fibre and the 40% of epoxy resin) can give an optimum result of the composite.
5. In water absorption test C-1(20% E-glass, 40% of banana fibre and the 40% of epoxy resin) can cause larger absorption of water. Thus the water absorption depends on quantity of banana fibre.

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