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A Study on the Effect of Fiber Loading and Orientation on Mechanical Behaviour of Jute Fiber Reinforced Epoxy Composites

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ABSTRACT

The natural fibers from renewable natural resources offer the potential to act as a reinforcing material for polymer composites alternative to the use of glass, carbon and other man-made fibers. Among various fibers, jute is most widely used natural fiber due to its advantages like easy availability, low production cost and satisfactory mechanical properties. For a composite material, its mechanical behavior depends on many factors such as fiber content, orientation, types, length etc. Attempts have been made in this research work to study the effect of fiber loading and orientation on the mechanical behavior of jute fiber reinforced epoxy composites. The aim of this study is to determine the mechanical properties of developed composite plates by varying percentage of Silicon carbide. The composite plates are fabricated by hand layup techniques which is very economical. The flexural properties under three-point bend test are investigated experimentally by using the theory of bending of beam. Experimental results show that the composite plate made with jute have strength closely, finally the developed reinforced composites are then characterized by flexural strength, bending stress and compressive strength. Also, impact test is performed on Charpy,s Impact testing machine to assess shock absorbing capability of material. Keywords- Hand lay-up, composite laminates, load carrying capacity, impact energy

I. INTRODUCTION

Natural fiber reinforced composites have a good potential as a substitute for wood-based material in many applications. This is due to fact that natural fibers are light weight low in cost and environmental friendly. Natural fiber composites with thermoplastic and thermoset matrices are now utilized for door panels, seed bags, head liners, dash boards and other interior parts by car manufacturers. Fiber reinforced polymer composites are now considered as an important engineering material. They offer outstanding mechanical property, unique flexibility in the design capability and ease of fabrication. Additional advantages include light weight, corrosion and impact resistance and excellent strength.

II. MATERIALS AND METHOD

Selection of Jute

We all know that natural fiber jute is readily available with minimum or negligible cost in comparison to other natural fibers. So the jute we have used here for reinforcing the composite was taken from gunny bags which are used for storing rice or wheat. First of all these jute were washed with water and then dried in the Sun. These dried jute were then cut into pieces as per our requirement. In this proposed work our specimen dimension is (330×55×20) mm, so the jute mat were cut into (350×60) mm

Natural fiber jute From Gunny Bags

Selection of Silicon Carbide

Silicon Carbide is the only chemical compound of carbon and silicon. It was originally produced by a high temperature electro- chemical reaction of sand and carbon. Silicon carbide is an excellent abrasive and has been produced and made into grinding wheels and other abrasive products for over one hundred years. Today the material has been developed into a high quality technical grade ceramic with very good mechanical properties. It is used in abrasives, refractories, ceramics, and numerous high- performance applications.

Selection of Resin

Epoxy Resin (General Purpose Epoxy Resin)

Epoxy Resin is the modern laboratory benchtop material that offers a superb combination of features and benefits. It is durable, extremely chemical and stain resistant, mechanically strong, easily cleaned and decontaminated and exhibits good fire resistance and fire propagation properties.

Mixing Ratio

For the fabrication of jute reinforced composite the mixing proportion of the Resin and hardener plays an important role. First of all we have taken general purpose resin as base chemical according to our requirement and then we added hardener and accelerator in proportionate ratio.

Resin used – Epoxy Resin (General purpose resin) Hardener used – Mekp (methyl ethyl ketone peroxide) Percentage of Silicon Carbide- 3% , 5% , 10% , 15%wt Percentage of Hardener – 8%

Hand Layup Technique

The oldest and simplest moulding technique in which reinforcing materials and catalyzed resin are laid into or over a mould by hand. These materials are then compressed with a roller to eliminate entrapped air.

III. EXPERIMENTAL WORK

Three-Point Bend Test

Flexural strength, also known as modulus of rupture, bend strength, or fracture strength a mechanical parameter for brittle material, is defined as a material's ability to resist deformation under load. The transverse bending test is most frequently employed, in which a rod specimen having either a circular or rectangular cross-section is bent until fracture using a three point flexural test technique. The flexural strength represents the highest stress experienced within the material at its moment of rupture.

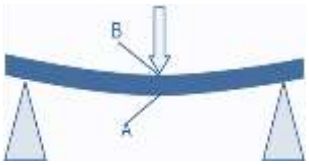

Fig.01 - Beam under 3 point bending

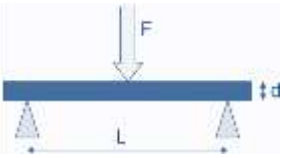

Fig. 02 - Beam of material under bending.

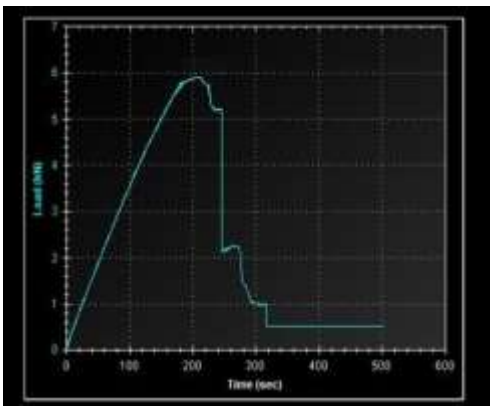

Fig.03. Load Vs Time Graph

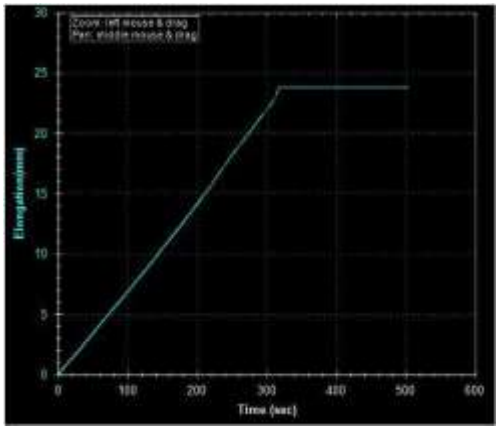

Fig.04. Load Vs Elongation Graph

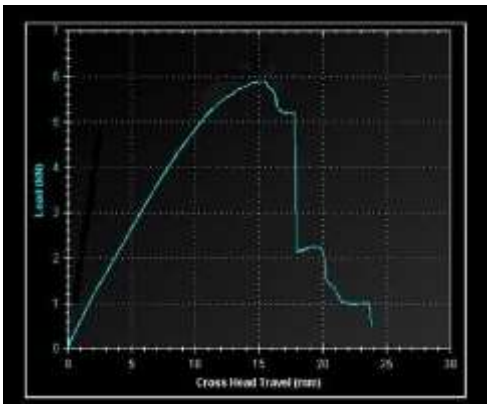

Fig.05. Elongation Vs Elapsed Time Graph

Charpy's Impact Test

The charpy impact test, also known as the charpy v-notch test, is a standardized high strain-rate test which determines the amount of energy absorbed by a material during fracture. This absorbed energy is a measure of a given material's toughness and acts as a tool to study temperature-dependent brittle-ductile transition. It is widely applied in industry, since it is easy to prepare and conduct and results can be obtained quickly and cheaply.

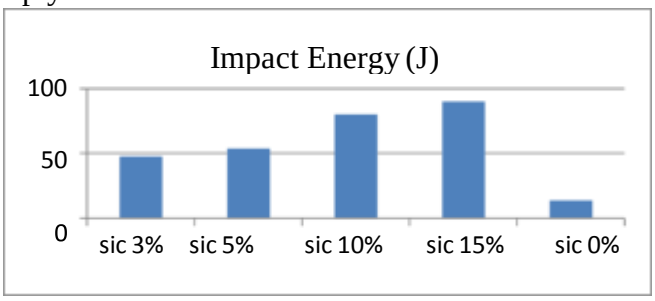

Fig.06.Graph between Impact Energy and Sic %

IV. RESULT AND DISCUSSION

Mechanical Characteristics of Composites:

This chapter presents the mechanical properties of the jute reinforced epoxy composites prepared by varying Sic percentage for the present investigation. Details of processing of these composites and the tests conducted on them have been described in the previous chapter. The results of various characterization tests are reported here. This includes evaluation of compressive strength, flexural strength; impact energy. The interpretation of the results and the comparison among various composite samples are also presented.

Effects of varying percentage of Sic on Flextural Strength

The graph shows that the flexural strength of specimen increases with increasing Sic percentages between 5-10%and gives increasing value from 76.58.72 N/mm^2 to 129.21 N/mm^2.When Sic% varying from 10-15% flexural strength value decreases 129.21 N/mm^2 to 74.33 N/mm^2.Thus result shows better flexural strength near 10% Sic with respect to thickness.

Effect of varying percentage of Sic on compressive strength

The compression test of specimen was performed on UTM machine TUE-C-400.The graph shows that the compressive strength increases with the increasing Sic percentage between 5-10% and compressive strength value increases from 4.117 to 6.15 N/mm2.On the other hand compressive strength value decreases from 6.15 to 3.36 N/mm2 with varying sic percentage from 10- 15%.

Effect of varying percentage of Sic on Impact strength

The impact energy value of different composite recorded during charpy impact test in table. It shows that the resistance to impact loading of jute fibre reinforced epoxy composite decreases in varying Sic percentage from 5-10% and gives the value 90 Joule to 80 Joule. And again decreasing with increase in Sic percentage 10-15%, it shows

impact strength value 80 to 14 joule. High strain rates or impact loads may be expected in many engineering applications of composite materials. The suitability of a composite for such applications should therefore be determined not only by usual design parameters, but by its impact or energy absorbing properties.

From the above discussion better flexural strength and compressive strength comes in the range of Sic percentage 5-10%. And better impact strength comes near 10% of sic with respect to total thickness of specimen.

V. CONCLUSION

This proposed investigation of mechanical behavior of jute reinforced epoxy composites leads to the following conclusions:

- This work shows that successful fabrication of a jute reinforced epoxy composites with different Sic percentage is possible by simple hand lay-up technique
- It has been noticed that the mechanical properties of the composites such as compressive strength, flexural strength, impact strength etc. of the composites are also greatly influenced by the Sic percentage with respect to thickness of specimen.
- Use of Sic in jute reinforced composite high brittleness nature of specimen.
- Industry Importance: At present jute reinforced is a agricultural product can be used for industrial application like partition panels, packaging and automotive industry in addition to solving environmental problems related to the disposal of product.

APPENDIX

Appendixes, if needed, appear before the acknowledgment.

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