Effect of Post Curing on Mechanical Behaviour of Glass Fiber Reinforced Polymer / Multiwalled Carbon Nanotubes

B.Chandra Reddy[1], M.Hari[2], Y.Gopinath[3], E.Bairappan[4], Mr.V.Rajesh[5]
[1,2,3,4,5] Dept of Mechanical Engineering
[5] Assistant Professor, Dept of Mechanical Engineering
[1, 2, 3, 4, 5] Adhiyamaan College of Engineering, Hosur-635109

Abstract- *The thermal and mechanical properties of glass fibre reinforced Polymers(GFRP) will vary abundant with the result of post hardening .The present study is concerning the impact of post hardening paramerters on thermal and mechanical properties of glass fibre reinforced Polymers(GFRP) and Multiwalled Carbon Nanotubes(MWCNT) composite. The dried GFRP specimens were post cured in an oven at 80°C, 110°C and 140°C for 2h, 4h, 6h, 8h and 12h. The heating rate was 2°C/min. The specimens were cooled in oven atmosphere. the subsequent mechanical tests were conducted Tensile test, Quasi-static compression test and Impact test. Finally at 140°c for 6 hrs we have a tendency to found to possess the versatile properties of thermal thermal and mechanical.*

Keywords- Glass Fiber Reinforced Polymer, Multiwalled Carbon Nanotubes, Post hardening, Mechanical Behaviour

I. INTRODUCTION

A composite could be a material system consisting of two or a lot of phases of identical materials on a gross scale, wherever mechanical performance and properties, are designed to be superior to those of the constituent materials acting severally. The constituents of a composite are usually organized so one or a lot of discontinuous parts are embedded in an exceedingly continuous phase. The discontinuous part is termed the reinforcement and therefore the continuous part is that the matrix. An exception to the present is rubber particles suspended in an exceedingly rigid rubber matrix, that produces a category of fabric referred to as rubber changed polymers. Normally the reinforcements are abundant stronger and stiffer than the matrix. Both constituents are needed, and each should accomplish specific tasks if the composite is to perform as supposed. The physical and mechanical properties of composites area unit enthusiastic about the properties, geometry, and concentration of the constituents. Increasing the degree content of reinforcements will increase the strength and stiffness of a composite to a degree. If the degree content of reinforcements is simply too high there'll not be enough matrixes to stay them separate, and that they will become tangled. Similarly, the pure mathematics of individual reinforcements and their arrangements among the matrix, the geometric arrangement and volume fraction of every constituent, the anticipated mechanical masses, the operative setting for the composite, etc. should all be taken into consideration. Fiber Reinforced Polymer (FRP) composites is outlined as a compound (plastic) matrix, either thermosetting or thermoplastic, that's reinforced(combined) with a fiber or different reinforcing material with a decent ratio (length to thickness) to supply a discernible reinforcing operate in one or a lot of directions. FRP composites are completely different from ancient construction materials like steel or metal. FRP composites area unit eolotropic (properties solely apparent within the direction of the applied load) whereas steel or metal is identical (uniform properties altogether directions, freelance of applied load). therefore, FRP composite properties are directional, meaning that the simplest mechanical properties area unit within the direction of the fiber placement.

II. LITERATURE SURVEY

"**Effect of post curing temperature on mechanical properties of a flax fiber reinforced epoxy composite**", by Charlotte Campana, et.al has mentioned that Post-curing temperature had a limited impact on the composite mechanical behaviour excepted at 150°C where ultimate stress and strain decreased drastically while the stabilized modulus slightly increases. Post curing is responsible of a slight decrease of the matrix tensile properties attributed to the polymer oxidation but cannot explain on its own the evolution of the composite behaviour. Interfacial adhesion played a minor role in the composite behaviour probably due to its 2 intrinsic weakness. Finally, the flax fabric was highlighted to be the component most sensitive to thermal treatment thus governing the drop in the composite mechanical properties.[1]

"**Effect of post curing temperature of vinyl ester/e-glass composites with wet hand layup and VARTM**'', by Raju, et.al has mentioned that Low/high level temperature post-curing promotes completion of the cross-linking process of the resin and achieves a higher mechanical stability. The increase of cross-linking density improves the mechanical stability of the material, and relaxation of molecular network can increase its ductility and, thus, the energy absorption during fracture. Post-curing also facilitates large-scale deformation involving a substantial portion of the polymer chains, which enhances fracture toughness. Commonly used post-curing techniques are thermal, microwave, ultraviolet radiation, electron beam and radio-frequency-energy curing. As expected, VARTM specimens had higher tensile and flexure strength compared with the hand laid specimens with higher fibre weight fraction. The actual fibre weights are determined using burn-off tests. Concluding, it was ascertained that with a temperature of 82°C for 2 hrs. provided optimum increase in the material properties for E-Glass/Vinyl ester composite laminate.[2]

"**Effect of post-curing on thermal and mechanical behaviour of GFRP composites**", by D S Kumar, et.al has mentioned that Curing cycle has a strong impact on the thermal and mechanical behaviour of thermosetting polymers. The extent of cross-linking which is a strong function of curing temperature and time is directly linked to the glass transition temperature (Tg) of the thermosetting polymer. This transition temperature speaks about the transformation of the polymer from glassy state to rubbery state, hence decides the applicability of the material at certain temperature with certain degree of safety and reliability. Hence assessment of Tg and its possible improvement is quite essential from material point of view. The present study is emphasized on the impact of post curing parameters on thermal as well as mechanical behaviour of glass fiber reinforced polymer (GFRP) composite. Post curing was carried out at 3 different temperatures (80°C, 110°C and 140°C) for different time periods (2hr, 4hr, 6hr, 8hr and 12hr). Short beam Shear (SBS) test was performed on each of the post cured samples to determine the apparent Interlaminar Shear Strength (ILSS) and the corresponding Tg was also evaluated using differential scanning calorimetry (DSC) analysis. The results revealed that the ILSS and Tg are significantly affected with post curing parameters. No significant change in ILSS was obtained at 80°C over the entire curing time. In case of 110°C a smooth increment in ILSS was observed with time (even till 12 hrs). For samples post cured at 140 °C a rapid improvement in ILSS takes place with time followed by saturation. With all the possible combinations of curing temperature and time, optimum values are noticed at 140°C for 6 hrs.

[3] "**Effect of Carbon Nano fiber Heat Treatment on Physical Properties of Polymeric Nano composites**'' by Khalid Lafdi, et.al has mentioned that vapour-grown carbon Nano fibers were subjected to varying heat-treatment temperatures. The strength of adhesion between the Nano fiber and an epoxy (thermoset) matrix was characterized by the flexural strength and modulus. Heat treatment to 1800◦C demonstrated maximum improvement in mechanical properties over that of the neat resin, while heat-treatment to higher temperatures demonstrated a slight decrease in mechanical properties likely due to the elimination of potential bonding sites caused by the elimination of the truncated edges of the graphene layers.[4]

III. MATERIALS AND EXPERIMENTAL STRATEGIES

For the fabrication of composite, two kinds of resins are used i) primary resin (matrix) ii) secondary resin (hardener). most typically used primary resins are epoxy, unsaturated polyester and polymer. Secondary resin i.e. hardener is another for hardening purpose. most typically used secondary organic compound includes amines or peroxides. The FRP Wrapping procedure accustomed prepare density hierarchical FRP skinny walled tubers for the axial compression test. Laminates were ready by hand lay-up technique. Specimens are created by layer of 300 gm/m2 fiber, layer of 450 gm/m2 fiber, and layer of 600 gm/m2 fiber.

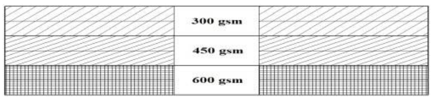

Fig1: Configuration of lamination

The ready laminates were taken from the mould and so specimens were ready for mechanical tests per ASTM standards ASTM-D3039 for tensile and ASTM-D790 for flexural tests. three identical check specimens were ready for various tests.

IV. RESULT AND DISCUSSION

In the present work we are conducting different mechanical tests of tensile test, compression test, and impact tests in keeping with ASTM standards and determined the energy absorption and specific energy absorption for each single specimen throughout the experiment using load vs displacement graph. Finally we tend to found that the specimen with 140°c for 6hrs with 0.2% of CNT composite given the versatile leads to all the three mechanical tests we conducted.

Tensile stress test graph for load v/s displacement

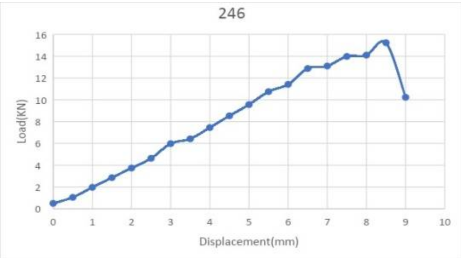

Fig2 : Load v/s displacement graph of density graded tube with 0.2% CNT at post curing temperature 140°C for 6 hours.

Quasi-static compression test graph for load v/s displacement

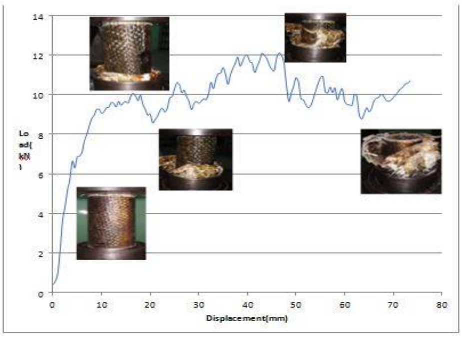

Fig3 : Load v/s displacement graph of density graded tube with 0.1% CNT at post curing Temperature 140°C for 6hours tested under quasi static compression.

Initial chamfer of 45 degrees were given to these tubes, due to this petaling was observed. Tube showed stable and progressive crushing throughout the crushing process. The energy absorption obtained from above LD graph is **0.70KJ** and specific energy absorption is **11.66KJ/Kg.**

Izord charpy impact test graph for load v/s displacement

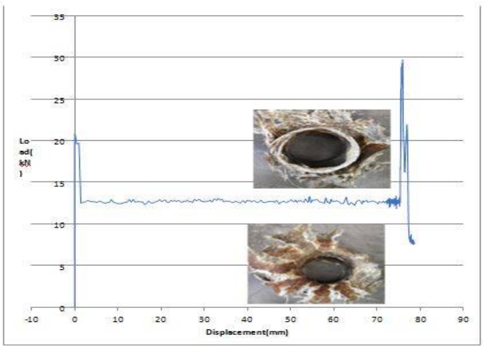

Fig 4: Load v/s displacement graph of density graded tube with 0.2% CNT at post curing Temperature 140°C for 6 hours, of drop weight test.

Initial chamfer of 45 degrees were given to these tubes, due to this progressive petaling & delamination between two layers was observed. 79mm compression was found on 90mm tube. Tube showed stable and progressive crushing throughout the crushing process. The Energy absorption obtained from above load v/s displacement is **0.945KJ** & Specific energy absorption **12.6KJ/Kg.**

V. CONCLUSION

The following conclusion is drawn from the present investigation at 140°C for 6hrs with 0.2% CNT has given the best flexible properties of thermal and mechanical properties.

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