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Experimental Investigation of the Behaviour Sisal Fiber Reinforcement of Epoxy Resin

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Abstract: The global demand for wood as a building material is steadily growing, while the availability of this natural resource is diminishing. This situation has led to the development of alternative materials. Of the various synthetic materials that have been explored and advocated, polymer composites claim a major participation as building materials. There has been a growing interest in utilizing natural fibres as reinforcement in polymer composite for making low cost construction materials in recent years. Natural fibres are prospective reinforcing materials and their use until now has been more traditional than technical. They have long served many useful purposes but the application of the material technology for the utilization of natural fibres as reinforcement in polymer matrix took place in comparatively recent years. Economic and other related factors in many developing countries where natural fibres are abundant, demand that scientists and engineers apply appropriate technology to utilize these natural fibres as effectively and economically as possible to produce good quality fibre reinforced polymer composites for housing and other needs. Among the various natural fibers, sisal is of particular interest in that its composites have high impact strength besides having moderate tensile and flexural properties compared to other lignocellulosic fibres. The present paper surveys the research work published in the field of sisal fibre reinforced polymer composites with special reference to the structure and properties of sisal fibre, processing techniques, and the physical and mechanical properties of the composites
Keywords: Sisal fiber; Epoxy resin; Wax; Reinforcement; Composite material ; Die casing process; Mechanical properties

I. INTRODUCTION

In our everyday life timber plays a significant role. However timber resources are getting depleted continuously while the demand for the material is ever increasing. According to the literature, by the beginning of the next century the wood will be scarce for the whole world (Singh, 1982). This situation has led to the development of alternative material. Among the various synthetic materials that have been explored and advocated, plastics claim a major share as wood substitutes. Plastics are used for almost everything from the articles of daily use to the components of complicated engineering structures and heavy industrial applications (Rai & Jai Singh, 1986). Plastics find an extensive application in buildings as flooring material because they are resistant to abrasion, have a low heat conductivity and low water absorption, sufficient hardness and strength. They fail to swell when moistened, readily take on varnishes and paints. Hardware items like door and window frames, flushing cisterns, overhead water storage tanks and water fittings are commercially available and are finding acceptance in the building industry. Plastics are used to manufacture various sanitary wares, which include wash basins, bathtubs, sinks, shower cabins, washing racks and others. Plastic pipes are widely used in the installation of various industrial purposes, water supply etc.

In the automotive industries aluminum alloys are frequently used because of lower density, light in weight. The other properties of aluminum alloys are that these are high in electrical and thermal conductivity and having good corrosion resistance, malleable in nature and formability is also good. The workability and inability of high performance Al alloys are horizontal to porosity due to gases dissolved during melting processes. The engineering application of pure aluminium and its alloys have occurred some problems like low strength, unstable mechanical properties etc. Hence by the modification of microstructure, mechanical properties of alloying, cold working, heat treatment and making composite by the addition of reinforcement can be improved. It will found that the effect of reinforcements on mechanical properties of base alloys.

Fibres obtained from the various parts of the plants are known as vegetable fibres. These fibres are classified into three categories depending on the part of the plant from which they are extracted. 1. Bast or Stem fibres (jute, mesta, banana etc.) 2. Leaf fibres (sisal, pineapple, screw pine etc.) 3. Fruit fibres (cotton, coir, oil palm etc.) Many of the plant fibres such as coir, sisal, jute, banana, palmyra, pineapple, talipot, hemp, etc. Sisal is an important leaf fibre and is very strong. Pineapple leaf fibre is soft and has high cellulose content. Oil palm fibres are hard and tough, and show similarity to coir fibres in cellular structure. The elementary unit of a cellulose macromolecule is anhydro-d-glucose, which contains three alcohol hydroxyls (-OH) (Bledzki et al., 1996). These hydroxyls form hydrogen bonds inside the macromolecule itself (intramolecular) and between other cellulose macromolecules (intermolecular) as well as with hydroxyl groups from the air. Therefore, all plant fibres are of a hydrophilic nature; their moisture content reaches 8-13%. In addition to cellulose, plant fibres contain different natural substances. The most important of them is lignin. The distinct cells of hard plant fibres are bonded together by lignin, acting as a cementing material. The lignin content of plant fibres influences its structure, properties and morphology. An important characteristic of vegetable fibre is their degree of polymerization (DP). The cellulose molecules of each fibre differ in their DP and consequently, the fibre is a complex mixture of polymer homologue $(C_6H_{10}O_5)_n$. Bast fibres commonly show the highest DP among all the plant fibres (~10,000). Traditionally these fibres have been used for making twines, ropes, cords, as packaging material in sacks and gunny bags, as carpet-backing and more recently, as a geotextile material.

II. MATERIAL SELECTION

Sisal is a precipitation hardening composite material, containing sisal fiber and epoxy resin as its major compositing elements. It has good mechanical properties and exhibits good composite ability. It is few of the common composite of sisal fiber for general purpose use. Hardener and Wax are used as additives. Base material sisal fiber were bought in natural armors and are weighed as per the composition and are cut into small piece for the convenience of placing them inside the crucible are heated to 75 oC in an induction furnace for half an hour. Mixing material .Epoxy resin and hardener are also weighed separately as per the weight ratio and are preheated to atmospheric temperature to improve the wettability of the material.

Fig1: Sisal Fiber

A. Properties of Sisal Fibre

1) Sisal fiber is exceptionally durable with a low maintenance with minimal wear and tear.
2) It is recyclable.
3) Sisal fibers are obtained from the outer leaf skin, removing the inner pulp
4) It is available as plaid , herringbone and twill.
5) Sisal fibers are anti static, does not attract or trap dust particles and does not absorb moisture or water easily.
6) The fine texture takes dyes easily and offers the largest range of dyed colours of all natural fibers.
7) It exhibits good sound and impact absorbing properties.
8) Its leaves can be treated with natural borax for fire resistance properties.

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B. Chemical Composition of Sisal Fiber

1.Cellulose	65%
2.Hemicelluloses	12%
3.Lignin	9.9%
4.Waxes	2%
5.Total	100%

C. Properties Of Epoxy Resin

Fig2: Epoxy Resin

The properties of Epoxy resin are Good hardness development, High gloss, Best UV resistance properties, Low viscosity, Long pot life, Water and chemical resistance.

III.EXPERIMENTAL PROCEDURE

This chapter contains the details about materials and the experimental procedure that were considered for the fabrication of composite and the test procedure followed for testing the characterization of composites, respectively. In the present investigation, sisal fiber composites were manufactured by die moulding technique.

In conventional die casting method, reinforced sisal fiber is mixed into the epoxy resin by hand mixing machine. Mixing machine is the most important element of this process. After the mechanical mixing, the mixer is directly transferred to a shaped mould prior to complete solidification. The essential thing is to create the good wetting between particulate resin and sisal fiber. The distribution of the reinforcement in the final solid depends on the wetting condition of the reinforcement with the melt, relative density, rate of solidification etc.

Fig3: Die Casting Process

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IV. TESTING OF COMPOSITE

In order to explore the mechanical characterization of the developed sisal fiber composites, various mechanical tests have been conducted and are discussed below.

A. Tensile Test

The materials used for engineering applications are usually selected on the basis of their properties, such as ultimate tensile strength, yield strength, and modulus of elasticity. The tensile test is the most common method for determining these mechanical properties. In the present work, a tensile test was conducted on a universal testing machine (UTM) and the developed composite specimen 1 were prepared as per ASTM standards.

Fig3: Tensile test specimen

Table1: Tensile test specimen reading

PARAMETERS	OBSERVED VALUE
Ultimate Tensile Strength (N/mm^2)	6.83
Ambient Temperature	28.4

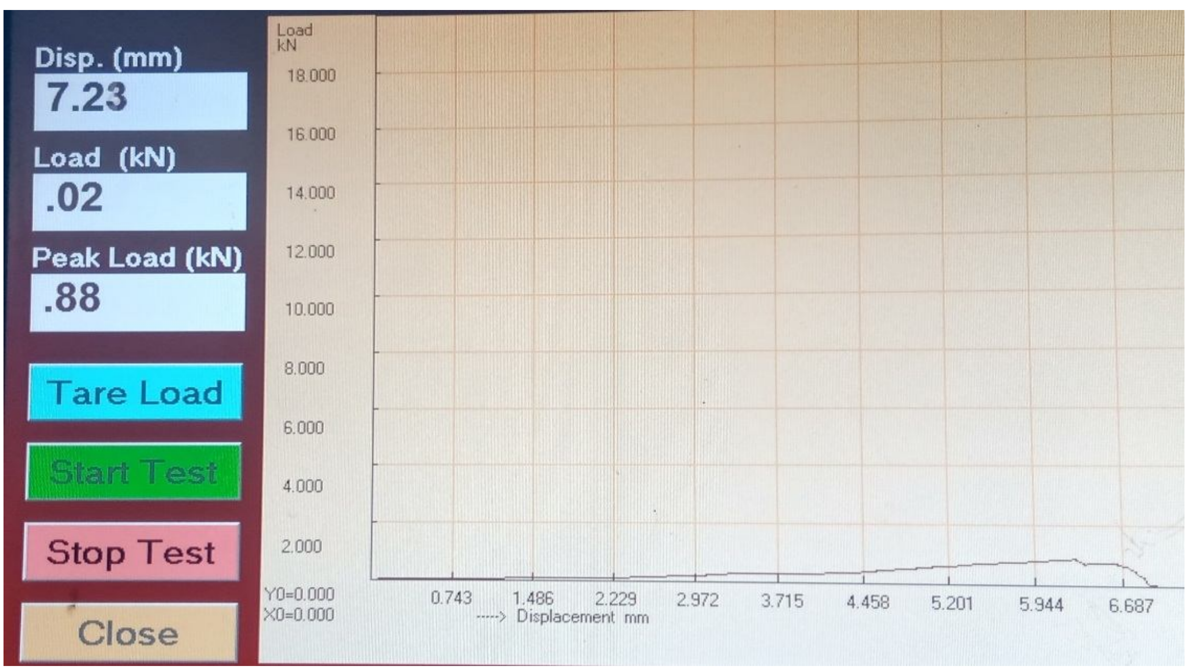

Fig4: Load/displacement chart

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B. Hardness Test

In the present work, a Brinell hardness tester with an indenter diameter of 5 mm was used to determine the hardness of the specimens A of the hybrid composite. A load of 5 kN was applied for 30 seconds on each specimen. The Brinell hardness number (BHN) was calculated by dividing the load applied by the surface area of the indentation. The BHN values obtained for the specimens 1 were 69, 67 and 66 respectively

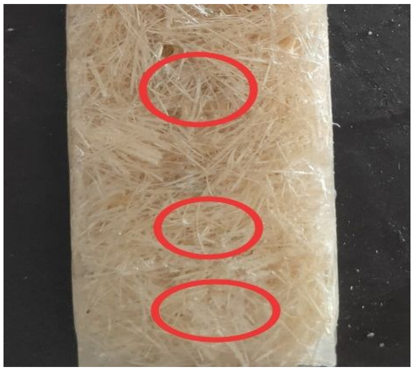

Fig5: Hardness test specimens

Table2: Hardness Test results

SPECIMEN	TRIAL 1	TRIAL 2	TRIAL 3
A	69	67	66

V. CONCLUSIONS

Sisal fiber was based on reinforced composite material have been successfully fabricated using die casting method with different types of composite particulates. Two different composite material with above corresponding ratio will be manufactured and their mechanical properties will be noted with the aid of tensile test, hardness test, SEM test. The technical difficulties associated with attaining a uniform distribution , good wettability between substances, and a low porosity material are presented and discussed. Thus the different compositions in volume fraction namely 55% Epoxy Resin ,43% sisal fiber and 2% wax with above corresponding ratio has been manufactured and their mechanical properties were noted and discussed with the aid of tensile test, hardness test, SEM test. In this project work the samples are 55% Epoxy Resin , 43%Sisal fiber 2% wax is reported to be the highest performing sample in tensile test, hardness test and SEM test.

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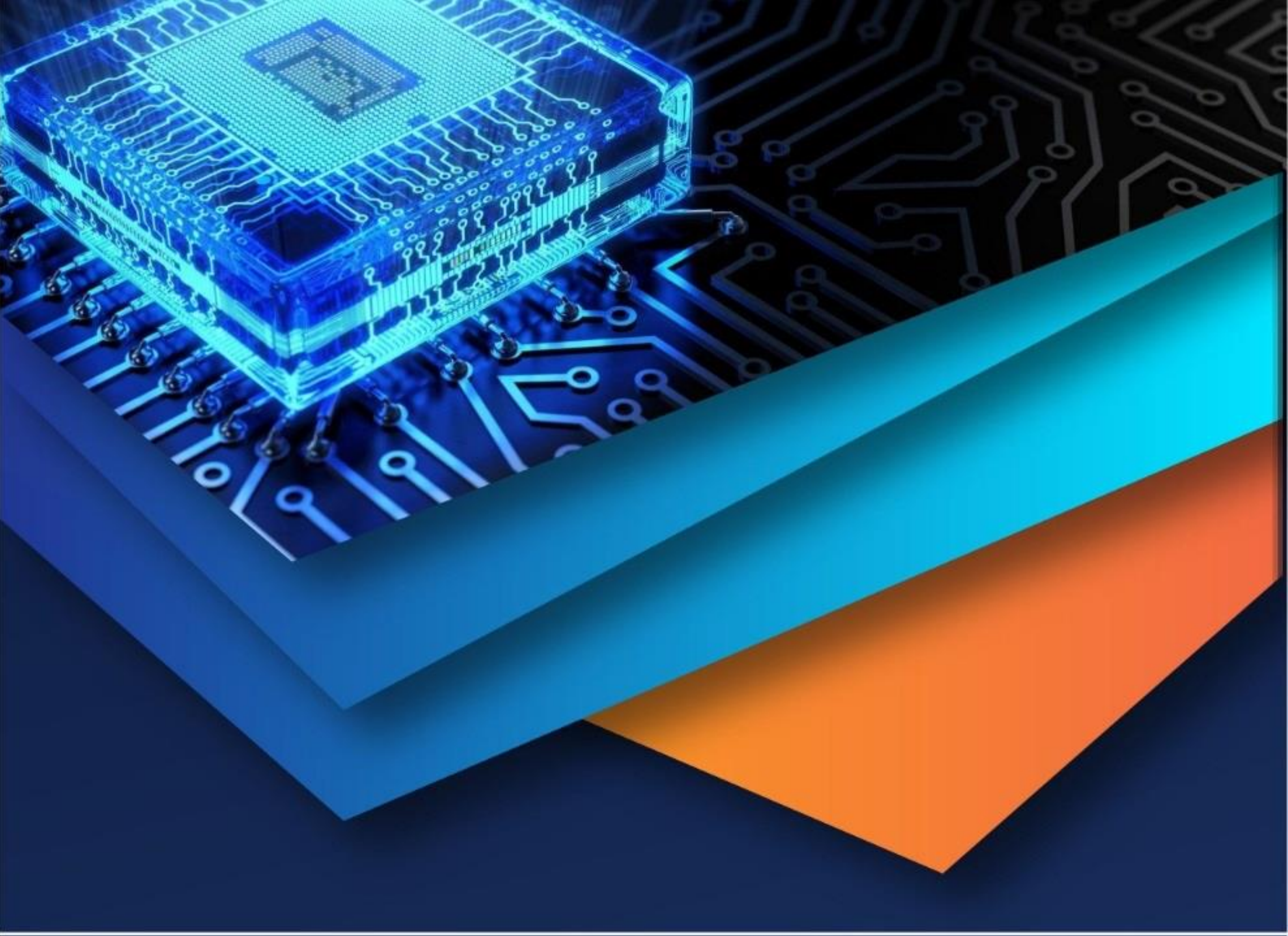

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