Mechanical Behaviors of Banana Fibres with Different Mechanical Properties

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Abstract

World is as of now concentrating on alternate material sources that are environment agreeable and biodegradable in nature. Because of the expanding natural concerns, bio composite produced out of regular fiber and polymeric resin, is one of the late advancements in the business and constitutes the present extent of experimental work. The use of composite materials field is increasing gradually in engineering. The composite consists of mainly two phases i.e. matrix and fiber. The accessibility of characteristic fiber and simplicity of assembling have enticed scientists worldwide to attempt by regional standards accessible inexpensive fiber and to learning their achievability of fortification determinations and to what degree they fulfill the obliged particulars of great strengthened polymer composite aimed at structural requisition. Fiber reinforced polymer composites has numerous preferences, for example, generally minimal effort of creation, simple to create and better quality contrast than perfect polymer tars due with this reason fiber strengthened polymer composite utilized within an assortment of provision as class of structure material. This work describe the fabrication and the mechanical behavior of banana fiber reinforced polymer composite at varying composition (25%, 30%, 35%) with that of silicon carbide at 4%, 8%, 12% respectively. Also the test such as the tensile test, hardness test and the bending test are carried out and the mechanical properties of the composite material are studied.

Keywords : Composite, banana fibers, epoxy, tensile strength.

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1 INTRODUCTION

Natural fibers have been used to reinforce materials for over thousand years. Recently, they have been employed in combination with plastics. Natural fibers are environmentally friendly, fully biodegradable, abundantly available, renewable and cheap and have less density. Natural fibers possess no health hazards and, finally, provide a solution to environmental pollution by finding new uses for waste materials. Currently, many types of natural fibers have been investigated for use in plastics including flax, hemp, jute straw, wood, rice husk, wheat, cane (sugar and bamboo), grass, reeds, kenaf, ramie, oil palm empty fruit bunch, sisal, coir, water, hyacinth, pennywort, kapok, banana fiber, pineapple leaf fiber. Fibers obtained from the various parts of the plants are known as vegetable fibers. Animals can also provide a source of fibers. A wide variety of properties can be achieved through proper selection of fiber type, fiber orientation and fiber reinforcement form.

The mechanical behavior of a natural fiber based polymer composite depends on numerous factors, for example, fiber length and quality, matrix, fiber-matrix adhesion bond quality and so forth. A good interface bond is required for effective stress transfer from the matrix to the fiber where by maximum utilization of the fiber strength in the composite is achieved [1]. Modification to the fiber also improves resistance to moisture induced degradation of the interface and the composite properties [2]. Mechanical properties of natural fibers, especially flax, hemp, jute, banana and very good and many complete with glass fiber in specific strength and modulus [3-4]. A number of investigations have been conducted on several types of natural fibers such as kenaf, hemp, flax, bamboo, banana and jute to study the effects of these fibers on the mechanical properties of composite materials [5-6]. Information on the usage of banana fibers in reinforcing polymers is limited in the literature. In dynamic mechanical analysis, Laly et al [7] have investigated banana fiber reinforced polyester composites and found that the optimum content of banana fiber is 40%. Mechanical properties of banana-fiber-cement composites were investigated physically and mechanically by Corbiere-Nicollier et al [8].

2 MATERIALS AND METHODS

Banana empty fruit fibers were obtained from coimbatore, Tamil Nadu, India. An easier and quicker way of extracting fibres is to use a machine extractor, called Raspador. The fiber has a diameter of 0.005-0.12 mm. The epoxy resin (LY 556) and the hardener (HY 917) are supplied by Ciba Geigy India Ltd. Silicon carbide (SiC) is collected from the local supplier in a range of 80 m. A stainless steel mould having dimensions of 21021040 mm3 is used for composite fabrication

2.1 Mechanical properties

2.1.1 Tensile Testing

Tensile test specimens were made in accordance with ASTM A 370 to measure the tensile properties. The sample was made according to the ASTM standards.. The samples were tested at a cross-head speed of 0.5 mm/min and the strain was measured using an extensometer

2.1.2 Flexural Testing

Three-point bend tests were performed in accordance with ASTM A 370 to measure flexural properties. The specimen made according to the ASTM standard. In three-point bending test, the samples were tested at a strain rate of 0.5 mm/min. A three-point bend tested was chosen because it requires less material for each test and eliminates the need to accurately determine center point deflections with test equipment.

2.1.3 Hardness Testing

A Hardness test were performed in accordance with ASTM E18 using Shore hardness test (D). The dimension were taken according to the ASTM standard. Shore Hardness, using either the Shore A or Shore D scale, is the preferred method for rubbers/Elastomers and is also commonly used for 'softer' plastics such as polyolefins, fluoropolymers, and vinyls. The Shore A scale is used for 'softer' rubbers while the Shore D scale is used for 'harder' ones. Durometer is one of several measures of the hardness of a material. Hardness may be defined as a material's resistance to permanent indentation

3 ANALYSIS USING ANSYS

3.1 Introduction of ANSYS

ANSYS is the usually preferred analysis software package because of its functionality. In this interface, you can apply forces, pressures, torques, etc on the models and see how the stresses develop. The ANSYS Workbench platform is the framework upon which the industrys broadest and deepest suite of advanced engineering simulation technology is built. An innovative project schematic view ties together the entire simulation process, guiding the user through even complex multiphysics analyses with drag-and-drop simplicity. With bi-directional CAD connectivity, an automated project level update mechanism, pervasive parameter management and integrated optimization tools, the ANSYS Workbench Platform delivers unprecedented productivity, enabling simulation driven product development.

3.2 Finite Element Analysis

It is not possible to obtain Analytical solution for many engineering problems. At the engineering solution is a mathematical model or expression that gives the value of the field variable at any location in the body. For problems involving complex shapes, material properties and complicated boundary conditions it is difficult, so for many of the practical problems, and engineer uses numerical methods to solve the problems and that provides approximate solutions which is also acceptable one. The three methods are used.

- Function Approximation

- Function Difference Method
- Finite Element Method

FEA and FEM are two of the very popular engineering applications offered by existing CAD/CAM systems. This is attributed to the fact that the FEM is perhaps the most popular numerical technique for solving engineering problems. The method is general enough to handle any complex shape or geometry, any material properties, any boundary conditions and any loading conditions. The generality of the FEA method analysis

The FEM is numerical technique for obtaining approximate solutions to engineering problems this method is adopted in the industry as a tool to study stresses in complex air frame structures. The method has gained popularity aimed of both researches and practitioners.

3.3 Meshing

Mesh generation is one of the most critical aspects of engineering simulation. Too many cells may result in long solver runs, and too few may lead to inaccurate results. ANSYS Meshing technology provides a means to balance these requirements and obtain the right mesh for each simulation in the most automated way possible. ANSYS Meshing technology has been built on the strengths of stand-alone, class-leading meshing tools. The strongest aspects of these separate tools have been brought together in a single environment to produce some of the most powerful meshing available. The highly automated meshing environment makes it simple to generate the following mesh types:

- Tetrahedral
- Hexahedral
- Prismatic inflation layer
- Hexahedral inflation layer
- Hexahedral core
- Body fitted cartesian
- Cut Cell cartesian

Consistent user controls make switching methods very straight forward and multiple methods can be used within the same model. Mesh connectivity is maintained automatically. Different physics requires different meshing approaches. Fluid dynamics simulations require very high-quality meshes in both element shape and smoothness of sizes changes. Structural mechanics simulations need to use the mesh efficiently as run times can be impaired with high element counts. ANSYS Meshing has a physics preference setting ensuring the right mesh for each simulation.

3.4 Materials

Three different types of fiber reinforced composite materials considered in this investigation, they are

- Epoxy composite
- Banana fiber
- Silicon carbide

The typical properties of the three different composite materials are illustrated in Table 1

Table 1: Properties of Materials

Property	Banana	Epoxy	SiC
Density(Kg/m3)	1350	1200	3210
Youngsmodulus(GPa)	3048	1.359	188
Poissons ratio	0.280	.3	0.28

4 Results and Discussion

The results of experimental values and analysis of the continuous fiber reinforced epoxy composite are done with mechanical tests and also using software of computational; fluid dynamics. The ratios of samples with SiC are matched with banana fibre and then accordingly epoxy ratio is fixed. Table 2 gives the details of the ratio.

Table 2: Ratio of Composition

Samples with Different Ratios	Banana Fiber	SiC
Sample 1	25%	4%
Sample 2	30%	8%
Sample 3	35%	12%

4.1 Tensile Test

The specimens (25%, 30%, 35%) are prepared as per the ASTM standards and to find out the ultimate tensile strength as shown in below. The load varies between 2 to 10 KN. And accordingly values are detailed in Table 3.

The Table 3 shows beneficial results in sample 3. The tensile strength in composite materials are in satisfactory zone.

Table 3: Tensile Test Values with Elongation

Samples with Different Ratios	Tensile Stress (N/mm2)	Elongation %
Sample 1	1.551%	.10%
Sample 2	2.569%	.18%
Sample 3	7.187%	.36%

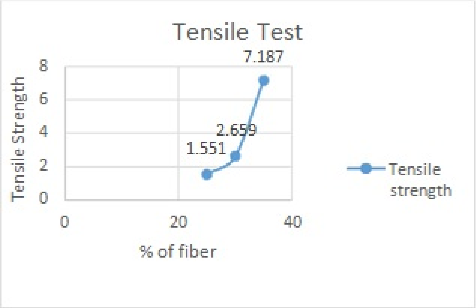

Figure 1: Percentage of Fiber vs Tensile Strength

4.2 Flexural Test

The specimens (25%, 30%, 35%) are prepared as per the ASTM standards and to find out the flexural strength as shown in below. The Table 4 gives the values obtained. The graph as drawn between percentage of fiber Vs Flexural load as show in below.

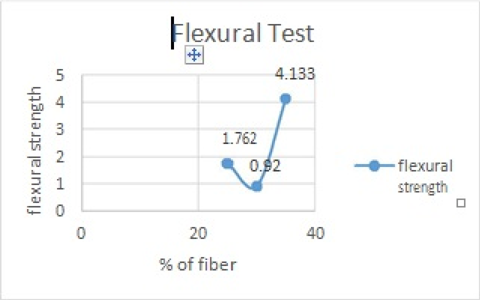

Figure 2: Percentage of Fiber vs Flexural load

Figure 1 and 2 shows that tensile strength and flexural strength increases as ratio of SiC increases. Upto 12% the SiC percent can increase the properties. And this will have adverse effects when the ratio is further increased.

4.3 Hardness test

The specimens (25%, 30%, 35%) are prepared as per the ASTM standards and to find out the hardness as shown in below. Table 4 gives various hardness values of different samples and respective Fig 3 also supports the results obtained. The sample 3 shows higher hardness. Hence increase in hardness gives better mechanical properties in manufacturing applications.

Table 4: Hardness Value obtained as per different ratio

Samples with Different Ratios	Hardness Number
Sample 1	81
Sample 2	83
Sample 3	86

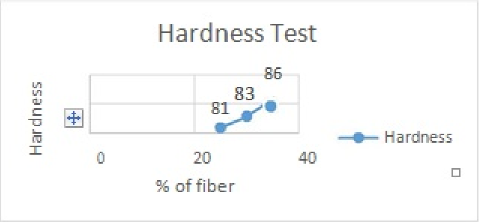

Figure 3: Hardness Number across Differnt Ratios of Fiber

4.4 Analysis Result

The Computational fluid dynamic (CFD) analysis of the samples from 1 to 3 using ANYSYS 15 by changing the fraction of the fiber from 25% to 35% .The results obtained from Fig 4 11 shows has major effect on the mechanical properties of the composites like tensile strength and flexural strength have good strength and light weight. Hence it can be used in aerospace industries. Also the deformation is better in Sample 3 when compared with other two samples of 1 and 2. Meshing as done in tetrahedral as to get the accuracy of the results. The CFD analysis compact with the mechanical tests conducted.

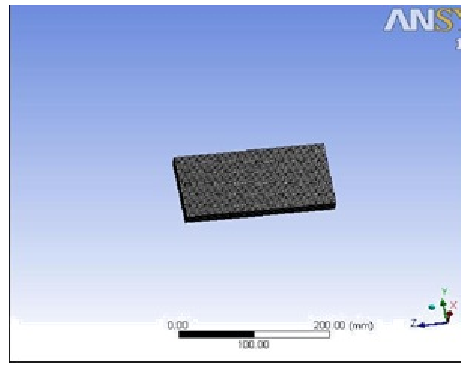

Figure 4: Mesh Model of Sample 1

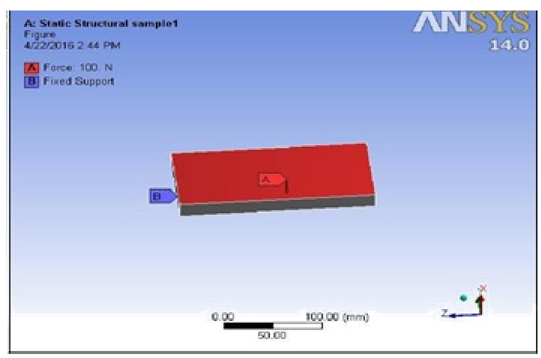

Figure 5: Boundry condition of Sample 1

Table 5: Result from CFD Data

S.No	Parameters	Sample1	Sample2	Sample3
1	Deflection(mm)	.0036869	.0020758	.0014344
2	Stress(MPa)	.293445	.31269	.31252
3	Strain	3.316986e-5	1.847e-5	1.2757e-5

5 Conclusion

This experimental examination of mechanical behavior of banana fiber based epoxy composites indicates to the many conclusions:

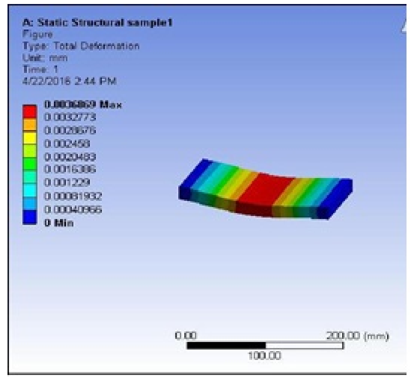

Figure 6: total deformation of sample 1

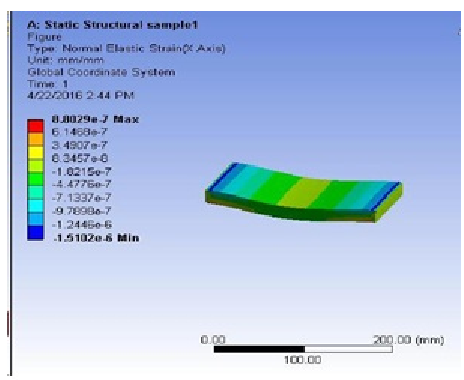

Figure 7: Normal Elastic Strain of Sample 1 using CFD analysis

- From the current experiments results, it has been observed that fiber ratio has major effect on the mechanical properties of the composites like as hardness, tensile strength, flexural strength and impact strength.
- It has been observed that the better mechanical properties found for composites having banana fiber at 35%.

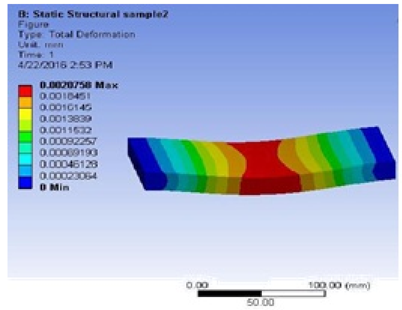

Figure 8: Total deformation of Sample 2

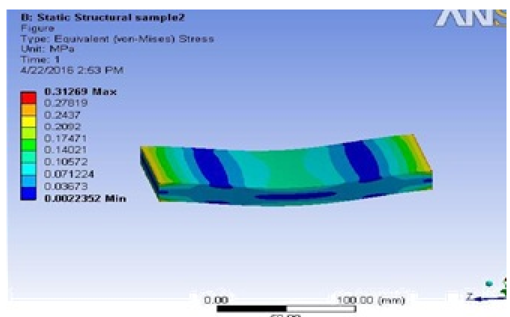

Figure 9: Equivalent stress of Sample 2

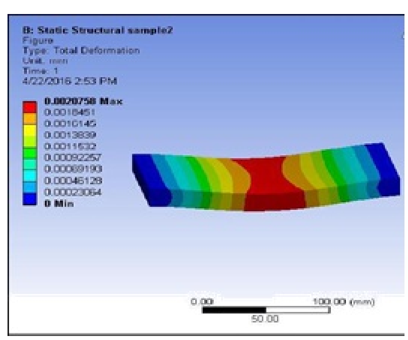

Figure 10: Normal stress of Sample 2

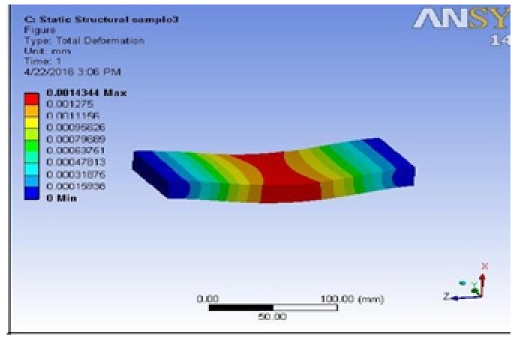

Figure 11: Total deformation of Sample 3

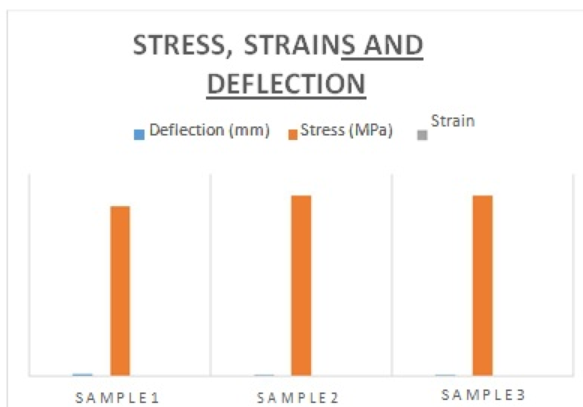

Figure 12: % Fiber vs Stress, Strain and Displacement

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