Analysis of Mechanical Properties of Various Fiber Reinforcement Composite Materials

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ABSTRACT

In this paper experimental studies of various reinforcement composite materials fiber types are presented. The experimental work covered the study of modulus of elasticity for long, short and woven reinforcement of composite materials types with different volume fraction of fiber. The results show that the effect of fiber and resin types on modulus of elasticity for composite materials is presented. The results shows have good agreement between experimental mechanical and theoretical study for different types of composite materials. In this present work, the mechanical properties such as impact strength, flexural test carried out on three fibers like long, short and woven using different testing methods respectively.

Keywords: composite materials, reinforcement fiber types, long, short, woven fibers.

1. INTRODUCTION

The role of engineering materials in the development of modern technology need not be accent. It is materials through which a designer puts forward his ideas into custom. We use a wide variety of materials for our needs and comfort and have been developing new materials for meeting our technological requirement. As the levels of technology have become more and more sophisticated, the materials used also have to be correspondingly made more efficient and effective. Several performance characteristics are expected from these materials. Bhagwan D.Agawal and Lawrance J.Broutman, studied the performance of fibre composites, 2/e, John wiley & sons, New York, 1990 [1]. Dr.D.K.N.Rao and M. Ramesh Babu presented the fabrication and testing of GFRP-Laminates [2]. N. Shyam kumar presented Mode I fracture toughness of composite laminate [3]. Chamis presented the difference between fibre composites and traditional materials. Any predictive approach for simulating structural fracture in fibre composites needs to formally quantify: (i) all possible fracture modes, (ii) the types of flaws they initiate, and (iii) the coalescing and propagation of these flaws to critical dimensions for imminent structural fracture [4]. Poursartip has presented experimental method to determine local SERR in mode-I and mode-II type fracture [5]. Jones R.M,Mechanics of composite materials 2/e, Taylor and Francis, Philadelphia, 1999 [6]. Valaria La Saponara found delamination growth in DCB both experimentally and by numerical analysis [7]. Standard test methods for flexural properties of unreinforced and reinforced plastics for ASTM international designation D790-02 [8]. Dynamic failure behavior of glass/epoxy composites under low temperature using charpy test method presented by Mahmood M Shokrieh, Mohammad A Toradizadeh and Abdolhossein Fereidoon in Indian Journal of engineering and material science vol. 18, june 2011 [9].Bradley and Harris [10] used unidirectional high carbon steel wires to improve the impact properties of epoxy resin reinforced with unidirectional carbon Fibre reinforced. Jawad Kadhim Uleiwi [11]: Studies Investigated the effect of fibre volume fraction on the flexural properties of the laminated composite constructed of different layers. Wen-Pin Lin et.al [12]: Studies analysed the Failure of Fibre-Reinforced Composite Laminates under Biaxial Tensile Loading.

2. MATERIALS AND METHODS

The matrix material used in this study was diglycidly ether of bi-phenol -A (DGEBA) based epoxy resin in the trade name LY 556 while the hardener was tri-ethylene tetra amine (TETA) in the trade name of HY 951 mixed in proportion of 100:10, both manufactured by Huntsman. The epoxy resin was superior in mechanical properties and had better resistance to degradation by water and other solvents.

Fiber: E-glass: The E-glass fibers were Chopped Strand Mat (CSM) and Woven roving mat (WRM) used as reinforcement. The composition of glass fiber consisted of oxygen (42.84%), silica (28.57%), calcium (17.27%) and aluminum (9.09%) in the highest concentration among constitutes, while the concentration of modifying and other oxides were below 1%. E-Glass is a low alkali glass with a typical nominal composition of SiO_2(54%), Al_2O_3(14%), CaO+MgO(22%), B_2O_3(10%) and Na_2O+K_2O less than 2%. Some other materials are also present as impurity.

The experimental study of composite materials included study of mechanical properties of difference types of composite materials with various volume fraction of reinforcement fiber as powder, particle, long, woven, and short reinforcement glass fiber, as shown in

Figure. 1. Over view pictures for types of composites fiber.

3. EXPERIMENTAL TESTS (Material and Method)

3.1. Tensile Test

The machine comprises of a loading unit (or straining unit), control panel, Hydraulic system, pendulum dynamometer, load indicating system and load-elongation recording system. Tensile test is conducted by gripping the tests specimen between the upper and middle crosshead. Compression and Bending tests are conducted between the middle crosshead and the lower table.

Figure. 2. UTM Test Rig

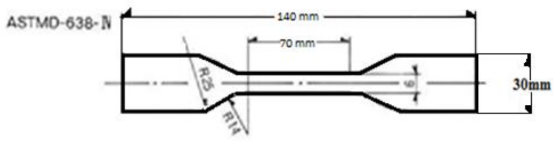


Figure 3.Tensile test specimen specifications as per ASTMD

3.2. FLEXURAL TEST:

A flexure test is more affordable than a tensile test and test results are slightly different. The material is laid horizontally over two points of contact (lower support span) and then a force is applied to the top of the material through either one or two points of contact (upper loading span) until the sample fails. The maximum recorded force is the flexural strength of that particular sample.

ASTM D 790 flexural test:

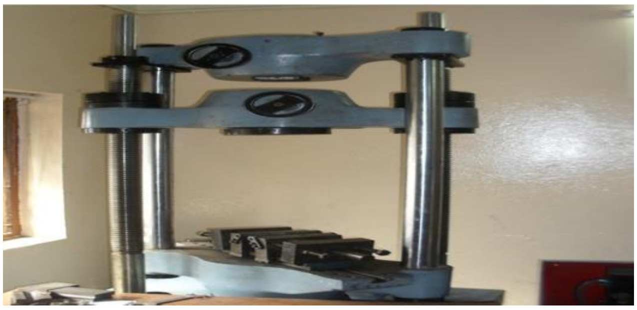


Figure.4. UTM for Flexural test

Figure. 5. Specimen dimension for flexural test

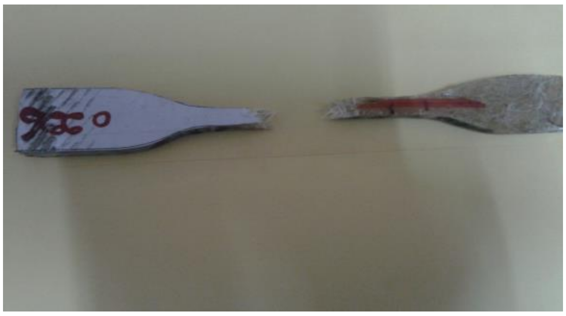
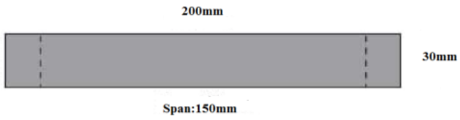


Figure.6 Sample before tension test.

Figure 7.Sample after tension test

Figure 9. Specimens of long fiber after tension test



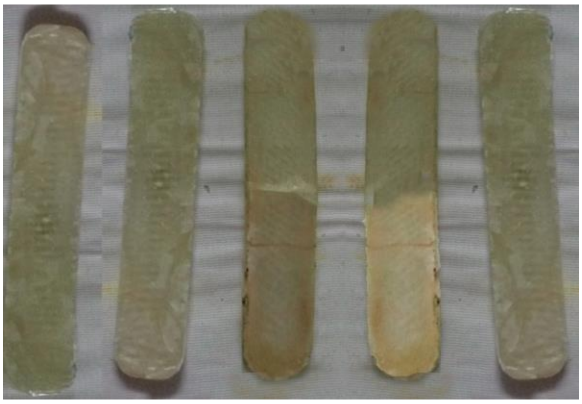


Figure 10. Specimens of woven fiber after tension test

Figure 11. Specimen during flexural test

Figure 8. Sample of short fiber for tension test

Figure 12. Specimen after test

Figure 13.Woven fiber Specimens after test

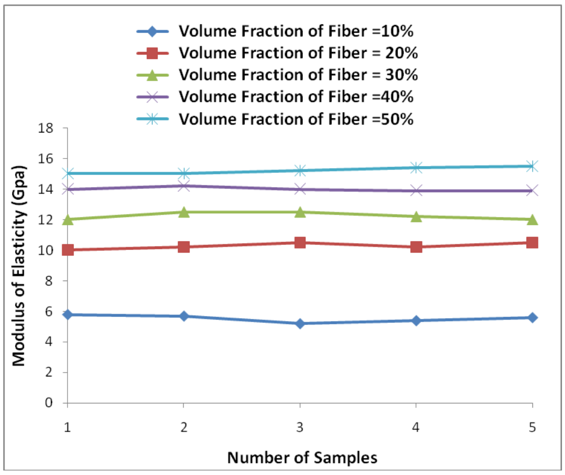


Figure.15. Experimental testing of five samples for short composite materials with difference volume fraction fiber.

Figure 14. Long fiber Specimens after test

4. RESULTS AND DISCUSSIONS

The results obtained from experimental and theoretical studies of modulus of elasticity for differences composite materials are calculated. The experimental work included the study of short, woven and long reinforcement fiber of composite materials for difference volume fraction of fiber. Figures. 16 to 21 show the modulus of elasticity of difference composite materials testing for five samples for each composite material type with volume fraction fiber. And, the average modulus of elasticity for composite materials is shown in Table 15 to 19.

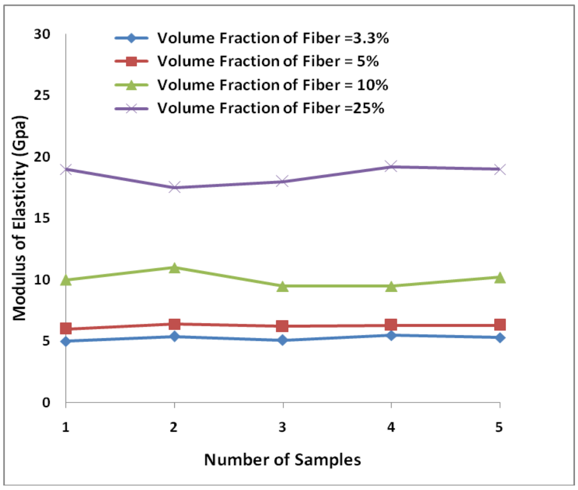


Figure.16. Experimental testing of four samples for woven composite materials with difference volume fraction fiber.

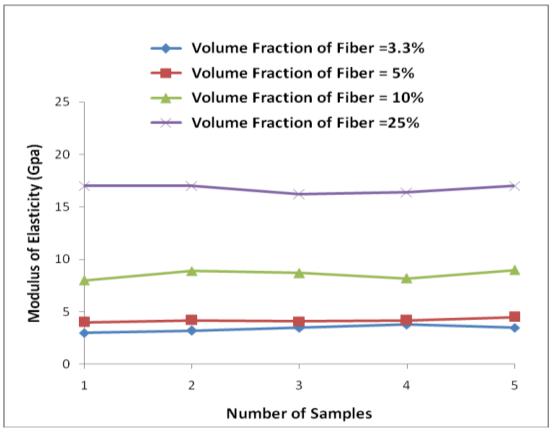


Figure 17. Experimental testing of four samples for woven composite materials with difference volume fraction fiber.

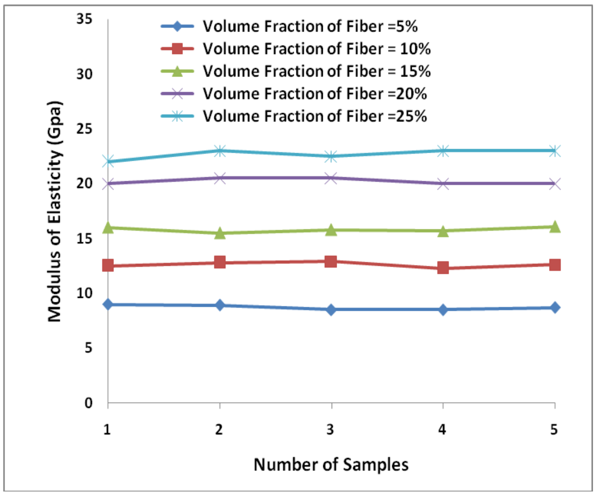


Figure.18. Experimental testing of five samples for long composite materials with difference volume fraction fiber.

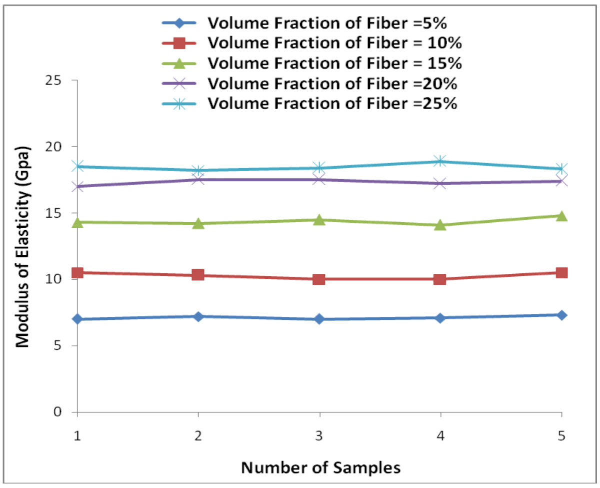


Figure19. Experimental testing of five samples for long composite materials with difference volume fraction fiber.

5. CONCLUSIONS

The Present work deals with the preparation of E-glass fibers with different forms of short, long woven reinforced epoxy composites. The successful fabrication of a new class of epoxy based composites reinforced with E-glass fibers with different forms of short, long woven reinforced epoxy composites have been done. It has been observed that form this work that the best modulus of elasticity is maximum for Long E glass fiber composite materials in any direction i.e 22 GPa which is greater than the short and woven e glass fiber composite material. The decrease in strength in other forms of composites is may be due to poor fiber- matrix adhesion. However, the flexural strength is found to be more in long E-glass fiber i.e18 GPa than the short and woven E glass fiber composite material. The lowest value of flexural strength is observed for short fiber i.e. this may be due to insufficient matrix material compared to volume fraction of fibers which results in lower flexural strength of the long e glass fiber composites. Possible use of these composites such as in storage devices, preferred insulating materials for several electrical applications, especially printed circuit boards, bushings, GIS spacers, generator ground wall insulation system and cast resin transformers.

6. REFERENCES

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