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ESTIMATING THE TENSILE BEHAVIOR OF HYBRID COMPOSITE LAMINATES

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ABSTRACT

The hybrids composite has emerged and have the potential reinforcement material for composites and thus gain attraction by many researchers. This is mainly due to their applicable benefits have they offer low density, low cost, renewable, biodegradability and environmentally harmless and also comparable mechanical properties with synthetic fiber composites. The laminates are reinforced with three different hybridization of fibre materials namely hybridization of E-glass and Kevlar fibres,hybridization of E-glass and jute fibres,hybridization of jute and kevlar and LY556 Epoxy resin and HY951 hardener.Hand layup method is used for fabrication of laminates.

Keywords- *Hybridization, jute fiber, glass fiber, kevlar fiber.*

I. INTRODUCTION

The incorporation of several different types of fibres into a single matrix has led to the development of hybrid bio composites. The behavior of hybrid composites is a weighed sum of the individual components in which there is a more favorable balance between the inherent advantages and disadvantages. Also, using a hybrid composite that contains two or more types of fibre, the advantages of one type of fibre could complement with what are lacking in the other. As a consequence, a balance in cost and performance can be achieved through proper material design.
One of the major scientific challenges for the composite engineers is the development of new

Stronger and tougher lightweight structural materials supporting latest technologies and design concepts for the complex shaped structures like aircraft, automotive structures, and large wind turbine blade structures. The development of composite materials improving their performance limits based on the reinforcement of two or more fibres (synthetic fibre with another synthetic fibre or synthetic fibre with natural fibre or synthetic fibre with metallic fibres) in a single polymeric matrix, which leads to the advanced material system called hybrid composites with a great diversity of material properties, is still in its infancy. They have been developed as a logical sequel to conventional composites containing one fiber. Hybrid composites have unique features that can be used to meet various design requirements in a more economical way than conventional composites. This is because expensive fibers like graphite and boron can be partially replaced by less expensive fibres such as glass and Kevlar.

II. EXPERIMENTAL PROCEDURES

Materials and their properties

Table 1. Physical properties of Jute fiber.

Physical property	Jute fiber
Density (g/cm3)	1.4
Elongation at break (%)	1.8
Cellulose content (%)	50 – 57

Lignin content (%)	8 – 10
Tensile strength (MPa)	700 – 800
Young's modulus(GPa)	30

Table 2. Physical properties of E-glass fiber.

Physical property	E-Glass fiber
GSM	280gsm
Orientation	plain-woven fabric
UTS	2000 MPa
Modulus	80 GPa
Density	2.55 g/cc

Table 3. Physical properties of Kevlar fiber.

Physical property	E-Glass fiber
Orientation	plain-woven fabric
UTS	2860 GPa
Modulus	64 GPa
Density	1.44 g/cc

Chemical treatment of jute fiber

Jute fibers are chemically treated in the sodium hydroxide flakes (Noah), which are mixed in the water with an estimated proportion of 10:100 and stirred systematically and jute fibers are soaked in that solution for 12-15 hours and dried out in the shadow up to 2 days. After the treatment we are seen, shrinkage of the fibers takes place. A significant effect on the fiber structure takes place due to the shrinkage of the fiber structure and, as a result, on the mechanical properties of the fibers. The improved mechanical properties are young's modules of the fibers increases nearly 30 to 50 percentage and Fibers attain the properties of stiffness and smoothness.

Specimen Fabrication

An attempt has been carried out to fabricate interplay hybrid composite laminates by using hybridization of jute and E-glass fiber reinforced epoxy, hybridization of jute and Kevlar fiber reinforced epoxy and a hybridization of kevlar and E-glass fiber reinforced epoxy. hybrid of jute/E-glass fiber reinforced epoxy.

Preparation of Epoxy-Hardner Mixture

For each laminate nearly 300g of epoxy-hardner mixture is taken. Hardner is taken in the ratio of 1:10 (*i.e.*; for every 10ml of epoxy 2ml of hardner is added). Then the mixture is thoroughly mixed for some time and is used for preparing laminates.

Fabrication of Laminates

The flat plat mould is used for fabrication of face sheets i.e., laminates. The mould was manufactured by using welding

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process. It having a two parts top and bottom, the laminates are laid in bottom plate and top plate is used for dispense the weight evenly throughout the laminate.

Fig: 1 Mould for Fabrication of laminates

The hybrid laminates are made of, reinforcement as reinforced with hybridization of E-Glass and jute fibers, E-Glass and Kevlar29 fibers, Kevlar29 and jute fibers and matrix as Epoxy resin LY556 with a hardener HY951 was selected which is a room temperature curing matrix. When the surface of the mold and the top plate of bottom surface are smoothened, the releasing moiler film is place on the mold which acts as a releasing agent, so that the final laminate does not adhere to the mold. The fiber fabric having required shape was placed on the surface of the moiler film, then by using brush the resin was uniformly applied, after first layer an another fiber material is set on top it which will be the second layer and another layer of resin coat was applied on the surface of it. Likewise, an alternate layer of fabrics material is laid. After fulfillment of every last one of layers the releasing moiler film is put on the final Layer then, the top mold plate is put on it. This mold with overlay is kept around 8-10 hours in a room temperature for curing, and then the hybrid face sheets are removed from the mould. Hybrid composite face sheets of different material combinations are shown in.

Fig: 2 Hybrid composite laminates

III. TESTING OF COMPOSITES

To enhance the tensile properties of hybrid composite laminates, tensile test is conducted by UTM. The below table shows laminates designations and layer sequence of each laminate

3.1 Laminates designation and Layer seqences

Composites	Composition
L1	G+K+G+K+G+K+G+K
L2	G+J+G+J+G+J+G+J
L3	J+K+J+K+J+K

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Glass layer
Kevlar
Glass layer
Kevlar
Glass layer
Kevlar
Glass layer
Kevlar

Glass layer
Jute
Glass layer
Jute
Glass layer
Jute
Glass layer
Jute

Jute
Kevlar
Jute
Kevlar
Jute
Kevlar

The above tables shows that Schematic representation of Hybrid composite laminates.
The thickness of each layer of Jute is 0.3mm, each layer of glass is 0.28 mm each layer of kevlar is0.3. As per ASTM standard, the thickness of each laminates is 3 mm, So as to maintain the ASTM standard, considering 4 layers of E-glass and 4 layers of Kevlar for L1 for L2 it takes 4 layers of E-glass and 5 layers of jute, for L3 it takes 3 layers of jute and 3 layers of Kevlar.

IV. TENSILE TESTING

Hybrid composite laminates are investigated by Tensile test by using Universal testing Machine (UTM) having capability of 60KN. In this present work the laminates are shaped into dumbel shape as shown in fig, for the purpose of holding the ends in grippers of UTM.

Fig: 3 Specimen for Testing

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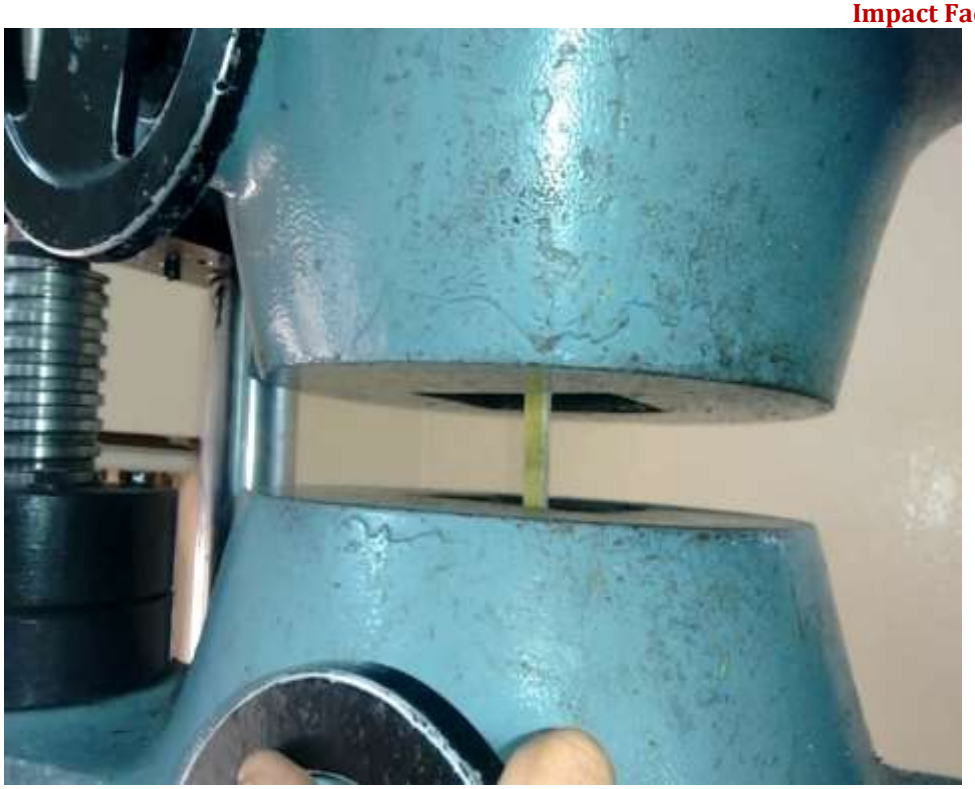

Fig: 4Tensile testing of specimen

V. RESULT& DISCUSIONS

Tensile Testing for Kevlar and Jute

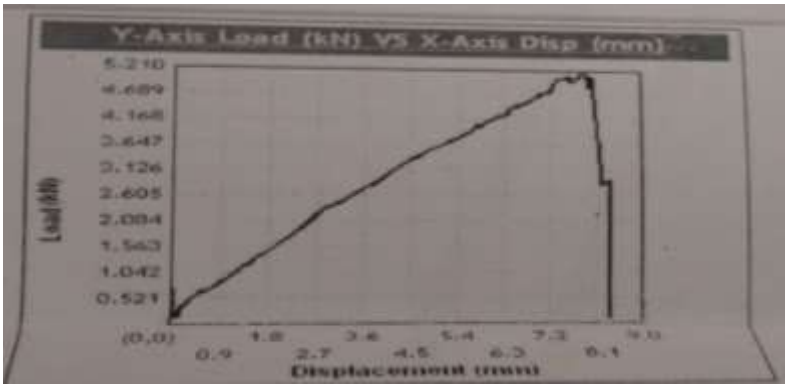

Fig: 5 Load Vs Displacement diagram

From the above curve, initially within a short period of time, the load increases and decreases suddenly with the effect of hybridization of materials (combinations of Kevlar & Jute), then the load increases gradually with the displacement up to the highest peak load i.e, Yield point, after yield point the failure of specimen takes by delamination between layers as shown in fig below, finally fracture takes place and load is abruptly decreases.

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Fig: 6 Fracture occurred with Delamination behaviour

Tensile Testing for E- glass and Jute fiber.

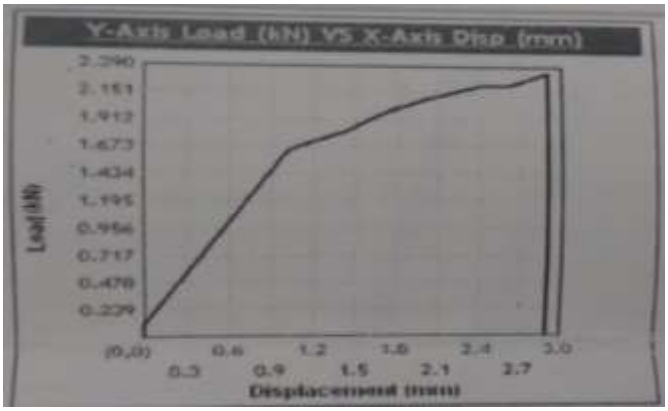

Fig: 7 Load Vs Displacement diagram

From the above curve, the load increases with no displacement, then the curve shows a linear behaviour up to the first peak load as shown in diagram. Then after the curve prolong in a irregular manner till it reaches the yield point of the material and sudden failure takes place with no displacement because of the hybridization of glass and jute shows a brittle behaviour.

Fig: 8 Fracture occurred with Brittle behaviour

Tensile Testing for E-glass and Kevlar fiber

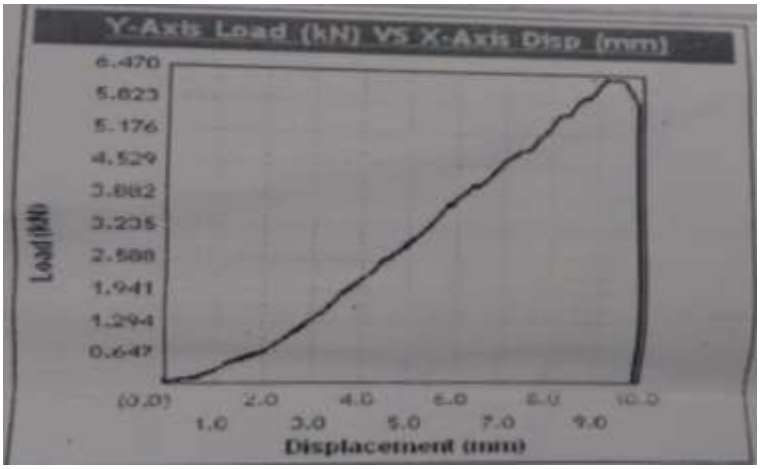

Fig: 9 Load Vs Displacement diagram

From the above diagram, we can observe that, the load increases continuously withthe displacement in nonlinear manner up to it reaches highest peak load i.e., yield point. In that yield condition the curve moved steadily without taking any load, then after failure takes place of specimen taken by delimitation of layers as shown in fig below, and then load is suddenly down.

Fig: 10 Fracture occurred with no Delamination

VI. CONCLUSION

The hybrid composite laminates are fabricated by using the Hand Layup method using different combinations like E-glass, Kevlar & jute. The coupons are reinforced with three different hybridizations of fiber materials, namely, hybridization of E-glass and Kevlar29 fibers, hybridization of E-glass and Jute, hybridization of Kevlar29 and Jute fibers and matrix is used as epoxy. Later they are subjected to tensile test for finding the tensile load carrying behavior. From the below table the hybridization of Glass and Kevlar shows a better tensile properties compare to other two hybridizations.

Hybridizations	Load(KN)	Displacement(MM)
Kevlar and Jute	5.21	8.1
E-Glass and Jute	2.39	3
E-Glass and Kevlar	6.47	10

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