ORIGINAL RESEARCH PAPER

Engineering

EVALUATION AND COMPARISON OF MECHANICAL PROPERTIES OF BANANA/ GLASS/KAPOK FIBER IN REINFORCED UNSATURATED POLYESTER COMPOSITE

KEY WORDS: Subsidy, European Economic Community. CAGP

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ABSTRACT

A good invention is when we make efforts to draw out all the advantages offered by nature especially renewable resources for the manufacturing of composite materials which consists of polymer and consistuents of natural fibers for preservation and conservation of natural resources. In this research paper, natural fibers like Banana (Musa acuminata) and Kapok(Ceiba pentandra) and synthetic fibre like Glass are fabricated with unsaturated polyester resin using hand-lay up method. Green Materials or biofabric materials are very important and useful as they are environment friendly, renewable or biodegradable resources and lessen the use of petroleum based chemicals. With the growing awareness about natural fibers, they are used as substitute for other costly fibres.. The use of fibers like kapok and banana in the industries is less due to non-availability of a its quality and durable product but because of new research and development its combination with glass shows good and improved mechanical properties that the composite which is manufactured are comparatively cheap and shows better stiffness per weight and its environmental impact is also low. These composites can be used in high tech applications. In this paper, tensile, flexural and shear strength of glass, banana and kapok is evaluated and compared. It is found that tensile, flexural and shear strength of glass is maximum as compared to banana, kapok and banana/glass.

1. INTRODUCTION

When the natural fibers like Banana and Kapok used with the glass, it creats the potential to substitute the traditional reinforc ement material used in fabrication of composites. They have benefits of low density, high toughness, high strength, less moisture absorption and low wear and tear and requires less amount of energy in fabrication.

Composites are the materials which are made up of carrying material known as reinforcement that can carries strong load which is imbedded in matrix(weaker material). The main function of reinforcement is to give strength, rigidity, toughness and to bear structural load. The matrix helps in maintaining the orientations and positions of reinforcement.

The composites formed have high specific strength, high stiffness, low cost, low density. In addition to this,they satisfy both ecological and environmental concerns and are easily available and are easy to use. It is known that the strength and stiffness of fiber composites mainly depends on fiber concentration, fiber aspect ratios, fiber matrix adhesion and powdered particles of fiber orientation and dispersion. The present work shows the different tests performed on banan, kapok, glass and banana/glass composites in reinforced unsaturated polyester gives different values of mechanical properties but glass composites have high mechanical properties (tensile, flexural and shear) as compared to banana, kapok and banana/glass composite. Thus inclusion of silica particles have greater impact and may solve the problem of lower mechanical strength in natural fibre.

Bandi Sruthi et.al (1) studied the tensile properties of banana fibre polyester composites. In his experiment the equipment i.e Universal Testing Machine is used and the specimen for tensile test is made in the form of composite plate. This experiment confers the conclusion that the tensile strength of composite is increased by 90% as compared to vugin polyester. It shows a ductile appearance.

Singh V.K et. al (2) worked on mechanical behavior of banana fibre based hybrid bio composites. this paper shows that addition of banana fibre reduced the bending strength but with the mixing of silica with banana doesn't improves its bonding strength as compared to the banana fibre reinforced composites.

M. Thiruchitrambalam et.al (3)shows that the mechanical properties of banana/kenaf polyester composite can be improved using sodium laulryl sulfate treatment. It is learnt from this paper that the use of Sodium laulryl sulfate treatment had provided better mechanical properties than alkali treatment.

A.V. Ratna Prasad et.al(4) emphases on mechanical properties of banana empty fruit bunch fibre reinforced polyester composites. It shows that the flexural strength of banana - EFB composite is minimum and flexural modulus shows fluctulating behavior as compared to plain polyester. The specific flexural modulus is 1.4.2 times that of polyester resin.

A.K. Chaitanya et.al (5) investigated on the mechanical properties of banana fibre reinforced polyester composites. In this paper the effect of NaOH solution on mechanical properties of Banana fibre in polyester matrix is studied. It seems that tensile strength, impact and bonding strength of composite using NaOH solution is increased as compared to without NaOH solution. The concentration of NaOH solution is 5% to water.

Laly A. Pothan et.al (6) worked on polarity parameters and dynamic mechanical behavior of chemically modified banana fibre polyester composites. They worked on acid base interactions which is to be investigated by solvatochromy and the zeta potential measurements. The results obtained from these two treatments are to be compared with the results of dynamic mechanical analysis and itis found that storage modulus value is maximum for the silane A151 treated fibre composites.

R. Murugan et.al (7) worked on static and dynamic mechanical behavior of Epoxy Woven Fabric Glass/ Carbon Hybrid Composites. They examined the mechanical properties like tensile strength, flexural atrength and impact strength. It is found that dedicated carbon laminate have high mechanical strength as compared to dedicated glass laminates expect for impact strength. Carbon laminates are found to be better substitute for glass.

G.Venkata Reddy et.al (8) studies the impact properties of kapok based unsaturated polyester hybrid composites. They studied the impact properties of kapok with glass and kapok with sisal fabrics reinforced polyester hybrid composites. The results shows that composites having 9% vol. of total fabrics loading in kapok/glass and 5% vol. fabrics loading in kapok/sisal composites have highest mechanical properties. Kapok/Glass hybrid composites and kapok/sisal hybrid composites have high impact strength as compared to kapok/polyester composites and sisal/polyester composites respectively.

2. MATERIALS AND METHOD:

a) Matrix material;

Raw materials used are as follows:-
1) Matrix: Unsaturated polyester
2) Reinforcement: Banana, Glass fibre, Kapok fiber

1) UNSATURATED POLYESTER

Polyester is cheap and is easily available and brought from local shop Arora fabric, Amritsar. It is used as base matrix in the composite. Accelator added is Cobalt napthanate. It is used as 0.8% of volume in entire mixture. The solution is mixed and stirred before applying on the laminate.

Catalyst used is Methyl ethyl ketone peroxide, was also bought from Arora Fabrics Amritsar.

2) REINFORCEMENT ELEMENT;

Banana, Glass and Kapok fiber:
Raw and plain banana fibres were obtained from Go Green products Chennai and were extracted using decorating machine. Banana fibres are obtained from banana trunk. 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.

Continuous Kapok fibres were obtained from Go Green products Kamala, Chennai.

The composites samples were fabricated by using hand lay up method. Hand lay up method is discussed below.

Hand lay-up method is one of the simplest method of processing of composites. The requirement of infrastructure for this method is also minimum. The processing steps are quite simple. Firstly a release gel is sprayed on the mould surface to avoid the sticking of polymer to the surface. Thin plastic sheets are used at the top and bottom of the mould plate to get good surface finish of the product. Reinforcement in the form of woven mats or chopped strand mats are cut as per the mould size and placed at the surface of mould after perspex sheet. Then thermosetting polymer in liquid form is mixed thoroughly in suitable proportion with a suitable hardner (curing agent) and poured onto the surface of mat already placed in the mould. The polymer is uniformly spread with the help of brush. Second layer of mat is then placed on the polymer surface and a roller is moved with a mild pressure on the mat-polymer layer to remove any air trapped as well as the excess polymer present. The process is repeated for each layer of polymer and mat, till the required layers are stacked. After placing the plastic sheet, release gel is sprayed on the inner surface of the top mould plate which is then kept on the stacked layers and the pressure is applied. After curing either at room temperature or at some specific temperature, mould is opened and the developed composite part is taken out and further processed.. The time of curing depends on type of polymer used for composite processing. For example, for polyester based system, normal curing time at room temperatur is 24-48 hours.

3. EXPERIMENTAL PROCEDURE:

Chemical treatment is done on the surface of fibre with the help of sodium hydroxide solution. It is done to enhance the fibre polymer interface. Parameters in manufacturing of composites are optimised to find the changes which is caused by effect of varying the mixing time, rotor speed on tensile properties of composites. Fibres along with polymer are also chemically treated to improve the hydrophobic character of polymer. Fibres treated with the help of NAOH shows high mechanical, thermal and water barrier properties.

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

3.1 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. Micrometer is used to measure thickness .Machine speed is 10mm/min.

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

Fig 1: UTM (Universal Testing Machine)
Fig 2: Specimen used for Tensile Strength Test

3.2 Flexural Strength Test:

Many specimen of different shapes can be used but mainly specimen of size 3mm*12.7mm*127mm is used.
The specimen is kept on the support span and with the help of loading nose load is applied at the center. The parameters used here are support span, loading speed i.e. 1.27mm/minute and maximum deflection. When deflection is 5% the test is stopped for ASTMD 790.

Flexural strength = 3PL /2wt*wt
where
P=Peak Load
L=Guage Length
W=Width
T=Thickness

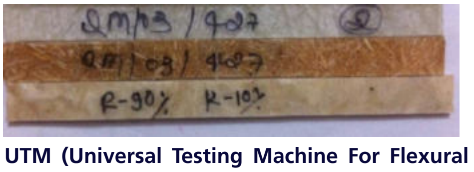


Fig 3: UTM (Universal Testing Machine For Flexural Test)
Fig4: Specimen used for Flexural Strength Test

3.3 Shear Strength Test:

It is basically the strength of a material which it 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.

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

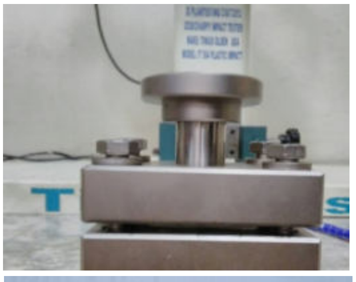


Fig 5: (Shear Strength Testing Machine)
Fig 6: Specimen used for Shear Strength Test

4.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)
Banana B 10% R 90%	1	16.88	42.11	33.72
	2	15.42	46.99	33.43
	3	18.9	40.13	33.45
	4	12.59	43.42	32.04
	5	13.67	43.44	35.25
	Avg	15.49	43.22	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.

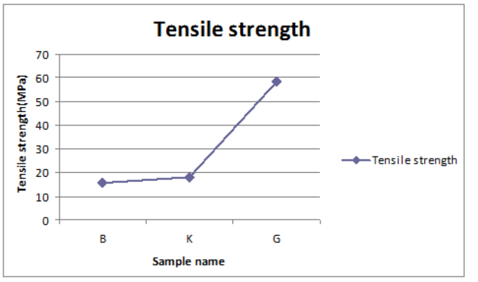
Sample No.		Tensile Strength (Mpa)	Flexural Strength (Mpa)	Shear Strength (Mpa)
Glass G 10% R 90%	1	65.22	70.83	56.63
	2	63.41	131.48	59.6
	3	51.96	132.44	36.95
	4	54.09	80.36	54.22
	5	58.66	84.48	50.36
	Avg	58.67	99.92	51.55

The samples of composites 1,2,3,4 and 5 of kapok fibre are tested for tensile strength, flexural, shear strength in UTM machine and following results are obtained and are shown in table 3.

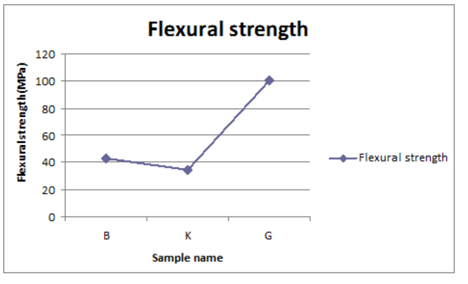
Table 3: Mechanical strength of different samples of Kapok Fibre.

Sample No.		Tensile Strength (Mpa)	Flexural Strength (Mpa)	Shear Strength (Mpa)
Kapok K 10% R 90%	1	21.04	36.02	25.94
	2	17.05	29.42	27.02
	3	19.22	46.33	29.01
	4	18.72	30.72	26.4
	5	14.41	29.41	28.94
	Avg	18.08	34.38	27.46

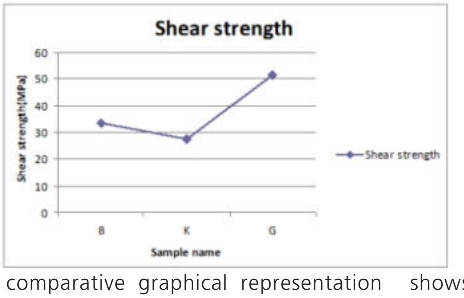
The graph is to be plotted between banana, glass fibre and kapok fibre composite to measure the tensile strength of the composite and it shows that the tensile properties of fibre increases as content of glass in composite increases and decreases as content of banana and kapok increases but kapok has little bit higher strength than banana because kapok fibres have good adhesion property with matrix than banana due to which it shows more tensile strength than banana.



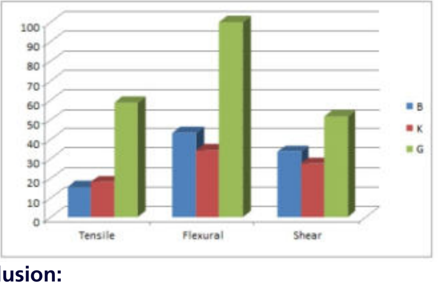
The graph is to be plotted between banana, glass and kapok fibre composite to measure the Flexural strength of the composite and it shows that the tensile properties of fibre increases as content of glass in composite increases and decreases as content of kapok increases but banana flexural strength is higher than kapok due to more cellulosic content which can bear more bending stress than kapok.



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 kapok 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, Kapok fibre.



5. Conclusion:

This paper shows the mechanical properties of glass, kapok and banana fiber reinforced unsaturated polyester composites. 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 and kapok fibre. 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, in making ceilings.

6.References:

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