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Fabrication and Mechanical Behavior Study of Fiber Reinforced Composites for Automobile Applications

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Abstract: The composites which made up of fiber Reinforcements are universally endorsed option for the Automobiles with light weight. They provide enhanced properties such as low weight, high impact strength and improved resilience. Due to unique properties of fiber reinforced composites it became a perfect alternative for traditionally used materials. Most of the automobile industries prefer polymer matrix fiber reinforced composites for the reason that its light weight helps in carbon emission reduction. In this present investigation mechanical behaviors of Carbon/Epoxy, E-glass/Epoxy, hybrid Composites fabricated by Vacuum bag molding process were studied and optimum hybrid structure.
Keywords: Automotive industry, composite materials, reinforced plastics and polymers, Vacuum bag molding.

I. INTRODUCTION

In the history of materials Fiber reinforced composite conceives significant advancement where the products developed for the appropriate shape by Flexible and basic manufacturing technologies. Polymers generateab solute materials that can be gentle to prepare, possess lightweight, and desirable mechanical properties. It follows, therefore, that high temperature resins are extensively used in aeronautical and automobile applications. These multi-functional materials having remarkable mechanical and physical properties such as corrosion, oxidation and wear so it can be tailored to meet the requirements of particular applications. Epoxy resins are widely used in filament-wound composites and are suitable for molding process. They are reasonably stable to chemical attacks and are excellent adherents having slow shrinkage during curing and no emission of volatile gases. These advantages, however, make the use of epoxies rather expensive. Also, they can withstand a temperature of 140ºC. Fiber reinforced composites offers significant weight saving over existing metals. FRC's can provide structures that are 20-50% lighter than the traditionally used aluminium composites designed to achieve the similar functional requirements. This is due to the lower density of the composites.

A. Fiber Reinforced Polymer (FRP)

Fiber reinforced polymer (FRP) is a composite material made of a polymer matrix reinforced with fibers. In Fiber reinforced composites length of Reinforcements are greater than cross sectional dimensions. This type of composites is considered as short fiber or discontinues fiber composites, where the fiber properties vary with respect to length. Matrix and fibers are the main ingredient of strength in fiber reinforced composites. Here matrix joins all the fibers together in shape by using adhesive and transfers stresses (load) between the reinforcing fibers.

B. FRP'S in Automobiles

Fiber–reinforced composites are potentially is strong. So it has more possibilities for combining advanced materials with technologies that are already familiar from the processing of plastics. For automobile structural components it possess light weight opportunities at a weight of 50% lighter than conventional steel and 30% lighter than aluminum, more automakers use these materials as the body structure or other car components. With these advantages that coordinate directly with the automotive industry's needs, plastics and polymer composites can be a major part of the solution for automobile manufacturers.

II. EXPERIMENTAL PART

A. Sample Preparation

The Investigation has been carried out on two composite laminates (Carbon/Epoxy, E-glass/Epoxy). These composite laminates were made up of vacuum bag molding process using an epoxy resin type LY556 Supplied from Indutch Industries (Gujarat). In

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particular the laminates were cured at room temperature for 24 hours followed by a post cure at 55oC for 10 hours. A vacuum pressure about 0.1 Mpa was continuously applied during the curing process by using high volume pump. Bleed valve controls vacuum level manually.

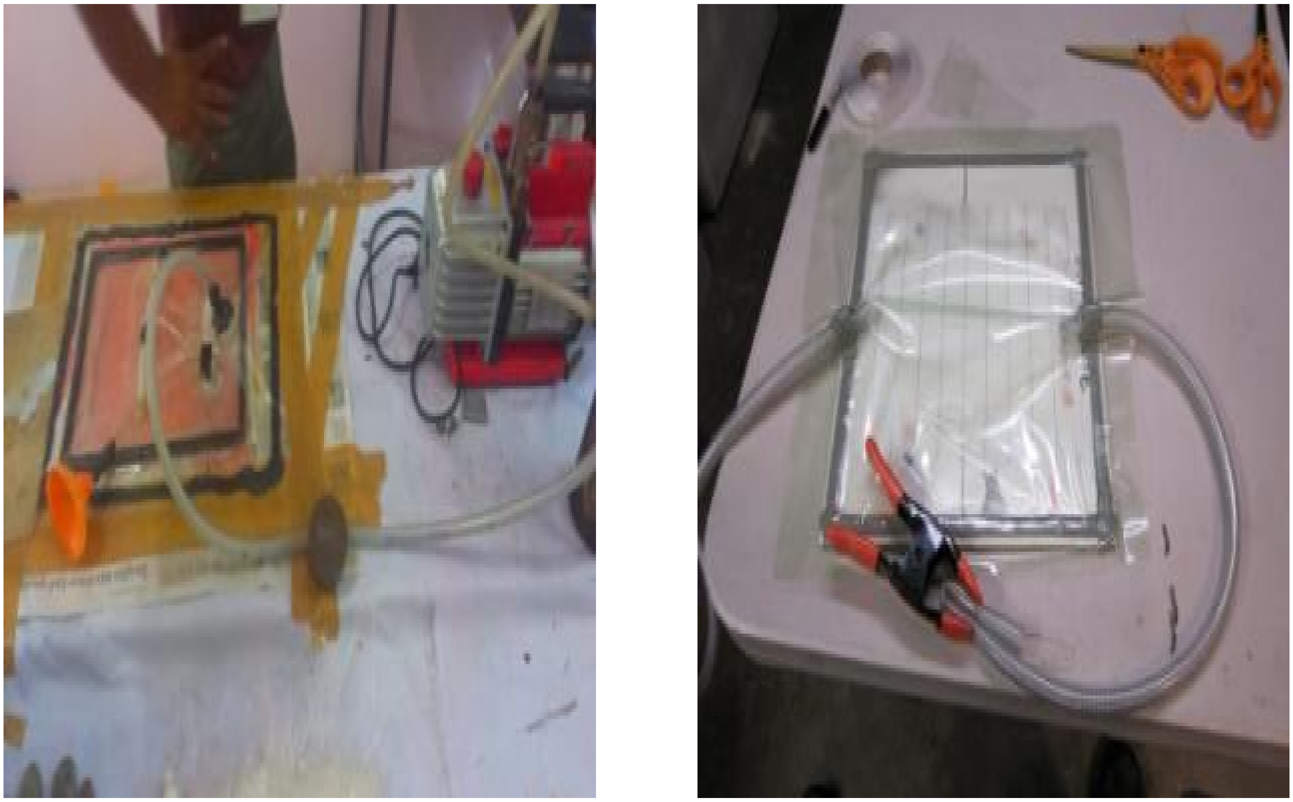

Fig. 1 vacuum bag molding setup

Both Carbon and E Glass sheets are characterized by a thickness of about 5mm. The fiber volume fraction has been evaluated by using classical formula

$$V_f = \frac{M_f}{\rho_f V_c}$$

Where m, ρ, v indicates the mass weight, Density and volume of laminates. f, m, c refers fibers, matrix and composites Respectively.

Fiber	E - Glass	Carbon
Fiber Density [g/cm^3]	2.04	1.95
Fiber Modulus [GPa]	95.8	198.7
Fiber Strength [MPa]	3334	4010
Matrix	Epoxy Resin LY556	Epoxy Resin LY556
Thickness[mm]	5	5
Fiber Volume Fraction [%]	36.5	38.3

Table. 1 Properties of Composite Laminates

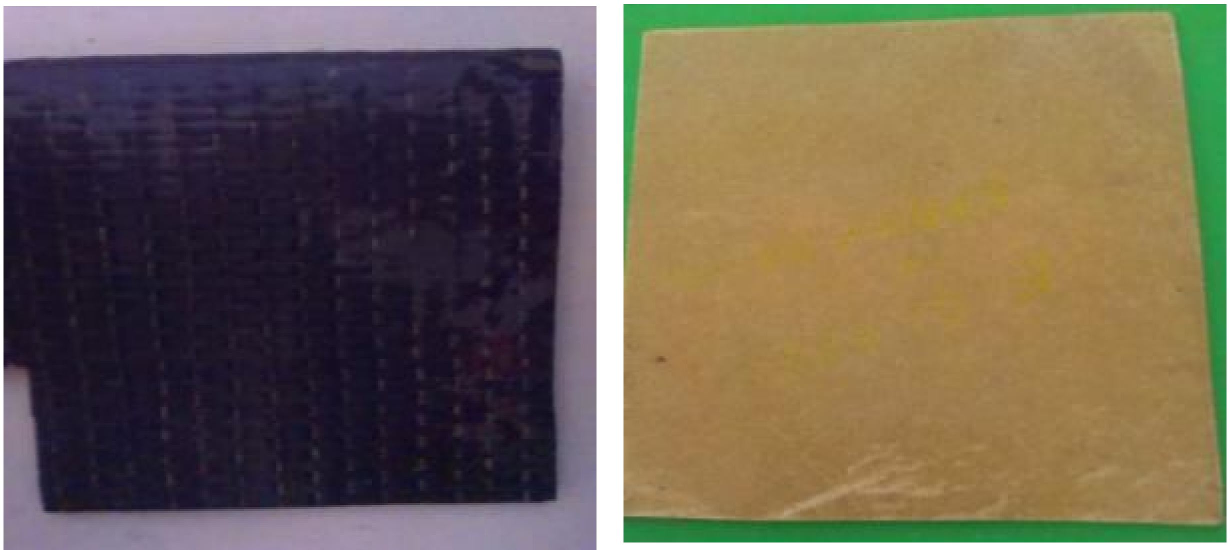

Fig.2 Composite Laminates, (a) Carbon laminate, (b) E-Glass laminate

B. Tensile Test

The tension testing is a carried out on the sample until it gets failure. The results from the test are commonly used to select a material for an application, for quality control, and to predict how a material will react under other types of forces. The tension test is carried out using specimen which is prepared as per ASTM standard. The experiments are conducted by using uniaxial tensile testing machine and it is the most common test method used for composite materials. The deflection of the specimen under various load conditions measured. The tensile strengthto the corresponding load is measured.The experiments are carried out at a temperature of around 25 °C with 50% humidity.The ultimate tensile strength, maximum elongation in area are directly measured via a tensile test.

C. Compression Test

Compression tests are adverse to tensile test where how the specimen withstands load and maximum size reduction is calculated. In other words, the maximum elongation is calculated in tensile test whereas maximum compression in compression tests. In this study maximum tensile, compression and strength of glass and carbon fiber reinforced composites were studied to select an optimum product for automobile applications.

Fig.3 Tensile Experimental Setup, (a) Tensile Test, (b) Compressive Test

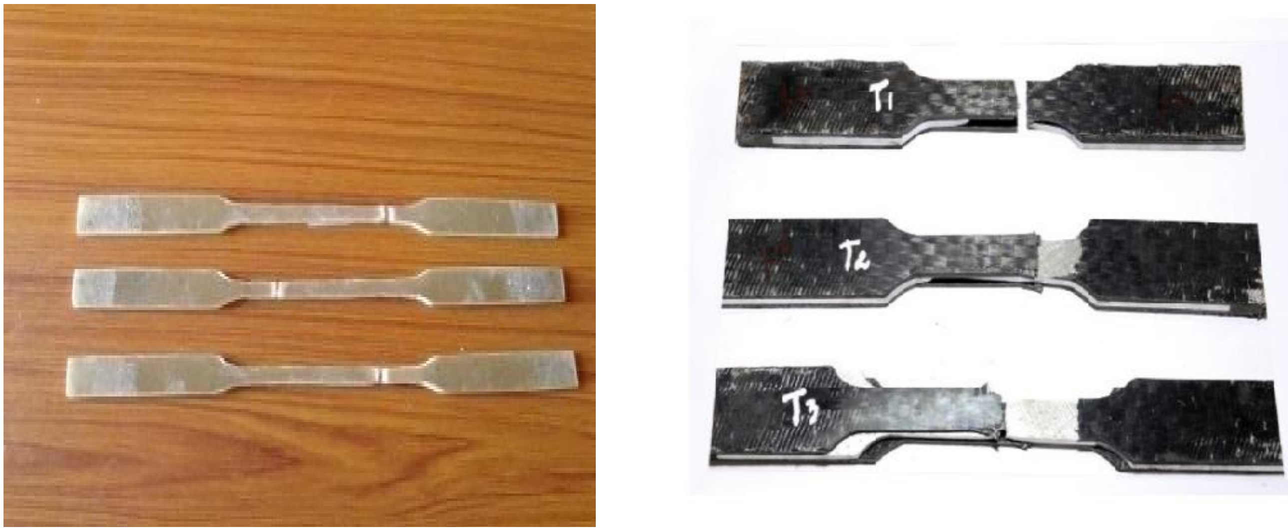

Fig.4 Specimens after Tensile Tests, (a) E- Glass fiber, (b) Carbon fiber

Fig.5 Specimens after Compressive Tests

III. RESULTS AND DISCUSSION

A. *Tensile Test Experimental Results*

Fiber	Thickness (mm)	Load, N	Tensile Strength (N/mm^2)
Carbon	5	123475	660.1
E-Glass	5	6025.5	321.4

Table. 2 Tensile Test Results

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B. Graph

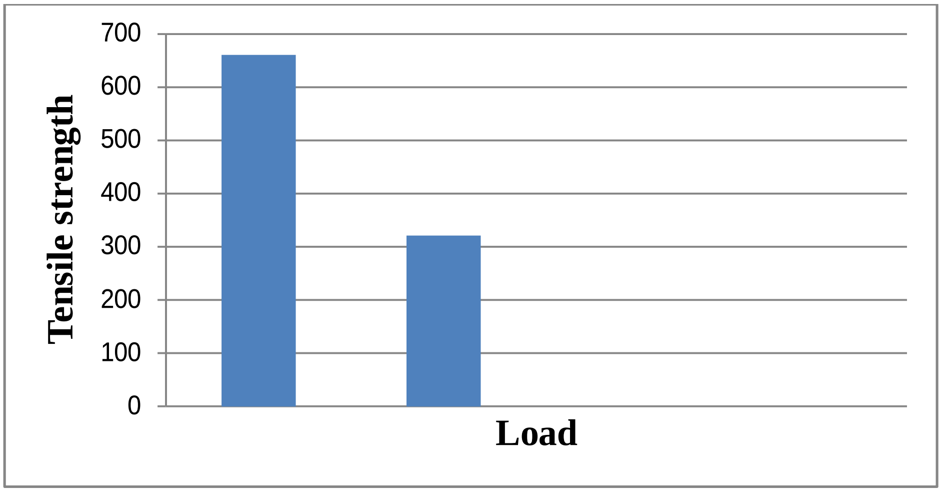

Fig.6 Tensile strength vs. Load

C. Compression Test Experimental Results

Fiber	Thickness (mm)	Load, N	Tensile Strength (N/mm^2)
Carbon	5	5700.5	126.7
E-Glass	5	4251.5	94.47

Table. 3 Compression Test Results

D. Graph

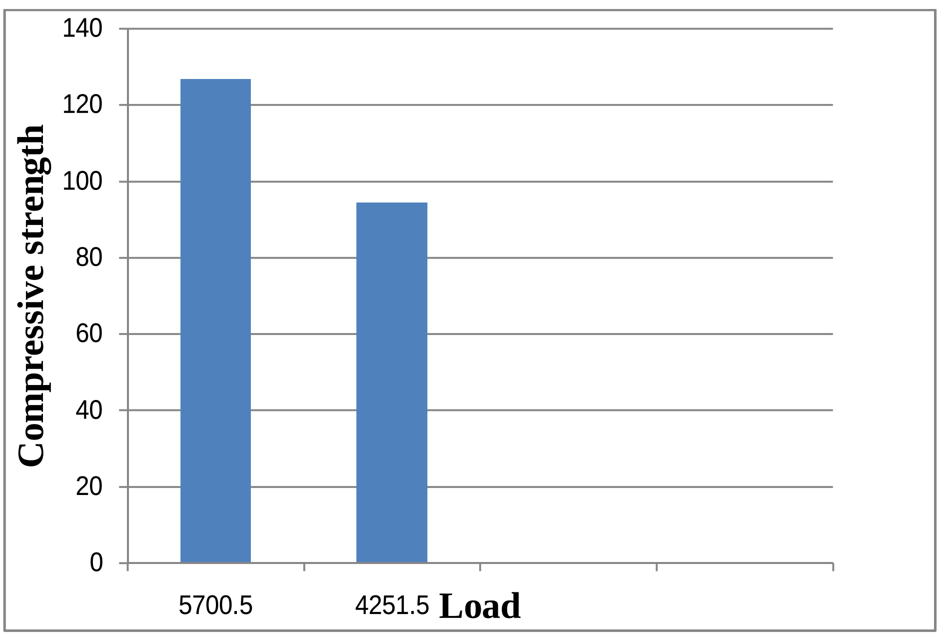

Fig.7 Compressive strength vs. Load

E. Result Comparison

Parameter	Carbon with epoxy	E-glass with epoxy	Steel
Compressive Strength(Mpa)	126.7	94.47	96
Tensile strength(Mpa)	660.1	321.4	276

Table.4 Comparison of Result

IV. CONCLUSION

In the present investigation, carbon fiber and glass fiber sandwich composites are fabricated and their mechanical properties are evaluated. Based on the experimental investigation and analysis, the following conclusions are drawn:

A. Tensile strength & compression strength is more in carbon fiber and less in glass fiber
B. Deformation is maximum in glass fiber and minimum in carbon fiber
C. Carbon fiber shows more in young's modulus and less in glass fiber
D. Maximum load at high yield point shows in carbon fiber and minimum in glass fiber.

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