EXPERIMENTAL EVALUATION OF MECHANICAL AND WEAR CHARACTERISTICS OF POLYMER MATRIX COMPOSITES REINFORCED WITH SISAL AND JUTE FIBRE

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Abstract - *Researchers are triggered by daily growth of environmental awareness and this leads to invention of more eco friendly composites. Natural fibre replaces the synthetic fibre due to its superior mechanical properties in recent days as it possess high specific strength, small weight to strength ratio, low cost, eco friendly and bio degradable characteristics. It serves as a best alternative to glass, carbon and manmade fibres. Synthetic fibres burn more readily than natural fibres. The natural fibre composites are used in producing bio gas containers, furniture, automobile roofs, helmets, etc. In this present work, sisal fibre and Jute fiber is reinforced with epoxy resin and hardener by using hand layup technique. Fibre length, orientation and thickness play a major role in determining the mechanical properties. Various samples were prepared by changing the fibre orientation. The tensile test specimens were prepared according to ASTM standard and tested in UTM. The hardness of the samples was obtained. The micro structural characteristics of the fibre samples have been investigated. Additionally flexural and impact test is carried out. The tensile test has been carried out. Tensile strength of the fibre reinforced composite was improved by changing the orientation. The hardness of the composites with vertical orientation of fibres found to be the maximum. The wear analysis showed that the vertical orientation of fibres has the minimum wear rate. Vertical having high flexural strength and 45 degree inclined having high impact strength*

Key Words: **Sisal hybrid composite, Epoxy and Hardener, Hand layup, Mechanical testing, SEM.**

1. INTRODUCTION

The Polymer matrix composite material can be defined as the material which is composed matrix and reinforced material on a macro scale with different properties to form a new material with a new increased in beneficial property that is different from the two individual constituents [1].The cost of natural fiber Composites is low easily available and light in weight but it has less strength compared to synthetic materials [2].The various benefits of using natural fibers over man-made glass and carbon fibers are low cost, low density, comparable specific tensile properties, non-abrasive to the equipments, non-irritation to the skin, Less energy consumption, low health risk, renewability, recyclability and bio-degradability [3].In the resin types instead of epoxy sodium hydroxide and other chemicals can be used as matrix materials [4].the fibre can be in the form of short or long fibre [7].Hand layup technique by rolling over the resin in the fibre. Specimen is prepared for the standard sizes for the mechanical testing. Then mechanical testing such as tensile wear hardness tests are conducted and the values are studied. To study about Dynamic behavior of the PMC and Scanning Electron Microscope images are taken for the composite. [6] [8] [9] [10]

1.1 PROBLEM SPECIFICATION:

There are many factors influencing fibre properties they are,

- Types of fibre Used,
- Types of Matrix Used,
- Fibre Dispersion,
- Fibre Orientation

From which in this study we are going to research on how properties may vary in the orient the fibre such as horizontal direction, vertical direction and 45 degree inclined direction of fibre.

2. MATERIALS AND METHOD

The material for reinforcement is chosen as sisal fiber, and jute fiber due to and the material for matrixepoxy resin (LY556 grade) and hardener (HY951) is taken as the matrix and binder for the composite. Hand layup technique is used to manufacture the parts. Work piece prepared in the dimension according to the standard size used for testing. The composition of matrix and reinforcement is 40 and 60 percentage respectively.

2.1 HAND LAYUP METHOD

Hand lay-up is an open molding method suitable for making a wide variety of composites products fromvery small to very large. Production volume per mold is low; however, it is feasible to produce substantial production quantities using multiple molds. Hand lay-up is the simplest composites molding method, offering low cost tooling, simple processing, and a wide range of part sizes.

Figure 1, 2. HAND LAYUP METHOD

2.2 HARDNESS TEST

Shore D Hardness test is measured by using Durometer scales. There are several scales of durometer hardness, used for materials with different properties. The two most common scales, using slightly different measurement systems, are the type A and type D scales. The A scale is for softer plastics,while the D scale is for harder ones. There are 12 scales, depending on the intended use; types A, B, C, D,DO, E, M, O, OO, OOO, OOO-S, and R. Each scale results in a value between 0 and 100, with higher values indicating a harder material.

HARDNESS SAMPLE HORIZONTAL ORIENTATION

Figure 3. HARDNESS TEST

In the figure 3 the horizontal orientation of Sisal, Jute fibre with epoxy resin and hardener specimen is tested for hardness values and the average hardness value is provided in the table 1. Similarly for vertical and inclined orientation composite is done the values are follows,

Table 1. HARDNESS VALUE

S.No	SAMPLE	OBSERVED VALUES, SHORE-D			AVERAGE SHORE-D
		1	2	3	
1	Horizontal	75	71	72	73
2	Vertical	75	77	76	76
3	Inclined	73	78	78	75

2.3 WEAR RESULTS

WEAR SAMPLE FOR A LOAD OF 10 KN

Figure 4. WEAR TEST SPECIMEN

The figure 4 represent specimen is tested for its wear properties.

Table 2. WEAR RESULTS FOR THE LOAD OF 10 KN

LOAD OF 10N INPUT DATA		OUTPUT DATA	
Test speed	200 rpm	Co efficient of friction	0.00574
Normal load	10 N	Wear rate	0.00135 mm3/Nm
Pin diameter	8 mm	Temperature	33.80 degree C
Track radius	30 mm	Frictional force	0.65 N

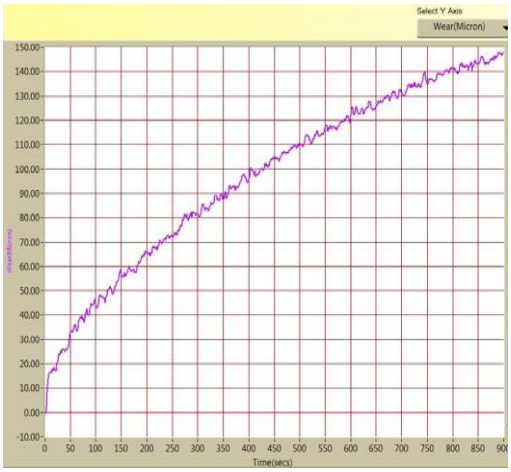

Figure 5. TIME VS WEAR

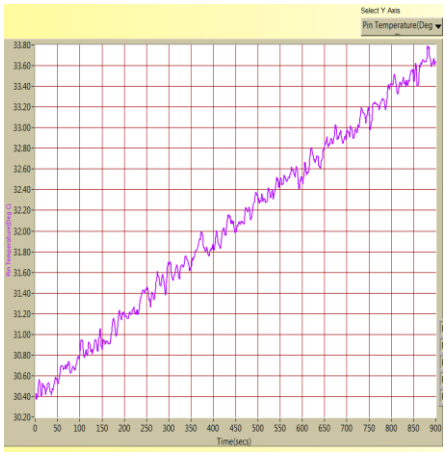

Figure 6. TIME VS TEMPERATURE

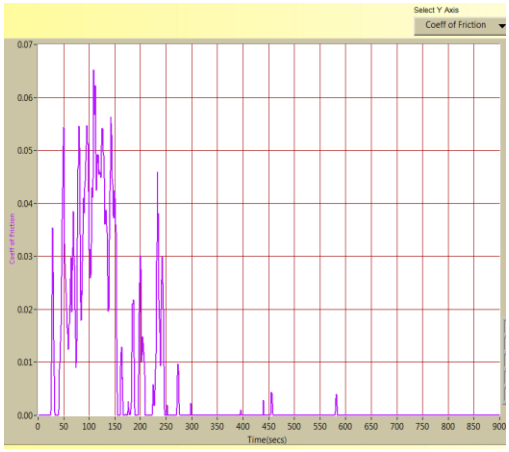

Figure 7. TIME VS COEFFICEINT OF FRICTION

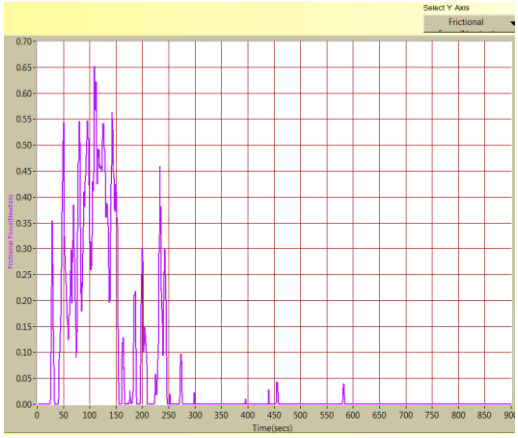

Figure 8. TIME VS FRICTIONAL FORCE

The figure 5,6,7,8 represents graph for wear properties

Table 3. WEAR RESULTS FOR THE LOAD OF 20 KN

LOAD OF 20N INPUT DATA		OUTPUT DATA	
Test speed	200 rpm	Co efficient of friction	0.00482
Normal load	10 N	Wear rate	0.00146 mm3/Nm
Pin diameter	8 mm	Temperature	37.80 degree C
Track radius	30 mm	Frictional force	0.72 N

2.4 FLEXURAL TEST

The flexural test was performed by the three-point bending method according to ASTM D 790, and a crossheadspeed of 2 mm/min. 3-specimens was tested and the averages were calculated. The maximum load was applied in the middle of the specimen, when the specimen was freely supported by a beam. The flexural modules are evaluatedfrom the slope of the initial portion of the load-deflection curve.

Table 4. FLEXURAL STRENGTH

S.NO	FLEXURAL STRENGTH (N/mm^2)		
	HORIZONTAL	VERTICAL	45 DEGREE ORIENTATION
1	25	36	22
2	32	44	26
3	37	41	31
AVERAGE	31	40	26

2.5 IMPACT TEST RESULTS

It is used to determine the amount of energy absorbed by a material

Table 5. IMPACT RESULTS

S.NO	IMPACT STRENGTH (J)		
	HORIZONTAL	VERTICAL	45 DEGREE ORIENTATION
1	0.52	0.67	0.7

TENSILE TEST SPECIMEN HORIZONTAL ORIENTATION

Figure 9. TENSILE TEST SPECIMEN HORIZONTAL ORIENTATION

The figure 9 represent specimen is tested for its tensile properties.

Table 6. TENSILE HORIZONTAL RESULTS

INPUT DATA		OUTPUT DATA	
Specimen shape	Flat	Load at yield	1.52 KN
Specimen type	Fibre	Yield stress	8.268 N/mm^2
Specimen description	Horizontal	Load at peak	1.960kN
Specimen width	19.21 mm	Tensile strength	10.661 N/mm^2
Specimen thickness	9.57 mm	Elongation	2.42%
Initial gauge length	50 mm		
Final specimen width	0 mm		
Final specimen thickness	0 mm		
Final gauge length	51.21 mm		
Final area	0 mm^2		
Specimen CS area	183.84 mm^2		

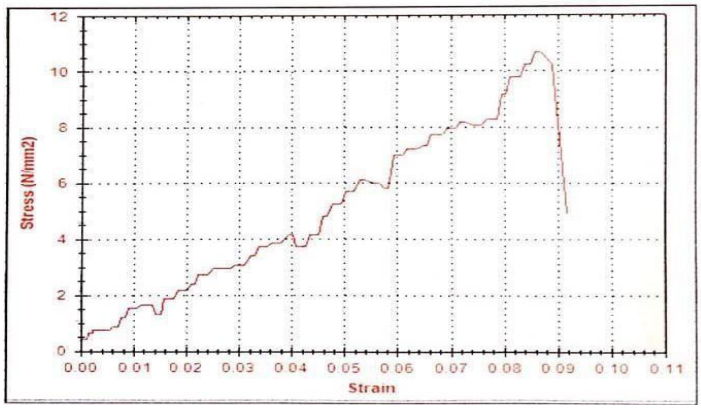

Figure 10. Tensile Test Graph

The figure 10 shows the relationship between strain x axis and stress in y axis for the tensile test of verticalorientation

Table 7. TENSILE VERTICAL RESULTS

INPUT DATA	VERTICAL	OUTPUT DATA	
Specimen shape	Flat	Load at yield	1.96 KN
Specimen type	Fibre	Yield stress	17.06 N/mm^2
Specimen description	Vertical	Load at peak	2.63kN
Specimen width	16.34 mm	Tensile strength	22.89 N/mm^2
Specimen thickness	7.03 mm	Elongation	1.74%
Initial gauge length	50 mm		
Final specimen width	0 mm		
Final specimen thickness	0 mm		
Final gauge length	51.63 mm		
Final area	0 mm^2		
Specimen CS area	114.87 mm^2		

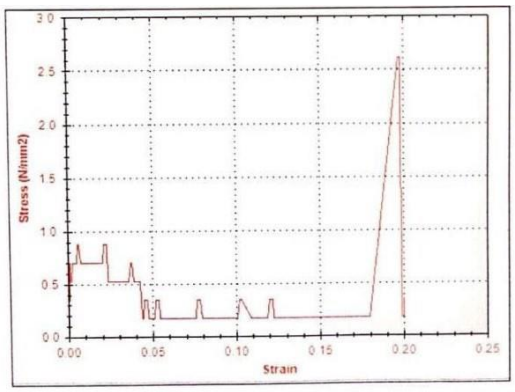

Figure 11. TENSILE TEST GRAPH

The figure 11 shows the relationship between strain x axis and stress in y axis for the tensile test of verticalorientation

3. CONCLUSIONS

- Tensile tests results show the maximum tensile load of 22 N/mm^2 in the vertical orientation fibre.
- Vertical orientation fibre results in high flexural strength.
- 45 degree inclined orientation fibre results in high impact strength.
- Horizontal orientation specimen shows the uniform coating of resin.
- Wear test of 10 KN has the low wear rate of 0.00135 mm3/Nm
- Highest Impact results obtained from 45 degree inclined orientation gives 0.7

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