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PROCESSING AND CHARACTERIZATION OF SISAL FIBER REINFORCED EPOXY COMPOSITES

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ABSTRACT

Now a days natural fiber reinforced bio-degradable composites are best alternative for Synthetic fiber composites. Natural fibers like Sisal, Kemp, plam, kenaf, sisal, banana, jute, and coir has been used as reinforcement in polymer composite for Domestic good applications. Natural fibers are cost is cheap compare to other fibers. In this project the Processing and Characterization of of sisal fiber reinforced epoxy composites was studied. Sisal fibre reinforced composite were prepared in volume fractions (Vf) such as 10 %, 20 % and 30 % of specimens by using epoxy. Composites were prepared by simple hand layup technique and specimens were cut as per ASTM standards. Computer controlled universal testing machines were used to determine the mechanical properties of polymer composites. The experimental result shows that the fibre volume fraction increases the tensile, flexural strength and modulus of the fibre reinforced composites

Keywords – Sisal fibre, Epoxy resin, tensile properties, Flexural properties

1. INTRODUCTION

2. Natural fibers are found superior to the artificial fibers with the properties like less weight, low density, eco-friendly, high specific strength etc. However, it has some of the disadvantages like poor surface characteristics, more moisture absorption, quality variations, etc. These natural fiber composites are commonly used in automobiles, packaging industries, aerospace, and construction and so on. The tensile load carrying capacity of the natural fibre reinforced composites are found to be increasing with the fibre content up to an optimum level and then start declining .Cellulosic fiber reinforced plastics materials are low cost, light-weighted, have enhanced mechanical properties, free from health hazard, and thus have the potential for structural applications. Despite the attractiveness of natural fiber reinforced polymer matrix composites, they suffer from lower modulus, lower strength, and relatively poor moisture resistance compared to synthetic fiber reinforced composites such as glass fibre reinforced plastics. Sisal fiber is one of the most widely used natural fibre sand is very easily cultivated. It has short renewal times and grows wild in the hedges of railway tracks. Nearly 4.5 million tons of sisal fibre is produced every year throughout the world. Tanzania and Brazil are the two main producing countries .Sisal is a hard fiber extracted from the leaves of the sisal plant (Agave sisalana). Though native to tropical and sub-tropical North and South America, sisal plant is now widely grown in tropical countries of Africa, the West Indies and the Far East. sisal fibers are extracted from the leaves. natural fiber composites combine plant-derived fibers with a plastic binder. The natural fiber components may be wood, sisal, hemp, coconut, cotton, kenaf, flax, jute, abaca, banana leaf fibers, bamboo, wheat straw or other fibrous material. The advantages of natural fiber composites include lightweight, low-energy production, and environmental friendly; to name a few. The use of natural fibers reduces weight by 10% and lowers the energy needed for production by 80%, while the cost of the components 5% lowers than the comparable fiber glass-reinforced componenent. Mechanical properties of banana fibre were observed that the failure of banana fiber intension is due to pull-out of micro fibrils accompanied by tearing of cell walls. The tendency for fiber pull-out decrease with increasing speed of testing. Nilza investigated the potentials of banana, coir and sisal fibers in composites. In their work, fiber samples were subjected to standardized characterisation tests such as ash and carbon content, water absorption, moisture content, tensile strength, elemental analysis and chemical analysis. Results revealed that the banana fiber exhibited the highest ash, carbon and cellulose content, hardness and tensile strength, while coconut the highest lignin content. Many researchers in the past have developed composites using natural fibers such as bamboo , coir , sisal and banana to name the few. Hybrid composites are materials are made by combining two or more different types of fibers in common matrix. Hybridization of two types of short fibers having different lengths and diameters offers some advantages over the use of either of the fibers alone in a single polymer matrix. Most of the studies are on the hybridization of natural fibers with glassfibers to improve the properties.The main parameters which affects the mechanical properties of the composites are fiber length, weight ratio, fiber orientation and interfacial adhesion between fiber and matrix. The effect of fiber volume fraction in the strength properties of short fibre reinforced cement was studied by Karam . He modified the existing model in order to calculate the strength of the composites. The mechanical properties of hybrid short fiber composites can be evaluated using the Rule of Hybrid Mixtures equation ,which is widely used to predict the strength and modulus of hybrid composites .The mechanical properties of natural fibre reinforced composites highly depend on the interface adhesion property between the fibres and the polymer matrix as have been reported by many researchers. Natural fibres contain cellulose, hemicelluloses, pectin’s and lignin and are rich in hydroxy1 groups, natural fibres tend to be strong polar and hydrophilic materials whilst polymer materials are a polar and exhibit significant hydrophobicity. In other words, there are significant problems of compatibility between the fibre and the matrix due to weakness in the interfacial adhesion of the natural fibres with the synthetic matrices. Therefore, surface modification of natural fibres by means treatment is one of the largest areas of recent researches to improve compatibility and interfacial bond strength. The present study aims to develop natural fibre composite from Agave (Agave Americana) fibre, one of the most widely used natural fibres in yarns, ropes, twines, carpets, mats and handicrafts. Agaves are succulent plants of a large botanical genus of the same name, belonging to the family Agavaceae. Chiefly Mexican, they occur also in Asia, North America and in central and tropical South America. In India it is available in wild. The main objective of this work into analyse the mechanical and thermal behaviours of raw and alkali treated Agave continuous fibre reinforced epoxy composites. Natural fibre composites are receiving more attention during the last thirty years due to their ecologically friendly behaviour specially when considering carbon foot print. Their low price in comparison with the synthetic fibre composites as well as their renewable nature helped in attracting the lights towards development of research in this field . On the other hand, natural fibres are also disadvantaged due to the presence of other undesired properties such as high moisture content, low tensile strength in comparison with carbon fibres, low thermal stability and irregular surface quality. In addition, the natural polar characteristic of natural fibres act as an obstacle regarding the compatibility to many non-polar matrix types which limits the use of the natural fibres in many useful industrial applications.[2– 4].One of the most industrially promising natural fibres is the sisal fibre (Agave sisalana). Fibres are extracted from the plant leaf which contains three main types of fibres: arch fibres, conducting fibres and structural fibres. The sisal fibre type which is commercially interesting is the structural fibre because of its durability as they do not split or fibrillate during extraction process

EXPERIMENTAL PROCEDURE

2. 1 MATERIALS

Sisal fibers are purchased from local sources. Purchased fibers are chopped into specified lengths to prepare the composites

Table1 Properties of Sisal fibre

Properties	**Sisal**
Density (kg/m)	1600
Tensile Strength (MPa)	500–650
Tensile modulus (GPa)	9.2–25
% Elongation	1.5–2.3

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2.2 EPOXY AND HARDENER

The matrix used to manufacture the composite specimen is epoxy Epotec YD 128 of density 1.16 g/cm^3 and it is mixed with hardener Triethylenetetramine (TETA) of density 0.978 g/cm^3 are purchased from Aditya Birla Chemicals Ltd. (Epoxy Division). The ratio of mixing epoxy and hardener is 10:1. The primary function of the resin is to transfer stress between the reinforcement fibers, act as a glue to hold the fibers together, and protect the fibers from mechanical and environmental damage.

Table 2 Properties of Epoxy

Properties	Epotec YD 128
Epoxide Value	5.10 – 5.50
Density @25ºC	1.14 g/cm^3
Moisture content	0.12 % max.
ECH content	10 ppm max.

Fig1 Fibre extracted from Source

2.3 PREPARATION OF SPECIMENS

Sisal fibre/epoxy composites with varying volume fraction of fibre (V_f) were manufactured by compression molding machine (Heating facility RT-350˚C, Press capacity 30T). A steel die of 300

mm x125 mm x 3 mm was used to fabricate the composites. The volume fraction of 10%, 20%, 30% chopped palm fibre was mixed with epoxy resin. Epoxy resin and fibre stirred thoroughly to ensure homogenous mixing. Then composite mixer was poured inside the die cavity and the die was closed by applying force of 2 tons by hydraulic compression to produce a composite sheet of 3 mm thickness. The mold was kept under pressure for 4 hrs at room temperature. Composite sheet was removed and mold release agent was already sprayed on

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inside the die cavity for remove composite sheet. The specimens were cut to the as per ASTM standard. Simultaneously same procedure for was followed to prepare sisal fibre/polyester composites.

Fig 2 Specimen Preparation

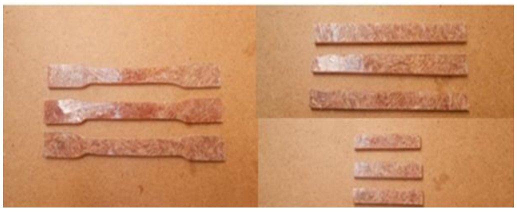

Fig 3 SFRP Specimens as per ASTM standards

3 Mechanical testing: Tensile properties of the

Sisal/Epoxy reinforced composites were determined using Deepak DTRX – 20KN tensile tester with a cross head speed of 5 mm/min, operated at room temperature. Tests were conducted as per ASTM D638 [18]. Averages of 3 specimens were used in each test. Flexural tests were conducted as per ASTM D790 [19] standards using Deepak DTRX – 20KN universal testing machine, with a cross head speed of 2 mm/min. The test specimens of size 127x12.7x3 mm were cut from Sisal/Epoxyr reinforced composites. Three specimens were tested in each composite and average values are reported. Impact tests were conducted as per ASTMD256 [20] standards using Deepak Digital impact tester. It was used for determining the impact properties of the composites. Un-notched rectangular specimens of size 63.5x13x3 mm were cut from Sisal/Epoxy reinforced composites. Three specimens were tested in each composite for their impact properties.

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4. RESULTS AND DISCUSSION

4. 1 EXPERIMENTAL RESULTS

A typical Load vs. Displacement graph of, SFRP composites was recorded during tensile test as per ASTM D638 standard. Graph was drawn from these recorded values are shown in Fig.4

Fig 4 shows the load increases to reach the peak value at 1271.4N in case of 30% volume fraction sisal fibre. But the load increases to reach the peak value at 1224.6N for 20% volume fraction sisal fibre. 30% volume fraction takes higher load to fracture specimens due to maximum volume of fibre compare with 20% volume fraction. And also 30% volume fraction experienced maximum displacement at peak load around the value of

2. 5217 mm, In 10% volume fraction specimen tends to break at 1049N.

Table 3 Mechanical properties of sisal/epoxy Composites

Sample	**Fiber(V_f) %**	**Tensile strength (MPa)**	**Flexural strength (MPa)**	**Impact strength (KJ/m²)**	**Tensile modulus (GPa)**	**Flexural modulus (GPa)**
SFRP	10	26.9	45.4	3.7	1.00	4.51
	20	31.4	55.2	4.8	0.88	5.62
	30	32.6	57.3	6.1	0.80	5.83

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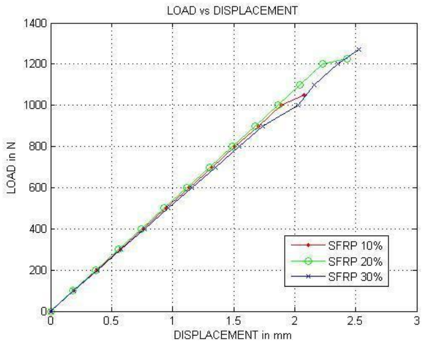

Fig 4 Load vs Displacement of SFRP Composites

CONCLUSION

The study presents Processing and Characterization of Sisal Fiber Reinforced Epoxy Composites. Based on the experimental results the following conclusions were drawn.

- Increase in volume fraction of fibre in composites tends to increase the tensile strength, Flexural strength and Impact strength.
- Maximum load required to fracture, increase in volume fraction of fibre.
- Tensile strength, Flexural strength and Impact strength of 30% volume fraction are higher than 10% and 20%.

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