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Synthesis and Characterization of Glass Fiber Reinforced Nano Composite Cylindrical Pipes Using TiO2 Nano Particles

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Abstract--Polymer matrix reinforced with fibers and Nano fillers are widely used in automotive, marine, and aerospace and construction industries because of their high tensile and compressive strength, low coefficient of thermal expansion, good fatigue resistance and suitability for the production of complex shape materials. The polymer composite materials are light weight when compared to steel. The commercially made steel pipe are more weight and poor resistance of corrosion and high cost. The nano materials will improve the strength, corrosion and chemical properties. In this research work to studies the effect of TiO2 on E-glass fiber reinforced polymer composite. The Nanocomposite cylindrical pipes were prepared by hand layup technique by varying percentages of TiO2 nanoparticles of 0, 1, 2, 3 and 4 wt% respectively .The distribution of TiO2 in polymer were analyzed using Scanning electron microscope (SEM). The result shows that addition of nano particles enhance the compressive strength 19.62% in the addition of 3wt% TiO2.
Keywords: Polymer matrix, Nano particle, E-Glass fiber, Compressive Strength, SEM

I. INTRODUCTION

Transmission pipelines in oil and gas industry investigated internal and/or external metal loss because of erosion and/or corrosion that can occur during transportation of the products or as a result of operating in a corrosive environment. More than 60% of the oil and gas transmission pipelines around the world are more than40 years old [1] and in urgent need of rehabilitation in order to re-establish their maximum operating capacity .Md Mainul Islam et al [2]. Reported a comprehensive review on the use of fibre-reinforced polymer composites on underground and underwater pipeline repairs As an alternative, fibre-reinforced composite has proven to be an effective repair solution for steel pipelines corroded. The advancement in this new material. Jacob Anderson et al [3]. The composite is cured by heating and circulating the air inside the bladder while its temperature is control at the recommended cure temperature of 121°C. A number of composite tubes were prepared as test samples by wrapping the bladder with the prepare. These cured samples were using bladder pressures of 69, 207, and 345 kPa. The fabricated composite cylinders were characterized by compressing sample rings obtained with the tubes. The normalized load- stiffness and deflection results indicate the flexural modulus of the tubes was improved with increased cure pressure. Variation in the cylinder wall thickness due to the changes in the cure pressure was also reported, this incress is attributed to the reduction of ring wall thickness due to increased cure pressure which leads to increased fiber volume fraction. Liqiong Chen et al. [4] studied the fiberglass reinforced plastics replace seamless steel pipe when conveying high viscosity of crude oil. Temperature fields within a period of time of both kinds of pipeline were numerically simulated by means of fluent software and temperature drop and pressure drop were simulated by PIPEPHASE software. [5] Analog results indicate that FRP offers a better thermal insulation property when transporting highly viscous crude and FRP requires smaller initial pressure when conveying the same medium, which is more energy-saving. Xiaolong Jia, Zigao Zeng, et al. [6] studied a range of design scenarios are modelled using analytical equations and finite element method in order to assess the validity of with live pressure in the design.

J.M. Duell, et al. [7] examined Pipe vessels containing the defects along with the composite structural repairs were modeled and the results were compared to field tests to find the effectiveness of the repairs. It was found that the defect width around the circumference had little impact on the ultimate rupture pressure of the repaired vessel, but influenced the stress state in the underlying pipe substrate. The results of the finite-element analysis compare well with experimental rupture tests. The full-scale evaluations performed on test vessels with machined defects failed at pressures predicted by the finite-element simulations R. Matadi Boumbimba , et al.[8] Dynamic mechanical analysis (DMA) tests have been conducted to determine the effect of Nanostrength on storage, loss modulus and glass transition temperature. A drop weight tower was used to perform low-velocity impact tests on laminate composites. Addition of Nano strength to the epoxy matrix led to an increase in both strength and impact resistance of the composite. Moreover, a moderate decrease of storage modulus and glass transition temperature was observed. The main aim of this project work is to synthesis the glass fiber reinforced polymer nanocomposite pipes using TiO2 nanoparticles in order to improve the strength and durability of the pipes used in oil industries, power plants, chemical industries etc. This investigation contains characterization of nanocomposite pipes using scanning electron microscope (SEM).

II. MATERIALS

In this research work, E-glass fiber of woven roving mat (WRM) were used in order to improve the load bearing property on both the directions. The material of Epoxy resin of trade name LY556 and hardner HY951 was used as matrix materials. TiO2 nanoparticles are used as a filler material to prepare the polymer nanocomposites laminates. Polyvinyl alcohol (PVA) is a water soluble synthetic polymer applied on the mold before the hand layup process for the easy removal of prepared laminates after curing.

III. FABRICATION

Fabrication processes starts with preparation of mandrel in stainless steel on diameter 30mm and length 700mm machined by using lathe in order to produce the conventional pipe using composite materials. The mandrel was then coated with polyvinyl alcohol for easy removal of fabricated composite pipe. TiO2 nanoparticles are mixed with epoxy resin using mechanical stirrer to achieve uniform dispersion of filler materials at speed of 750rpm for 2hours. After that the fibers were layered on the mandrel by the hand layup technique seven layers were used to make the composites pipes. Epoxy resin with TiO2 mixture were applied on each layer respectively. After curing of 48hrs the composite pipe was removed from the mandrel. The prepared specimen of composite pipe as shown in Fig. 1.

Fig.1. Fabricated specimen

IV. COMPRESSION TEST

Mechanical test of compression were preformed to find the maximum rate of compressive load of material can be fracturing. Piece to be test were in the form of a, cylinder, prism and cube, is compressed between the platens of a compression-testing machine by applying gradual load. Brittle materials such as cast iron, brick, rock, and concrete may exhibit great compressive strengths but ultimately that fracture. As pre the ASTM D1599 Standard the dimension for the compression test of the composite pipe is length of 20mm and the inner diameter 30mm and outer diameter of 35mm.

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Fig. 2. Testing specimen

Fig. 3. Compression testing machine

V. RESULT AND DISSCUSSION

The compressive strength results was showed Fig. 4 that by varying the wt percentage of TiO2 the compression strength increases. The compressive strength and modulus values of woven Roving mat (WRM) glass fibre/epoxy nanocomposite were presented in Table.1 There is a gradual increase in compressive strength from 15.8N/mm^2 for neat epoxy to 18.9 N/mm^2 for 1 wt% Tio2.

TABLE.1. Compression strength values

Tio2 (wt %)	Compressive strength (N/mm^2)	% of Gain/Loss in strength
0	5.8	
1	16.5	4.43
2	17.8	12.65
3	18.9	19.62
4	11.3	-28.65

The compression strength results are shown in Fig.4. They indicate that This improvement is due to the presence of exfoliated nanocomposite structure (well dispersion of TiO2).

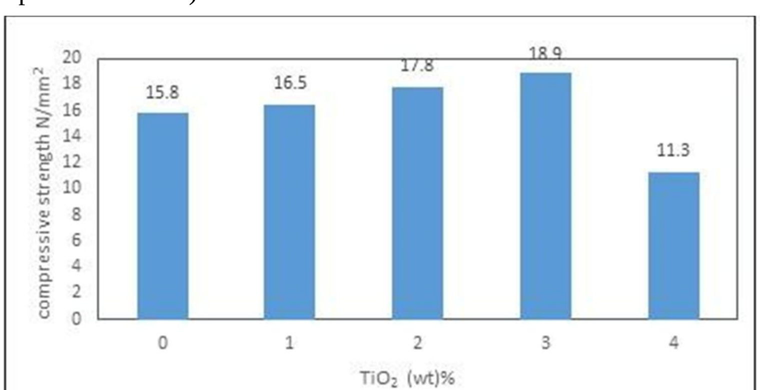


Fig: 4 compressive test result

A similar trend was observed in at 4wt% of TiO2 properties. The modulus was increased by 4.43% and 19.62% with 1 wt% and 3 wt% Tio2 respectively. A small amount of TiO2 (3 wt %) also contributed to the augmentation of compression modulus, but adding higher concentration of TiO2 did not improve the compression properties. This phenomenon might be due to the comparatively poorer dispersion of Tio2 in epoxy and more possibility of the existence of voids in composites.

VI. FRACTURE ANALYSIS OF WRM/EPOXY NANOCOMPOSITES USING SEM

The compression fractured surfaces were examined by Scanning Electron Microscope (SEM) in order to understand the fracture behaviors of the nanocomposites. Fig 5 and 6 shows the SEM micrographs of WRM glass fiber/epoxy composite with and without TiO2. The purpose of choosing failure sample in Fig 5 that neat epoxy sample exhibits relatively smooth fiber surfaces and crack propagation. Fiber pull-out and small gaps were observed at the interface between the matrix and the fibers which revealed weak interfacial bonding. However samples is to identify the interface failures such as crack, deboning, fibre breakage and fibre pull-out. It can be, fracture surfaces of 3% TiO2 show considerably different fracto graphic features as shown in Fig 6 Generally, a much rougher fracture surface was seen upon adding TiO2 into the epoxy matrix. This fracture surface roughness indicates that the resistance to crack propagation is high for pure epoxy has and crack has not propagated as easily as seen in TiO2 nano samples.

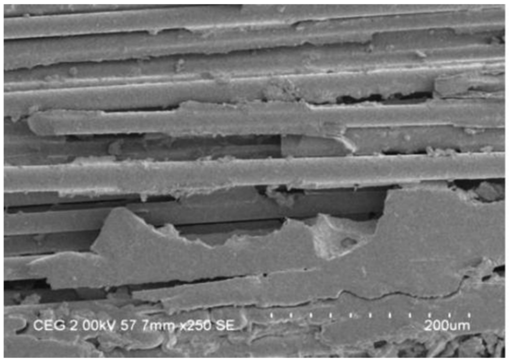


Fig. 5. SEM micrographs of neat epoxy

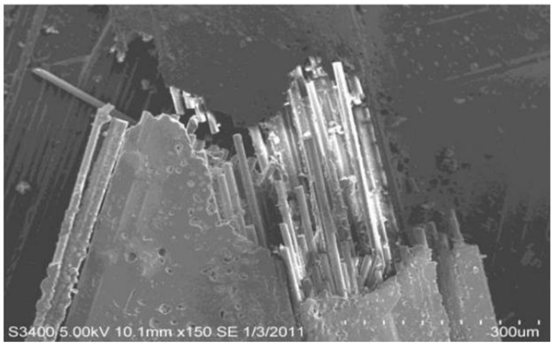


Fig. 6. SEM micrographs of 3 wt% TiO2

This effect results in higher strength to failure and causes improved strength of nanocomposites. Increased surface roughness implies that the path of the cracks is distorted because of the TiO2, making crack propagation more difficult. However, the failure mode was considerably changed when the Nano TiO2 content was increased to 3 wt% as shown in Fig 6 Though the fracture roughness is predominant at 4 wt% TiO2, sample, the existence of agglomeration of particles could have decreased the strength of nanocomposites. The TiO2 filled Glass-epoxy matrix shows good bonding between the fiber and matrix. These hard particle well protects the fiber from worn surface was relatively smooth and less damage to the Matrix was observed as compared to unfilled TiO2 composites. The failure was initiated at a localized domain which may be due to the presence of unexfoliated aggregates of TiO2 particles.

VII. CONCLUSION

Glass fiber reinforced nano cylindrical pipe of varying weight percentage such as 0, 1, 2, 3, and 4wt% respectively was successfully prepared by using hand lay-up technique

Mechanical stirrer was used to mix the TiO2 in matrix material.

The prepared polymer TiO2 nano composite was characterized by using scanning electron microscope (SEM)

The compressive strength was increased by 19.62% when 3 wt% TiO2 was added into the matrix

It was observed that TiO2 particles were uniformly dispersed into epoxy resin

REFERENCES

[1] A.Nariman Saeed, A.Hamid Ronagh ,B.C.Amandeep Virk, “Composite repair of pipelines, considering the effect of live pressure-analytical and numerical models with respect to ISO/TS 24817 and ASME PCC-2”, Composites Vol. 58, pp. 605–610 2014,.
[2] Pipelines International. Evaluating different rehabilitation approaches; 2009.
[3] T.S.Manjunatha and D.Abdul Budan, “Investigation on the Feasibility of Composite Coil Spring for Automotive Application” World Academy of Science and Technology Vol. 46, pp.45-77 2012.
[4] Gulur Siddaramanna Shiva Shankar and Sambagam vijayarangan, “Mono Composite Leaf Spring for Light Weight Vehicle – Design, End Joint Analysis and Testing” Materials Science (Medziagotyra). Vol. 12, pp.343-444 2006.

[5] T.S.Manjunatha and D.Abdul Budan, "Manufacturing and experimentation of composite helical springs for automotive suspension", International Journal of Mechanical Engineering and Robotics Research. Vol. 1, pp.789-840 2012.

[6] Xiaolong Jia, Zigao Zeng, Gang Li, David, Xiaoping Yang, Shiren Wang, "Enhancement of ablative and interfacial bonding properties of EPDM composites by incorporating epoxy phenolic resin" Composites part b. vol . 1–9. pp.668-876 .2007

[7] Duell jm, Wilson jm, kessler mr, "Analysis of a carbon composite overwrap Pipeline repair system". International journal press pipe. Vol .8 pp.56-67 2008.

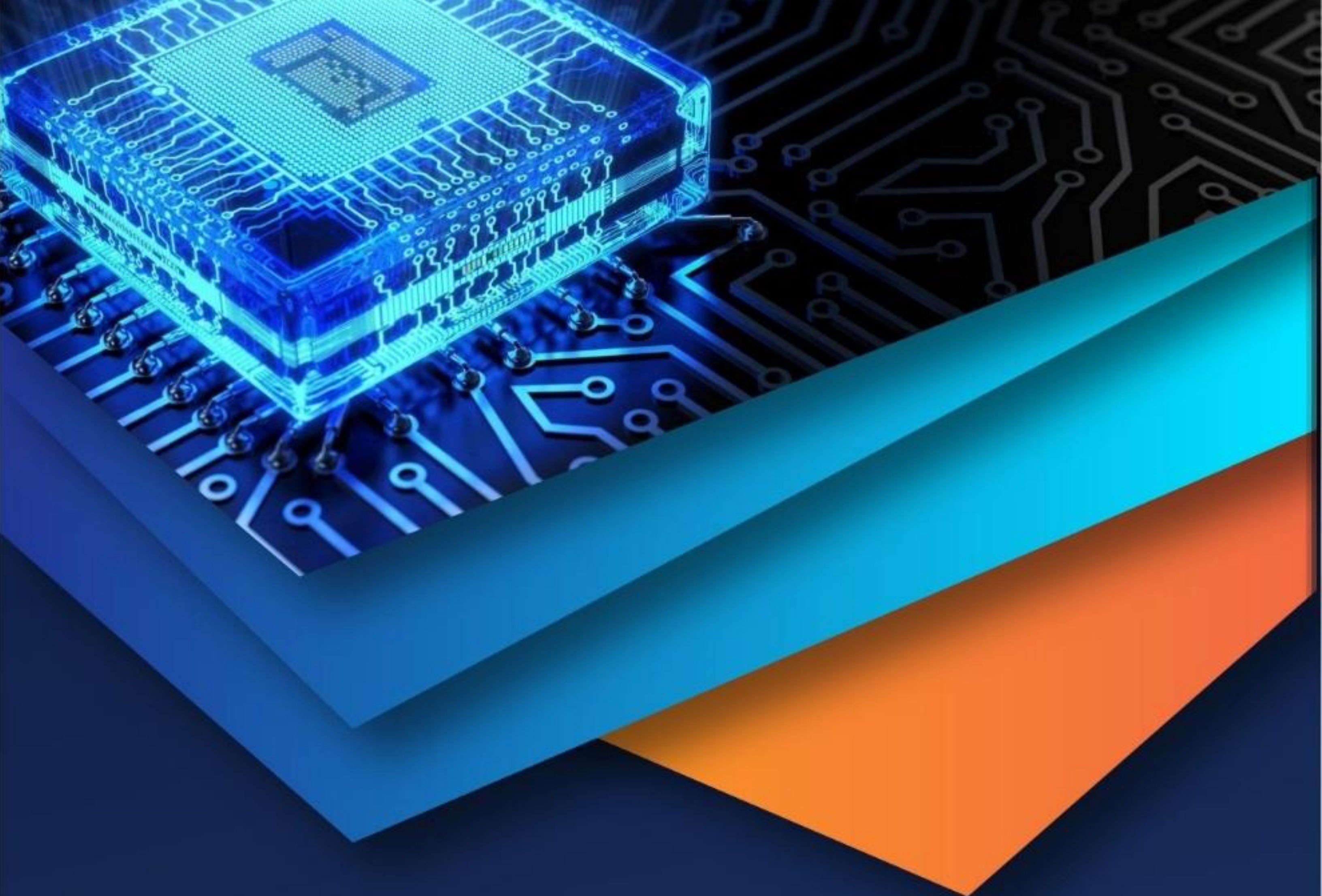
[8] Goertzen wk, kessler mr, "Dynamic mechanical analysis of carbon/epoxy Composites for structural pipeline repair". Composite part b: vol. 1–9.pp.121-222 2007

[9] V.PoZhilarasu, T.Parameshwaran Pillai, "Comparison of Performance of Glass Fibre Reinforced Plastic Leaf spring with Steel Leaf Spring" IJCRGG Vol. 5, pp. 434-676 2013.

[10] A.Saianuraag K.Bitraguntha Venkatasivaram, "Comparison of Static, Dynamic &Shock Analysis for Two &five layered Composite Leaf Spring" IJERA Vol.2, pp.9-23 2012.

[11] ASME. B31.1: power piping; "International Journal of Modern Engineering Research". Vol.2, 2010.

[12] K.Anand Babu ,MD Abid ali, "Finite Element Analysis of Glass/Epoxy Composite Laminates with Different Types of Circular Cutouts" Indian Journal of Applied Research Vol. 3, pp.55-88 2013.



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