ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

IJARMATE

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE) Vol. II, Issue IV, April 2016.

MECHANICAL BEHAVIOR OF CARBON NANO FIBER /GLASS FIBER REINFORCED POLYMER MATRIX COMPOSITE

[1]N. DANNI , [1]T. SASIKUMAR,[2] S. VIMAL, [2] M. KARTHIKEYAN
[1]Centre for Research, Department of Mechanical Engineering, [2] Undergraduate student, Department of Mechanical Engineering Sandwich, Lord Jegannath college of Engineering and Technology, Tamilnadu, India.
engineerdanni@gmail.com

Abstract:

The development of nano particle reinforced composites is presently one of the most explored areas in materials science and engineering. Multiscale composites can be produced with superior properties by combining nano particles with traditional reinforcement materials. The diameter of Carbon nanofiber extent of variation between 100 nm - 250 nm and the length of the CNF extent of the microns perspective ratio of diameter, length greater than 100 nm. Composites are good properties enhanced due to the inclusion of nano fillers with epoxy resins are having many applications such as aircraft, marine, chemical, automotive, biomedical etc due to their high chemical and good mechanical properties. In this work, efforts have been made to fabricate glass fiber reinforced composites with carbon nanofiber inclusion with glass fiber reinforced composite in epoxy combinations to identify flexural strength of the composite.

Keywords: carbon nanofiber, glass fiber, flexural testing

1. Introduction:

Nano scale and nanostructure materials, an incipient branch of materials research, are magnetizing a great deal of attention because of their potential applications in areas such as electronics, optics, catalysis, ceramics, magnetic data storage, and Nano composites. The exceptional properties of nano particles have made them a focus of widespread research. Carbon nano tubes (CNTs) carbon nanofibers (CNFs) and other nano particles have the potential to greatly enhance the properties of composites when combined with traditional reinforcements such as carbon- glass and aramid-fibers [1]. Carbon nanofibers (CNFs) consist of graphite platelets perfectly arranged in various orientations with respect to the fiber axis giving rise to assorted confirmations [2]. Carbon nano fibres (CNF) are hollow cylinders with diameters ranging between 100 nm-250 nm and lengths of a few tens of microns giving high aspect ratios (length/diameter> 100). They have a larger diameter and are less crystalline, while keeping acceptable mechanical and physical properties. They are expected to be promising nano filler for the preparation of composites with multiple enhanced properties [3]. Because of their high aspect ratio and of Vander Waals attractive interactions arising at the nano scale, CNFs are tangled and form aggregates of different sizes which makes their homogeneous dispersion inside

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

IJARMATE

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE) Vol. II, Issue IV, April 2016.

the matrix one of the main hurdles [4]. These fibers are produced by a catalytic vapor deposition process and are highly graphitic in structure and more economically attractive for use in electronics, automotive and aerospace industries than carbon nano tubes. Structural composite applications on advanced aerospace vehicles require high temperature, high performance resins. Major applications of fiber-reinforced composites appear in aerospace and military fields due to their low density, mechanical properties and high temperature performance. Carbon fiber composites have become the primary material in many wings, fuselage and empennage components as well as secondary structures of commercial aircraft. High temperature organic matrix composites are also finding applications in jet engines. Future applications for organic matrix composites are demanding a challenging combination of properties. In addition to process ability, mechanical, and thermal performance, other properties to consider include electromagnetic interference (EMI) and radio frequency interference (RFI) shielding [5]. In this research work focus on the CNF inclusion with epoxy resin matrix in glass fiber reinforced polymer composite to justify the flexural strength of the composites was investigated.

2. MATERIALS USED

- Carbon nanofiber – Pyrograf II (PR-25 -XT) (DIA. 125 – 150nm).
- Glass fiber fabric
- Araldite standard epoxy resin CY 230-1 (HUNTSMAN).
- Aradur HY 951(Hardner)

2.1 FABRICATION OF GLASS FIBER COUPONS

The CNF inclusion with glass fiber four layer laminate coupons and another set was glass fiber four layer laminate was fabricated by using a hand-lay-up method. The thickness of the plate is 2 mm with each layer of a thickness of 0.45 mm. The laminate was fabricated using CY 230-1 epoxy with hardener HY951. Coupon with the dimension 80, 25, and 2 mm, length, width and thickness respectively were fabricated without any edge damage. The ASTM D790 coupons are shown in figures 1 (a) & (b).

1(a)

1(b)

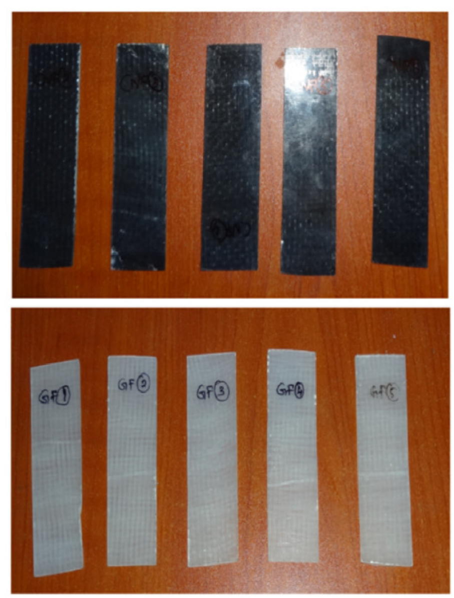


Figure 1(a) CNF inclusion with glass fiber reinforced coupons (b) Glass fiber reinforced coupons

2.2 FLEXURAL TESTING:

The flexural coupons obtained from the CNF inclusion glass fiber reinforced coupons and another set glass fiber reinforced coupons are subjected to the

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE) Vol. II, Issue IV, April 2016.

Point load was applied using a DAK 10-ton universal testing machine (UTM). Ten coupons were tested. The spans were 60 mm and the support length is 10 mm each side. The feed rate was 5 mm/min maintained throughout the testing. The test coupons were loaded with a three point bending test as per ASTM D790. The load was gradually applied in the middle of the coupon. The load was applied until the coupon failure and was repeated for all coupons as shown in figure 2.

Figure 2. Flexural Test Setup

3. RESULT AND DISCUSSION:

3.1 Flexural Testing:

The flexural properties of the CNF /Glass fiber reinforced resin matrix composite and glass fiber reinforced composite each proportion 5 coupons are fabricated and tested. The flexural strength of the composites was estimated and was given in the Table 1 and 2 below.

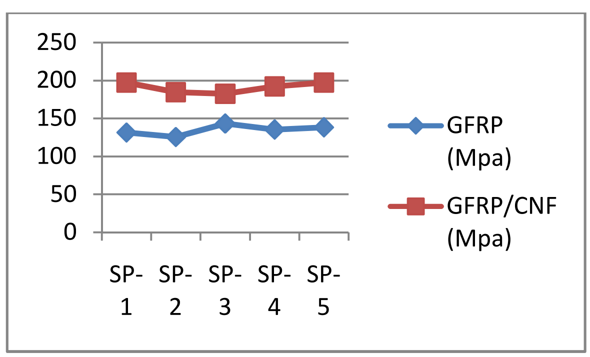
Table: 1 Load test result for CNF/GFRP

CNF/GFRP	Load (Mpa)
Coupon-1	197.18
Coupon-2	184.42
Coupon-3	182.46
Coupon-4	192.27
Coupon-5	197.18

Table: 2 Load test result for GFRP

GFRP	Load (Mpa)
Coupon-1	131.45
Coupon-2	125.56
Coupon-3	143.22
Coupon-4	135.37
Coupon-5	138.32

The flexural result shows while adding CNF into the matrix it gives a derastic improvement in flexural strength upto 54.93 Mpa as shown in figure 3.



ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

IJARMATE

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE) Vol. II, Issue IV, April 2016.

Figure 3. shows the flexural strength of GFRP and GFRP/CNF

4. CONCLUSION

The flexural test showed that the inclusion of carbon nanofiber with Glass fiber has more strength than the glass fiber reinforced in a polymer composite material. This work clearly illustrates the mechanical properties of the GFRP in composite material due to the dispersion of carbon nanofiber. The flexural load value of CNF/ GFRP composite has increased 10% when compared to the GFRP. These materials are suggested in the area of aerospace and military applications due to its lesser weight with higher strength.

Reference:

[1] Gojny F, Wichmann M, Kopke U, Fiedler B and Schulte K 2004. Carbon Nanotube-Reinforced Epoxy Composites: Enhanced Stiffness and Fracture Toughness at Low Nanotube Content, Composites Science and Technology, 64: 2363-2371.

[2] MordkovichVZ 2003. Carbon nanofibers: a new ultrahigh strength material for chemical technology, Theoretical Foundations of Chemical Engineering, 37(5): 429-38

[3] Matzek MD 2004. Polymeric carbon nanocomposites, physical properties and osteoblast adhesion Studies, Dayton OH USA, University of Dayton, Master's Thesis.Sandler J, Werner P, Shaffer MSP, Demchuk V, Altstadt V and Windle AH 2002. Carbon-nanofibre-reinforced poly (ether ether ketone) composites, Composites Part A, 33(8): 1033-1039.

[4] Maruyama B and Alam K 2002. Carbon nanotubes and nanofibers in composite materials, SAMPE Journal, 38(3): 60-69.

[5] Smith Jr. JG, Connell JW, Hergenrother PM, Yokota R, Criss JM. High temperature transfer molding resins based on 2,3,3’,4’-biphenyltetracarboxylicdianhydride. Soc. Adv. Mat. Proc. Eng. Ser.2002; 47: 316.

