FABRICATION AND INVESTIGATION OF TENSILE PROPERTIES OF EPOXY/GLASS FIBER COMPOSITES

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Abstract

Traditionally the epoxy/glass fiber composites, consisting of an epoxy resin matrix reinforced with glass fiber are used since they are light weight, immune to corrosion and possess high strength. In this investigation the composite material is fabricated by hand lay-up technique with epoxy LY556 resin and bi – directional e-type glass fiber. The fabrication and characterization of the epoxy/glass fiber composite has been studied by analyzing the tensile properties and topographical investigation of the specimens broken by tensile test were carried out using Scanning Electron Microscope (SEM). The composite plates of 5mm thickness were fabricated as per D638 ASTM standard.

Keywords: Epoxy/Glass Fiber, Hand Layup Technique, Tensile Property. SEM.

I. INTRODUCTION

A composite material consists of two or more materials and offers a significant weight saving in structures in view of its high strength to weight ratio and high stiffness to weight ratio. The orientation of the reinforcing fiber influences the mechanical properties of the composite. In the fiber reinforced composite materials, the fibers are the main load bearing members, and the matrix, which has low modulus and high elongation, provides the necessary flexibility and also keeps the fibers in position and protect them from the environment.

Epoxy resins are the most commonly used thermoset plastic in polymer matrix composites. The epoxy resins are generally manufactured by reacting epichlorohydrin with biphenol. As the proportion of epichlorohydrin is reduced the molecular weight of the resin is increased [1]. Epoxy LY556 resins are mostly used as matrix in composite materials in many applications, such as aerospace industries, automobile industries, structural panel, Marine applications, because of low creep, good adhesiveness, high strength, low viscosity, and low shrinkage during curing time. In addition, E-type glass fiber resin can be used in both laminating and hand layup techniques to give better mechanical strength and morphological properties[2].

Glass Fiber resin is a composite material made of a glass matrix reinforced by fine fibers [3]. Glass Fiber Reinforcement Plastic (GFRP) is a lightweight, strong material with many applications such as doors and panels in aerospace, outer and inner layer of the boats, automobiles, water tanks, roofing, pipes and cladding [4]. Glass fiber has good stiffness, very good tensile and compression strength along its axis.

II. EXPERIMENTAL METHOD

A. Epoxy and Laminated Glass Fiber:

Epoxy Araldite LY 556 along with hardener HY 951 were used as bonding material used in the fabrication of glass reinforced epoxy composite plates. The mixing ratio of epoxy (Araldite) and hardener is in the ratio (100: 10). The epoxy LY556 (Araldite) was used in this investigation since they are widely used in aerospace industries and Marine applications.

The bi-directional woven glass fiber is available in the standard form of 0.45 mm thickness. In this investigation the bi – directional e-type glass fiber was used because of it ± 45 degree orientation on both sides which gives additional strength to the composite material. First the glass fiber is taken and four sheets were cut to a standard size of $300 = 300$ mm and weighed. Each glass fiber sheet weighed 84 grams. Totally 4 numbers of glass fiber sheets were used in this process weighing 336 grams.

B. Hand layup Method:

Hand lay-up is a simple method for fabrication of composite material. A mold must be used for hand lay-up parts unless the composite is to be joined directly to another structure. The mold can be as simple as a plate or having infinite curves and edges.

For some intricate shapes, molds must be joined in sections so they can be taken apart for part removal after curing. Before lay-up, the patten boundary is prepared with a release agent to insure that the composite part will not adhere to the mold after curing. A brush was used to impregnate the fibers with the resin. The specimen thickness of the plate were maintained as 5 mm to conform to ASTM standard. After the hand layup technique, process the specimens was allowed cure at room temperature for 2 days. After curing process the material was cut in to required size and shape as per ASTM standard.

C. Tensile Test

Tensile test subjects a sample to uni axial tension until it fails by fracture or yielding. The results from the test are commonly used to select a material for an application to predict how a material will react under the different working environment and the while subjected to forces. The tensile specimens were milled to size $165 \times 19 \times 5$ mm (length $\times$ width $\times$ thickness), as per ASTM (American Standard Testing Methods) standard D638. Four specimens were used to conduct the tensile test and the graphs obtained from the tensile tests are shown in Figure. 1-4.

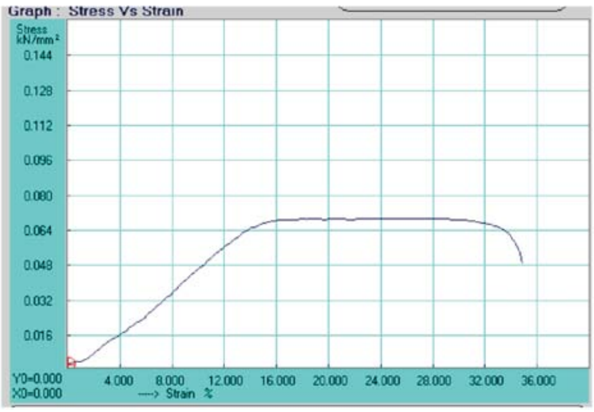

Fig. 1. Graph for stress vs. strain for tensile test Sample 1

III. RESULTS AND DISCUSSION

A. Tensile strength

Four samples were tested using computerized UTM (Universal Testing Machine) machine. The four samples were tested with same loading conditions. The sample S1 shown Ultimate strength is 0.069KN/mm^2 with same loading conditions and Sample S2 shown

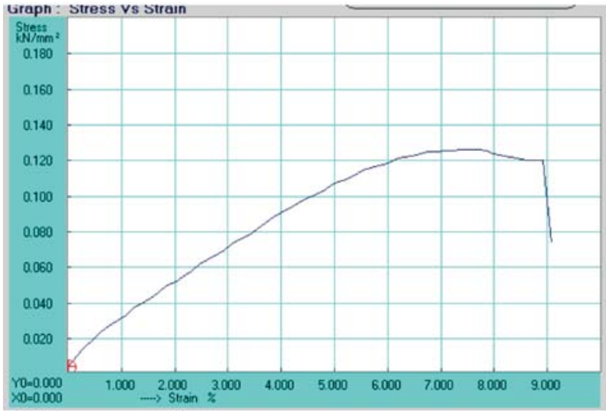

Fig. 2. Graph for stress vs. strain for tensile test Sample 2

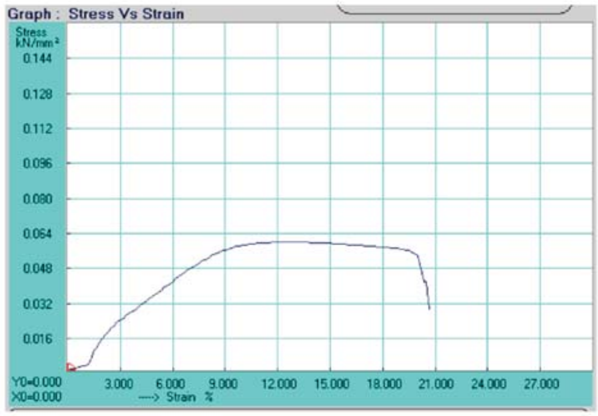

Fig. 3. Graph for stress vs. strain for tensile test Sample 3

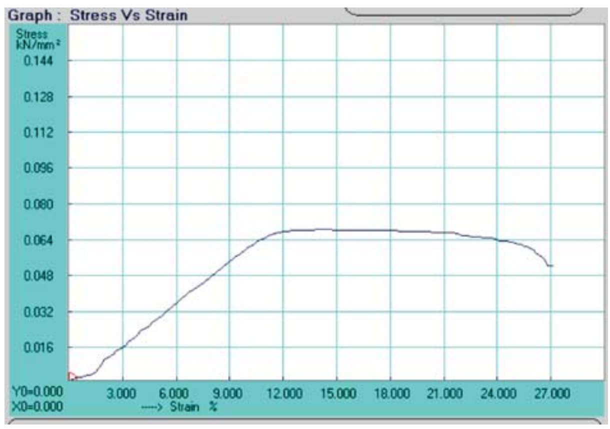

Fig. 4. Graph for stress vs. strain for tensile test Sample 4

Ultimate strength is 0.126 KN/mm^2 and Sample S3 shown Ultimate strength is 0.060KN/mm^2 and the sample S4 shown ultimate strength is 0.069 KN/mm^2. From the four Samples, Sample S2 had higher ultimate strength and better elongation when compare to other samples, as shown in Table 2 and 3.

Table 1. Load vs Ultimate Strength

Sample No	Load (KN)	Ultimate Strength (KN/mm^2)
S 1	3.385	0.069
S 2	7.770	0.126
S 3	2.885	0.060
S 4	3.360	0.069

Table 2. Load vs Displacement

Sample No	Load (KN)	Max Displacement (mm)
S 1	0.375	15.10
S 2	0.375	15.20
S 3	0.410	15.32
S 4	0.375	15.20

B. Morphological Properties

The SEM micrographs of fractured tensile surface of Epoxy/Glass Fiber composites revealed regions of cleavage and shearing [2]. It was observed that the surface of Epoxy/Glass Fiber have relatively very less holes and porosities which indicates the existence of a good bonding between the epoxy matrix and glass fiber, as shown in figure.5. The fractography images show that the interfacial interaction between glass fiber and epoxy is improved due to the proper application of epoxy over the fiber.

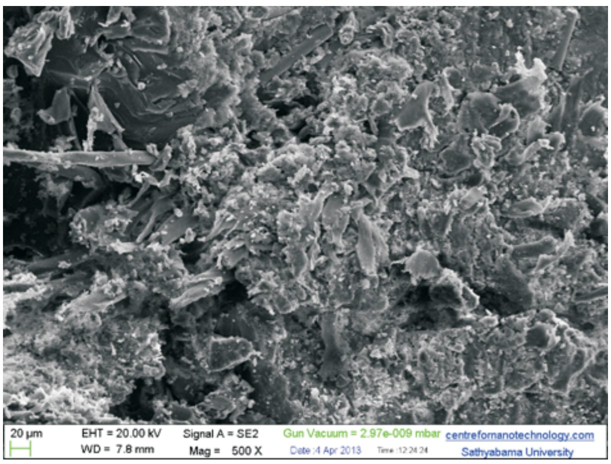

Fig. 5. SEM micrographs taken from the Tensile fractured surface of Epoxy /Glass Fiber composites.

IV. CONCLUSION

Experiments were conducted on Epoxy and Glass Fiber laminate composite specimens with fiber orientation of 45 degree orientation of woven type E - glass fiber and the tensile property was investigated. The topography of the fractured specimens were analysed from SEM images. It is observed from the results that the tensile property of Epoxy / Glass Fiber composite gives higher strength based on the skill of the technician fabricating the materials.

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