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VIBRATION ANALYSIS OF CARBON NANOTUBE REINFORCED COMPOSITE USING ANSYS

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ABSTRACT

The energy crisis and global inclination to reduce green house gas emissions have been catalytic in directing the attention of research scientists to look for light weight materials with high strength .Composites are the ones with this kind of exceptional properties .The emergence of Carbon Nanotubes has created new opportunities for fabrication of polymer composites that possess strong potential for a wide spectrum of the applications .The one-dimensional structure of carbon nano tubes has a very high anisotropic nature and unusual mechanical properties, which made them as promising nano filler for the composite structures. The primary focus currently is to develop new generation of Nano-composite materials capable of exhibiting good combination of properties .The present research work is focused on the evaluation of mechanical properties like Young's modulus and also to investigate the natural frequency of nano particle reinforced composites through Finite Element Analysis. The Vibration test is carried out to get the information of the first mode shape of this discrete Nano composite, and this is used to further estimate the mode shapes in the composite for different end conditions and also to check this composites performance in real time situations using the probable cuts in the model and this procedure is done by using ANSYS Pack.

Keywords: *Composite: a material made from two or more constituent materials..*

I. INTRODUCTION

Composite comes from a Latin word commoner means to put to gether. A composite material consists of two or more constituent materials with significantly different properties combined together at a macroscopic scale with a recognizable interface between them, to produce a material with characteristics different from its constituents. Nature itself has a number of Composite materials like Wood, human bone, Bamboo etc. The Composites are classified into different types based on the matrix and reinforcement materials.

II. PROBLEMOBJECTIVE

The objective of the present work is to analyze the vibration of carbon nano tube reinforced composite using ANSYS to utilize it in industries. First we have to find the Elastic properties of the CNT reinforced composite which is having spherical shape particles of micron diameter as reinforcement in the epoxy resin as matrix..And to find the first Natural frequency of the SWCNT reinforced composite .Now we have to model and simulate for different boundary end conditions and see the vibrational behaviour of the 1,2 and 3 wt% CNT reinforced composite at these conditions .And finally we have to find the Natural frequency of the SWCNT reinforced composite which is having a irregularity in itsshape.

III. RESULTS ANDDISCUSSION

Micro mechanical analysis of swcnt reinforced composite

The Elastic properties of composites are evaluated effectively by adopting Representative Volume Element (RVE) that consist of a single spherical particle surrounded by matrix material and a One-eighth portion is considered for analysis as shown in Figure 3.1. Due to the spherical shape of the nanotube, the cubic shape unit cell is considered for the analysis.

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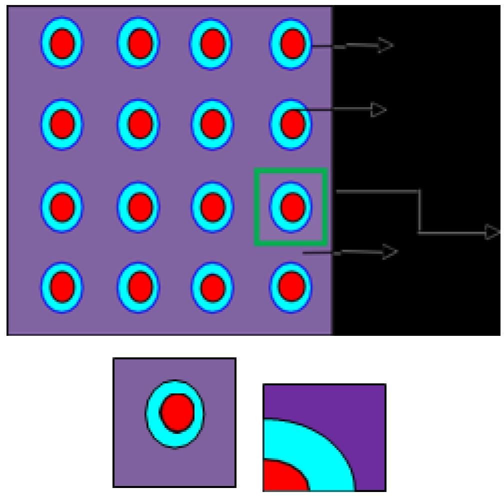

Figure 1.(a)Uniform distribution of spherical particles in matrix. (b)Isolated Unitcell and (c)one eigthmodel

The Finite Element Analysis of the composite is done by adopting RVE and for this volume fraction of the particle is necessary for the generation of RVE. The Experimentation was done by weight fractions which are to be converted into volume fractions for Finite Element Analysis of CNT reinforced composite The Finite Element Models were prepared for different volume fractions of the SWCNT and Elastic properties were calculated. Finite Element Model of 1 wt. % of SWCNT reinforced epoxy resin composite is shown in Figure2.

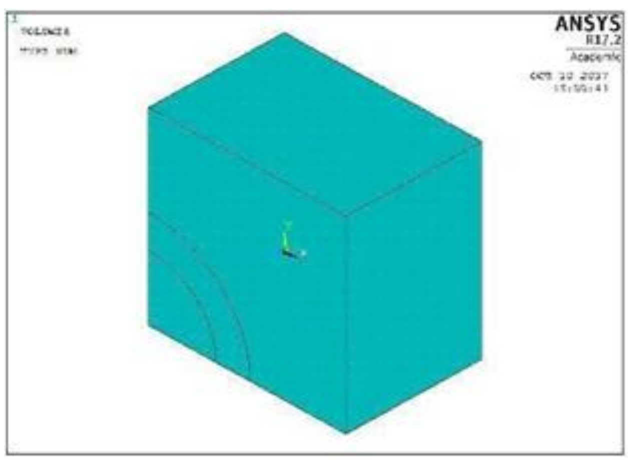

FIG 2.FE Model of CNT reinforced Composite at 1 wt.% of SWCNT.

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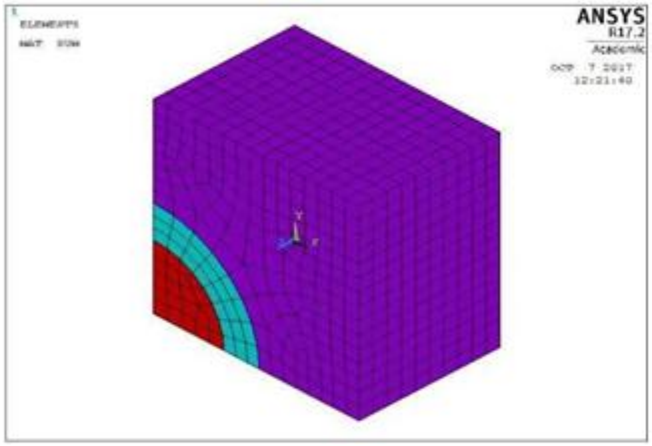

FIG.3 Converged mesh model of SWCNTs reinforced composite at 1 wt% of SWCNT.

The Elastic properties of the Composite at different weight fractions are calculated. Figure 3.5 shows a variation of Young's Modulus (E) of CNT reinforced composites with respect to wt. % of SWCNT. The Young's modulus increases with the increase in the weight percentage of the reinforcement in the matrix material.

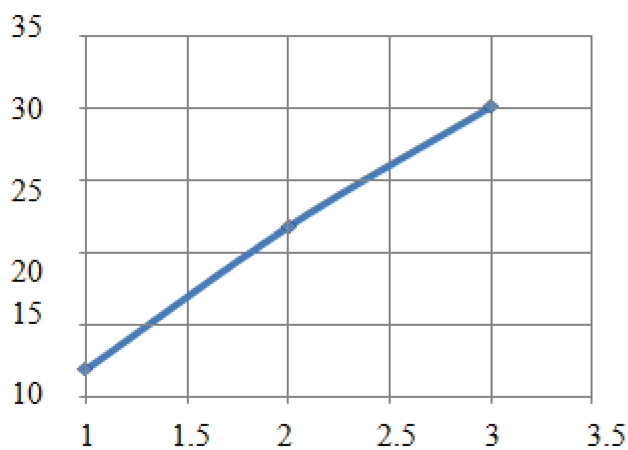

FIG 4. Young's Modulus (E) with respect to wt. % of CNT

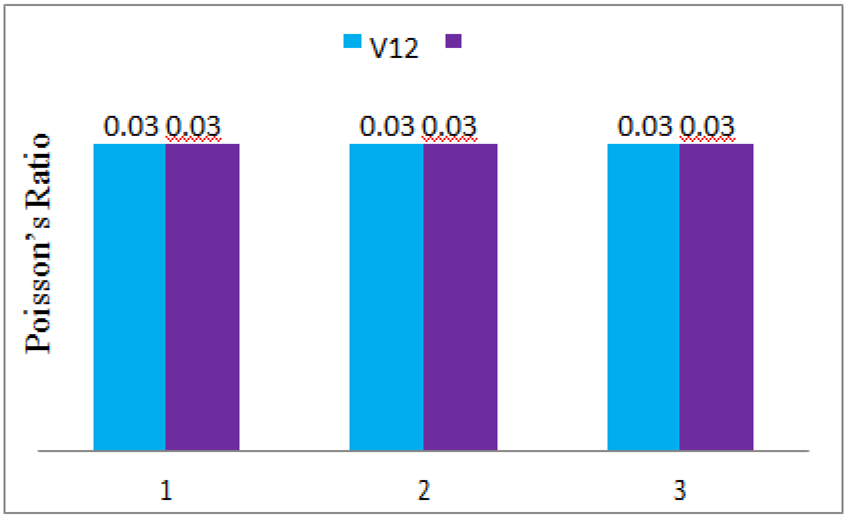

FIG5. Poisson's Ratio with respect to wt %of CNT Weight Percentage of SWCNT(in %)

The Young's Modulus (E) increased with the increase in the weight percentage of reinforcement whereas the poisons ratio is neutral showing no considerable change. From the FEA analysis, it is understood that on addition of the CNT as a reinforcement there is a considerable increase in the Elastic properties say, Young's modulus.

Finite element analysis of swcnt reinforced composite to evaluate natural frequency

Vibrational Analysis is performed to obtain the mode shapes of the CNT reinforced composite using FEA software. The geometry for this simulation is considered as a square plate that we fabricated according to the ASTM standards, say the length and the breadth of the plate are 100 mm and the thickness is 3 mm. The Finite Element Models were prepared for different volume fractions of the SWCNT and natural frequency was calculated.

The meshed Finite Element Model of 1 wt. % of SWCNT reinforced epoxy resin composite is shown in Figure 6

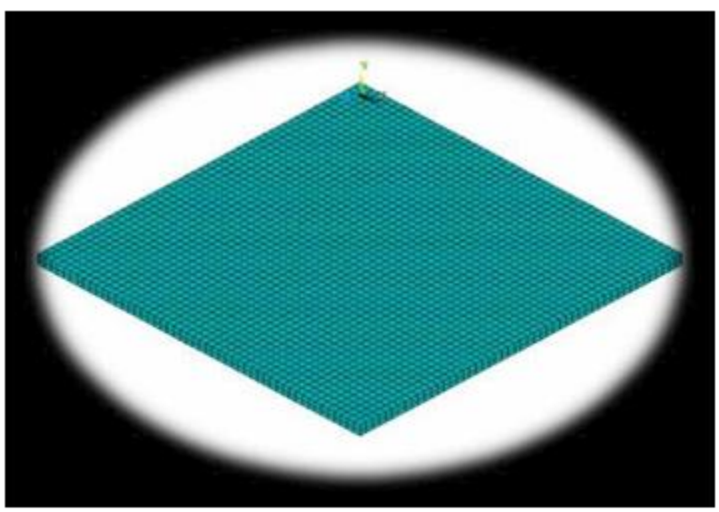

FIG 6.Modelled and meshed 1% CNT reinforced Composite

The boundary conditions are given according to the testing performed on the specimen. It is seen that the plate is assumed to be simply supported so for our present simulation we go for the simply supported end conditions for the plate and the end conditions are as follows

- Constrained for all four edges of the plate inZ-direction
- Any two parallel edges are constrained inX-direction
- Remaining two parallel edges are constrained in Y- direction.

The boundary condition applied plate of 1 wt. % CNT reinforced composite is seen in Fig 7

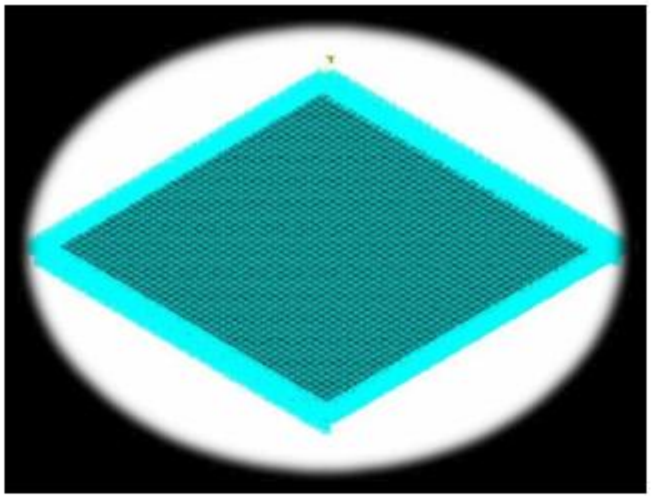

Fig 7.Loaded 1% CNT reinforced Composite

The vibration properties of the Composite say the natural frequency at different weight fractions are calculated. Figure 4.3 shows a variation of first mode shapes of CNT reinforced composites with respect to wt. % of SWCNT. The mode shape increases with the increase in the weight percentage of the reinforcement in the matrix material.

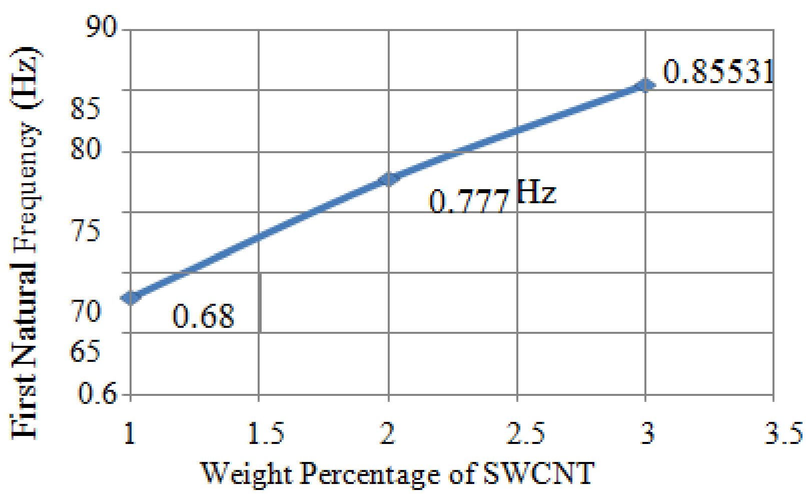

Fig 8.First mode shape with respect to wt. % of CNT

From the previously procured information we were capable of successfully performing the FEA and thus got the natural frequencies for the composite at simply supported condition and hereby we can conclude that the vibration behaviour is competent within the composite for such combination of materials, in other words the SWCNT can

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enhance the natural frequency of the epoxy by adding only a little amounts and there by providing the stiffness in the matrix though they are deficient in this property solely. Therefore it can be concluded that the small amounts of SWCNT added can enhance the vibrational behaviour of the matrix chosen.

Effect of the boundary conditions on natural frequency of swcnt reinforced composite

The main objective of the present work is to find the Natural frequency of the SWCNT reinforced composite which is having spherical shape particles of nano diameter as reinforcement in the epoxy resin as matrix. The overall analysis is taken using the ANSYS Software

The boundary conditions are different end conditions like Cantilever, All edges fixed and Two parallel edges fixed on the specimen. So the boundary conditions to be applied are as follows

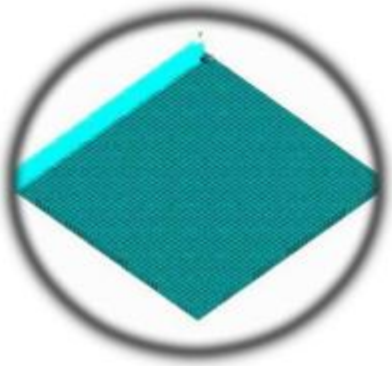

Fig 9.Cantileverend conditioned 1wt%composite

Fig 10.all edges fixed end condition 2 wt% Composite

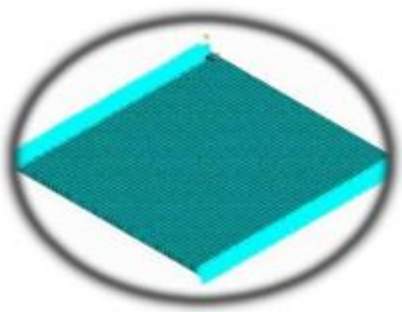

Fig 11.Two edges fixed 3wt% CNT composite

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The simulation is done for all 3 different conditions and the results are compared along with the experimental end condition and the result can be seen in the Figure12.

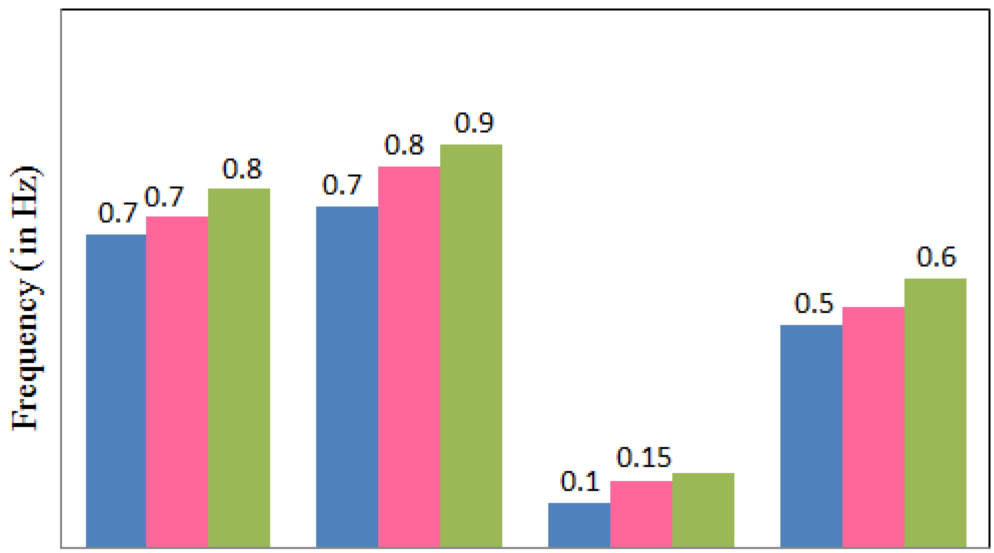

Fig 12.Result graph of natural frequency of 1,2,3 wt% CNT reinforced composite for all end conditions.

Result graph of first natural frequency of 1,2 and 3 wt % CNT reinforced composite for all endconditions.

From the result diagram we can see that the vibrational properties differ for all end boundary conditions i.e clearly there is a difference in the natural frequency though there is no change in the amounts of the reinforcement.

The natural frequency of the SWCNT reinforced composite with all fixed condition is showing higher value rather than other boundary conditions because of the stiffness provided with in it by the end boundar condition.In other words along with the stiffness provided from the reinforcement additional stiffness is offered to the composite by this boundary condition.

The cantilever end condition provided only small amounts of natural frequency values due to the same fact of less stiffness offered by the end condition, So in such cases we may increase the amount of the reinforcement upto a level of close package of the SWCNT with in the matrix,i.e the addition is restricted for any internal defects that are generally observed in the experimentation.

So we can conclude that the first natural frequency increases for the increase in wt % of the CNT in any end condition provided for CNT reinforced composite.The effect of boundary condition is quite commom as of the vibrational behaviour is concerned unless to get the better frequency, a certain limit of SWCNT can be added to attain the requirement.

Effect of geometrical irregularities on the swcnt reinforced composite

The main objective of the present work is to find the Natural frequency of the SWCNT reinforced composite which is having a irregularity in its shape. The overall analysis is taken using the ANSYSSoftware.

The boundary conditions are applied to the plate as previous plates FEA is done to get the results of the mode shapes for all 3 wt% composites and at all four end conditions and also for all the geometrical **shapes**.

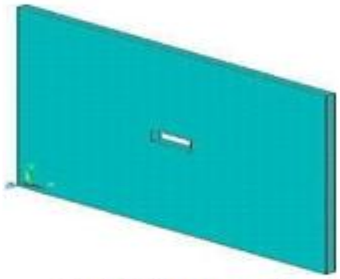

Fig 13.Rectangularcut

Fig 14.Suarecut

Fig15Traingularcut

Fig 16.Cicularcut

All the geometrical irregularities provided SWCNT reinforced composite are constrained with the different end conditions, and the results are understood from the following figure.

It is seen that the results obtained shows a good correlation with the results from the previous chapter i.e., the results or the natural frequency does not get effected by irregularities provided in other words it is seen that the natural frequency for a particular weight percent of CNT at a particular end condition gives the same or near identical mode shape for any kind of geometric cutprovided.

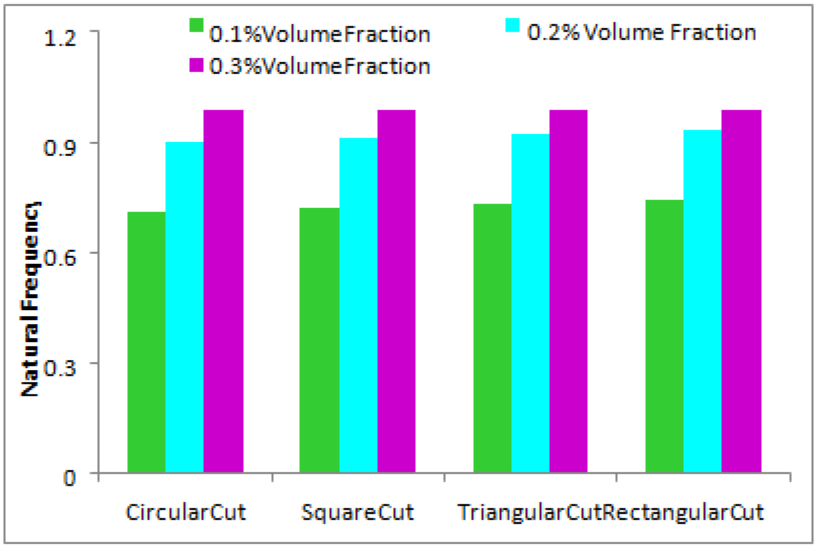

Fig 17.Simply supported result for all shaped cuts

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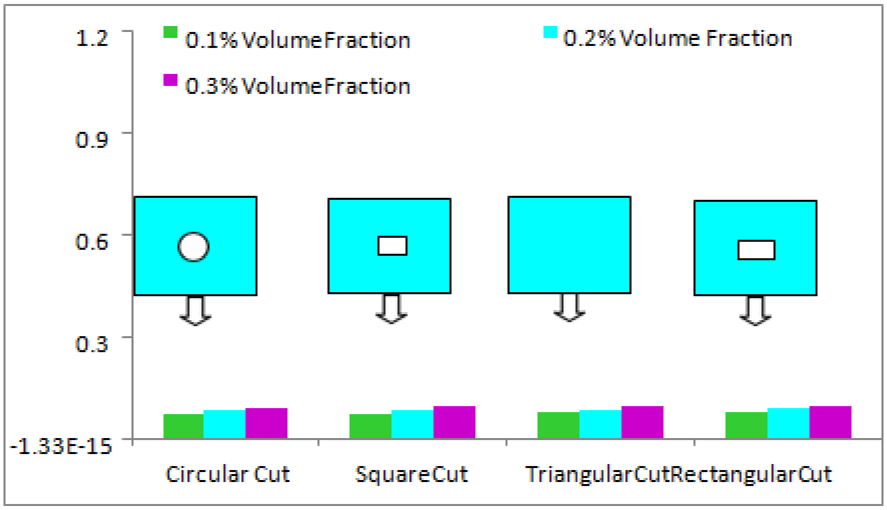

Fig 18 Cantilever end result for all shaped cuts

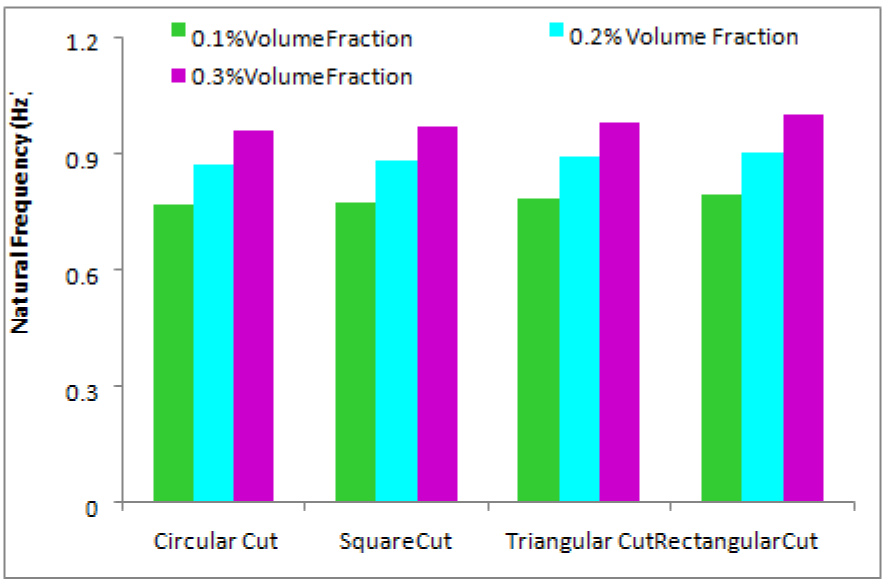

Fig 19.Two edges fixed result for all shaped cuts

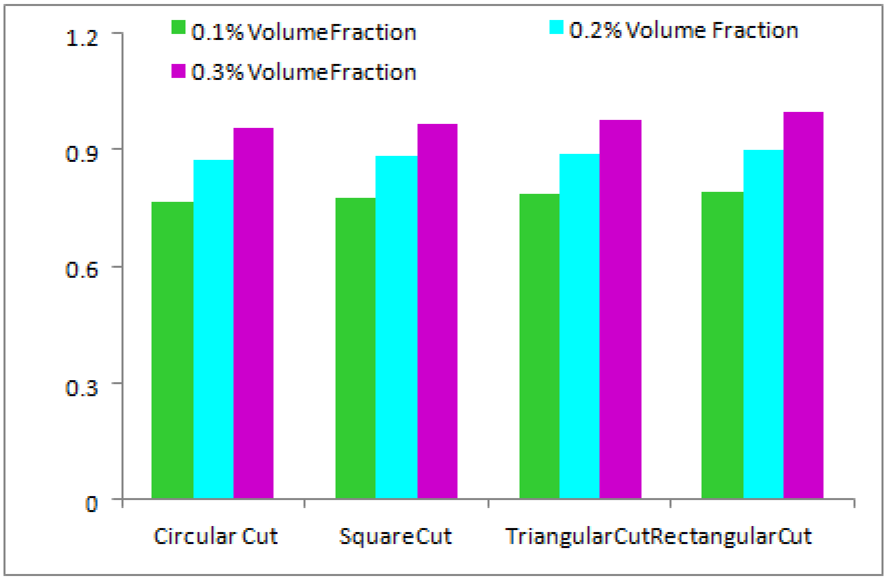

Fig 20. All end fixed result for all shaped cuts

The modelling of four general geometrical shaped irregularities, say square, triangle, rectangle and circle are provided for the composite and the simulation for each type in all four distinct boundary condition is done.

Now from the results we can clearly say that there is no variation in the natural frequency obtained for a particular wt % composite, at a particular boundary condition provided with a particular shaped irregularity. This clearly understood that the simply supported conditioned 1 wt% composite's natural frequency is identical to the all the four geometrical irregularities' simply supported end conditioned natural frequency Hence we can conclude that despite of the geometrical irregularity there is insignificant change in the natural frequency of the SWCNT reinforced composite.

IV. CONCLUSIONS

In the present research, the evaluation of the elastic properties and natural frequency of Single Walled Carbon naotubes (nano particles) reinforced epoxy composites by Finite Element Analysis is presented by doing the micro mechanical analysis for the evaluation of Elastic properties of SWCNT Reinforced Composite. The Elastic properties obtained from Experimentation are utilised for the evaluation of natural frequency of the CNT reinforced composite in FEA thus deriving the natural frequency from th eANSYS.

From the results and discussions of each the following conclusions have been made from this present research work. The following conclusions were made from the different aspects as of done in the report work

1. The addition of the SWCNT to the epoxy increases the Young's moduli or the elastic moduli of the composite i.e the increase in the amounts of reinforcement induces the strength to the matrix there by increase the Elastic Modulii of the composite.Hence the addition of the SWCNT as the reinforcement can lead to the successful sustainment and excellent behaviour of the Composite.
2. The addition of the SWCNT decreases the deflection or percentage elongation in the composite that is by providing the stiffness to the matrix.This provided stiffness makes the composite to withstand or exhibit good vibrational performance.
3. It is clearly seen that the first natural frequency increased with the increasing amounts of reinforcement added. This shows that the SWCNT provides the stiffness within the matrix to exhibit best vibrationalbehavior

4. From the FEA, we can say that the addition of SWCNT to enhance the elastic moduli purely depends up on the diameter value of the SWCNT, as there will be decrease in the elastic moduli after a particular point of weight percentage proving the importance of the diamtere consideration. This can be understood clearly that the diameter consideration is important for the composite to overcome the defects like agglomeration that is from this study we have shown the close packing of the SWCNT in the epoxy matrix at a distinct level of weight percentage.So it proves that the diamtere of the SWCNT effects the particular Elastic modulii of the produced Composite
5. The natural frequency obtained from the different boundary conditions prove that the best possible mode shapes can be procured from the All edges clamped condition as an additional end conditioned stiffness is provided for the composite along with the reinforcement's stiffness.
6. Irrespective of the shape of the irregularity provided there is negligible change in the mode shapes of the composites at any weight fraction and at any boundary condition proving that the produced composite can be used in real time applications were frequency is featured as a important factor.

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