ISSN : 2394-2975 (Online)
ISSN : 2394-6814 (Print)
Vol. 4, Issue 4 (Oct. - Dec. 2017)
International Journal of Advanced Research in Education & Technology (IJARET)

Mechanical Characterization of Epoxy/Heat Treated Glass Fiber and $CaSiO_3$ Based Polymer Matrix Composite

[I]GuruPrasad H L, [II]Kiran Kumar S, [III]Dr. J N Prakash
[I]Associate Professor, Dept. of Mechanical Engg., EWIT , VTU, Karnataka, India
[II]M-Tech Student, Dept. of Mechanical Engg., EWIT, VTU, Karnataka, India
[III]Principal, Dept. of Mech. Engg., Netaji Institute of Engg. and Tech., Topranpet, Telangana, India

Abstract
Composite materials are kind of engineering materials having a variety of applications in many fields because of their very good mechanical and thermal properties like light weight, high strength – weight ratio etc. In the present work polymer matrix composite were developed to study the mechanical characterization by performing different tests. Using hand layup technique Epoxy / Calcium silicate hybrid composite is prepared. Epoxy is a copolymer formed from two different chemicals, referred to as "resin" and "hardener". The resin consisting of short chain polymer at the either end. Lapox L-12 and K-6 were selected as a resin and hardener respectively because of their good electrical and mechanical properties with high HDT. Laminates of epoxy are fabricated at different conditions using Hand layup technique and tested using computerized UTM. Experimental results and graphs are obtained and verified to conclude its properties and behaviour under different condition.

Keywords
Composites, epoxy, Hand Layup, Lapox L-12, UTM.

I. Introduction

Generally composite materials are known as "combination of inherently two different materials, which exceeds the constituent material". The main aim of the composites is to allow the new material to have properties from both the material, in order to overcome the weakness of the original material. In general, composites are a structural material that consists of combination of two or constituents at macroscopic level and not soluble in each other. The one phase is known asreinforcing phase in which material may be in the form of fibres, particles, or flakes and other phase is known asmatrix phase in which embedded materials it is generally continuous.Example: Composites system include concrete reinforced with steel, epoxy reinforced with graphite fibre etc.

II. Objectives and Methodology

(i). Objectives

- Preparing the mould using hand lay-up technique.
- Preparing epoxy with $CaSiO_3$ laminates using same hand lay-up technique.
- Curing the laminates at room temperature.
- As per the requirement of the machine laminates were cut down.
- Tensile and flexural test is conducted on epoxy laminates.
- Water absorption test is conducted for hardness.
- Sem test

(ii). Materials

Raw materials choosed for this experimental work are as follows:

- Epoxy resin (Epoxy 12)
- Lapox – 12
- Hardener, K6
- Calcium silicate
- E-Glass fiber

(iii). Fabrication process

For the present work the epoxy/calcium silicate laminate are prepared by using hand lay-up technique. The laminates are prepared by using epoxy such as Lapox 12 with K6 hardener with varying the amount of percentage of $CaSiO_3$ and without any. The laminates of 250mm × 250mm × 4mm were prepared as per the standard test specimen for 4mm thickness. Later the prepared laminates were cut into 250mm × 25mm × 4mm for the testing on UTM.

Weight calculation

- Density of Lapox – 12 = 1.120 gm/cm^3
- Density of K6 hardener = 0.954 gm/cm^3
- Average density of L12 and K6 = 1.037 gm/cm^3 (in the 10:1 ratio)
- Volume of the laminates = 25 × 25 × 4 = 250 cm^3
- Weight of the mixture = 250 × 1.037 = 259.25 gm

(iv). Design and development of mould

The basic design of a mould is geared up by using scheme software called CATIA V5 R20 the outlook of a die or mould is as shown in figure 1. The material used for mould preparation is cast iron and it is treated for a smooth surface.

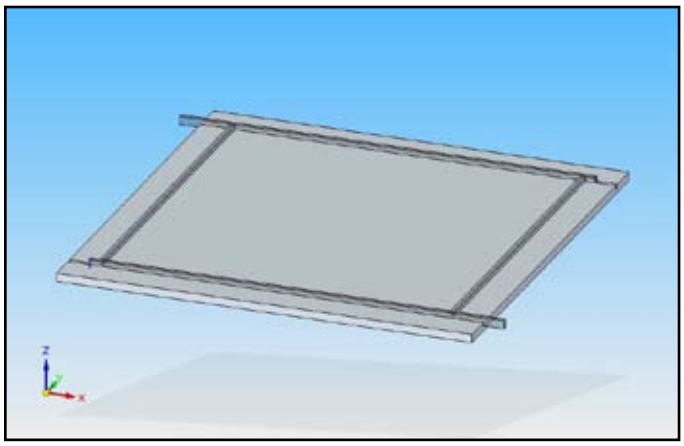


Fig. 1 : CATIA modal of mould

ISSN : 2394-2975 (Online)
ISSN : 2394-6814 (Print)

(v). Mould preparation

When the resin is used without fiberglass, the flow of resin will take place out of the mould, so the end cover plate is used to stop the flow of resin out of the mould and makes the mould as closed mould for fabricating the laminates with only resin.

(vi). Preparation of raw material

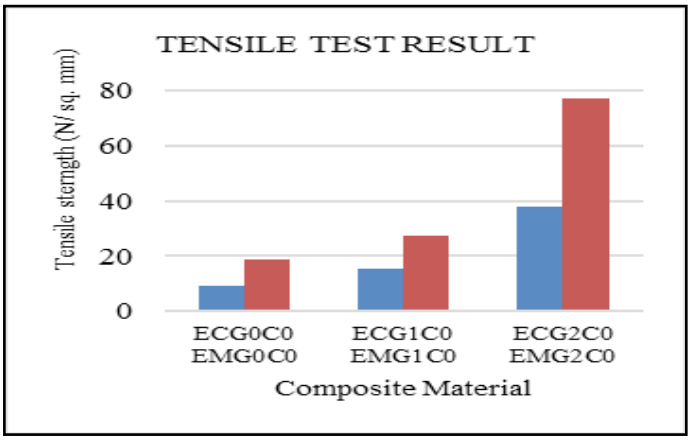
Reinforcement preparation: Chopped and Matted E-glass fiber of 350GSM is used as the reinforcement material. The reinforcement is provided to give extra strength to the material prepared. The Matted E-glass fiber is trimmed and tailored to less than 250*250 mm. The laminates thus prepared are reinforced with one layer and two layers of E-glass fiber.

(vii). Preparation of resin mixture

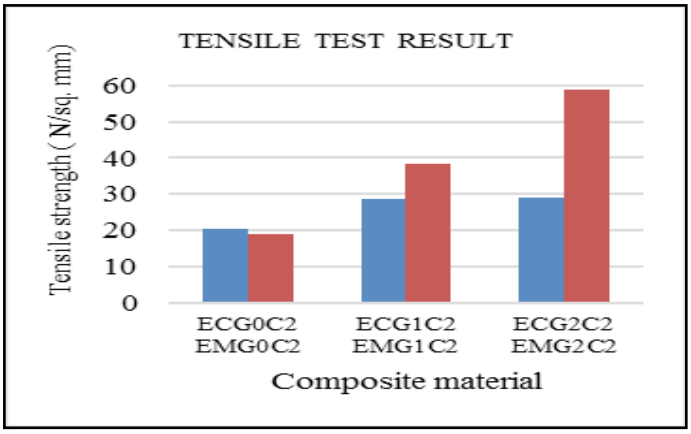
The resin used is Epoxy Lapex-12 and the suitable hardener used is K-6. The calculated amount of epoxy, K-6 hardener and CaSiO3 is mixed thoroughly in a clean beaker by using a glass rod to avoid formation of air bubbles. After thorough mixing of these two the required amount of Calcium Silicate ($CaSiO_3$) is added in small quantities to this mixture. Care has to be taken so that small lumps of $CaSiO_3$ are not formed in this mixture.

III. Results and Discussion

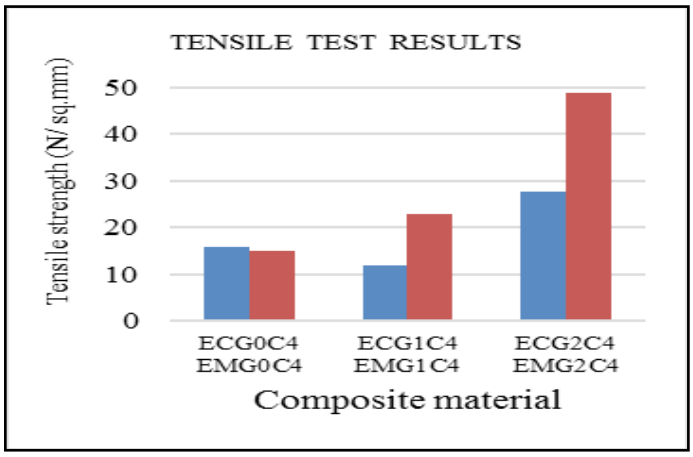
(i). Tensile test



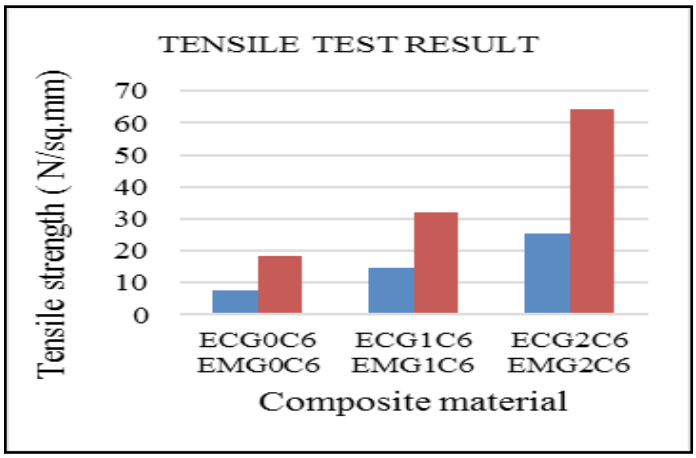
Graph 1



Graph 2

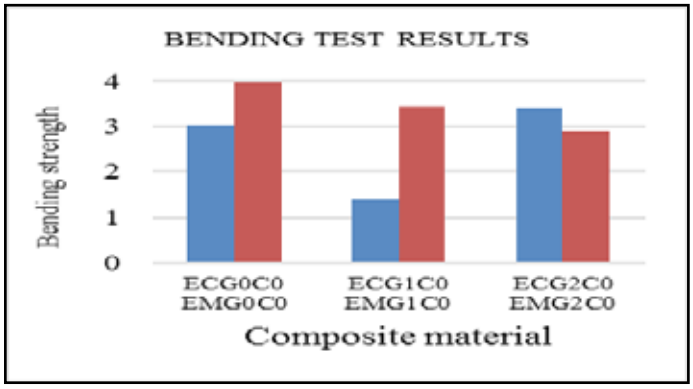


Graph 3

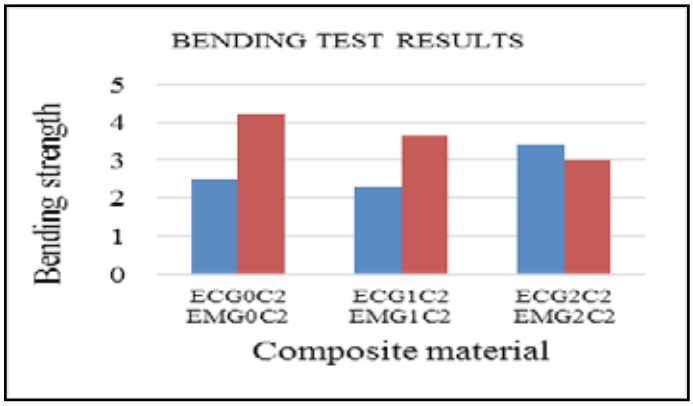


Graph 4

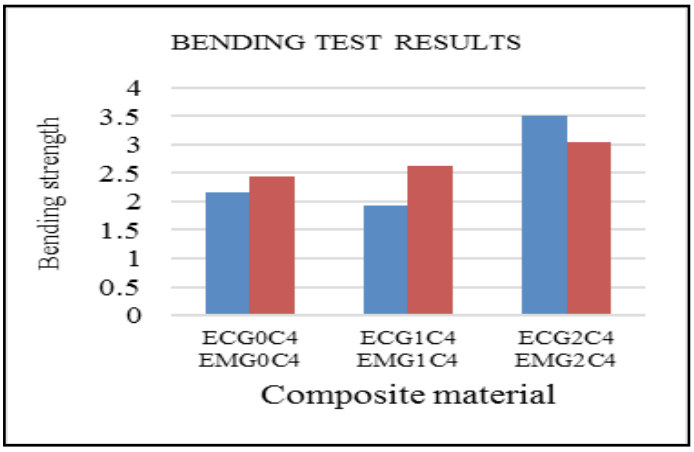
(ii). 3 point bending test



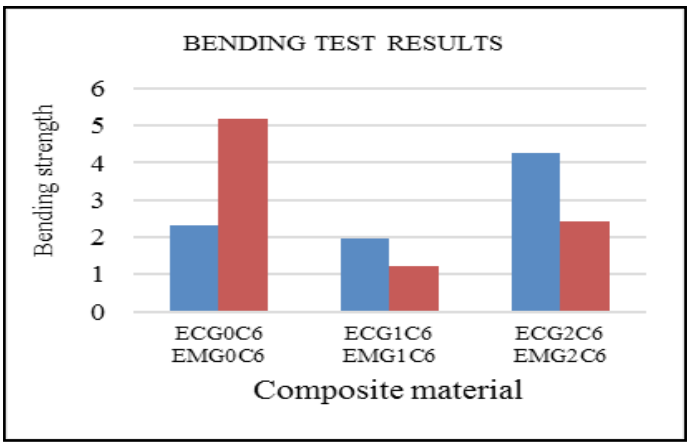
Graph 5



Graph 6



Graph 7



Graph 8

IV. Conclusion

The present work was aimed to find the mechanical properties of the prepared composite material at different condition. In the present work, the attempt has been made to study the mechanical properties of the EPOXY/HEAT TREATED GLASS FIBER AND CaSiO3 BASED POLYMER MATRIX COMPOSITES. The laminates are prepared by using epoxy L12 as the matrix material, E-glass fiber as reinforcement and $CaSiO_3$ as the filler material. The specimen was prepared by varying the percentage of filler material calcium silicate (0%, 2%, 4% & 6%) and number of E-glass fiber layers (0,1, &2).

The testing for the mechanical properties are showing the good behavior. The matted and chopped glass fiber have exhibited overall good mechanical properties but the specimen with 2% $CaSiO_3$ as shown the good mechanical properties. The specimen with 4% $CaSiO_3$ & 2-layer ethyl silicate treated and 2% $CaSiO_3$ and 1 layer of heat treated E-glass fiber are shown good properties in tensile test and percentage (%)of elongation, peak load and flexural property.

The present work is justified that the epoxy/E-glass fiber with 2-4% $CaSiO_3$ is exhibiting good mechanical properties.

As the increase in number of E-glass fiber will also affect the mechanical property of laminates. Hence, to improve the mechanical property of the epoxy/E-glass fiber $CaSiO_3$ based laminates, we can increase the number of layer of E-glass fiber.

(i). Tensile test

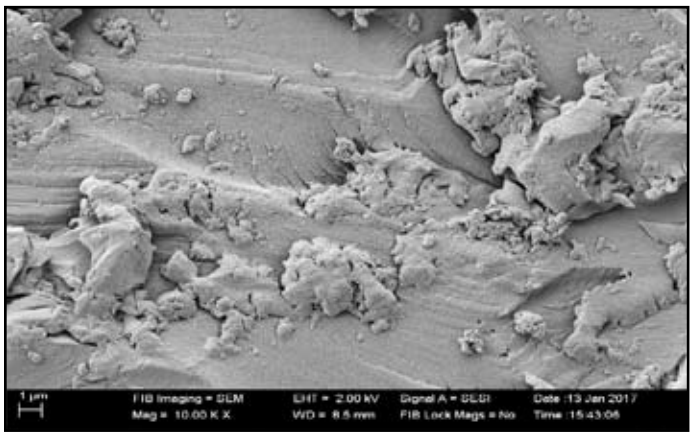
By conducting the tensile test, it can be concluding that tensile strength of the material increases as increase in the percentage of calcium silicate, since calcium silicate is a hard material when it is added, the composite becomes more brittle, hence the strength decreases.

(ii). Bending test

By conducting the bending test, it can be concluding that bending strength of the material decreases as increase in the percentage of calcium silicate.

(iii). SEM test

EMG_1C_2 (HT)



ECG_1C_2 (HT)

References

[1] *Shivakumar S, G.S. GuggariInternational Journal of Advances in Engineering & Technology, Nov 2011.*

[2] *Dean, R & D, Department of Mechanical Engineering, SMSMPITR, Akluj, Solapur, Maharashtra, India, International Journal of Scientific Engineering and Research (IJSER), Volume 1 Issue 4, December 2013*

[3] *Wasim Akram, Sachin Kumar Chaturvedi, Syed Mazhar Ali. Published in International Journal of Engineering Research & Technology, Vol.2 - Issue 7 (July - 2013)*

[4] *Dr. Jawad Kadhim Uleiwi, Experimental Study of Flexural Strength of Laminate Composite Material, Eng. & Technology, Vol. 25, Suppl.of No. 3, 2007, pp 454-466.*

[5] *WEN-PIN LIN, HSUAN-TEH HU, Parametric Study on the Failure of Fiber Reinforced Composite Laminates under Biaxial Tensile Load, Journal of composite materials, Vol. 36, No. 12/2002, pp 1481-1503.*

[6] *Slimane Metiche and RadhouaneMasmoudi, Full-Scale Flexural Testing on Fiber Reinforced Polymer (FRP) Poles, The Open Civil Engineering Journal, 1, 37-50, 2007, pp*

37-50 J. Davies and H. Hamada, Flexural possessions of a hybrid polymer matrix composite containing carbon and silicon carbide fibres, Adv. Composite Maters., 10(1), 2001, pp. 77-96.

[7] Isaac M. Daniel, Emmanuel E. Gdoutos, Deformation and Failure of Composite Structures, Journal of Thermoplastic Composite Materials 2003; 16; 345.

[8] Hoo Tien Kuan, Wesley Cantwell and HazizanMdAkil, The Mechanical Possessions of Hybrid Composites Based on Self-Reinforced Polypropylene, Malaysian Polymer Journal, Vol. 4, No.2, 2009, p 71-80

[9] Geon-Woong Lee, JoongSik Choi, Sang-Soo Lee, Min Park, Junkyung Kim, Chul-Rim Choe, and Soonho Lim, Mechanical Possessions and Failure Mechanism of the Polymer Composite with 3-Dimensionally Stitched Woven Fabric, Macromolecular Research, Vol. 11, No. 2, 2003, pp 98-103.

[10] Jane Maria Faulstich de Paiva, Alexandre De Nadai dos Santos, Mechanical and Morphological Characterizations of Carbon Fiber Fabric Reinforced Epoxy Composites Used in Aeronautical Field, Materials Research, Vol. 12, No. 3, 2009, pp. 367-374.

[11] Jean-Marc Scanzi and Bruno Hilaire "All-Thermoplastic Composite Sandwich Panels – Part II: Modelling of Bending Behaviour" Journal of Sandwich Structures and Materials 2004; 6; 423.

[12] Toshio Ogasawara, Yuichi Ishida and Tetsuokasai [2009], Mechanical possessions of carbon fibre/fullerene -dispersed epoxy composites, composites science and technology,vol.69, issues 11-12, pp. 2002-2007.013)