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Analysis of Composite Material Blended With Thermoplastics and Jute Fibre

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Abstract
Recently natural fibres have been receiving considerable attention as substitutes for synthetic fibre reinforcements due to their low cost, low density, acceptable specific strength, good thermal insulation properties, reduced tool wear, reduced thermal and respiratory irritation and renewable resources. The aim of this work is to develop chemically treated and chemically untreated fibre reinforced composite material with optimum properties so that it can replace the existing synthetic fibre reinforced composite material for a suitable application. In this work, polyester resin has been reinforced with jute fabric, so as to develop jute fibre reinforced plastic (JFRP) with a weight ratio of 10:1:1 Hand lay-up technique was used to manufacture the composites where Methyl Ethyl Ketone Peroxide and cobalt Naphthalene were used as coupling agent and accelerator respectively. The thickness of the composite specimen was obtained by laying up layer of fibre and matrix. The untreated composites have been used and mechanical properties are compared with natural fibre and jute fibre composite by using the Ansys method.
Keywords: Jute fiber, Epoxy resin, Jute fibre reinforced composite, Tensile strength, Ansys solving.

I. INTRODUCTION:-

Now-a-days, newer polymer matrix composites reinforced with fibers such as glass, carbon, aramid, etc. are getting a steadyexpansion in usesbecause of their favorable mechanical properties.

For this natural fibres such as jute, can be alternately used to reduce the cost of the composites. Moreover, production of environmentally friendly materials is another important issue.The use of natural fibres, derived from annually renewable resources, as reinforcing fibres in both thermoplastic and thermoset matrix composites provide positive environmental benefits with respect to ultimate disposability and raw material utilization.The prominent advantages of natural fibres include acceptable specific strength properties, low cost, low density, high toughness, good thermal properties, and so on. Low specific weight, which results in a higher specific strength and stiffness than glass is a benefit especially in parts designed for bending stiffness.

In this work, polyester resin has been reinforced with jute fabric, so as to develop Jute Fibre Reinforced Plastic (JFRP) with a weight ratio of 10:1:1 (epoxy resin, methyl ethyl ketone peroxide,and cobalt naphthalene) Hand lay-up technique was used to manufacture the composites where Methyl Ethyl ketone peroxide and cobalt Naphthalene were used as coupling agent and accelerator respectively and composites were prepared under various processing parameters using manual Hand layup technique.

II. METHODOLOGY

The fibres usually mats, are cut and placed in a mould, see figure. The resin is applied by rollers. One option is to cure while using a vacuum bag, then it's called vacuum bagging. By applying vacuum, excess air is removed and the atmospheric pressure exerts pressure to compact the composite.A possible product is the boat hull . The advantages are the high flexibility and the simplicity of the process and the cheap tooling.

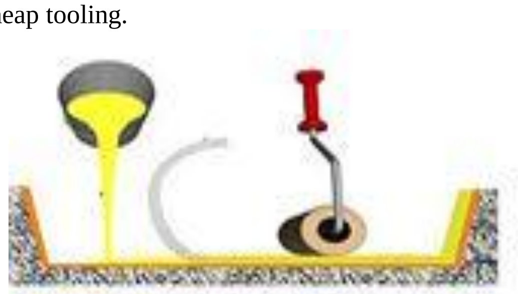


Fig 2.1 Hand layup method

III. FIBRE EXTRACTION PROCESS

The Jute fiber is available from jute tree. When the plants are about 15 – 20 cm tall, they are thinned out. About four months after planting, harvesting begins. The stalks are cut off close to the ground. The stalks are tied into bundles and soaked in water (retting) for about 20 days. This process softens the tissues and breaks the hard pectin bond between the bast and jute hurd (inner woody fibre stick) and the process permits the fibre to be separated. The fibre are stripped from the stalks in long strands and washed in clear, running water. Then the fibers were cleaned and dried in sunlight.

IV. CHEMICAL TREATMENT

The rough jute fibres are pre-washed with large amount of distilled water to remove the surface dirt present in the fibres and then put in an oven at 100°c for drying until it gains a constant weight. The mercerization or alkali treatment is carried out by immersing the washed jute fibres 200 gms in a 10 % (w/v) sodium hydroxide aqueous solution 2lt for 3hrs in a temperature of 70°c. It should be stirred occasionally and after that the fibres are taken out and washed in order to remove any absorbed alkali.

Fig 4.1 Jute fibre

V. FIBRE PREPARATION

In order to evaluate the flexural strength of the composites three point bending test is carried out by JFPC means cut as per the ASTM D790 to measure the tensile test. The samples taken for the tensile test is 160×30×5 mm (length, breadth, height) which is cut by using a diamond cutter. Care has been taken for maintaining uniformity and homogeneity of the composite. The data reported here is the average of five successful tests.

Fig5.1 Die Pattern

VI. COMPOSITE FABRICATION

Polyester resins are used as matrix in different type of composites. These materials are noted for their versatility, but their relatively high cost has limited their use. High resistance to chemicals and outstanding adhesion, durability, and toughness has made them valuable as coatings. Because of their high electrical resistance, durability at high and low temperatures, and the ease with which they can be poured or cast without forming bubbles, polyester resin are especially useful for encapsulating electrical and electronic components. Polyester resin adhesives can be used on metals, construction materials, and most other synthetic resins. They are strong enough to be used in place of rivets and welds in certain industrial applications. Polyester resin is a thermosetting peroxide polymer that polymerizes and cross links when mixed with a catalyzing agent or "hardener". Unsaturated isophthalic polyester resin is used as polyester resin, 2% cobalt naphthalene (as accelerator) is mixed thoroughly in isophthalic polyester resin and then 2% Methyl-Ethyl-Ketone-Peroxide (MEKP) as catalyst is mixed in the resin prior to reinforcement. With reinforcement of jute fibrethe chicken feathers collected from poultry units are cleaned with a polar solvent, like ethanol, and are dried. The quills are removed and the short fibres are obtained. To prepare the composite slabs, these fibres in pre-determined weight proportion 20% are reinforced with random orientation into the polyester resin. A block is thus cast. The casting is put under load for about 24 hours for proper curing at room temperature. Specimens of suitable dimension are cut using a diamond cutter for physical characterization. The jute particles obtained were used to prepare composites. To prepare the composite slabs, these particles in pre-determined weight proportion 20% are reinforced with random orientation into the polyester resin. The casting is put under load for about 24 hours for proper curing at room temperature.

Specimens of suitable dimension are cut using a diamond cutter for physical characterization is shown in figure 6.1.

Fig 6.1 Hand Layup Method

VII. CUTTING THE ASTM D790

The steps included in the cutting of sample specimen described here;

1. The prepared composite plate were cut ASTM specimen dimension shown in fig below D790 tensile test specimen.
2. The burrs were removed with smooth emery cloth and the specimens were cleaned.

The images are illustrated below:

Fig 7.1 Tensile Sample A

Fig 7.2 Tensile Sample B

Fig 7.3 Tensile Sample C

Fig 7.4Tensile Sample D

VIII. EXPERIMENTAL PROCESS

8.1 TENSILE TESTING

Tensile testing, also known as tension testing, is a fundamental materials science test in which a sample is subjected to a controlled tension until failure. The results from the test are commonly used to select a material for an application, for quality control, and to predict how a material will react under other types of forces. Properties that are directly measured via a tensile test are ultimate tensile strength, maximum elongation and reduction in area From these measurements the following properties can also be determined: Young's modulus, Poisson's ratio, yield strength, and strain-hardening characteristics.

Table 8.1 Treated Jute Fibre

Fibre Name	Tensile Strength [N/mm^2]	Yield Strength [N/mm^2]	Elongation %
Treated jute fibre A	142	96	7.25
Treated jute fibre B	136	91	6.75
Treated jute fibre C	141	89	6
Treated jute fibre D	122	84	7.15

Table 8.2 Untreated Jute Fibre

Fibre Name	Tensile Strength N/mm^2	Yield Strength (N/mm$^{2)}$	Elongation %
Untreated Jute Fibre A	121	87	6
Untreated Jute Fibre B	123	78	5.75
Untreated Jute Fibre C	116	66	5
Untreated Jute Fibre D	111	65	5.25

8.2 BRINELL HARDNESS TEST

The load is applied for a standard time (~30s), and the diameter of the indentation is measuredin this test. The impression so obtain is measured by a microscope and the brinell hardness number B.H.N. is found out by the following equation.

B.H.N = {Load / Area of Impression} BHN = $\frac{F}{\frac{\pi}{2}D\,\{D-\sqrt{(d^2-D^2)}\}}$

Where,

F - Load in kg,

d - Diameter of ball in mm, and

D-Diameter of indentation in mm

Table 8.3Brinell Hardness TestResult

SI No	Diameter of Impression	Load [Kg]	BHN
1	3.1	1500	194
2	3.3	1750	200
3	3.5	2000	202
4	3.6	2250	204

8.3 ROCKWELL HARDNESS TEST

The determination of the Rockwell hardness of a material involves the application of a minor load followed by a major load, and then noting the depth of penetration from a dial, on which a harder material gives a higher number. The chief advantage of Rockwell hardness is its ability to display hardness values directly, thus obviating tedious calculations involved in other hardness measurement techniques.

Table 8.4 Rockwell Hardness Test Result

Sl No	Indenter	Load [Kg]	H [mm]
1	Diamond	100	91
2	Diamond	100	93
3	Diamond	100	95
4	Diamond	100	97

8.4 SCANNING ELECTRON MICROSCOPE ANALYSIS

A Scanning Electron Microscope (SEM) is a type of electron microscope that produces images of a sample by scanning it with a focused beam of electrons. The electrons interact with electrons in the sample, producing various signals that can be detected and that contain information about the sample's surface topography and composition. The electron beam is generally scanned in a raster scan pattern, and the beam's position is combined with the detected signal to produce an image.

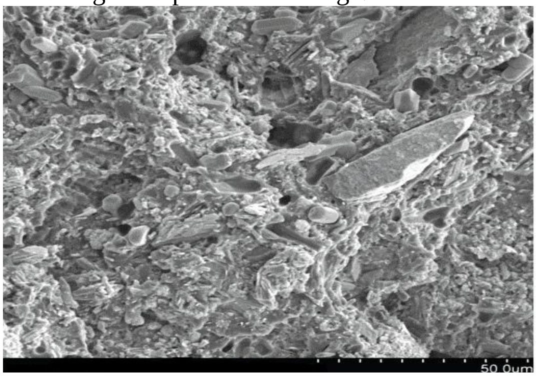


Figure 8.4SEM Images

8.5 TENSILE TEST RESULT FOR ANSYS

The tensile test is generally performed on ASTM specimens. The commonly used specimens for tensile test are the dog-bone type and the straight side type with end tabs. During the test a uni-axial load is applied through both the ends of the specimen. The ASTM standard test method for tensile properties of fiber resin composites has the designation D790. The tensile test results of Stress were analysed.

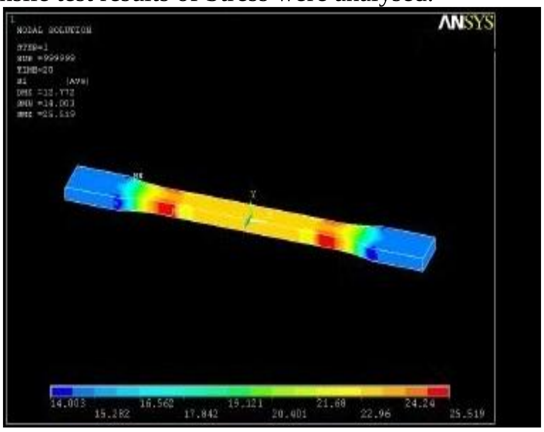


Figure 8.5 stress analysis

IX. RESULTS

9.1MECHANICAL PROPERTIES

In the present investigation the reinforcement of jute in short form into polyester resin has not shown any encouraging results in terms of mechanical properties. However, there enforcement has caused a reduction of about 13% in the composite density which leads to improvement in the strength to weight ratio. The density of the composite is measured to be 0.97 gm./cc (with void fraction of 1.2%) which is less than the density of neat polyester resin (1.12 gm./cc) mechanical properties of SF reinforced urea-formaldehyde resin composites have been described. Whereas the flexural, wear resistance and water absorption properties are proved to be excellent in the composite with 30 wt.% SF under the present experimental conditions adopted.

9.2 TENSILE TEST

The tensile test is conducted for the natural fibre and jute fibre composite.

Table 9.1 Comparison of Tensile Test

Specimen	Tensile Strength N/mm²	Elongation %	Yield Strength N/mm²
Original Jute Fibre	118	1.8	74
Jute Fibre Composite	140	6.75	90

9.3 HARDNESS TEST

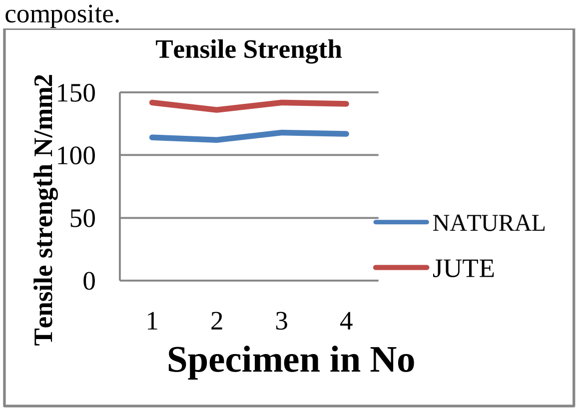
The hardness test is conducted for the natural fibre and jute fibre composite. Thus we have compared the hardness values in table 9.2.

Table 9.2Comparison of Hardness Test

Material	Diameter of Indentation [mm]	Hardness [BHN]
Original jute fibre	10	126
Jute fibre composites	10	204

X. GRAPH COMPARISON

The following graph were plotted to compare and visualize the analytical and experimental results. While comparing the properties of tensile test and Hardness of original jute fibre with jute fibre composite.



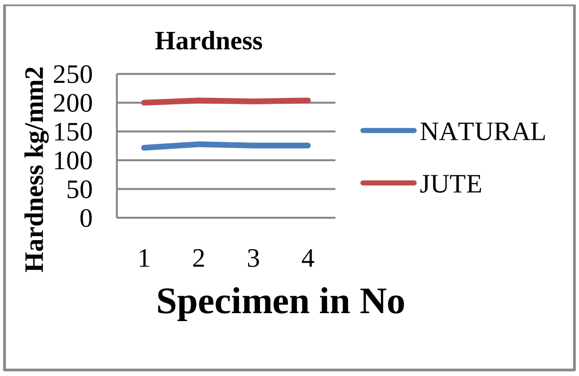


Fig10.1 Graph Comparison

XI. DISCUSSION

Here in this chapter, the important components used in our project were discussed. Also descriptions of parts were discussed along with photographic illustration. The SEM micrographs of impact fractured and worn surfaces reveal that the proper jute fibre addition can improve the fracture energy, strengthen interfaces and lower wear rate.

Here in the microstructure analysis the following parts were identified,the portion which Projected outside is indicated by Jute Fibre present in it. A light grove concludes the Ethyl Methyl Ketone peroxide. Cobalt Naphthalene was in the form of a grey colour. Finally the Grains like pattern indicate the distribution of Epoxy Resin.

The fibres themselves possess a higher wear resistance than the matrix and should protrude from the surface after some time. Hence, the applicability ofthese composites in fibreboard can be expanded.

XII. CONCLUSIONS

The experimental investigation on the effect of chemical treatment on mechanical behavior of jute fiber reinforced POLYMER MATRIX COMPOSITES (PMC) leads to the following satisfactory conditions.

The experimental conclusions obtained from this study are as follows:

- ✓ Jute fibrereinforced PMC can be successfully fabricated.
- ✓ The mechanical rate behavior is different for oblique and at normal impact angles.
- ✓ The results indicate that angle of impact is the most important parameter Stress and strain during mechanical .The angle of impact greatly affects the mechanical behavior of poultry feather and jute reinforced polyester matrix composites.
- ✓ Jute reinforced PMCs show better resistance to mechanical compared to coir reinforced PMCs.
- ✓ Polyester composites showed better resistance to mechanical composites.
- ✓ At higher impact angles, high degree of cavitation along with formation of cracks is observed in case of all the PMCs.
- ✓ Steady state mechanical rate is observed in case of reinforced PMCs at higher time values.

However, the density of the composites decreases due to the reinforcements which tend to increase the strength to weight ratio which is an important parameter in industrial and commercial application of composite.

XIII. FUTURESCOPE

The present work leaves a wide scope for future investigators to explore many other aspects of bio-fibre reinforced polymer composites. Some recommendations for future areas of research include.To increase mechanical strength of these composites for their use in different sectors can be studied. Environmental study of feather fibre reinforced polymer composites i.e. the effect of different environmental conditions like alkaline medium, acidic medium, freezing temperature etc. On the properties and/or degradation of these composites is to be evaluated. Possible use of other fibres/flakes obtained from bio-wastes in the development of new composites. Other polymers can be tried as the matrix material for fabrication of poultry feather reinforced composites.

REFERENCES

[1] G.Velmurugan, D.Vadivel, R.Arravind (2012),"*Tensile Test Analysis Of Natural Fiber Reinforced Composite Interfaces*", International Journal of Mechanical and Industrial Engineering (IJMIE) ISSN No. 2231 –6477, Vol-2, Iss-4.

[2] S. Thitithanasarn, K. Yamada, Y.W. Leong, H. Nishimura, H. Hamada,(1997),"*Effect of Surface Treatment on Thermal and Mechanical Performance of Jute Fabric Reinforced Composites*", Engineering thermoplastic Composites Science and Technology, 67–79.

[3] M. S. Islam, K. L. Pickering, G. W. Beckermann and N. J. Foreman, (2005),**"***The Effect of Fibre Treatment Using Alkali on Industrial Hemp Fibre/Epoxy Resin Composites*", Proceedings of the International Conference on Mechanical Engineering (ICME2005) 28- 30 December 2005, Dhaka, Bangladesh.

[4] Dr. Navdeep Malhotra, Khalid Sheikh and Dr. Sona Rani, (2005), "*A Review on Mechanical Characterization of Natural Fiber Reinforced Polymer Composites*", Journal of Engineering Research and Studies,101–107.

[5] Gunti Rajesh, Atluri V. Ratna Prasad, (1997), "*Effect of Fibre Alkali Treatments on Tensile Properties of Short Jute Fibre Reinforced Polypropylene Composites*", Journal of Materials Science,4261–4267.

[6] Pal S., Mukhopadhayay D., Sanyal S., Mukherjea R. Studies on process variables for natural fibre composites- effect of PEAP as interfacial agent. Journal of Applied Polymer Science, 973–985 (1988).

[7] Bisanda E. T. N.: *The effect of alkali treatment on the adhesion characteristics of sisal fibres.* Applied Composite Materials, 331–339 (2000).

[8] Joseph P. V., Joseph K., Thomas S.: Short sisal fibre reinforced polypropylene composites: the role of interface modification on ultimate properties. CompositeInterfaces, 171–205 (2002).

[9] Fung K. L., Xing X. S., Li R. K. Y., Tjong S. C., Mai Y-W.: An investigation on the processing of sisal fibre reinforced polypropylene composites. Composites Science and Technology, 1255–1258 (2003).

[10] Wei C., Mu Q-H., Luo W-H.: Influences of treatment methods for sisal stems on properties of sisal fibre/formaldehyde resin composites. China Plastics, 44–47 (2003).