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Design and Experimental Investigation on Tensile Strength Properties Using Different Forms of Layers for Epoxy Materials

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ABSTRACT

In aeronautical, marine and automobile industries the use of composites has increased due to their high stiffness and strength-to-weight ratios long fatigue life, resistance to electrochemical corrosion and other superior material properties of composites. In this paper, the experiments of vibrational analysis are carried out using Kevlar. Samples of Kevlar composites of different layers are used in this research. composites are truly materials of future, composites will help in developing components with better fatigue life and strength also these composite components can be tailor made to match the exact requirement. In this work we are developing and studying the behaviours of two different composites (regular and hybrid), hybrid composites are those which have multiple fiber reinforced lamina in their laminate. Configurations of the composites are as follows

E-glass/epoxy$(0)_3$, E-glass/epoxy$(0)_5$, E-glass-Kevlar/epoxy$(0)_3$, E-glass-Kevlar/epoxy$(0)_5$, E-glass/epoxy$(0)_3$(2mm – 2nd layer thickness), E-glass/epoxy$(0)_5$(2mm – 2nd & 4th layer thickness), E-glass-Kevlar/epoxy$(0)_3$(2mm – 2nd layer thickness), E-glass-Kevlar/epoxy$(0)_5$(2mm – 2nd & 4th layer thickness) in hybrid composite specimens reinforcement is changed in alternative layers.

INTRODUCTION

A composite material is composed of two or more materials and holds the properties which could not have been attained from any of its principal materials. In such materials the main load bearing supporters are the fibers. The matrix has low modulus and high elongation and it delivers elasticity to the structure keeps the fibers in situation and protects them from the exterior forces of the atmosphere.

Composites have wide use in mechanical and aerospace applications due to their high specific stiffness and high specific strength. Fiber-reinforced composites usually exist in the form of thin plates. They are most of the time subjected to compressive loads which when it reaches critical buckling load has a possibility of failure. Hence the buckling behavior of the composites has been a major concern.

Laminated composite plates are made up of plates consisting of layers bonded together and made up of materials chemically different from each other but combined macroscopically. These have an application in aircrafts, railway coaches, bridges et cetera because they are easy to handle, have got improved properties and the cost of their fabrication is low. But their failure can lead to catastrophic disasters. And generally the failure of these structures is due to the combined effect of excessive stresses on it and buckling. Hence the buckling behavior of these kinds of plates should be analyzed properly.

IMPORTANCE OF PRESENT STUDY

Composite materials have extensive application in mechanical, aerospace, biomedical engineering fields because it is easy to handle, has got good mechanical properties and the cost of its manufacture is also low. The failure of composites is usually due to buckling. Cut outs are often required in structural mechanisms due to functional necessities, and to produce lighter and more effectual structures. Most immovability studies of composite plates have focused on square plates under simply reinforced conditions to minimize the scientific formulations.

LITERATURE REVIEW

Laminated composites are used generally as thin plates, and under compressive load the load carrying capacity is investigated by most of the researchers. Thus far, there has been research on the laminated structures which find applications in aerospace, biomedical, civil, and marine and mechanical engineering because of the improved properties they have and its cost-effectiveness and because of the ease with which they can be handled.

Hu and Lin in 1995 studied the buckling resistance of symmetrically laminated plates with a given material system and subjected to uniaxial compression. The research was done with plates having different plate thicknesses, aspect ratios, central circular cutouts and different end conditions. Due to these variations, the optimal fiber orientations and the associated optimal buckling loads of symmetrically laminated plates were investigated.

Due to the importance of buckling analysis of composite structures in various industrial applications, a comparative study of buckling behaviours of composite plates was done by Darvizeh et al in 2004. Mathematical modelling developed in this work for generally laminated plates was based on generalized differential quadrature rule (GDQR) and Rayleigh Ritz method. The buckling load was analyzed using both the methods and then compared. The comparison shown in form of tables showed the efficiency of GDQR.

The influence of boundary conditions on the buckling load for rectangular plates of various cutout shape, length/thickness ratio, and ply orientation was examined by Baba in 2007. Boundary conditions considered were clamped, pinned and their various combinations. The plates were subjected to in-plane compression load. The results of experimentation were validated using numerical analysis by ANSYS.

An exact solution for buckling of simply supported symmetrical cross-ply composite rectangular plates under a linearly varying boundary load was presented by Zhong and Gu in 2007. It was developed based on the first-order shear deformation theory for moderately thick laminated plates. Buckling loads of cross-ply rectangular plates with various aspect ratios were obtained and the effects of load intensity variation and layup configuration on the buckling load were also investigated. The results were verified using the computer code ABAQUS.

Qablan et al in 2009 evaluated the effect of cut out size, cutout location, fiber orientation angle and type of loading on the buckling load of square cross-ply laminated plates with circular cut outs. Three types of in-plane loading were considered; namely,

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uniaxial compression, biaxial compression and shear loading.

Komur et al in 2010 carried out a numerical buckling analysis on a woven–glass–polyester laminated composite plate with a circular/elliptical hole. The laminated composite plates were arranged as symmetric cross-ply [(0_/90_) 2] s and angle ply [(15_/_75_) 2] s, [(30_/_60_) 2] s, [(45_/_45_) 2] s. Finite element method (FEM) was applied to perform research on various plates based on the shape and position of the elliptical hole.

Gaira et al in 2012 worked out the buckling load factors for laminated composites with different aspect ratio, d/b ratio and d/D ratio. They found that the presence of cut-outs lowered the buckling load factors. Also the factor increased with increase of aspect ratio up to 1.11. The load was inversely proportional to d/b ratio up to 0.15 and also inversely proportional to d/D ratio up to 0.25.

RECTANGULAR PLATE WITH 3 LAYERS OF E GLASS EPOXIES EACH 1MM THICKNESS:

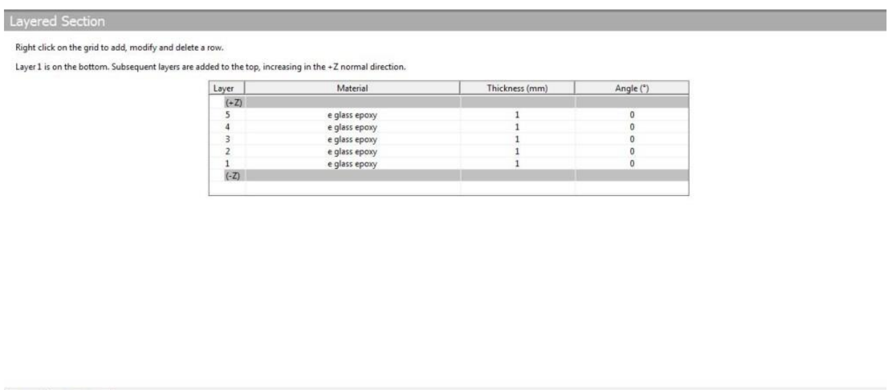
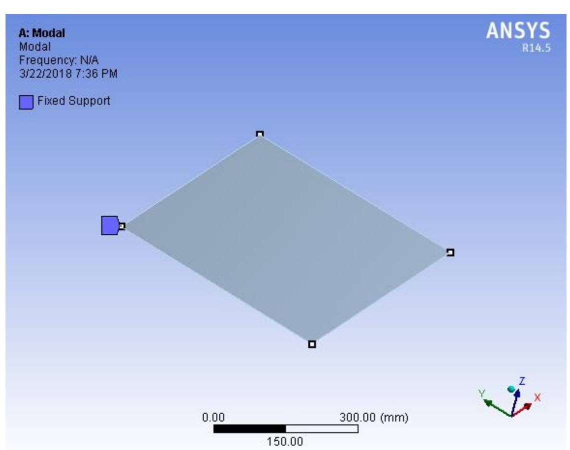
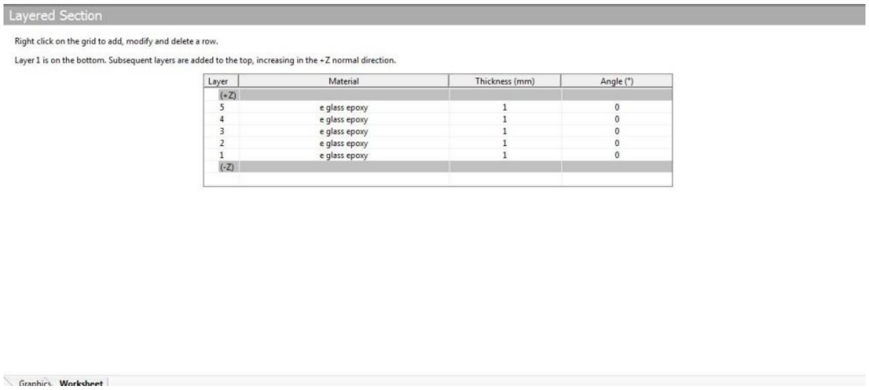


Figure: Layering with e glass Epoxy as material

Boundary conditions



RECTANGULAR PLATES WITH 5 LAYERS E GLASS EPOXY EACH LAYER AS 1MM THICKNESS: LAYERED SECTION


Layered Section

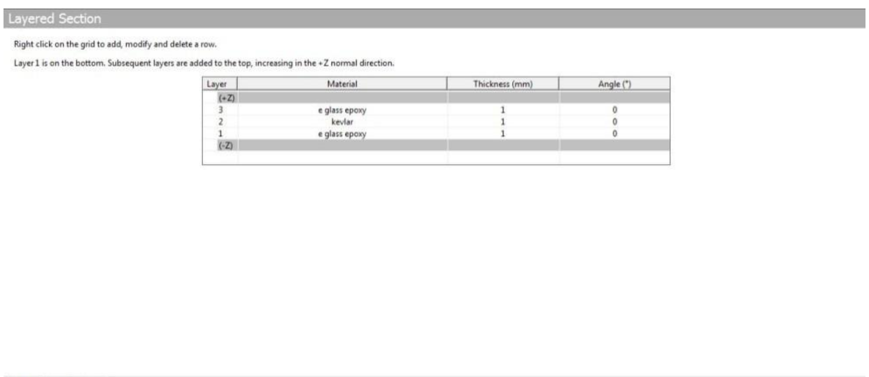
Right click on the grid to add, modify and delete a row.

Layer 1 is on the bottom. Subsequent layers are added to the top, increasing in the +Z normal direction.

Layer	Material	Thickness (mm)	Angle (°)
(+Z)			
5	e glass epoxy	1	0
4	e glass epoxy	1	0
3	e glass epoxy	1	0
2	e glass epoxy	1	0
1	e glass epoxy	1	0
(-Z)			

Graphics Worksheet

RECTANGULAR PLATE WITH 3 LAYERS E GLASS EPOXY + KEVLAR + E GLASS EPOXY EACH 1MM THICKNESS: LAYERED SECTION


Layered Section

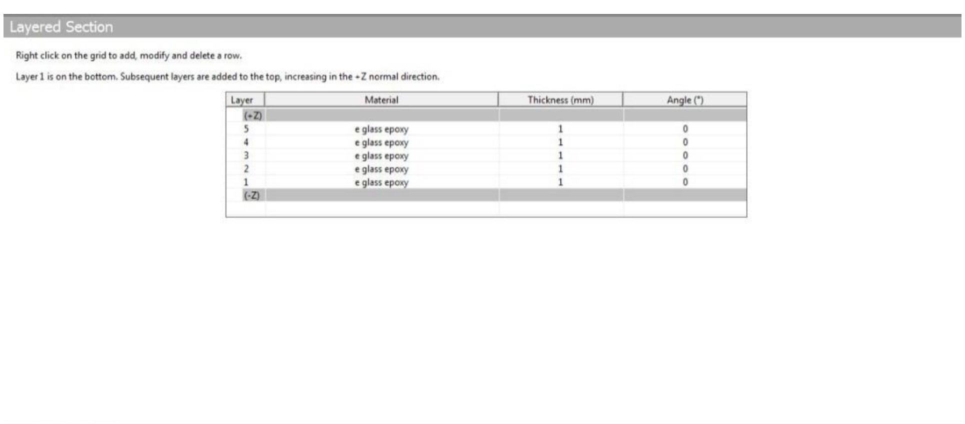
Right click on the grid to add, modify and delete a row.

Layer 1 is on the bottom. Subsequent layers are added to the top, increasing in the +Z normal direction.

Layer	Material	Thickness (mm)	Angle (°)
(+Z)			
3	e glass epoxy	1	0
2	kevlar	1	0
1	e glass epoxy	1	0
(-Z)			

Graphics Worksheet

RECTANGULAR PLATE WITH 5 LAYERS E GLASS EPOXY + KEVLAR + E GLASS EPOXY + KEVLAR + E GLASS EPOXY EACH 1MMTHICKNESS: LAYERED SECTION


Layered Section

Right click on the grid to add, modify and delete a row.

Layer 1 is on the bottom. Subsequent layers are added to the top, increasing in the +Z normal direction.

Layer	Material	Thickness (mm)	Angle (°)
(+Z)			
5	e glass epoxy	1	0
4	e glass epoxy	1	0
3	e glass epoxy	1	0
2	e glass epoxy	1	0
1	e glass epoxy	1	0
(-Z)			

Graphics Worksheet

RECTANGULAR PLATE WITH 3 LAYERS AS E GLASS EPOXY AS (1 + 2 + 1MM) THICKNESSES: LAYERED SECTION

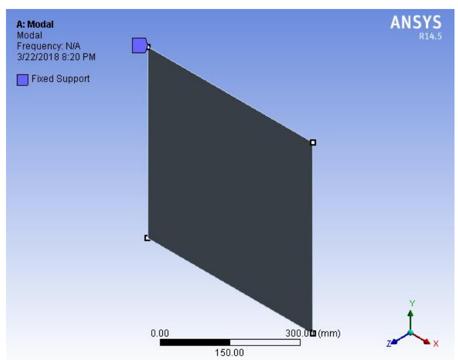
Layered Section

Right click on the grid to add, modify and delete a row.

Layer 1 is on the bottom. Subsequent layers are added to the top, increasing in the +Z normal direction.

Layer	Material	Thickness (mm)	Angle (°)
(+Z)			
3	e glass epoxy	1	0
2	e glass epoxy	2	0
1	e glass epoxy	1	0
(-Z)			

RECTANGULAR PLATE WITH 5 LAYERS E GLASS EPOXY AS 1 MM AND ALTERNATE LAYER 2 AND 4TH LAYER AS 2MM THICKNESS (1 + 2 + 1MM) THICKNESS BOUNDARY CONDITIONS



RECTANGULAR PLATE WITH 3 LAYERS E GLASS EPOXY + KEVLAR (E GLASS EPOXY AS 1MM THICKNESS AND KEVLAR AS 2MM THICKNESS): LAYERED SECTION

Right click on the grid to add, modify and delete a row.

Layer 1 is on the bottom. Subsequent layers are added to the top, increasing in the +Z normal direction.

Layer	Material	Thickness (mm)	Angle (°)
(+Z)			
3	e glass epoxy	1	0
2	kevlar	2	0
1	e glass epoxy	1	0
(-Z)			

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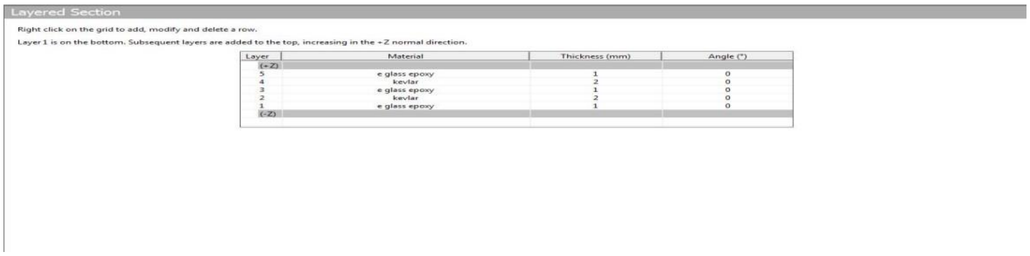
RECTANGULAR PLATE WITH 5 LAYERS E GLASS EPOXY + KEVLAR (E GLASS EPOXY AS 1MM THICKNESS AND KEVLAR AS 2MM THICKNESS): LAYERED SECTION



Layered Section

Right click on the grid to add, modify and delete a row.

Layer 1 is on the bottom. Subsequent layers are added to the top, increasing in the +Z normal direction.

Layer	Material	Thickness (mm)	Angle (°)
(+Z)			
5	e glass epoxy	1	0
4	kevlar	2	0
3	e glass epoxy	1	0
2	kevlar	2	0
1	e glass epoxy	1	0
(-Z)			

TABLES

MODAL ANALYSIS

Materials	Total deformation	Total deformation-2	Total deformation-3	Total deformation-4	Total deformation-5	Total deformation-6	Total deformation-7	Total deformation-8	Total deformation-9	Total deformation-10
e glass epoxy	39.668	59.558	59.556	64.44	58.76	42.272	74.466	74.476	75.882	68.315
e glass epoxy 5 layers	30.72	46.345	46.343	49.894	45.501	32.736	57.67	57.677	58.745	52.875
e glass + kevlar 3 layers	41.328	62.584	62.581	67.289	61.238	44.03	77.653	77.663	79.31	71.422
e glass + kevlar 5 layers	32.109	50.854	50.852	52.83	47.684	34.202	60.562	60.57	62.505	56.282
e glass 2mm	34.35	51.687	51.685	55.796	50.88	36.605	64.485	64.494	65.7	59.142
e glass 5 layers 2mm	25.955	39.384	39.383	42.143	38.437	27.658	48.715	48.722	49.608	44.635
e glass + kevlar 2mm	36.515	56.387	56.385	59.725	54.15	38.892	**68.733**	68.743	70.517	63.522
e glass + kevlar	27.73	44.499	44.498	45.746	41.213	29.534	52.349	52.356	54.168	48.75

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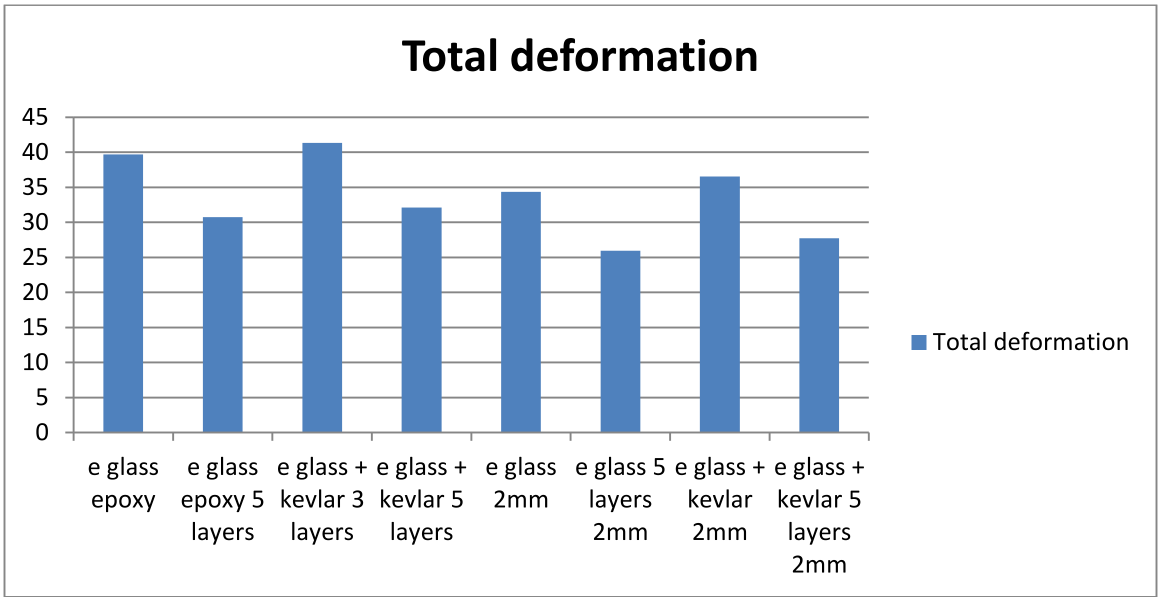
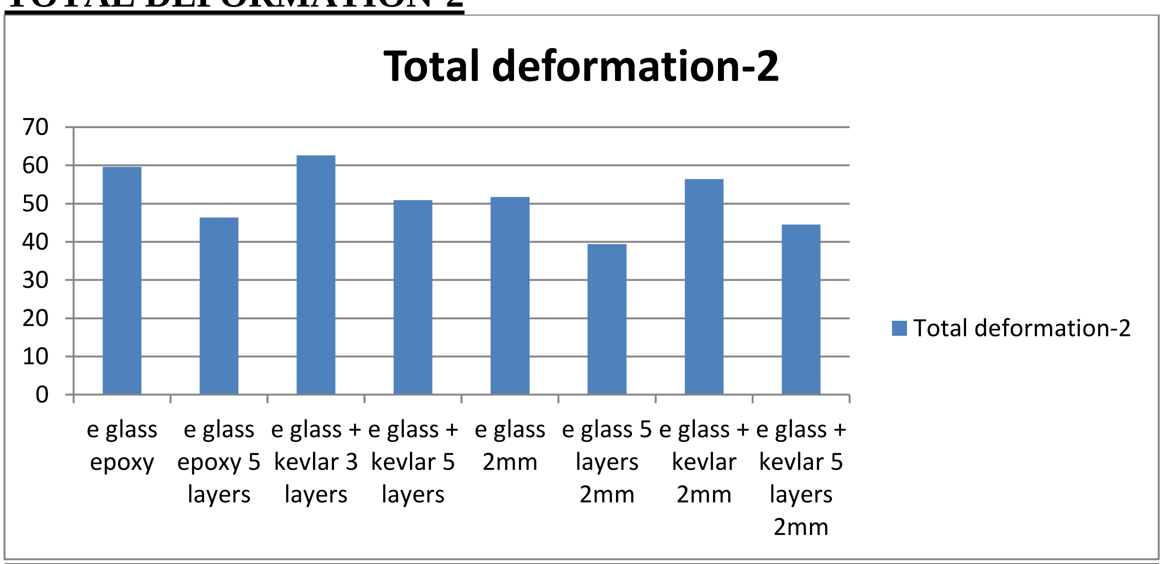
5 layers 2mm										

GRAPHS
MODAL ANALYSIS

TOTAL DEFORMATION



TOTAL DEFORMATION-2



TOTAL DEFORMATION-3

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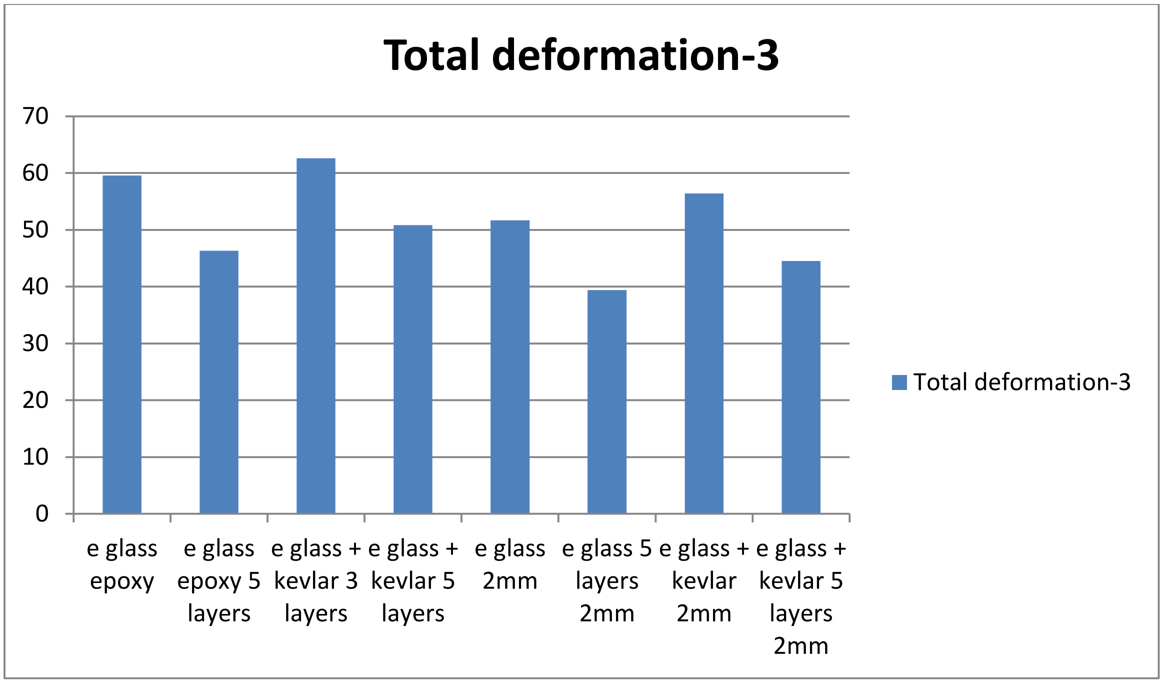
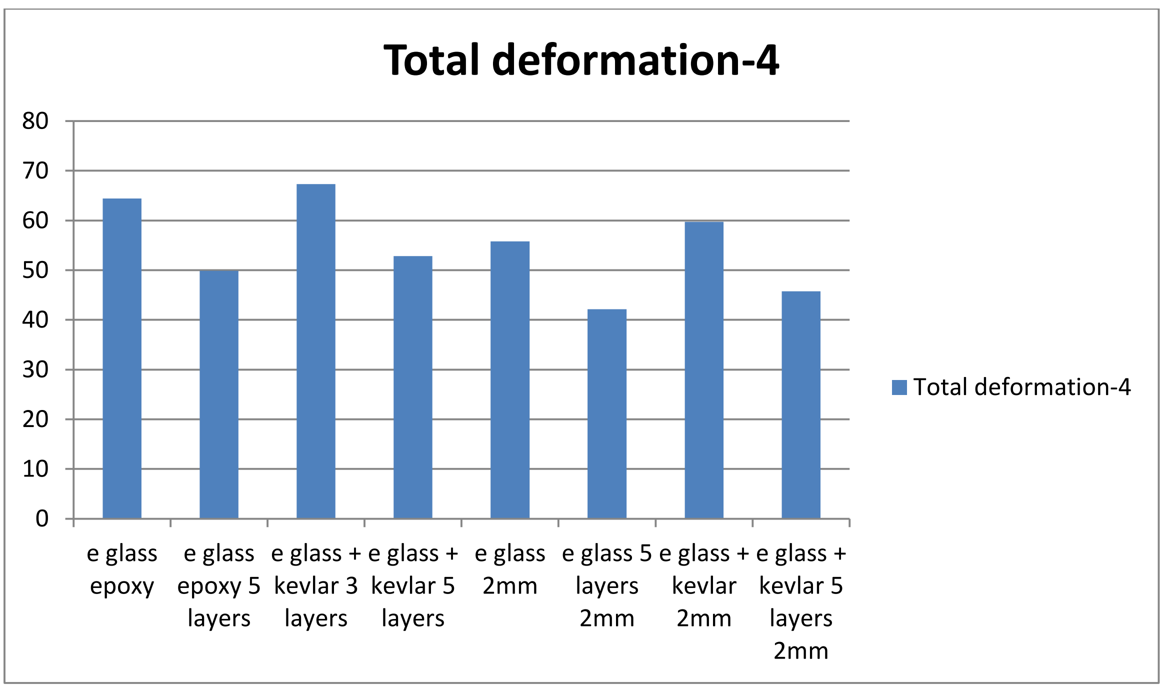


TOTAL DEFORMATION-4



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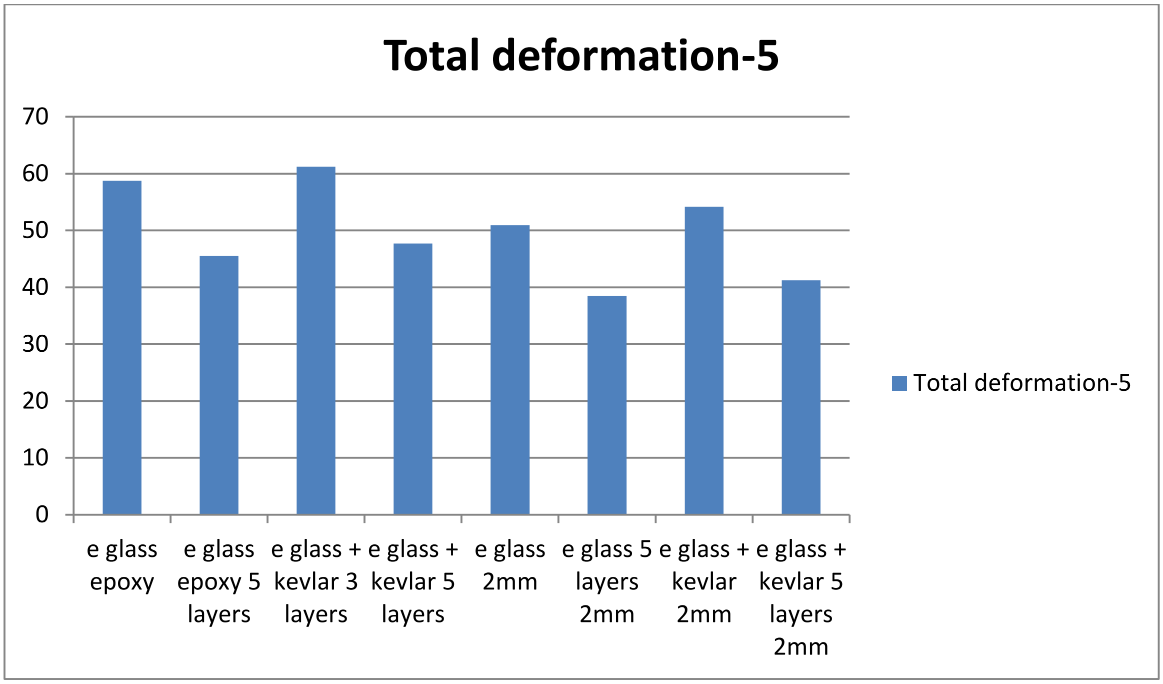
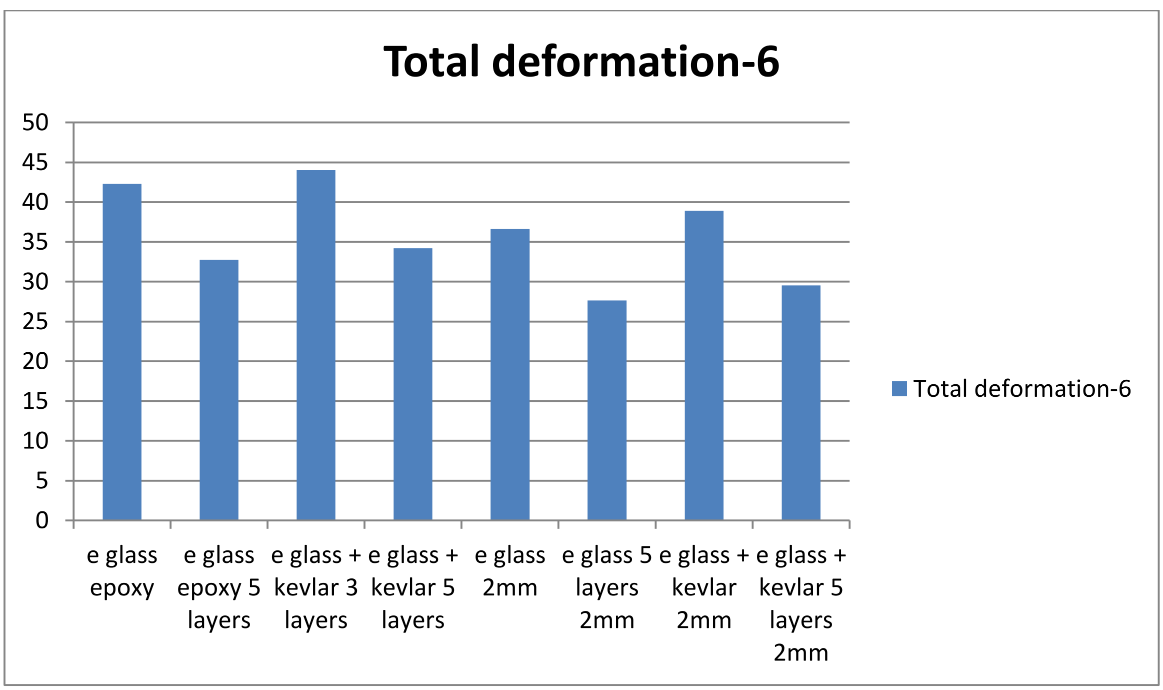
TOTAL DEFORMATION-5



TOTAL DEFORMATION-6



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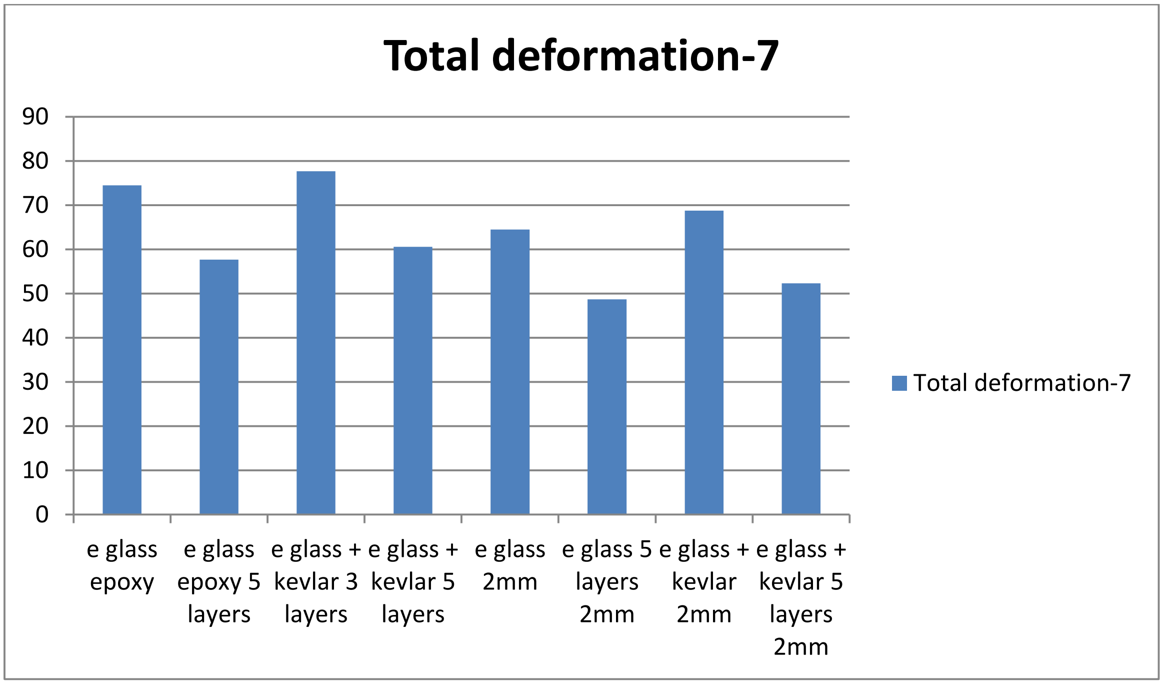
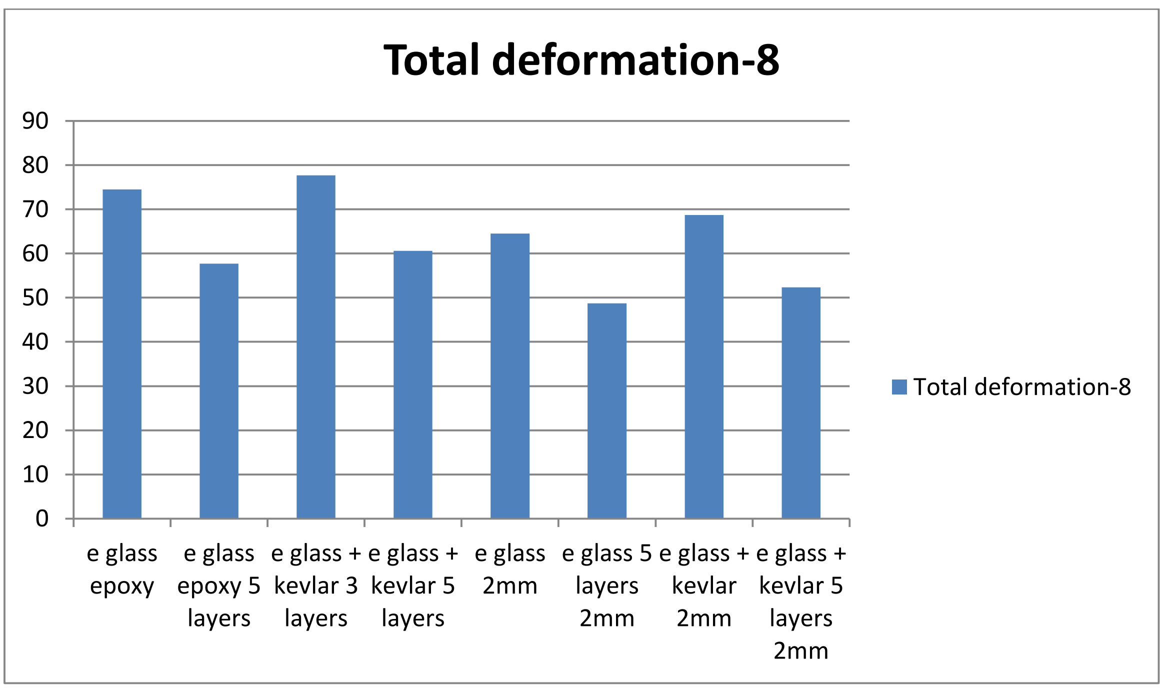
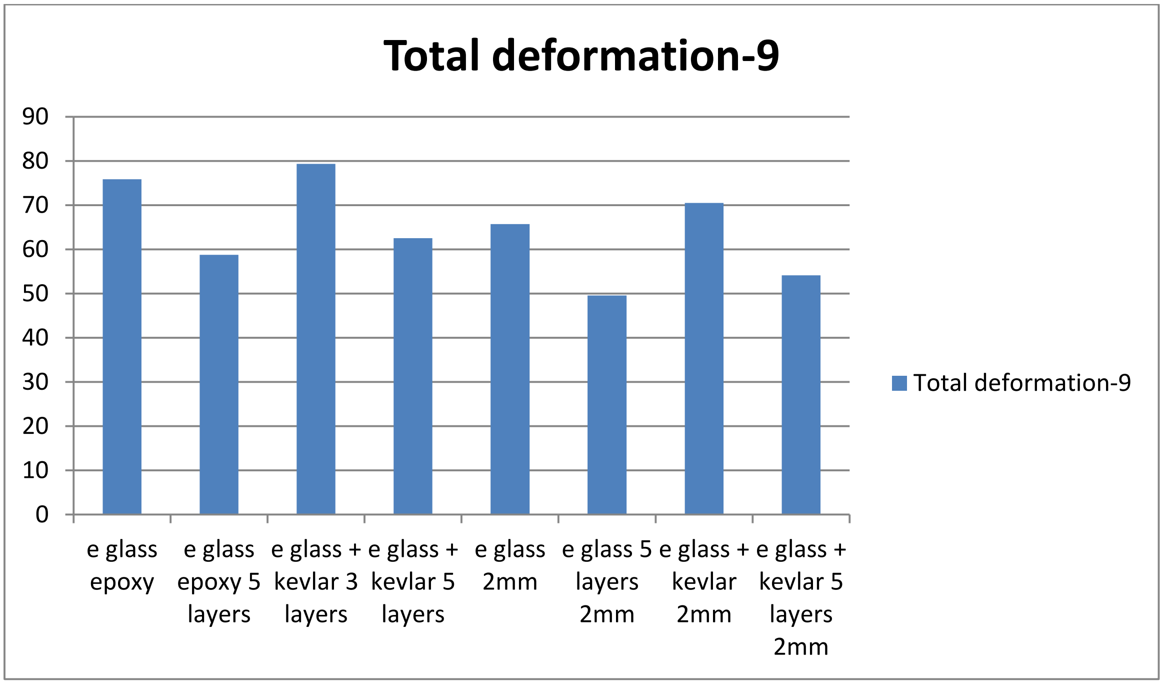
TOTAL DEFORMATION-7



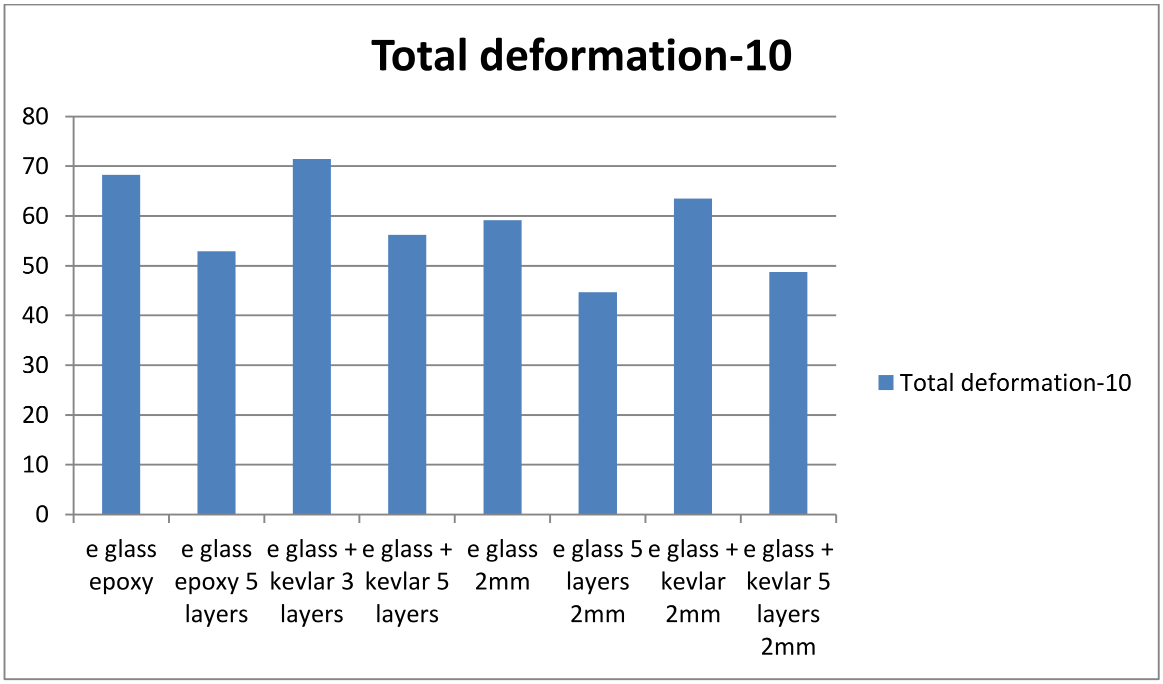
TOTAL DEFORMATION-8



TOTAL DEFORMATION-9



TOTAL DEFORMATION-10



CONCLUSION

E-glass/epoxy$(0)_3$, E-glass/epoxy$(0)_5$, E-glass-Kevlar/epoxy$(0)_3$,E-glass-Kevlar/epoxy$(0)_5$, E-glass/epoxy$(0)_3$(2mm – 2nd layer thickness), E-glass/epoxy$(0)_5$(2mm – 2nd & 4th layer thickness), E-glass-Kevlar/epoxy$(0)_3$(2mm – 2nd layer thickness),E-glass-Kevlar/epoxy$(0)_5$(2mm – 2nd & 4th layer thickness) in hybrid composite specimens reinforcement is changed in alternative layers. All the specimens are tested analytically.

As if we observe all the obtained results we can clearly observe that as if we change the layered section and even if we change the alternative layered section, the graphical representation clearly give the output that if the component is being used with pure E-glass epoxy, it could get more sustained and give better life output as deformations are very less when compared with all the other layered sections. As per the cost analysis we can either use e glass epoxy as 1,, thickness of 5 layered component or for more strength we can go to the same E-glass epoxy (1+2+1+2+1) layered thickness component. As this material layered is suggested for the automotive applications to increase the strength of the component.

REFERENCES

[1]. Parth Bhavsar, Prof. Krunal Shah, Prof. Sankalp Bhatia, "An overview of buckling analysis of single ply composite plate with cut-outs". International Journal of Engineering Research and General Science Volume 2, Issue 5, August-September, 2014 ISSN 2091-2730

[2]. Joshi A, Ravinder Reddy P, Krishnareddy V.N, Ch.V.Sushma, "Buckling analysis of thin carbon/epoxy plate with circular cut-outs under biaxial compression by using fea". IJRET: International Journal of Research in Engineering and Technology, (2013) eISSN: 2319-1163 | pISSN: 2321-7308

[3]. Nagendra Singh Gaira, Nagendra Kumar Mourya and Rakesh Kumar Yadav, "Linear buckling analysis laminar composite plate". International journal of engineering science and advanced technology(2012) volume 2, Issue :4

[4]. Hamidreza Allahbakhsh and Ali Dadrasi, "Buckling Analysis of laminated composite panel with Elliptical cut-out subjected to axial compression". Volume 2012, Article ID 171953, 10 pages.

[5]. Bucket Okutan Baba (2007), "Buckling Behaviour of Laminated Composite Plates". Canakkale Onsekiz Mart University / Turkey

[6]. Hsuan-Teh Hu, Chia-Hao Yang, Fu-Ming Lin, "Buckling analysis of composite laminate skew plate with material non-linearity". Science direct composites: Part B 37, (2006) 26-36.