International Journal of Research
Available at https://journals.pen2print.org/index.php/ijr/
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 09
August 2019

Fabrication And Analysis Of Industrial Safety Helmet Structured Of Composite Materials

Sandaka Venkata Padmavathi received the B.Tech degree in mechanical engineering from Aditya Engineering College, JNTU, Kakinada, Andhra Pradesh, India, in 2016 year and perusing M.Tech in MACHINE DESIGN from Kakinada institute of engineering and technology, JNTU, Kakinada, Andhra Pradesh, India

Mrs. N. Venkata Lakshmi, M.Tech (Ph.D.), Head of the Department, Department of Mechanical engineering from Kakinada institute of engineering and technology, JNTU, Kakinada, Andhra Pradesh, India

ABSTRACT

All helmets attempt to protect the user's head by absorbing mechanical energy and protecting against penetration. Their structure and protective capacity are altered in high-energy impacts. Beside their energy-absorption capability, their volume and weight are also important issues, since higher volume and weight increase the injury risk for the user's head and neck. Every year many workers are killed or seriously injured in the construction industry as a result of head injuries.

Composite materials as heterogeneous materials consisting of two or more solid phases, which are in intimate contact with each other on a microscopic scale, they can be also considered as homogeneous materials on a microscopic scale in the sense that any portion of it will have the same physical property.

In this thesis a new helmet is fabricated with composite materials and tested against injection moulded plastic helmet, this attempt is to achieve a higher safety level. Materials like randomly oriented glass fiber mates, glass woven mates, polyester resign, are used in manufacturing the specimens. These materials are considered for their low density and cost. Impact test will be conducted on the specimens. Validation for these experimentation results will be done using ansys simulation.

INTRODUCTION

Man has been persecution materials since the start of the logged history. At the start solely natural materials like stone, clay, wood etc. were used. Materials have a exact important role within the lifetime of Homo sapiens and are creating important contribution to the techno-economic development of the fashionable world. Materials are separated into 3 broad categories: (i) metals, (ii) ceramics, and (iii) polymers. Composites reinforced metal; ceramic and chemical compound matrices have furthermore been developed. Polymers (synthetic and biopolymers) and chemical compound composites need emerged as vital materials. The 2 main constituents of a chemical compound composite are: (i) a chemical compound matrix, and (ii) a reinforcing material. A composite offers advanced properties than those of its constituent materials, since of synergistic properties of constituent materials. In an exceptionally composite, one amongst the constituent materials is in incessant section, and is named because the matrix, and also the alternative is discontinuous or phase and is termed since the reinforcement or the reinforcing material. Chemical compound composite embrace, translucent substance or the additional particle bolstered chemical compound composites; short aramid fibres or the extra short fiber bolstered chemical compound composites; unceasing carbon fiber bolstered epoxy or the other thermosetting or thermoplastic chemical compound composites; Nano particles or Nano fibres bolstered chemical compound composites. Properties of a chemical compound composite area component ruled by properties and amount of the chemical compound matrix; possessions (for example; ratio, chemical nature, purity, distribution, orientation and geometry) and amount of the reinforcement; and similarly the surface adhesion between the 2. Therefore the properties of a composite area element powerfully influenced by the properties of their constituent materials, their amounts then distribution, and likewise the fiber/matrix surface bond, There are a unit many blessings of such chemical compound composite; but, the most limitation is that the drawback of appropriate removal or use when the top of life and utilize of each the elements quite troublesome

LITERATURE REVIEW

This section brief-outs the various earlier works done in the area of laminated composite material. These are grouped under four broad headings. More recently, Hajianmaleki[1] presented a review of analysis of laminated composite structures used in recent decades. Many authors analyzed the laminated beam structures.

Yildirim [2] used stiffness method for the solution of the purely in-plane free vibration problem of symmetric cross-ply laminated beams. The rotary inertia, axial and transverse shear deformation effects are considered in the mathematical model by the first-order shear deformation theory. A total of six degrees of freedom, four displacements and two rotations are defined for an element. The exact in-plane element stiffness matrix of 6×6 is obtained based on the transfer matrix method. The element inertia matrix consists of the concentrated masses. The sub-space iteration and Jacobi‟s methods are employed in the solution of the large-scale general eigen value problem.

Jun et al. [3] introduced a dynamic finite element method for free vibration analysis of generally laminated composite beams on the basis of first-order shear deformation theory. The influences of Poisson effect, couplings among extensional, bending and torsional deformations, shear deformation and rotary inertia are incorporated in the formulation. The dynamic stiffness matrix is formulated based on the exact solutions of the differential equations of motion governing the free vibration of generally laminated composite beam.

Gurban and Gupta [4] analysed the natural frequencies of composite tubular shafts using equivalent modulus beam theory (EMBT) with shear deformation, rotary inertia and gyroscopic effects has been modified and used for the analysis. The modifications take into account effects of stacking sequence and different coupling mechanisms present in composite materials. Results obtained have been compared with that available in the literature using different modelling. The close agreement in the results obtained clearly show that, in spite of its simplicity, modified EMBT can be used effectively for rotor-dynamic analysis of tubular composite shafts.

MODELING

International Journal of Research
Available at https://journals.pen2print.org/index.php/ijr/
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 09
August 2019

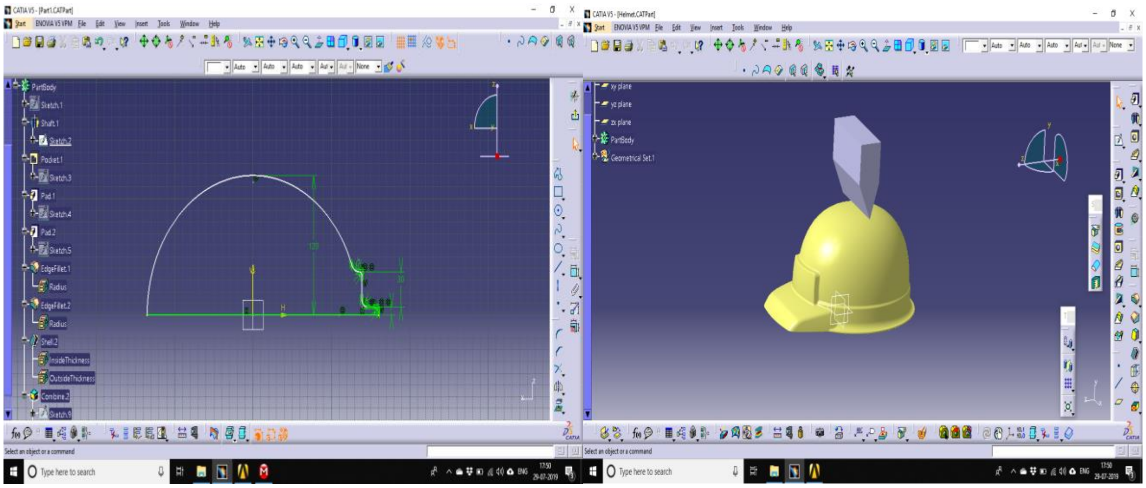


Fig: Side view and Isometric view of the helmet

FABRICATION

Fibers used: Glass fabric and Random oriented glass mats.

Fig : Image of glass fabric mats

Fig: Image of Random oriented glass fiber

Resin materials: polyester resigns.

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 09
August 2019

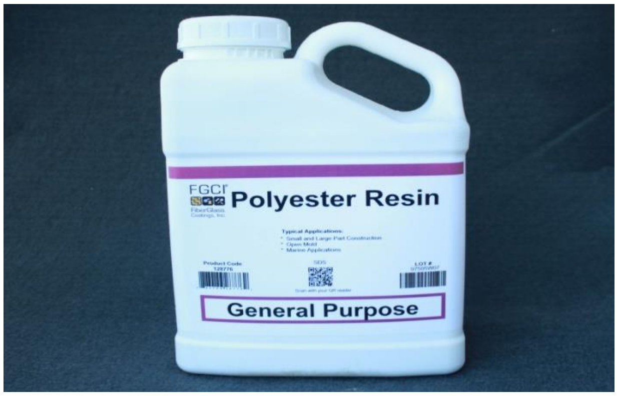


Fig Image of polyester resigns

Fig Image of Hardener

Mixing ratio of resign/accelerator/hardener: 100:1:1

Process:

Step 1: take 100 ml of resign (yellowish liquid) into a plastic/ disposable container

Step 2: pore 1 ml of accelerator (blue color liquid) in to the resign and mix thoroughly

Step 3: mix resign and accelerator until resign changes into light pinkish color.

Step 4: now add 1 ml of hardener (colorless liquid) to the mixture and mix well

Step 5: apply this mixture on the fibers using a paint brush or a roller.

Manufacturing method: Hand layup

Image of hand layup process

Fig wrapping helmet in polyethylene film

Fig Images after application of resign on fiber

Fig Images after application of resign on fiber

Fig top view after curing

Fig: PVC helmet used as dummy inside the specimen

Fig Heat application with the help of hot air blower for removing dummy

Fig While removing the dummy

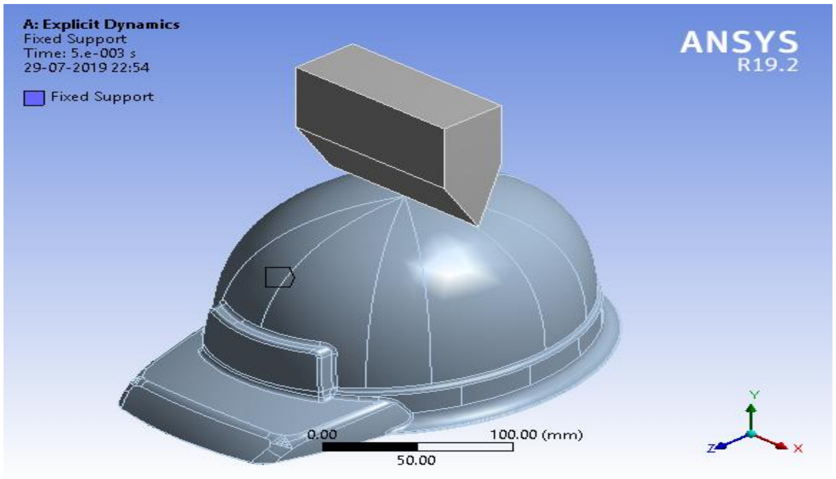
Fig Post removal of dummy

TESTING RESULTS

energy absorbed (J)	experimentation
pvc helmet	59.566
glass mat helmet	61.83
glass fabric helmet	61.2612

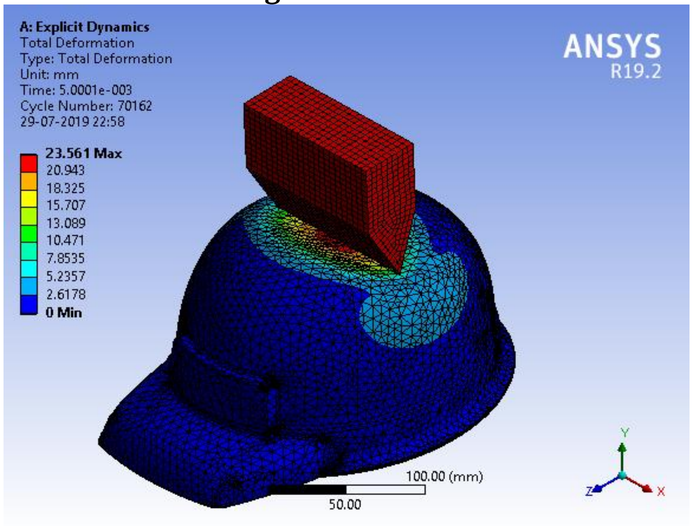
ANSYS

Geometry

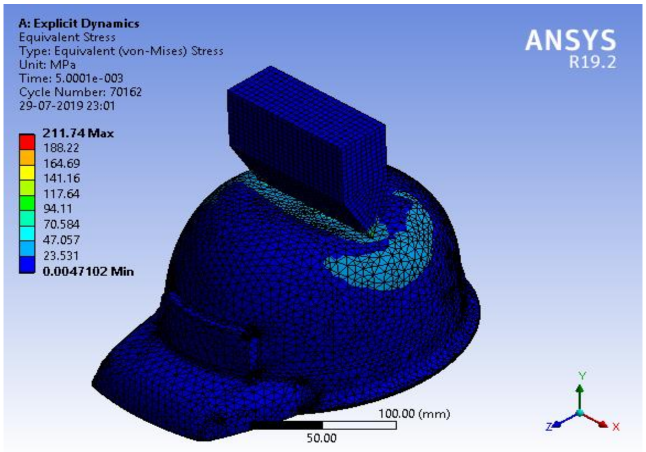


Explicit dynamic analysis of PVC helmet

Fig Total deformation

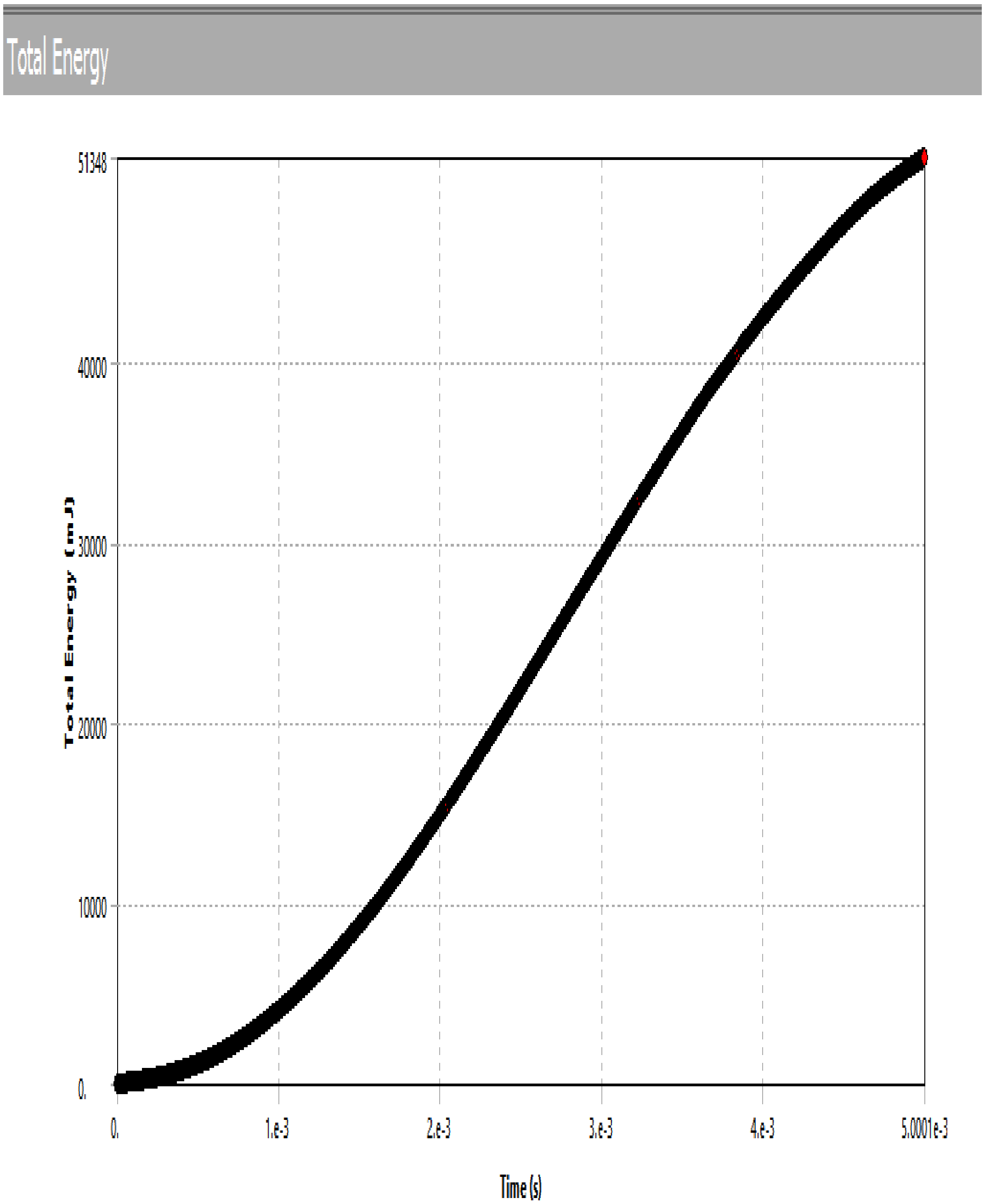


Equivalent stress



.

Total energy absorbed by the body ()



Explicit dynamic analysis of fiber glass mat helmet

REPORT

Simulation results of explicit dynamics of helmet impact test

Table:

simulation result	deformation(mm)		directional deformation(mm)		elastic strain(mm/mm)		equivalent stress(Mpa)	
	min	max	min	max	min	max	min	max
PVC helmet	0	23.561	-23.488	0.98328	2.71E-07	0.089561	0.00471	211.74
glass mat helmet	0	26.298	-0.14513	25.001	8.11E-08	0.0040636	9.14E-03	172.25
glass fabric helmet	0	26.27	-0.14317	24.985	8.88E-08	0.0039975	1.71E-03	169.52

Comparison of simulation and experimentation results

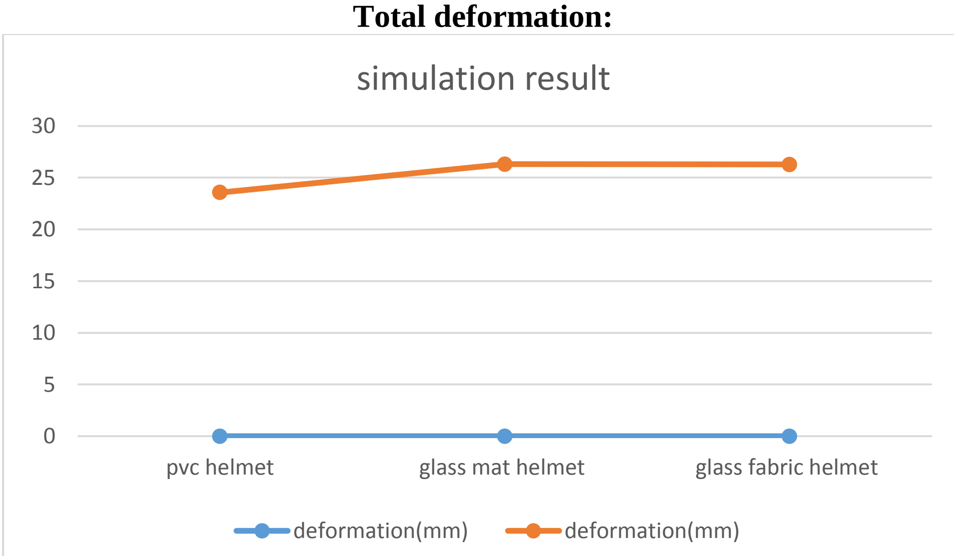
Table:

energy absorbed (J)	experimentation	simulation	Deviation (%)
PVC helmet	59.566	51.35	13.79646
glass mat helmet	61.83	51.53	16.66343
glass fabric helmet	61.2612	51.48	15.97455

GRAPH

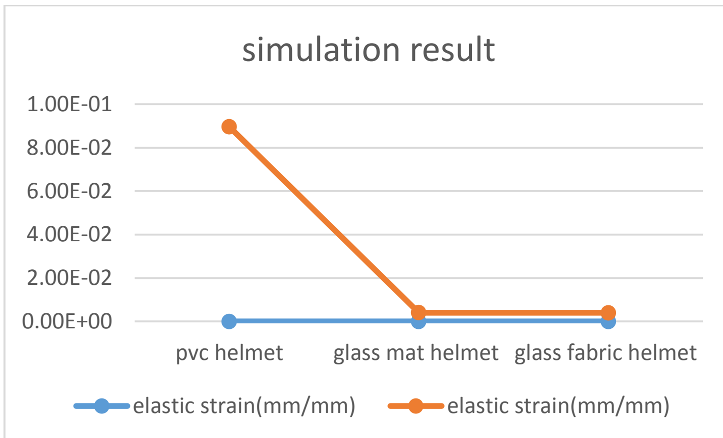
Graphical representation of the above results

Total deformation:

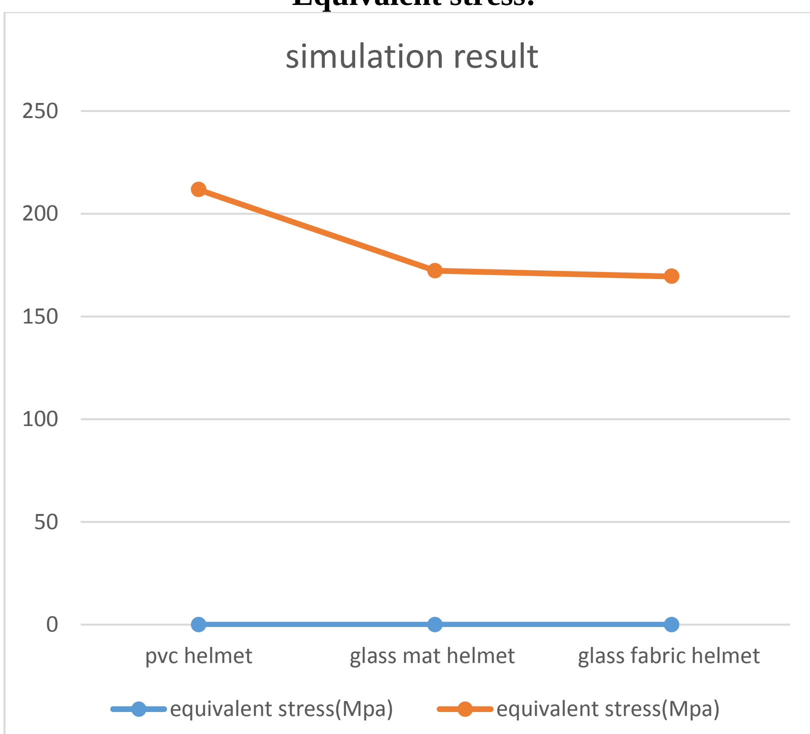


e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 09
August 2019

Equivalent elastic strain:



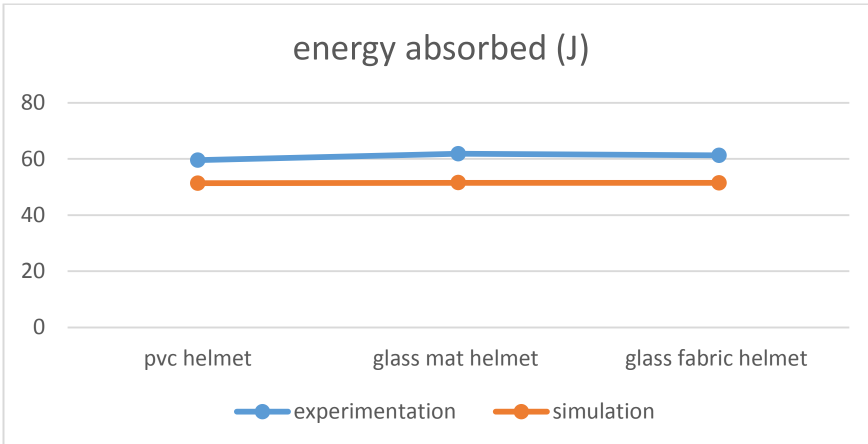
Equivalent stress:



Here the stress is represented in the above graph. Stress produced in the composites is way less than that are in PVC helmet.

Energy absorption comparison:

International Journal of Research
Available at https://journals.pen2print.org/index.php/ijr/
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 09
August 2019



Energy absorbed by the specimens is similar but the PVC specimen has failed by deforming 23mm. while the other specimens made with fibre glass are good enough to with stand there shape and structure even after absorbing so much energy.

Fig: Graph representing total deformation at various positions from central plane

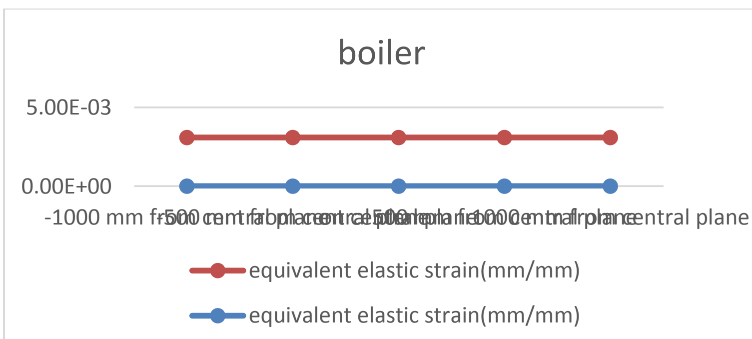


Fig: Graph representing equivalent strain at various positions from central plane

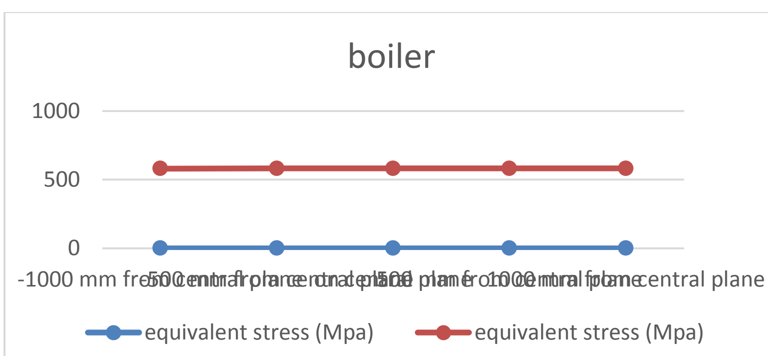


Fig: Graph representing equivalent stress at various positions from central plane

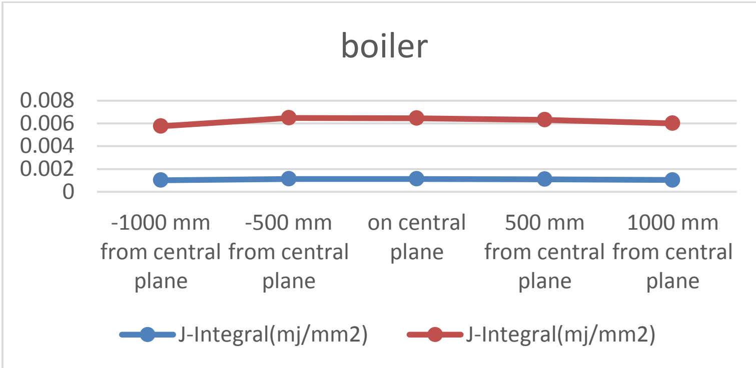


Fig: Graph representing energy release rate at various positions from central plane

CONCLUSIONS

In this study 3 different models of helmets namely commercially available industrial helmet, helmet made with s-glass random oriented fibre mate/polyester resign and s-glass fabric/ polyester resign are tested using izod impact testing and Ansys simulation The models for simulation are developed in Catia V5 R20. And are simulated using Ansys 19.2 Explicit dynamics. For better understanding. Specimens for experimentation are fabricated using hand layup method. The following observations are made during the study

1. Directional deformation shows the true deformation, here the positive value indicates the displacement of the hammer and the negative value indicates the deformation of the helmet, as the helmet is positioned in on X-Z plain.
2. Here the stresses are represented in the above graph. Stress produced in the composites is way less than that are in PVC helmet.
3. Energy absorbed by the specimens is similar but the PVC specimen has failed by deforming 23mm. while the other specimens made with fibre glass are good enough to with stand there shape and structure even after absorbing so much energy.
4. The low stress developed in the composite specimens indicated better ability to with stand impact load
5. From the analysis and experimentation manufacturing helmets with composite material is a good idea, already some companies are manufacturing automobile helmets with composites

REFERNCES

1. M. Hajianmaleki and M. S. Qatu, 'Vibrations of straight and curved composite beams: A review‟, Composite Structures, Vol. 100, pp 218-232,2013.
2. V.Yildirim, „Effect of the longitudinal to transverse moduli ratio on the in-plane natural frequencies of symmetric cross-ply laminated beams by the stiffness method‟, Composite structures, vol.50, pp.319-326, 2000.
3. L. Jun, H.Hongxing and S.Rongying, „Dynamic finite element method for generally laminated composite beams‟, Int. J.Mechanical Sciences, vol.50, pp.466-480, 2008.

4. H.B.H.Gubran and K.Gupta, „The effect of stacking sequence and coupling mechanisms on the natural frequencies of composite shafts", J.Sound and Vibration, vol.282, pp.231248, 2005.
5. YegaoQu, Xinhua Long, Hongguang Li, GuangMeng, „A variational formulation for dynamic analysis of composite laminated beams on a general higher-order shear deformation theory", Composite Structures, Vol. 102 ,175–192, 2013.
6. Y.Qu, X. Long, S.Wu and G.Meng, „A unified formulation for vibration analysis of composite laminated shells of revolution including shear deformation and rotary inertia", Composite structures, vol.98, pp.169-191, 2013.
7. Xiang Xie, Guoyong Jin, Yuquan Yan, S.X. Shi, Zhigang Liu, „Free vibration analysis of composite laminated cylindrical shells using the Haar wavelet method", Composite Structures, vol. 109, pp 167-199,2014.
8. R.Sahoo and B.N. Singh, „A new trigonometric zigzag theory for static analysis of laminated composite and sandwich plates", Aerospace science and technology, vol.35, pp.15-28, 2014. 37
9. M. H.Rarani,S .S. K.Sharifi and M.M. Shokrieh, „Effect of ply stacking sequence on buckling behavior of E-glass/epoxy laminated composites", Computational Material Science, vol.89, pp.89-96, 2014.
10. K Alnefaie, „Finite Element Modeling of composite plates with internal delamination", Composite Structures, Vol. 90, pp 21-27, 2009