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3.3.1 Number of research papers published per teacher in the Journals as notified on UGC CARE list during

AY 2018

S.No	Title of paper	Name of the author/s	Department of the teacher	Calendar Year of publication
1	Flow And Heat Transfer On Alcohol In Micro-Channel	T.MASTANAIAH	Dept of Mechanical	2018
2	Thermo Elastic Behaviour of A Thin Hydrid Four Layered FRP SKEW Cross PLY Laminates with circular cutout	K.DURGA	Dept of Mechanical	2018
3	Thermo Elastic Behaviour of A Thin Hydrid Four Layered FRP SKEW Cross PLY Laminates with circular cutout	T.SRINIVASA RAO	Dept of Mechanical	2018
4	Thermo Elastic Behaviour of A Thin Hydrid Four Layered FRP SKEW Cross PLY Laminates with circular cutout	D.GOPICHAND	Dept of Mechanical	2018
5	Vibration Analysis of Carbon Nanotube Reinforced Composite Using ANSYS	V.EESWARI	Dept of Mechanical	2018
6	Vibration Analysis of Carbon Nanotube Reinforced Composite Using ANSYS	MD.SHAREEF	Dept of Mechanical	2018
7	Experimental Analysis of double pipe heat Exchanger by using nano-fluids AL2O2 and SIO2	SK.SUBHANI	Dept of Mechanical	2018
8	Experimental Analysis of double pipe heat Exchanger by using nano-fluids AL2O2 and SIO2	D.GOPICHAND	Dept of Mechanical	2018
9	Global journal of Engineering science and Researches Analysis of Mono leaf Spring	G.P.V.P RANGA RAO	Dept of Mechanical	2018

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10	Global journal of Engineering science and Researches Analysis of Mono leaf Spring	G.VIJAY KUMAR	Dept of Mechanical	2018

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ISSN 2348 – 8034
Impact Factor- 5.070

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

FLOW AND HEAT TRANFER ON ALCOHOL IN MICRO-CHANNEL

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ABSTRACT

The objective of the current experimental program is to generate data for liquid flow through micro-channels. The channel dimensions are 1.5 mm deep x 0.75 mm width. Rectangular 47 micro-channels were cut on a stainless steel substrate (230 mm x 160 mm) by Electro Discharge Machining (EDM) technique. The use of micro channels is recent topic of investigation. Micro channels are used to remove high heat fluxes from smaller area. Such as electronic components like printed circuit board (PCB), chip, space, laser applications etc. It is proposed to design and fabricate micro channels and to study the heat transfer characteristics, such as heat flux, liquid temperature, wall temperature and Nusselt number correlation. However the single phase forced convective heat transfer and flow characteristics of alcohol in micro channels structures plates with small rectangular channels and distinct geometric configurations are to be investigated experimentally. Finally experimentally obtained values will be compared with the theoretical or predicted values.

Keywords: *Experiments, Laminar, Friction factor, Nusselt number and Micro-channels.*

Nomenclature

C	empirical constant {no units}
c_p	specific heat, J/kg-K
d	diameter, m
f	friction factor, {no units}
H	height of the channel, m
h	heat transfer coefficient, W/m^2-K
k	thermal conductivity, W/m-K
l	length of the channel, m
$\dot{m}$	mass flow rate, kg/s
Nu	Nusselt number, {no units}
p	pressure drop, Pa
Pr	Prandtl number, {no units}
Q	heat transfer rate, W
q"	heat flux, W/m^2
Re	Reynolds number, {no units}
T	temperature, °C
v	velocity, m/s
W	width of the channel, m
z	no. of channels

Greek symbols

Δ	Difference
μ	Viscosity, Pa s
ρ	Density, kg/m^3

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Subscripts
eq equivalent
fi fluid inlet
fo fluid outlet
fm fluid mean
wm wall mean

I. INTRODUCTION

Fluid flow through micro-scale flow geometries is encountered in numerous engineering systems such as cooling of electronic devices and compact heat exchangers. Experimental Investigation of flow and heat transfer in micro-channel [1]. Micro-channel flows have been used for liquid dosing and flow measurement [2]. The literature sources are more recent to the extent that micro-scale flow passages are concerned. Tuckermann & Pease [3, 4] were, perhaps, the first to conduct a systematic research into micro-scale flow and heat transfer. Several investigations ensued which dealt with flow of gases [5] and liquids [6, 7, 8, 9,10] through micro-geometries. Issues pertaining to micro-channel heat exchangers were dealt with by [11,12,13]. Theoretical approaches to fluid flow and heat transfer were also reported [14, 15]. Water, methanol and n-propanol were used as liquid media and nitrogen, helium, argon and hydrogen as gaseous media for experiments. The test section geometries varied from a fraction of a μm to a few 100s of μm. There had been only one study with mixtures of fluids [16]. The substrates used were silicon, glass, copper and stainless steel. Based on these studies provide evidence to prove that flow and heat transfer in micro-channels need to be addressed differently compared to conventional channels. It appears that, firstly, the transition from laminar to turbulent flow takes place at a low Reynolds number and secondly, friction factor and heat transfer cannot be described by the empirical relations used for normal geometries. There is a need for more experimental data on a variety of fluids and flow geometries so that some generalized conclusions can be evolved.

II. FABRICATION OF MICRO-CHANNELS

Micro-components are mostly fabricated using etching, deposition and photo-lithographic techniques. There are numerous techniques available and also being innovated to meet the requirements of specific formations on various substrates. Non-circular geometries are often adopted because of their relative simplicity in fabrication as compared to circular channels. The conventional techniques, which have been administered for the fabrication of heat sinks and heat exchangers, include a) precision sawing or cutting and b) micro machining. The latter is an offshoot of bulk and surface chemical machining processes widely used in microelectronics industry. Other techniques for producing micro-channels include [17]: i) spark erosion or EDM ii) laser machining iii) stereo lithography and iv) LIGA (Lithography, Galvanoformung, Abformung) electroforming, a process developed initially in Germany [18]. It was reported that with a precision EDM dimensional tolerances up to 0.5 μm could be obtained.

In the present case, a channel of 1.5 mm deep and 0.75 mm width was cut by using EDM on a 230 mm x 160 mm x 1.6 mm stainless steel plate. Figure 3.1 shows the micro-channel dimensions typical (47 channels). The surface roughness measurement of test section was done to check the uniformity of the channel. The flow passage is formed by the machined plate and another stainless steel plate of thickness 1.6 mm on top. The inlet and outlet conduits were attached and brazed together with the two plates.

III. EXPERIMENTS IN MICRO-CHANNEL

Normally as a consequence, it is expected from experiments on micro-channels are, the prediction of (i) the zone of transition between the laminar and turbulent regimes (ii) the magnitude of friction factor and (iii) the magnitude of heat transfer rate. The objective of the current experimental program is to generate data on the friction and heat transfer characteristics in rectangular micro-channels.

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The schematic experimental setup is shown in figure 2. It consists of liquid reservoir/sump (capacity ~ 10 lit) to supply fluid to the test section. A diaphragm operated pump is used to pump fluid to the test section through a micro-filter (~ 100 micron) built-in in the main line to

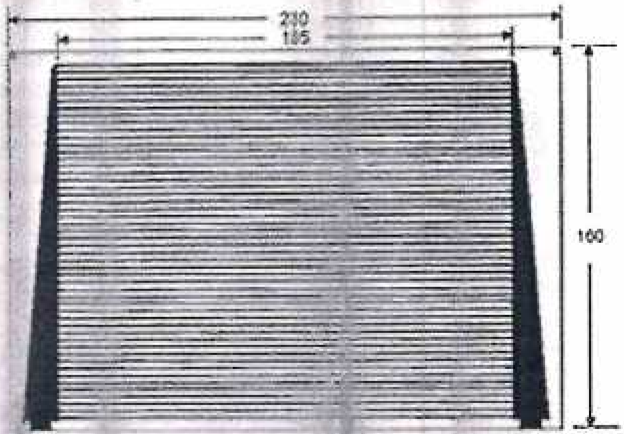

Fig. 1: Typical micro-channel test section

avoid any dirt that may enter into the test section. In the absence of micro-filter poor measurement data could be resulted due blockage of the channels to the flowing fluid. It is provided with by-pass line and control valves to establish the required flow rate in the test section and as well the pressure drop, measured with the aid of U-tube differential mercury manometer.

The flow medium used to test was filled in the reservoir. To start the experiment all the required precautions were taken into consideration. The pump is switched on while keeping the by-pass valve in open position and control valves to test section closed. The required discharge flow rate of the pump is obtained through stroke adjustment in the pump system. Control valve was somewhat opened allowing the flow to take place in the test section. Further, the control valve was tuned to set the required pressure drop indicated by the U-tube manometer. Corresponding to a pressure drop, flow rate through the test section was measured by collecting either known volume of liquid or a known period of time. Several trials were carried out and the average value is taken to evaluate flow rate in terms of cc/min basis. The average value of flow rate was taken from several run to reduce the measurement uncertainty. However, it may be noted that flow rate was based on manual measurement, as the flow meter put in the setup does not have instrument (display unit). The manometer system accuracy is about ±0.25 mm. The experiment was repeated for various values of pressure drops (range ~ 1 to 250 mm of Hg). The time intervals for flow rate measurement are carried out depending on the flow rate. Experiments were conducted at room temperature (~ 34°C). Figure 3.2 shows plot of pressure drop *vs* flow rate data.

In case of heat transfer experiments, fluid and wall temperatures are measured using thermocouples located at appropriate places in the test section (see Fig. 2 and 3.1) in addition to the above flow rate and pressure drop data. Electrical foil heaters mounted on either side heated equally the test section. This entire assembly of the test section is insulated on all sides to minimize heat loss to the surroundings. The wall temperatures were measured at 6 Locations which are located at a gap of 40mm.

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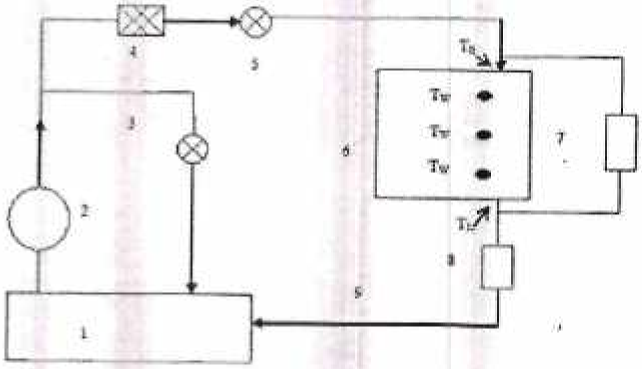
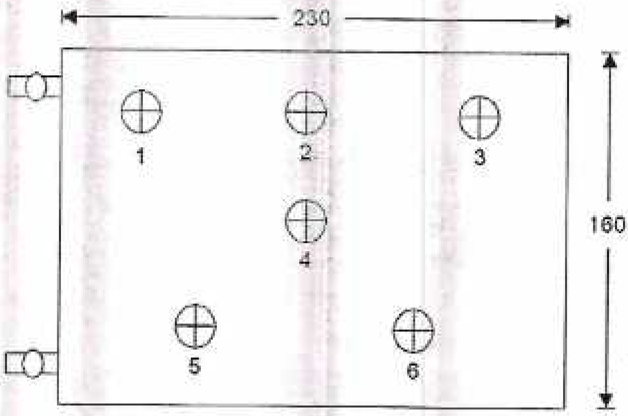


Fig. 2: Schematic experimental setup fluid flow and heat transfer

Legend: 1-Sump 2-Pump 3-By-pass control valve 4-Micro-filter 5-Flow control valve 6-Test section 7-Differential pressure gage 8-Flow meter 9-Return line to sump. T_w- Thermocouple location on wall and $T_{fi/o}$- Thermocouple location for fluid inlet/outlet.



1, 2, 3, 4, 5, 6 shows nodes of thermocouple locations

Fig. 3.1: Arrangements of Thermo couple points in micro channel

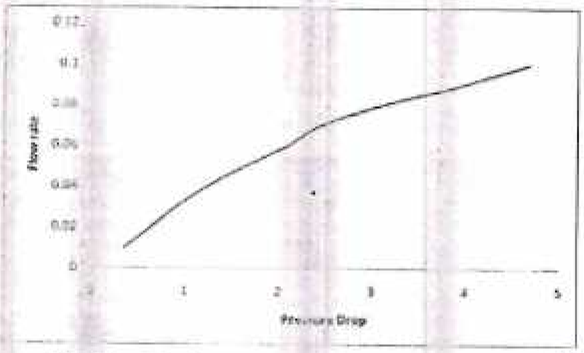


Fig. 3.2: Plot between pressure drop Vs Flow rate

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IV. FLUID FLOW DATA REDUCTION

The primary objective of this flow experiment is to obtain the friction factor *versus* Reynolds number relation. The friction factor 'f' is deduced from the raw data using Darcy-Weisbach formula [18] given below:

$$\frac{\Delta p}{\rho} = f \left(\frac{l}{d}\right) \frac{v^2}{2} \qquad (1)$$

Where, Δp is the pressure drop, ρ is the density, f is the friction factor, l/d is length to diameter ratio and v is the velocity. The Reynolds number is defined in the conventional way $Re = \rho v d/\mu$. The velocity v (average) is calculated from flow rate based on the cross-sectional area of the channel. For non-circular ducts, diameter d is replaced by equivalent diameter defined as, $d_{eq} = 2\, WH/(W+H)$ where W and H are width and height of the channel respectively. The thermo physical properties were evaluated at inlet temperature of the test fluid neglecting the viscous heating effect in the channel. Table 1 and Table 2 shows the Experimental and calculated values of Thermo physical properties of methanol.

Table 1: Experimental data

Pressure Drop (bar)	Flow rate (lpm)	[illegible]	Fluid temperature (oC)		Wall temperature (°C)						
			T_i	T_o	T_1	[illegible]	T_3	T_4	T_5	T_6	T_{avg}
[illegible]	0.01	[illegible]	33	51.1	42	[illegible]	55	73	66	66	61.83
[illegible]	0.02	[illegible]	33	49.7	42	[illegible]	54	72	65	65	61
[illegible]	0.03	[illegible]	33	48.6	42	[illegible]	53	69	64	63	59.67
[illegible]	0.04	[illegible]	33	47.5	42	[illegible]	55	69	64	63	59.5
[illegible]	0.05	[illegible]	33	46.6	42	[illegible]	52	68	63	61	58.5
[illegible]	0.06	[illegible]	33	46	42	[illegible]	51	67	63	61	58.17
[illegible]	0.07	[illegible]	33	45.4	42	[illegible]	51	66	62	60	57.5
[illegible]	0.08	[illegible]	33	44.3	42	[illegible]	50	63	60	59	56.17
[illegible]	0.09	[illegible]	33	44	42	[illegible]	50	63	60	58	55.83
[illegible]	0.1	[illegible]	33	43.5	42	[illegible]	50	63	59	58	55.67
[illegible]	0.01	[illegible]	33	51.1	42	[illegible]	55	73	66	66	61.83

Table 2: Calculated data

Sl. no	Mass flow rate (kg/s)	Flow velocity V (m/s)	Reynolds number (Re)	Friction factor		Nusselt number (Nu)	h	Heat flux q
				f_{exp}	f_{the}		(W/m²k)	(W/m²)
1	[illegible]	0.1481	212.79	0.3651	0.3008	[illegible]	0.1717	0.016
2	[illegible]	0.2963	425.59	[illegible]	0.1504	[illegible]	0.2429	0.0215
[illegible]	[illegible]	0.4444	[illegible]	[illegible]	[illegible]	[illegible]	0.2975	0.0269
[illegible]	[illegible]	0.5926	[illegible]	[illegible]	[illegible]	[illegible]	0.3435	0.0286
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.384	0.0328
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.4207	0.0346
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.4544	0.0376
[illegible]	[illegible]	1.1852	[illegible]	[illegible]	[illegible]	[illegible]	0.4858	0.0409
[illegible]	[illegible]	1.3333	[illegible]	[illegible]	[illegible]	[illegible]	0.5152	0.0435
[illegible]	[illegible]	1.4815	[illegible]	[illegible]	[illegible]	[illegible]	0.5431	0.0446

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4.1 Results and discussion

The friction factor data obtained from the present experiments for the test section is shown in figure 4, as plot of friction factor *vs* Reynolds number (f-Re). Normally, the flow experiment results give an initiative to identify flow regimes (laminar, turbulent and zone of transition). Further, friction factor dependence on Reynolds number could be established. The experimental values are compared with conventional theory and earlier correlations. Pattern characterizes the 'f' theoretical value in laminar regime (i.e.; f = 64/Re) and pattern stands for smooth pipe turbulent regime by *Blasius* relation [19].

$$f = \frac{0.316}{Re^{0.25}} \quad (2)$$

It is customary in pipe flow; the laminar flow regime is identified as friction factor 'f' varies inversely to Reynolds number (typically as f = 64/Re for tubes). The laminar flow is continued up to Re ~1200. In the test section in view of the limitation constrained by the differential pressure gauge (maximum 250 mm Hg) used. Consequently, the experimental data for the laminar region fitted in the friction factor relation of the form f = C/Re, yielded the constant C value 75.73 for methanol with regression coefficient (R^2) of 0.95 is observed as in figure 4. Therefore it appears that these micro-channels are preferred at low pumping power with high heat flux rate applications such as electronic cooling.

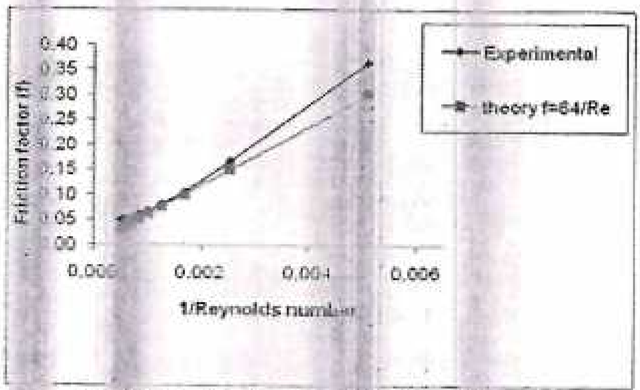

Fig. 4: Plot of friction factor Vs 1/Reynolds number

V. HEAT TRANSFER DATA REDUCTION

From the measured flow rate and temperatures various parameters are evaluated to obtain heat transfer rate and Nusselt number. The total heat transfer rate is obtained from energy balance of the fluid between inlet and outlet in the micro-channels as heat gained,

$$Q = \dot{m}\, c_p \left(T_{fo} - T_{fi}\right) \quad (3)$$

The heat flux q" and heat transfer coefficient 'h' are calculated from the total heat transfer rate Q as

$$q'' = \frac{Q}{z2L(W+H)} \quad (4)$$

$$h = \frac{q''}{T_{wm} - T_{fm}} \quad (5)$$

The average Nusselt number is evaluated as

$$Nu = \frac{h\, d_{eq}}{k} \quad (6)$$

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5.1 Results and discussion

The experimental average Nusselt number variation in the present experiment is depicted in figure 5 as a plot of Nusselt number *vs* Reynolds number. In general the data distribution is complex.

$$Nu = 0.00222\,\mathrm{Pr}^{0.4}\,\mathrm{Re}^{\text{[illegible]}} \quad (7)$$

$$Nu = 0.00805\,\mathrm{Re}^{4/5}\,\mathrm{Pr}^{1/3} \quad (8)$$

It is seen that the empirical relations given by equations (7) and (8) have not fit to the present data but be placed on either side. In view of the less experimental data available, at present it is not possible to either evolve a correlation or any supposition on heat transfer in micro-channel.

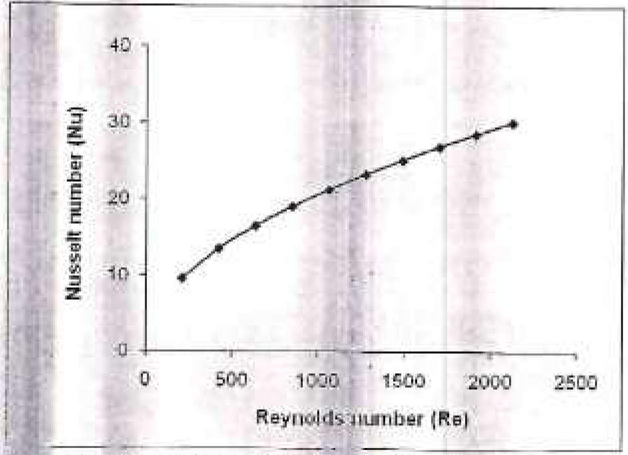

Fig. 5: Plot of Nusselt number Vs Reynolds number

VI. CONCLUSION

The present experiment investigation was carried out in a test section with micro-channel dimensions 1.5 mm deep x 0.75 mm width having each 135 mm long and 47 channels. The working fluid used in this experiment is methanol. Hydraulic diameter and aspect ratio are an important in micro-channel plate design. Hence we achieved by micro-channel design calculation for present study. In friction characteristics, pressure drop and flow rate are used to evaluate friction factor in the micro-channel. A plot of f vs. Re is obtained. The results have shown that the friction factor is higher than that of the conventional channels for laminar flow. More experiments and accurate results are required to identify the zone of transition in the case of micro-channel. In heat transfer characteristics, laminar data indicates that behavior in micro-channel is as normally sized channels and behaves with less pressure drop than that of smooth conventional tube flow.

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ISSN 2348 – 8034
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GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

THERMO ELASTIC BEHAVIOUR OF A THIN HYBRID FOUR-LAYERED FRP SKEW CROSS-PLY LAMINATES WITH CIRCULAR CUTOUT

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ABSTRACT

The present paper deals with the prediction of thermo elastic behaviour of the thin four-layered Cross-ply Hybrid Fibre Reinforced Plastic (FRP) skew laminated composite plate with circular cut out by considering two composite materials Graphite- Epoxy and Boron-Epoxy materials which are subjected to uniform pressure load and thermal loading. The problem is modeled by using ANSYS software based on the Classical Lamination Theory (CLT) which is suitable for the analysis of thin laminates with circular cut-out. The effect of size of the circular cut out and skew angle on the stresses are shown for Cross and Angle-ply laminates. The principle stresses and shear stresses are evaluated for different cross sections. The present analysis is useful for the safe and effective design of the skew laminates with circular cut out under uniform pressure load and thermal load conditions.

Keywords: *hybrid FRP, Skew laminate, Finite element analysis, cross-ply , classical theory, thermal stresses, Circular cut out.*

I. INTRODUCTION

A composite material is made by combining two or more materials – often ones that have very different properties. The two materials work together to give the composite unique properties. However, within the composite you can easily tell the different materials apart as they do not dissolve or blend into each other. Most composites are made of just two materials. One is the matrix or binder. It surrounds and binds together fibres or fragments of the other material, which is called the reinforcement. The first modern composite material was fibreglass. It is still widely used today for boat hulls, sports equipment, building panels and many car bodies. The matrix is a plastic and the reinforcement is glass that has been made into fine threads and often woven into a sort of cloth. On its own the glass is very strong but brittle and it will break if bent sharply. The plastic matrix holds the glass fibres together and also protects them from damage by sharing out the forces acting on them. Some advanced composites are now made using carbon fibres instead of glass. These materials are lighter and stronger than fibreglass but more expensive to produce.

They are used in aircraft structures and expensive sports equipment such as golf clubs.

Statical and dynamical behaviour of thin fibre reinforced composite laminates with different shapes Based on the classical laminated plate theory [1] Thermal buckling analysis of symmetric and antisymmetric cross-ply laminated hybrid composite plates with an inclined crack subjected to a uniform temperature rise [2] , buckling of functionally graded plates (FG plates) with an elliptical cut out under combined thermal and mechanical loads is investigated using Finite Element Method [3] The free vibration analysis of laminated composite skew plates with delamination around a centrally located quadrilateral cut out is carried out based on the high-order shear deformation theory (HSDT) [4] the prediction of interlaminar stresses in simply supported laminated FRP composite plate with a circular cut-out under transverse load using 3-D finite element analysis [5] the free vibration analysis of a thin Fibre Reinforced Plastic (FRP) skew laminated composite plate with a circular cut-out at the geometric centre [6] the interlaminar stresses are predicted for a bidirectional skew laminated unidirectional continuous fibre reinforced plastic (FRP) composite with a circular cut out at the geometric centre of the plate using three dimensional finite element method with geometric nonlinear option [7].
The present investigation intends to apply the finite element technique, based on classical lamination theory, for the analysis of symmetric and anti-symmetric thin laminates under uniform pressure load and thermal loading

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Nomenclature:

l	length of the plate
h	Total thickness of laminate
S	(l/h), thickness ratio of the laminate
d/l	Diameter ratio.
α	Skew angle
Eij	Young's modulus of lamina.
Gij	Shear modulus of lamina.
υij	Poisson's Ratio of Lamina.
σ	Normal stress.
w	Deflection
τxy	Shear stresses

II. PROBLEM MODELING

2.1 Geometric modelling

A laminated composite general shell element (SHELL99) is used for meshing the geometry of the problem. This element is suited for modeling moderately thin laminates composite shells. As shown in the Fig.1, the element consists of number of layers of perfectly bonded orthotropic materials. The element is quadratic and has six degrees of freedom per node namely, translations in x, y and z directions respectively, and rotations about x, y and z axes respectively.

The element gives results of high accuracy and discretization involves fewer elements. As shown in the Fig.3, the lamination sequence is between the bottom and top faces of the element with the layer setup starting from the bottom face. This element is used to model the present problem with 0/90/90/0, layer sequence.

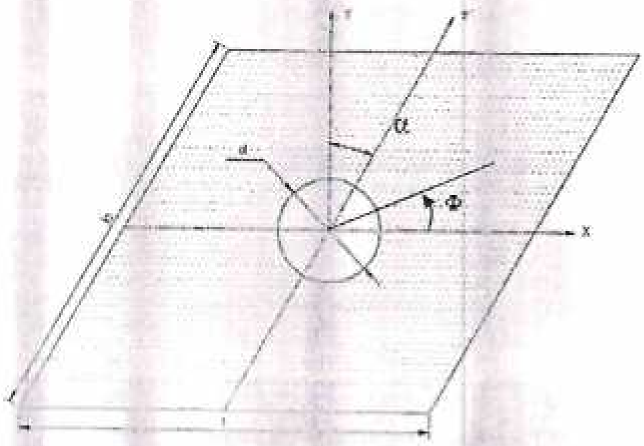

Fig.1, Geometric modelling

2.2. Finite Element Modeling

The finite element model of the problem are shown in Fig.2, The side of the plate 'l' is taken as 20mm and five layers are considered with total thickness (h) of 1mm, so that the length to thickness ratio becomes 's'=20. The skew angle α is taken as a value varying from 0 to 500. A circular hole is placed at the geometric centre of the plate. The size of the cut out is varied as per the ratio d//l ranging from 0.1 to 0.6mm.

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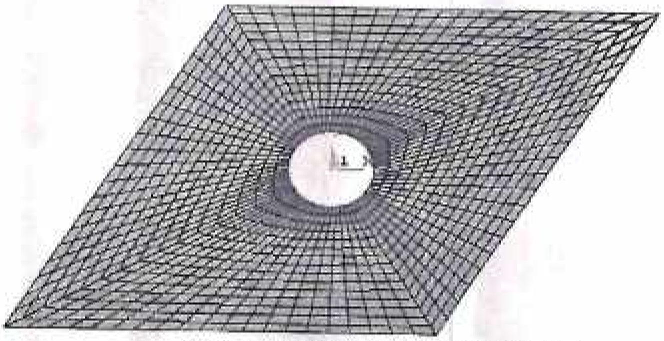

Fig.2, Finite element mesh on skew plate

2.3 Boundary Conditions and Loading

All the sides of the skew plate are clamped. The skew laminate is subjected to the combined transverse pressure load of 1MPa and thermal load 200^0.

2.4 Material properties

The material properties used for the Graphite and Boron epoxy materials are given table below:

	Boron-epoxy	Graphite-epoxy
Young's modulus in GPa		
E1	241873	141675
E2=E3	25511.5	12383.9
Poisson's Ratio		
ν12= ν13	0.25392	0.25772
ν23	0.26458	0.42057
Rigidity Modulus in Gpa		
G12=G13	6715.8	3880
G23	10084	4356
Temperature effects		
A1	5.30E-06	1.00E-07
A2	2.20E-05	2.80E-05
A3	2.40E-05	2.40E-05

III. RESULTS AND DISCUSSIONS

The Finite element model is generated in the ANSYS software and the stresses are obtained. The results are taken in Cross-ply laminates. The effect of skew angle and the effect of diameter of the cut out are taken into considered in the following cases. These results are taken the case of Four-layered Cross-ply laminates.

3.1 The arrangements of material in individual layers are as follows.

Case1 - Taking all boron -epoxy layers
Case2 - Taking all graphite -epoxy layers
Case3 - Hybrid-1: Graphite-epoxy/Boron- epoxy/ Boron-epoxy/Graphite-epoxy
Case4 - Hybrid-2: Boron-epoxy/Graphite-epoxy/Graphite-epoxy/Boron-epoxy

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3.2. Stresses Evaluation:

3.2.1 Analysis Of Cross-Ply Laminates: A laminate is called cross-ply laminate if all the plies used to fabricate the laminate are only $0^0$and 90^0.The proposed work deals with the static analysis of the Hybrid FRP thin skew laminates with cutout. The main aim is to evaluate the stresses in the clamped skew laminates, which are subjected to combined transverse pressure load and temperature load. Arrange the four layers in $0^0/90^0/90^0/0^0$.

3.2.2: Case1- Taking all boron -epoxy layers

i) Effect of d/l at $\alpha = 0^0$: The values of σx, σy, and τxy gradually decreases as increases d/l ratio at the skew angle 0^0, τxy values are small compared to σx and σy.

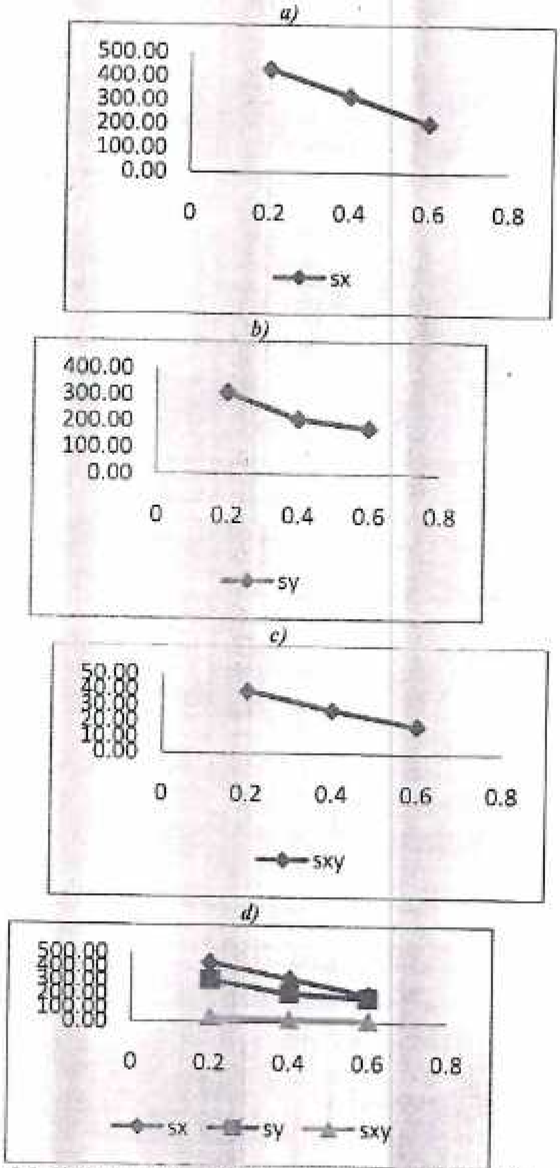

Fig. 3.1, Variation of s_x, s_y and s_{xy} with respect to d/l ($\alpha = 0^0$)

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ii) Effect of d/l at α = 30^0 : The values of σx, σy, and τxy gradually decreases as increases d/l ratio at the skew angle 30^0, σx and σy are same at d/l=0.6, τxy values are small compared to σx and σy.

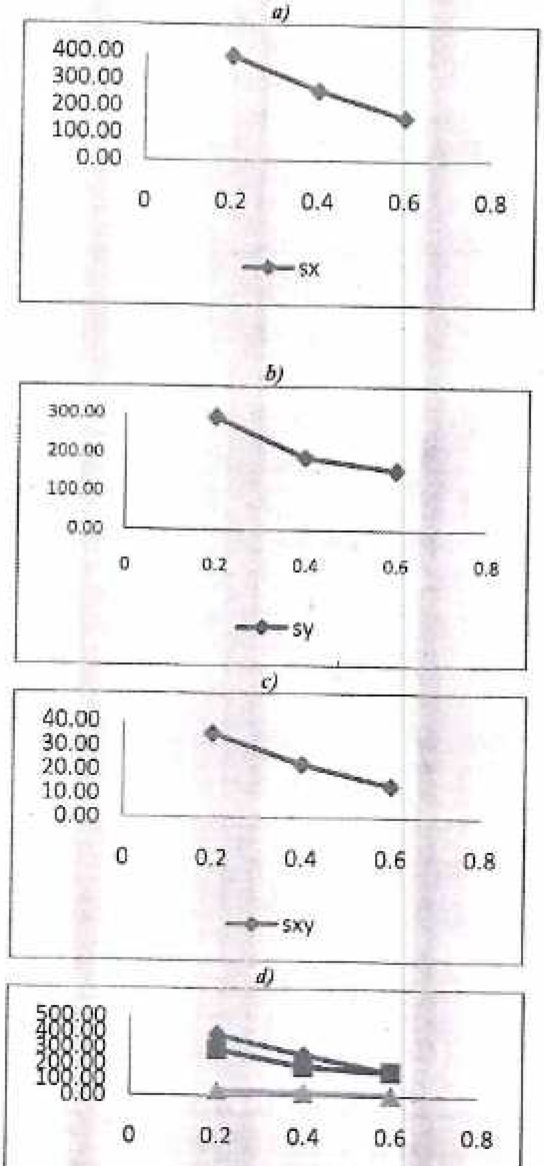

Fig. 3.2:Variation of s_x, s_y and s_{xy} with respect to d/l (α =30^0)

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3.2.3: Case 2- Taking all graphite-epoxy layers

i) Effect of d/l at $\alpha = 0^0$: The values of σx, σy, and τxy gradually decreases as increases d/l ratio at the skew angle 0^0, stresses in case-2 are high compared to case-I

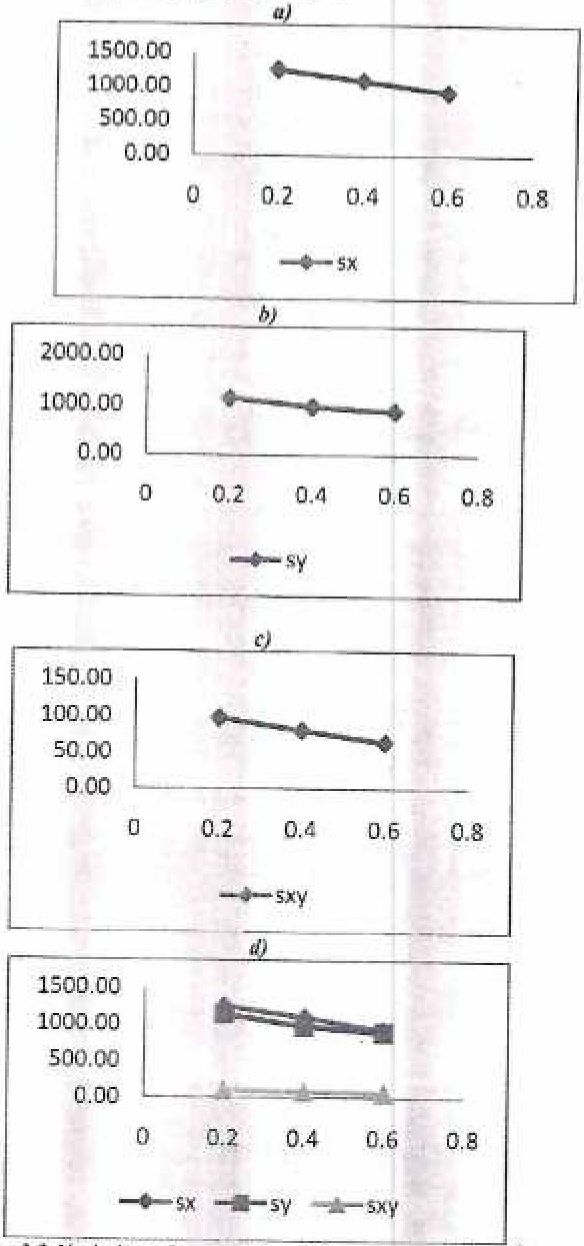

Fig. 3.3: Variation of s_x, s_y and s_{xy} with respect to d/l ($\alpha = 0^0$)

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i) Effect of d/l at $\alpha = 30^0$: The values of σx, σy, and τxy gradually decreases as increases d/l ratio at the skew angle 30^0.

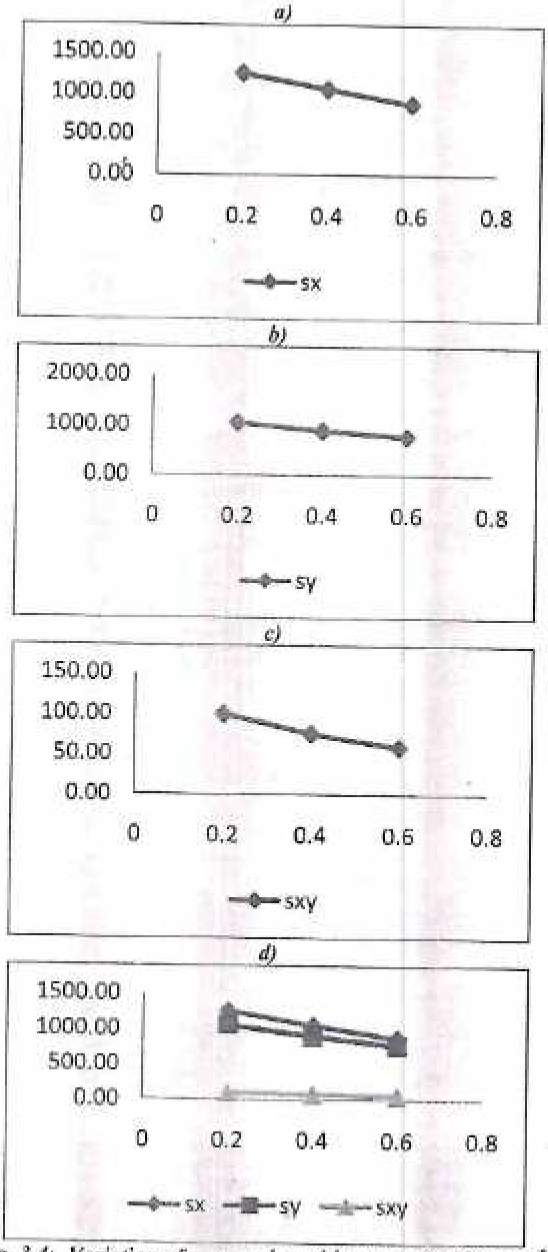

Fig. 3.4: Variation of s_x, s_y and s_{xy} with respect to d/l ($\alpha = 30^0$)

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3.2.3:Case 3- Hybrid-1: Graphite-epoxy/Boron-epoxy/ Boron-epoxy/Graphite-epoxy

i) Effect of d/l at $\alpha = 0^0$: The values of σx, σy, and τxy gradually decreases as increases d/l ratio at the skew angle 0^0. Values of σy are more compared to case-1 and case-2.

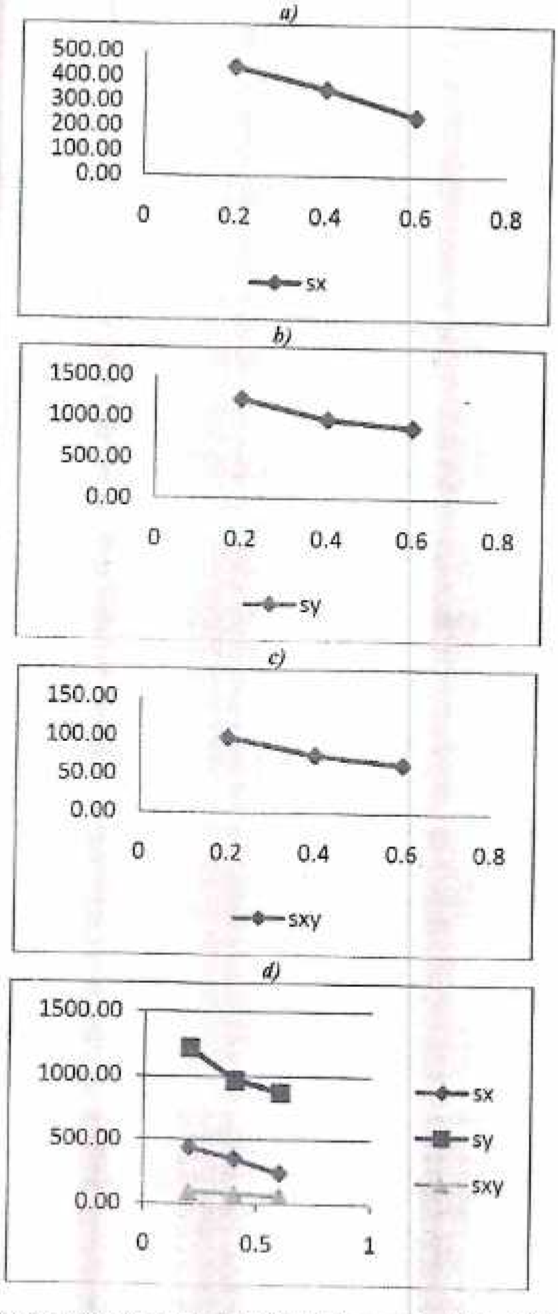

Fig.3.5: Variation of s_x, s_y and s_{xy} with respect to d/l ($\alpha = 0^0$)

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ii) Effect of d/l at $\alpha = 30^0$: The values of σx, σy, and τxy gradually decreases as increases d/l ratio at the skew angle 30^0.

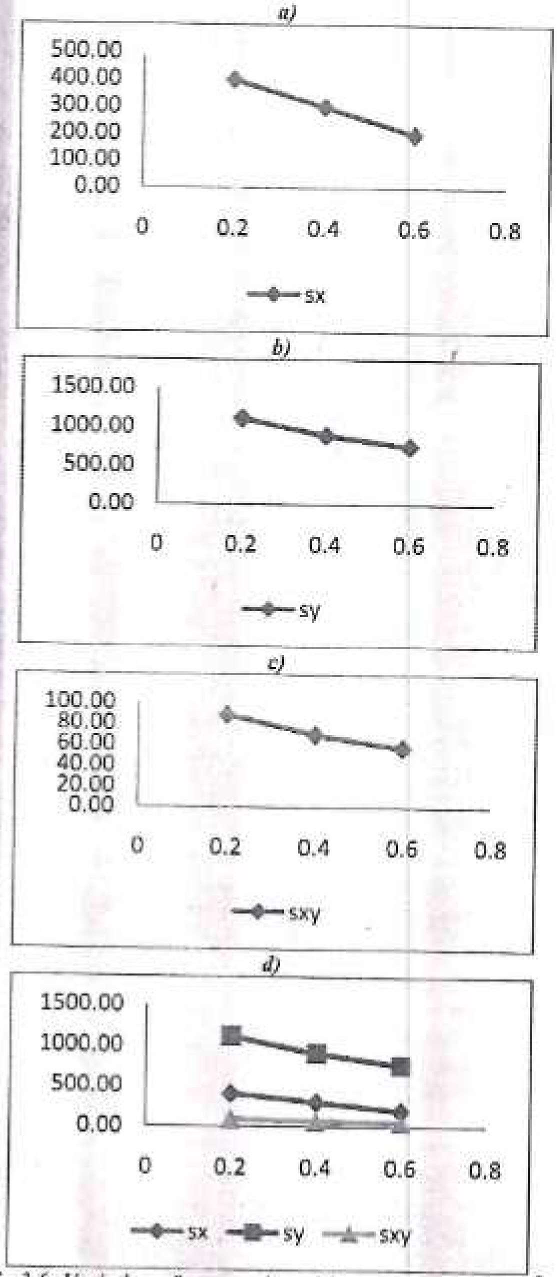

Fig.3.6: Variation of s_x, s_y and s_{xy} with respect to d/l ($\alpha = 30^0$)

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3.2.3:Case4- Hybrid-1: Boron-epoxy/ Graphite-epoxy/ Graphite-epoxy/Boron-epoxy

i) Effect of d/l at $\alpha = 0^0$: The values of σx gradually decreases as increases d/l ratio at the skew angle 0^0. The values of σy, and τxy very less compared to σx.

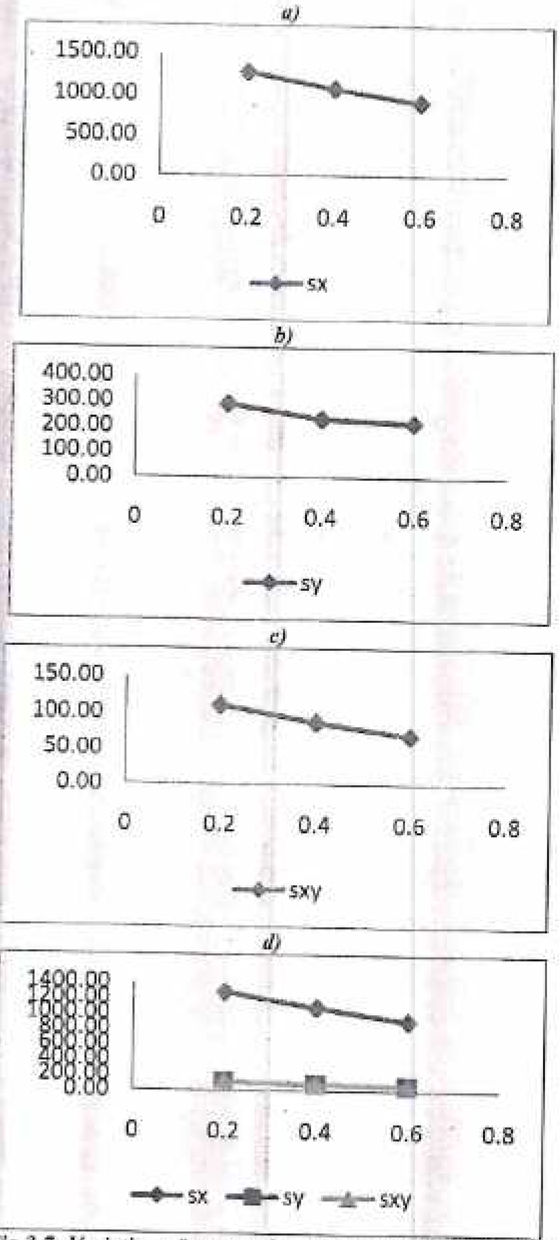

Fig.3.7: Variation of s_x, s_y and s_{xy} with respect to d/l ($\alpha = 0^0$)

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ii) Effect of d/l at $\alpha = 30^0$: The values of σx gradually decreases as increases d/l ratio at the skew angle 30^0.

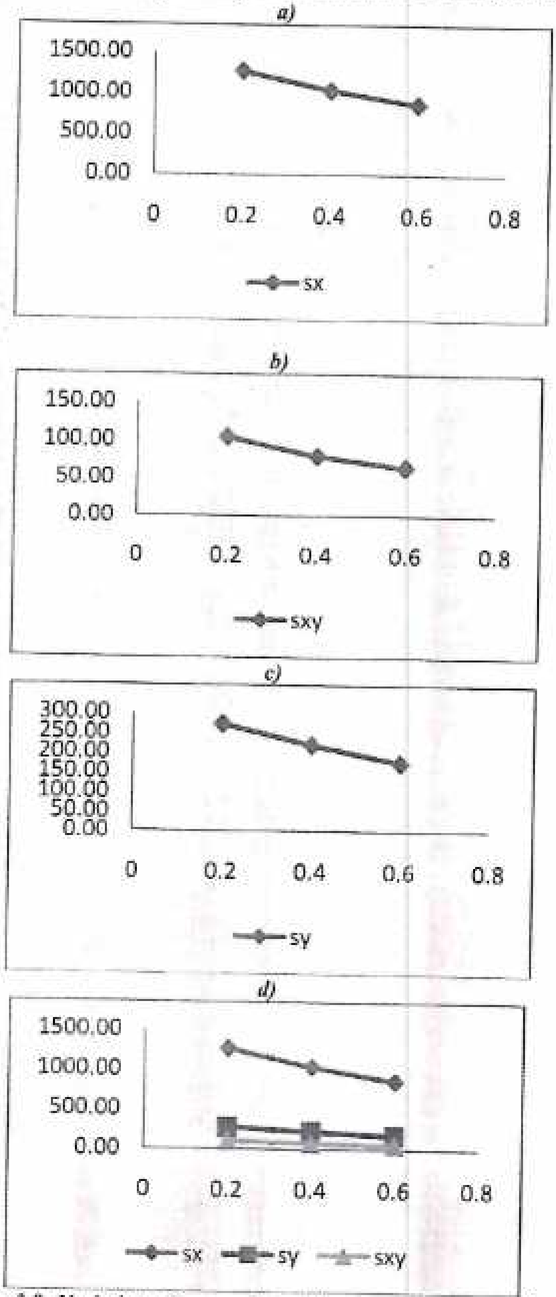

Fig.3.8: Variation of s_x, s_y and s_{xy} with respect to d/l ($\alpha = 30^0$)

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GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

THERMO ELASTIC BEHAVIOUR OF A THIN HYBRID FOUR-LAYERED FRP SKEW CROSS-PLY LAMINATES WITH CIRCULAR CUTOUT

K. Durga*[1] & T. Srinivasa Rao[2] & D.Gopi Chand[3]
*1,2&3Department of Mechanical Engineering, Vikas Group Of Institutions, Nunna, India

ABSTRACT

The present paper deals with the prediction of thermo elastic behaviour of the thin four-layered Cross-ply Hybrid Fibre Reinforced Plastic (FRP) skew laminated composite plate with circular cut out by considering two composite materials Graphite- Epoxy and Boron-Epoxy materials which are subjected to uniform pressure load and thermal loading. The problem is modeled by using ANSYS software based on the Classical Lamination Theory (CLT) which is suitable for the analysis of thin laminates with circular cut-out. The effect of size of the circular cut out and skew angle on the stresses are shown for Cross and Angle-ply laminates. The principle stresses and shear stresses are evaluated for different cross sections. The present analysis is useful for the safe and effective design of the skew laminates with circular cut out under uniform pressure load and thermal load conditions.

Keywords: *hybrid FRP, Skew laminate, Finite element analysis, cross-ply , classical theory, thermal stresses, Circular cut out.*

I. INTRODUCTION

A composite material is made by combining two or more materials – often ones that have very different properties. The two materials work together to give the composite unique properties. However, within the composite you can easily tell the different materials apart as they do not dissolve or blend into each other. Most composites are made of just two materials. One is the matrix or binder. It surrounds and binds together fibres or fragments of the other material, which is called the reinforcement. The first modern composite material was fibreglass. It is still widely used today for boat hulls, sports equipment, building panels and many car bodies. The matrix is a plastic and the reinforcement is glass that has been made into fine threads and often woven into a sort of cloth. On its own the glass is very strong but brittle and it will break if bent sharply. The plastic matrix holds the glass fibres together and also protects them from damage by sharing out the forces acting on them. Some advanced composites are now made using carbon fibres instead of glass. These materials are lighter and stronger than fibreglass but more expensive to produce.

They are used in aircraft structures and expensive sports equipment such as golf clubs.

Statical and dynamical behaviour of thin fibre reinforced composite laminates with different shapes Based on the classical laminated plate theory [1] Thermal buckling analysis of symmetric and antisymmetric cross-ply laminated hybrid composite plates with an inclined crack subjected to a uniform temperature rise [2] , buckling of functionally graded plates (FG plates) with an elliptical cut out under combined thermal and mechanical loads is investigated using Finite Element Method [3] The free vibration analysis of laminated composite skew plates with delamination around a centrally located quadrilateral cut out is carried out based on the high-order shear deformation theory (HSDT) [4] the prediction of interlaminar stresses in simply supported laminated FRP composite plate with a circular cut-out under transverse load using 3-D finite element analysis [5] the free vibration analysis of a thin Fibre Reinforced Plastic (FRP) skew laminated composite plate with a circular cut-out at the geometric centre [6] the interlaminar stresses are predicted for a bidirectional skew laminated unidirectional continuous fibre reinforced plastic (FRP) composite with a circular cut out at the geometric centre of the plate using three dimensional finite element method with geometric nonlinear option [7].
The present investigation intends to apply the finite element technique, based on classical lamination theory, for the analysis of symmetric and anti-symmetric thin laminates under uniform pressure load and thermal loading

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Nomenclature:

l	length of the plate
h	Total thickness of laminate
S	(l/h), thickness ratio of the laminate
d/l	Diameter ratio.
α	Skew angle
Eij	Young's modulus of lamina.
Gij	Shear modulus of lamina.
υij	Poisson's Ratio of Lamina.
σ	Normal stress.
w	Deflection
τxy	Shear stresses

II. PROBLEM MODELING

2.1 Geometric modelling

A laminated composite general shell element (SHELL99) is used for meshing the geometry of the problem. This element is suited for modeling moderately thin laminates composite shells. As shown in the Fig.1, the element consists of number of layers of perfectly bonded orthotropic materials. The element is quadratic and has six degrees of freedom per node namely, translations in x, y and z directions respectively, and rotations about x, y and z axes respectively.

The element gives results of high accuracy and discretization involves fewer elements. As shown in the Fig.3, the lamination sequence is between the bottom and top faces of the element with the layer setup starting from the bottom face. This element is used to model the present problem with 0/90/90/0, layer sequence.

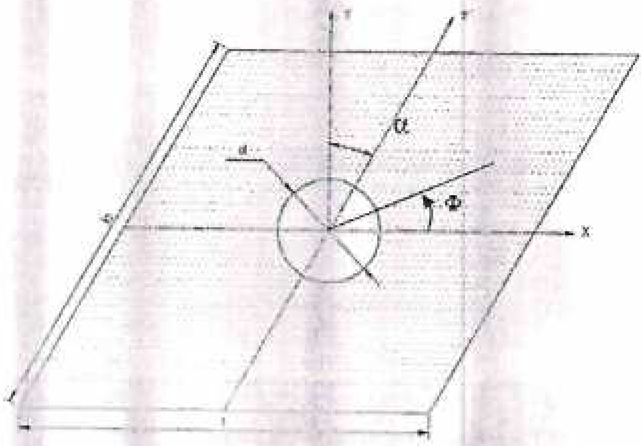

Fig.1, Geometric modelling

2.2. Finite Element Modeling

The finite element model of the problem are shown in Fig.2, The side of the plate 'l' is taken as 20mm and five layers are considered with total thickness (h) of 1mm, so that the length to thickness ratio becomes 's'=20. The skew angle α is taken as a value varying from 0 to 500. A circular hole is placed at the geometric centre of the plate. The size of the cut out is varied as per the ratio d/l ranging from 0.1 to 0.6mm.

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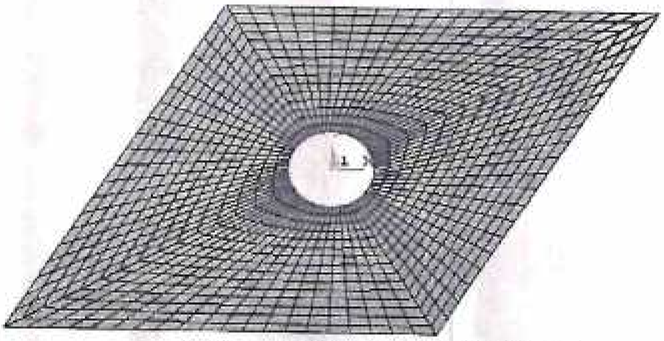

Fig.2, Finite element mesh on skew plate

2.3 Boundary Conditions and Loading

All the sides of the skew plate are clamped. The skew laminate is subjected to the combined transverse pressure load of 1MPa and thermal load 200^0.

2.4 Material properties

The material properties used for the Graphite and Boron epoxy materials are given table below:

	Boron-epoxy	Graphite-epoxy
Young's modulus in GPa		
E1	241873	141675
E2=E3	25511.5	12383.9
Poisson's Ratio		
v12= v13	0.25392	0.25772
v23	0.26458	0.42057
Rigidity Modulus in Gpa		
G12=G13	6715.8	3880
G23	10084	4356
Temperature effects		
A1	5.30E-06	1.00E-07
A2	2.20E-05	2.80E-05
A3	2.40E-05	2.40E-05

III. RESULTS AND DISCUSSIONS

The Finite element model is generated in the ANSYS software and the stresses are obtained. The results are taken in Cross-ply laminates. The effect of skew angle and the effect of diameter of the cut out are taken into considered in the following cases. These results are taken the case of Four-layered Cross-ply laminates.

3.1 The arrangements of material in individual layers are as follows.

Case1 - Taking all boron -epoxy layers
Case2 - Taking all graphite -epoxy layers
Case3 - Hybrid-1: Graphite-epoxy/Boron- epoxy/ Boron-epoxy/Graphite-epoxy
Case4 - Hybrid-2: Boron-epoxy/Graphite-epoxy/Graphite-epoxy/Boron-epoxy

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3.2. Stresses Evaluation:

3.2.1 Analysis Of Cross-Ply Laminates: A laminate is called cross-ply laminate if all the plies used to fabricate the laminate are only 0^0 and 90^0. The proposed work deals with the static analysis of the Hybrid FRP thin skew laminates with cutout. The main aim is to evaluate the stresses in the clamped skew laminates, which are subjected to combined transverse pressure load and temperature load. Arrange the four layers in $0^0/90^0/90^0/0^0$.

3.2.2: Case1- Taking all boron -epoxy layers

i) Effect of d/l at $\alpha = 0^0$: The values of σx, σy, and τxy gradually decreases as increases d/l ratio at the skew angle 0^0, τxy values are small compared to σx and σy.

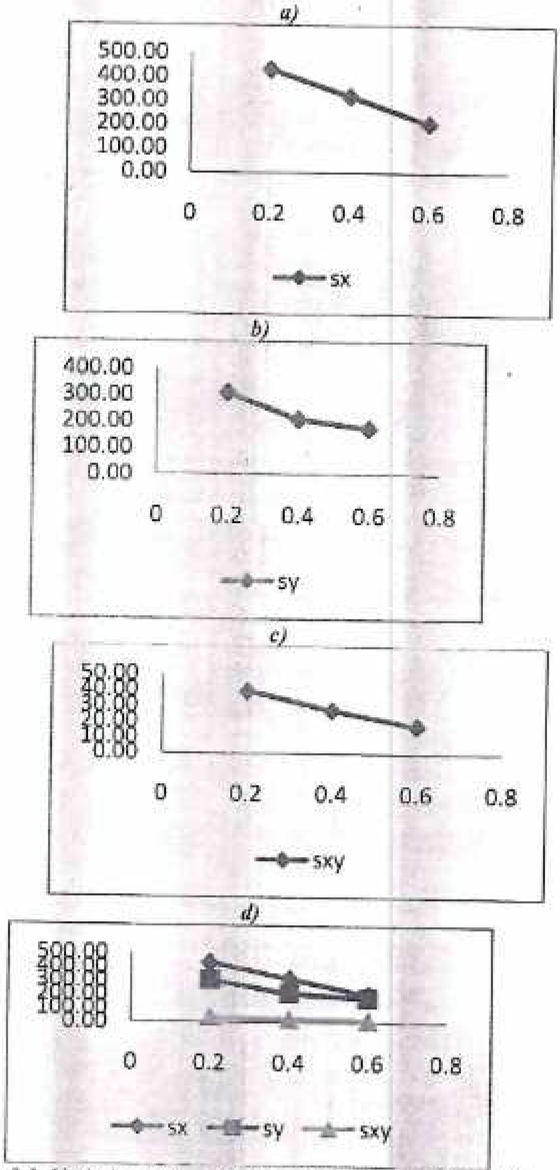

Fig. 3.1, Variation of s_x, s_y and s_{xy} with respect to d/l ($\alpha = 0^0$)

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ii) Effect of d/l at $\alpha = 30^0$: The values of σx, σy, and τxy gradually decreases as increases d/l ratio at the skew angle 30^0, σx and σy are same at d/l=0.6, τxy values are small compared to σx and σy.

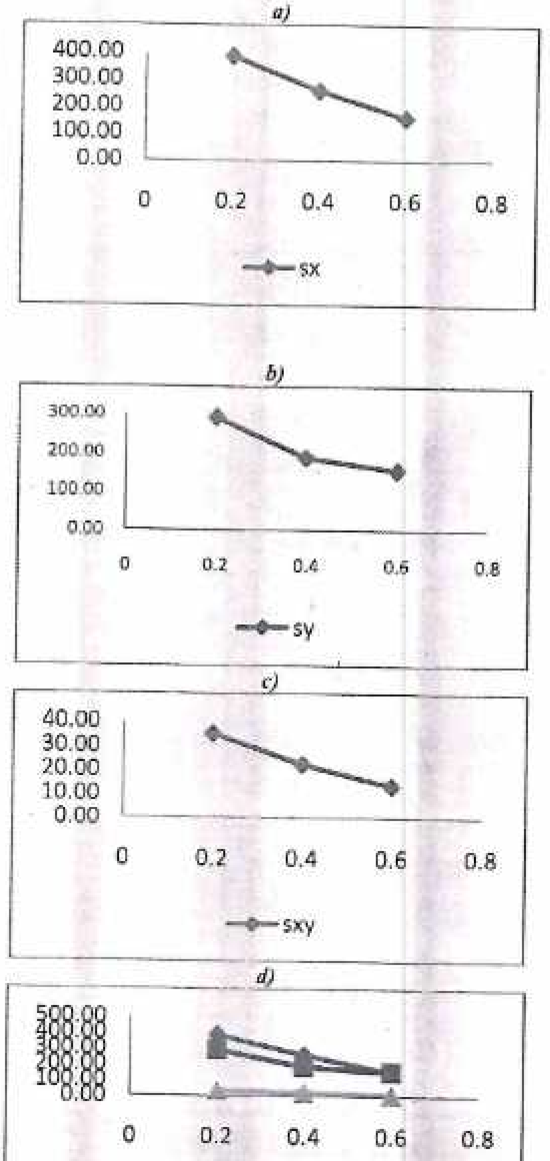

Fig. 3.2:Variation of s_x, s_y and s_{xy} with respect to d/l ($\alpha = 30^0$)

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3.2.3: Case 2- Taking all graphite-epoxy layers

i) Effect of d/l at $\alpha = 0^0$: The values of σx, σy, and τxy gradually decreases as increases d/l ratio at the skew angle 0^0, stresses in case-2 are high compared to case-I

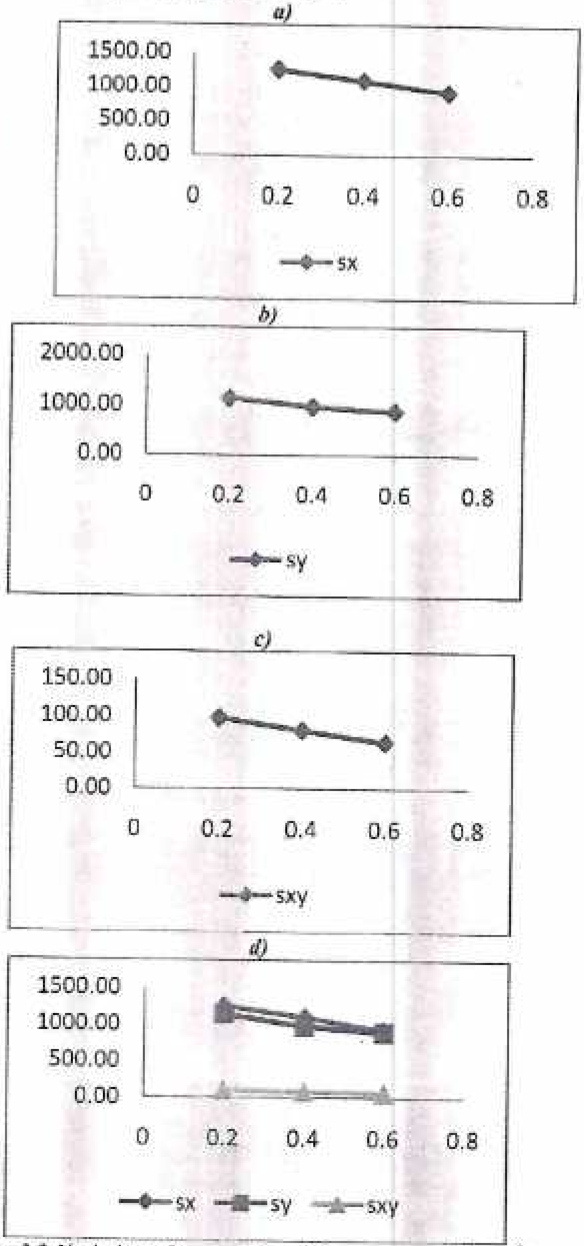

Fig. 3.3: Variation of s_x, s_y and s_{xy} with respect to d/l ($\alpha = 0^0$)

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i) Effect of d/l at $\alpha = 30^0$: The values of σx, σy, and τxy gradually decreases as increases d/l ratio at the skew angle 30^0.

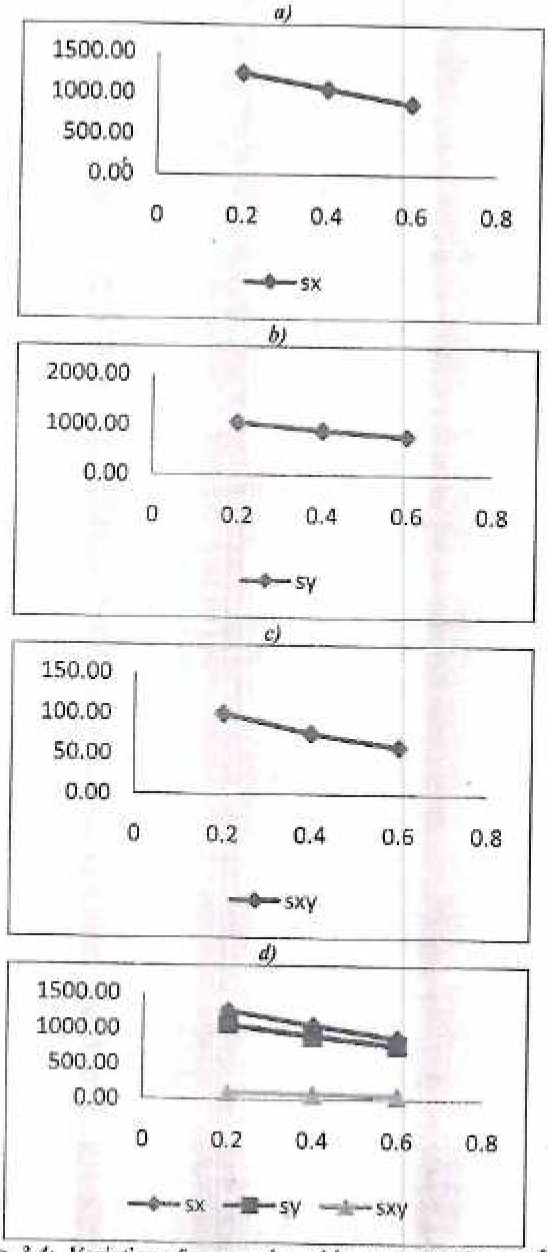

Fig. 3.4: Variation of s_x, s_y and s_{xy} with respect to d/l ($\alpha = 30^0$)

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3.2.3:Case 3- Hybrid-1: Graphite-epoxy/Boron-epoxy/ Boron-epoxy/Graphite-epoxy

i) Effect of d/l at α = 0^0 : The values of σx, σy, and τxy gradually decreases as increases d/l ratio at the skew angle 0^0. Values of σy are more compared to case-1 and case-2.

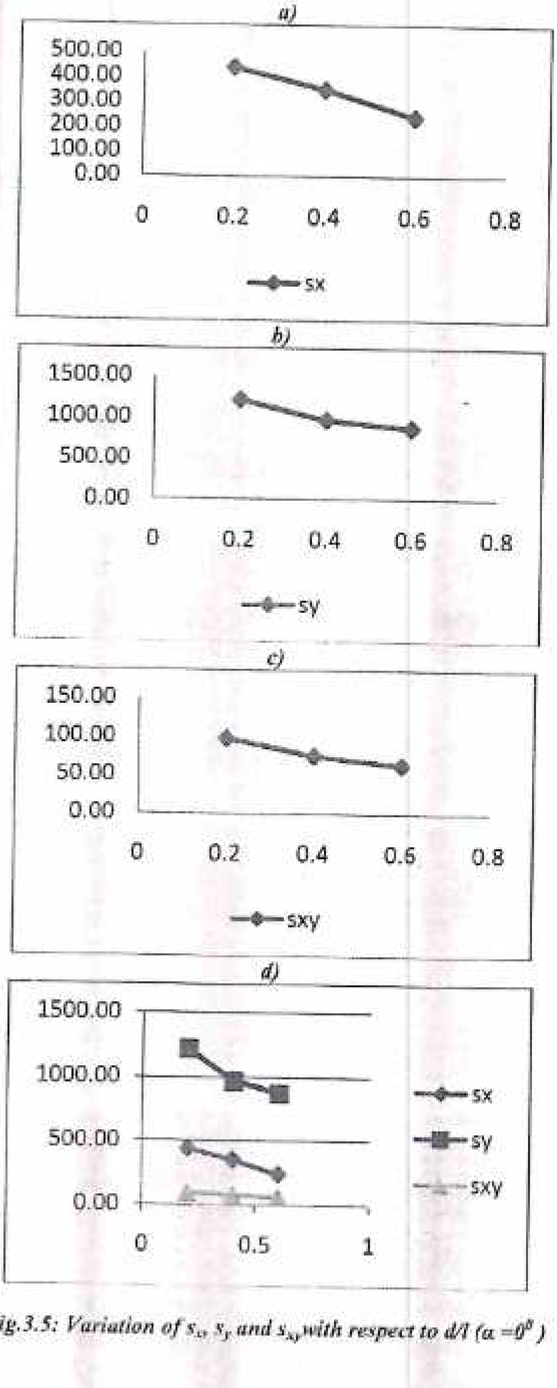

Fig.3.5: Variation of s_x, s_y and s_{xy} with respect to d/l (α =0^0)

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ii) Effect of d/l at $\alpha = 30^0$: The values of σx, σy, and τxy gradually decreases as increases d/l ratio at the skew angle 30^0.

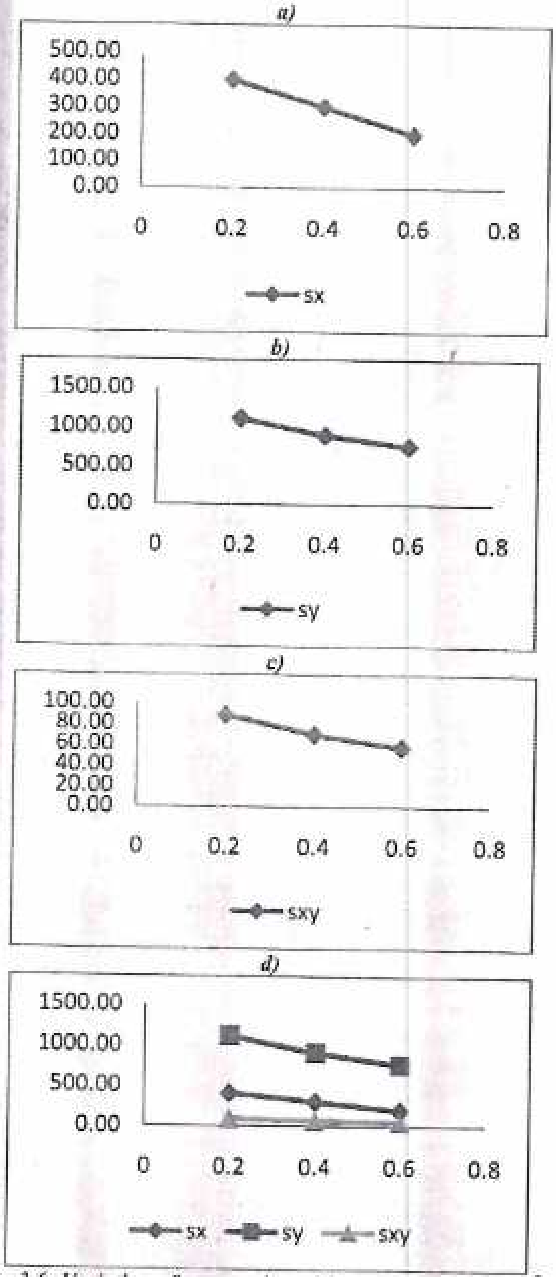

Fig.3.6: Variation of s_x, s_y and s_{xy} with respect to d/l ($\alpha = 30^0$)

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3.2.3:Case4- Hybrid-1: Boron-epoxy/ Graphite-epoxy/ Graphite-epoxy/Boron-epoxy

i) Effect of d/l at $\alpha = 0^0$: The values of σx gradually decreases as increases d/l ratio at the skew angle 0^0. The values of σy, and τxy very less compared to σx.

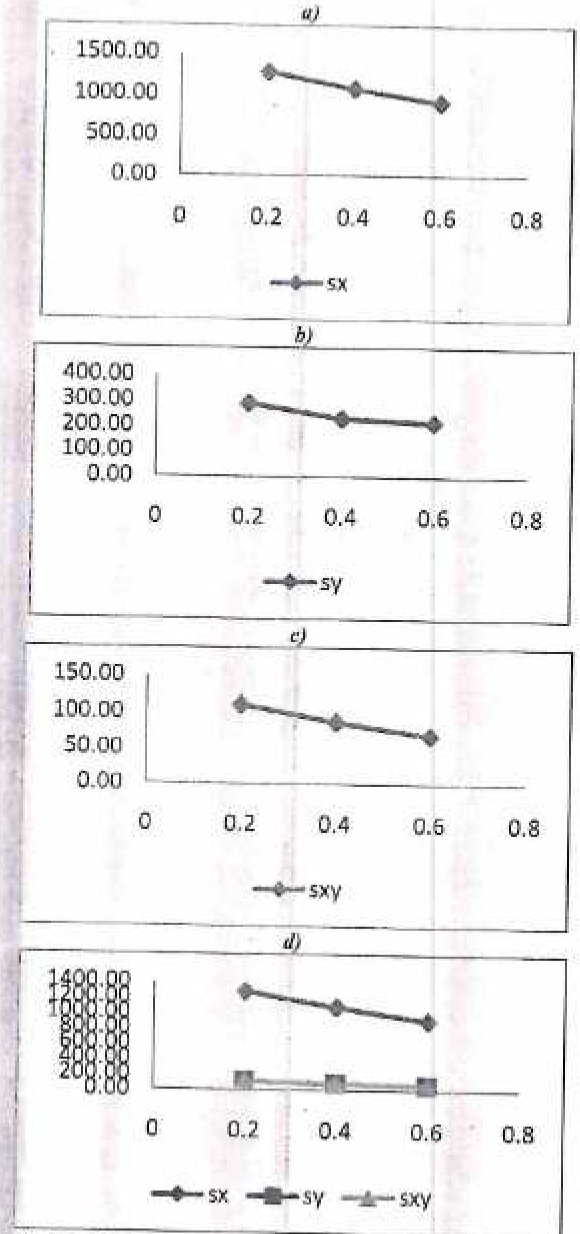

Fig.3.7: Variation of s_x, s_y and s_{xy} with respect to d/l ($\alpha = 0^0$)

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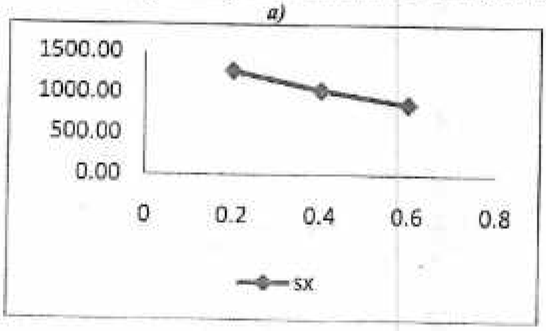
ii) Effect of d/l at $\alpha = 30^0$: The values of σx gradually decreases as increases d/l ratio at the skew angle 30^0.

a)



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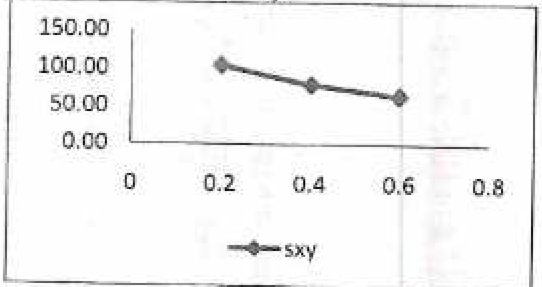

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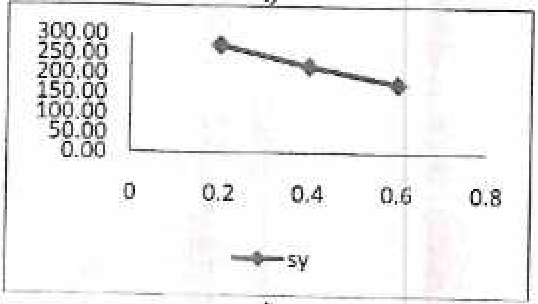

d)

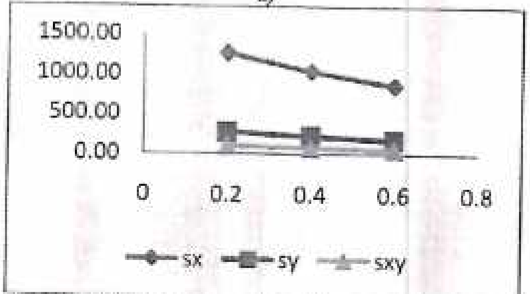

Fig.3.8: Variation of s_x, s_y and s_{xy} with respect to d/l ($\alpha = 30^0$)

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THERMO ELASTIC BEHAVIOUR OF A THIN HYBRID FOUR-LAYERED FRP SKEW CROSS-PLY LAMINATES WITH CIRCULAR CUTOUT

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ABSTRACT

The present paper deals with the prediction of thermo elastic behaviour of the thin four-layered Cross-ply Hybrid Fibre Reinforced Plastic (FRP) skew laminated composite plate with circular cut out by considering two composite materials Graphite- Epoxy and Boron-Epoxy materials which are subjected to uniform pressure load and thermal loading. The problem is modeled by using ANSYS software based on the Classical Lamination Theory (CLT) which is suitable for the analysis of thin laminates with circular cut-out. The effect of size of the circular cut out and skew angle on the stresses are shown for Cross and Angle-ply laminates. The principle stresses and shear stresses are evaluated for different cross sections. The present analysis is useful for the safe and effective design of the skew laminates with circular cut out under uniform pressure load and thermal load conditions.

Keywords: *hybrid FRP, Skew laminate, Finite element analysis, cross-ply , classical theory, thermal stresses, Circular cut out.*

I. INTRODUCTION

A composite material is made by combining two or more materials – often ones that have very different properties. The two materials work together to give the composite unique properties. However, within the composite you can easily tell the different materials apart as they do not dissolve or blend into each other. Most composites are made of just two materials. One is the matrix or binder. It surrounds and binds together fibres or fragments of the other material, which is called the reinforcement. The first modern composite material was fibreglass. It is still widely used today for boat hulls, sports equipment, building panels and many car bodies. The matrix is a plastic and the reinforcement is glass that has been made into fine threads and often woven into a sort of cloth. On its own the glass is very strong but brittle and it will break if bent sharply. The plastic matrix holds the glass fibres together and also protects them from damage by sharing out the forces acting on them. Some advanced composites are now made using carbon fibres instead of glass. These materials are lighter and stronger than fibreglass but more expensive to produce.

They are used in aircraft structures and expensive sports equipment such as golf clubs.

Statical and dynamical behaviour of thin fibre reinforced composite laminates with different shapes Based on the classical laminated plate theory [1] Thermal buckling analysis of symmetric and antisymmetric cross-ply laminated hybrid composite plates with an inclined crack subjected to a uniform temperature rise [2] , buckling of functionally graded plates (FG plates) with an elliptical cut out under combined thermal and mechanical loads is investigated using Finite Element Method [3] The free vibration analysis of laminated composite skew plates with delamination around a centrally located quadrilateral cut out is carried out based on the high-order shear deformation theory (HSDT) [4] the prediction of interlaminar stresses in simply supported laminated FRP composite plate with a circular cut-out under transverse load using 3-D finite element analysis [5] the free vibration analysis of a thin Fibre Reinforced Plastic (FRP) skew laminated composite plate with a circular cut-out at the geometric centre [6] the interlaminar stresses are predicted for a bidirectional skew laminated unidirectional continuous fibre reinforced plastic (FRP) composite with a circular cut out at the geometric centre of the plate using three dimensional finite element method with geometric nonlinear option [7].
The present investigation intends to apply the finite element technique, based on classical lamination theory, for the analysis of symmetric and anti-symmetric thin laminates under uniform pressure load and thermal loading

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Nomenclature:

l	length of the plate
h	Total thickness of laminate
S	(l/h), thickness ratio of the laminate
d/l	Diameter ratio.
α	Skew angle
Eij	Young's modulus of lamina.
Gij	Shear modulus of lamina.
υij	Poisson's Ratio of Lamina.
σ	Normal stress.
w	Deflection
τxy	Shear stresses

II. PROBLEM MODELING

2.1 Geometric modelling

A laminated composite general shell element (SHELL99) is used for meshing the geometry of the problem. This element is suited for modeling moderately thin laminates composite shells. As shown in the Fig.1, the element consists of number of layers of perfectly bonded orthotropic materials. The element is quadratic and has six degrees of freedom per node namely, translations in x, y and z directions respectively, and rotations about x, y and z axes respectively.

The element gives results of high accuracy and discretization involves fewer elements. As shown in the Fig.3, the lamination sequence is between the bottom and top faces of the element with the layer setup starting from the bottom face. This element is used to model the present problem with 0/90/90/0, layer sequence.

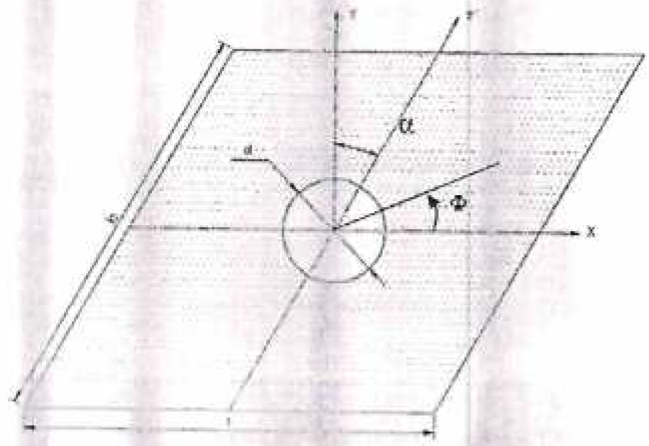

Fig.1, Geometric modelling

2.2. Finite Element Modeling

The finite element model of the problem are shown in Fig.2, The side of the plate 'l' is taken as 20mm and five layers are considered with total thickness (h) of 1mm, so that the length to thickness ratio becomes 's'=20. The skew angle α is taken as a value varying from 0 to 500. A circular hole is placed at the geometric centre of the plate. The size of the cut out is varied as per the ratio d//l ranging from 0.1 to 0.6mm.

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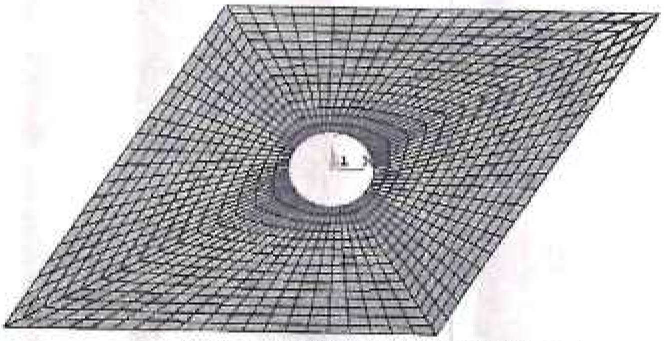

Fig.2, Finite element mesh on skew plate

2.3 Boundary Conditions and Loading

All the sides of the skew plate are clamped. The skew laminate is subjected to the combined transverse pressure load of 1MPa and thermal load 200^0.

2.4 Material properties

The material properties used for the Graphite and Boron epoxy materials are given table below:

	Boron-epoxy	Graphite-epoxy
Young's modulus in GPa		
E1	241873	141675
E2=E3	25511.5	12383.9
Poisson's Ratio		
ν12= ν13	0.25392	0.25772
ν23	0.26458	0.42057
Rigidity Modulus in Gpa		
G12=G13	6715.8	3880
G23	10084	4356
Temperature effects		
A1	5.30E-06	1.00E-07
A2	2.20E-05	2.80E-05
A3	2.40E-05	2.40E-05

III. RESULTS AND DISCUSSIONS

The Finite element model is generated in the ANSYS software and the stresses are obtained. The results are taken in Cross-ply laminates. The effect of skew angle and the effect of diameter of the cut out are taken into considered in the following cases. These results are taken the case of Four-layered Cross-ply laminates.

3.1 The arrangements of material in individual layers are as follows.

Case1 - Taking all boron -epoxy layers
Case2 - Taking all graphite -epoxy layers
Case3 - Hybrid-1: Graphite-epoxy/Boron- epoxy/ Boron-epoxy/Graphite-epoxy
Case4 - Hybrid-2: Boron-epoxy/Graphite-epoxy/Graphite-epoxy/Boron-epoxy

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3.2. Stresses Evaluation:

3.2.1 Analysis Of Cross-Ply Laminates: A laminate is called cross-ply laminate if all the plies used to fabricate the laminate are only $0^0$and 90^0.The proposed work deals with the static analysis of the Hybrid FRP thin skew laminates with cutout. The main aim is to evaluate the stresses in the clamped skew laminates, which are subjected to combined transverse pressure load and temperature load. Arrange the four layers in $0^0/90^0/90^0/0^0$.

3.2.2: Case1- Taking all boron -epoxy layers

i) Effect of d/l at $\alpha = 0^0$: The values of σx, σy, and τxy gradually decreases as increases d/l ratio at the skew angle 0^0, τxy values are small compared to σx and σy.

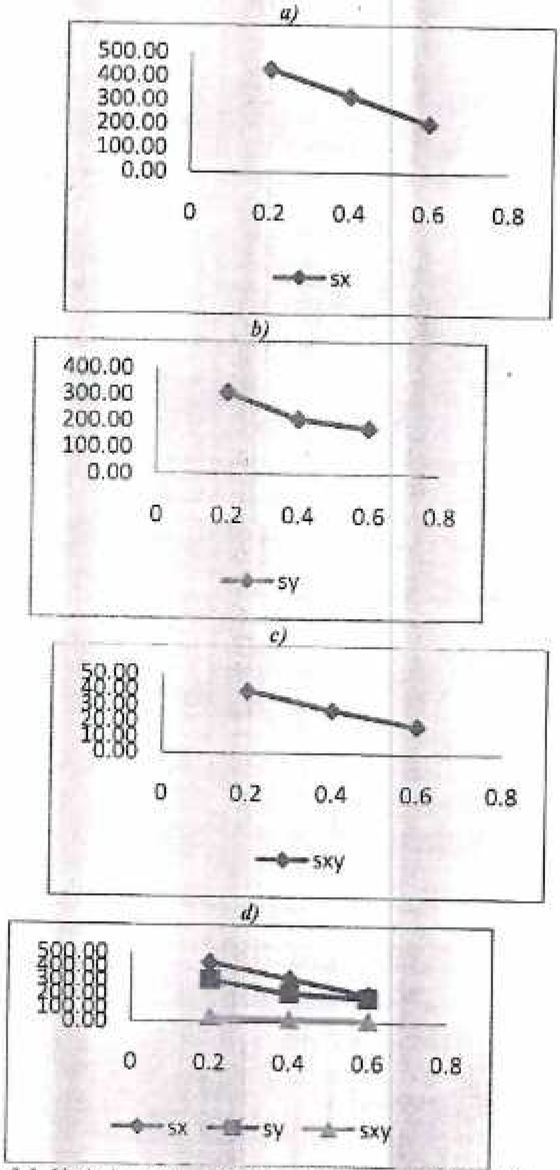

Fig. 3.1, Variation of s_x, s_y and s_{xy} with respect to d/l ($\alpha = 0^0$)

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ii) Effect of d/l at $\alpha = 30^0$: The values of σx, σy, and τxy gradually decreases as increases d/l ratio at the skew angle 30^0, σx and σy are same at d/l=0.6, τxy values are small compared to σx and σy.

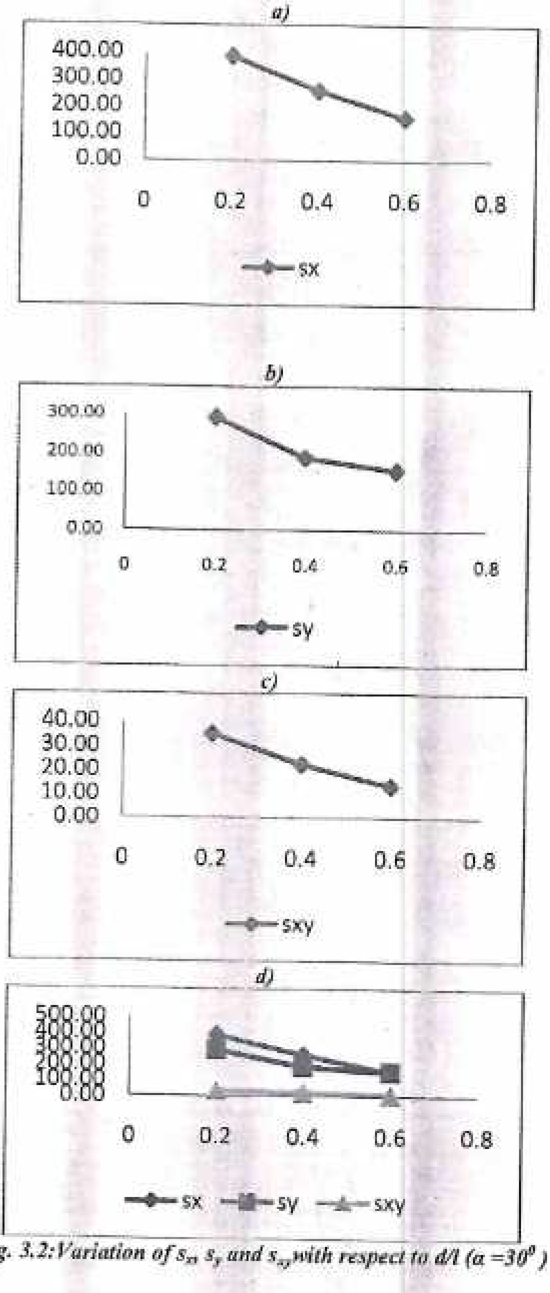

Fig. 3.2:Variation of s_x, s_y and s_{xy} with respect to d/l ($\alpha = 30^0$)

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3.2.3: Case 2- Taking all graphite-epoxy layers

i) Effect of d/l at $\alpha = 0^0$: The values of σx, σy, and τxy gradually decreases as increases d/l ratio at the skew angle 0^0, stresses in case-2 are high compared to case-I

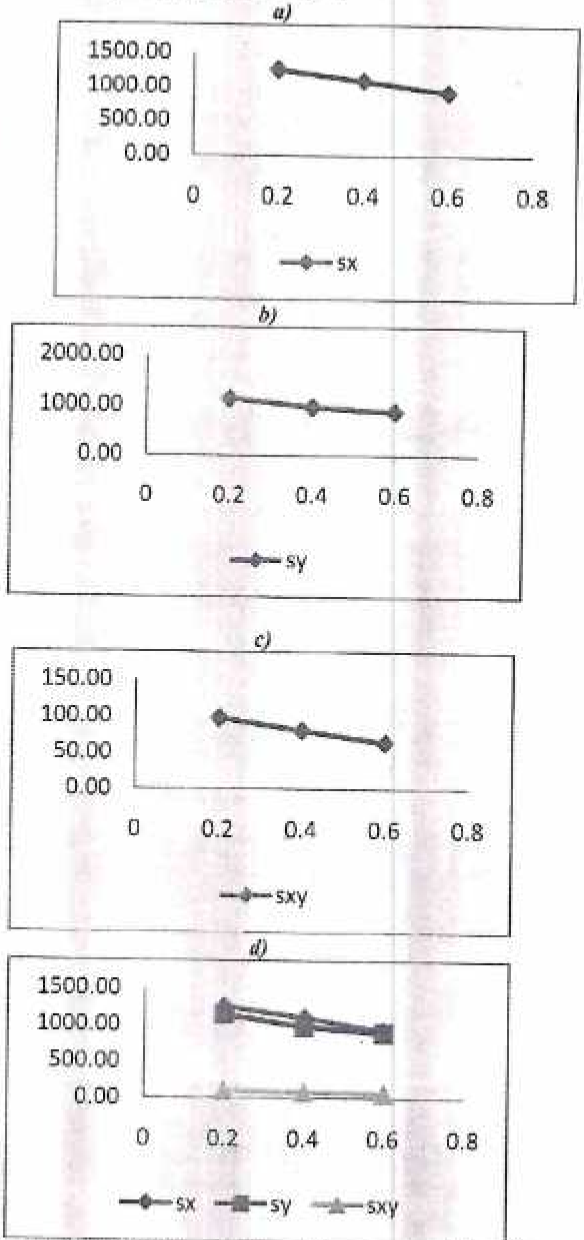

Fig. 3.3: Variation of s_x, s_y and s_{xy} with respect to d/l ($\alpha = 0^0$)

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i) Effect of d/l at $\alpha = 30^0$: The values of σx, σy, and τxy gradually decreases as increases d/l ratio at the skew angle 30^0.

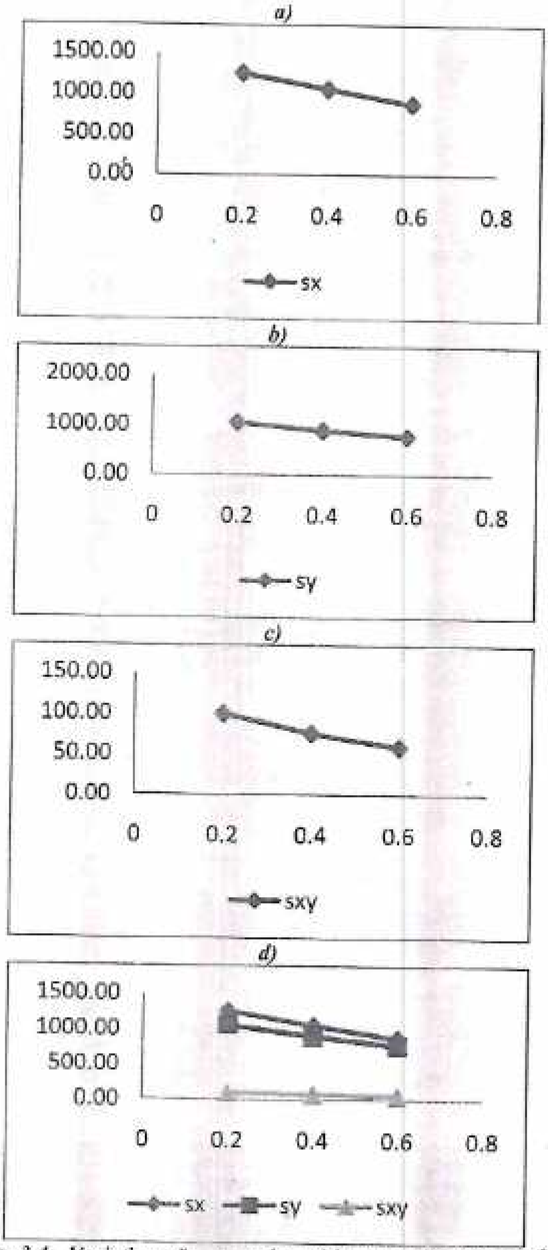

Fig. 3.4: Variation of s_x, s_y and s_{xy} with respect to d/l ($\alpha = 30^0$)

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3.2.3:Case 3- Hybrid-1: Graphite-epoxy/Boron-epoxy/ Boron-epoxy/Graphite-epoxy

i) Effect of d/l at $\alpha = 0^0$: The values of σx, σy, and τxy gradually decreases as increases d/l ratio at the skew angle 0^0. Values of σy are more compared to case-1 and case-2.

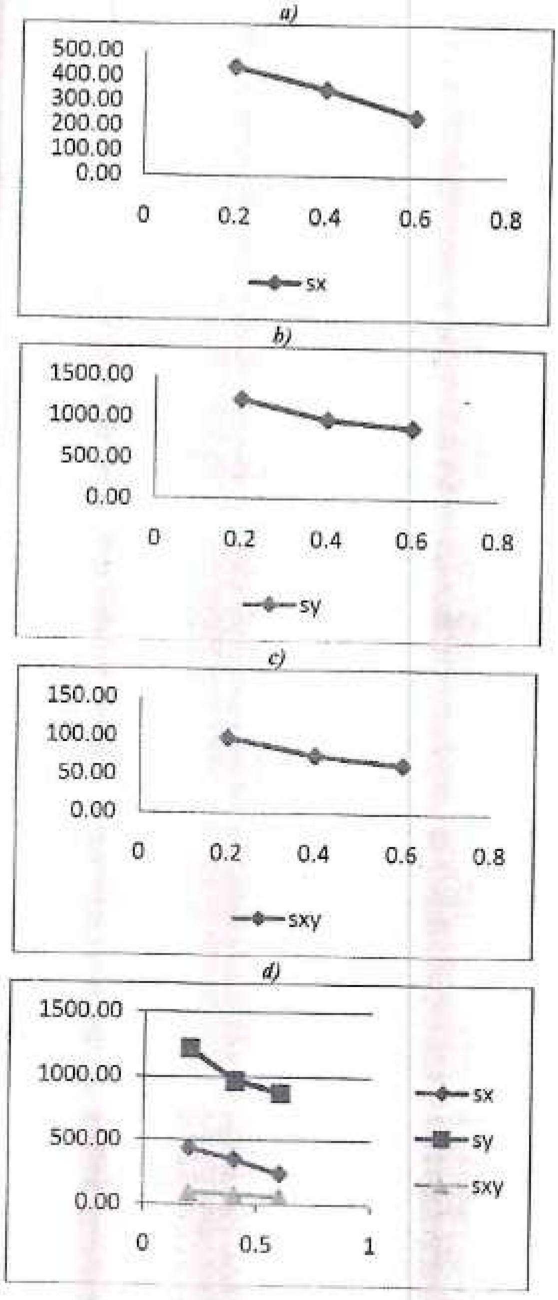

Fig.3.5: Variation of s_x, s_y and s_{xy} with respect to d/l ($\alpha = 0^0$)

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ii) Effect of d/l at $\alpha = 30^0$: The values of σx, σy, and τxy gradually decreases as increases d/l ratio at the skew angle 30^0.

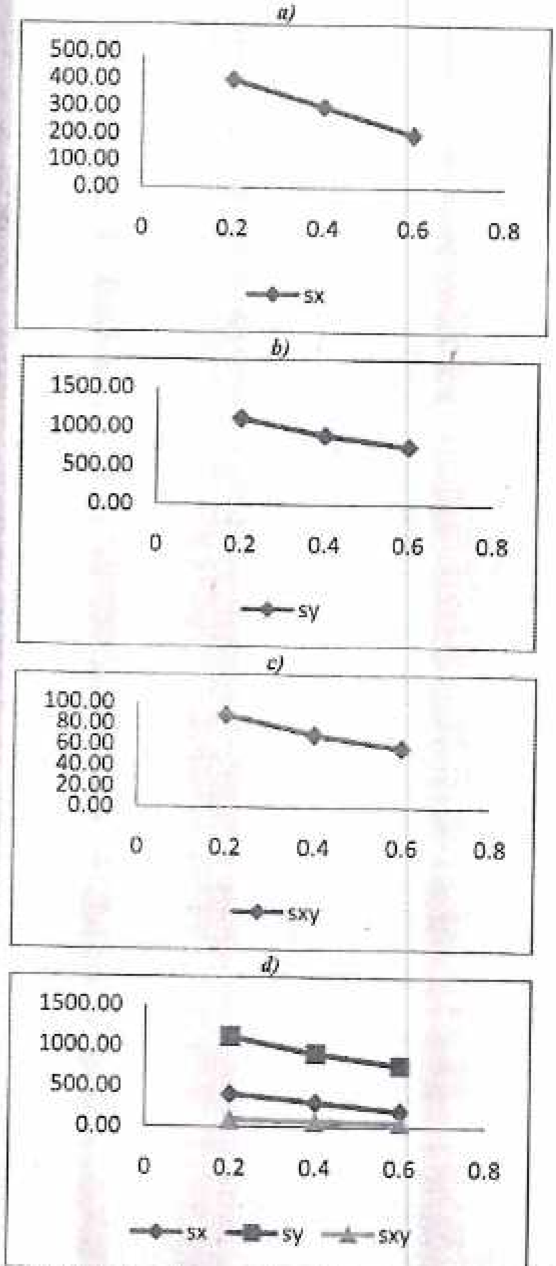

Fig.3.6: Variation of s_x, s_y and s_{xy} with respect to d/l ($\alpha = 30^0$)

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3.2.3:Case4- Hybrid-1: Boron-epoxy/ Graphite-epoxy/ Graphite-epoxy/Boron-epoxy

i) Effect of d/l at $\alpha = 0^0$: The values of σx gradually decreases as increases d/l ratio at the skew angle 0^0. The values of σy, and τxy very less compared to σx.

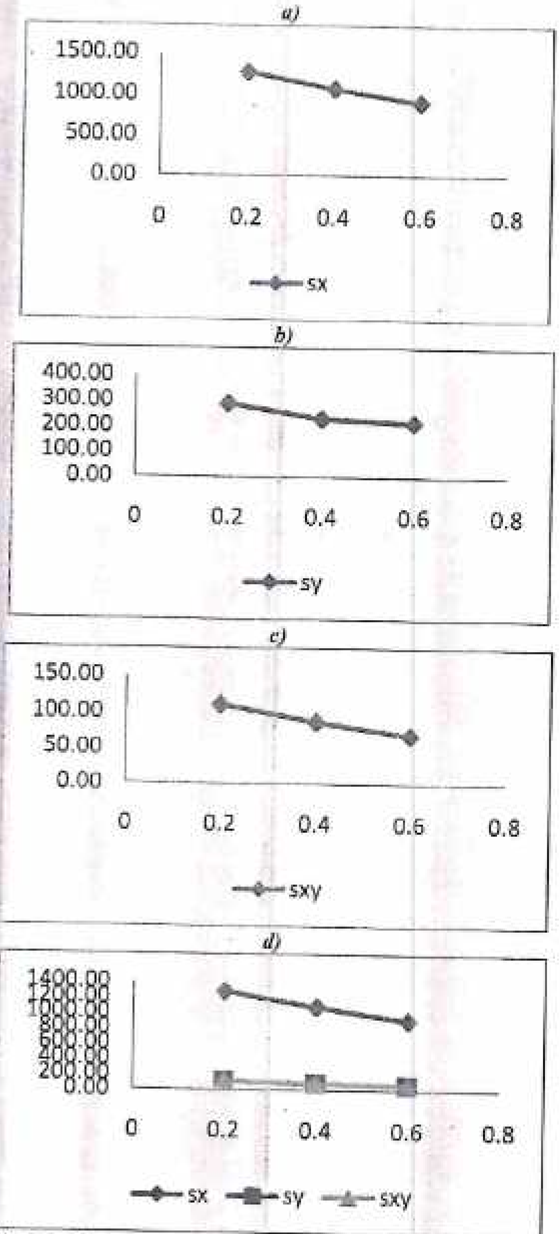

Fig.3.7: Variation of s_x, s_y and s_{xy} with respect to d/l ($\alpha = 0^0$)

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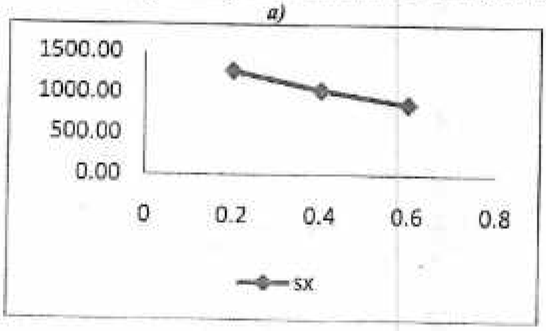
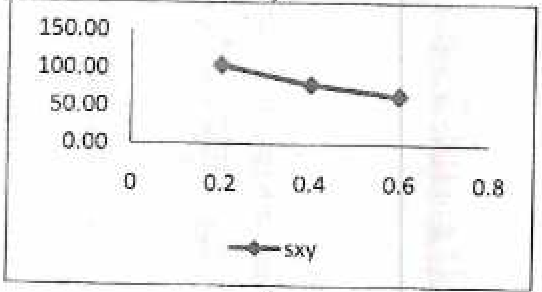
ii) Effect of d/l at $\alpha = 30^0$: The values of σx gradually decreases as increases d/l ratio at the skew angle 30^0.

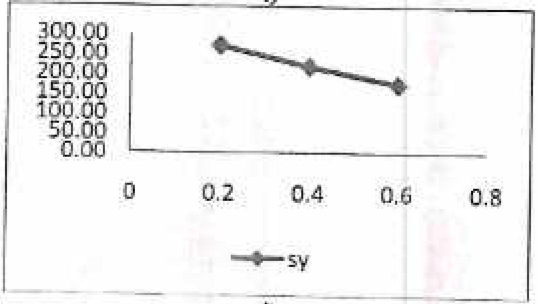
a)



b)



c)



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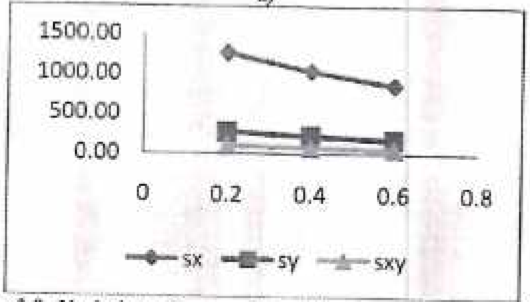

Fig.3.8: Variation of s_x, s_y and s_{xy} with respect to d/l ($\alpha = 30^0$)

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VIBRATION ANALYSIS OF CARBON NANOTUBE REINFORCED COMPOSITE USING ANSYS

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[1&2]Department of Mechanical Engineering

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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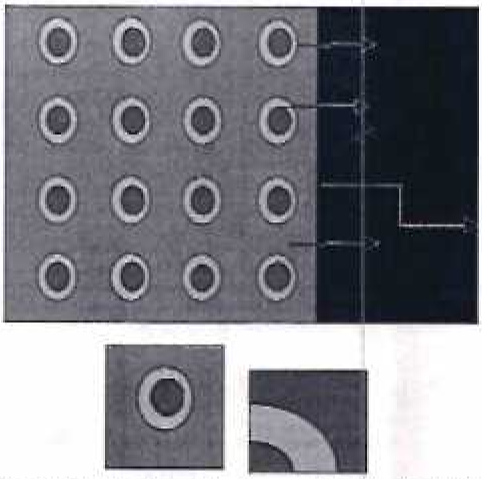

Figure 1.(a) Uniform distribution of spherical particles in matrix. (b)Isolated Unitcell and (c)one eigthmodel

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.

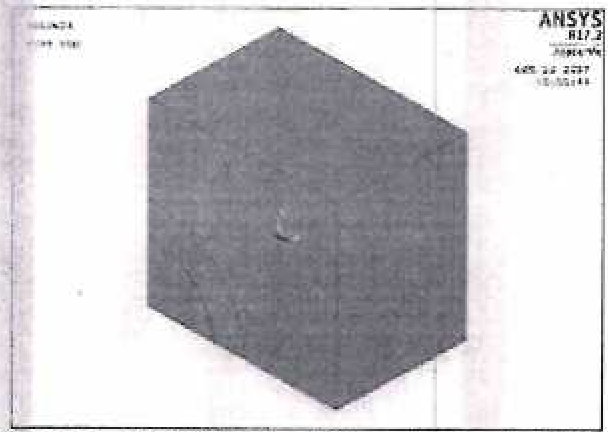

FIG 2.FE Model of CNT reinforced Composite at 1 wt.% of SWCNT.

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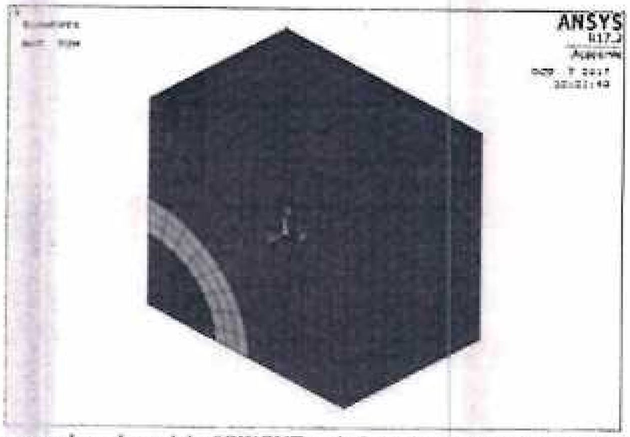

FIG.3 Converged mesh model of SWCNTs reinforced composite at 1 wt% of SWCNT.

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.

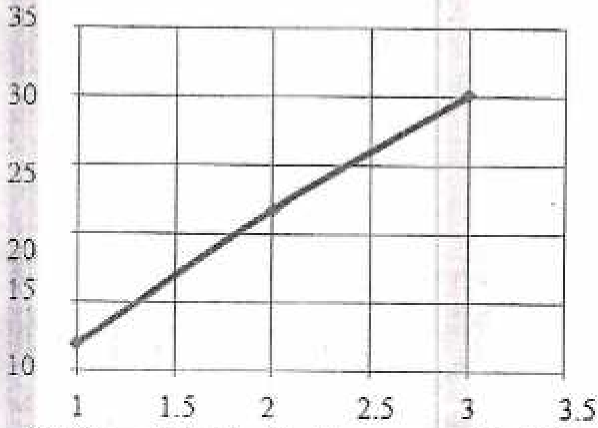

FIG 4. Young's Modulus (E) with respect to wt. % of CNT

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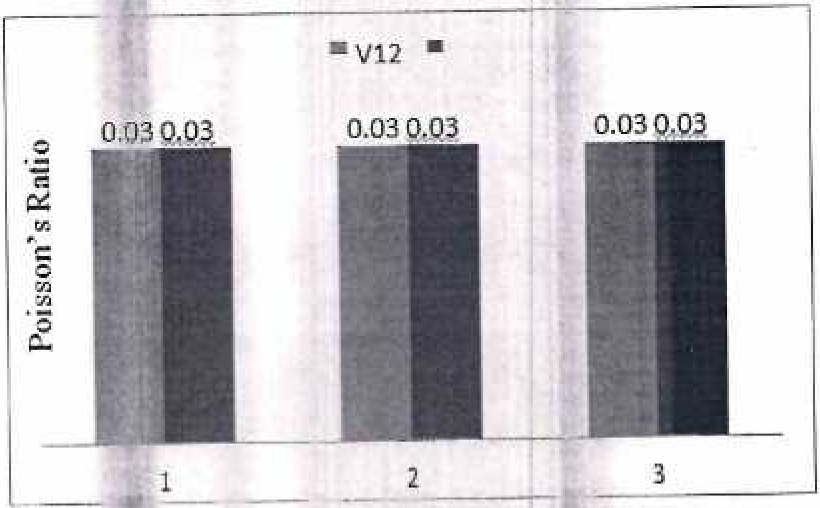

FIG5. Poisson's Ratio with respect to wt %of CNT Weight Percentage of SWCNT(in %)

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

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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

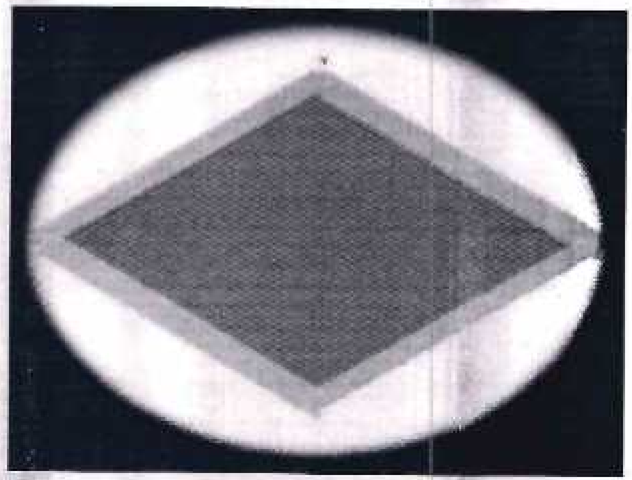

Fig 7.Loaded 1% CNT reinforced Composite

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.

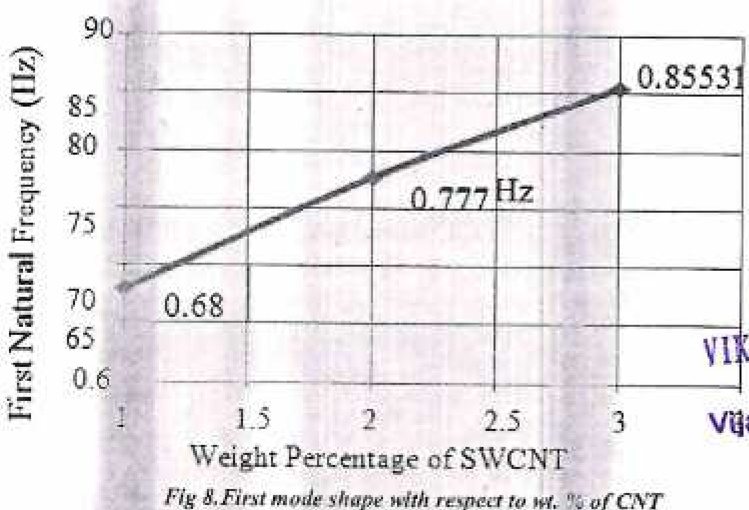

Fig 8.First mode shape with respect to wt. % of CNT

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

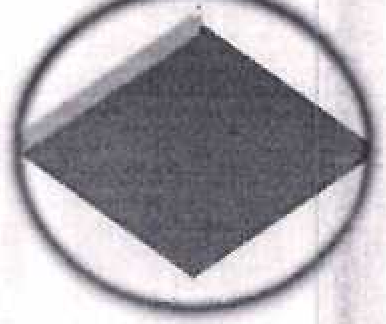

Fig 9.Cantileverend conditioned 1wt%composite

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

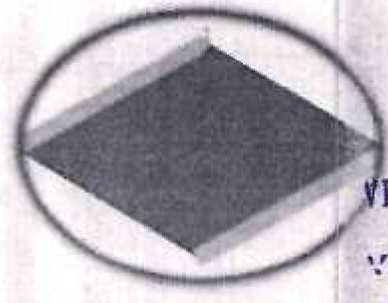

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Fig 11.Two edges fixed 3wt% CNT composite

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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.

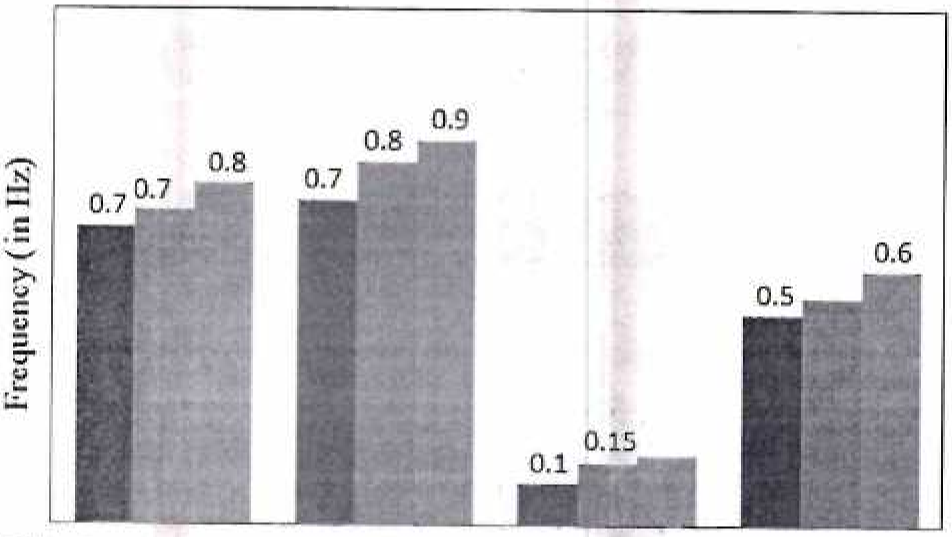

Fig 12.Result graph of natural frequency of 1,2,3 wt% CNT reinforced composite for all end conditions.

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.**

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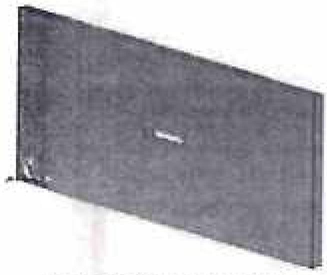

Fig 13.Rectangularcut

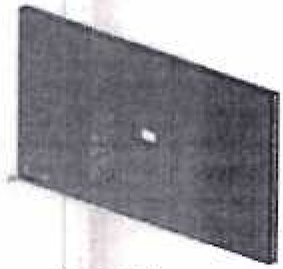

Fig 14.Suarecut

Fig15Traingularcut

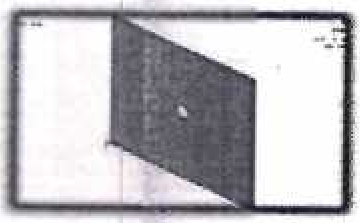

Fig 16.Cicularcut

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.

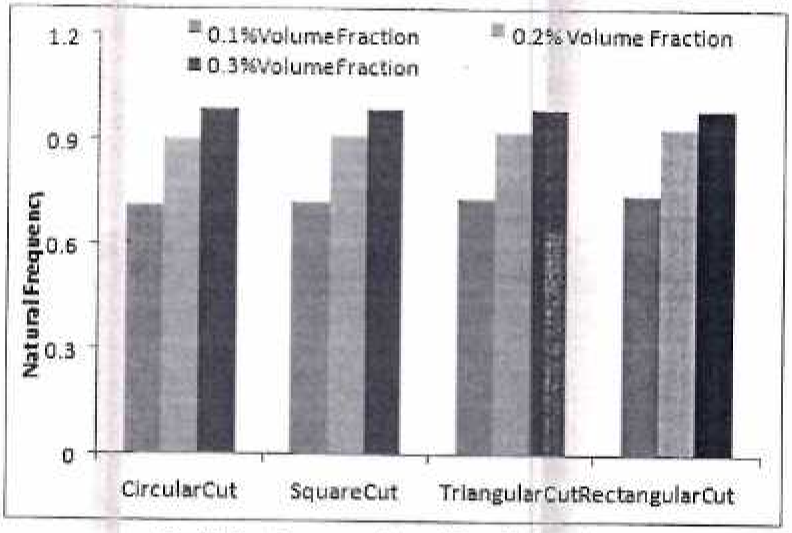

Fig 17.Simply supported result for all shaped cuts

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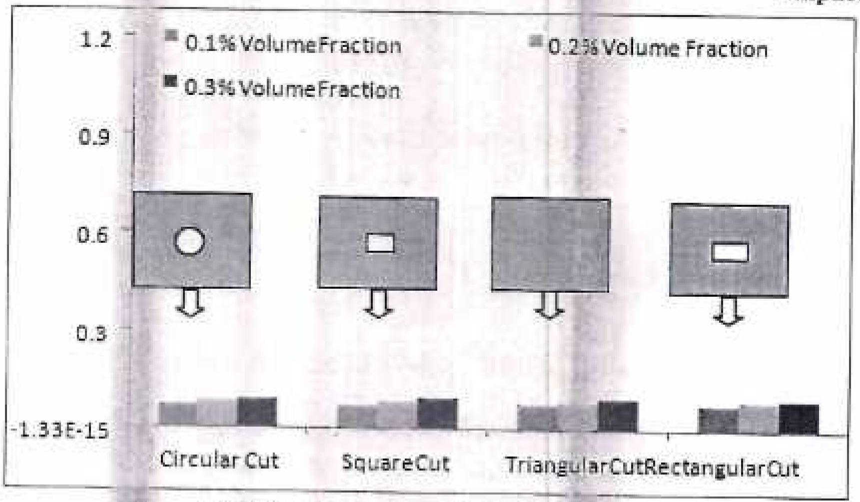

Fig 18 Cantilever end result for all shaped cuts

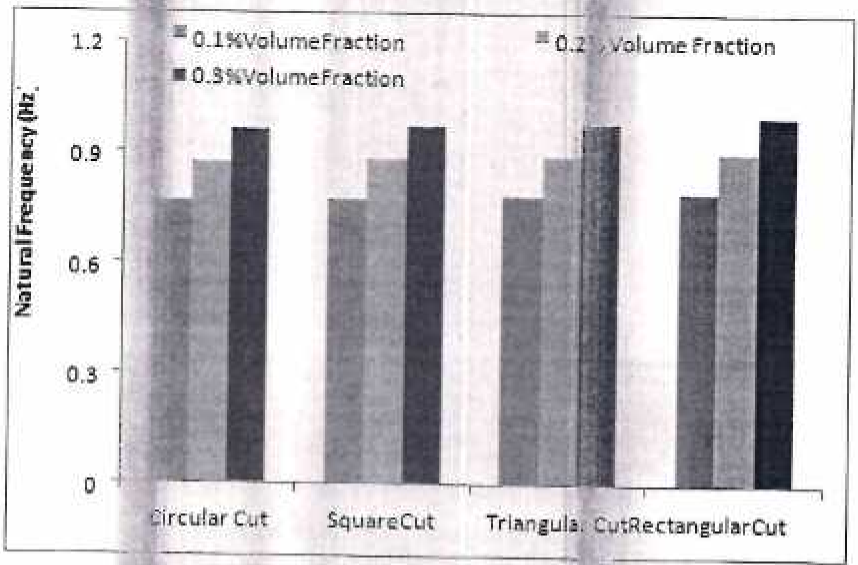

Fig 19.Two edges fixed result for all shaped cuts

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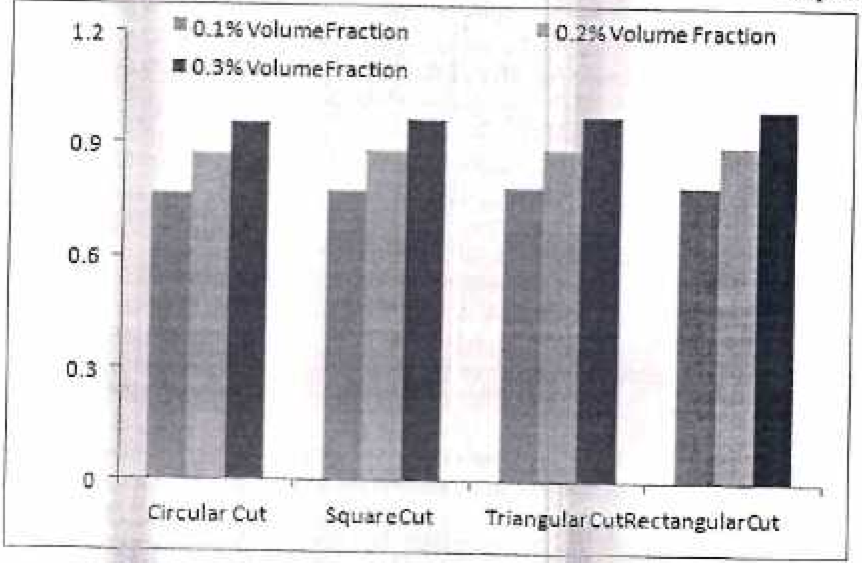

Fig 20. All end fixed result for all shaped cuts

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

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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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VIBRATION ANALYSIS OF CARBON NANOTUBE REINFORCED COMPOSITE USING ANSYS

V.Eeswari[1] & Md.Shareef[2]
[1&2]Department of Mechanical Engineering

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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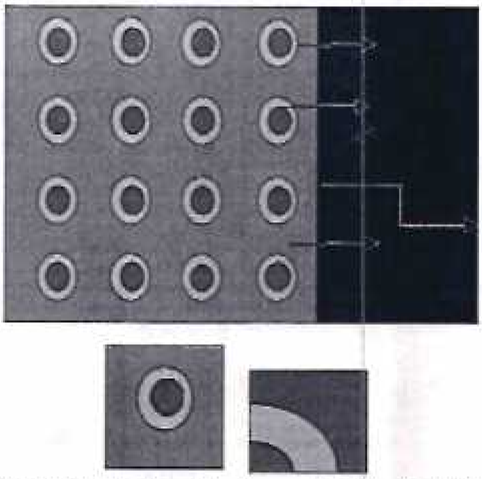

Figure 1.(a) Uniform distribution of spherical particles in matrix. (b)Isolated Unitcell and (c)one eigthmodel

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.

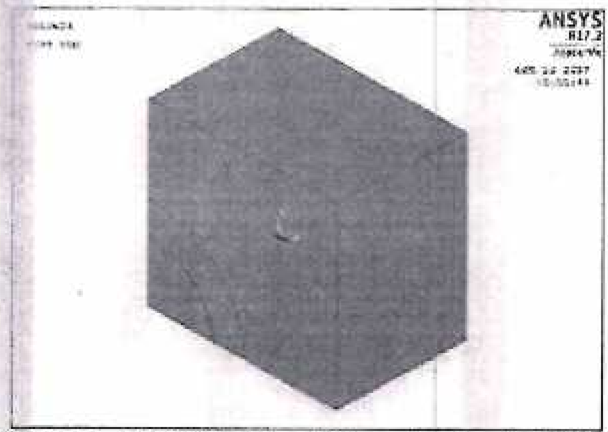

FIG 2.FE Model of CNT reinforced Composite at 1 wt.% of SWCNT.

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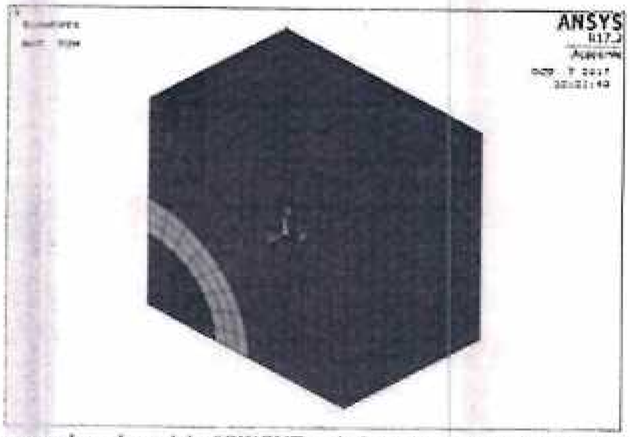

FIG.3 Converged mesh model of SWCNTs reinforced composite at 1 wt% of SWCNT.

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.

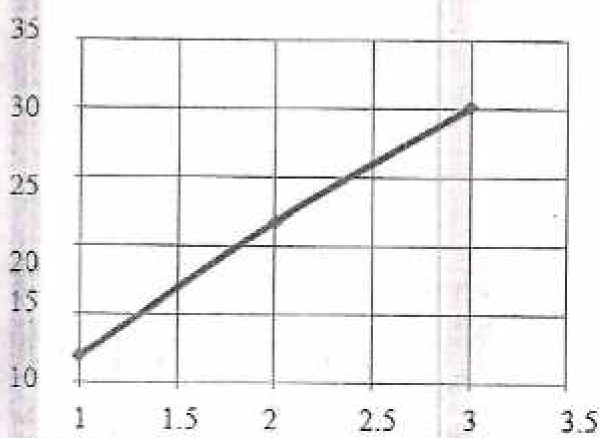

FIG 4. Young's Modulus (E) with respect to wt. % of CNT

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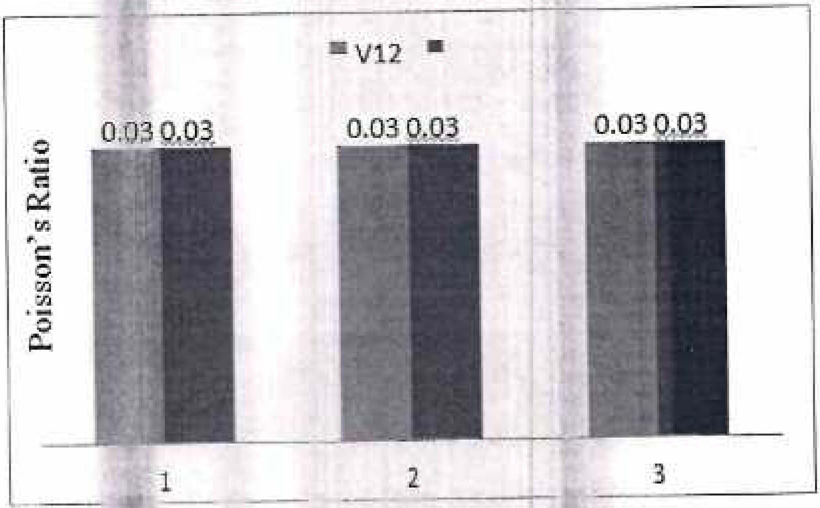

FIG5. Poisson's Ratio with respect to wt %of CNT Weight Percentage of SWCNT(in %)

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

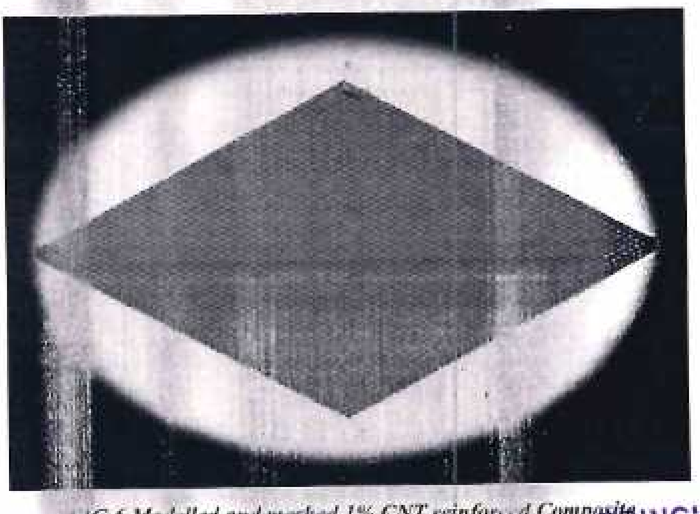

FIG 6.Modelled and meshed 1% CNT reinforced Composite

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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

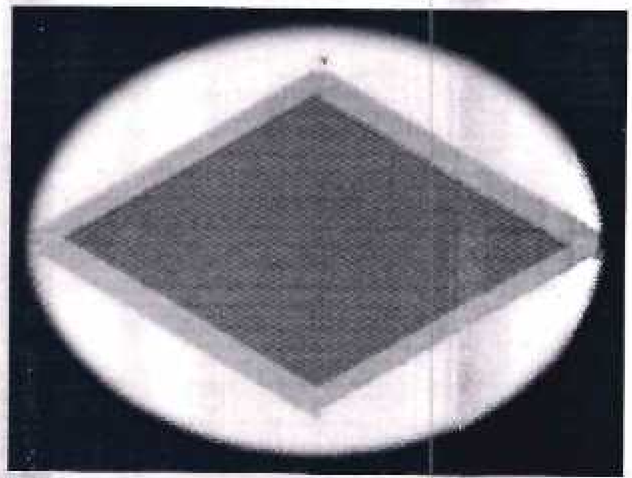

Fig 7.Loaded 1% CNT reinforced Composite

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.

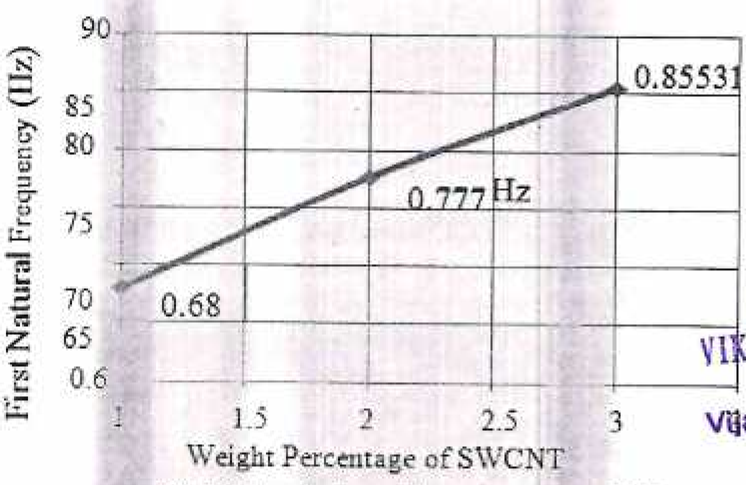

Fig 8.First mode shape with respect to wt. % of CNT

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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

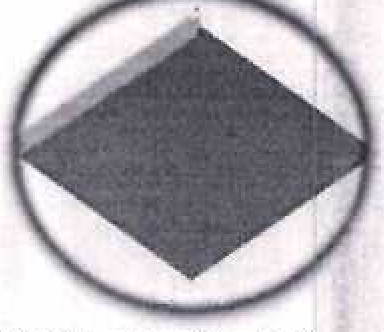

Fig 9.Cantileverend conditioned 1wt%composite

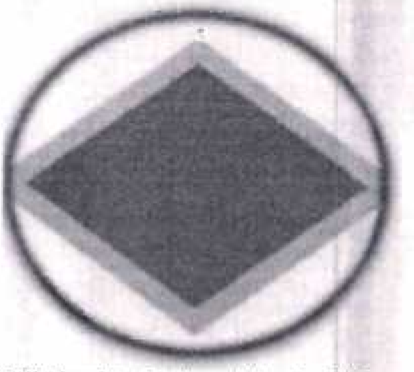

Fig 10.all edges fixed end condition 2 wt% Composite

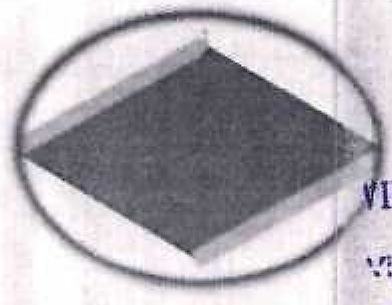

Fig 11.Two edges fixed 3wt% CNT composite

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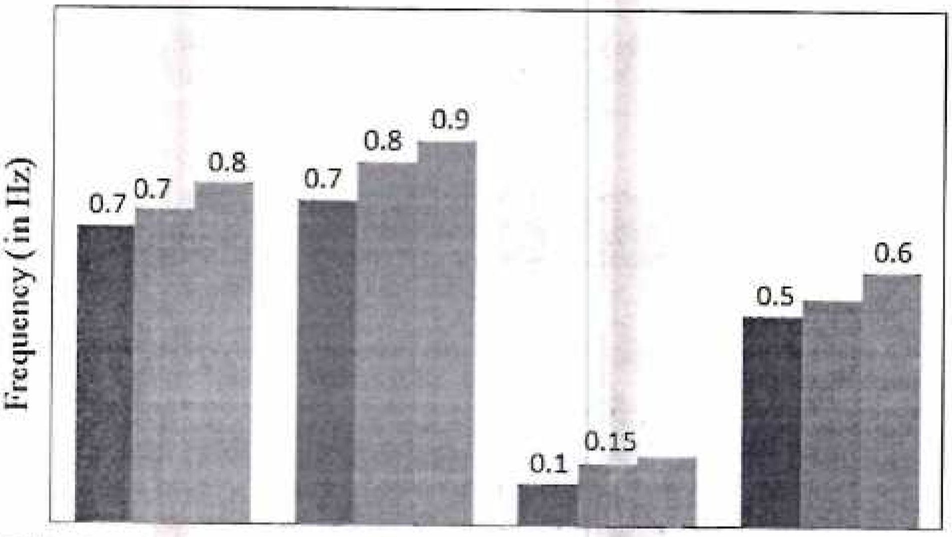
The simulation is done for all 3 different conditions and the results are compared along with the experimental end condition and the result can be seen in the Figure12.



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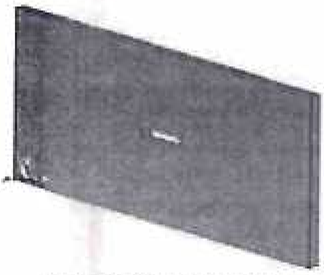

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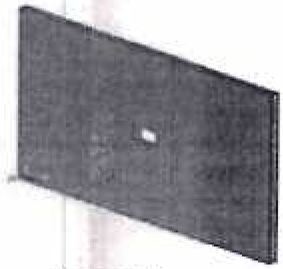

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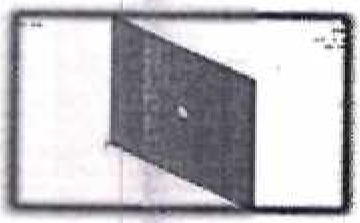

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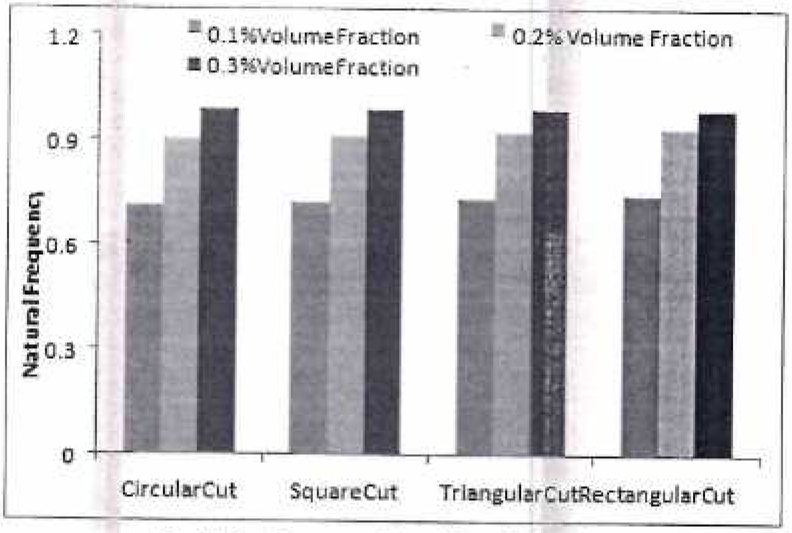

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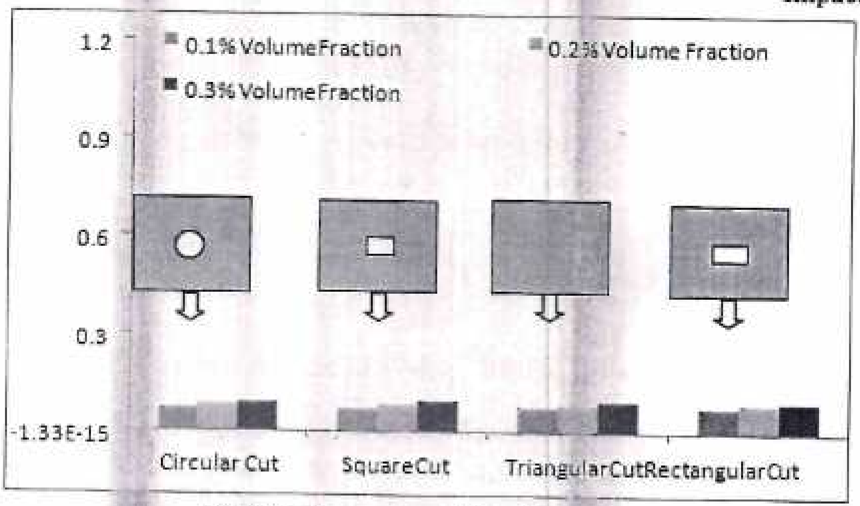

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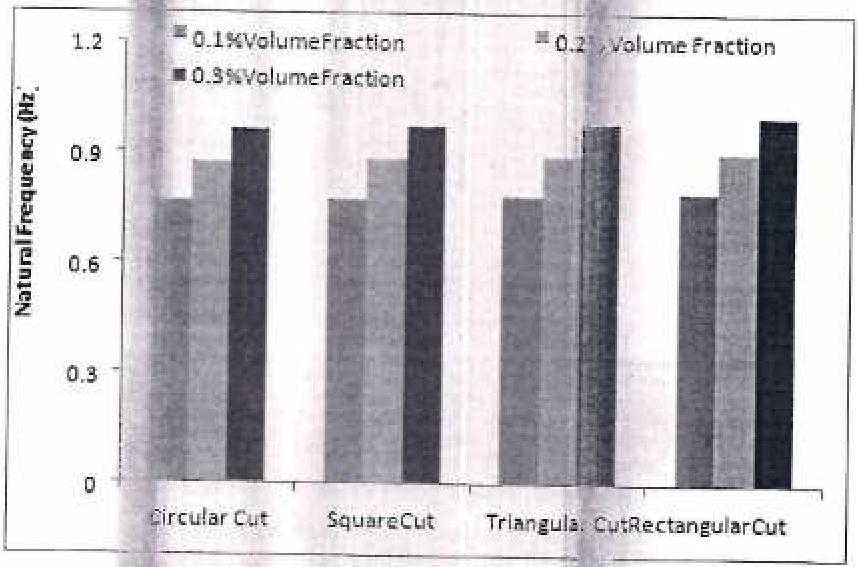

Fig 19.Two edges fixed result for all shaped cuts

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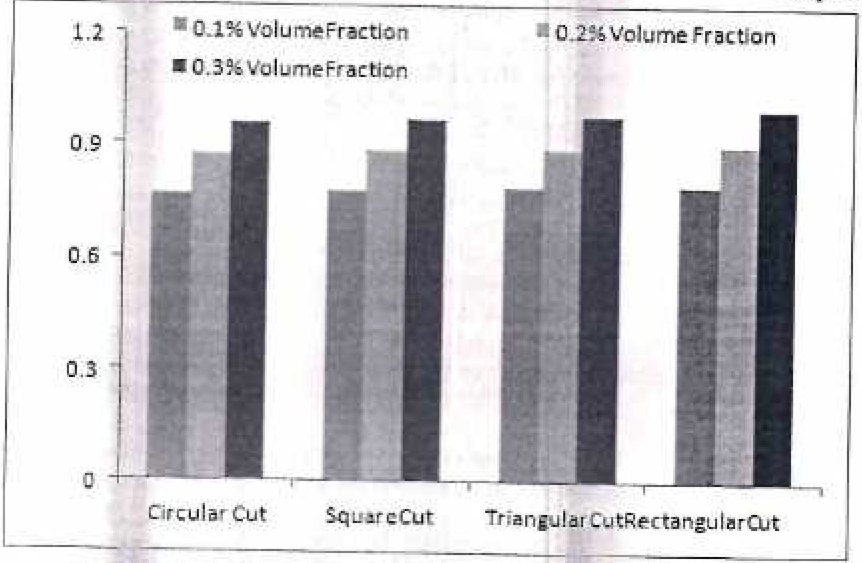

Fig 20. All end fixed result for all shaped cuts

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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

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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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ISSN 2348 – 8034
Impact Factor- 5.070

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

EXPERIMENTAL ANALYSIS OF DOUBLE PIPE HEAT EXCHANGER BY USING NANO – FLUIDS AL_2O_3& SIO_2

Sk.Subhani[1] & D.Gopi Chand[2]
[1&2]Assistant Professor, Department of Mechanical Engineering, Vikas Group Of Institutions, Nunna, Vijayawada, AP.

ABSTRACT

In this research work forced convection flows of Nano-fluids consisting of water with Nanoparticles $AL_2O_3$and SIO_2in a horizontal tube with constant wall temperature are investigated numerically. A single-phase model having two- dimensional equations is employed with either constant or temperature dependent properties to study the hydrodynamics and thermal behaviors of the Nano-fluid flow. The velocity and temperature vectors are presented in the entrance and fully developed region. The variations of the fluid temperature, local heat transfer coefficient and pressure drop along tube length are shown in the paper. Numerical results shows that the heat transfer enhancement due to presence of the Nanoparticles in the fluid in accordance with the results of the experimental study used for the validation process of the numerical model.

Keywords: *CSTR-PID-ZN-Fuzzy-MRAM-MATLAB.*

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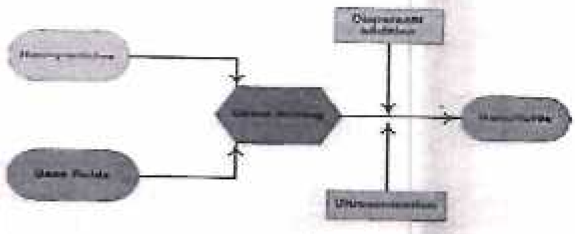

Fig 1.1.1 Two-Step Mixing Procedure Diagram of Nano- Fluid

Due to the difficulty in preparing stable Nano fluids by two-step method, several advanced techniques are developed to produce Nano fluids, in one-step method.

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1.2 One-Step Method

To reduce the agglomeration of Nanoparticles, Eastman et al. developed a one-step physical vapor condensation method to prepare (Al2O3+water and SiO2+water) Nano fluids. The one-step process consists of simultaneously making and dispersing the particles in the fluid. In this method, the processes of drying, storage, transportation, and dispersion of Nanoparticles are avoided, so the agglomeration of Nanoparticles are minimized, and the stability of fluids are increased. The one-step processes can prepare uniformly dispersed Nanoparticles, and the particles are suspended in the base fluid. The vacuum-SANSS (submerged arc Nanoparticle synthesis system) is another efficient method to prepare Nano fluids using different dielectric liquids. The different morphologies are mainly influenced and determined by various thermal conductivity properties of the dielectric liquids. The prepared Nanoparticles exhibit needle-like, polygonal, square, and circular morphological shapes. The method avoids the undesired particle aggregation fairly well. One-step physical method cannot synthesize Nano fluids in large scale, and the cost is also high, so the one-step chemical method is developing rapidly. Zhu et al. presented a novel one –step chemical method for preparing copper Nano fluids by reducing C u S O4· 5 H2O with N a H2P O2· H2O in ethylene glycol under microwave irradiation Well-dispersed and stably suspended copper Nano fluids were obtained. Mineral oil- based Nano fluids containing silver Nanoparticles with a narrow-size distribution were also prepared by this method the particles could be stabilized by Koran tin, which coordinated to the silver particle surfaces via two oxygen atoms forming a dense layer around the particles. The silver Nanoparticle suspensions were stable for about 1 month. Stable ethanol- based Nano fluids containing silver Nanoparticles could be prepared by microwave-assisted one-step method .In this method, polyvinylpyrrolidone (PVP) was employed as the stabilizer of colloidal silver and reducing agent for silver in solution. The cationic surfactant octadecylamine (ODA) is also an efficient phase-transfer agent to synthesize silver colloids the phase transfer of the

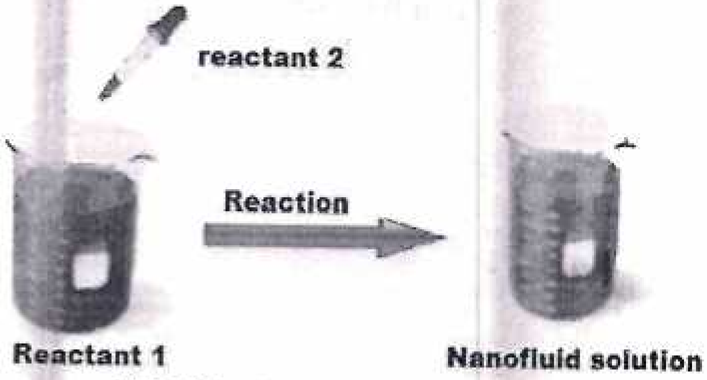

Fig1.1.2 One-Step mixing procedure of Nano-Fluid

silver Nanoparticles arises due to coupling of the silver Nanoparticles with the ODA molecules present in organic phase via either coordination bond formation or weak covalent interaction. Phase transfer method has been developed for preparing homogeneous and stable grapheme oxide colloids. Grapheme oxide Nano sheets (GONs) were successfully transferred from water to n-octane after modification by oleylamine.

II. EXPERIMENTAL WORK

Objective

To study the overall heat transfer co-efficient & effectiveness of the heat exchanger by using Nano fluids and making a comparison with base fluid as water at different flow rates.

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Introduction

Heat exchanger is a device in which heat is transferred from one fluid to another. The necessity for doing this arises in a multitude of industrial applications. Common examples of heat exchangers are the radiator of a car, the condenser at the back of a domestic refrigerator and the steam boiler of a thermal power plant.

Heat exchangers are classified in three categories:

- Transfer Type.
- Storage Type.
- Direct Contact Type

Theory

A transfer type of heat exchanger is one on which both fluids pass simultaneously through the device and heat is transferred through separating walls. In practice most of the heat exchangers used are transfer type.

The transfer type exchangers are further classified according to flow arrangement as

- Parallel flow in which fluids flow in the same direction.
- Counter flow in which fluids flow in the opposite direction.
- Cross flow in which they flow at right angles to each other.

A simple example of transfer type of heat exchanger in the form of a tube type arrangement in which one of the fluids are flowing through the inner tube and other through the annulus surroundings it. The heat transfer takes place across the walls of the inner tube.

Heat transfer rate, LMTD and overall heat transfer coefficient can be calculated as follows:

$$Q = M C_p (T_o - T_i)$$

$$\Delta T_m = \frac{\Delta T_o - \Delta T_i}{\ln \frac{\Delta T_o}{\Delta T_i}}$$

$$U = \frac{Q}{A \Delta T_m}$$

Where Q is amount of heat transfer, U is overall heat transfer coefficient and ΔT_m is log mean temperature difference. M, T_o, T_i are mass flow rate, outlet temperature and inlet temperature respectively. ΔT_o, ΔT_i outlet temperature difference, inlet temperature difference and heat transfer area respectively.

Fig3.3 Double pipe Heat Exchanger apparatus

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Description:
The apparatus consists of a concentric tube heat exchanger. The hot water flows through inner tube and cold water flows through outer tubes. Direction of cold fluid flow can be changed from parallel or counter to hot water so that unit can be operated as parallel or counter flow heat exchanger. For flow measurement Rota meters are provided. A magnetic drive pump is used to circulate the hot water from a recycled type water tank, which is fitted with heaters and digital temperature controller.

Required utilities:

- Electricity Supply: Single phase, 220 V AC, 50 Hz, 5-15 Amp combined socket with earth connection.
- Water Supply: Continuous 5 LPM at 1 Bar.
- Floor drain required.
- Bench area required: 1.75m × 0.5m.

Experimental procedure:

1. First switch ON the unit panel.
2. Start the flow of cold water through the annulus and run the exchanger as counter flow or parallel flow.
3. Switch ON the geyser provided on the panel & allow to flow through the inner tube by regulating the valve.
4. Adjust the flow rate of hot water and cold water by using valves.
5. keep the flow rate same till steady state conditions are reached.
6. Note down the temperatures on hot and cold water sides. Also note the Keep flow rate.
7. Repeat the experiment for different flow rates and for different temperatures.

Precautions & maintenance instructions:

- Never run the apparatus if power supply is less than 200 volts and more than 230 volts.
- Never switch ON mains power supply before ensuring that all the ON/OFF switches given on the panel are at OFF position.
- Operator selectors switch OFF temperature indicator gently.
- Always keep the apparatus free from dust.

Heat exchanger
Heat exchanger is nothing but a device which transfers the energy from a hot fluid medium to a cold fluid medium with maximum rate, minimum investment and low running costs.

About heat exchanger
The heat transfer in a heat exchanger involves convection on each side of fluid and conduction taking place through the wall which is separating the two fluids. In a heat exchanger, the temperature of fluid keeps on changing as it passes through the tubes and also the temperature of the dividing wall located between the fluids varies along the length of heat exchanger.

Examples:

- Boilers, super heaters, re-heaters, air preheaters.
- Radiators of an automobile.
- Oil coolers of heat engine.
- Refrigeration of gas turbine power plant.
- In waste heat recovery system.

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Types:

Based on contact

1. Direct contact type of heat exchanger,
2. Non-contact type of heat exchanger.

Based on direction of flow

Direction of motion of fluid:

1. Parallel flow,
2. Counter flow
3. Mixed flow.

III. RESULTS AND DISCUSSION

3.1 Result: comparison between Nano fluids (Al_2O_3+water and SiO_2+water) and water

Table 6.1 comparison between Nano fluids (Al_2O_3+water and SiO_2+water) and water

Flow rate kg/sec	Overall heat transfer coefficient W/m^2-K	Water		Al_2O_3 (0.2% volume concentration)		SiO2 (0.2% volume concentration)	
		Parallel	counter	Parallel	counter	Parallel	counter
45	U_o	571.50	750.53	656.542	843.57	679.45	820.12
95	U_o	1185.56	1556.02	1400.50	1730.657	1436.23	1820.23

From the above results which we have obtained shows that the heat transfer rate and overall heat transfer co-efficient increases by using Nano fluids

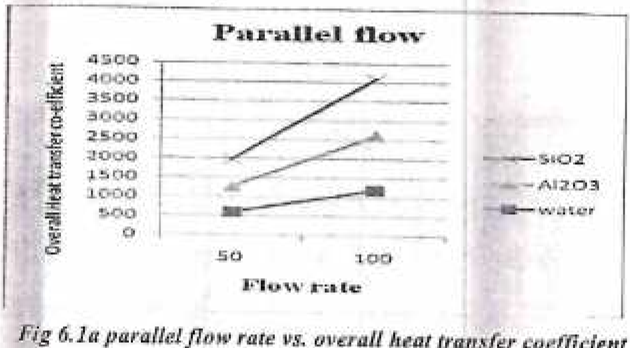

Fig 6.1a parallel flow rate vs. overall heat transfer coefficient

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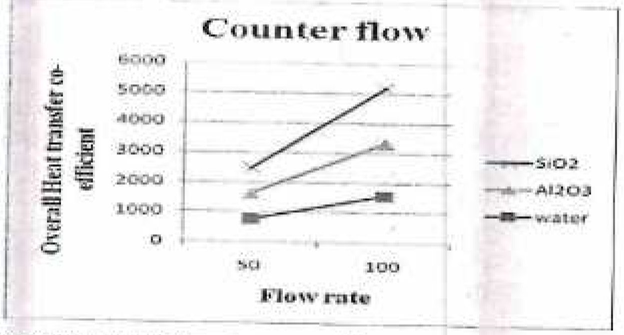

Fig 6.1b counter flow rate vs. overall heat transfer co- efficient

IV. CONCLUSION

From the above experimental analysis we are going to say that by using Nano fluids in the heat exchangers we can improve the overall heat transfer co-efficient due to the thermal properties of Nano powders. so that the efficiency of the heat exchanger can be increased.

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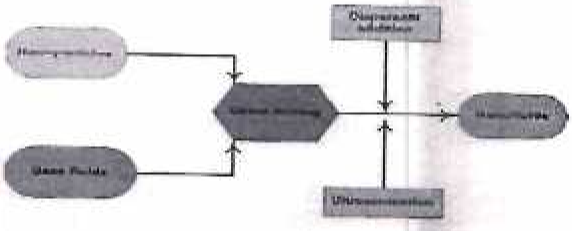

Fig 1.1.1 Two-Step Mixing Procedure Diagram of Nano- Fluid

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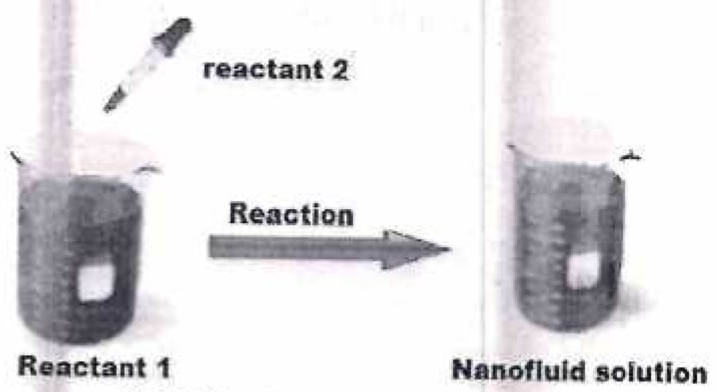

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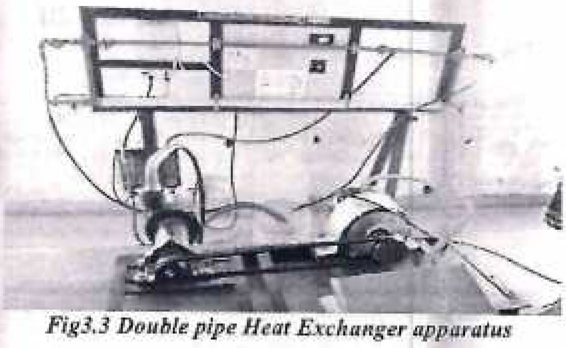

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Based on direction of flow
Direction of motion of fluid:
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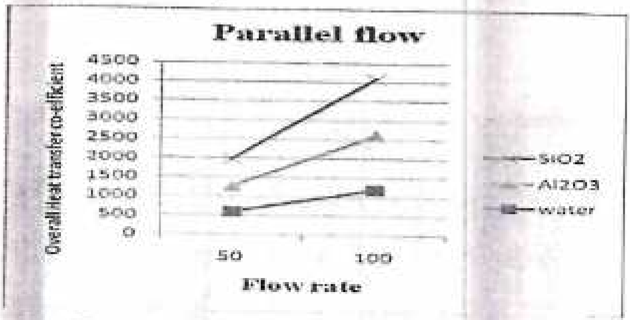

Fig 6.1a parallel flow rate vs. overall heat transfer coefficient

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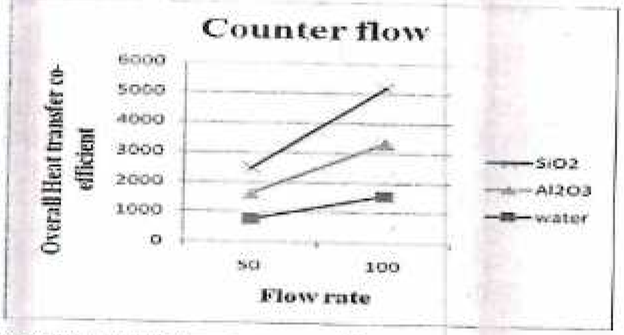

Fig 6.1b counter flow rate vs. overall heat transfer co- efficient

IV. CONCLUSION

From the above experimental analysis we are going to say that by using Nano fluids in the heat exchangers we can improve the overall heat transfer co-efficient due to the thermal properties of Nano powders. so that the efficiency of the heat exchanger can be increased.

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GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

ANALYSIS OF MONO LEAF SPRING

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[1&2]Assistant Professor, Department of Mechanical Engineering, Vikas Group Of Institutions, Nunna, Vijayawada, AP

ABSTRACT

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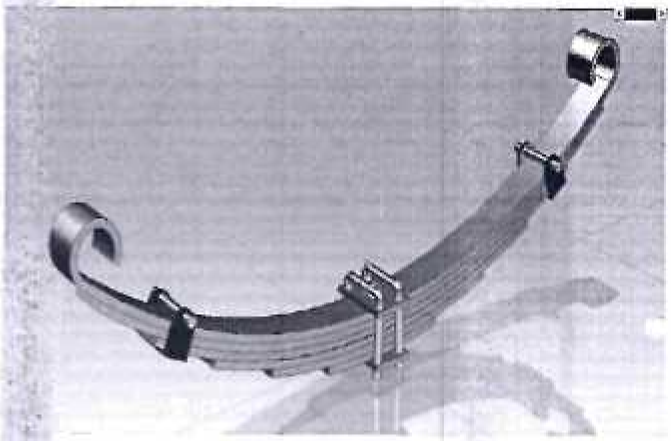

Figure 1: Leaf Spring

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Spring eyes for heavy vehicles are usually bushed with phosphor bronze bushes. However, for cars and light transport vehicles like vans, the use of rubber has also become a common practice. This obviates the necessity of lubrication as in the case of bronze bushes. The rubber bushes are quiet in operation and also the wear on pin or the bush is negligible. Moreover, they allow for slight assembly misalignment, "Silentbloc' is an example of this type of bushes. Fatigue strength and hence the life of spring can be increased by shot – peening the top surface of each leaf, which introduces a compressive residual stress, rounding the edges of the leaves also avoids stress concentration, thereby improving the fatigue strength. When the leaf spring deflects, the upper side of each leaf tips slides or rubs against the lower side of the leaf above it. This produces some damping which reduces spring vibrations, but since this available damping may change with time, it is preferred not to avail of the same. Moreover, it produces squeaking sound, Further if moisture is also present, such inter-leaf friction will cause fretting corrosion which decreases the fatigue strength of the spring, and phosphate paint may reduce this problem fairly. Occasionally, thin liners of zinc or any other soft metal are also help to keep the value of the friction coefficient constant. In some springs special inserts are provided at the end of each leaf, excepting however the master leaf. The material for the inserts may be rubber or waxed cloth, or even some soft bearing metal impregnated with oil. This gives efficient spring operation. Sometimes the leaf springs are provided with metallic or fabric covers to exclude dirt. The covers also serve to contain the lubricant used in between the spring leaves. The leaves of the leaf spring require lubricant at periodic intervals. If not, the vehicle is jacked up so that the weight of the axle opens up the leaves. The spring is then cleaned thoroughly and sprayed with graphite penetrating oil However, it is important to remember that in some vehicles, (e.g. Ambassador) it is specified that the lubricant of spring leaves should not be done. In such cases the instruction must be followed. The lubrication of shackle pins at regular intervals, say 1000km, should also be done with S.A.E 140 oil. However, no lubrication is required when rubber bushes are used, as in case of the Hindustan Ambassador car.

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Number of Graduated Length Leaves Ng = 1
Width = 70mm

Model is created witth Pro-e

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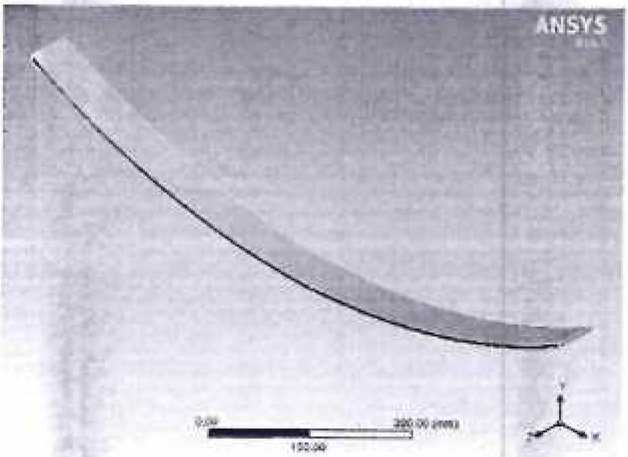
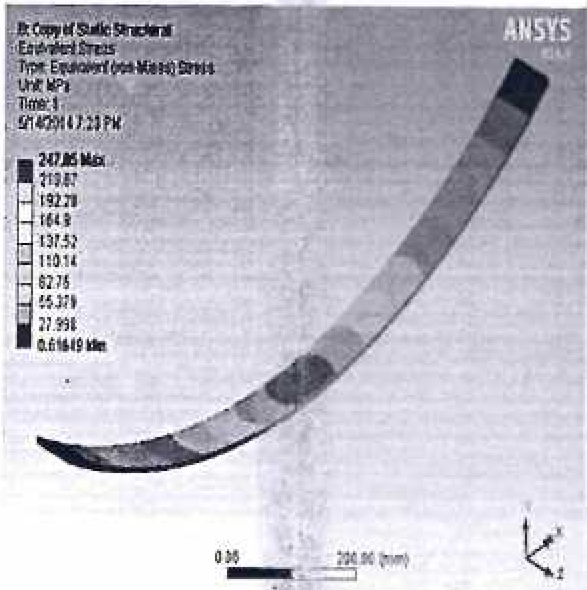
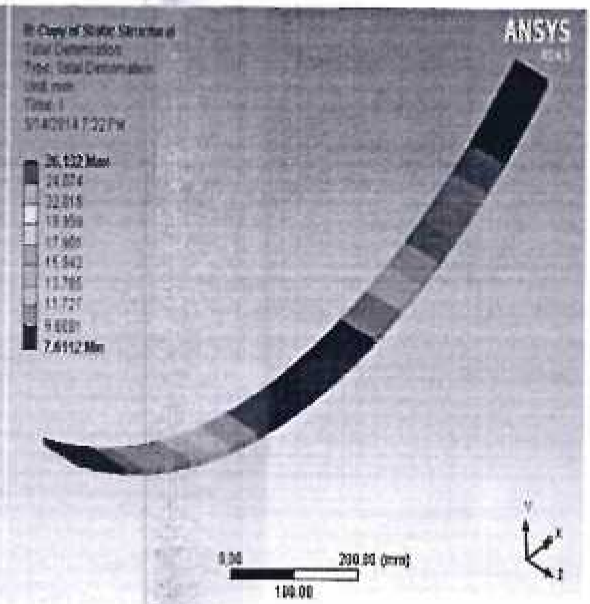


Fig 2 leaf with dimensions

III. ANALYSIS OF MONO LEAF (STEEL) WORK BENCH

A point Load of 1000N is applied at centre





Analytical Calculations

Bending stress = (6 F.L) / b.t2 = 309.91 N/mm2

Deflection δ = 4F.L3 / Ebt3 = 22.34 mm

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Parameter	Analytical	FEA	Difference
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Bending Stress (N/mm2)	309.12	247.05	20.03 %

IV. COMPOSITE MATERIALS

Composite materials (also called **composition materials** or shortened to **composites**) are materials made from two or more constituent materials with significantly different physical or chemical properties, that when combined, produce a material with characteristics different from the individual components. The individual components remain separate and distinct Material Properties are shown below for both within the finished structure. The new material may be preferred for many reasons: common examples include materials which are stronger, lighter or less expensive when compared to traditional material for The Analysis E- Glass Epoxy and Carbon Epoxyls are considered. And Divided the Leaf into Ten Layers By using Ansys Classic- 13

Property	E-Glass Epoxy	Carbon Epoxy
Exy	34000 MPa	147 GPa
Eyz=Ezx	6530 Mpa	10.3 GPa
μxy & μxz	0.217	0.27
μyz	0.366	0.54
G1,2 & G1,3	2433 Mpa	7 Gpa
G2,3	1698 MPa	3.7 GPa

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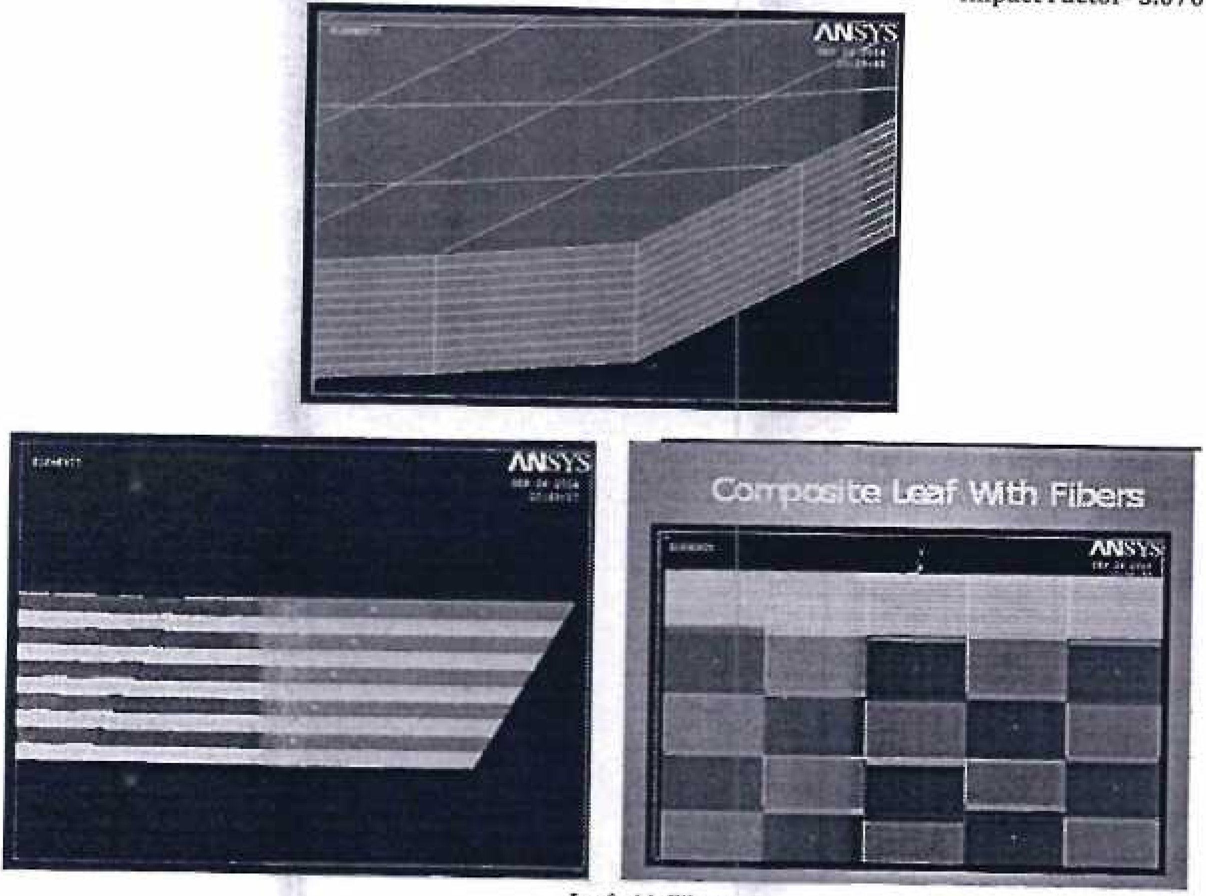
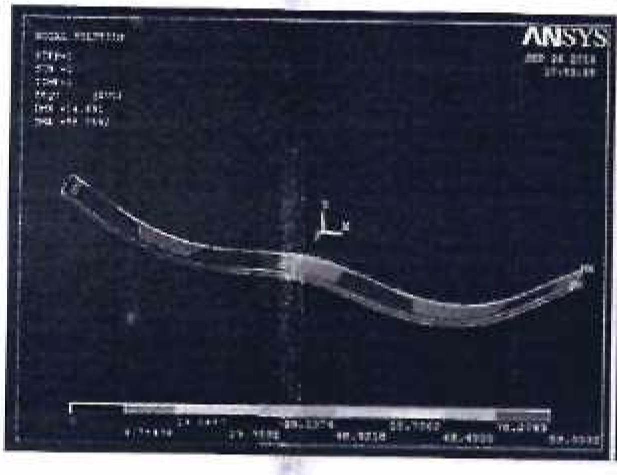
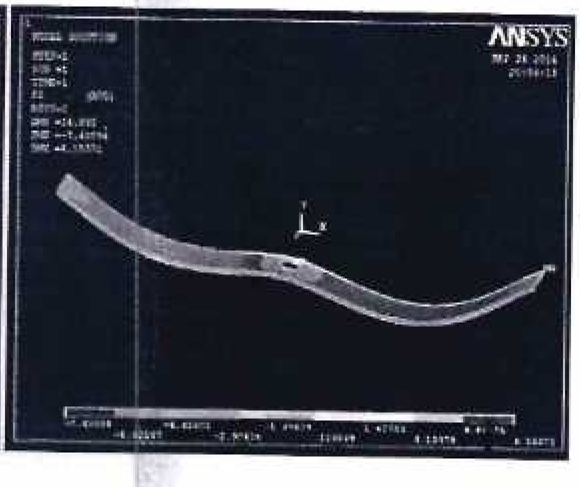


Leaf with Fibers

V. ANALYSIS OF MONO LEAF (E-GLASS EPOXY)

VON MISES STRESS STRESSZ-COMPONENT





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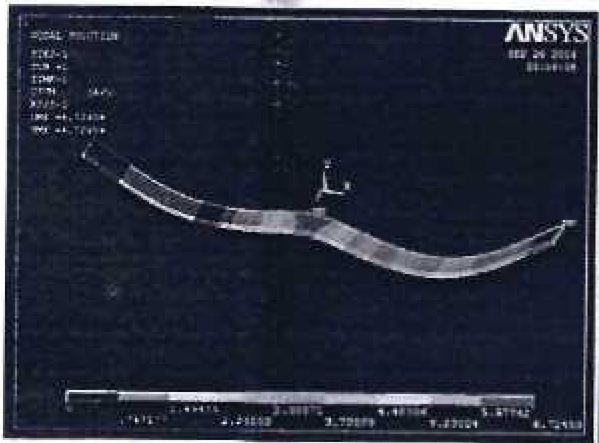
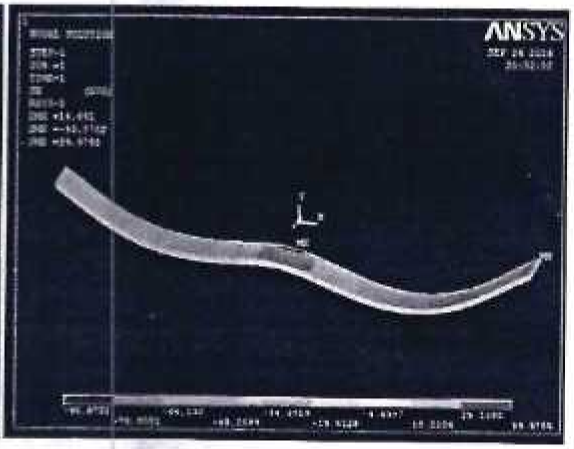


STRESS X-DIRECTION



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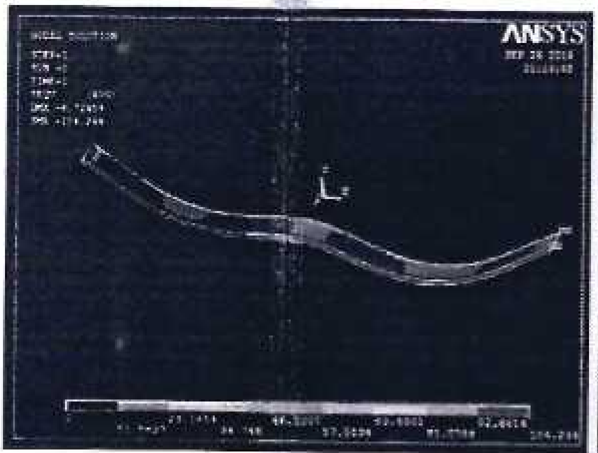
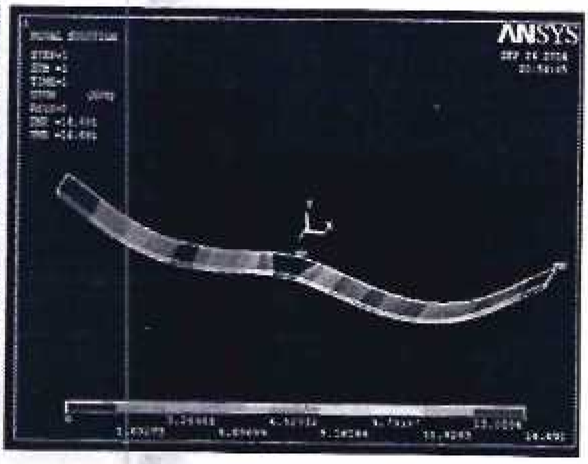


VON MISES STRESS



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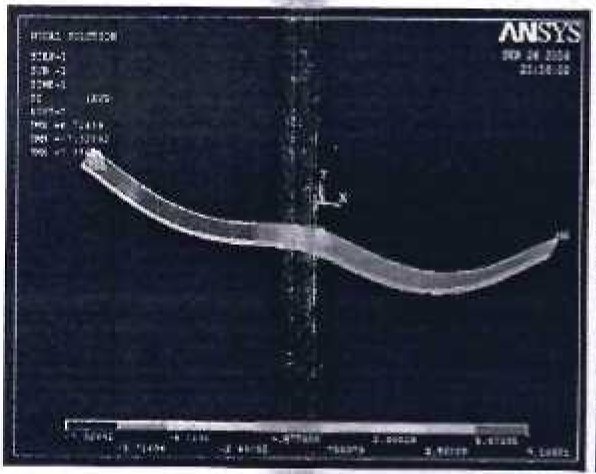
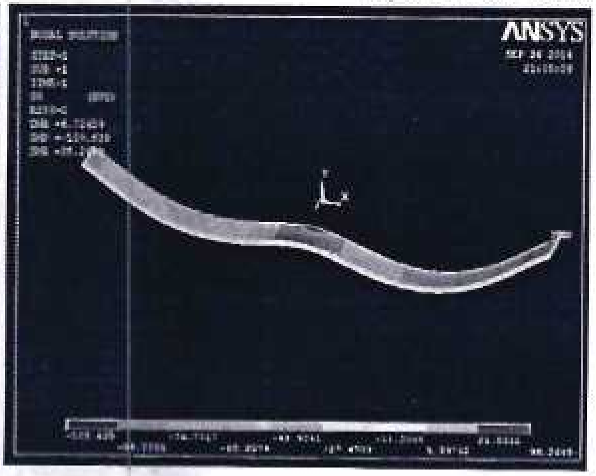


STRESS –Z COMPONENT



STRESS –X COMPONENT

Tabular form of results

COMPOSITE MATERIAL	X-Component Stress (N/mm^2)	Z-Component Stress (N/mm^2)	Deflection (mm)	Von Mises Stress (N/mm^2)
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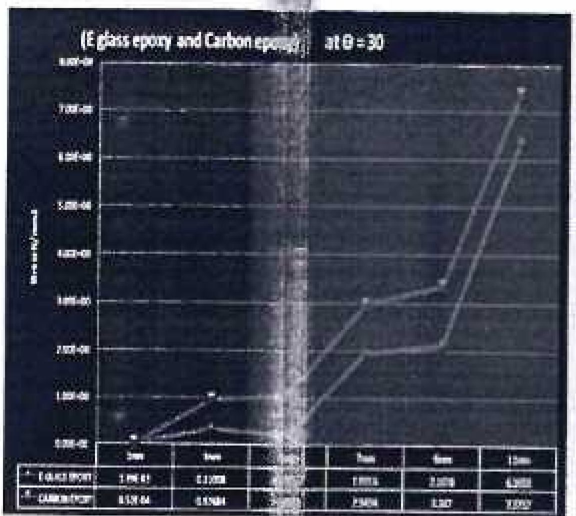

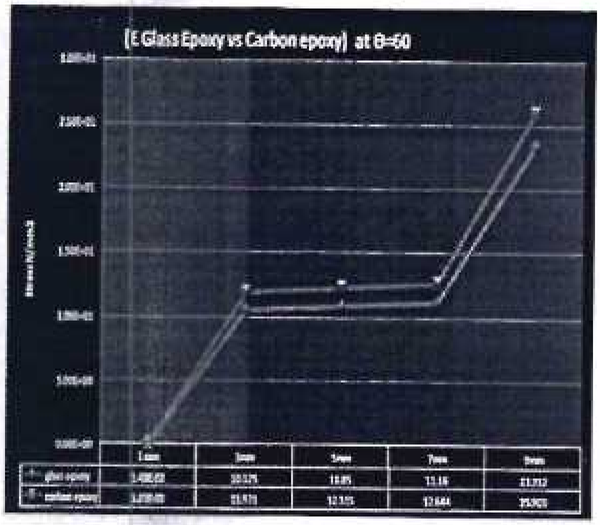

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ANALYSIS OF MONO LEAF SPRING

G.P.V.P.Ranga Rao[1] & G.Vijay Kumar[2]
[1&2]Assistant Professor, Department of Mechanical Engineering, Vikas Group Of Institutions, Nunna, Vijayawada, AP

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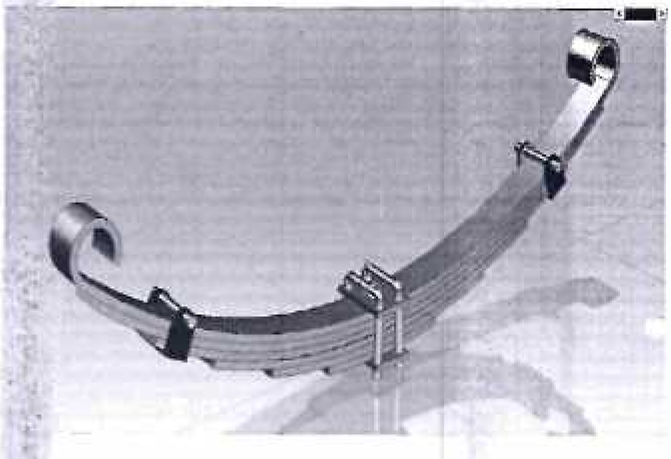

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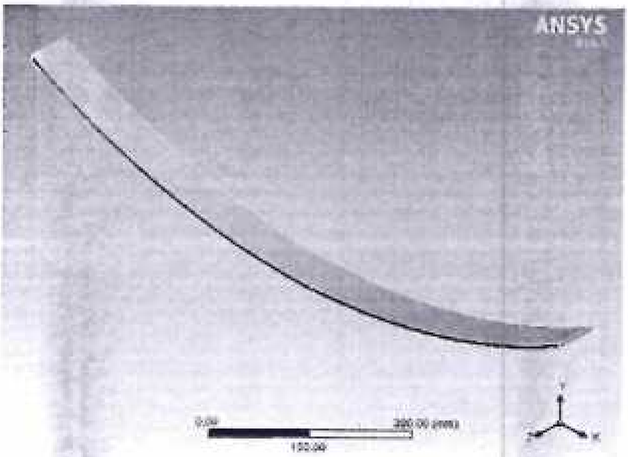

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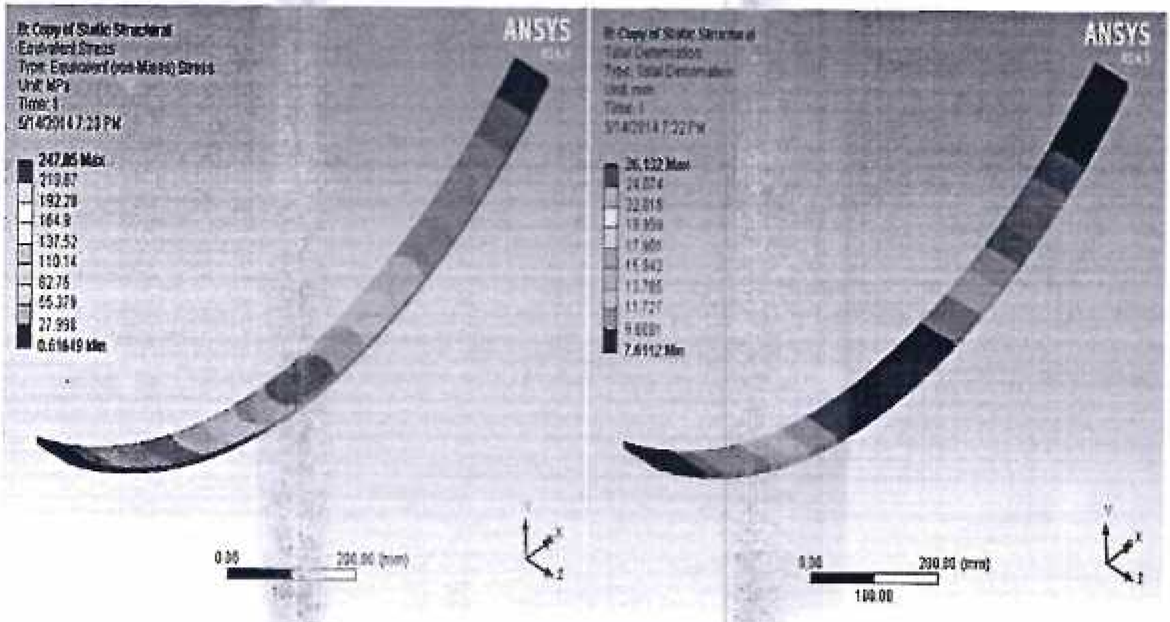

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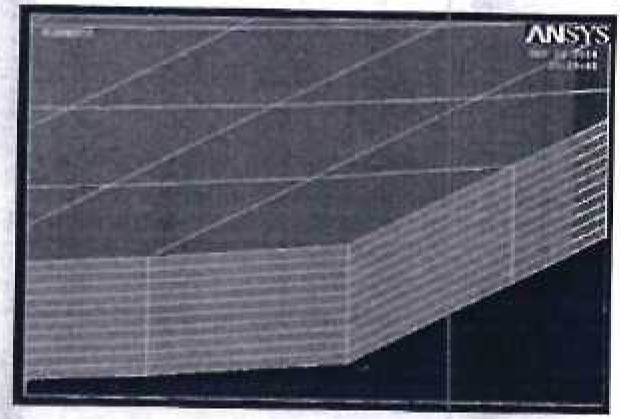
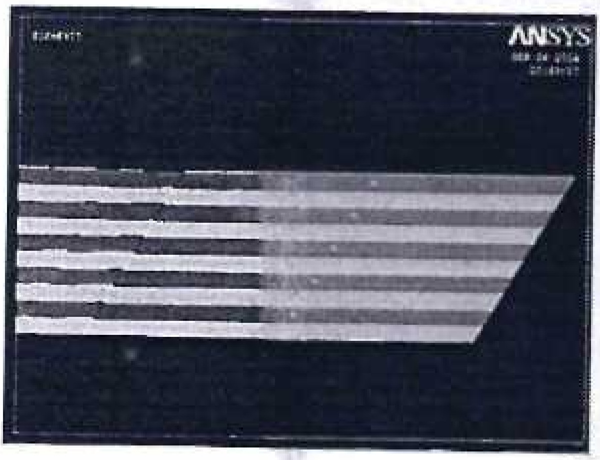
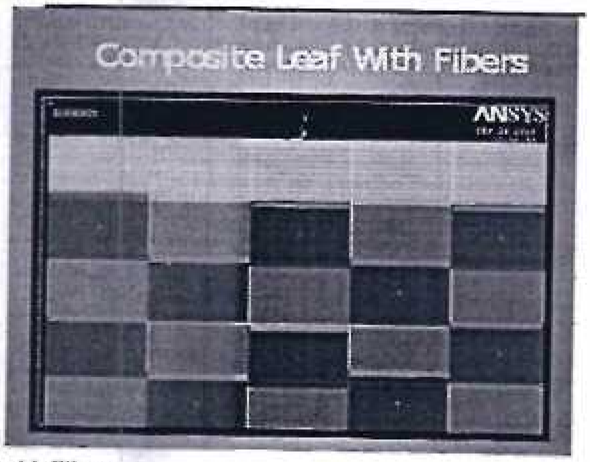


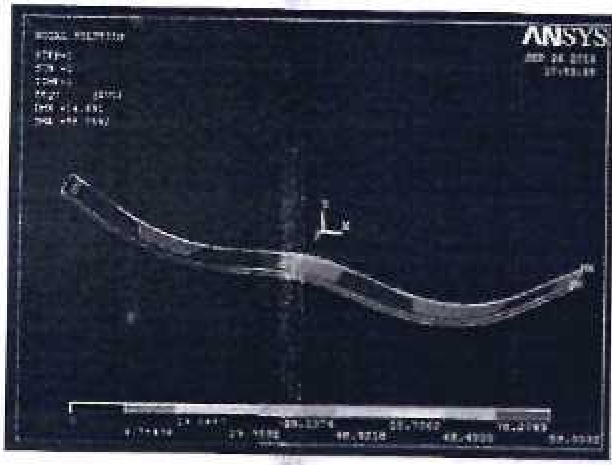


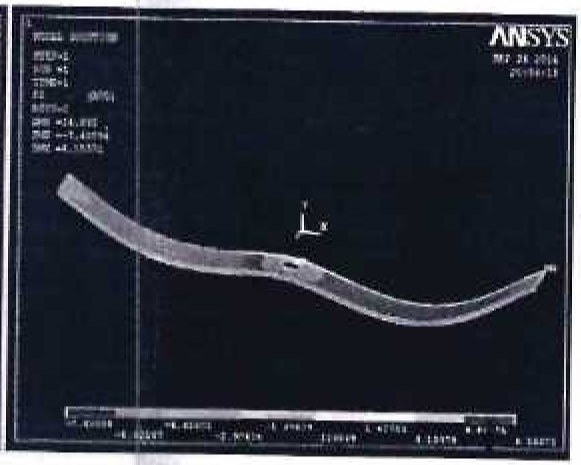


Leaf with Fibers

V. ANALYSIS OF MONO LEAF (E-GLASS EPOXY)

VON MISES STRESS　　STRESSZ-COMPONENT





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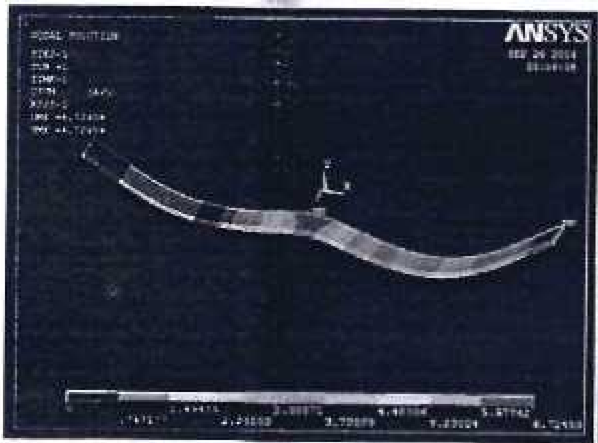
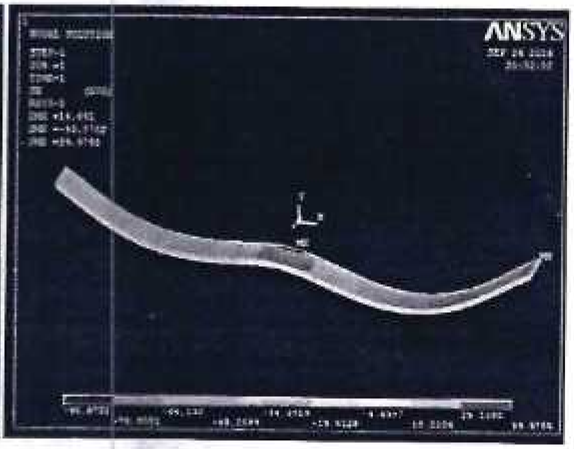


STRESS X-DIRECTION



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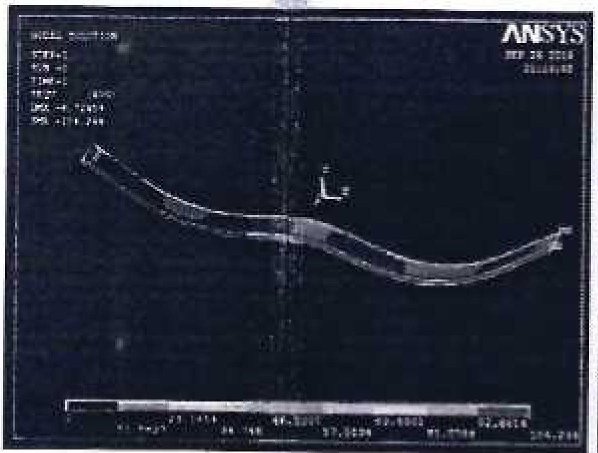
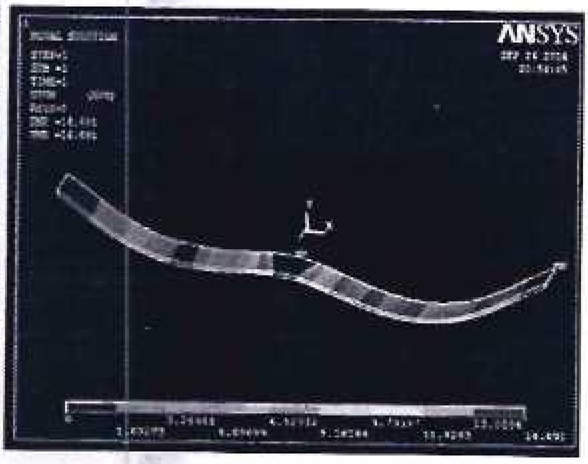


VON MISES STRESS



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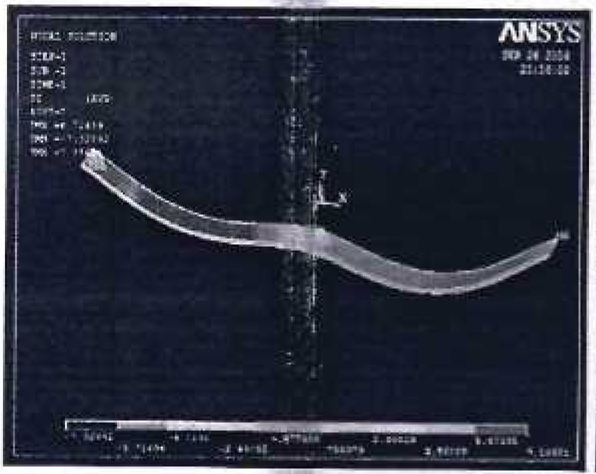
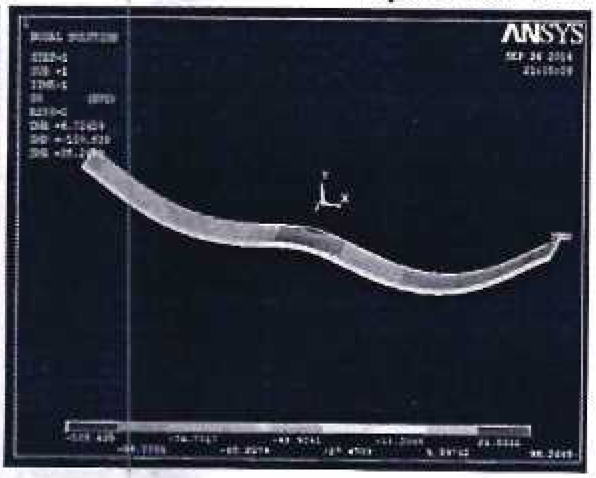


STRESS - Z COMPONENT



STRESS - X COMPONENT

Tabular form of results

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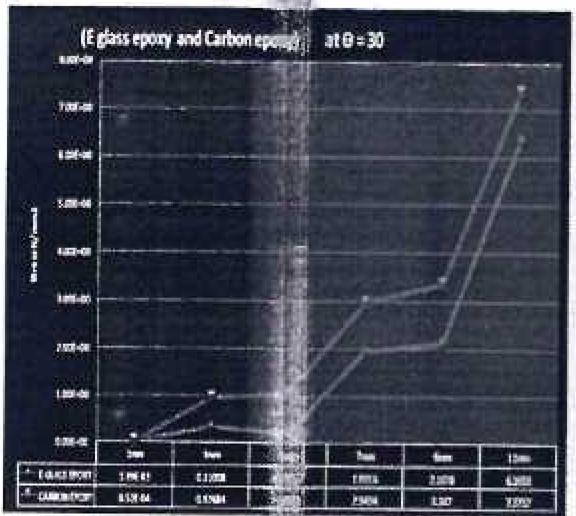

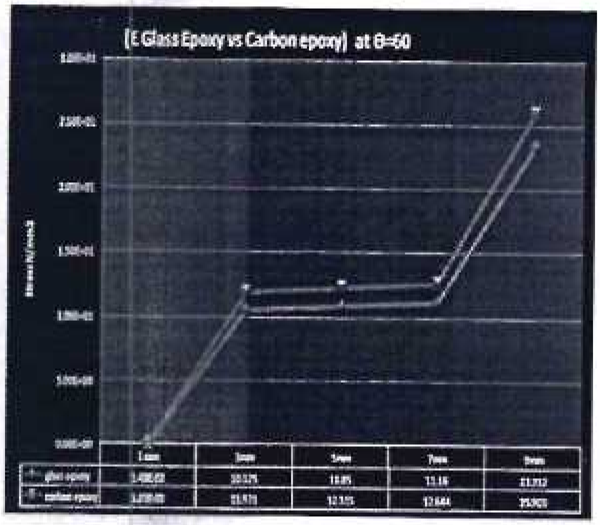

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