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Investigation of Mechanical Properties on Woven Glass – Sisal Fiber Hybrid Composites

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Abstract

Natural and artificial fibers play a significant role in the world to satisfy the most recent world situation. It has significant properties over artificial fibers like environment friendly and easily decomposable. Experimental analysis of woven glass is done by combining sisal fiber and e-glass fiber with different orientations of 0º, 45º, and 90º sisal fiber square measure combined with e-glass fiber form of a plate for analyzing the mechanical properties.

Keywords —*Woven glass, Sisal fiber, E-glass fiber, testings*

I. INTRODUCTION

Composites are the sum of matrix and reinforcement matrix, a thermo set property and includes vinyl ester, epoxy, and polyester. Chandramohan [1] conducted Studies on natural fiber particle reinforced composite material to conserve natural resources. Particularly concentrate on the availability, cost, and had biodegradable properties. Natural fibers are suitable for the above requirements. The powder material of natural fibers Sisal, Banana & Roselle, Sisal and banana, Roselle and banana, and Roselle and sisal are fabricated with the polymer by molding method. This invention focuses on the improvement of the mechanical and material properties of the hybrid composite. The wide range of the fiber composite applications for the bone-implant and the variety of automotive, furniture, upholstery, house hold goods, and computer goods.

Shadrach jeyasekaran et al. [2] has Evaluated the mechanical properties of woven aloevera and sisal fiber hybrid reinforced epoxy composites. The various tensile, flexural, and impact tests were carried out for woven aloevera and sisal fiber hybrid-reinforced epoxy composites. Composites fabricated by hand lay-up method. The surface morphology was examined by scanning electron microscope and finally discussed the automotive and transportation industry applications since it has low-density and high-specific properties of sisal fiber composites.

Sajeeb et al. [3] has Evaluated the Mechanical Properties of Natural Fiber Reinforced Melamine Urea Formaldehyde (MUF) Resin Composites. Natural fibers are environmentally-friendly, biodegradable, easily available, easily accessible, non-toxic, nonabrasive, renewable, cheap, and low density. They developed the composites by different combinations of resins and fibers. Fabrication is done by hand lay-up process. The Melamine Urea Formaldehyde resin (MUF) and polyester resin are used as binding agents. Khadi, coconut leaf midrib (CLM), and glass fibers are used as reinforcing materials for developing the composites. Mechanical properties were evaluated in that MUF resin is greater than that of composites than polyester resin.

Ramesh et al.[4] has evaluated the mechanical property of sisal–jute–glass fiber reinforced polyester composites since it has high specific strength, lightweight, and biodegradability. It was evaluated the various mechanical properties such as tensile strength, flexural strength, and impact strength. The characteristics study was made to study the internal structure of the fractured surfaces. The results indicated that incorporating sisal–jute fiber with GFRP can improve the properties and be used as an alternate material for glass fiber reinforced polymer composites.

Senthilkumar et al. [5] have renewed mechanical properties' evaluation of sisal fiber-reinforced polymercomposites. In that, they stated that the impact of natural fiberon the eco-friendly environment for different applications. Very few among the natural fiberskenaf, jute, oil palm, cotton, flax, banana, and hemp, sisal show the availability, simplest fabrication processes, eco-friendly nature, and very suitable mechanical properties. And also viewed the Effect of water absorption of natural fiber, chemical concentration, exposure time of fiber, filler weight%, and individual fiber loading % in the hybrid composites for future research contribution.

Ashishkumre et al. [6] has reviewed the mechanical property of sisal glass fiber reinforced polymer composites. To overcome the construction materials and fill the space with suitable natural fibers with (GFRP) having similar properties like strength, weight ratio, availability, factors influencing the environment, chemical, and physical properties.

Ramesh et al. [7] has made a Comparative evaluation on the Properties of Hybrid Glass Fiber- Sisal/Jute Reinforced Epoxy Composites by analyzing various tests like tensile and flexural. Also, characteristics study were made to identify the internal structure of the fractured surfaces and material failure morphology. The results sisal fiber shows better properties in tensile and jute shows better result in flexural when reinforced with GFRP.Agnivesh Kumar Sinha et al. [8] reviewed the Mechanical properties of natural fiber polymer composites and extended its usage by analyzing the various mechanical strength testing. They studied the type of matrix and fiber, interfacial adhesion, and compatibility between matrix and fiber in this work. And also suggested that the natural fiber composites are also to be used in the field of vibration by adding filler materials such as red mud and fly ash.

Bahrain et al. [16] has Produced a Laminated Natural Fiber Board from Banana tree wastes. Various mechanical tests were taken like tensile strength, Elongation at break, flexural modulus,impact strength to find the strength of the laminated board, and studied the orientation of fiber and its effects on impact strength viscous component in the laminated boards.

Pickering et al.[10] has reviewed the recent developments in natural fiber composites and their mechanical performance. By improving strength, stiffness, and impact strength, including moisture and weathering and cost.Applications of natural fiber composites on load-bearing and outdoor applications such as automotive exterior underfloor paneling, sports equipment, and marine structures.And also reviewed the research for future improvement of natural fiber composites with moisture resistance and fire retardance for their wide application.Balakrishnan et al. [11] has studied the Natural fiber and polymer matrix composites and their applications in aerospace engineering. Nowadays,the Aerospace industry uses the Fiber-reinforced composites due to their low weight and mechanical properties and have environmental benefits due to their biodegradability and, owing to their low cost. Also, they studied the inferior thermal and fire resistance, water absorption, degradability, and variability in properties, and their reliable prediction tools have to be solved in the future for successful aerospace applications.

Sanjay and B Yogesha [12] has studied the Natural/Glass Fiber Reinforced Polymer Hybrid Composites as an Evolution. Has analyzed the recent developments of natural fiber reinforced polymer hybrid composites made by hand lay-up and compression molding techniques. And stated that hybrid composites made of natural fiber with glass fiber exhibit better mechanical properties than natural fiber composites and suggested it for the future.

Amir et al. [13] has studied and investigated the Effects of Fiber Configuration and Mechanical Properties of Banana Fiber/PP/MAPP Natural Fiber Reinforced Polymer Composite. Here they used the continuous banana fiber as a reinforcement. They investigated the mechanical properties of the composite materials and maleic anhydride grafted polypropylene (MAPP), which is added to the composites to improve bonding between the polymer matrix and the natural fiber with various states. Mechanical properties and Microstructure analysis were studied.

MohitSood [14] and GauravDwivediviewed the Effect of fiber treatment on natural fiber reinforced composites' flexural properties. They renewed the fiber interface bonding with matrix and imparting strengths to the composite by Chemical treatment and concluded that natural fiber composites' flexural strength shows further betterments in the composites.Sivakandhan et al. [15] studied hybrid composites' performance and their mechanical properties by fabrication. For the fabrication process, they used the Epoxy resin (LY556 grade) and hardener (HY951) as a matrix. And took five different kinds of samples of jute/epoxy and sisal fiber/epoxy composite with a matrix weight ratio of 35%.They state that co-axial tensile strength of jute/epoxy and sisal fiber/epoxy composite shows better results than sisal epoxy. Characteristics studies were made for the different combinations.

The composite materials square measure utilized in the widespread application in defense industries, automobile industries, region, and marine. Since composite materials square measure has low fabrication value, smart mechanical properties have been researching the employment of natural fibers as reinforcements in composites for numerous applications. The bulk of the analysis has been directed towards sisal, jute, hemp, and pineapple. Papers have reviewed the developments in these fields and numerous attention-grabbing applications. From the literature, it is clearly stated that the sisal fiber-reinforced composites have good tensile properties and other also other mechanical properties.

II. MATERIALS

Natural fibers' employment in chemical compound matrices is extremely helpful due to the strength and toughness of the ensuing composites square measure bigger than those of unreinforced plastics. Moreover, cellulose-based fiber lightweight in weight, low-cost, abundant, renewable, and bio-degradable compared to artificial fibers like nylon, glass and carbon that squarely measure big-ticket and non-renewable. E.g., Sisal fiber

Glass fiber is created once skinny strands of silica-based or alternative formulation glass square measure extruded into several fibers with tiny diameters. The fiber most typically used square measure principally E-glass (alumino-borosilicate glass with but 1 Chronicle w/walkali oxides, principally used for glass-reinforced plastics).

Fig 1. Natural sisal leaves

Fig 2. Sisal fiber

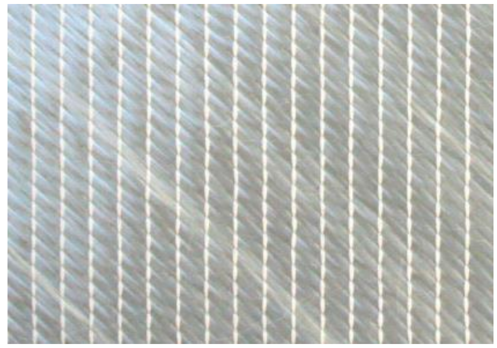

Fig 3. E- glassfiber

III. METHODOLOGY

The specimens square measure ready following ASTM standards. Before beginning the tests, the steps needed for the preparation of sisal fiber strengthened epoxy composites square measure as follows:

Step 1: Extracting the natural continuous sisal fiber.

Step 2: Making ready the sisal fiber mat as per demand (Orientation).
Step 3: Making ready the woven fiber and mat.
Step 4: Mould preparation.
Step 5: Combining the Epoxy and Hardener within the magnitude relation of 10:1.
Step 6: Preparation of the specimen as per ASTM commonplace.
Step 7: Testing, Flexural, and Impact
Step 8: Results and Analysis.

IV. MECHANICAL TESTINGS

The prepared test specimens were undergone different mechanical testings. The following tests were taken the tensile test, flexural test, and impact test as per the ASTM standards.

V. RESULT AND DISCUSSION

The mechanical properties of the Sisal fiber and woven glass hybrid epoxy composites are prepared for the investigation, and it is presented in the following discussion. The results of various mechanical tests like tensile strength, flexural strength, impact strength were illustrated in table 5.1, 5.2, and 5.3.

A. Tensile tests

The tensile test specimen is subjected to Tensile testing to measure the Ultimate strength, young's modulus, and percentage elongation of the composite materials with different orientations. Result discussed in Table 5.1

Table. 5.1. Tested values of Tensile test

No of Tests	SPECIMEN ORIENTATIONS								
	SPECIMEN A (0 °)			SPECIMEN B (45 °)			SPECIMEN C (90 °)		
	Ultimate strength (MPa)	Youngs modulus (MPa)	Elongati - on (%)	Ultimate strength (MPa)	Youngs modulus (MPa)	Elongati- - on (%)	Ultimate strength (MPa)	Youngs modulus (MPa)	Elongation (%)
1	55.4123	4839.37	3.278	33.3456	3129.6	2.438	34.5835	4344.26	1.488
2	48.6937	4555.27	2.6785	38.1236	3389.95	2.687	40.4971	4326.85	1.8765
3	52.2286	4539.47	2.7455	39.6905	3881.49	2.387	33.1436	4460.73	1.7065

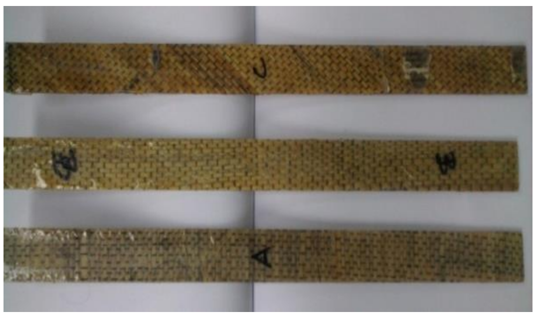

Fig 5.1.1 Specimen before tested

Fig 5.1.2 specimen after tested

a) Analysis of tensile test results

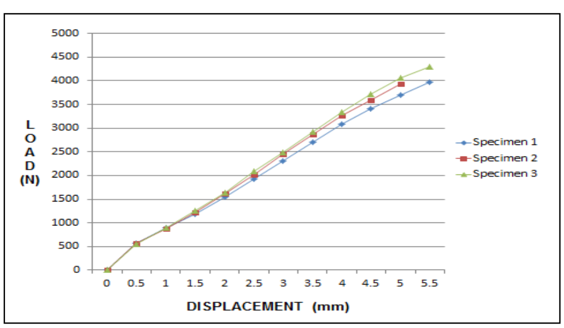

Fig 5.1.3 Orientation A (0°)

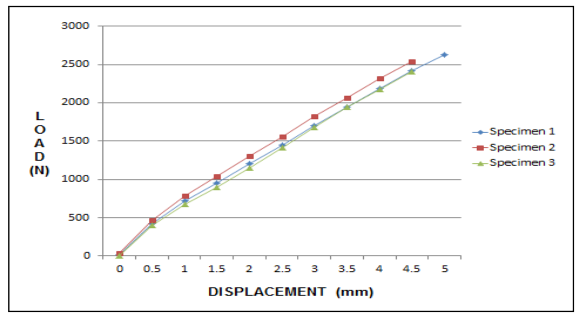

Fig 5.1.4 Orientation B (45°)

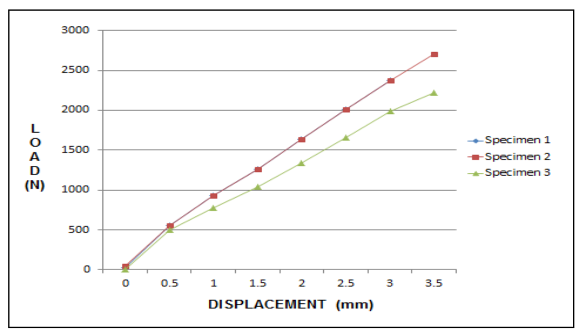

Fig 5.1.5 Orientation C (90°)

From the on top of analysis durability, Young's modulus and Elongation for the 3 specimens1,2 and three square measure tabulated and found that Orientation B (0°) has high price than the opposite 2 Orientations A (90 °) and C (45°). It's clear that Orientation B (0°) is comparably higher than Orientation A (90°) and Orientation C (45°) as its breaking load is higher.

B. Flexural test

A flexural test is used to find the flexural strength of the specimen for the applied load. The result of the flexural test is discussed in Table 5.2

Table. 5.2. Tested values of Tensile test

No of Tests	SPECIMEN ORIENTATIONS					
	SPECIMEN A (0 °)		SPECIMEN B (45 °)		SPECIMEN C (90 °)	
	Flexural load N	Flexural strength MPa	Flexural load N	Flexural strength MPa	Flexural load N	Flexural strength MPa
1	170.25554	114.86527	202.67546	136.36964	151.11143	175.99742
2	225.87674	144.884	176.61937	118.86548	172.30566	129.58275
3	177.93671	127.75146	180.39671	131.07347	181.38792	201.29053

Fig 5.2.1 Specimen before tested

Fig 5.2.2 specimen after tested

a) Analysis of flexural test results

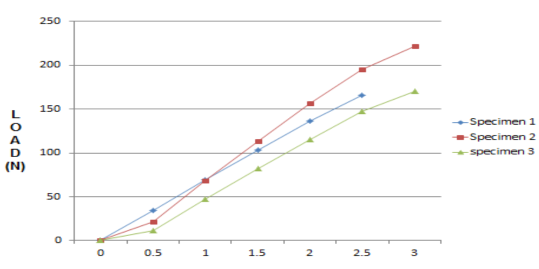

Fig 5.2.3 Orientation A (0°)

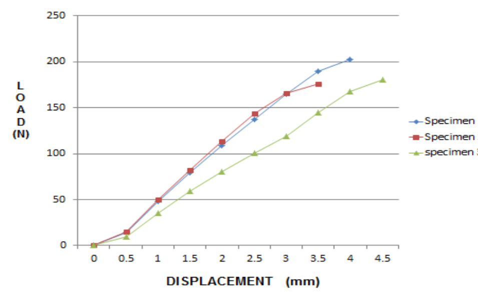

Fig 5.2.4 Orientation B (45°)

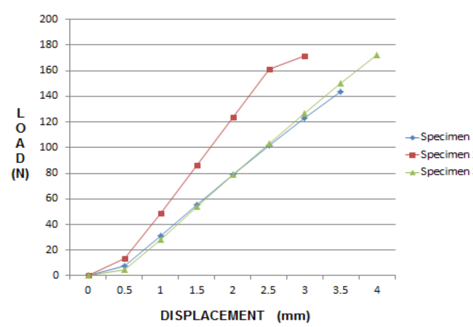

Fig 5.2.4 Orientation C (90°)

Flexural load and Flexural strength for the three specimens1, 2, and 3 tabulated and found that Orientation A (90°) has high value than the other two Orientations B (0°)and C (45°). It is clear that Orientation A (90 °)is comparably better than Orientation B (0°) and Orientation C (45°) as its breaking load is higher.

C. Impact test

Table. 5.3. Tested values of Impact test

No of Tests	SPECIMEN ORIENTATIONS					
	SPECIMEN A (0 °)		SPECIMEN B (45 °)		SPECIMEN C (90 °)	
	Impact Reading J	Impact Strength J/m	Impact Reading J	Impact Strength J/m	Impact Reading J	Impact Strength J/m
1	1.4739	475.463	1.6335	664.044	0.8706	375.29
2	1.475	458.097	1.6439	662.894	0.8655	366.76
3	1.1027	361.548	1.5001	604.899	0.647	253.74
4	1.3811	413.527	1.7875	659.602	0.7072	260.99
5	1.1156	370.644	1.6335	664.044	0.723	283.531

a) Analysis of impact test results

Fig 5.3.1 Specimen before tested

Fig 5.3.2 specimen after tested

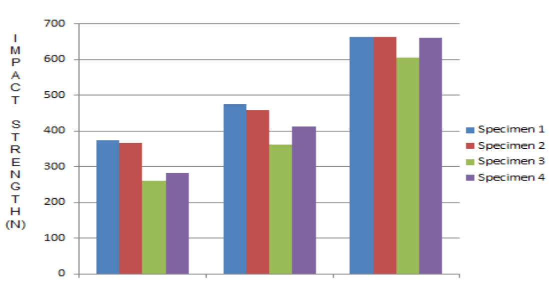

Fig 5.3.3 Orientations (0°, 45 °, 90 °)

VI. CONCLUSION

The experimental analysis of the sisal fiber composite was created with success. By exchange, the traditional artificial fibers have overcome the benefits like lightweight weight and high strength. On examination edge for the 3 Orientations A (90 °), B (0°), and C (45°) of the fiber within the specimens, it is often clearly seen that Orientation B (0°) has nice tensile and flexural strength than the opposite 2 and therefore the Orientation C (45°) has nice impact strength. In the future, it is often distended by selecting {different different completely different} alkalis and different resins to get higher properties.

By variable, the mix of natural and artificial fibers different composite materials are often obtained**.**

ACKNOWLEDGMENT

The investigation of the composites gives better scope for the future in the field of Manufacturing Engineering.

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