A STUDY ON EFFECT OF FILLER (SiO_2) ON MECHANICAL PROPERTIES OF GLASS/EPOXY (HT CURE) COMPOSITE

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Abstract

Glass fiber reinforced epoxy based composites(GFREC) are mostly widely used as structural material in engineering applications such as aerospace , automotive ,ship building , sports and chemical industries , etc. because of their tailor made properties. The mechanical properties of glass fiber reinforced composite materials are different for different constituents. GFREC materials are in anisotropic nature.

In the present investigation fiber polymer glass epoxy composites are reinforced with silicon dioxide(sio_2)as filler in different weight fractions are fabricated and cured in auto clave process (HT cure). The fabricated laminates are tested according to ASTM standards to determine physical properties, barcol hardness, flexural strength, and inter laminar shear strength (ILSS).From the experimental results obtained, it shows that the mechanical properties were enhanced when the percentage of silicon dioxide(sio_2) was increased

Keywords: *Glass-epoxy, glass fiber, filler, tensile strength, inter laminar shear strength, physical properties.*

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1. INTRODUCTION:

Composite materials are heterogeneous materials made of different constituent materials with significantly differ in physical and chemical properties. A composite materials is one which consists of two or more materials working together to form a new material. one of the material is called as reinforcing phase which is the form of fibers and is embedded in the other material is called the matrix phase . E-glass fibers are the common type of reinforcements used in the composite materials due to its good load carrying capacity .In thermo set polymer matrices epoxy resins are widely used as matrix in fiber reinforced composite material. Glass/epoxy based composite materials are frequently used in structural applications because of their specific strength properties

The present paper is experimental study on glass/epoxy based composite materials with and without addition of filler materials are fabricated and cured in auto clave process (HT cure). The filler used for the purpose of study is silicon dioxide(sio_2).the study focuses on the determination of mechanical properties.

2. EXPERIMENTAL PROCEDURE

The following section of highlights the materials used, specimen fabrication, testing of mechanical properties

2.1 Materials:

Bi-woven E-glass of 0/90 fiber orientation materials is used as reinforcing material ,low temperature curing epoxy resin LY556 suitable hardener fine hard972 is used as the matrix material in the proportion of 100:27 by weight at room temperature laminate were fabricated and Cured in auto clave process. The thickness of e-glass is measured as 13mil (0.33mm).Different types of fillers like natural or synthetic both organic and inorganic is being used for improving the performance of composites. In the present study organic oxide fillers silicon dioxide(sio_2) with weight percentage 0%,5%,10%,15%is used for the preparation of composite laminates and specimens specified as C_0, C_1 , C_2 ,C_3.

Table-1: The details of materials combinations as shown below

Constituents	Specification
Reinforcement	e-glass fabric
Epoxy	LY556
Hardener	Fine hard 972
Filler material	silicon dioxide(sio_2)

2.2 Specimen Preparation:

Hand layup technique is adopted for the fabrication of the composites. A metal mould of 300mmX300mm can be used for this purpose. The mould surface is cleaned with acetone and easy release agent wax or petroleum jelly is applied to removal of laminate from the mould. As per the size of the mould glass fabric are to be cut and layered on flat surface of the mould. The matrix material (epoxy resin LY556 and hardener fine hard972) with varied fiber volume fraction of silicon dioxide is spread evenly on the surface of fiber cloth.

The resin is squeezed and compressed on the surface with the help of roller. The reinforcing materials are stacked one upon the other to the required thickness of the laminate. After obtaining the thickness, the complete mould has been compressed

Fig-1: Hand layup process fabrication of composite laminate.

Fig-2: Prepared composite laminate.

The compressed mould is cured in auto clave process and set the temperature of auto clave to 150^0@ 1^0c per minute when component temperature reaches to 140^0hold it and maintain for 4 hours. After completion of hold, start cooling the auto clave from 140^0 to 60^0@ 1^0c per min. when air temperature reaches to 60^0 the auto clave has to be switched off and reaching the room temperature the mould is taken out of the auto clave and laminates are removed from the mould and cut into required size as per ASTM standards to test the mechanical properties

2.3 TESTING OF MECHANICAL PROPERTIES:

2.3.1 Physical properties:

The strength of of any composite material depend on physical properties like fiber volume fraction and density. The matrix and reinforcement of material plays vital role for determining the strength and stiffness. Hence it is important to study the physical properties

2.3.2BarcolHardness:

The Barcol hardness is tested according to ASTM D 2583 and measured hardness on a dial scale from 0 to 100 values The barcol hardness test is used to determine the hardness of the material through depth penetration of indicator this test is significantly used of the composite materials to determine the degree of cure of the composite material.

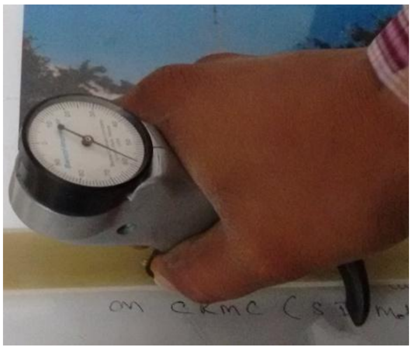


Fig-3: Barcol Hardness Testing

2.3.3 Flexural Strength:

The flexural strength was carried out according to ASTM D 790 the 3-point flexural test was carried out in universal testing machine INTRON 4505 (UTM).The cross head speed of UTM in 2mm/min and span length to specimen depth ratio is s/t=16 was selected in flexural strength measurement. The test specimen dimensions are 130mmX25mmX3mm were used for the test. A minimum a five samples were tested and average value of flexural strength was determined.

Fig.4: Test for Flexural Strength

Fig.5: Test for ILSS

2.3.4 Inter laminar shear strength (ILSS):

The inter laminar shear strength was calculated by using short beam shear test (SBS) as per ASTM D 2344. Five samples were tested in electro mechanical testing machine INTRON 4505(UTM) with the cross head speed is 1mm/min and span length to specimen ratio s/t=4 was used for this test.

The force applied at the time of failure was recorded and the stress were determined by ILSS=0.75$\frac{p}{bh}$

When ILSS inter laminar shear strength n/m^2

p_b is the breaking load (N)

'b' and 'h' are the width and the depth of the specimen (mm)

3. RESULTS AND DISCUSSIONS:

The test specimens were prepared according to ASTM standards and are tested to evaluate their physical properties, barcolhardens, and flexural strength and inter laminar strength.

3.1 Physical Properties:

The physical properties of test result indicates that optimum fiber volume fraction (32.74% resin 67.26% fiber) and maximum density of 1.81 is obtained in the composite filled with silicon dioxide (Sio_2) 10%volume.

Table-2: Physical properties of different composites

Specimen code	**Fiber volume fraction %**		**Density**
	Resin	**Fiber**	
c_0	31.26	68.74	1.80
c_1	42.12	57.88	1.67
c_2	32.74	67.26	1.81
c_3	35.16	64.84	1.78

3.2 Barcol Hardness:

The barcol hardness instrument is placed on to the surface and light pressure is applied on the specimen. The spring loaded indicator get into the material and harness reading is instantly indicated on the dial. It is observed that hardness decreases with 5%filler material and increase hardness by 10% of filler by 56 and further increase filler up to 15% hardness decreases.

Table-.3: Barcol Hardness

Specimen code	Barcol hardness
C_0	54
C_1	46
C_2	56
C_3	52

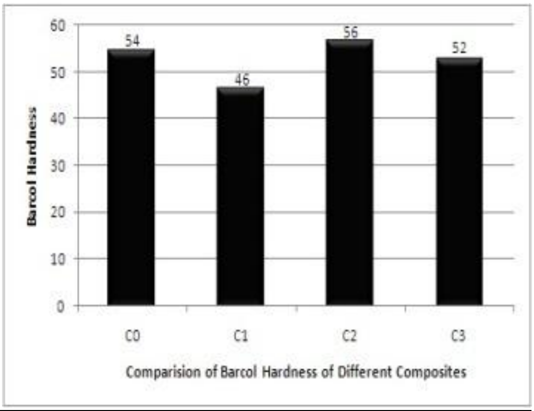


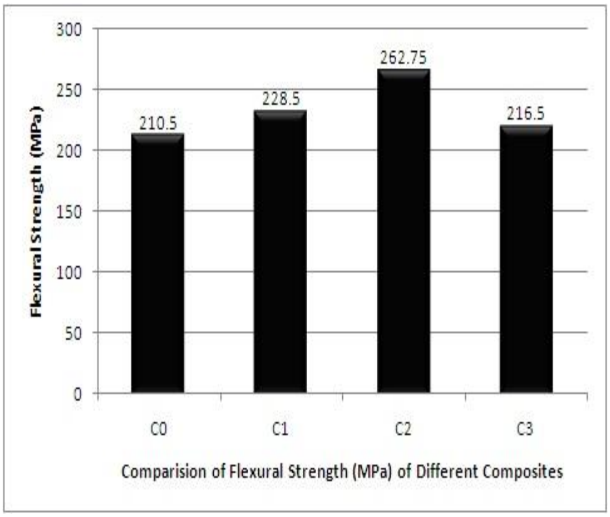
Chart-1: Comparison of Barcol Hardness

3.3 Flexural strength:

The flexural strength and flexural modulus of glass/epoxy composites with different fiber volume fractions are shown in fig.1. The test results indicates that laminate filled by 10% Sio_2exhibited maximum flexural strength 262.75MPa and maximum flexural modulus 20.18GPa.The reduction of flexural strength and flexural modulus are observed due to increase filler material and may be changes in matrix properties and reduces their bonding strength between fiber and matrix.

Table-4: Flexural strength (MPa) and Flexural Modulus (GPa)

Specimen code	Flexural strength(MPa)	Flexural modulus(GPa)
C_0	210.5	16.37
C_1	228.5	16.30
C_2	262.75	20.18
C_3	216.5	18.45



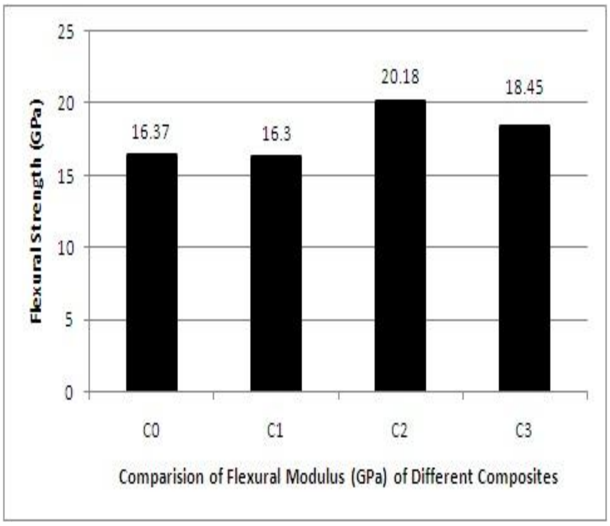


Chart-2 & 3: Comparison of Flexural strength (MPa) and Flexural Modulus (GPa)

3.4 Inter laminar shear strength (ILSS):

Inter laminar shear strength (ILSS) depends on matrix properties and fiber matrix interfacial strength. From test results it is observed that maximum value of ILSS for 10% of Sio_2 filled laminates shows 35.92 MPa. The value of ILSS decreases with respect to percentage of filler. This may be increase in void fraction with increasing filler material, as a result decrease degree of adhesion among filler and matrix.

Table-5: ILSS (MPa)

Specimen code	ILSS(MPa)
C_0	32.83
C_1	35.40
C_2	35.92
C_3	32.59

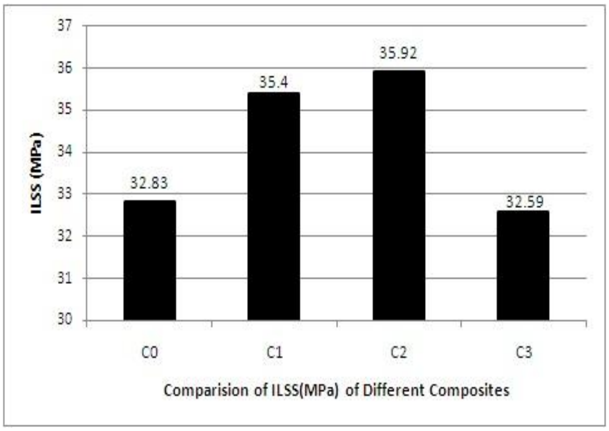


Chart-4: Comparison of ILSS (MPa)

4. CONCLUSION:

In the present work glass fiber reinforced with Sio_2 particle fillers were used for preparation of sample laminates by using hand layup technique. The barcol hardness, flexural strength and flexural modulus and inter laminar shear strength were tested. The composite with 10 % of Sio_2 filler has shown the improved properties than the composite without filler, further increase of filler material decreases hardness, flexural strength and flexural modulus and inter laminar shear strength.

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