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

Authors
Md. Shadab Alam¹, Mr. Saurabh Singh², Mr. Indra Prakash³
NIMS Institute of Engineering and Technology, NIMS university, Jaipur-303121 INDIA.
Email- shadab.alam1011@gmail.com

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, headliners, 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
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 Flexural 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 to 129.21 N/mm². When Sic% varying from 10-15% flexural strength value decreases 129.21 N/mm² to 74.33 N/mm². 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
Appendices, if needed, appear before the acknowledgment.

ACKNOWLEDGMENT
I take this golden opportunity to express my heartfelt thanks and my profound sense of gratitude to my project guides Mr. Saurabh Singh, Asst. Professor of Mechanical Engineering Department for their valuable suggestions, guidance and encouragement throughout my thesis work. I express my heartfelt thanks and my profound sense of gratitude to my project co-guides Mr. Indra Prakash, Asst. Professor of Petroleum Engineering Department & Mr. Anuj Gangwar, Asst. Professor of Mechanical engineering Department for sharing his knowledge and support during the course of this dissertation work. I cannot close these prefatory remarks without expressing my deep sense of gratitude and reverence to the authors of the various papers I have used and referred to in order to complete my research work. Last but not least, I also express my wholehearted gratitude in huge measure to my family, all my classmates and friends, for their everlasting help, encouragement and moral support throughout my entire work.

REFERENCES
1. Abdalla A. Ab. Rashdi, Sapuan Salit Mohd, Abdan Khalina and Megat Mohamad Hamdan. Water Absorption Behaviour Of Kenaf Reinforced Unsaturated Polyester Composites And Its Influence On Their Mechanical Properties. Pertanika J. Sci. & Technol. 18 (2): 433 – 440 (2010).
2. Hasani H. Effect of Different Processing Stages on mechanical and surface Properties of Cotton Knitted Fabrics.
3. Indian Journal of Fibre and Textile Research, Vol.35, June2010,pp.139-144.
4. Satapathy Alok and Kumar Alok. Processing and Characterization of Jute-Epoxy Composite Reinforced with SiC Derived from Rice Husk. Journal of...
5. Ratna A V, Rao Mohana K And Nagasrinivasulu G. Mechanical properties of banana empty fruit bunch fibre reinforced polyester composite. *Indian journal of fiber and textile research* Vol 34 June 2009, pp.162-167.

6. Khan Mubarak, Ghoshal Sushanta, Khan Ruhul, Pervin Shamim-Ara And Mustafa Ahmed. Preparation And Characterization Of Jute Fiber Reinforced Shellac Biocomposites: Effect Of Additive. *Chemical Technology* Vol. 2, No. 3, 2008.

7. Goswami D.N, Ansari M.F, Day A, Prasad N & Baboo B. Jute-fibre glass-plywood/particle board composite. *Indian journal of chemical technology* Vol. 15, July 2008, pp. 325-331.

8. Acharya S.K, Mishra P. and Mishra S.C. Effect of Environment on the Mechanical Properties Of Fly-Ash-Jute polymer composite. *Indian Journal of Engineering Material Science*, Vol.15, Dec 2008, pp.483-488.

9. A. K. Bledzki A.K, Mamun A.A, Faruk O. Abaca fibre reinforced PP composites and comparison with jute and flax fibre PP composites. *Express Polymer Letters* Vol.1, No.11 (2007) 755–762.

10. Rashed H.M.M.A, Islam M.A. And Rizvi F.B. Effects Of Process Parameters On Tensile Strength Of Jute Fiber Reinforced Thermoplastic Composites. *Journal Of Naval Architecture And Marine Engineering*, June 2006