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Investigation of Mechanical Properties of Sisal Fiber

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ABSTRACT: Natural fibres are naturally available it appears as an alternative reinforcement to synthetic fibres, reducing costs and showing results close to synthetic fibres.Here promoter, catalyst and axylator treated fibre is used in composites. One of the traditional method hand lay-up technique is use for preparing sisal fibre reinforcing epoxy composite. The final product is under taken to mechanical analysis to check the properties of the fibre.

I.INTRODUCTION

Composites are the class of material referring to a combination of two or more materials mainly divided into matrix and reinforcement. “Materials composed of two or more distinctly identifiable constituents” are used to describe natural composite like timber and organic materials like tissue surrounding the skeletal system. Composite are mainly classified as polymer matrix, metal matrix and ceramic matrix composite. Reinforcement can be in the form of fiber, particulates or whiskers properties can be achieved depending on matrix and reinforcement satisfying the application needed. The reinforcement fiber provides strength and stiffness to the composite whereas the matrix provides rigidity and resistance. The matrix binds the reinforcement phases. Composites are anisotropic and have a non-homogeneous structure. The volume fraction of matrix and fiber decides the total strength of the composites.

Composites cannot be made from constituents with divergent linear expansion characteristics. Fibers may be long continuous or short chopped resulting in different properties. The alignment of fiber is most important in determining the strength of composite. So the fibers can be unidirectional, bidirectional or random directional and they are woven. The main property of composite is that it provides high strength to weight ratio compared to metals. Most composite materials remain elastic till failure occurs and show decreased failure strain, when loaded in tension and compression so they are almost brittle. The other properties cannot be defined without specifying the type of composite.

In recent years, there has been growing environmental consciousness and understanding of the need for sustainable development, which has raised interest in using natural fibers as reinforcements in polymer composites to replace synthetic fibers such as glass. The advantages of natural fibers include low price, low density, unlimited, sustainable availability, and low abrasive wear of processing machinery. Further, natural fibers are recyclable, biodegradable and carbon dioxide neutral and their energy can be recovered in an environment.

II.LITERATURE REVIEW

Jorg mussig, holder Fischer investigated on **“Testing methods for measuring physical and mechanical fiber properties.”** This reference is used to analyzing the different type of testing methods and parameters for composite materials. Vol. 232, 2016.

M.Ramesh, K.Palanikumar investigated on **“Mechanical property evaluation of sisal-jute-glass fiber reinforced polyester composites**.” In this study, the use of composite material in the different fields is increasing day by day due to their improved properties. And the natural fiber properties are evaluated and compared. Vol. 63, 2014.

Robert S.Fielder Zorana dicic, investigated on **“Natural fiber- reinforced polymers in automotive interior applications**.” In this study, the use of composite material common applications is noted. And overviewed the technical applications of the natural fibers. Vol. 264, 2015.

W.D. (Rik) Brouwer investigated on **“Natural fiber composites in structural components**.” International journal on 201, 2016.The above paper is used to refer the natural fibers are composites implemented in structural formats. Vol. 264, 2015.

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This chapter outlines some of the recent reports published in literature on Mechanical behavior of natural fiber based polymer composites with special Emphasis on laminate of sisal fiber reinforced polyester composites.

NATURAL FIBER REINFORCED COMPOSITES

The mechanical properties of a natural fiber-reinforced composite depend on many parameters, such as fiber strength, modulus, fiber length and orientation, in addition to the fiber-matrix interfacial bond strength. A strong fiber-matrix interface bond is critical for high mechanical properties of composites. A good Interfacial bond is required for effective stress transfer from the matrix to the fiber whereby maximum utilization of the fiber strength in the composite is achieved. Modification to the fiber also improves resistance to moisture induced degradation of the interface and the composite properties.

In addition, factors like processing conditions, techniques have significant influence on the mechanical properties of fiber reinforced composites.

Mechanical properties of natural fibers, especially flax, hemp, jute and sisal, are very good and may compete with glass fiber in specific strength and modulus. A number of investigations have been conducted on several types of natural fibers such as sisal, hemp, flax, bamboo, and jute to study the effect of these fibers on the mechanical properties of composite materials.

Mansur and Aziz studied bamboo-mesh reinforced cement composites, and found that this reinforcing material could enhance the ductility and toughness of the cement matrix, and increase significantly its tensile, flexural, and impact strengths.

SISAL FIBER REINFORCED COMPOSITES

Sisal Fiber

Sisal fiber is fairly coarse and inflexible. It has good strength, durability, ability to stretch, affinity for certain dyestuffs and resistance to deterioration in seawater. Sisal ropes and twines are widely used for marine, agricultural, shipping, and general industrial use sisal, henequen, and palm fiber have very similar physical, chemical, and tensile properties. Cazaurang etc. carried out a systematic study on the properties of henequen fiber and pointed out that these fibers have mechanical properties suitable for reinforcing thermoplastic resins.

III. FABRICATION OF NATURAL FIBER COMPOSITE MATERIAL

Fabrication of natural fiber reinforced epoxy composite is done by hand lay-up technique. Hand lay-up technique is the very easiest and cheapest way of fabricating a composite. In hand lay-up technique the achieved composite contains many voids as matrix material cannot occupy the fiber voids evenly, so the thickness of the composite is varying by 0.3mm but measures can be taken to minimize the variation.

The raw materials are
1. Sisal fiber
2. Epoxy resin
3. Epoxy hardener
4. PVA Mold release agent

Shape - rectangle
Dimension required - 150 X 150 X 10 mm

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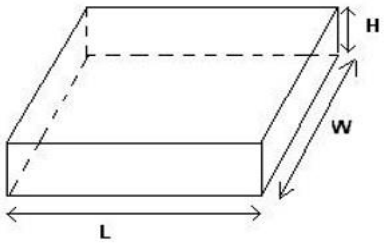

Dimension of the plate

FIBERS

Sisal fiber

Sisal fiber, it is called as (sisal hemp) because for centuries hemp was a major source for fiber, the sisal fiber is traditionally used for rope and twine, and has many other uses, including paper, cloth, and dartboards etc…

Characteristics

1. Compatible with polyester, vinyl ester, and epoxy.
2. Good resistance to weave distortion.
3. High mechanical strength in both directions of weave.
4. Excellent impregnation and low consumption of resin.
5. Easy process ability in molding techniques.

Epoxy resin propertie

1. High adhesive **strength** and high **mechanical** properties are also enhanced by high **electrical** insulation and good chemical **resistance**.
2. High stiffness, high ductility, high strength.
3. It has excellent thermal properties, it can withstand up to 80 degrees Celsius.

FABRICATION OF NFREC

Materials needed

1. Mold
2. Raw materials
3. Roller
4. Plastic breaker
5. Blade
6. Weighing machine
7. Paint brush
8. Thinner
9. Insulation tape
10. Medical gloves

Design cavity

Sisal fiber laminate

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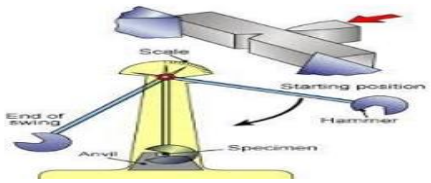
IV. TESTING OF FABRICATED MATERIAL

TYPES OF TESTING
1. Impact test
2. Hardness test
3. Tension test

IMPACT TEST
There are two type of test they are:
1. Charpy test
2. Izod test

THEORY:
In both test the employee a swinging pendulum to strike a notched plate. It is used to compute the energy required fracture the plate and the plate impact strength.



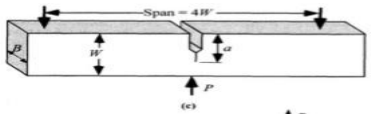
Procedure for impact test

1. Charpy test

In charpy test the work piece is fixed horizontally.

Formula for calculating the impact strength
Impact strength = energy absorbed / cross sectional area

Unit of impact strength is J/mm2.



Charpy test work piece
Observation:
Area of cross section of the given material: 81mm2

Tabulation of charpy test

IZOD TEST

In izod test the work piece is fixed perpendicularly.
Formula for calculating the impact strength
Impact strength=energy absorbed / cross sectional area
Unit of impact strength is J/mm2.

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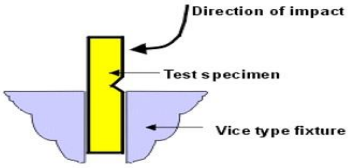


Izod test work piece

Observation:

Area of cross sectional of the given material= 81mm2

S.No	Material used	Energy absorbed by the specimen	Impact strength J/mm^2	Mean value
1	Sisal fiber composite material	12	0.1481	0.1605
		14	0.1728	
		13	0.1605	

Tabulation of izod test

IMPACT TEST RESULT

In, the sisal fiber having high impact strengths.

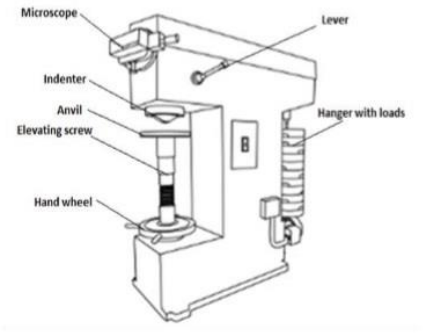
Charpy test for sisal fiber = 0.1892 J/mm2

Izod test for sisal fiber = 0.1605J/mm

HARDNESS TEST

The natural fiber material hardness check by two methods these are,

1. Brinell hardness test
2. Rockwell hardness test



Hardness testing machine

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BRINELL TEST

Theory:

In this test consists a hardened steel ball into a test specimen. In this usually steel ball of diameter (D) under a load (P) is forced in to the test piece and the mean diameter d of the indentation left in the surfaces after removal of load is measured.

Brinell hardness number = 2P / πD(D-D√ D2-d2)

Procedure for brinell hardness testing

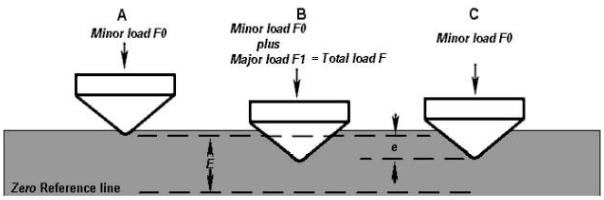
ROCKWELL TEST

Theory:

In Rockwell hardness test consist in touching an indenter of standard cone or ball into the surface of a test piece in two operations and measuring the permanent increases of depth of indentation of this indenter under specified condition. From it Rockwell hardness is deducted.

S.No	Material used	Diameter of the intender (mm)	Load (kgf)	Diameter of the impression (mm)	Brinell hardness number (BHN)	Mean value
1	Sisal fibre material	5	750	2.05 2 2	104.34 102.15 105.02	103.53

HRB = Rockwell hardness measured on B scale.
HRC = Rockwell hardness measured on C scale.



Procedure for Rockwell hardness test

Observation:

Rockwell hardness test

TENSION TEST

Specimens for tension test were carefully cut from the laminate and shaped to the accurate size using emery paper. Tests were conducted using Shimadzu make testing machine (model: AG-IS 50 KN, capacity: 5T, and accuracy: 0·2%) at a cross head speed of 5 mm/min as per ASTM D638.

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Observation:

S.No	Materials used	Maximum stress N/mm^2	Maximum strain	Maximum load (N)
1	Sisal fiber material	13.46	0.032	1.75*10^3

Tabulated value for tensile test

Parameters	Values
Young's modulus	210 kN/mm^2
Poisson's ratio	0.3
Density	7800 kg/m^3
Yield strength	500 MPa
Tangent modulus	21 GPa

V.DESIGN AND ANALYSIS OF FABRICATED SISAL PLATE COMPOSITE PLATE

Automotive industry is going through a transformational phase with increased pressure to reduce weight, increase volume and remain sustainable. Composites have traditionally played a key role in achieving these objectives, although at a high cost and low volume requirements. With the advancement in the composites technologies, resulting in availability of low cost raw materials, support for high volume production composites usage and adoption in automotive industry is going a key turning point.

Parameters of plastic material
Plastic properties
PLASTIC DEFORMATION CURVE

Deformation curve

COMPARISON OF PLATES

PLASTIC PLATE	SISAL PLATE
Less flexibility	Greater flexibility
Low strength (ductile)	High strength (ductile)
Low temperature property	High temperature property
Low load carrying capacity	High load carrying capacity
Wear resistance is less	Higher wear resistance

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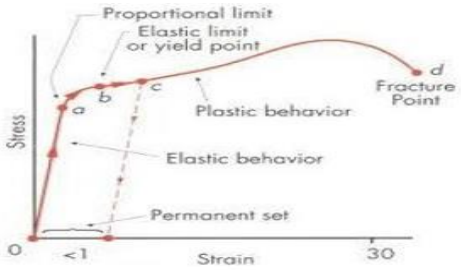

VI.PHOTOGRAPHY

VII.CONCLUSION

The use of composite materials in the different fields is increasing day by day due to their improved properties. Engineers and scientists are working together for number of years for finding the alternative solution for the high solution materials. In the present study of natural fiber composite materials and their effect on mechanical properties is evaluated. The test results for the impact test and hardness testing for the fabricated natural fiber material. In this project found out the strength of sisal fiber is good.

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