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Characterisation of Aloe Vera-Jute Fiber Reinforced Hybrid Polymer Composites

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Abstract

Natural fiber reinforced composites dominate the field of engineering in the past few years. The need for composites with increased performance is getting increased day by day, which revived this research, to fabricate aloe Vera Fiber Reinforced epoxy composite and estimate the mechanical properties of the same Aloe Vera Fiber composites. In this work, the methodology used for the fabrication of composites is hand layup process. Here, Aloe Vera fibers are used as reinforcement in epoxy resin matrix with varying compositions of fiber layers. The tensile strength, compression strength, and impact strength of the composites are carried out as per ASTM standards. From the results of the testing process, it has been found the hybrid composite specimen that contains both Aloe Vera fibers and Jute fibers exhibited mechanical tensile properties.
Keywords: Aloe Vera, Epoxy resins, Tensile Properties.

1. Introduction

Natural fibers are eco-friendly compared to synthetic fibers such as glass fibers. Thanks to the advantageous properties of the Natural fibre reinforced polymer composites that lead them being used in automobile components, construction industry, and aerospace parts. There are different natural fibers available. Among these, aloe Vera is a known plant whose fibers are mainly used in a wide variety of structural applications like building and construction. Elastic recovery, strength of the Fiber, breaking extension of the fiber when its dry, moisture regaining ability, resistance to heat degradation and the tensile strength of the fiber are some of the properties of Aloe Vera to be kept in mind. Aloe Vera plant and aloe Vera fibers are shown in figure 1 and figure 2 respectively. Some of the mechanical and physical properties of Aloe Vera Fiber are listed in Table 2.

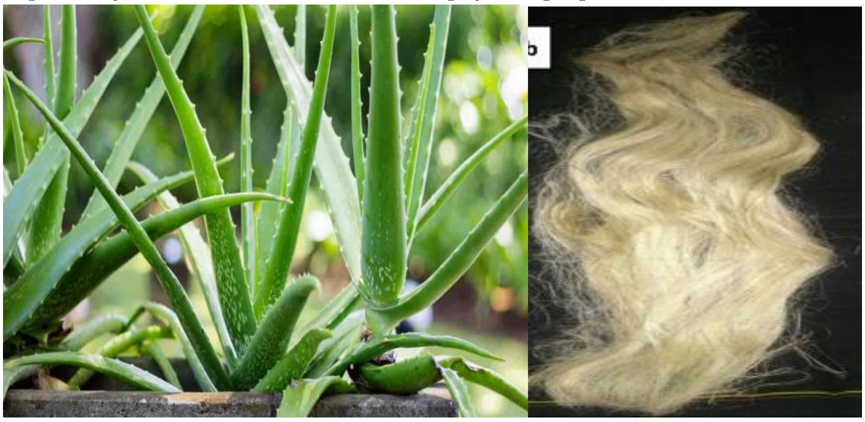

Figure. 1. Aloe Vera Plant; Figure. 2. Aloe Vera Fibers

Developing high-performance composites using natural fibers have become a major area of concern. This work focusses on increasing the mechanical properties of aloe Vera fiber reinforced hybrid composites. Ways (Major) of trying to improve the mechanical properties of aloe Vera fiber reinforced composites: This work tries to bridge the gap between the above two that leads to a new hybrid FRP Composite, (in which the orientation of the fiber is also changed) thereby contributing to the novelty of the work.

2. Materials and Methods

Fiber Selection

The specimen was prepared using Aloe Vera Fiber and a jute Fiber Reinforced Polymer (GFRP) of length 250 mm. In the experiment as discussed, four aloe Vera fiber mats were taken, and three for jute; and they were arranged sequentially resembling a sandwich-like structure and has a fibre orientation: AJAJAJA – 0 90 0 90 0 90 0. From Visual inspection system (at SPF), the aloe Vera fiber diameter was measured and is 30 micron.

Table 1. Fiber Arrangement

Aloe Vera
Jute
Aloe Vera

Jute
Aloe Vera

Table 2. Physical properties of materials used

Properties	**Aloe Vera fiber**	**Jute fiber**
Density g/cm^3	1.51	1.3
Tensile strength (MPa)	400	393-773
Young's Modulus (G Pa)	12	26.5

Hand Lay-up Process

Epoxy resin (LY 556) accompanied with hardener (HY 951) was used to concoct the Hybrid Fibre Reinforced Polymer laminates by taking advantage of the hand lay-up technique. The thickness of the material is 5.72 mm. The dimensions of the specimen was set to 250*250*5 mm. The mats have been infused with the resin and fibers were allowed to dry. The Fiber composites were bathed in the thinner solution and were hence freed from impurities. The Fibers were then placed on the die and were spread over the epoxy resin. On the top of the last mat (on both sides), a polymer coating was done that assists to warrant a better surface finish. They are then allowed to settle for a period of 48 hours for curing and subsequent hardening. The schematic setup is shown in figure 3.

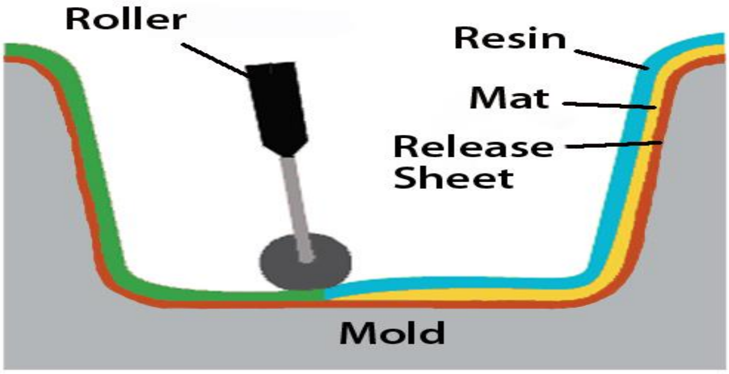

Figure 3. Hand layup Method

3. Tensile test

Tensile tests were carried out, on the composite specimen as per American Society for Testing and Materials (ASTM) D638 standard with the help of an universal testing machine (UTM) to find the tensile strength at room temperature as shown in figure 3. The specimen was held using the grippers, as in figure 4, and the test was carried out by applying load until the specimen failed, as shown in figure 5. The regularly used dog-bone sort specimen for tensile test is as shown in the figure 6.

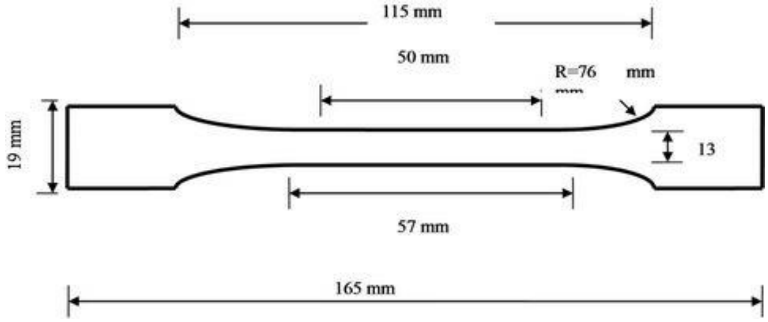

Figure 4. ASTM D638 standard specimen size

Figure 5. Tensile Test Setup; **Figure 6.** Tensile Test Specimen

A plot between the stress and the strain was engendered. The tensile strength of a material is the maximum amount of tensile stress that it can take before failure. Brittle fracture took place. At a load of 960N, the specimen failed.

Tensile Stress = Tensile Load /Area

Tensile Stress = 960/50.98 = 18.83 N/mm^2

The tensile strength is found to be 18.83 Mpa. The tensile stress-strain graph is shown in figure 14.

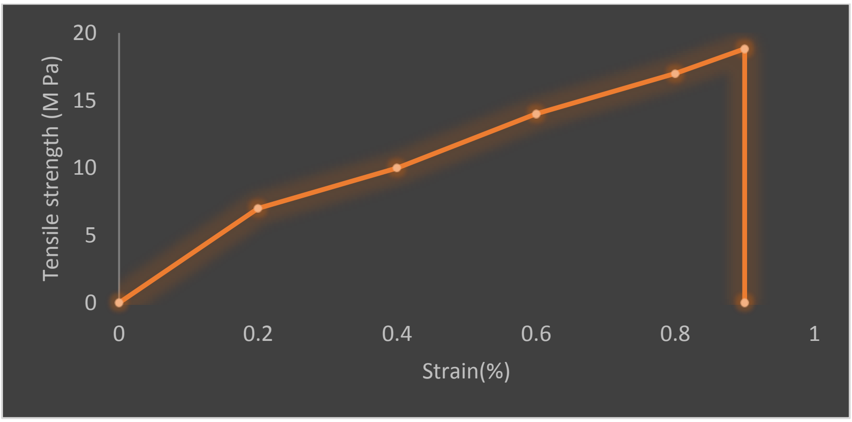

Figure 14. Stress vs strain graph of tensile testing

4. Compression Test

Compressive strength is defined as the capability of a material to resist loads that tend to decrease size. The compression test is accomplished using an universal testing machine (UTM) and results were investigated to determine the compression of composite specimens. The compression test was carried out as per the ASTM D638 standards.

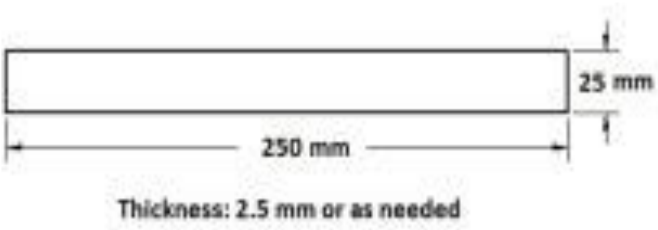

Figure 7. ASTM D638 standard specimen size


Figure 8. Compression Test Setup; Figure 9. Compression Test Specimen

Brittle fracture took place. At a load of 1760N, the specimen failed.

Compressive Stress = Compression Load /Area

Compressive Stress = 960/80.96 = 21.74 N/mm^2

The Compression strength is found to be 21.74 M Pa.

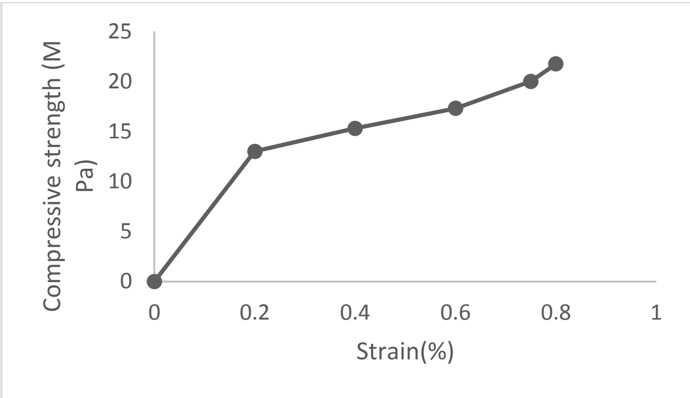

Figure 15. Stress vs strain graph of Compression testing

5. Impact Test

Impact Test was carried out using a Charpyimpact test machine. The specimens prepared according to the ASTM D638 standards were used for this process.

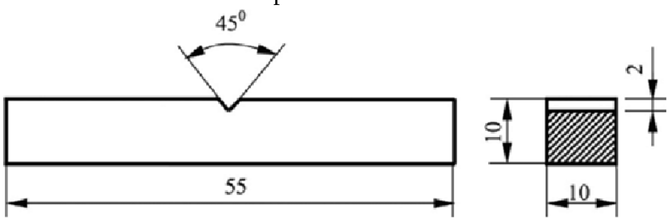

Figure 10. ASTM D638 standard specimen size



Figure 11. Charpy Impact Testing Machine; Figure 12. Impact Test Setup; Figure 13. Impact Test Specimen

Impact energy denotes the endurance of a material to sudden, tremor loads. The breaking load of fiber reinforced composite is found to be 2 Joules.

6. Conclusion

Fibre-reinforced composites have numerous applications in our daily life because of their usability and strength. Fibres which are oriented in the same direction produce enhanced strength properties. Natural fibres are used to reduce the use of synthetic fibres. Natural fibres are obtained from things which are considered as waste, they are eco-friendly and easily available. They are highly strong and weigh less than the conventional materials. They are mainly used in aerospace, automotive, marine, and construction industries due to its less weight, high modulus, specific strength and high fracture toughness.

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