Synthesis and Characterization of Sisal & Hemp Fiber Reinforced Hybrid Composites

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Abstract— Now a days, natural fibers such as sisal, flax, hemp, jute, bamboo, banana, coir etc. are widely used for environmental concern. In this work, a new material was developed which possess high strength to weight ratio. Two natural fibers such as sisal and hemp reinforced with epoxy matrix. These fibers were treated with NAOH (alkali treatment) for better fiber matrix adhesion, the hybrid composites were prepared by compression molding technique at room temperature with applied pressure 410.4 kg/cm2 for 3 hours pressurization time. The mechanical properties were characterized according to standards. The amount of reinforcement varied was 10%, 20%, 30% and 40%. Prepared specimens were examined for mechanical properties such as tensile strength and flexural strength. Hybrid composite with 30% wt of sisal & hemp fiber were found to posses higher strength (tensile strength = 24.70Mpa; and flexural strength = 93.98Mpa) among the fabricated hybrid composite specimens.

Key words: Natural Fibers (Sisal & Hemp), Room Temperature, Sodium Hydroxide, Mechanical Properties

I. Introduction

Composites are presently broadly being utilized for restoration/fortifying of previous structures that must be retrofitted to make them seismic resistant, or to repair harm brought about by seismic movement. Dissimilar to ordinary materials (e.g., steel), the properties of the composite material can be planned considering the auxiliary perspectives. The configuration of a basic part utilizing composites includes both material and basic outline. The fascination in using natural fiber, for instance, unmistakable wood fiber and plant fiber as backing in plastics has extended definitely all through most recent couple of years. Concerning the biological perspectives if regular fibers may be used as opposed to glass fibers as fortress in some basic procurement it may be to a great degree fascinating. Natural fibers have various purposes of interest stood out from glass fiber, for example they have low thickness, and they are biodegradable and recyclable. Additionally they are renewable crude materials and have for the most part incredible strength and stiffness. While composites have officially demonstrated their value as weight-sparing materials, the present test is to make them practical. The endeavors to create financially appealing composite parts have brought about a few inventive assembling strategies as of now being utilized as a part of the composites industry. It is self-evident, particularly for composites, that the change in assembling innovation alone is insufficient to defeat the cost obstacle. It is key that there be an incorporated exertion in outline, material, process, tooling, quality confirmation, producing, and even program administration for composites to wind up aggressive with metals. Hence the movement of composite applications from air ship to other business utilizes has ended up conspicuous as a part of late years. Progressively empowered by the presentation of fresher polymer resin matrix materials and elite support fibers of glass, carbon and aramid, the infiltration of these propelled materials has seen an unfaltering extension in uses and volume. The volume and number of utilizations of composite materials have become consistently, infiltrating and overcoming new markets steadily. Current composite materials constitute a critical extent of the built materials market going from ordinary items to refined corner applications. Composites are just a combination of different materials in such a way that the resulting materials have desired/improved properties. Nowadays, composite materials are widely used for no of applications like engineering structures, aerospace, marine application, sports and so on. Light, strong and corrosive resistant, the composite materials are being used in large number of products as more manufactures discover the benefits of these versatile materials.

II. Experimental Details

A. *Materials used*

The sisal fibers were collected from local resource and hemp fibers were procured from Sreelaxmi groups, vijayawada, Andhra Pradesh, India. The epoxy resin with brand name AW 106 and hardener with brand name HV 953 were used for the experimentation. Chemical composition and properties of sisal and hemp fibers are listed in below Table.

Properties	Sisal	HEMP
Density [g/cm^3]	1.500	1.481
Tensile strength [N/mm^2]	600-700	550-900
Stiffness [kN/mm^2]	38.05	70.12
Elongation at break [%]	2-3	1.60
Moist absorption [%]	11.0	8.0
Price of raw fiber [$/kg]	0.60-0.70	0.60-1.80

Table 1: Material Used

B. *Sisal Fiber*

Sisal fiber is derived from the leaves of the plant Agave sisalana. It is usually obtained by machine decortications in which the leaf is crushed between rollers and then mechanically scraped. The fiber is then washed and dried by mechanical or natural means. The dried fiber represents only 4% of the total weight of the leaf. Once it is dried the fiber is mechanically double brushed. The lustrous strands, usually creamy white, average from 80 to 120 cm in length and 0.2 to 0.4 mm in diameter. Sisal fiber is fairly coarse and inflexible. Sisal fiber are originated from Mexico and is now mainly cultivated in East Africa, Brazil, Haiti, India and it is grouped under the broad heading of the “hard fibers” among which sisal is placed second to manila in durability and strength. A good sisal plant yields about 200 leaves with each leaf having a mass composition of 4% fiber, 0.75% cuticle, 8% other dry matter and 87.25% moisture. Thus a normal leaf weighing about 600g yields about 3% by weight of fiber with each leaf containing about 1000 fibers. The fiber is extracted from the leaf either by retting, by scraping or by retting followed by scraping or by mechanical means using decorticators .The diameter of the fiber varied from 100µm to 300µm. Sisal Fiber is one of the most widely used natural fiber and is very easily cultivated. The fibers can be spun into thread for twine and textile production, or pulped to make paper products.

Fig. 1: Sisal Fibers

C. Hemp Fiber

Hemp is a commonly used term for high-growing varieties of the Cannabis plant fibers which grow on the outside of the plant's stalk. Bast fibers give the plants strength. Hemp fibers can be between approximately 0.91 m (3 ft) and 4.6 m (15 ft) long, the hemp may naturally be creamy white, brown, gray, black or green. hemp fibers have been used in prototype quantities to strengthen concrete, and in other composite materials for many construction and manufacturing applications. Hemp bast or long fiber and hurds or inner short fiber can be processed and used with existing technology in construction. The hemp stalk can be incorporated into building materials straight from the field. Hemp fiber added to concrete increases tensile and compressive strengths, reduces shrinkage and cracking. The demand for renewable raw materials is increasing. Currently many companies produce non-woven products like mats for insulation and car/vehicle composites based mainly on flax but increasingly now on hemp fibers. Hemp fibers have excellent potential – they can reinforce plastics, substitute mineral fibers, be recycled, can be grown ecologically, and have no waste disposal problems. A range of products can be derived from non-woven mats for a range of uses: insulation, filters, geotextile, growth media, reinforced plastics and composites. some of the advantages of Hemp fibers are, excellent acoustic insulation, self-draining and waterproof, non-flammable (no toxic combustion products), flexible and easy to use.

Fig. 2: Hemp Fibers

D. Fiber Surface Treatment

Both sisal and hemp fibers were chopped in to small size of about 10-15mm. The chopped fibers were initially washed in tap water and then soaked in 10 % NaOH solution for 10 hours. The NaOH treated fibers were again washed in distilled water three times to remove the sticking NaOH on fiber surface and then dried for 3 days in sunlight to completely remove moisture.

E. Preparation of Hybrid Composite

The traditional compression molding method was used to prepare the composite specimens. A mould with the dimension of 250 mm ×250mm × 6mm was used to prepare the composite specimen. A layer of Wax polish was applied to the male die and female die to obtain good surface finishing of the specimens. After 10 minutes a thin layer of poly vinyl alcohol (PVA) was coated to the both molds to facilitate easy ejection of the specimens from mold after drying. Epoxy resin and hardener were mixed in the ratio of 10:1 to prepare the matrix and 10wt % of fibers are added to matrix and mixed well in a boul. A well mixed matrix and fibers mixture was poured into the female die cavity. The male die was placed on the female die and pressurized to 410.4 kg/cm^2 from hydraulic pressing machine for 3 hours. The required specimens were extracted from the prepared composite for evaluation of mechanical properties.

Fig. 3: Male & Female Die

Fig. 4: Fibers poured in female die

Fig. 5: Hydraulic Pressing Machine

III. RESULTS AND DISCUSSION

A. Mechanical Properties

Tensile and flexural test specimens were prepared according to ASTM D-3039 and ASTM 790-03 standard respectively. The tests were carried out on computerized universal testing machine (UTM). The average value of the four test results was recorded. Hardness test of polymers is most commonly measured by the shore-D (Durometer). Shore-D hardness test measures the resistance of the specimen for the indentation and provide empirical values. The shore-D hardness test was carried out according to ASTM-D2240 standard.

Fig. 6: Universal Testing Machine (UTM)

Fig. 7: Test Specimens

B. Evaluation of Properties

	Tensile strength (MPa)	Bending strength (MPa)	Shore – D hardness
(sisal+hemp) (10%)	16.1 MPa	43.75 MPa	62
(sisal+hemp) (20%)	19.5 MPa	63.19 MPa	70
(sisal+hemp) (30%)	24.7 MPa	93.98 MPa	73
(sisal+hemp) (40%)	21.95MPa	82.64 MPa	75

Table 2: Evaluation of Properties

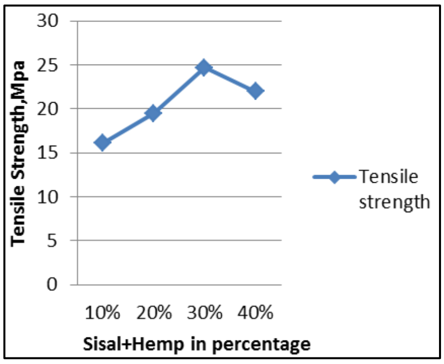

Fig. 8: Tensile strength of hybrid composites

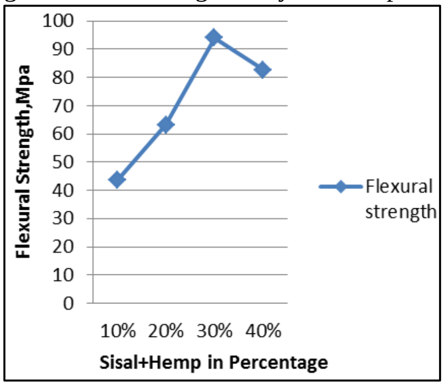

Fig. 9: Flexural strength of hybrid composites

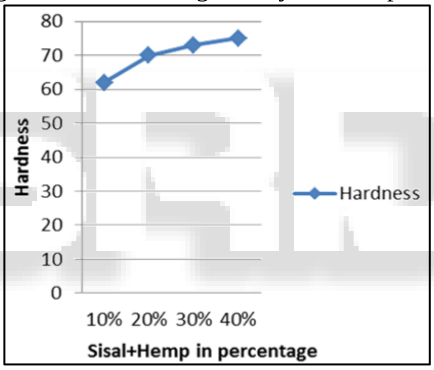

Fig. 10: Hardness number of hybrid composites

The 30%wt. sisal & hemp fiber reinforced hybrid composites shows more tensile and flexural strength than other hybrid composites as shown in fig.4 and fig.5 respectively. Shore-D hardness number increases with increasing the fiber percentage in composite as shown in fig.5.

C. Scanning Electron Microstructures

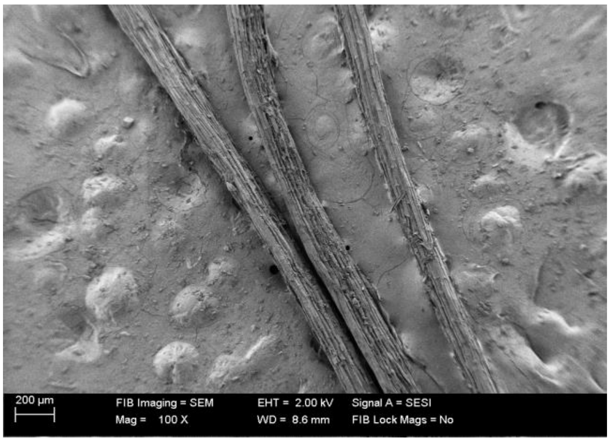

Fig. 11(a): Sisal Fiber Untreated

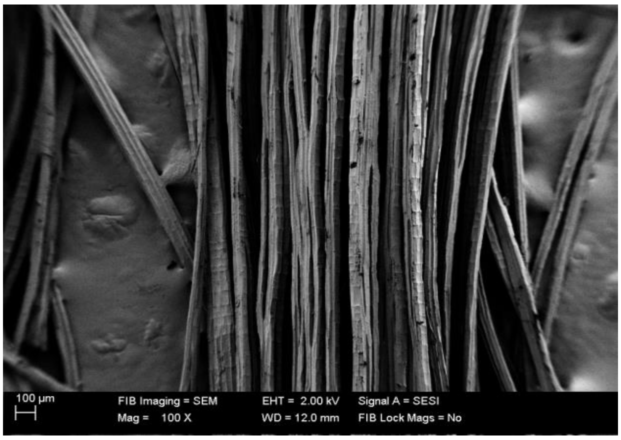

Fig. 11(b): Hemp fiber Untreated

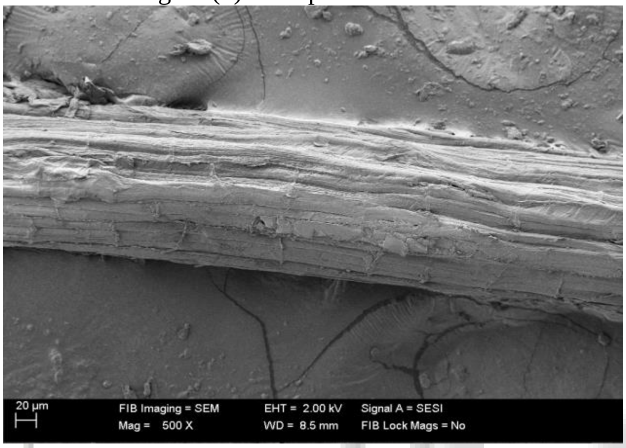

Fig. 12(a): Sisal fiber NAOH treated

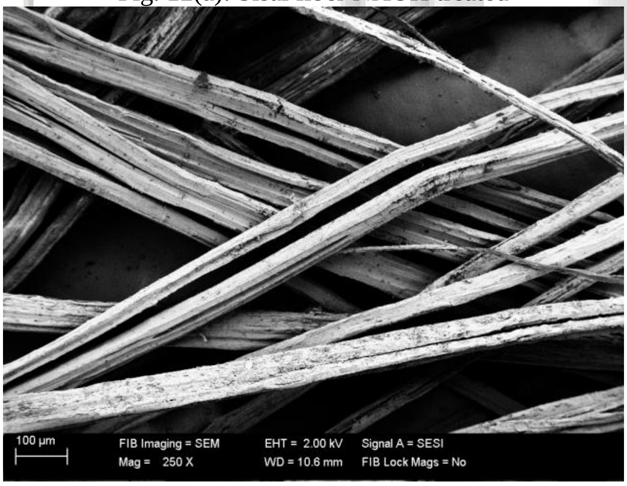

Fig. 12(b): Hemp fiber NAOH treated

IV. CONCLUSION

Experimental investigation of tensile strength, flexural strength and shore-D hardness number properties of different wt % of sisal & hemp fibers reinforced epoxy resin hybrid composites lead to the following conclusions.

1) The natural fiber reinforced epoxy hybrid composites are successfully fabricated using Compression molding technique.
2) 30%wt. sisal & hemp fiber reinforced hybrid composites discloses more tensile strength (24.70 MPa) than other hybrid composites.
3) 30%wt. sisal & hemp fiber reinforced hybrid composites discloses more flexural strength (93.98 MPa) than other hybrid composites.
4) Shore-D hardness number increases with increasing the fiber percentage.
5) It can be concluded that alkali (NAOH) treatment of the natural fibers is necessary to get composites with moderate mechanical properties as well as better adhesion between fibers and matrix.

REFERENCES

[1] Madhukiran.J, Dr. S. Srinivasa Rao & Madhusudan.S, “Fabrication and Testing of Natural Fiber Reinforced Hybrid Composites Banana/Pineapple,” Vol-3, Issue- 4, July-august. 2013
[2] Girisha.C, Sanjeevamurthy & Guntiranga Srinivas, “Effect Of Alkali Treatment, Fiber Loading And Hybridization On Tensile Properties Of Sisal Fiber, Banana Empty Fruit Bunch Fiber And Bamboo Fiber Reinforced Thermoset Composites,” Volume-2, Issue-3, May-Jun 2012
[3] N. Venkateshwaran, A. ElayaPerumal, A. Alavudeen, M. Thiruchitrambalam, “Mechanical and water absorption behaviour of banana/sisal reinforced hybrid composites,” 6 March 2011
[4] Dr A Thimmana Gouda, Jagadish S P, Dr K R Dinesh, Virupaksha Gouda H & Dr N Prashanth, “Characterization and Investigation of Mechanical Properties of Hybrid Natural Fiber Polymer Composite Materials Used As Orthopaedic Implants for Femur Bone Prosthesis,” Volume 11, Issue 4 Ver. II, Jul- Aug. 2014)
[5] S.Muthukumar & K.Lingadurai, “Investigating The Mechanical Behaviour Of Coconut Shell And Groundnut Shell Reinforced Polymer Composite,” ISSN 2348-8034,May 2014
[6] K Sudhakar & Ch Srinivas, “Investigation of Mechanical Properties of Rice Straw Fibre Polypropylene Composites,” Vol. 4, Issue 1 Ver. 2, January 2014

