A Relative Comparative investigation on Jute and Sisal Fiber Composite Material

MANSOOR.P[1]

[1] *Asst. Professor, Dept. of Mechanical Engineering, Chiranjeevi Reddy college of Engineering, Andhra Pradesh, India.*

Abstract - *The composite materials are helping the modern world in all accepts as a replacement, by using the alternative materials. These alternative composite materials are more versatile than metals and can be tailored to meet performance needs and complex design. Long life and its excellent fatigue-, impact-, environmental-resistance and reduced maintenance requirements helping in replacing the conventional materials. Best in mechanical properties against high tensile strength , high strength to weight ratio and low thermal expansion. The Natural fiber composites such as Sisal and jute polymer composites has shown good properties such as high specific strength, lightweight and biodegradability. Sisal and jute Reinforced Polymers are showing huge applications. In this study, Sisal–Jute reinforced epoxy composites are Elaborated and their mechanical properties like flexural strength, impact strength and tensile strength are calculated. The detailed structures like internal cracks and fractured surfaces are determined by using Scanning Electron Microscope (SEM). The results obtained shows that the Sisal and jute polymer composites can be used as an alternate material for synthetic fiber reinforced polymer composites*

Key Words: Composite materials, Sisal fiber, jute fiber.

1. INTRODUCTION

The Fiber reinforced polymer (FRP) is a composite material made of a polymer matrix reinforced with fibres. The fibres are usually glass, carbon, aramid, or basalt. Rarely, other fibres such as paper, wood, or asbestos have been used. The polymer is usually an epoxy, vinylester, or polyester thermosetting plastic, though phenol formaldehyde resins.

Fibres constitute the main bulk of reinforcements that are used in making structural composites. A fibre is defined as a material that has the minimum 1/d ratio equal to 10:1, where 1 is the length of the fibre and d is its minimum lateral dimension. The lateral dimension d (which is the diameter in the case of a circular fibre) is assumed to be less than 254 m. The diameter of fibres used in structural composites normally varies from 5m to 140m. A filament is a continuous fibre with the l/d ratio equal to infinity. A whisker is a single crystal, but has the form of a fibre.

Common low density fibres are manufactured from lighter materials especially those based on elements with low atomic number (e.g., H, Be, B, C, N, O, Al, Si, etc.). The cross-section of a fibre may be circular, for example as in the cases of glass, boron and Kevlar fibres, but some fibres may have regular prismatic cross-sections (e.g., whiskers) or arbitrary cross-sections.

Natural fibers are chosen as reinforcement because they have very good tool wear reducing properties, while processing, the system of steps and serving as alternatives for artificial fiber composites in the increasing global energy crisis and ecological risks. In the current study the mechanical properties of jute and Sisal reinforced composite materials is studied. The jute and sisal reinforced composite materials are manufactured by hand layup method and compressed using Compression moulding machine. The properties such as tensile, flexural and impact are studied and presented in detail.

2. Experimental details

2.1 Materials

Jute fibres are composed primarily of the plant materials cellulose (major component of plant fibre) and lignin (major components of wood fibre). The fibres can be extracted by either biological or chemical retting. The fibers are off-white to brown, and 1–4 metres (3–13 feet) long. Jute is also called the golden fiber for its color and high cash value Jute fibers were bast Fibers extracted out of plants of the genus Corchorus that grow mainly in warm and moist regions. The fibers of this study are extracted with a mechanical process. Sisalis derived from the leaves of the plant. It is usually obtained by machine decortications in which the leaf is crushed between rollers and then mechanically scraped. The fibre is then washed and dried by mechanical or natural means. The dried fibre represents only 4% of the total weight of the leaf. Once it is dried the fibre is mechanically double brushed.

2.2 Alkali treatment

Fibers are effectively well treated by 5 wt% NaOH solutions. Fibers were fully immersed in the NaOH solution for 24 h at 50°C and then followed by washing with distilled water until the pH was neutral.The fibers were washed for several times with water to remove any alkali solution sticking on their surface, neutralized with dilute acetic acid and then washed again with water. Finally result Fibers were dried at 80°C for 10 h at oven.

2.3 Preparation of composites

A rectangular wooden board of 350 mm, 350 mm was taken and wooden patterns of thickness 6 mm were fixed on these wooden boards with the help of clips. These wooden patterns were placed hence that a space of 180 mm, 15 mm, and 6 mm was obtained.

After the moulds of required dimensions were prepared, wax was applied to the inner sides of the moulds for easy release of the composite without sticking to the mould walls. Again hardener is mixed with epoxy. So matrix solution is prepared. The epoxy and the hardener ratio were maintained at 10:1. The appropriate quantity of fibers was placed such that epoxy mixture completely spread over the fibers after Initial layer of the mould was filled with the epoxy resin and hardener mixture. Again, epoxy mixture was poured on the fiber. As a result, the starting and ending of the layers were of epoxy resin.

A plastic firm was placed on the top of the uncured mixture. Before application of compression, efforts were made to eliminate all bubbles using roller. Then the compression pressure of 0.06 MPa was applied and cured for 24 h at room temperature evenly. In this, specimens containing 40% wt fractions of fiber were prepared. The specimen is prepared with the dimensions of 160 mm length, 12 mm width and 6 mm thickness according to ASTM D 3039-76 is used for carrying out tests

3. Mechanical Tests

Test specimens were cut from the composite plates as per the ASTM standard

3.1 Tensile test

Tensile testing was carried out in a FIE universal testing machine UTE-40 with a 500 kN capacity with a gauge length of 160 mm and a cross head speed of 1 mm/min, as per ASTM D 3039

Figure 1: Jute fiber composite material

3.2 Flexural test

Preparation for flexural test specimens as per the ASTM standards and 3-point flexure test is beingused for testing. The deflection of the specimen is measured and the tests are carried out at an average relative humidity of 55% and the temperature about 40ºC. From the testing machine the flexural loads as well as the displacements are recorded for all the test samples.

3.3 Impact test

The impact test specimens are prepared according to the required dimension following the ASTM-A370 standard. During the testing process, the specimen will be loaded in the testing machine and allows the pendulum until it fractures or breaks. During impact test, the impact force needed to break the material can be measured easily and can be used to measure the toughness of the material and the yield strength. The outcome of strain rate on fracture and ductility of the material can be analyzed using the impact test.

Figure 2: Sisal fiber composite material

4. Results and discussion

In this study natural fibers are fabricated and their effect on tensile, impact and flexural properties are evaluated and compared. The results for the tensile, flexural and impact.

Table 1: Results for tensile testing of jute fiber composite sample

Specimen	Maximum Load (N)	Tensile extension at Maximum Load (mm)	Tensile stress at Maximum Load (MPa)	Modulus (Automatic Youngs) (GPa)
1	642.112	0.436	16.324	4.342
2	725.349	0.575	23.654	5.563
3	1349.986	0.794	42.263	7.258
Mean	905.815	0.602	27.41	5.721

Table 2: Results for tensile testing of Sisal fiber composite sample

Specimen	Maximum Load (N)	Tensile extension at Maximum Load (mm)	Tensile stress at Maximum Load (MPa)	Modulus (Automatic Youngs) (GPa)
1	1676.543	1.342	52.543	7.865
2	867.432	0.743	28.763	6.863
3	924.673	0.683	30.234	6.753
Mean	1156.216	0.922	37.18	7.160

Table 3: Results for flexure testing of Jute fiber composite sample

Specimen	Maximum Flexure Load (N)	Flexural extension at Maximum Flexure Load (mm)	Flexure stress at Maximum Load (MPa)	Modulus (Automatic Youngs) (GPa)
1	114.654	1.67353	68.832	9.762
2	183.728	2.67735	103.735	11.863
3	165.257	1.78362	88.652	10.842
Mean	154.546	2.044	87.073	10.88

Sample papragraphDefine abbreviations and acronyms the first time they are used in the text, even after they have been

Table 4: Results for impact testing of jute fiber composite sample

Specimen	Maximum Flexure Load (N)	Flexural extension at Maximum Flexure Load (mm)	Flexure stress at Maximum Load (MPa)	Modulus (Automatic Youngs) (GPa)
1	114.654	1.67353	68.832	9.762
2	183.728	2.67735	103.735	11.863
3	165.257	1.78362	88.652	10.842
Mean	154.546	2.044	87.073	10.88

Table 5: Results for flexural stress of Sisal composite material

Specimen	Maximum Load (N)	Tensile extension at Maximum Load (mm)	Tensile stress at Maximum Load (MPa)	Modulus (Automatic Youngs) (GPa)
1	112.543	1.863	72.752	7.973
2	467.987	0.652	128.972	6.863
3	673.833	0.962	91.965	6.534
Mean	805.141	1.159	97.89	17.01

4.1 Tensile properties

The composite samples are tested in the UTM and the stress-strain curve is plotted. The graph generated directly from the machine for tensile test for jute fiber and Sisal fiber presented in Figure 3

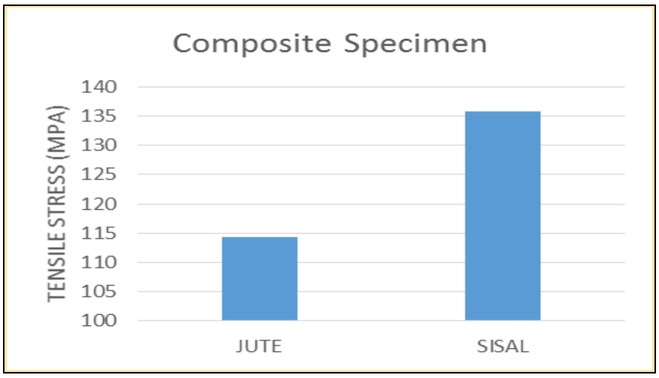

Figure 3: Stress strain curve of tensile test for Jute and Sisal fiber

4.2 Flexural properties

The flexural properties of the composite samples tested in the UTM and the typical curve generated for jute fiber composite sample and Sisal fiber composite sample is presented in Figure 4

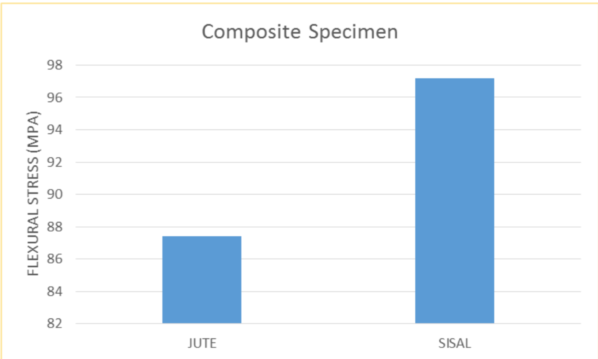

Figure 4: Stress strain curve of flexural test for Jute and Sisal fiber

The flexural load for composite samples are seen and drawn in Fig 4. From the above figure, it is clearly understood that the flexural load carrying by sisal fiber composites is better than jute fiber composites tested. From the results, it has been noted that the tensile and flexural strength of sisal fiber composites is better than the jute fiber composites tested. Hence these work tensile and flexural studies are carried out for jute fiber and sisal fiber composites.

4.3 Impact properties

For analyzing the impact strength of the different specimens an impact test is carried out. The impact test will be carried out by Izod impact test. The impact response in jute and sisal fiber composites reflects a failure process involving crack initiation and growth in the fiber breakage, fiber pullout, delaminating and disbanding. The results is presented in Fig 5 indicated that the maximum impact strength is obtained for sisal fiber composites.

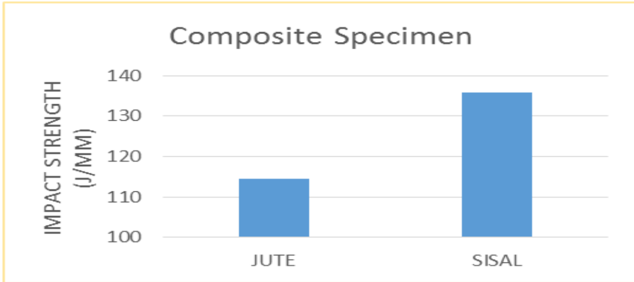

Figure 5: Results of impact energy for Jute fiber and Sisal fiber

4.4 Microscopy scanning electron (SEM) analysis

The morphology of both the composite samples used jute and sisal fiber is examined through scanning electron microscopy. The SEM image of the samples undergone test is presented in Fig 6 and 7. The fracture takes place in the specimen by the addition of load. The below figures indicate the fiber fracture and carry out from the specimen and also the dislocation of fibers

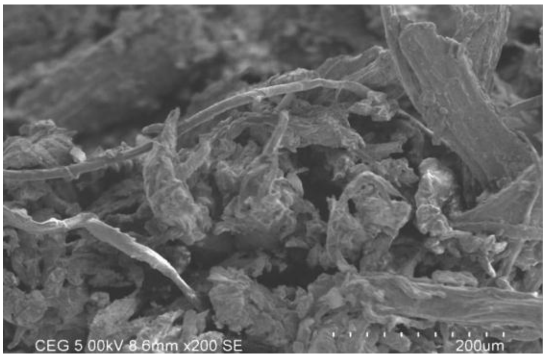

Figure 6: SEM image of Sisal fiber after tests

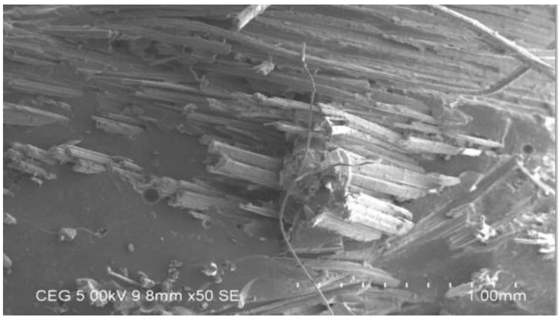

Figure 7: SEM image of jute fiber after tests

5. Conclusions

The jute and Sisal fiber reinforced epoxy composites are hand fabricated and compressed using Compression molding machine. The natural fiber composites are then subjected to mechanical testing like tensile, flexural and impact test. Depends on the results, the conclusions are derived.

1. The results show that sisal fiber reinforced epoxy composite materials have maximum tensile strength and can hold the strength up to 37.18 MPa.
2. The sisal fiber reinforced epoxy composites are capable of having maximum flexural strength 87.073 N.
3. The maximum impact strength for the sisal fiber composite and has the value of 136.654 J/mm.
4. The tensile test SEM images show the, internal cracks, interfacial properties and internal structure of the fractured surfaces of the composite materials.
5. The flexural test SEM images show the fracture in the fiber and incomplete distribution of the fiber and matrix in the composite material.
6. The images indicates the disintegration at the breaking point of the fiber and matrix in the composite material.

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BIOGRAPHIES

MANSOOR.P
Chiranjeevi Reddy college of Engineering & Technology, Anantapur, Andhra Pradesh
(Dept. of Mechanical Engineering)