(IJAER) 2016, Vol. No. 11, Issue No. II, February e-ISSN: 2231-5152/ p-ISSN: 2454-1796

COMPARATIVE MECHANICAL TESTING ON HYBRID FIBER REINFORCED POLYMER COMPOSITES

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ABSTRACT

Composite materials consist of two or more constituent materials, the fiber and the matrix. Generally the matrix is of ductile and fiber is of brittle in nature. Fiber reinforced polymer composites are becoming very popular and replacing conventional materials nowadays, because of their excellent properties suitable for various applications. The properties of fiber reinforced polymers are comparable to most conventional materials like metallic materials. This is due to their lower density compared to the higher density in metals which leads to higher strength to weight ratio for the composites compared to that of the metallic materials. These composites are also easier to obtain in desirable shape and require much less energy in making the required product. There are number of fibers available for making composite material including synthetic as well as natural fibers. Natural fibers are available in plenty and it is also eco friendly, which go waste if not utilised further. In this experimental work, different fibers sisal fiber, kenaf fiber, banana fiber, carbon fiber and rice husk hybrids are separately used to prepare a specimen using a thermosetting polymer unsaturated polyester and suitable hardener, accelerator and catalyst for the improvement of the process, various mechanical testing such as Tensile test , Flexural test, Impact test of the composite material under various conditions are carried out. The properties of the were compared. ASTM standards were followed for carrying out all these tests.

Keywords: *Sisal fiber, Kenaf fiber, Banana fiber, Carbon fiber, Rice husk, Polyester resin and Hybrid composite.*

1. INTRODUCTION

Fiber reinforced polymer composite materials are very popular and replacing conventional materials nowadays because of their excellent properties suitable for various applications [1]. Natural fiber-reinforced composites is growing rapidly due to their mechanical properties, low cost, processing advantages and low density. The availability of natural fibers such as kenaf, sisal, banana in india is more and also has some advantages over traditional reinforcement materials in terms of cost, density, renewability, recyclability, abrasiveness and biodegradability. The performance of the fiber reinforced composites mainly depends on the fiber matrix and the ability to transfer the load from the matrix to the fiber [2-5]. The sisal, jute and glass fibers with epoxy resin are used to produce the hybrid composite materials with weight ratio of fibers to resin as 30:70. The use of natural fibers resulted in the reduction of cost and it has no harmful environmental impact as these are easily biodegradable [6]. Srinivasan et al. [7] Is paper deals with one of such hybrid composite made of natural fibres namely, banana and flax fibres. The structural build-up is such that one layer of banana fibre is sandwiched between two layers of flax fibres by hand layup method with a volume fraction of 40% using Epoxy resin and HY951 hardener. This lamination also increases the overall mechanical properties along with better surface properties. The properties of this hybrid composite are determined by testing its tensile, impact, and flexural loads using a Universal testing machine.

Sisal fibers are extracted from the leaves of sisal plant. The fibers are extracted through hand extraction machine composed of either serrated or non serrated knives. The peel is clamped between the wood plank and knife and hand-pulled through, removing the resinous material. The extracted fibers are sun-dried which whitens the fiber. Once dried, the fibers are ready for knotting. A bunch of fibers are mounted or clamped on a stick to facilitate segregation. Each fiber is separated according to fiber sizes and grouped accordingly. To knot the fiber, each fiber is separated and knotted to the end of another fiber manually. The separation and knotting is repeated until bunches of unknotted fibers are finished to form a long continuous strand [8].

Rice husk (RH) is the major by-product produced in rice milling. In recent years, rice husk has been used for power generation. How-ever, the evolution of greenhouse gas and ash formed by burned rice husk are inevitable. The rice husk ash produced in power generation is dangerous, for the ultrafine silica powder in the ash has the persistent, carcinogenic and bio-accumulative effects, which could result in silicosis syndrome, fatigue, shortness of breath, loss of appetite and respiratory failure [9].

Carbon fibres have been generally used in high performance composite materials because of their outstanding properties such as superior mechanical properties, high temperature resistance, chemical stability, and light weight. These excellent properties of carbon fibres are transferred to matrix through their interface. Accordingly most of carbon fibres reinforced composite properties are controlled by interfacial adhesion between carbon fibres and matrix resins[10].

The same author also have attempted to conduct experiment on carbon fibre reinforced polymer composites using various machining conditions with the help of different cutting tool materials and the effects of the tribological operating parameters applied load, sliding velocity and sliding distance on the frictional and wear performance of natural fibre polymer composites are demonstrated. [11-13].

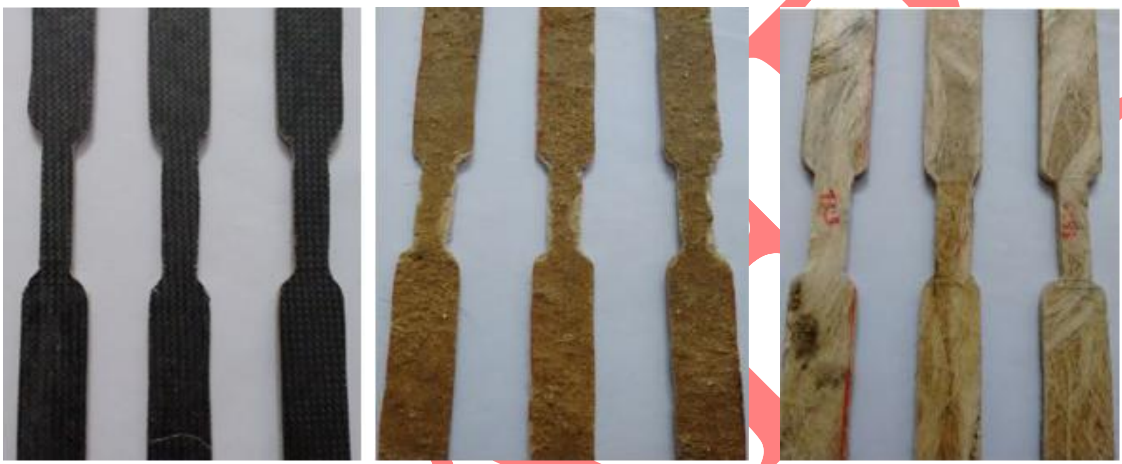
2. EXPERIMENTAL DETAILS AND PROCEDURE

In this work we have used the natural, synthetic fiber and adding the rice husk used in this composites. The polyester resin is prepared by adding 1.5% accelerator (Cobalt Octate) and 1.5% catalyst (Methyl ethyl ketone peroxide). Catalysts are added to the resin system shortly before use to initiate the polymerization reaction. The catalyst does not take part in the chemical reaction but simply activates the process. An accelerator is added to the catalyzed resin to enable the reaction to proceed at workshop temperature and at a greater rate. The spacer is placed on the plastic sheet. Now a layer of resin is applied on the plastic sheet. A layer of fiber is placed on top of the resin. Resin is applied on top of the layer of fiber and its ensured that the fiber is completely wet . fiber reinforced polymer composite plates were made. The manufacturing process selected for the fabrication of the specimen plate is Compression Molding Process. Combinations: [30% Fibers + 70% polyester (by weight)]. And the composite are

1. Sisal + Rice husk + Polyester
2. Sisal + Banana + Kenaf+ Polyester
3. Carbon+Rice husk+ Sisal + Polyester

2.1 Tensile Test

The tensile test is done by cutting the composite specimen as per ASTM D638 standard. The dimension are as follows, the overall length is 165mm, Gage length is 50mm, width of narrow section is 13mm and overall width is 19mm in shown in Fig. 1. A universal testing machine with maximum load rating of 400 kN is used for testing. The material is held by the grips and load is applied till failure occurs. Ultimate tensile test is noted. A stress versus strain graph is generated.



(a) (b) (c)

Fig. 1 Tested specimen of before tensile test (a) carbon, sisal and rice husk (b) sisal and rice husk (c) sisal, banana and kenaf

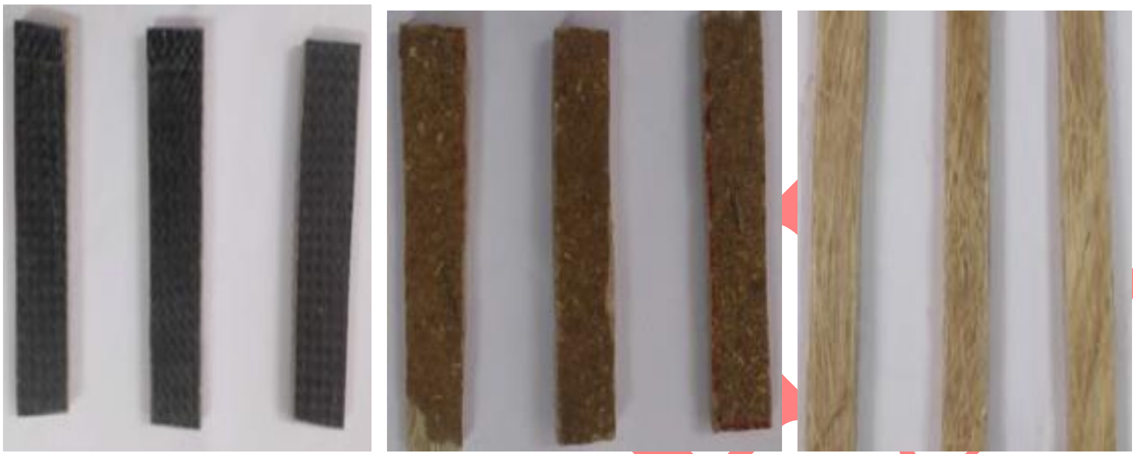
2.2 Flexural test

The Flexural test is done in a three point flexural setup as shown in Fig. 2 based on ASTM: D790 standard. The specimen bends and fractures when the load is applied at the middle of the beam. This test is carried out in the universal testing machine from which the breaking load is noted and Load vs Deflection graphs are generated.

Fig. 2 Experimental testing on flexural

2.3 Impact test

The impact test set up consists of a pendulum which is dropped from an angle of 125 degree to impact the specimen and to fracture it Izod impact test was performed on the test pieces. The test pieces were fabricated following the standard ASTM D4813 which is the standard for impact test for un-notched test pieces. The loss of energy during impact that is the energy absorbed



(a) (b) (c)

Fig. 3 Tested specimen of before tensile test (a) carbon, sisal and rice husk (b) sisal and rice husk (c) sisal, banana and kenaf

3. RESULTS AND DISCUSSION

3.1 Tensile test

The composites specimens are tested for tensile properties in universal testing machine and obtained tensile properties are shown in Table. 2. The stress vs strain curve was obtained during the test. Figure.4 shows the stress strain curve for fiber reinforced composite. In carbon and sisal composite the observed tensile strength value 92.737 MPa and yield strength value 75.059 MPa is high when we compare to other two composite material. In sisal and rice husk composites observed tensile strength 82.765 MPa and yield stress value 65.251 MPa is high when we compare to other two samples. In sisal and rice husk composites observed tensile strength 84.784 MPa and yield stress value 64.148 MPa is high when we compare to other two samples. The comparison of the tensile test results are shown Figure. 5.

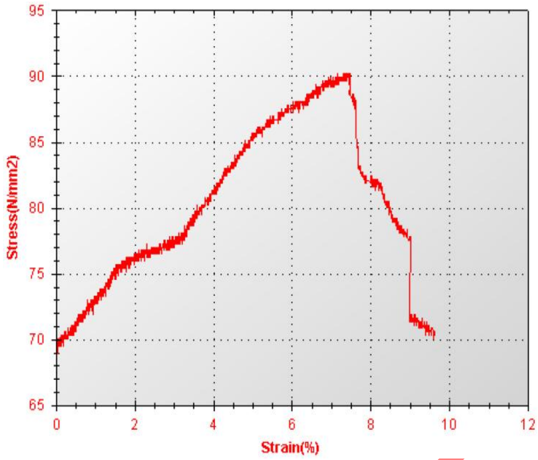


Fig. 4 Stress Vs Strain Curve for Tensile Test of Carbon, Sisal and Rice husk

Table. 1 Tensile test results

S. No.	Sisal + Rice Husk (N/mm^2)	Carbon + Sisal + Rice husk (N/mm^2)	Sisal + Banana + kenaf (N/mm^2)
Specimen 1	78.328	92.737	81.306
Specimen 2	84.784	90.198	68.557
Specimen 3	81.345	88.18	82.765

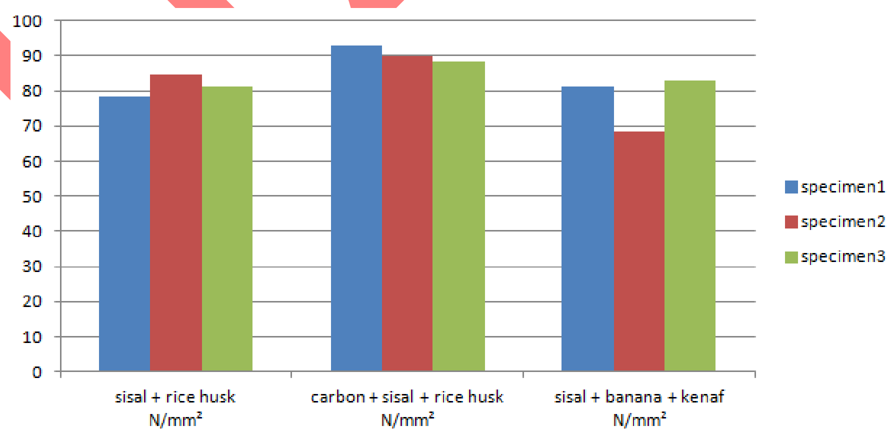
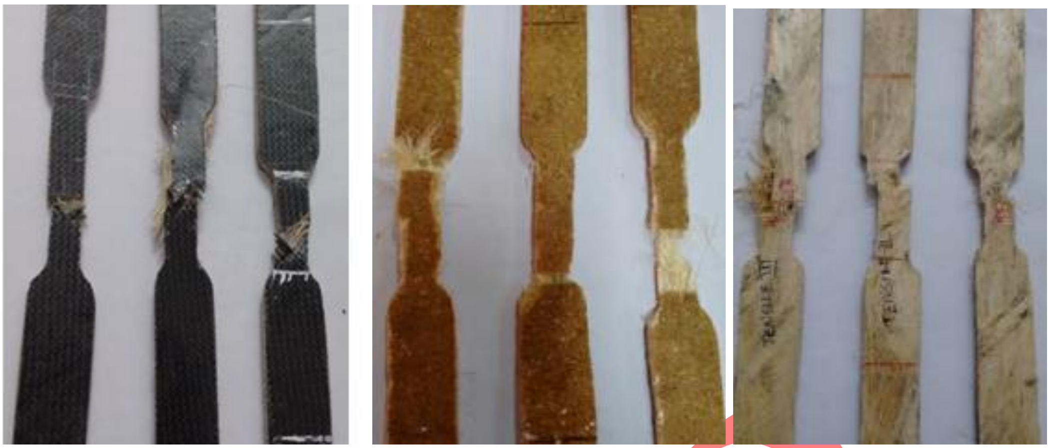


Fig. 5 comparison of tensile test results of composites



(a) (b) (c)

Fig. 6 Tested specimen of after tensile test (a) carbon, sisal and rice husk (b) sisal and rice husk (c) sisal, banana and kenaf

3.2 Flexural test results

The flexural properties of the fiber reinforced composite will be discussed. The work piece was fabricated following the standard ASTM D790. The specimen bends and fractures when the load is applied at the middle of the beam. This test is carried out in the universal testing machine from which the breaking load is noted and Stress vs Elongation graphs are generated. The flexural properties found are shown in Table. 2 The Stress vs Elongation curve for this flexural test is shown in the Figure. 7. The flexural load for the graph being 226.01 N. The comparison of the flexural test results shown in Fig. 9

Fig . 7 Tested specimen of after flexural test carbon, sisal and rice husk

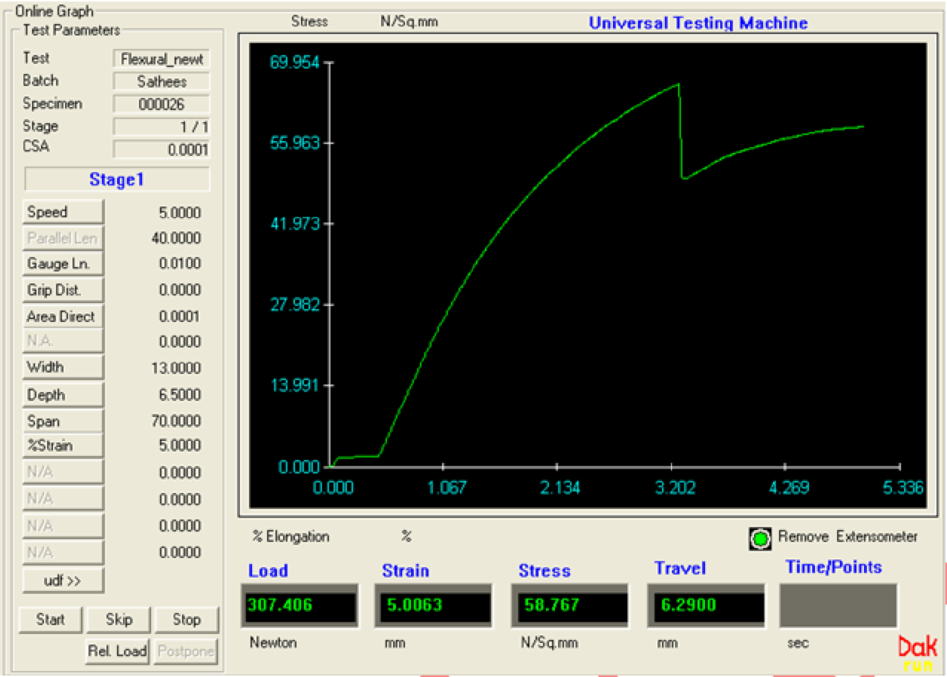


Fig. 8 flexural test for sisal + Banana + Kenaf fiber composite

Table .2 Flexural test results

S.No	Sisal + Rice Husk		Carbon + Sisal + Rice husk		Sisal + Banana + kenaf	
	Flexural load (N)	Flexural strength (N/mm^2)	Flexural load (N)	Flexural strength (N/mm^2)	Flexural load (N)	Flexural strength (N/mm^2)
specimen 1	47.448	10.664	226.02	77.85	345.73	66.09
specimen 2	75.68	16.98	212	73.02	355.42	67.94
specimen 3	65.04	13.54	209	71.02	342.26	65.12

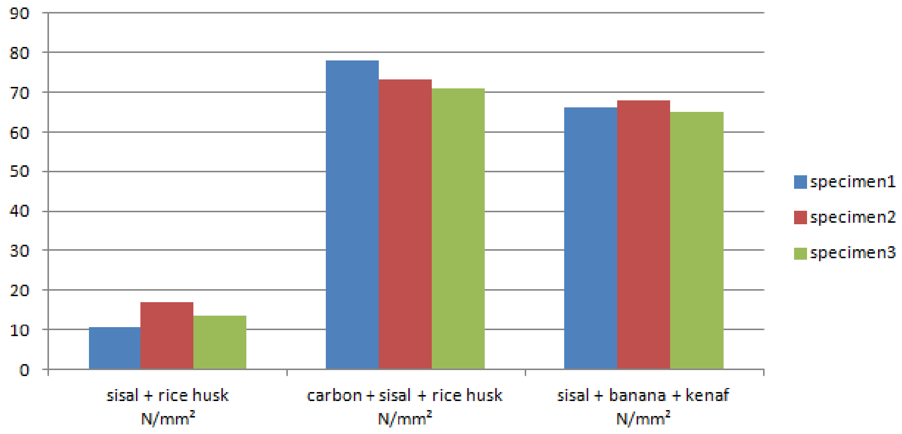


Fig. 9 comparison of flexural test results of this composites

3.4 Impact test results

Izod impact test was performed on the test pieces. The test pieces were fabricated following the standard ASTM D4813 which is the standard for impact test for un-notched test pieces. In the composite sisal and rice husk energy absorption is 3.35J. sisal banana and kenaf composite energy absorbed 1.65J and maximum energy absorbed carbon, sisal and rice husk is 3.5. The loss of energy during impact that is the energy absorbed is depicted in Table. 3. And the failure of the specimen pieces is shown in Fig. 8. The comparison of impact test results are shown in Fig. 10.

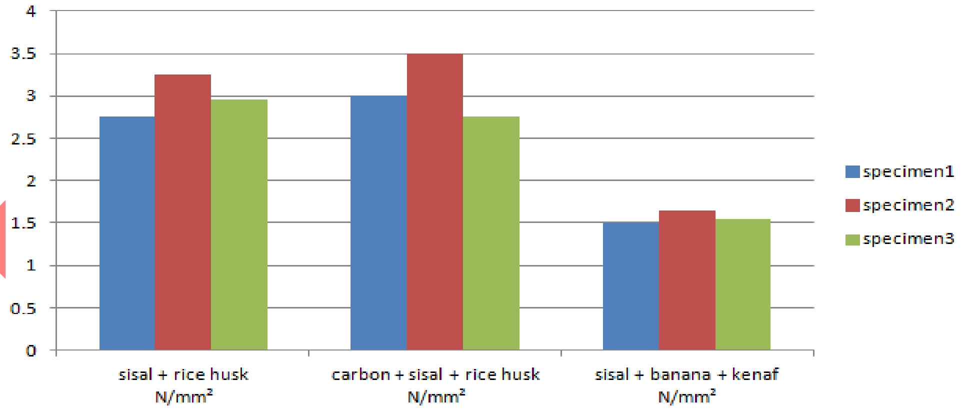


Fig. 10 comparison of impact test results of this composites

Fig. 11 Tested specimen of after impact test carbon, sisal and rice husk

4. CONCLUSION

This paper presents the fabrication of hybrid natural composite using Sisal, Kenaf, Banana, Rice Husk and Carbon fiber reinforced natural composite by compression molding method. The work compares their mechanical properties. From the tests and comparisons, the following conclusions are drawn.

The ultimate tensile strength of the composite carbon, sisal and rice husk is 92 N/mm^2 and the flexural strength is 77.85 N/mm^2 and the impact strength energy absorbed 3.5 J. The ultimate tensile strength of the composite sisal and Rice husk is 84.784 N/mm^2 and the flexural strength is 16.98 N/mm^2 and the impact strength energy absorbed 3.25 J.

The ultimate tensile strength of the composite sisal, banana and kenaf is 81.306 N/mm^2 and the flexural strength is 67.94 N/mm^2 and the impact strength energy absorbed 1.65 J. The composite carbon, sisal and rice husk shows relatively higher ultimate tensile strength of 92 N/mm^2 than other composites. The composite carbon, sisal and rice husk shows relatively higher flexural strength of 77.85 N/mm^2 than other composites.

Also the carbon, sisal and rice husk composite absorbs relatively high energy of 3.5 J which is higher than composites fabricated.

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