Characterization and Comparison Study of Sisal and Jute Hybrid Composite

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Abstract— Among the various synthetic materials that have been explored as an alternate to iron and steel for the use in automotive, plastics claim a major share. During the last decade, the study of filled plastic composites has simulated immense interest in meeting the shortage of plastic materials. Plastics find an extensive application as they have less weight, low water absorption, high stiffness and strength. At present, due to uncertain conditions in the shortage and the cost of petroleum, and it's by products, there is a need to search for its alternate, which is nothing but natural fibers are cheaper, bio-degradable and have no health hazard. Furthermore natural fiber reinforced fibers are seen to have good potential in the future as a substitute. Natural fibers are extracted from various plant parts and classified accordingly. In present investigation natural hybrid composite is developed using Sisal, Jute and E-Glass as reinforcing material and Epoxy as a matrix material. To sustain the environmental condition and water absorption, E-Glass is used. The fabrication is done using hand layup technique. The developed hybrid composite will be subjected to different kind of test to determine mechanical properties. The result shows that the Sisal hybrid composite has good mechanical properties compared to other hybrid composite.

Key words: Sisal, Jute, Hybrid Composite

I. Introduction

A. Composite Materials

The development of composite materials and their related outline and assembling innovations is a standout amongst the most critical advances ever. A composite material can be defined as a mix of two or a bigger number of materials that outcomes in preferable properties over those of the individual segments utilized alone. Composites are the material utilized as a part of different fields having selective mechanical and physical properties and are created for specific application. Composite materials having a scope of focal points over other traditional materials, for example, tensile strength, impact strength, stiffness and fatigue characteristics. In light of their various favorable circumstances they are broadly utilized as a part of the aerospace business, business mechanical designing applications, similar to machine segments, vehicles, burning motors, mechanical segments like commute shafts, tanks, brakes, weight vessels and flywheels, warm control and electronic packaging, railroad mentors and aircraft structures.

At the point when two or more materials with distinctive properties are joined together, they shape a composite material. Composite material involve strong load carrying material (known as reinforcement) imbedded with weaker materials (known as matrix). The essential elements of the matrix are to exchange stresses between the reinforcing fibers and to protect them from mechanical and/or environmental damage whereas the presence of fibers/particles in a composite improves its mechanical properties like tensile strength, compression strength, impact strength, stiffness.

Natural fiber reinforced polymer composites have emerged as a potential ecologically amicable and practical choice to engineered fiber reinforced composites. The accessibility of natural fibers and simplicity of manufacturing have enticed analysts to attempt mainly accessible modest fibers and to study about their attainability of reinforced purposes and to what degree they fulfill the obliged details of good reinforced polymer composite for tribological applications. With ease and high particular mechanical properties, characteristic strands speak to a decent, renewable and biodegradable distinct option for the most widely recognized manufactured reinforced, i.e., glass fiber. Regardless of the interest and ecological bid of natural strands, their utilization has been constrained to non-bearing applications because of their lower quality and solidness contrasted and manufactured fiber reinforced polymer composite. The solidness and quality inadequacies of bio-composites can be overcome by basic setups and better course of action it could be said of putting strands in particular areas for most astounding quality execution.

II. Methodology

A. Sisal Fiber

Sisal Fiber is one of the most widely used natural fiberand is very easily cultivated. It is obtain from sisal plant. This plant is referred to formally as Agave sisalana. These plants produce rosettes of sword-shaped leaves which start out toothed, and step by step lose their teeth with development. Every leaf contains various long, straight filaments which can be uprooted in a procedure known as decortication.

Properties	Values
Tensile strength(MPa)	80-840
Young's modulus(Gpa)	9-22
Specific modulus(Gpa)	6-15
Failure strain(%)	2-14
Aspect ratio,I/d	115
Density(Kg/m³)	1300-1500

Table 1: Physical properties of Sisal fiber

B. Jute Fibers

Jute, a natural fiber utilized all around, is the bark of a slim plant of tropical and subtropical origin. The considerable leap forward made in material innovation at the beginning of the mechanical upset bailed jute turn out as a stunning fabric from its age-old use as cordage and rope. From that point forward the multitudinous increases and alterations in its shape and structure prepared jute into an irreplaceable material everywhere throughout the world for a variety of other determined and unspecified uses, Favorable conditions for jute development are found in the deltas of the great rivers of their tropics and sub-tropics.

Properties	Values
Tensile strength(MPa)	200-450
Young's modulus(Gpa)	20-55
Specific modulus(Gpa)	14-39
Failure strain(%)	2-3
Aspect ratio,I/d	157
Density(Kg/m³)	1300-1500

Table 2: Physical properties of jute fiber

C. E-Glass Fiber

Glass was first made by man in 3000 BC in Asia Minor. Glass fibers as of now contain more than 90% of fibers utilized as a part of polymer composites. There are five major types of glass used to make glass fibers. A glass (high alkali), C glass (chemical), D glass (low dielectric constant), E glass (electrical) and S glass (high strength), out of which the last two sorts, because of their unrivaled mechanical properties, are most broadly utilized as a part of composite roofing, pressure vessels, containers, tanks, pipes, etc

Fiber glass fabrics are utilized as a part of an extensive variety of modern applications. High strength, dimensional stability design flexibility and excellent electrical properties are a percentage of the attributes that guarantee ideal execution and economy with this exceptionally designed material.

Properties	Values
GSM	300
Density(kg/m^3)	2550
Tensile strength(MPa)	3450-5000
Young's modulus(Gpa)	70
Elongation at break (%)	2.5

Table 3: Physical properties of E-Glass fiber

D. Fabrication Procedure

- Wight of fabric and quantity of resin is determined in grams.
- Mix the Epoxy resin with hardener in the container.
- At the bottom, the slab of the mould (granite slab) is thoroughly cleaned with acetone and release film is placed on the slab.
- The blend of epoxy resin and hardener arranged by obliged organization in a container, from it, the first coating is done on the release film guaranteeing consistency utilizing a hand roller/brush.
- First layer of fabric is placed over the resin coat.
- Immediately after the first layer of fabric has been applied a compression roller is used to compress the mat and squeeze air bubble.
- Successive layer of laminate are to be applied on one another.
- After the final resin coat is applied, the lay-up is covered by another release film.
- On the top slab approximately weight of 20 kgs is placed which will compresses the lay-up to the desired thickness of 4 mm.
- Allowed to cure for 24 hours in room temperature condition before it is retrieved from the mould.

III. RESULTS AND DISCUSSION

In this study natural fibers are added to E-Glass fiber with different orientation and their effect on tensile and flexural properties are evaluated.

A. Tensile Test

Tensile test is conducted according to ASTM standards. The specimen is enclosed between the grippers of universal testing machine. Load is gradually applied by deforming the specimen, load corresponding to deformation is noted down. Stress strain for corresponding load and corresponding deformation are determined. The procedure is repeated for different specimens.

Fig 1: Tensile test specim

B. Flexural Test

Flexural test is conducted according to ASTM standards. Specimen is placed as simple supported beam and central load is applied gradually, load at which maximum deformation is noted down. Procedure is repeated for different trials.

Fig. 2: Flexural test specimen

The results for tensile and flexural testing of the hybrid composites samples are given below.

Materials	Orientation	Ultimate Tensile Stress (MPa)	Young's Modulus (MPa)	Flexural strength (MPa)
S/G	0°	67.19	2789.76	117.17
	30°	55.88	2556.68	138.26
	45°	38.74	2211.14	125.23
J/G	0°	65.85	3525.46	108.34
	30°	65.07	2973.80	132.52
	45°	62.29	2739.80	125.95
SJ/G	0°	69.74	3854.15	57.81
	30°	50.08	3099.02	119.39
	45°	44.63	2904.05	88.83

Table 4: Test results of specimens

C. Overall comparison of ultimate tensile strength with different materials

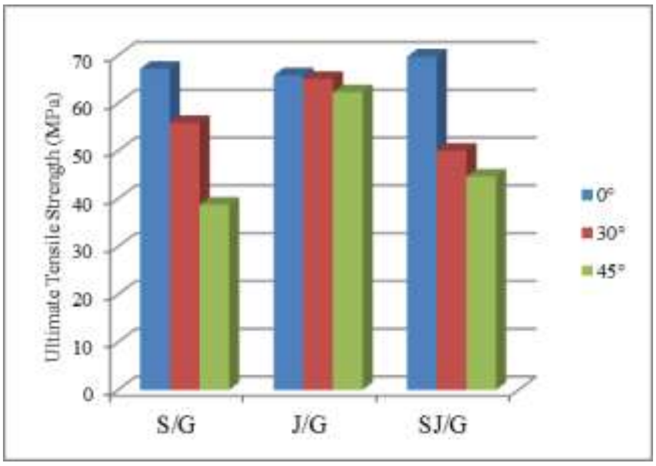

Fig 3: Overall comparison of ultimate tensile strength with different materials

D. Overall comparison of Young's Modulus with different materials

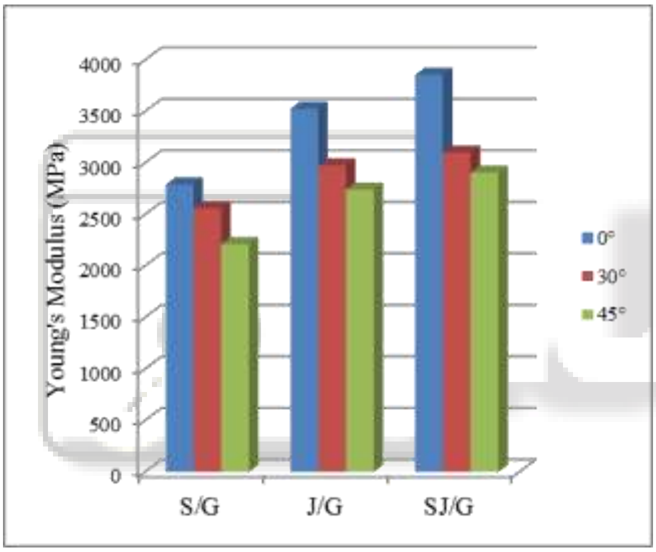

Fig 4: overall comparison of Young's Modulus with different materials

E. Overall comparison of flexural strength with different materials

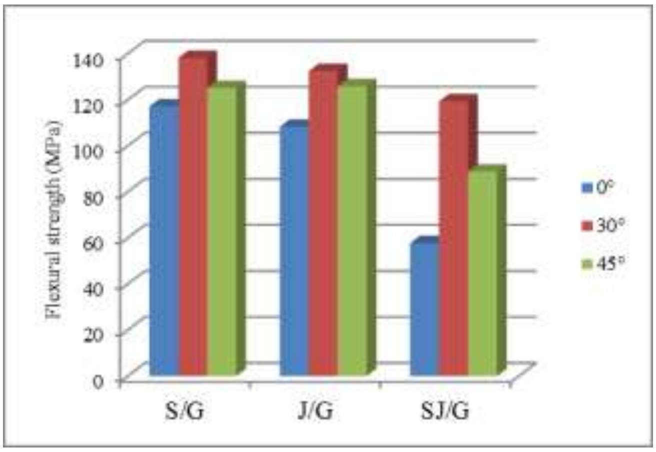

Fig 5: Overall comparison of flexural strength with different materials

The fig 3 shows the overall comparison of tensile strength for different materials. The fig 3 shows the maximum tensile strength for Sisal+Jute/E-Glass composite as compared to Sisal/E-Glass and Jute/E-Glass composite. Fig 4 shows the Young's modulus of Sisal+Jute/E-Glass composite at 0° orientation found to be more as compared to Sisal/E-Glass composite at 0°, 30° & 45° orientation and Jute/E-Glass composite at 0°, 30° & 45° orientation.

The fig 5 shows the overall comparison of flexural strength with different materials. The flexural load Sisal/E-Glass composite at 30° orientation found to be more as compared to 0°& 45° orientation. The flexural load of Sisal/E-Glass composite at 30° orientation found to be more as compared to Jute/E-Glass composite at 0°, 30° & 45° orientation and Sisal+Jute/E-Glass composite at 0°, 30° & 45° orientation.

IV. Conclusion

The natural hybrid composite is developed by using hand layup technique. The effect of combination of fibers is investigated. The experiments are carried out to understand tensile and flexural behavior for different orientations. From the discussion of the results obtained the following may be concluded. The tensile strength of Sisal/E-Glass hybrid composite, Jute/E-Glass hybrid composite and Sisal+Jute/E-Glass hybrid composite for 0° orientation varies marginally. But the tensile strength obtained for Jute/E-Glass hybrid composite in 30° and 45° orientation is more as compared to other two hybrid composites. The flexural strength is more at Sisal/E-Glass hybrid composite as compared to Jute/E-Glass hybrid composite and Sisal+Jute/E-Glass hybrid composite. Overall comparison between the properties of all composites tested revealed that the Sisal hybrid composite has good mechanical properties compared to other hybrid composite.

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