Mechanical Behavior of Unidirectional E-glass/Epoxy Composite at Different Orientation of Fibre

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Abstract - *In this work, LapoxL12resin is used as epoxy matrix and unidirectional E-glass fibre is used to reinforce with polymer matrix by hand layup process. The glass fibre reinforced composites are prepared with fibre orientations of 0°, 45° and 90°. The specimens, after preparation, are tested for various mechanical properties at different angles of the laminate. The properties studied in this case are Tensile Strength, Tensile Modulus, Specific Tensile Strength and Specific Tensile Modulus. The results have then been tabulated and studied to understand variation in the properties with orientation of fibre in the composite. Experimental procedure is carried out as per ASTM D638M, ASTM D790, ASTM D4812 standards.*

Key Words:E-Glass fibre, Polymer matrix composites, Hand layup, Epoxy resin, Mechanical properties.

1. INTRODUCTION

Fiber reinforced composite materials are demanded by the industry because of their high specific strength, especially for applications where weight reduction is critical. It is well known that the fibre orientation affects the strength and stiffness of polymer matrix composite structure. The main properties that describe a composite material are the engineering constants and the strength properties of a single unidirectional lamina that make the laminated structure. Greater understanding of the role of variation in tensile properties with orientation of fibres in the laminate was acquired through the experiments

2. FABRICATION OF SPECIMENS

The process of fabrication is carried out by using Lapox L12 as the epoxy matrix, Hardener k6 is added to matrix in the ratio 100:13.The composite specimen is fabricated as per the standard procedure. Unidirectional fabric of E-glass with density 1100 gsm is used to reinforce the polymer matrix. Hand layup method was used to make the laminates. The surface will be thoroughly cleaned in order to ensure that they were free from oil, dirt etc., before bonding at room temperature and pressure.Then a mould release sheet is applied throughout the mould to facilitate easy removal of the laminate. A coat of mixed resin is applied on the cleaned surface before placing a layer of E-glass fibre.A layer of E-glass fibre is kept with a coat of resin over it. Consequent layers of E-glass fibre are placed until the required thickness is obtained.

Fig -1: Manufacture of glass fibrelaminates using Hand layup method

The finished composite is now is clamped at all the ends. Then the load is applied. The laminate will be allowed to cure for about 24 hours. The system also facilitates good resin distribution and consolidation of the laminate. At the end of the manufacturing process, the final thickness of plate was measured as about 3.00 mm for the glass Fibre, and then it is cut to obtain test specimens with three different orientations of glass fibre (0°, 45° and 90°).

3. EXPERIMENTAL DETAILS

Testing for tensile strength, impact strength, impact strength was carried as per ASTM D638M, ASTM D4812, and ASTM D790 Standards.This test method determines the in-plane properties of polymer matrix composite material reinforced by high modulus fibers. The specimen is machined from a flat laminate in to the required shape. Density of the specimen was calculated and found to be approximately equal to 1.99 g/cm^3

4. RESULT AND DISCUSSION

Using the density of the material and the values of the tested properties were calculated and tabulated as shown in table. 1.

Table -1: Tabulation of testing result

Orientation (degrees)	Specimen Number	Tensile strength (MPa)	Flexural Strength (MPa)	Impact strength (J/m)
0	1	48	98.7	84
45	1	72	101	129
90	1	204	575	278

Fig -2: Fractured Test Specimens

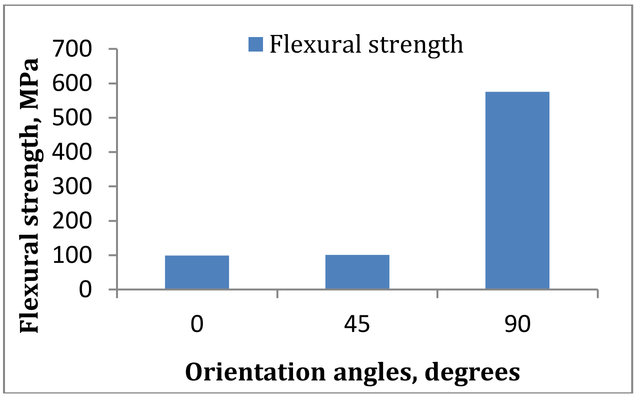

Fig -3: Flexure strength for E-glass Epoxy for different orientation

From the above results (Fig. 3 to Fig. 5), it is tested that the prepared glass/epoxy laminates exhibit various strength and stiffness values such as tensile strength, flexural strength and impact strength at different fibre orientations. Strength of the laminate are found to be highest in the longitudinal direction as compared to the other tested directions. This is because of the dominant properties of the fibre in the longitudinal direction.

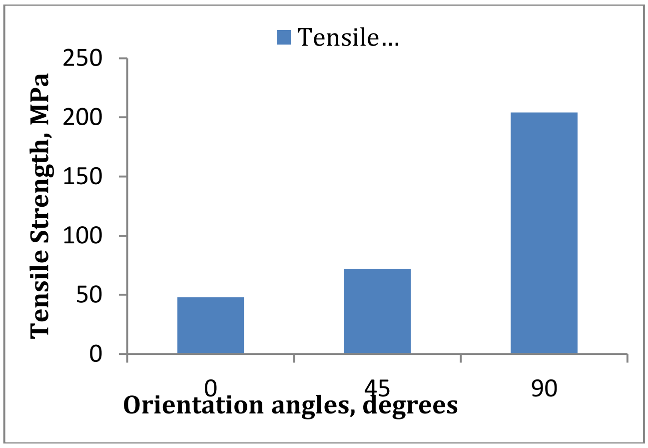

Fig -4: Tensile strength for E-glass Epoxy for different orientation

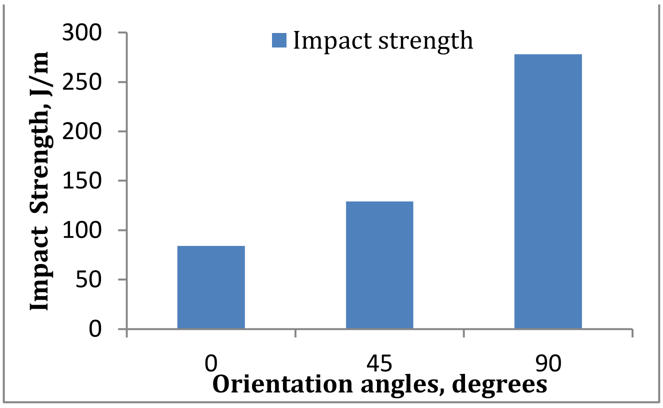

Fig -5: Impact strength for E-glass Epoxy for different orientaion

As the fibre orientation changes from 90° to 0°, the properties of the fibres decline and the properties of the properties of the matrix dominate. At 45° orientation of fibres both the fibre and the matrix play a major role in determining the properties of the composite. The difference in these properties may be observed from the obtained results.

5. CONCLUSION

Over the course of this project, the glass fibre/epoxy laminate has been fabricated and suitable specimens have been created and tested to understand the mechanical properties of the composite. The properties studied are tensile strength, flexural strength and impact strength. The values have been calculated and tabulated.

From the result it is understood that the fibre reinforced polymer laminates exhibit higher strength in 90° orientation as compared to other directions.

REFERENCES

[1] AlokeHegde, R. S. Darshan, FayazMulla, "tensile properties of unidirectional glass/epoxy composites at different orientation of fibre", vol. 5, march 2015, pp. 2248-9622.

[2] Rajanish, M. N. V. Nanjundaradhya, and S. Sharma Ramesh, "*A Review of Failure of Composite Materials*." Vol. 3.2, 2012, pp. 122-124.

[3] Humberto junior, sandrocamposamico, clarissacoussiratangrizani, "Effwct of fibre orientation on shear behavior of glass fibre/epoxy composites, 2015.

[4] Rajanish, ramesh, Sharma, "Influence of nano modification on the interlaminar shear strength of unidirectional glass fibre reinforced epoxy resin" 2014.

[5] Hansen, jenszangenberg, "Methodology for characterisation of glass fibre composite architecture",2012

[6] Kullor L.P and springer G.S., "*Mechanics of Composite Structure*", Cambridge University Press Stanford, 2003

[7] Grit, "The Advantages of Epoxy Resin versus Polyester in Marine Composite Structure", RINA Marine Renewable Energy Conference, The Royal Institution of Naval Architects, 2008.

[8] American standard and testing methods. Standard test method for mechanical properties of composite polymer matrix composite materials.

[9] M. Ashok kumar, G.v. Rao, "Influence of fibre orientation on E-glass/epoxy composite laminate subjected to quasi static loading" 2007.

[10] Grit, "the advantages of Epoxy Resin versus polyster in marine composite structure", RINA Marine renewable energy conference, the royal institute of naval architects, 2008.