Study of Mechanical Behavior of Banana fiber and Glass fiber polyester reinforced composite

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Abstract—**World is now focusing on natural resources as a substitute for conventional one. Natural fibers composites are preferred because of the said advantages i.e. to increase the strength, to optimize the weight and the cost of the product fibers from the natural sources. There are certain advantages of natural over synthetic reinforcement materials such as low cost, low density, non-toxicity, comparable strength, and minimum waste disposal problems. In this project, banana and glass fiber reinforced polyester composites are prepared and the mechanical properties of these composites are tested. The composite samples with different fiber volume fractions were prepared by using the hand lay-up process and pressure is applied uniformly. The prepared samples were subjected to the mechanical testing such as tensile, flexural loading.**

Keywords- banana fiber, composite, glass fiber, hybrid, mechanical properties

I. INTRODUCTION

The composite materials could be termed as those materials which are synthesized by two or more materials having diverse properties a blend of properties that a singular can't have the capacity to give. Multi-component composite materials comprising of two or more families of fibres have been attracting the attention of researchers these years. This is because, the usage of one type of fibre alone has proved to be inadequate in satisfactorily tackling all the technical and economic problems confronted by them while making fibre reinforced composites. Mohan and Kishore [1] have reported that glass has got good reinforcement effect along with jute. Clark and Ansell [2] have reported improvement of various mechanical properties of jute-glass hybrid laminates with different arrangements of jute and glass in the laminate. Pavithran *et al.* [3] have studied the mechanical properties of coir-glass hybrid composites containing varying amounts of glass fibre. Attempts have been made in our laboratory to prepare hybrid composites of sisal and glass in polyethylene and oil palm empty fruit bunch fibre and glass in PF. It has been reported that addition of glass has improved the orientation characteristics and thereby the tensile strength of the composites [4]. A ratio of 0.26:0.74 volume fractions of glass and oil palm fibre gave 23% improvement in the Izod impact strength of the composite. Better properties were given by randomly mixed hybrid composites [4]. In the previous studies, it was noted that banana fibre was an effective reinforcement in polyester composites [5]. Current research work includes the improvement in mechanical properties of the composite by the addition of glass fibre, based on the reports of other researchers [1-6]. Composites with different volume fraction of glass have been prepared and analyzed. The composites can be prepared with desired and fiber orientation can be done as per application The composites are comparatively cheaper to manufacture and there are various manufacturing processes available for the composites. The surface finish of the composite is comparatively much higher and it can be manufactured in different techniques. The use of composites has given more flexibility to design engineers to develop new design and for modifications in the existing design. Since the composites are easier to handle and synthesize. At present banana fiber is a waste product of banana cultivation, therefore without any additional cost these fibers can be obtained for industrial purposes [7]. Pothan et al [8] studied the dynamic mechanical behavior of banana fiber reinforced polyester composites and found that the volume fraction of the fiber has great influence on the mechanical properties of the composites. Polymeric matrix composites are the most commonly used matrix materials. The reasons for this are two-fold. In general the mechanical properties of polymers are inadequate for many structural purposes. In particular their strength and stiffness are low compared to metals and ceramics. By reinforcing other materials with polymers these difficulties can be overcome. Secondly high pressure and high temperature are not required in the processing of polymer matrix composites. For this reason polymer composites developed rapidly and became popular for structural applications with no time. Polymer composites are used because overall properties of the composites are superior to those of the individual polymers. The **purpose** of this paper is to-

a) Fabricate the new class of polyester based hybrid composites reinforced with glass fibers and banana fibers.

b) Testing of mechanical properties such as tensile strength, flexural strength.

Properties	Banana fiber	Glass fiber
Tensile strength (MPa)	60–75	3450 - 4590
Density (g/cm3)	1.35	2.52
Elongation at break (%)	1.73	1.38

Table 1.1 Properties of banana and glass fiber

II. EXPERIMENTAL SETUP

2.1 Materials

a) Banana fiber – raw and plain continuous fiber from Navsari Agricultural University, Navsari, Gujarat.
It is untreated extracted from banana trunk. Fiber layers are prepared and separated mechanically from banana stalk.
b) Glass fiber- continuous fiber, E-type fiber procured from PL composites, Ahmedabad, Gujarat
c) Polyester – cheaply available everywhere bought from local shop SP Polymers in Surat, Gujarat.
It is used as base matrix in the composite.
d) Cobalt napthanate is added as an accelerator. It is used as 0.8% of volume in entire mixture. The solution is mixed and stirred before applying on the laminate.
e) Hardener is used for hardening of composite and for curing process.

2.2. Specimen Preparation Method
The moulds have been prepared with dimensions of 250 x 250 x 5 mm^3. The banana fiber layer of different weight has been mixed with matrix mixture with their respective values by simple mechanical stirring and mixture is slowly poured in different moulds, keeping the characterization standards and view on testing condition. The releasing agent has been use on mould sheet which is easy for composites removal from the mould after curing the composites. A sliding scale has been used to remove the trapped air from the uncured composite and mould has been pressed hard till the constant thickness is achieved. It is kept pressed at constant pressure for nearly 20 hours.

Flowchart:

Prepare different glass and banana fiber layers
↓
Apply mixture and place layers by hand lay-up technique
↓
Remove the voids/traps by moving sliding scale on it.
↓
Leave it for curing for overnight.
↓
Cut the specimen as per given ASTM
↓
Testing of specimen- tensile and flexural

III. TESTING OF THE COMPOSITE

3.1Tensile Test: The fabricated hybrid composite is cut using grinding cutter to get the dimension of the specimen for tensile testing as per ASTM: D3039 standards. The test is carried out on tensometer. The test was carried out using a tensometer at a room temperature. The load versus displacement graph was recorded when the test is started. It is continued until it undergoes fracture. Specimen was placed in the grip of the machine. The actual gauge length was 150 mm. The graph is plotted for 0degree orientation.

Figure3.1 Tensile test on Tensometer

Figure3.2 Failure during tensile test

The tensile strength is calculated by the rule of hybrid mixture formulas for composite materials.

3.2 Flexural Test: In this test, it is three point bending test. The specimen to be is subjected to breakage or until its fracture. Load is applied along the midway of the span. This test determines the behaviour of the specimen when it is subjected to simple beam loading. Flexural test determines the maximum stress induced in the outer most fibre. This test is carried out according to ASTM D790 standards.
When a beam of homogeneous, elastic material is tested in flexure as a beam simply supported at two points and loaded in midpoint, the maximum stress at the outer surface occurs at mid span.

Figure 3.4 Flexural Test on Tensometer

The stress is calculated by general equation (1)

$$\sigma = 3PL/2bh^2 \qquad (1)$$

Where:
σ - Stress at the outer surface of mid-span, Mpa
P - Applied force, N
L - Support span, mm
b- Width of specimen, mm
h- Thickness of specimen, mm

Figure3.5 failure during bending test

Flexural modulus could be found by the ratio of stress to strain in the flexural deformation. It determines the tendency of the material to bend. In the 3 point testing of the material the flexural strength can be calculated by using equation 2. It is expressed in MPa .

$$Ef = L^3m/4bh^3 \ (2)$$

Where,
Ef - flexural secant modulus of elasticity, Mpa
L – Support span, mm
b – Width of specimen, mm
h – Thickness of specimen, mm
m – Slope of the secant of the force-deflection curve

IV. RESULTS AND DISCUSSION

The specimen of 90degree orientation has been omitted. It has undergone premature failure. It was not able to sustain the minimum tensile strength measured by the instrument. These values are selected only for 0 degree orientation and unidirectional laying method

4.1 Effect of tensile strength on different loading of fiber parameter

Specimen no.	Weight fraction B/G	Tensile strength MPa	Elastic modulus MPa	Max. load N
1	10/20	123	3100	8030
2	20/10	99.5	3320	6470
3	10/30	169	3740	11000
4	20/20	157	3520	10200
5	25/25	168	3320	10900
6	15/35	171	3260	11100

Table 4.1 comparisons of tensile strength of specimens

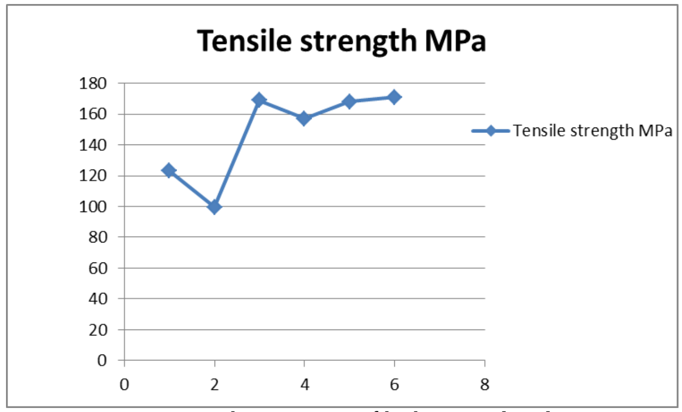

Figure 4.1 schematic view of highest tensile value

It shows there is increase in tensile modulus of banana fiber with the addition of glass fiber. Here specimen 6 has highest tensile strength. Hence we can say that 15% Banana fiber and 35% glass fiber shows highest tensile strength from above samples.

4.2 Effect of flexural strength on different loading of fiber parameter

Specimen no.	Weight fraction B/G	Flexural strength MPa	Flexural modulus MPa	Break force N
1	10/20	80	3210	212
2	20/10	110	6870	292
3	10/30	135	6360	357
4	20/20	150	6990	396
5	25/25	150	8780	396
6	15/35	151	9110	400

Table 4.2 comparisons of flexural strength of specimens

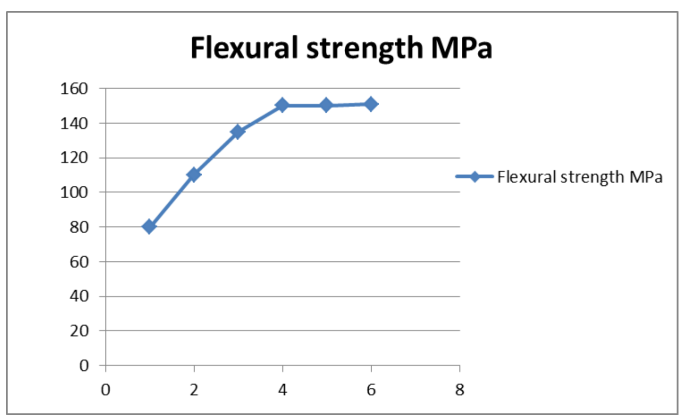

Figure 4.2 schematic view of highest flexural value

While comparing the table of flexural test result, it is found that 50% of fiber loading is effective in case of flexural strength. Though the 50% fiber loading and 40% fiber loading has nearly all the values same, the modulus is different. Hence the specimen with 15% banana fiber and 35% glass fiber loading has good bending strength.

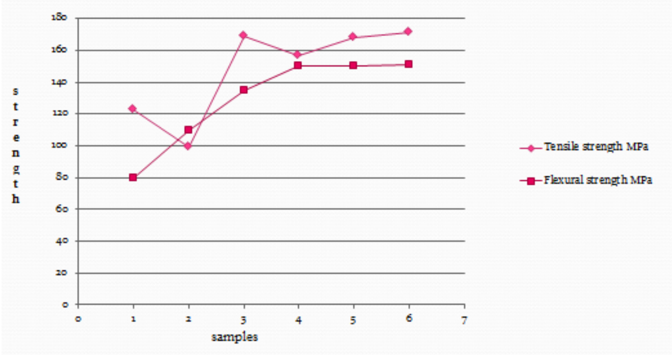

Figure 4.3 Comparisons of both test for above samples

V. CONCLUSIONS

The Maximum Tensile Strength is **241 MPa** of the **(15/35)%** weight fraction of banana/glass fibres and minimum is **99.5 MPa** for **(20/10)%** weight fraction of banana/glass fibers.

The Maximum Flexural Strength is **151 MPa** of the **(15/35)%** weight fraction of banana/glass fibres and minimum is **80MPa** for **(10/20)%** weight fraction of banana/glass fibers.

From the experimental work the Tensile Strength is increase with increase the weight fraction of the fibers loading and also increases the Flexural Strength with increase the weight fraction of the fibers loading.

If we increase the percentage of weight fraction of glass fibers then there is increase the Tensile Strength and decrease in Flexural Strength.

In this work, Optimum tensile strength and flexural strength has reached at 50% weight fraction of the fiber in hybrid composite.

The composite can be regarded as a useful light weight engineering material and also the manufacturing cost of the composite can be reduced considerably by adding banana fiber hybridized with glass fiber to the matrix.

VI. . REFERENCES

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