ISSN: 0974-2115
www.jchps.com Journal of Chemical and Pharmaceutical Sciences

Experimental investigation of aluminium alloy with glass-flax fiber reinforced hybrid composite

Dinesh C, Ranga Raj R, Sivakumar P, Sivasakthi M
Department of Aeronautical Engineering, Sri Ramakrishna Engineering College, Coimbatore, Tamil Nadu – 641 022
***Corresponding author: E-Mail: sivasakthi.1208038@srec.ac.in**

ABSTRACT

Natural fibers have recently become attractive to researchers, engineers and scientists as an alternative reinforcement for fiber reinforced polymers composites. In this experimental study, Aluminium 8011 metal is reinforced with Glass/Flax fabric by epoxy resin. Aluminium 8011, Glass/Flax fabric layer were sequentially stacked in two different variations to fabricate eleven plies- Aluminium 8011, Glass/Flax fabric hybrid composite. The two different sequentially stacked laminates were processed by Compression moulding and were subjected to Tensile, Compression and Flexural test in order to determine the Mechanical and Elastic properties of these hybrid composites. The results of two differently stacked laminates were examined and compared.

KEY WORDS: Hybrid, Glass/Flax fabric.

1. INTRODUCTION

A Composite is a structural material that consists of two or more materials combined together. As they possess low density, they have been used in aerospace, automotive and defense industries. A composite material is generally made with reinforced fibers or particles which is embedded in a matrices mainly Polymers, metals and ceramics. The matrices acts as a load transfer medium between fibers and in less ideal cases where the complex loads are acting. The matrix also protects the fiber from environmental damage. Natural fiber reinforced composite are more considerable because of low cost, light weight, high strength to weight ratio, renewability, lower density and lower energy requirements for processing. From the researches it is found that the natural fibers have the drawbacks such as incompatibility between fibers and matrix and reduced resistance to moisture. This drawback can be overcome by chemical modification of and treatments such as alkali treatment, benzoylation, acetylation etc. The widely used natural composites are Flax, Jute, hemp etch. The natural fibers are mainly considered as a potential alternatives to glass fiber for composite materials as the density of natural fiber is 1.5 compared to 2.5 of glass fiber. As the flax and glass have different properties, they can be enhanced through hybridization. Hybrid composite is a weighted sum of several different components in which more preferable balance between the advantages and dis-advantages, were the advantage of one type fiber could complement what are lacking in other component. The hybrid composites can offer better resistance to water absorption, cost reduction, weight savings and increased modulus of materials. The hybrid composite can be arranged in different arrangements but the mechanical properties of hybrids have been limited to configuration in which how the fibers are mixed within the matrices. Natural fibers which are incorporated in hybrid composites are studied for economical, ecological and recycling advantages and also the specific strength benefits. They provide high specific strength/stiffness, corrosion resistance, light weight construction, low thermal conductivity. The Natural fiber reinforced polymer composites with (polyester, epoxy or vinyl-ester matrix) reinforced with glass fiber is mainly applicable in the structural engineering which can be compared with existing material such that the high cost fibers which is now way in the industry can be replaced. The studies show that the effect of varying textile yarn linear density, configuration and stack sequence improves the fracture toughness of the composite.

2. MATERIALS AND METHODS

2.1. Specimen preparation: In this experiment, aluminium 8011 alloy sheet, combined with E- Glass/Flax fiber. The properties of those materials are shown below. The epoxy based on LY556 resin and HY951hardener was used to manufacture the composite plate. The samples were prepared using the Aluminium, Glass/Flax fibers and epoxy, which are handled differently in the processing. The moulds are cleaned and dried before applying epoxy. Wax was used as the releasing agent. In the case of glass/flax fiber/epoxy fabrication, the epoxy mixture is laid uniformly over the mould using a brush. Apply the epoxy on the layer of both glass and flax fiber uniformly. The same process was repeated until required such layers of epoxy and woven roving mat were applied. Now the mould is closed and compressed for a curing time of 2 hours at 80 0c. A releasing agent should be applied after which a coat of epoxy was applied. After the curing process, test samples were cut to the required sizes prescribed in the ASTM standards.

Table.1.Stacking sequence of hybrid composite

Notation	Number of laminates	Structure of laminates	Sequence
Al, G, F	11	Al8011+ Glass+Flax	Al+G+F+G+Al
			Al+F+G+F+Al

2.2. Tensile Testing: The tensile tests were carried out in accordance with ASTM 3039-76 dimension standard. The laminate dimension for specimen 1 is (100×25×6mm) and for the specimen 2 is (100×25×5mm).

Fig.1.Specimen for tensile test

2.3. Compression Test: A compression test determines behavior of materials under crushing loads. The specimen is compressed and deformation at various loads is recorded. Compressive stress and strain are calculated and plotted as a stress strain diagram which is used to determine elastic limit, proportional limit, yield point, yield strength and compressive strength. The compressive test were carried out in accordance with ASTM D6641 standard specimen which has the dimension of (15×15×6mm) for the one laminate and a dimension of (15×15×5mm) for the second laminate.

2.4. Flexural Test: The aim of this work was to determine the value of Young's modulus for three specimens in order to have more accurate value. The specimens are in ASTM D790 dimension. The modulus of elasticity is calculated by steepest initial straight –line portion of the load-deflection curve. The specimen dimension were in the dimension of (50×15×6mm) for the first laminate and for the second laminate is (50×15×5mm).

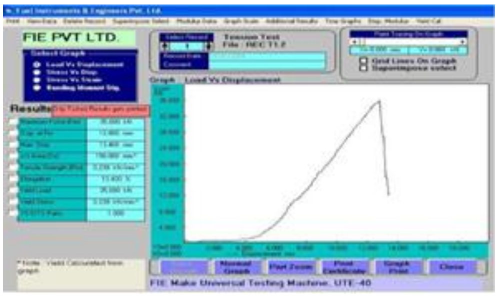
3. RESULTS AND DISCUSSION

Table.2.Experimental values for tensile test laminate which have flax fiber in center

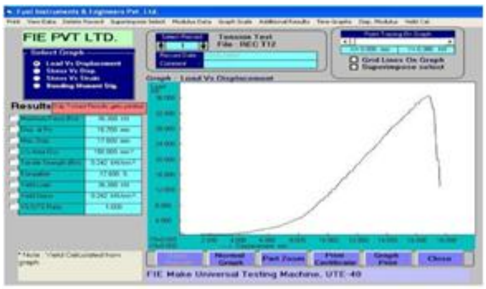
Specimen	Maximum Breaking Load (KN)	σ N/mm^2	Extension Mm	% of Elongation	E N/mm^2
T1	35.88	239.2	0.872	13.14	274.31
T2	36.36	242.4	0.833	17.6	290.99
T3	35.6	237.3	0.868	13.8	273.42

Table.3.Experimental values for Tensile test Laminate which have glass fiber in center

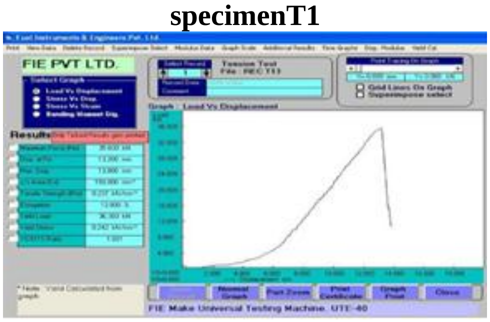
Specimen	Maximum Breaking Load (KN)	σ N/mm^2	Extension Mm	% of Elongation	E N/mm^2
T4	16.08	128.64	0.831	18.9	154.8
T5	24.22	193.76	0.868	15	223.22
T6	23.48	187.84	0.879	13.1	213.69



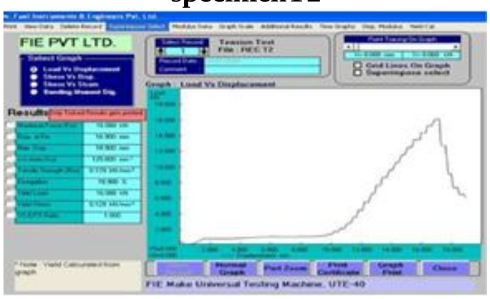
Graph.1. Load vs. Displacement for tensile specimenT1



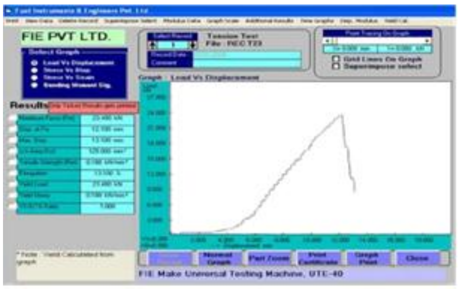
Graph.2.Load vs. Displacement for tensile specimenT2



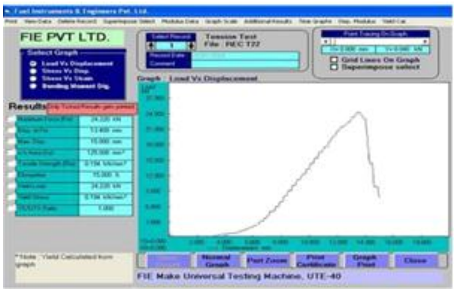
Graph.3.Load vs. Displacement for tensile specimenT3



Graph.4.Load vs. Displacement for tensile specimenT4



Graph.5.Load vs. Displacement for tensile specimenT5



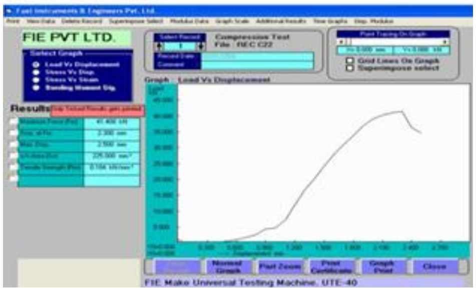
Graph.6.Load vs. Displacement for tensile specimenT6

Table.4.Compressive values for laminate which have flax fiber in center

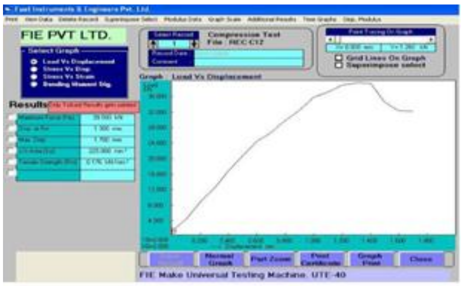
Specimen	Maximum Breaking Load (KN)	Ultimate compressive strength (N/mm^2)	Extension mm	Young's modulus (N/mm^2)
C1	31.320	139.2	0.8	174
C2	43.160	191.822	0.8727	219.796

Table.5.Compressive values for laminate which have glass fiber in center

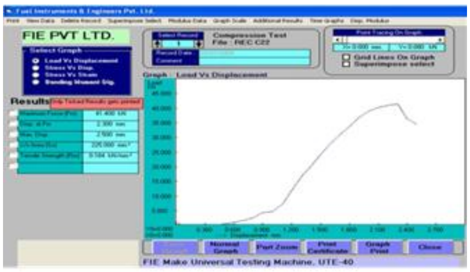
Specimen	Maximum Breaking Load (KN)	Ultimate compressive strength (N/mm^2)	Extension mm	Young's modulus (N/mm^2)
C3	39.500	175.55	0.87	201.7885
C4	41.400	184	0.77	238.96



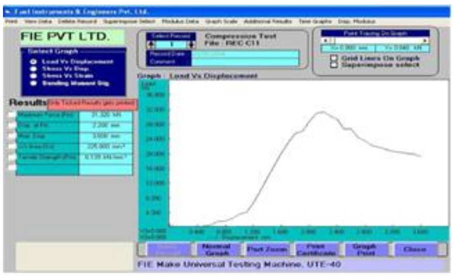
Graph.7.Load vs. Displacement for compressive test specimenC1



Graph.8.Load vs. Displacement for compressive test specimenC2



Graph.8.Load vs. Displacement for compressive test specimenC3



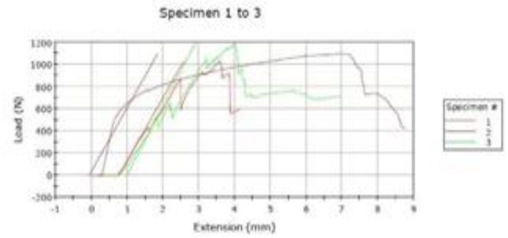
Graph.9.Load vs. Displacement for compressive test specimenC4

Table.6.Flexure values for laminate 1

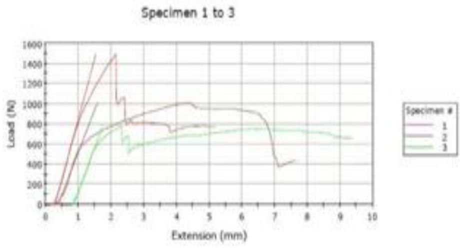
Specimen	I1	I2	I3
E(MPa)	2609.432453	24212.65743	3661.20639

Table.7.Flexure values for laminate 2

Specimen	I1	I2	I3
E(MPa)	13478.966	6515.03740	5929.0362



Graph.10.Load vs. Extension for test specimen1



Graph.11.Load vs. Extension for test specimen 2

4. CONCLUSION

Based on the study of the mechanical properties of different layered stacking sequences of Aluminium, Flax/Glass Hybrid epoxy composite , the following conclusion has been made,

The laminate which have the Flax fiber in Centre of the laminate possess considerably greater tensile strength and young's modulus "E" than the laminate which have glass fiber in center. For the Strength: weight ratio of the two laminates, the results were nearly 2.5N/kg.mm2 for both the laminates. The weight of laminate which have flax fiber in Centre have 20 grams more than the laminate which have glass fiber in center. So that the laminate which have Glass fiber in center can be used instead of laminate which have Flax fiber in center as the strength and young's modulus match necessary to withstand and also reduces the weight of the material. For compression strength, the laminate which have the Flax fiber in center offers highest resistance to the maximum load applied in KN were as the laminate which has Glass fibers slightly below the results shown by the other. The strength and young's modulus determined in Flax centered laminate is 1.2 times greater than Glass centered laminate. The modulus of rapture (or) the strength of material under bending (or) Flexural strength is very high in case of laminate which have Glass fiber in Centre when compared to the Flax centered laminate.

REFERENCES

Alaattin Aktas, The effect of stacking sequence on the impact and post-impact behavior of woven/knit fabric glass/epoxy hybrid composites, Elsevier, Composite Structures, 103, 2013, 119–135.

Bongarde U.S, Review on the tensile properties of natural fiber reinforced polymer composites, International Journal of Engineering Science and Innovative Technology (IJESIT), 3 (2), 2014, 431-436.

Chensong Dong, Optimal design for the flexural behavior of glass and carbon fiber reinforced polymer hybrid composites, Elsevier, Materials and Design, 37, 2012, 450–457.

Clement Gourier, Mechanical analysis of elementary flax fiber tensile properties after different thermal cycles, Elsevier, Composites: Part A, 64, 2014, 159– 166.

Karandeep Singh Sodhi, Development and Mechanical Characterization of Low Cost Natural Hybrid Date/Jute Fiber Reinforced Epoxy Composite, International Journal of Research in Mechanical Engineering & Technology, 5 (1), 2015, 94-99.

Mayur Thombre, Study of Mechanical properties of hybrid natural fiber composite, IOSR Journal of Mechanical and Civil Engineering, 2014, 1–5.

Muralidhar B.A, Study of flax hybrid performs reinforced epoxy composites, Elsevier, Materials and Design 52, 2013, 835–840.

Quazi T.H. Shubhra, Mechanical properties of polypropylene composites: A review, Research gate, Journal of Thermoplastic Composite Materials, 26 (3), 2013, 362–391.

Raffaele Sepe, Mechanical properties of woven natural fiber reinforced composites, Research Gate, European Conference on Composite Materials, 2012, 1-12.

Soma Dalbehera, Study on mechanical properties of natural fiber reinforced woven jute-glass hybrid epoxy composites, Advances in Polymer Science and Technology, 2014, 1-6.

Sutharson B, Optimization of natural fiber/glass reinforced polyester hybrid composites laminate using Taguchi methodology, International Journal of Materials and Biomaterials Applications 2 (1), 2012, 1-4.

Taranu Nicolae, Fiber Reinforced Polymer Composites as Internal and External Reinforcements for Building elements Buletinul Institutului Politehnic Din Iaşi Publicat de Universitatea Tehnica, Gheorghe Asachi, din Iaşi Tomul LIV (LVIII), Fasc.1, Sectia, Construct II, Arhitectura, 2008, 7-20.