Indian J.Sci.Res. 17(2): 87-90, 2017
ISSN: 0976-2876 (Print)
ISSN: 2250-0138(Online)

EXPERIMENTAL INVESTIGATION OF MECHANICAL PROPERTIES OF HYBRID REINFORCEMENT POLYMER MATRIX

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Abstract - Hybrid composites have emerged and potential reinforcement materials for composite. This is mainly due to their applicable benefits have they offer low density, low cost, environmentally harmless and also comparable mechanical properties with synthetic fiber composites. In this project carbon fiber/ glass hybrid laminates and carbon/sisal/glass hybrid composite laminates were obtained by vacuum bag molding process. The effect of fiber orientation and properties are studied. The composites were cut into pieces as per ASTM standards for different observations deals with the testing of tensile, flexural strength and impact test on a universal testing machine. The graphs and resultant values are obtained from the tests . The properties of carbon/sisal/glass and carbon fiber/ glass are compared. The carbon fiber/ glass laminates exhibit higher mechanical properties. Hence, the high performance hybrid laminated materials has extensive engineering applications such as naval, aeronautical, automobile industries.

Keywords**:** Hybrid Laminates, Mechanical properties, epoxy, vacuum bag molding

I. Introduction

Polymers are particularly attractive as matrix materials because they are easily processable and their density is comparatively low when compared to other materials. The reinforcements share the major load especially when a composite consists of fiber reinforcements dispersed in a weak matrix (e.g., E Glass/carbon/epoxy composite), the fibers carry almost all the load, therefore, controlled by the strength and stiffness of constituent fiber. Carbon is superior high-temperature materials with strength and stiffness properties maintainable at temperature up to 2500 ^{0}K. Originally, these materials were produced for applications where hardware was exposed to extreme temperatures requiring high performance standards, such as solid rocket motors. Nowdays carbon composites are used in commercial as well as naval applications. Several researchers studied the influence of glass fiber and carbon fiber reinforced epoxy polymer matrix on the mechanical properties. The hybrid composites were developed by varying the reinforcements from 15%, 30%, 45% and 60% of glass fiber and carbon fiber in 40% epoxy matrix under vacuum bag process (Jagannatha et al., 2015). The composite engineers are focusing on the development of new stronger, 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 (Gururaja et al., 2012). The development of composite materials improves their performance based on the reinforcement of two or more fibers in a single polymeric matrix, which leads to the advanced material system called hybrid composites with a great diversity of material properties (Prabhakaran et al., 2012). Studied impact response of woven glass fiber epoxy matrix composite laminates, they show that the laminates exhibited two types of failure modes viz.,crack initiation and perforation of the laminate (Rajesh et al., 2010). The compressive experimental study to identify the effects of fiber cross sectional aspect ratio on tensile & flexural properties and failure modes of glass fiber/epoxy composites by using fibers of different cross sectional Shapes was carried by Deng et al., 1999. Studied the effect of the fibre length on the fatigue of a short carbon/epoxy composite. They showed that fatigue life is independent of fibre length at any peak strain (Hitchen et al., 1995). In the present work, an attempt has been made to prepare carbon / glass and carbon/sisal/glass fiber hybrid laminates. The laminates were obtained by vacuum bag molding process. The effect of fiber orientation of laminates has been investigated to determine property data for material specifications.

II. Experimental Procedure

II.I. Material Preparation

The Epoxy and hardener are mixed in the ratio of 1:10 in order to obtain resin .The E-glass fiber, Carbon fibers and sisal fibers are selected as reinforcements and epoxy as matrix material. The epoxy resin LY-556 of density 1.1-1.2gm/cc and hardener HY140 were used. The glass fiber of bi-directional woven cloth with 600 gsm and the density of 2.5 gm/ cc, the Carbon Fiber of bi-directional woven cloth with 200 gsm and the density of 1.78 gm/cc and sisal fibers are used. The sisal fibers are isolated from the meshes manually and rinsed with a tap water (4% cleanser solution) to remove the pollutants ,impurities etc,. The separated fibers are air-dried for 48 h at atmospheric temperature. Then the fibers are sliced according to length (200mm) as needed and conserved in polyethylene covers. The glass fiber, carbon fiber and sisal fiber used in the fabrication of hybrid fiber reinforced composites are shown in Figure 1.

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Fig.1 Glass/sisal/carbon fibers

II.II. Fabrication of Composites

The vacuum bag process is used for preparing the laminates. At first, the experimentation of the composite is carried at atmospheric temperature. The resin and hardener were mixed thoroughly for this work. laminates. The prepared specimens are sliced into pieces as per the required dimensions and the fiber is placed manually in the open mold and the molded surface must be smoother in order to facilitate bonding to the composite. After placing the laminates the mold is sealed, the air is removed from the sealed mold using vaccum bag at the pressure of 0.1 bar. The entire air is removed .After that, the prepared resin is poured into the mold. Due to the vaccum resin is evenly spreaded up. All the prepared mechanical specimens are removed from the mold and cured in the same atmospheric conditions. Moreover, the specimens are cured again in an oven at a temperature of 50 °C for 1 hour. The vacuum bagging process adopted for the development of hybrid composite is shown in Figure 2**.**

Fig 2 Experimental Setup

II.III. Specimen Preparation

The carbon/sisal/glass and carbon fiber/ glass epoxy materials so far prepared are taken out and then materials of suitable dimensions are obtained from composites for different mechanical investigations as per ASTM standards. The investigated specimens are sliced from laminates by using water jet cutter in the mechanical shop. Tensile test, flexural strength and Impact test specimens are prepared as per ASTM D3039 standard.

II.IV. Mechanical Testing

Mechanical properties of composites are analyzed by tensile, flexural strength and impact test readings. The specimens are prepared from the obtained composites and edges of the specimen are poised by using file and emery paper for tensile testing. Tensile tests are evaluated according to ASTM D3039. According to the ASTM standard, the dimensions, gauge length and cross-head speeds are fixed. The specimen is placed in a machine for tensile test to mounting and subjected it to the tensile stress. The evaluating process involves placing the test specimen in the testing machine and applying tensile stress to it until it fractures. Due to the load, the elongation and threshold load of the testing specimen is recorded. As per the ASTM standard the flexure specimens are prepared. The deflection of specimen is measured by the cross head position. The testing process involves placing the test specimen in the universal testing machine and force is applied to it, until it breaks. Further, Specimens are prepared for impact test according to the the ASTM standard. It is a standardized method which determines the amount of energy absorbed by a material during tensile fracture. This absorbed energy is the measure of a given material's toughness

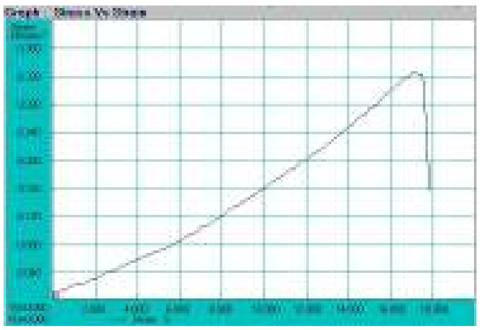
III. Results And Discussions

Tensile properties

The tensile strength is higher for carbon/E-glass when compared to carbon/sisal/E-Glass. The UTS of carbon fiber/ glass reinforced composite is higher because of the strength of carbon fiber is higher and behaves like elastic material during tensile loading compared to the substitute. The inclusion of carbon fiber cloth reinforced polymeric composite significantly enhance the ultimate tensile strength of the composite.

Laminate Hybrid Composites		Load (F) Kn	Disp.At Fmax Mm	Thickness(T) Mm	Area Of Cross Section Mm^2	Stress (S) Kn/Mm^2	Elonga-Tion %	Yield Stress Kn/Mm^2
Carbon / E-Glass	1	12.355	10.90	5	39.00	0.316	16.667	0.081
Carbon /sisal/ E-Glass	1	11.795	10.20	5	36.40	0.324	13.333	0.259

Carbon/E-Glass

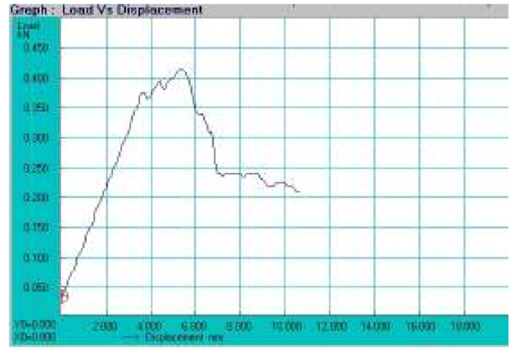


Carbon/E-Glass /Carbon/sisal/E-Glass

Flexural properties

From the test, the graph of flexural strength is plotted for the carbon fiber/ glass and carbon fiber/ glass composites. The observed results indicates that the maximum impact strength is obtained for Carbon/ E-Glass composites.

Laminate Hybrid Composites	Load (F) Kn	Disp At Fmax Mm	Thickness (T) Mm	Area Of Cross Section Mm^2	Stress (S) Kn/Mm^2	Max. Disp
Carbon/ E-Glass	0.415	5.30	5	44.4	0.009	10.70
Carbon/sisal/E-Glass	0.370	2.70	5	44.45	0.008	15.60



Carbon/sisal/E-Glass

Impact Test

The impact test carried out is charpy impact test. The obtained the results indicates that the maximum impact strength is obtained for Carbon/ E-Glass composites are 6.2 J.

Laminate Hybrid Composites	Impact Load (Joules)
Carbon/E-Glass	6.2
Carbon/Sisal/E-Glass	5.2

IV. Conclusion

The evaluated results clearly indicates the reinforcements are always oriented in the load direction while designing composite materials . If the load direction is variable and not parallel to the fibers, it becomes crucial to investigate the laminate's mechanical behavior. The tensile strength of carbon / sisal / glass fiber hybrid is tested and found that the glass fiber composite is exhibiting higher tensile strength than the sisal fiber reinforced composite. The sisal / glass fiber hybrid composite tensile strength is higher than sisal reinforced composite but lower than glass fiber reinforced composite. As a whole, the carbon/e-glass is ideal and possess more strength in comparison to sisal fiber.

Reference

[1] T D Jagannatha, G. Harish (2015), "Mechanical Properties of Carbon/glass Fiber reinforced epoxy hybrid polymer Composites", International Journal of Mechanical Engineering and robotics Research (IJMERR), Vol. 4, No. 2, pp. 132-137.

[2] Gururaja M N and Hari Rao A N (2012), "A Review on Recent Applications and Future Prospectus of Hybrid Composites", International Journal of Soft Computing and Engineering (IJSCE), Vol. 1, No. 6, pp. 352-355.

[3] Prabhakaran R T D, Madsen B, Toftegaard H and Markussen C M (2012), "Flexural Properties of

Hybrid Natural Composite-Micromechanics and Experimental Assessment”, Proceedings of 3rd Asian Conference on Mechanics of Functional Materials and Structures (ACMFMS), Vol. 1, pp. 469-472, Indian Institute of Technology, New Delhi.

[4] N. Rajesh Mathivanan*, J. Jerald(2010) " Experimental Investigation of Woven E-Glass Epoxy Composite Laminates Subjected to Low-Velocity Impact at Different Energy Levels". Journal of Minerals & Materials Characterization & Engineering, Vol. 9, No.7, pp.643-652.

[5] Deng, S., Ye, L. and Mai, Y.-W. (1999). Influence of Fiber Cross-sectional Aspect Ratio on Mechanical Properties of Glass Fiber/Epoxy Composites, 1. Tensile and Flexure Behavior, Composite Science and Technology, 59: 1331–1339

[6] S.A.Hitchen, S.L.ogin and P.A.Smith, Effect of fibre length on Fatigue of short carbon fibre/epoxy composite, Composites, Vol26, No 4,1995, p 303.