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EXPERIMENTAL STUDY ON FLAX AND SISAL HYBRID COMPOSITES REINFORCED WITH EPOXY RESIN

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Abstract: Natural fibers have been used to reinforce materials for more than 200 years. The aim of this study is to evaluate mechanical properties, such as tensile, compression and bending properties of hybrid sisal and flax reinforced with epoxy resin composites. Natural fibers like as hemp, jute, flax, sisal and banana have the advantages that they are renewable resources and these agricultural wastes can be utilized to organize fiber composites, which has many advantages over conventional glass fiber and inorganic materials. Strength of the material which is prepared using epoxy resin with natural sisal and flax fibers is mainly depend on the composition based on which matrix and reinforcement being added.
Keywords: Sisal fiber, Flax fiber, Epoxy resin, Damping factor, Natural frequency.

I. INTRODUCTION

Composite materials are the new generation materials. It is developed to meet the request of fast development of technological, changes of the industry. Composite materials or composites are engineering materials produced using two or more constituent's materials that remain separate and distincton macroscopic level whereas forming a single component.Physical Characteristics Requirements: strength, toughness, elasticity, corrosion-resistance, wear resistance, long term dependability natural fibers are a renewable resource material all through the world particularly in the tropics. According to the food and agricultural organization survey, natural fibers like jute, sisal, flax, coir, banana, and so are abundantly available in developing countries. Natural fibers are an appealing exploration region since they are eco-accommodating, economical, abundant and renewable, lightweight, low density, high toughness, high particular properties, biodegradability and non-grating to handling qualities, Therefore, regular strands can serve as fortifications by enhancing the quality and firmness furthermore by lessening the heaviness of the subsequent bio composite materials in spite of the fact that the properties of characteristic fibers differ with their source and medicines. Sisal fiber is completely biodegradable, green composites were produced with soy macromolecule tar modified with gelatin. It is exceedingly renewable resource of essentiality. Sisal fiber is especially solid and a low backing with unimportant wear and tear.Flax fiber is delicate, shining and flexible. It is extra grounded than cotton fiber yet less versatile. The most straightforward grades are utilized for material fabrics, for case, damasks, strip and sheeting.

II. METHDOLOGY

The methodology depicted in Figure.2 has been adopted as shown, fabrication and testing of composite material for mechanical properties in manufacturing has been selected as a broad field of research. The composite specimen is fabricated according to ASTM standard. The rule of mixture will be calculated for each test. The various compositions are taken as 20% sisal fiber 5% flax fiber, 75% epoxy resin. The other composition 20% sisal fiber10% flax fiber, 70% epoxy resin and in another composition 20% sisal fiber,15% flax fiber, 65% epoxy resin as taken.

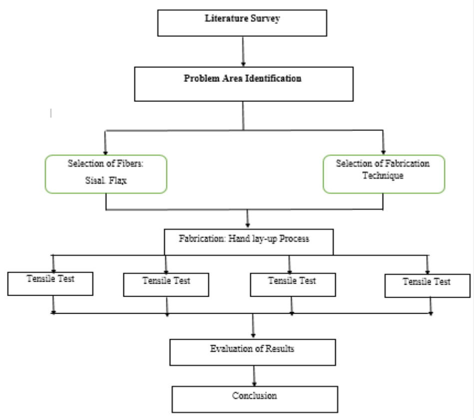

Fig.1 Methodology

A. Hand lay-up technique Hand lay-up is the least difficult and most seasoned open molding strategy for the composite manufacture forms. It is a low volume, work concentrated technique suited particularly for expansive segments.

For various composition the stages involved in hand lay-up process are as follows:

Cut down the fibers as per the required Length. Place the ASTM standard die. Wax a releasing agent can be applied to the die.Lay up the mixture of separate parent fibers. Sisal fiber and flax fiber percentage can be taken placed in the die. The epoxy resin mixed with a hardener with a percentage can be poured on the die uniformly. Allow a Curing time of about 24 hours and then separate the composite plate.These procedure continues for various combination.

III. EXPERIMENATION

A. Tensile test

For tensile test ASTM standard D3039 is selected. The most common specimen for ASTM D3039 has a consistent rectangular cross segment, 25 mm (1 in) wide and 250 mm (10inch) long and 3mm thickness.


Fig.2.Tensile test specimen

L= Length (250 mm); W= Width (25 mm); t = thickness (3 mm); P = Load

The tensile test can be conducted on Universal Testing Machine. For testing the specimen gauge length can be determined with the help of Vernier Caliper. The specimen is fixed between the upper cross head and middle cross head of the UTM. After the crosshead has been fixed proper range of loading can be selected (0-300KN). As the load increases deformation increases up to the specimen fails or fracture.

B. Compression Test

For compression test ASTM standard D3410 is selected. The most common specimen for ASTM D3410 has a consistent rectangular cross segment, 25 mm (1 in) wide and 140 mm (10inch) long and 3mm thickness.


Fig. 3 compression test specimen

L= Length (140 mm); W= Width (25 mm); t = thickness (3 mm); P = Load

Compression test is a one of the fundamental type of test is used to characterize the metals, composites, wood, plastic and many other common materials. A compressive strength is a maximum compressive stress of a material is capable of withstanding without fracture.

C. Bending test

For bending test ASTM standard D790 is selected. The most common specimen for ASTM D790 has a consistent rectangular cross segment, 25 mm (1 in) wide and 125 mm (10inch) long and 3mm thickness.


Fig. 4 Bending test specimen

L= Length (125 mm); W= Width (25 mm); t = thickness (3 mm); P = Load

The bending test measures the ductility of the materials. The cross sectional area of the specimen can be measured with the help of vernier caliper. The specimen will be placed over the supports as the loading comes exactly at the center of the specimen. The load will be applied very slowly until the specimen fails.

D. Damping test

The fabrication of composite by hand lay-up technique, the hybrid sisal-flax laminate are prepared. Sisal and flax fiber as reinforced materials and industrially accessible epoxy resin as a matrix material. A cantilevered rectangular symmetric plate of hybrid sisal-flax fabric fortified epoxy composite having measurements 300x300x5 mm.


Fig.5 Damping test specimen


Fig.6 Experimental setup

Length (300 mm); W= Width (300 mm); t = thickness (5 mm)

A matrix of 7x6 (42 focuses) estimation focuses are set apart over the surface of the laminates. The laminate is then braced on test apparatus and a impulse method was utilized to energize the structure by effect hammer with force transducer worked into the tip to enrol the force input. The impact force of the hammer will be within the 4-6 KN will be taken. Beyond the 6 KN or before the 4 KN and force of frequency not be accepted and the rebounding frequency also not accepted. The excitation signal is encouraged to the analyser through amplifier unit. The yield information of every one of the 42 estimations was utilized as an information for LABVIEW-2009 software to recognize response frequencies.

IV. RESULT AND DISCUSSION

A. Tensile test results

Table.1 Tensile test result

Sl. No	Polymer Matrix Composite	Tensile Load (KN)	Breaking Load (KN)	Tensile Strength (MPa)	Youngs Modulus (GPa)
1	20% Sisal+5% Flax+75% Epoxy resin	4.980	4.320	65.33	0.0260
2	20% Sisal+10% Flax+70% Epoxy resin	5.540	4.260	72.66	0.0285
3	20% Sisal+15% Flax+65% Epoxy resin	6.600	4.320	80.66	0.0309

It is observed that tensile strength of Sisal 20%+Flax 15%+ Epoxy resin 65% is (80.66MPa) high compared to tensile strength for Sisal 20%+Flax 10%+ Epoxy resin 70% is (72.66MPa). Tensile strength is low for Sisal 20%+Flax 5%+Epoxy resin 75% is (65.33MPa).

It is observed that youngs modulus of Sisal 20%+Flax 15%+ Epoxy resin 65% is (0.0309GPa) high compared to youngs modulus for Sisal 20%+Flax 10%+ Epoxy resin 70% is (0.0285GPa). Youngs modulus is low for Sisal 20%+Flax 5%+Epoxy resin 75% is (0.026GPa).

B. Compression results

Sl No	Polymer Matrix Composite	Compression Load (KN)	Breaking Load (KN)	Compression Strength (MPa)	Youngs Modulus (GPa)
1	20%Sisal+5% Flax+75% Epoxy resin	4.600	4.400	59.66	0.00738
2	20% Sisal+10% Flax+70% Epoxy resin	4.740	4.240	62.66	0.0135
3	20% Sisal+15% Flax+65% Epoxy resin	5.180	4.360	67.66	0.0329

Table.2 Compression test result

It is observed that compression strength of Sisal 20%+Flax 15%+ Epoxy resin 65% is (67.66MPa) high compared to compression strength for Sisal 20%+Flax 10%+ Epoxy resin 70% is (62.66MPa).Compression strength is low for Sisal 20%+Flax 5%+Epoxy resin 75% is (59.66MPa).

It is observed that youngs modulus of Sisal 20%+Flax 15%+ Epoxy resin 65% is (0.0329GPa) high compared to youngs modulus for Sisal 20%+Flax 10%+ Epoxy resin 70% is (0.0135GPa). Youngs modulus is low for Sisal 20%+Flax 5%+Epoxy resin 75% is (0.00738GPa).

C. Flexural test result

Table.3 Bending test results

Sl. No	Polymer Matrix Composite	Flexural Load (KN)	Breaking Load (KN)	Flexural Strength (MPa)	Youngs Modulus (GPa)
1	20%Sisal+5% Flax+75% Epoxyresin	4.300	4.260	36	10.18
2	20% Sisal+10% Flax+70% Epoxyresin	4.340	4.320	35.6	10.09
3	20% Sisal+15% Flax+65% Epoxyresin	4.380	4.300	35	9.97

It is observed that flexural strength of Sisal 20%+Flax 15%+ Epoxy resin 65% is (36MPa) comparatively high compared to flexural strength for Sisal 20%+Flax 10%+ Epoxy resin 70% is (35.6MPa). Flexural strength is low for Sisal 20%+Flax 5%+Epoxy resin 75% is (35MPa).

It is observed that youngs modulus of Sisal 20%+Flax 15%+ Epoxy resin 65% is (10.18GPa) comparatively high compared to youngs modulus for Sisal 20%+Flax 10%+ Epoxy resin 70% is (10.09GPa). Youngs modulus is low for Sisal 20%+Flax 5%+Epoxy resin 75% is (9.97GPa).

D. Damping test result

Table.4 sisal+flax+epoxy resin composition

Polymer matrix composite	Mode number	Frequency Hz	Material damping factor
20% Sisal+5% Flax+75% Epoxy resin	Bending	21.150	1.807
	Twisting	48.082	2.510
	Double bending	151.795	2.430
	Combination of bending and twisting	173.365	2.406
	Complex	290.085	1.045

Table.5 sisal+flax+epoxy resin composition

Polymer matrix composite	Mode number	Frequency Hz	Material damping factor
20%Sisal+15 Flax+65% Epoxy resin	Bending	18.382	2.282
	Twisting	40.386	2.488
	Double bending	105.940	2.347
	Combination of bending and twisting	122.007	2.544
	Complex	150.347	3.848

Table.6 sisal+flax+epox resin composition

Polymer matrix composite	Mode number	Frequency Hz	Material damping factor
20%Sisal+10 Flax+70% Epoxy resin	Bending	19.373	0.732
	Twisting	40.209	1.211
	Double bending	118.362	2.943
	Combination of bending and twisting	144.124	1.181
	Complex	232.136	0.822

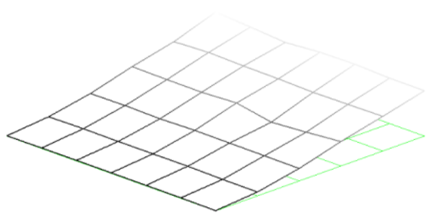

Fig. 7. Bending mode

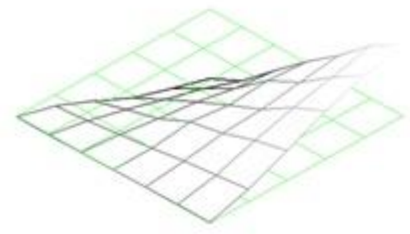

Fig. 8. Twisting mode

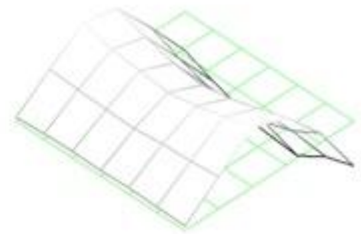

Fig.9. Double bending mode

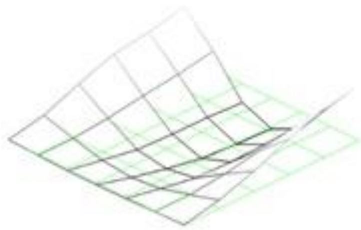

Fig.10. Combination of bending twisting mode

Fig.11. Complex mode

The natural frequency (290.08 Hz) highly increases in 20% Sisal+5% Flax+75% Epoxy resin composite plate, natural frequency (232.13 Hz) is comparatively low in 20% Sisal+10% Flax+70% Epoxy resin composite plate and thenatural frequency (150.34 Hz) is low comparing with and the composition 20% Sisal+15% Flax+65% Epoxy resin composite plate.

The damping factor (2.510) low in 20% Sisal+5% Flax+75% Epoxy resin composite plate, damping factor (2.943) is comparatively high in 20% Sisal+10% Flax+70% Epoxy resin composite plate and thedamping factor (3.848) is high for the composition 20% Sisal+15% Flax+65% Epoxy resin composite plate.

V. CONCLUSION

The mechanical properties such as tensile, compression, bending and hardness are characterized and studied through experimentally, the key followings are explained of the present work as follows. Natural frequency, damping factor and mode shapes are experimentally determined by using Fast Fourier Technique (FFT) analyzer.

- This work shows that successful fabrication of different composition of sisal and flax hybrid composite materials are prepared by using hand lay-up technique as per ASTM standard.
- For each combination specimens are prepared and tested for tensile, compression, flexural, hardness and damping test.
- Tensile strength, compression strength and flexural strength is high for the combination 20% sisal+15% flax+65% epoxy resin laminates and low for the combination 20% sisal+5% flax+75% epoxy resin.
- The modal analysis for prepared specimen was carried out to find first natural frequencies, damping factor and corresponding mode shapes.
- The natural frequency is high for the combination 20% sisal+5% flax+75% epoxy resin laminates. The natural frequency low for the combination 20% sisal+15% flax+65% epoxy resin.
- It is observed that for hybrid composites, when the percentage of sisal fiber and flax fiber is more, the tensile strength, compression strength and flexural strength s increases.

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