International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 2 Issue 9, September - 2013

Fabrication and Characterization of Tensile properties of Laminated Composites –Effect of Fiber orientation

Pathalinga Prasad [1], Santhosh Kumar.S [2], Sridhar N Shastry [3]

[1,2,3]Assistant Professor, Department of Mechanical Engg., RNS Institute of Technology, Bangalore-98, India

Abstract

The work presented in this project investigates the experimental study of tensile properties of polymer matrix composite materials with respect to orientation of fibres to the test direction. Behaviour of Glass fibre-reinforced (GFRP) and Carbon fibre reinforced (CFRP) composite materials is studied. The test specimens are fabricated by simple hand lay-up technique and prepared according to ASTM standards. With a UTM TUE-600(C) high stroke rate test machine the related experiments are carries out to find out the tensile properties of test specimens. Hence using matrix and reinforcement in 65:35 ratios it can be seen that results are good for application like automotive parts manufacturing and few aerospace parts.

Keyword: *CFRP, GFRP, Hand lay-up, Tensile Test, Quasi-Isotropic Laminate.*

1. Introduction

The technological developments, industries are searching for lighter weight, higher strength and safer material to meet the demands of structural designs and for economic benefit. In order to extend the application area of plastics, plastic composites are developed by adding reinforcement materials to the polymer matrix. Some of the reinforcements used in structural and industrial applications are Carbon, Aramid and Glass fibers; the most commonly used is glass fiber. Plastic composite material has therefore become one of the new competitive materials in engineering. Fiber reinforced plastic is a relatively new class of composite material manufactured from fibers and resins, and has proven efficient and economical for the development and repair of new and deteriorating structures. The mechanical properties of FRPs make them ideal for widespread applications in various industries worldwide. The enhancement of the mechanical and structural properties due to addition of fibers makes FRPs ideal materials for aircraft parts, aerospace structures, and railways, marine and other industrial applications[1].

2. Literature Review

W.Richards Thissels, Anna k. zurek and Frank addessio [3] the IM6 fibers 3051/6 epoxy resin showed a 40% increased in stress –strain slope under compression loading at strain rate of 2000 L/S than 1×10^{-3} L/S when the applied load was parallel,45^0 and normal to the fiber axis. The compression test showed that delamination significant failure component. The applicability of current hole in plate analytical methods to highly anisotropic material is there questionable. Both hole in a plate analytical methods indicates that G_I is about 50% higher than G_1. Jane Maria Faulstich de Paiva [4] investigated a mechanical (flexural, shear, tensile and compressive tests) and morphological characterizations of four different laminates based on 2 epoxy resin systems (8552^{TM} and F584^{TM}) The results show that the F584-epoxy matrix laminates present better mechanical properties in the tensile and compressive tests than 8552 composites. It is also observed that PW laminates for both matrices show better flexural and interlaminar shear properties. Roberto J. Cano and Marvin B. Dow [5] In this study, the unidirectional laminate strengths and moduli, notched (open-hole) and unnotched tension and Compression properties of quasi-isotropic laminates, and compression after- impact strengths of five carbon fiber/toughened matrix composites, IMT/E7T1-2, IMT/X1845, G40-800X/5255-3, IM7/5255-3, and 1M7/5260, have been evaluated. This investigation found that all five materials were stronger and more impact damage tolerant than more brittle carbon/epoxy composite materials currently used in aircraft structures. José Ricardo Tarpani [6] Quasi-static tensile properties of four aeronautical grade carbon-epoxy composite laminates, in both the as-received and pre-fatigued states, have been determined and compared. The materials also displayed a significant tenacification (toughening) after exposed to cyclic loading, resulting from the increased stress (the so-called wear-in

ISSN: 2278-0181
Vol. 2 Issue 9, September - 2013

phenomenon) and/or strain at the maximum load capacity of the specimens. With no exceptions, two-dimensional woven textile (fabric) pre-forms fractured catastrophically under identical cyclic loading conditions imposed to the fiber tape architecture, thus preventing their residual properties from being determined.

3. Methodology

The Test laminates of 300mm X 300 mm were initially fabricated to prepare mechanical test specimens by Hand lay-up followed by Room temperature. The resin and the hardener of required quantities are taken in a previously weighed empty bowl. They are mixed properly in the bowl using a paintbrush. The mixture is used immediately in the preparation of the laminate which otherwise would start gelation. PVA wax was applied and was left for 20 minutes to dry. The wax was then applied in order to form a thin realizing film. A small quantity of resin system was coated on the mould surface and then a layer of the fabric (300 x 300mm) already cut was placed on that. The resin system was applied on the fabric to wet it and then the next layer of fabric was placed. The same procedure was followed till the required layers were placed ensuring adequate impregnation. The mylar sheet was sticked on the topmost ply and specimen war rolled using roller. Finally the specimen was allowed to cure for 48hrs in RT after that specimens are kept for post curing. After post curing, the specimens were hardened. The hardened specimens are ejected from the mould. The laminates were properly labeled and kept aside for further processing. The tensile test specimens are prepared according to the ASTM-D3039 standards for unidirectional laminates and SACMA SRM9 standards for quasi-isotropic laminates with 2mm thickness.

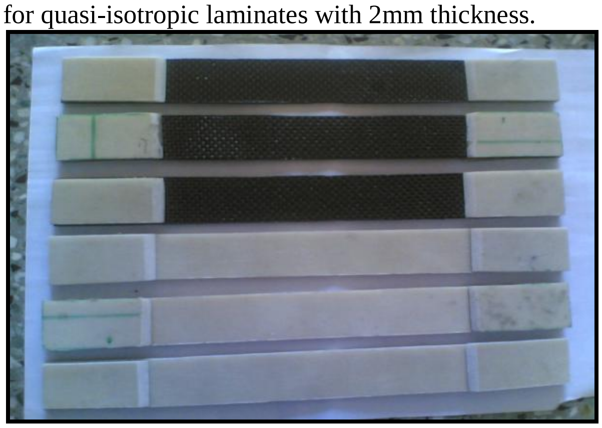

Fig. 1: Tensile Test Specimens

4. Results and Discussions

Tensile test results for CFRP & GFRP unidirectional composites

Material	Breaking Load (KN)	Maximum Displacement (mm)	Tensile Strength (MPA)
Carbon fiber with 2mm thick unidirectional laminate	31.08	1.3	585.24
Carbon fiber with 2mm thick quasi-isotropic laminate	16.62	3.11	426.19
Glass fiber with 2mm thick unidirectional laminate	12.30	2.29	190.11
Glass fiber with 2mm thick quasi-isotropic laminates	8.04	1.93	166.12

Table 1: Tensile Test Results

From the above results it is clear that CFRP & GFRP composite shows more strength in uni-directional fiber orientation laminates than quasi-isotropic fiber orientation laminate under tensile loading.

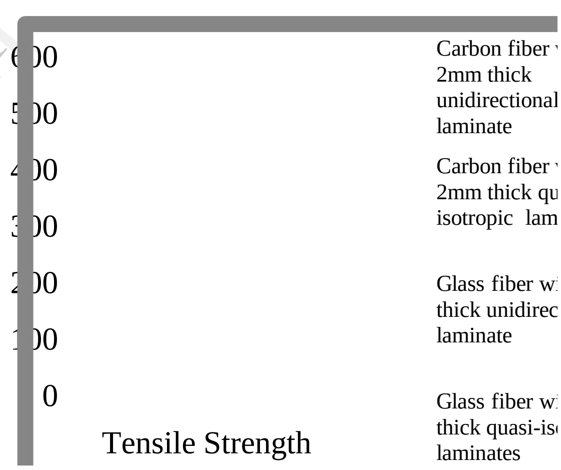

Fig. 2: Comparison of Results

The experimental results clearly indicate that when composite materials are designed, the reinforcements are always oriented in the load direction. However if the load direction is variable and not parallel to the fibers it becomes more important to investigate the laminate mechanical behaviour. Specimens with different fiber orientations were prepared under the same conditions as discussed earlier. The experimental results show that the tensile strengths are affected by the fiber orientation significantly.

5. Conclusions

By using a simple hand lay-up process, E-glass epoxy and carbon epoxy polymer matrix composites have been successfully fabricated. In case of Carbon epoxy polymer matrix composites, the tensile strength of unidirectional plies was found to be 27% greater than quasi-isotropic plies. In case of E-glass epoxy polymer matrix composites, the tensile strength of unidirectional plies was found to be 13% greater than quasi-isotropic plies. In the overall study, the strength of carbon epoxy polymer composites has highest value than that of E-glass epoxy polymer composites.

6. References

[1]. Composites Volume 21 of ASM Handbook ,page-42, ASM International Handbook Committee, 2001.
[2]. Mel M. Schwartz, “Composite Materials, Vol. II: Processing, Fabrication, and Applications:, 1/e, ISBN: 0-13-300039-7, 1997.
[3]. W.Richards Thissels, Anna k. zurek and Frank addessio, Mechanical properties and failure mechanism of carbon fiber reinforced epoxy laminated composites, : materials research and processing science MS:G755 fluid dynamics MS:B216LOS Aldmos NM 87545.
[4]. 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, 367-374, 2009
[5]. Roberto J. Cano and Marvin B. Dow, Properties of FiveToughened MatrixComposite Materials, NASA Technical Paper 3254, October 1992.
[6]. José Ricardo Tarpani*, Marcelo Tadeu Milan, Dirceu Spinelli, Waldek Wladimir Bose, Mechanical Performance of Carbon-epoxy Laminates Part II: Quasi-static and Fatigue Tensile Properties, Materials Research, Vol. 9, No. 2, 121-130, 2006