The International Journal Of Engineering And Science (Ijes)
||Volume||2 ||Issue|| 2 ||Pages|| 185-189 ||2013||
Issn: 2319 – 1813 Isbn: 2319 – 1805

# Analysis Of Mechanical Properties Of Chopped Strand Mat E-Glass Fiber Epoxy Resin Nanoclay Composites

[1,]Dr.P.K.Palani, [2,]M.Nanda kumar
[1,]*Associate Professor, Dept Of Mechanical Engineering, Government College Of Technology, Coimbatore*
[2,]*P.G.Scholar,Dept of Manufacturing Engineering, Government College of Technology,Coimbatore-641013.*

**Abstract**

*Composite materials play a vital role in many industrial applications. Researchers are working on fabrication of new composite materials worldwide to enhance the applicability of these materials. In view of this, the objective of the present work is to analyse the effect of nanoclay content on the mechanical behaviour of chopped strand mat E-glass fiber, reinforced in epoxy matrix with nanoclay filler. Three different types of composites are fabricated using 1wt% nanoclay, 5wt% nanoclay and 7wt% nanoclay with 30% wt fiber, epoxy resin and hardener. The epoxy resin and hardener are mixed in 10:1 weight ratio. The results of the study show that the incorporation of nanoclay has a significant effect on the mechanical behaviour of composites.*

***Keywords*** *- chopped strand mat E-glass fiber, Nanoclay, Epoxy resin*

Date Of Submission: 12, February, 2013 ⟷ Date Of Publication: 28, February 2013

## I. Introduction

Fiber reinforced polymer composites are very widely used because of their favourable properties such as high specific tensile and compressive strength, controllable electrical conductivity, low coefficient of thermal expansion, good fatigue resistance and suitability for the production of complex shape materials. These materials have become the alternative of conventional structural materials such as steel, wood or metals in many applications. Typical areas of composite applications are car industry, aircraft fabrication, wind power plant, boats, ships, etc. During the human history, composites made occasionally large breakthroughs in construction and other materials. Among the composites, Chopped strand mat E-glass/ epoxy composite is emerging as a promising material for marine application due to their excellent superior strength, moisture resistance and electrical and fire insulation than that of other composites in making boat hulls,fiber glass boat. Bijesh[1], studied the mechanical properties of chopped strand mat E-glass / epoxy composite with different fiber wt%. He found that 50wt% fiber composite gave the high mechanical properties than that of (30 and 40wt %). Lam, et al, studied the mechanical properties of nanoclay/ epoxy composites with different amount of nanoclay particles. They found that 5wt% nanoclay epoxy sample gave the highest tensile strength & Vickers hardness value among all remaining (0 to 8 wt%). Literature survey indicate that very limited work has been done on mechanical behaviour of chopped strand mat E-glass fiber reinforced epoxy composite of varying fiber wt%. Therefore,the aim of this work is to fabricate the chopped strand mat E-glass / epoxy nanoclay composite of varying wt% using hand lay up technique and to study the mechanical properties of the composites. Various other different methods of fabricating the polymer matrix composites are wet lay up (hand lay up), resin transfer molding, filament winding and compression molding. Among the techniques mentioned above, Hand lay up technique is used in this study since, it is effective, economic, good surface finish[4] and easy fabrication.

## II. Experimental Procedure

Chopped strand mat (powder bonded) is formed by binding chopped glass fibers, using spraying powder binder. The density of the mat is 450g/m$^2$ supplied by Binani Industries Limited (Glass Fibre Division). Initially (330x330) mm mat of four layers are cut for fabricating each composite. The fibre content in the three composites are 30 wt% of total weight of the composite. The type of epoxy resin used in the present investigation is Araldite LY556 and hardener is HY951. They are mixed in 10:1 weight ratio. The epoxy in the three composites are 69wt%, 65wt% and 63wt% of total weight of the composite. Nanoclay is a clay from the smectite family, Smectites have a unique morphology featuring one dimension in the nanometer range. Nanomaterials can be defined as materials which have structured components with atleast one dimension less than 100 nm. The selected nanoclay is a type of nanoclay, which has its surface modified with 25-30wt% methyl dihydroxyethyl hydrogenated tallow ammonium.

## III. Composites Preparation

The composite material used for this study is prepared by hand lay up method (Fig.1). Mold release agent is applied to milar sheet of 75 micron. Epoxy resin and nanoclay are mixed and kept for one or two hours. Then, this mixture is mixed with the hardener, and applied to the milar sheet. Then the mat is kept and final mixture is applied to the mat. Now, roller is used to eliminate air bubbles. The same procedure is carried out for all four mats for each composite. Another milar sheet is kept on this and air bubbles are removed. Then the composites so prepared are cured at room temperature for 18 hours. The post curing is carried out in sun light for 4 hours on each side of the three composites. The stoppers are used for ensuring uniform thickness for the composites. Figures 2,3 and 4 show the composites prepared for this study.

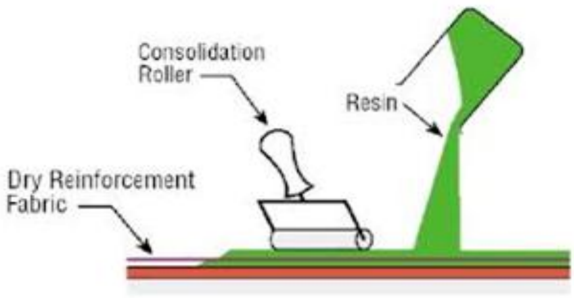


Fig .1- hand lay up method

Fig.2- 1wt% nanoclay composite

Fig.3- 5wt% nanoclay composite

Fig.4- 7wt% nanoclay composite

## IV. Testing Of Mechanical Properties

The three varieties of composites are evaluated for their mechanical properties by conducting hardness test, tensile test, flexural test and charpy impact test. The test specimen are shown in Fig.5 to Fig.8.

### 4.1Hardness test

The test was conducted using Rockwell L- scale, which is especially for plastic materials, bakellite and vulcanized rubber. The indenter chosen is of steel ball of 1/4$^{th}$ inch diameter. A load of 60 kg was used for the test.


Fig.5- Specimen after hardness test

**4.2 Tensile test**

The tensile test was carried out using an universal testing machine of capacity 5 tons. The test specimen is prepared according to ASTM D 638-03 standard. The tensile strength is calculated according to the following formula

$\sigma_t = P / bh$ - - - - - - - - (1)

(Where,

P-ultimate load on the specimen (N)

b- Initial width of specimen (mm)

h- Initial thickness of specimen (mm))

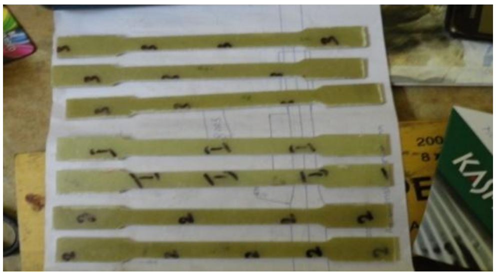

Fig.6- Specimen before tensile test

**4.3 Flexural test**

The flexural test is carried out using the universal testing machine of capacity 5 tons. The test specimen was prepared according to ASTM D790 standard. The flexural strength is calculated according to the following formula

Flexural strength: $\sigma_f = 3PL/2bh^2$ - - - - - -(2)

(Where,

P is the maximum load (N)

L- Span length of the specimen (mm)

b- Width of specimen (mm)

h- Thickness of the specimen (mm))

Fig.7- Specimen before flexural test

**4.4 Charpy impact test**

The charpy impact test, also known as the charpy v – notch test, is a standardized high strain – rate test which determines the amount of energy absorbed by a material during fracture. The test specimen was prepared according to ASTM D 256 standard.

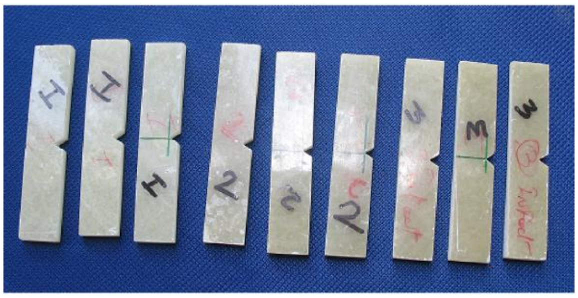

Fig.8- Specimen before charpy impact test

## V. Results And Discussion

From the results of hardness test it is observed that the hardness increases with increase in % nanoclay. However, further increase in % wt nanoclay hardness starts decreasing. The maximum hardness was observed for 5wt% nanoclay composite. The results are shown in fig.9.

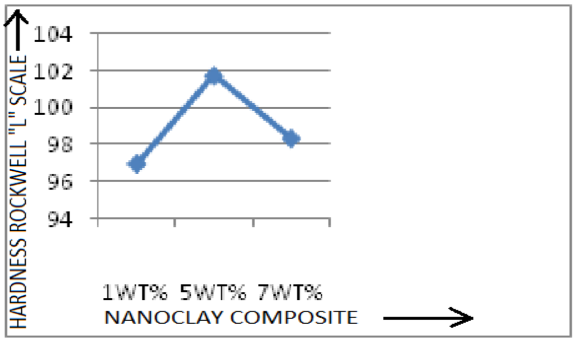


Fig.9- Hardness of three composites

Fig.10 shows the results of tensile test. The results indicate that tensile strength increases with increase in wt% of nanoclay and reaches maximum value for 5wt% nanoclay composite. However, Further increase in wt of nanoclay, the tensile strength decreases.

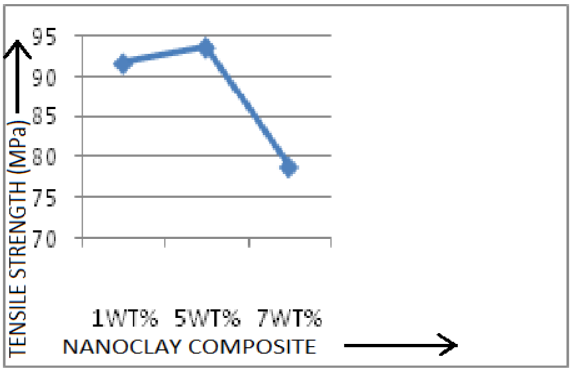


Fig.10- Tensile strength behaviour of three composites

Test results on flexural strength, indicate that it increases from the 1wt% nanoclay composite to 5wt% nanoclay composite and then decreases with further addition of nanoclay. The flexural strength of 5wt% nanoclay composite is the maximum among the three composites.(Fig.11)

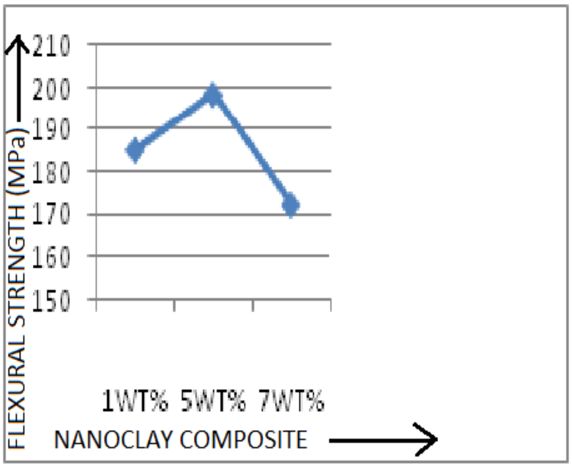


Fig.11- Flexural strength of three composites

Results of impact energy test, indicate that impact energy decreases with addition of nanoclay. The results are depicted in Fig.12.

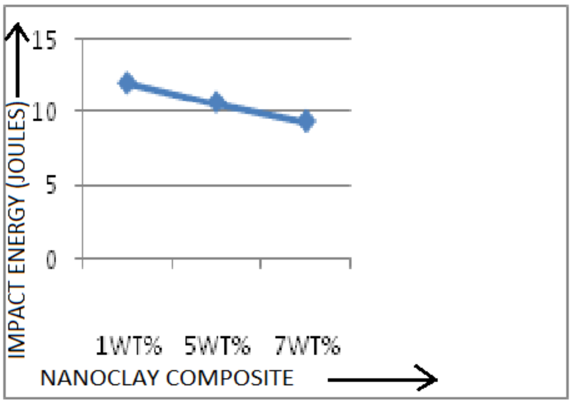


Fig.12- Impact energy of three composites

## VI. CONCLUSION

Chopped strand mat E-glass / epoxy composite of nanoclay is prepared with three different wt% of nanoclay, viz 1wt%, 5wt% and 7wt%.

From the study, following observations were made:

(i) The tensile strength for 5wt% nanoclay composite is more compared to 1wt% and 7wt% nanoclay composite.
(ii) The flexural strength for 5wt% nanoclay composite is maximum compared to 1wt% and 7wt% nanoclay composite.
(iii) The hardness for 5wt% nanoclay composite is higher compared to 1wt% and 7wt% nanoclay composite.
(iv) The impact energy for 1wt% nanoclay composite is maximum. The impact energy is minimum for 7% nanoclay composite.

## References

[1] Bijesh ,” study of mechanical behaviour of chopped strand mat and epoxy composites “.(may2010)
[2] B suresha, G chandramohan, P R sadananda rao,P sampathkumaran, S seetharamu & vartha venkateswarlu, “Friction and slide wear characteristics of glass-epoxy and glass-epoxy filled with SICp composites” dec 2006.
[3] Mahmood M Shokrieh, Mohammed A Torabizadeh & Abdolhossein Fereidoon “Dynamic failure behavior of glass/ epoxy composites under low temperature using charpy impact test method” june 2011.
[4] S P Borkar,V Senthil kumar & S S Mantha “ Effect of silica & calcium carbonate fillers on the properties of woven glass fibre composites ” june 2007.
[5] Dr. Emad S. A L- Hassani & Sheelan R. Areef,“ The effect of fiber orientation on creep behavior and flexural strength in epoxy composites ” 2010.
[6] Youssef K . Hamidi, Levent Aktas and M. Cengiz Altan . “Effect of nanoclay content on void morphology in resin transfer molded composites” march 2008.
[7] L. Aktas , Y. K. Hamidi and M. C . Altan, “Characterisation of nanoclay dispersion in resin transfer moulded glass nanoclay/epoxy composites.” oct 2004.
[8] Levent Aktas, Sudha Dharmavaram , Youssef K.Hamidi and M. Cengiz Altan,“ Filtration and breakdown of clay clusters during resin transfer molding of nanoclay/glass/epoxy composites. ” oct 2008.
[9] L. Aktas and M.C. Altan, “Effect of nanoclay content on properties of glass –waterborne epoxy laminates at low clay loading” 2010.
[10] Tom pawlak, ”chopped strand mat and epoxy”.(summer 2003)
[11] William D. Callister, Jr, “material science and engg”.
[12] Sidney H. Avner (second edition ),”introduction to physical metallurgy”.
[13] ASTM standard (D 638-03),” standard test method for tensile properties of polymer matrix composite materials”.
[14] ASTM standard (D790),”standard test method for flexural properties of polymer matrix composite materials”.
[15] ASTM standard (D256),”standard test method for impact properties of polymer matrix composite materials”.
[16] Nanoclay definition from http://www.nanocor.com/glos_pop.htm#nanoclay
[17] Smectite definition from http://www.nanodic.com/nanomaterial/Nanoclay.htm
[18] Nanomaterials definition from http://www.nanodic.com/nanomaterial/Nanomaterial.htm
[19] Nanoclay structures from http://www.nanocor.com/nano_struct.asp