Comparative Study on Axial Loading Conditions and Effect of Mineral Filler on CSM and WF Fibres

Lokesh K S[1], Dr. Thomas Pinto[2]

[1]*Assistant Professor, Department of Mechanical Engineering & Faculty of Nano Technology, Srinivas Institute of Technology, Karnataka, India*
[2]*Professor & Head, Department of Mechanical Engineering, Srinivas Institute of Technology, Karnataka, India*

Abstract - *Study on mineral fillers swept huge attention now a days by being the fractional part of the composite materials to fulfil the potential aspects of industries. In this work two different categories of E-glass fibres namely woven fabric and chopped strand mats are used as a reinforcing materials and epoxy resin constitutes matrix system. Several studies proved that the strength of GFRP composites progressively increased with adding fillers. Keeping this in mind the present work highlights the utilization of mineral filler called calcium ino silicate powder having the composition of CaSio3 as a filler material. By employing hand layup technique samples have been prepared from both woven and chopped type and tensile test is conducted as per ASTM standards and corresponding results are tabulated and recorded. The present work also highlights the comparison of tensile strength for both woven and chopped laminates. It is observed that use of mineral filler influences greatly on tensile properties of polymer matrix composite and it is also cleared that woven laminates shows greater resistance to axial loading as compared to chopped strand mats.*

Keywords: Mineral fillers, axial loading, lightweight materials.

I. INTRODUCTION

Composites are made of two or more materials combined in the macro scale to get the integrated properties of individual materials. Composite materials are formed from two or more materials producing properties that could not be obtained from any one material. One of the constituent materials acts as the matrix and at least one other constituent material act as the reinforcement in the composites. Composite materials emerge as a promising alternative to correct the deficiencies caused by steel reinforcement in concrete structures [1-5]. Composite materials have replaced metals in various engineering applications owing to their numerous advantages, like high strength/weight ratio, low cost, low density, better stealth properties, etc[6-7]. Due to these advantages, there is an increasing demand for use of these materials in defines applications like naval ships, warplanes, armor vehicles and re-entry vehicles. In addition to this composites find their applications in automotive and aerospace industries such as bushes, gears, seals, cams, shafts etc. The most common types of reinforcement used in polymeric matrix composites (PMC) are strong and brittle fibres incorporated into a soft and ductile polymeric matrix. In this case, PMC are referred to as fibre reinforced plastics (FRP's)[8].Composites in civil engineering applications have been steadily increasing. This is primarily due to the ever-increasing demand for materials, which are characterized by high strength-to-weight and stiffness-to-weight ratios at an effective installed or life cycle cost [9]. The advantageous properties of fibre reinforced polymer (FRP) includes, high strength-to-weight ratio, and corrosion and fatigue resistance create an interest in engineers; the most economical choice depends on the cost of material, production cost, life cycle cost, and material properties.

Weight savings and performance, naturally, play a major factor in the choice of materials [10]. A combination of good mechanical properties and relatively low cost makes glass fibre attractive choice for the marine structures. The glass fabric chosen was woven roving E-glass supplied by Fibre Glass Industries' (FGI) and designated as per FGI 1854 and glass fibres had Super 317 sizing for ease of handling, fast wet out, and compatibility with a number of resins including vinyl ester [11]. The glass fibres reduce the quantity of water absorbable material and thus, the water sorption of FRC should be less compared to that of the matrix polymer. In-plane shear properties of both carbon and glass fibre composites were comparable and inter laminar shear properties of E-glass composites were observed to be better than the carbon composite because of the better nesting between the E-glass fabric layers.

II. FABRICATION OF SPECIMENS

Reinforcing material used in this present study is glass fiber with density of 360GSM and chopped strand mat fibre of having 200GSM along with epoxy resin (araldite GY250) and hardner (teta), mineral powder of 80 microns size as a filler material. Glass fiber is a material consisting of numerous extremely fine fibers of glass. It is most commonly used as reinforcement material because of is exceptional properties. Although not as strong or as rigid as carbon fiber, it is much cheaper and significantly less brittle. Here type of glass fibre used is E-glass, the main compositions of E-glass (electrically conductors) are the oxides of silica, aluminium and calcium [12]. The glass fiber is also called as calcium alumino borosilicate glass. Epoxy is the cured end product of epoxy resins, as well as a colloquial name for the epoxide functional group. Epoxy resin is relatively low molecular weight pre polymers capable of being processed under a variety of conditions. In this work a fine powder of calcium ino silicate mineral called wollastonite is used as a filler material. Filler sample collected is as shown in Fig.1.

Fig.1:Casio3 Powder

Based on the thickness required, number of layers are calculated with 250x250 sized glass fiber was cut. The required amount of Epoxy resin was weighed. Calculated amount of powdered filler was added. The different percentages of wollastonite used are: 1%, 3%, 5%, 7%. The resin hardener proportion ratio of 10:1 was mixed and thoroughly stirred. The laminate surfaces will be cleaned thoroughly to make sure that they were free from oil, dirt. etc., this process could be done before bonding takes place between the laminates at room temperature and pressure. By using Hand layup technique the glass fiber along with resin was compressed and cured in the die for 24hours. The constant thicknesses of 4 mm are maintained for all specimens prepared. The fabricated and cured samples of both woven and chopped specimens are shown in fig 2 and 3 respectively.

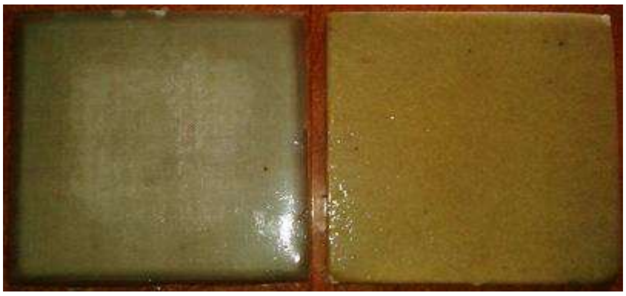

Fig.2: woven sample Fig.3: chopped sample.

III. EXPERIMENTAL METHOD

Tensile test is conducted on digital UTM where the test is generally performed on flat specimens prepared and cut according to ASTM standards. The commonly used specimens for tensile test are the dog-bone type and the straight side type with 14 end tabs. The tensile experiments were performed according to ASTM standard D3039 [13]. The tensile test specimens of 200*15 dimensions were prepared after resizing of the samples from 250*250mm dimensions in which it is derived from cured glass fibre epoxy reinforced laminates of both woven and chopped strand mats. The grip length at both ends of the specimens for tensile test is allowed to ensure proper breaking of the specimens. A universal testing machine was used for tensile test. The top end of the specimen was fixed by the grips on the top cross-head of the machine while the bottom end was not fixed before applying the load. A slotted steel plate was placed between the top of the bottom anchor and the bottom of the middle cross-head. When the specimen was loaded this plate engaged the bottom anchor: The load was applied at a constant speed until the failure of the specimen. Testing setup is as show in figure 4. The tensile test specimens prepared in the order of filler percentage (i.e 1%,3%,5%,7%) for both woven and chopped type is as shown in fig.5 and fig.6 respectively.

Fig 4: UTM machine (for tensile test)

Fig.5: WF Samples for testing.

Fig.6: CSM Samples for testing

IV. RESULTS & DISCUSSIONS

With the varied filler percentage of 1,3,5,7% woven and chopped test samples are prepared successfully. In order to predict tensile parameters such as ultimate tensile strength, peak load and modulus of tested specimens, simple digital tensile test System is employed. Tensile parameters for fabricated specimens were tested as according to ASTM standards and the results are tabulated. Fig 8 and 9describes typical tensile load vs. deflection of both woven and chopped specimens of having 1% filler (only 2 sample graphs have been indicated). Curves for both specimens show linear behaviour until failure. Curves show inflection at the point of yielding in both cases; tensile strength and tensile stiffness have been recorded.

It can be observed from table 1, the effect of filler addition which directly influence on tensile strength of glass fibre composites, for woven fabric laminates, addition of 1% filler material shows that the material is able to withstand maximum load as well as it bears higher values of ultimate tensile strength as compared to the unfilled(without filler) tested samples, this behaviour is continued for the samples containing 3% filler which shows better performance compared to unfilled samples but it lags behind the 1% filled samples in showing greater tensile test results, further increase in adding filler percentage shows least tensile test results. In case of chopped samples, it is observed that effect of filler content influences greatly on tensile parameters, it is cleared that samples congaing higher percentage of filler(i.e 7%)shows maximum resistance to bending load and also bears maximum tensile strength.

However, the increase in strength and stiffness in case of woven seems to be more significant as compared to chopped fibers. Finally we observed that, glass/epoxy (woven) with 1% filler have higher strength, stiffness and load carrying capacity than the rest of the samples. Hence, it is suggested that woven fiber is preferred for designing of structures like which is more beneficial for sectors like, Aerospace, auto motives, marine, space etc.

Fig.7: Failure of test specimens under tensile loading (both woven and chopped type with 3% filler)

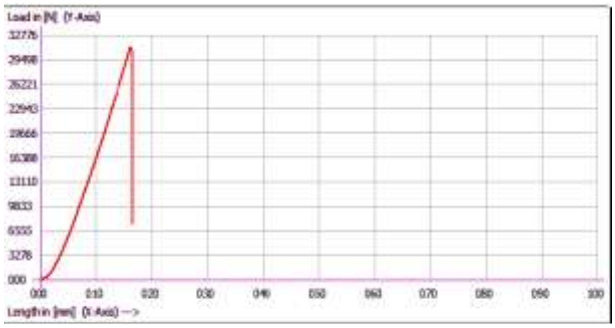

Fig.8: Shows load v/s length for woven (1% filler)

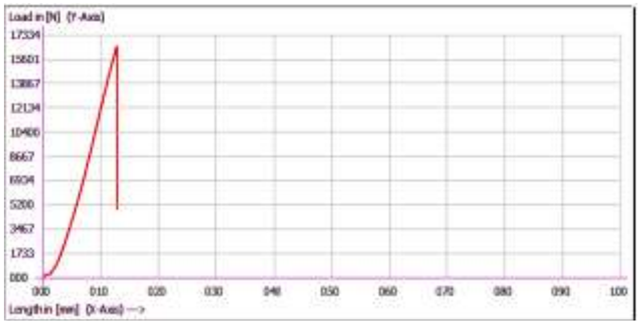

Fig.9: Shows load v/s length for chopped (1% filler).

V. CONCLUSION

Axial loading conditions are evaluated for the two set of samples prepared with varied filler percentage. The load-deflection curve was evaluated. Effect of mineral filler content in GFRP composites significantly directs the material behaviour in axial loading conditions addition to reduction in weight of the sample which concludes the woven samples are comparatively lighter than chopped samples due to over consumption of resin. Experiments were conducted on Glass/Epoxy laminate composite specimens with varying fiber orientation to evaluate the tensile properties. It is clearly concluded from the results that glass/Epoxy with woven fibre with 1% filler yields' better strength when compare to the rest of the samples. It is also concluded from the results, woven fabric samples yield better experimental results compare to the chopped strand mat samples.

REFERENCES

1. Dr.P.K.Palani,M.NandaKumar,"Analysis of Mechanical Properties of chopped strand Mat S-Glass epoxy resin NanoclayComposites",The International Journal of Engineering and Science (Ijes)||Volume||2||Issue||2||Pages||185189||2013||Issn: 2319-1813 ISBN:2319-1805.

2. KS Lokesh , Evaluation of Toughness on Varied Thickness of Chopped Strand Mat /PU-foam Sandwich Structures , International Research Journal of Engineering and Technology(IRJET), e-ISSN:2395-0056 Volume: 05 Issue: 09 | September-2018, p-ISSN: 2395-0072

3. KS Lokesh , Synthesis and Study on Effect of Thickness on 3-point Bending Strength of Sandwich Composites, International Research Journal of Engineering and Technology(IRJET), e-ISSN:2395-0056 Volume: 05 Issue: 08 | August-2018, p-ISSN: 2395-0072

4. KS Lokesh , Preparation and Tensile strength Evaluation of Synthetic fibers Sandwiched with Foam structures. International Research Journal of Engineering and Technology(IRJET), e-ISSN:2395-0056 Volume: 05 Issue: 09 | September-2018, p-ISSN: 2395-0072

5. Harris B,"Fatigue and Accumulation of damage in Reinforced Plastics", Composites, 8,1977, 214-220.

6. KS Lokesh, T Pinto ,Experimental Study on Effect of Metallic Oxides Mixture on Tribological Behaviour of Aluminium Based Metal Matrix Composites, International Research Journal of Engineering and Technology(IRJET),e-ISSN:2395-0056 Volume: 05 Issue: 06 | June-2018, p-ISSN: 2395-007

7. Konur O and Mathews F.L," Effects of the properties of the constituents on the fatigue Performance of Composites: A Review", Composites, 20(4), 1989, pp.317-328.

8. Lokesh K.S, Dr.Thomas Pinto, & Ravi S.M. (2017). Evaluation of Mechanical Properties and Wear Characterization of Polymer Composites under Varying Temperature Conditions: A Review. International Journal of Engineering and Information Systems(IJEAIS),1(4),64–68. http://doi.org/10.5281/zenodo.821168

9. Lokesh K. S., Bandu Ummaji, Gururaj P., K. Rayappa, Yashavantha J., Effect of Red Mud Particles on Scratch Resistance of Aluminum Based Metal Matrix Composites, American Journal of Aerospace Engineering. Vol. 5, No. 1, 2018, pp. 24-29. doi: 10.11648/j.ajae.20180501.14

10. K.S. Lokesh, Thomas Pinto, C.G. Ramachandra. Effect of Tool Wear & Machinability Studies on Polymer Composites; a Review. International Journal of Engineering and Information Systems, 2017,1(5),pp.7177. 〈http://www.ijeais.org/index.php/vol-1- issue-5-july2017/〉. 〈hal-01571294

11. Lokesh KS, "Impact of Modified Thickness on Flexural Modulus of PU-Foam /CSM Glass Fabric Sandwich Panels ",International Journal of Scientific Research in Mechanical and Materials Engineering (IJSRMME), ISSN : 2457-0435, Volume 2 Issue 3, pp. 29-35, July-August 2018.URL : http://ijsrmme.com/IJSRMME182210

12. Lokesh K S , Karthik B.Y, Avinash C.G, Ganesh Kamath, Samson Lobo, "Experimental Study on Tribological Characteristics of E-waste filled Fibre Reinforced Plastics ", International Journal of Scientific Research in Mechanical and Materials Engineering (IJSRMME), ISSN : 2457-0435, Volume 2, Issue 1, pp.11-16, .2018URL http://ijsrmme.com/IJSRMME182203

13. Lokesh K S, Dr.Thomas Pinto, Mohammed Gowspeer, Effect of E-waste Rubber on Wear Behaviour of Glass fibre Reinforced with Epoxy Composites Pages: 20-25 DOI: 10.7324/IJASRE.2018.32624 DOI URL: http://dx.doi.org/10.7324/IJASRE.2018.32624