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Enhancement of Mechanical Properties of Glass Fiber Reinforced Vinyl Ester Composites by Embedding Multi-Walled Carbon Nanotubes through Solution Processing Technique

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Abstract - This research work enumerates the effect of Multi Wall carbon Nano Tubes (MCNT) when added to glass fibre reinforced polymer composite on the performance characteristics. In the present era, the demand and usage of FRP composites was increasing in rapid manner. The applications of these composites are not limited to a field, but it is widely spread over to various areas. The field of applications includes automotive, sporting goods, aerospace, structural, cryogenic vessels, solar panels and oil and gas pipe lines. Fibre and glass reinforced polymeric composite materials are subjected to different range of crosshead speeds during their in-service life. The work has been focused to investigate the effect of carbon Nano tube addition in glass fibre reinforced polymer (GFRP) composite on tensile behaviour. MCNT modified matrix was processed with vinyl ester as a matrix materials and multi walled carbon Nano tubes (MCNT) as filler with constant MCNT content (3%). The tensile strength are dependent on the MCNT content in GRRP composite. During this investigation average tensile strength 15.8N/mm, Hardness of GFRF composite is 46HRM and Flexural strength is 22.04N/mm^2.

Key Words: Glass fibre, Vinyl ester, Glass vinyl ester and Multi walled carbon Nano tubes.

1. INTRODUCTION

The present era, Fiber Reinforced Polymer (FRP) composites are used for various applications such as structural, automotive, aerospace, marine, construction, electrical, electronic etc. The reliable properties of these composites are having high strength to weight ratio, high strength to modulus ratio, excellent corrosion resistance, low density and good in fatigue properties. FRP composite is a combination of two or more constituent materials. Vinyl ester (VE) polymer has excellent immunity and tensile strength due to high cross linking density so is best suitable for marine applications.

It can form thick interphase while contact with materials, which has been effective medium for increasing the load transfer, it can affect the mechanical properties. FRP composite industry glass fiber are preferred for reinforcing polymer due to high strength to wear ratio at low price.

In addition of Nano fillers can bring extraordinary changes in the FRP composites. Carbon nanotubes as ideal reinforcement material in polymeric composites. CNT provides excellent mechanical performance in terms of strongest and stiffest reinforcement materials to the high aspect ratio.

2. Materials

Vinyl ester (VE) epoxy supported Bisphenol A epoxy backbone was used as a matrix and Methyl Ethyl Ketone Peroxide (MEKP) as a catalyst. The fabric were purchased from Pliogrip Industries, India. MCNTs are having length and diameter 2–10 lm and 5–20 nm respectively, these material is purchased from Platonic Nanotech Pvt. Ltd, India.

3. Fabrication of the laminates

The solution processing technique is used for making the specimen. The hand layup method used to prepare glass fiber reinforced vinyl ester (GVE), and 0.1% MCNTS filled glass fiber reinforced vinyl ester (0.1% MCNT-GVE) composite laminates. In VE polymer MCNTS is incorporated. The solution processing method is shown in fig 3.1 which uses acetone as a solvent. Acetone and MCNTS mixed at a speed of 1000 rpm for 30 min at room temperature.

VE resin was stirred at 400 rpm for 30 min at 120^{0}C. After this it was mixed with the previously sonicated mixture of acetone and MCNTS. After acetone-MCNTs-VE suspension was allowed for stirring at 1000 rpm at a temperature of 120^{0}C till the acetone is evaporated.

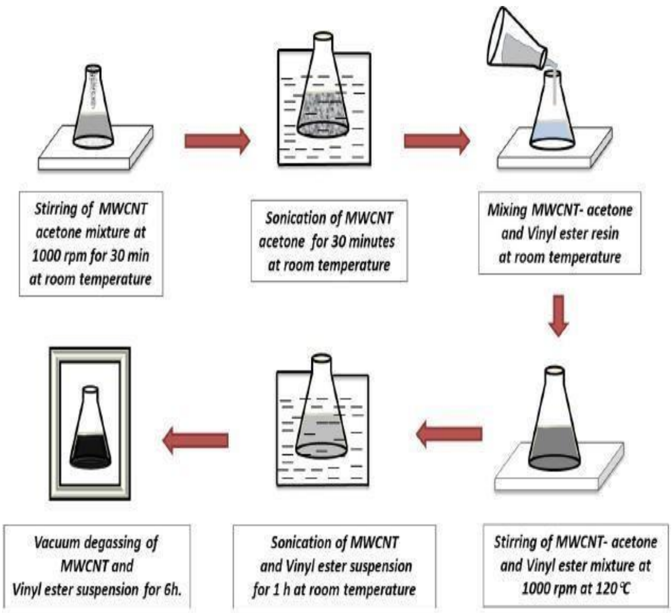


Fig: 3.1 Schematic view of solution processing technique

Again it was sonicated for 1 h. Finally, MCNTS-VE suspension was reserved for 6 h, for removing air bubbles from the suspension. The laminates are fabricated by using five layers of GF, mat size of 30 X 25 cm2, and the fiber and

matrix composition as 1:1 ratio. 1.5 wt. % of the matrix is used as a catalyst. The hydraulic press is used for procuring purpose, at a temperature of 600c and a pressure of 1 MPa for 20 min. The test specimens prepared using a diamond cutter. The specimens were kept in a hot air oven at 1400C for 6 hrs for the post-curing purpose.
The images of the fabricated materials taken through Machine vision instrument are as follows

Fig: 3.2 Molding Plate

4. Matrix Reinforcement Ratio

GFRP fiber layer weight	200gm
Vinyl Ester	300gm
Hardener & Accelerator	10 ml
MWCNT	9gm

Table: 4.1 Sample Ratio

S NO	SAMPLE
T-1	Vinyl Ester-70%+ GFRP fiber-30% + MWCNT-9gm

Table: 4.2 Sample

Fig: 4.1 Multi Wall Carbon Nano Tube Plates

5. GFRPP Embedded With MCNT Specimen Images

Fig: 5.1 Tensile, bending and Impact specimen Images

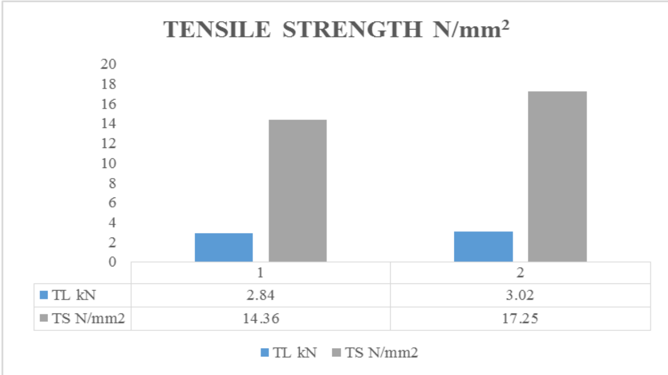
6. RESULT AND DISCUSSION

6.1Tensile strength values

Identification	Thick mm	Width mm	CSA mm^2	TL KN	TS N/mm^2	IGL mm	FGL mm	%E
T-1	8.10	24.42	197.802	2.84	14.36	300	302	0.67
T-2	7.58	23.10	175.098	3.02	17.25	303	306	1.00

Table: 6.1 Tensile Strength

Tensile Strength Graph

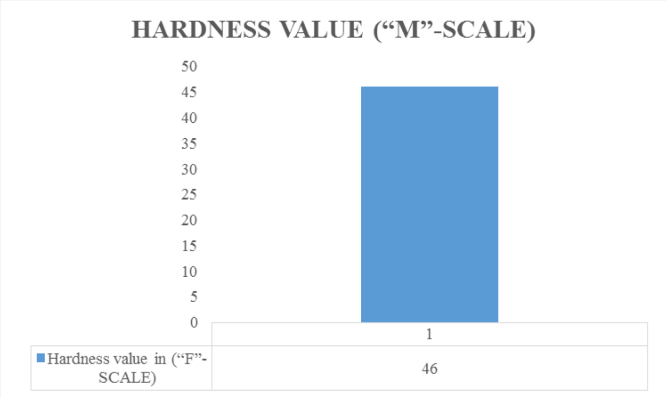


6.2 Hardness Test

S No	Hardness value in (“M”-SCALE)-LOAD-100 Kgf-1/4” Ball indenter
1	46

Table: 6.2 Hardness

Hardness Strength Graph

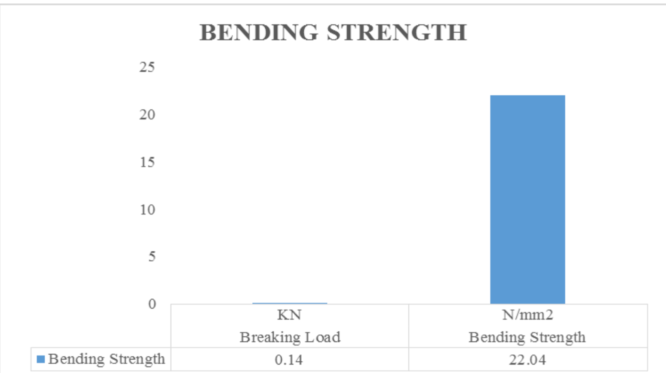


6.3 Flexural Strength Test

Identification	Length mm	Breadth mm	Depth mm	Breaking Load KN	Bending Strength N/mm^2
F-1	200	27.66	8.30	0.14	22.04

Table: 6.3 Flexural strength

Flexural Strength Graph



3. CONCLUSIONS

In general, GFRP and Vinyl ester doped with MCNTS gives a much better performance than from the commercially available normal GFRP. Glass fiber reinforced polymer composites with constant of Vinyl ester resin reinforcement together with fillers 3% of MWCNT were successfully processed and developed with a minimum percentage of voids with hand layup method of fabrication at room temperature. The current investigation comprises on the tensile response of the CNT addition with GFRP composites and further tested the subsequent conclusions. During this investigation average tensile strength 15.8 N/mm2, Hardness of the GFRP composite is 46 HRM and Flexural strength is 22.04 N/mm2 is noticed.

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