ISSN No: - 2456 - 2165

Evaluation and Comparison of Mechanical Properties of Banana and Glass Fiber in Reinforced Unsaturated Polyester Composite

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ABSTRACT :- Now a days with growing consciousness about environment, biofabric reinforced composite materials are replacing old traditional materials and their demands are increasing day by day due to its superior and valuable properties like high tensile strength, high strength to weight ratio ,lower cost ,light in weight, biodegradable and easily recyclable. In the present work a hybrid of banana and glass fibre has been reinforced with polyester matrix .The mechanical properties like tensile strength, flexural strength and shear strength are evaluated and compared. It is found that glass fibre composite shows good tensile strength, have high flexural strength and shows maximum shear strength.

I. INTRODUCTION

Natural fibres when compared to artificial fibres have many properties which are superior to it. They have low weight, low density, biodegradable have high specific strength etc. Natural fibres reinforced composites found applications in building and construction work are used in making of window frames panels, fencing, door shutters etc .These are used in automobile industries and many more despite of its usefulness composites have lower strength and poor moisture resistance as compared to synthetic fibre. To overcome such problem a hybrid of banana and glass composite is made. Silica particles provides good strength and also prevent the moisture absorption by composites. Instead of thermoplastic resin which is mainly limited to low temperature, thermosetting resin i.e. unsaturated polyester is used which provides good reinforcement.

Therefore best results may be seen by using natural fibre composites with synthetic materials. Fibre reinforced composites are most important composites which are used in last four decades due to its high specific strength and modules. Mostly composites used high strength composites such as glass, graphite etc .There has been lot of work done on glass fibre reinforced polymer composite. The main advantage of adding glass as a fibre in a banana composite is that it will provide strength to composite. It will have properties of both banana i.e natural as well as synthetic fibre. Banana as a natural fibre will have high specific strength , low cost small weight but for mechanical properties we use glass fibre. The combination of two may solve problem of low mechanical strength in natural fibres. The hybrid component formed is cheaper and easy to use.

V.P. Arthanarieswaran (1) evaluated mechanical properties of banana and sisal fibre reinforced epoxy composites & Influence of glass fibre hybridization. Stacking sequence of B, S, BS, G/B/G, G/S/G, G/BS/G, G/B/G/B/G, G/S/G/S/G and G/BS/G/BS/G by chopping Banana(B),Sisal (s) and woven E –Glass synthetic fibres reinforced with epoxy matrix and Mechanical properties like tensile strength, flexural strength and impact strength were evaluated and compared. Scanning Electron Microscope (SEM) was used to study the micro structural behaviour of the tested specimen. Tests showed that the addition of two and three layer of glass fibre can improve the tensile strength by a factor of 2.34 and 4.13 respectively also flexural properties were enhanced on banana–sisal fibre with two layers of glass fibres rather than three layers and the laminate with sisal and three glass ply offers better impact strength.

Ashish kumre et al (2) worked on reviewing mechanical property of sisal glass fibre reinforced polymer composites .In this work the natural fibre polymer composites was mixed with the glass fibre, to enhance the mechanical property of composite. In this work Glass Fibre Reinforced Polymers was mixed with sisal with various sisal fibre lengths (5, 10, and 15, 20 mm) to increase Engineering and Technology applications.
Rahul Shrivastava et al (3) worked on Mechanical Properties of Coir/ G Lass Fibre Epoxy Resin Hybrid Composite. In this work both artificial and natural fibres were mixed so as to increase mechanical property of fibre. Naturally occurring coir fibre and synthetic glass fibre mats are used as reinforcement while thermosetting polymeric resin Epoxy is used as matrix material .Coir fibre was chemically treated with sodium hydroxide to decrease its moisture absorption behaviour. Short coir fibre /glass fibre mat hybrid composite was fabricated by hand-layup method

Work confirmed that the mechanical properties of the composites changes with volume fraction and fibre length of the fibres.M.Ramesh et al (4) in their work comparatively

ISSN No: - 2456 - 2165

evaluated Properties of Hybrid Glass Fibre- Sisal/Jute Reinforced Epoxy Composites. Aim of work was to evaluate mechanical properties such as tensile and flexural properties of hybrid glass fibre-sisal/jute reinforced epoxy composites. Indications proved that incorporation of sisal fibre with GFRP showed superior tensile properties than the jute fibre reinforced GFRP composites and jute fibre reinforced GFRP composites had better flexural properties.

R. Bhoopathi et al (5) worked on fabrication and property evaluation of Banana-Hemp-Glass FIBRE reinforced composites .Hand layup method was used for fabrication of three different types of hybrid laminates with glass .banana and hemp fibres as reinforcing materials with epoxy resin. Test were done with universal testing machine(UTM).Results indicated that the banana-hemp-glass fibres reinforced hybrid epoxy composites exhibited superior properties and used as an alternate material for synthetic fibre reinforced composite materials.

Laly A. Pothan et. al (6) studied dynamic mechanical analysis of banana fibre reinforced polyester composites. Their studies determine the chemical or physical changes in the matrix by the addition of fibre and examine the behaviour of properties of each phase. Work concludes that mechanical properties greatly depends upon volume fraction fibre. Maximum improvement in properties is observed when fibre is 40% loaded.

M.R. Sanjay et al (7) have done studies on Mechanical properties of Banana/E glass Fabrics reinforced Polyester Hybrid composites .Mechanical properties like Tensile strength, Flexural strength, impact strength and hardness of six laminates of dimension 240*240*3 prepared of different composition of banana and e-glass fabrics were evaluated .Laminates were fabricated by hand lay up and vacuum bagging method and impregnation was done by using polyester as matrix material.

Results showed maximum Tensile strength, Flexural strength, impact strength and hardness for glass fabric laminate and minimum for banana fabric laminate besides glass fabric laminate absorbed more water and banana fabric laminate absorbed minimum water. Conclusion was that glass layer in the laminate increased mechanical strength.

II. MATERIALS AND METHOD

A. Matrix Material

- Polyester

This material can be solid but it depends on the speed of the reaction by which it takes place. Along with unsaturated polyester resin7.2wt% of styrene monomer and 1.6%(vol%) of hardener is used .The styrene is volatile and heat is only added to the system when cure time is long. Catalyst helps to derive the reaction. Polyester and styrene react together to form a film. Appropriate quantity of catalyst is very important as it helps the proper cure of polyester resin system.

B. Reinforcement Element

- Banana and Glass

Banana fibres were obtained from go green products Chennai and were extracted using decorating machine. Banana fibres are obtained from waste products of banana cultivation. Because of high cellulose content it shows good tensile properties.

Glass fibres were obtained from sun tech glass works. Addition of glass fibres improves the mechanical strength and reduces the wear. The composites samples fabricated by using hand layup method.

III. EXPERIMENTAL PROCEDURE

Firstly chemical treatment has been done on the surface of fibre using sodium hydroxide solution. It is done to improve fibre polymer interface. The parameters in preparation of composites were optimized to see the changes which is caused by effect of varying the mixing time,rotor speed on tensile strength of composites. Fibres along with polymer were also chemically treated to enhance the hydrophobic character of polymer. Fibres treated with NAOH have high mechanical, thermal and water barrier properties.

After that fabrication process was done. Banana glass fibre were actually weighed and then mixed with unsaturated polyester resin mixture and banana and glass fibres. Compression pressure of 0.06Mpa was ensured and the mould is left to cure for one whole day. After that composites were also post cured.

A. Tensile Test

The tensile test can be performed on specimens by cutting them as per ASTM: D638 standard. It is done on INSTRON make Universal Testing Machine (UTM) The tensile test which is performed on dumbbell shaped specimen of composites with different combination of fibres were tested and compared. Uniaxial load is applied from both the ends with the help of suitable micrometer its width and thickness is measured .Machine speed is set at 10mm/min.

$$\text{Tensile strength} = \frac{\text{Peak load (N)}}{\text{Max displacement (mm)}}$$

ISSN No: - 2456 - 2165

Fig 1: UTM (Universal Testing Machine)

Fig 2: Specimen used for Tensile Strength Test

B. Flexural Strength Test

In this test , a beam is bend under three point loading conditions and force required to bend is determined ,load is applied at the middle of component lit bends and fractures. This test is used to select the materials which can stand with loads without flexing. Three point flexural strength test is done by using INSTRON make machine as per ATSM:D790 standard .

Flexural strength = 3PL /2wt*wt

where

P=Peak Load

L=Guage Length

W=Width

T=Thickness

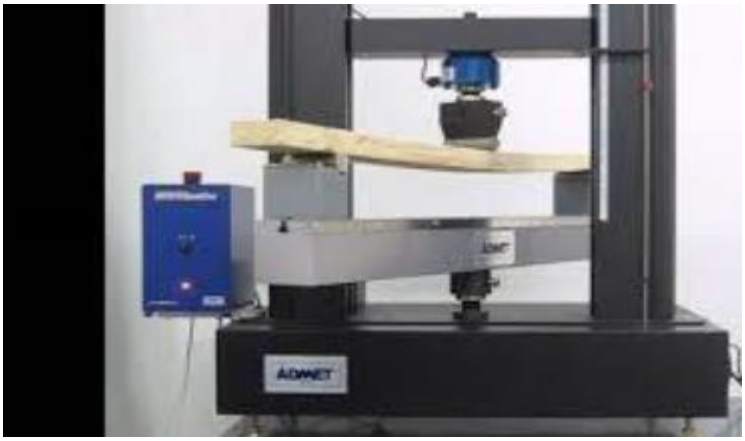

Fig 3: UTM (Universal Testing Machine For Flexural Test)

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Fig4: Specimen used for Flexural Strength Test

C. Shear Strength Test

It is basically the strength of a material which the material shows for the yield or structure failure where it fails in shear. It is the force which produces a sliding failure with the plane which is parallel to application of force. It is very important to know that the amount of load that a composite can support or withstand. It is therefore very much important to have then knowledge of shear strength as it can be used to :

1) Designing of foundations
2) Designing of embankment for dams, roads
3) In earth retaining structures

But here in this test we used UTM (universal testing machine) to make holes or tears in the composite and shearing force is measured.

Shear stress = Force/Area

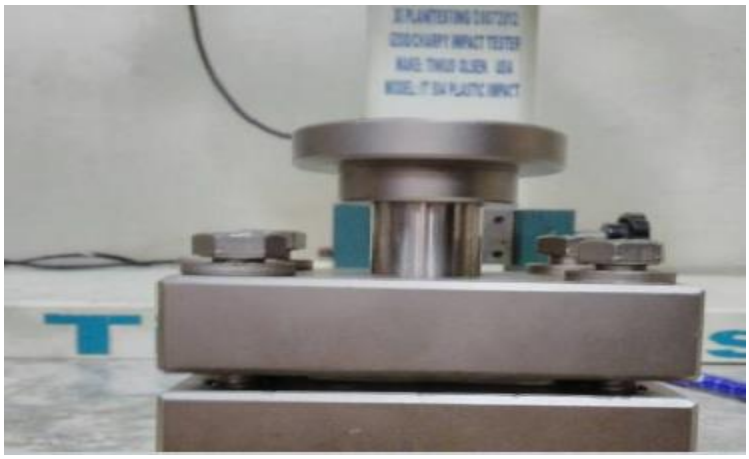

Fig 5: (Shear Strength Testing Machine)

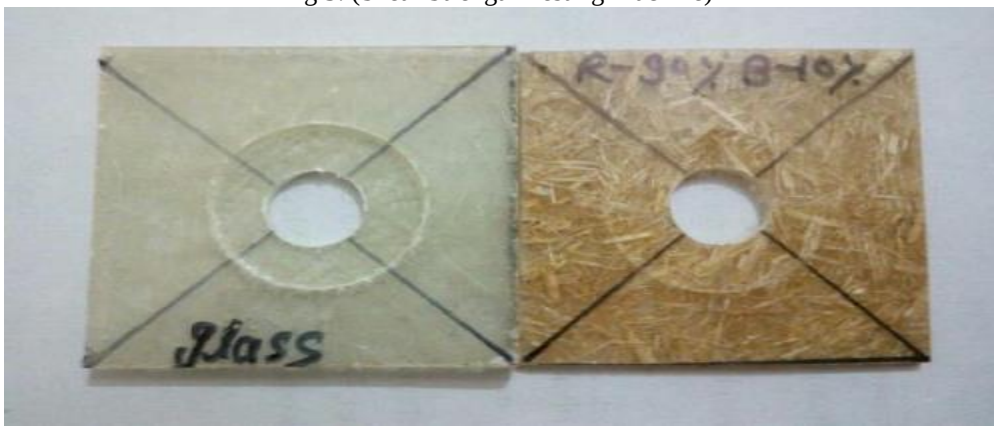

Fig 6: Specimen used for Shear Strength Test

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IV. RESULTS AND DISCUSSION

The samples of composite 1,2,3,4and 5 of banana are tested for tensile strength ,flexural strength and shear strength in UTM machine and following results are obtained for mechanical properties are produced below in table 1.

Table 1 : Mechanical strength of different samples of Banana Fibre.

Sample No.		Tensile Strength (Mpa)	Flexural Strength (Mpa)	Shear Strength (Mpa)
	1	65.22	70.83	56.63
	2	63.41	131.48	59.6
	3	51.96	132.44	36.95
Glass	4	54.09	80.36	54.22
G 10%	5	58.66	84.48	50.36
R 90%	Avg	58.67	99.92	33.58

The samples of composite 1,2,3,4 and 5 of glass are tested for tensile strength ,flexural strength and shear strength in UTM machine and following results are obtained for tensile strength produced below in table 2.

Table 2 : Mechanical strength of different samples of Glass Fibre.

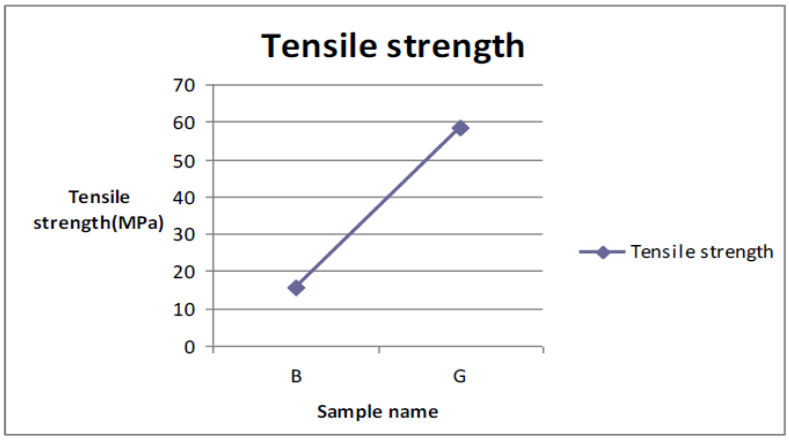
Sample No.		Tensile Strength (Mpa)	Flexural Strength (Mpa)	Shear Strength (Mpa)
	1	65.22	70.83	56.63
	2	63.41	131.48	59.6
	3	51.96	132.44	36.95
Glass	4	54.09	80.36	54.22
G 10%	5	58.66	84.48	50.36
R 90%	Avg	58.67	99.92	33.58

Different mechanical properties of Glass and Banana are compared in table 3

Table 3 : Mechanical strength of different samples of Banana & Glass Fibre

Sample No.		Tensile Strength (Mpa)	Flexural Strength (Mpa)	Shear Strength (Mpa)
Banana 10%	1	15.49	43.22	33.58
Glass 10%	2	58.67	99.92	51.55

The graph is to be plotted between banana and glass fibre composite to measure the tensile strength of the composite and it shows that the tensile properties of fibre increases as content of glass in composite increases and decreases as content of banana increases.



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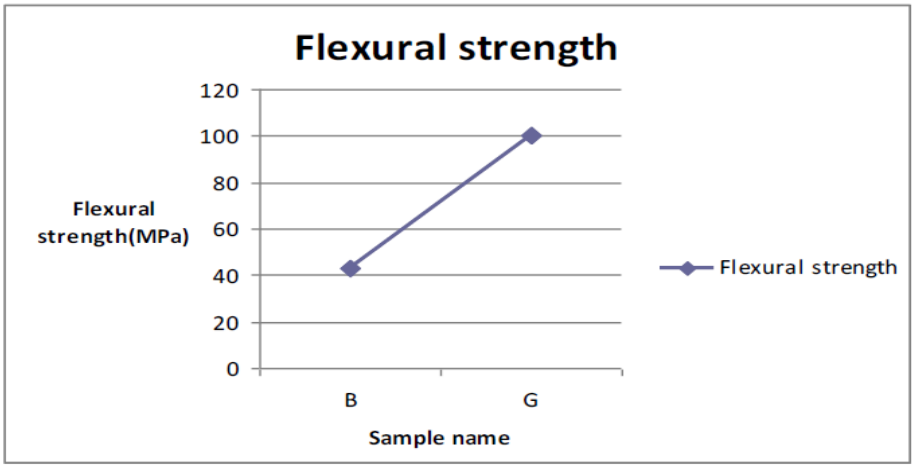
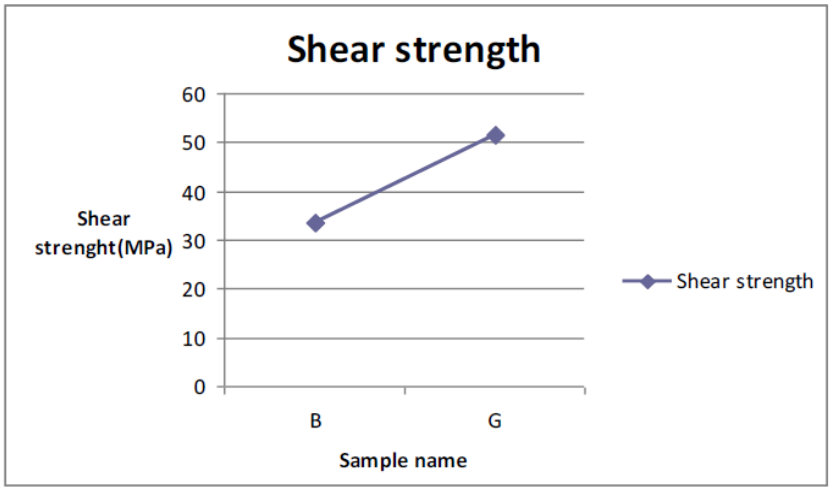
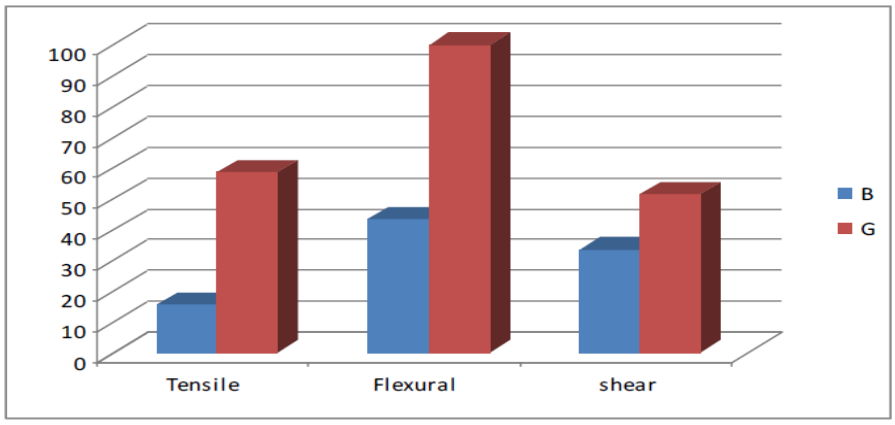
The graph is to be plotted between banana and glass fibre composite to measure the Flexural strength of the composite and it shows that the tensile properties of fibre increases as content of glass in composite increases and decreases as content of banana increases.



The graph is to be plotted between banana and glass fibre composite to measure the Shear strength of the composite and it shows that the tensile properties of fibre increases as content of glass in composite increases and decreases as content of banana increases.



Below comparative graphical representation shows that mechanical properties i.e Tensile Strength, Flexural Strength & Shear Strength of glass fibre are better than that of Banana fibre.



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IV. CONCLUSION

In this paper, mechanical properties of glass and banana fiber reinforced unsaturated polyester composites have been discussed. The tensile, flexural and shear strength of glass reinforced unsaturated polyester composites are better than that of tensile, flexural and shear strength test of banana. The result shows that glass reinforced unsaturated polyester composites have encouraging mechanical properties and these composites can be used in automobile, building and construction product industries.

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