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MECHANICAL BEHAVIOR OF SISAL FIBER AND EPOXY RESIN MATRIX COMPOSITE

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Abstract: The fiber which serves as a reinforcement in reinforced plastics may be synthetic or natural. In the present work the Sisal/Epoxy composited were fabricated using treated and untreated Sisal fibers by varying their weight percentage at three levels viz., 30%,35%,and 45%. The fabricated Sisal/Epoxy composites were subjected to mechanical tests such as tensile, flexural and impact tests. The tensile strength, flexural strength and impact strength increases due to increase in weight percentage of fiber in composite for both treated and untreated fiber. The tensile strength and flexural strength of treated Sisal fiber is higher compared to that of untreated Sisal fiber and the impact strength is higher for untreated Sisal fiber than that of treated Sisal fiber.

Keywords: Sisal fiber, Epoxy resin, Treated and Untreated fiber, mechanical testing, weight percentage

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INTRODUCTION

Many works have been carried out on artificial fibers such as glass carbon as fiber reinforcement in composites although glass and other synthetic fiber–reinforced epoxy composite posses high specific strength, Their fields of application are very limited because of their inherent higher cost of production. In this connection, an investigation has been carried out to make use of sisal, a natural fiber abundantly available in India. Natural fibers are not only strong and light weight but relatively very cheap. With the increasing of environmental protection consciousness, natural fibers as a group of environmental friendly reinforcements are in considerable demand in composites [1, 2]. Natural fibers such as flax, hemp, sisal, nettle and jute were the most common reinforced elements [2, 3]. Of course, natural fiber reinforced degradable polymers composite is likely more eco friendly because the reinforcement is readily biodegradable.

Among the various natural fibers, sisal fiber is fairly coarse and inflexible. It possesses moderately high specific strength and stiffness, durability, ability to stretch, and resistance to deterioration in saltwater [4, 5].

Sisal fibers are anti static, do not attract or trap dust particles and does not absorb moisture or water easily. The fine texture takes dyes easily and offers the largest range of dyed colors of all natural fibers. Therefore, it can be used as a reinforcing material in polymeric resin matrices to make useful structural composite materials [6–8]. Tensile strength and elongation at break slightly reduce with pure SBS, however the young’s modulus increases remarkably. The tear strength of the composite increases more than twice that of pure SBS [10]. The compressive and impact strength of sisal /glass fiber hybrid component is higher than the sisal fiber reinforced composite but lower than the glass reinforced composite, So that the presence of glass fiber in the sisal/glass fiber hybrid composite improve the impact and compressive strength [11]. Studied the structure and properties of sisal fiber, processing techniques, physical and mechanical properties of the composites [12]. The mechanical properties of composites reinforced with hybrid Palms - Kevlar fiber. Impact strength, tensile strength, flexural strength and hardness were studied for composite material reinforced with hybrid fibers for Palms and Kevlar. These fibers were mixed with epoxy resin LY 556 in different reinforcement percentage [13]. Untreated and alkali-treated fibers were used as reinforcement in Banana epoxy composites and the tensile, flexural and impact properties were determined at different fiber contents. The alkali treatment found to be effective in improving the tensile strength [14]. In the present work Sisal/Epoxy composites were fabricated and their mechanical properties like tensile strength flexural strength and impact strength were investigated.

I. EXPERIMENTAL PROCEDURE

The present work, Sisal /Epoxy composite were fabricated and their mechanical properties were evaluated. Sisal fiber, which is rich in cellulose, relative inexpensive and abundantly available has the potential for polymer reinforced composite.

The matrix system used is an epoxy resin (LY 556) and hardener (HY 951) supplied by Javanthee Enterprises Chennai 32, India. LY 556 is a liquid, unmodified epoxy resin of medium viscosity. Hardener HY951 is a low viscosity room temperature curing liquid. It is generally preferred in hand- lay-up applications. Being reactive it gives a short pot life. Sisal fiber is a hard fiber extracted with a diameter of 0.2 to 0.3 mm.The sisal fibers were treated with a NaOH aqueous solution for 1 hour at room temperature. The pellets of NaOH are mixed with water in the ratio 1:10. In this work 500g of NaOH is mixed with 5 litres of water. They were then washed with water until all the NaOH was eliminated subsequently; the fibers were dried at room temperature for 24 hours.

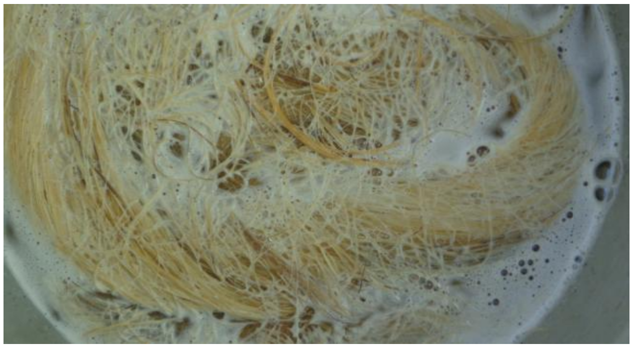

Fig 1 Soaking of Sisal fiber in NaOH

The Sisal/Epoxy composites were fabricated by varying their weight percentage as shown in table1

Table 1 Preparation of samples

specimen	Fiber type	Weight % of fiber	Weight % of epoxy
1	Untreated fiber	30 %	70%
2		35%	65%
3		45%	55%
4	Treated fiber	30%	70%
5		35%	65%
6		45%	55%

A matrix was created by mixing Epoxy resin with its hardener in the ratio 10:1. The mixture is poured into the mould of dimension 300x300x3mm. Mould release films were applied on top and bottom of the specimen to obtain a smooth surface. Finally, the composite samples are allowed to set inside the mould at the room temperature for one day and then removed the specimens were cut as per ASTM standard using water jet machining. The specimens were subjected to tensile, flexural and impact test as per ASTM standards. The standards followed were ASTM-D 3039, ASTM D790 and ASTM-D 256 for tensile tests, flexural tests and impact tests respectively. The tensile tests and flexural tests were conducted at a 2mm/min at room temperature. The impact test on Izod impact test machine were conducted at room temperature.

II. RESULTS AND DISCUSSION

The composites were fabricated using treated and untreated fiber by varying weight percentage and they are subjected to tensile test, flexural test is shown in table2.

Table 2. Mechanical properties of Tensile and flexural test

Weight % of fiber	Tensile strength (MPa)		Flexural strength (MPa)	
	Untreated Sisal fiber	Treated sisal fiber	Untreated Sisal fiber	Treated sisal fiber
30	9.25	14.85	1.67	2.23
35	11.428	24.6	1.78	2.6
45	25.76	30	2.34	2.79

A. Effect of fiber weight percentage on tensile strength

The tensile strength of composites increases by increase in the weight percentage of fiber. The tensile strength of treated fiber is higher compared to that of untreated fiber for same weight percentage as shown in figure 2.

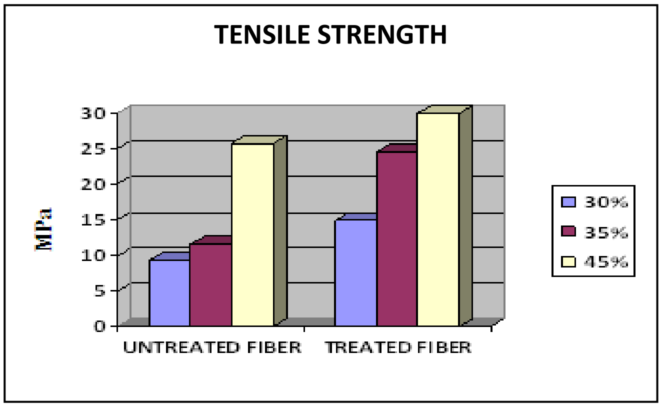

Fig 2 Tensile strength of untreated and treated sisal fiber

The tensile strength of treated fiber is higher than the untreated fiber due to the surface modification which promoted good wettability and better fiber-matrix adhesion, allowing efficient stress transfer between the matrix and the fibers.

B. Effect of fiber weight percentage on flexural strength

The flexural strength of composites increases by increase in the weight percentage of fiber. The flexural strength of treated fiber is higher compared to that of untreated fiber for same weight percentage as shown in figure 3.

The flexural strength of treated fiber is higher than the untreated fiber due to the surface modification which promoted good wettability and better fiber-matrix adhesion, allowing efficient stress transfer between the matrix and the fibers.

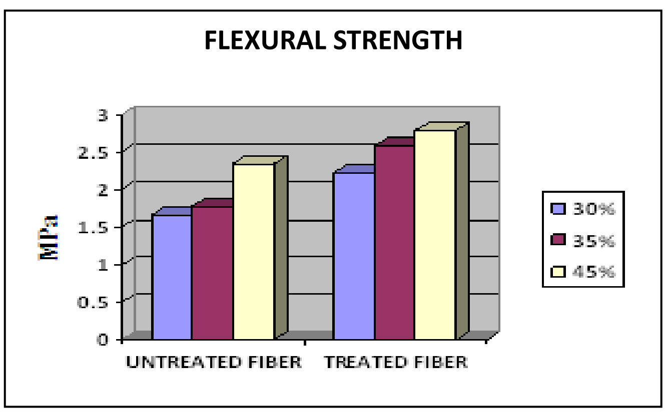

Fig 3 flexural strength of untreated and treated sisal fiber

C. Effect of fiber weight percentage on Impact strength

The composites were fabricated using treated and untreated fiber by varying weight percentage and they are subjected to Impact test is shown in table 3.

Table 3 Impact strength of untreated and treated sisal fiber

Weight % of fiber	Impact strength kj/m^2	
	Untreated Sisal fiber	Treated sisal fiber
30	20.51	12.82
35	25.64	15.38
45	35.8	20.51

The Impact strength of composites increases by increase in the weight percentage of fiber. The Impact strength of treated fiber is lower compared to that of untreated fiber for same weight percentage as shown in figure 3.

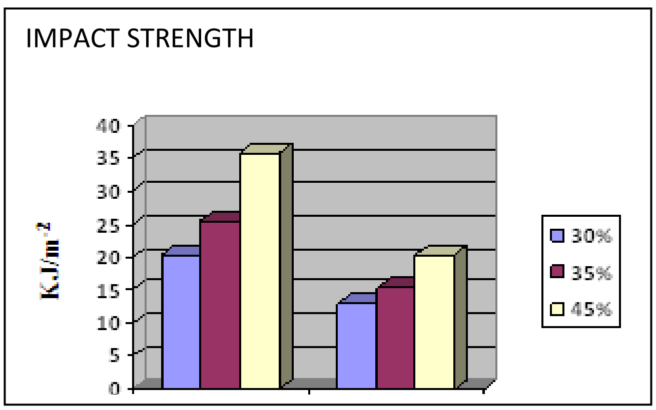

Fig 4 Impact strength of untreated and treated sisal fiber

The negative impact of the treated composites is attributed to the fact that the surface treatment improves the fiber-matrix adhesion, which leads to the fracture of fibers.

III. CONCLUSION

The composites were fabricated using treated and Untreated fiber by varying their weight percentage and following conclusions were made.

i. Tensile strength and flexural strength and Impact strength of composites increased with increase in weight percentage of treated and untreated fiber.

ii. Tensile and flexural strength of treated fiber is higher compared to that of untreated fiber due to good wettablility and better fiber adhesion with matrix.

iii. The impact strength of treated fiber is lower than that of untreated fiber due to the surface treatment improves the fiber-matrix adhesion, which leads to the fracture of fibers.

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