International Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN: 2349-2163
Issue 11, Volume 5 (November 2018) www.ijirae.com

DESIGN AND FE ANALYSIS OF HYBRID MOTOR CYCLE HELMET

Dr. M.LAKSHMI KANTH REDDY*
Principal, Department of Mechanical Engg. MTIET, Palamaner, India
lkrmusani@rediffmail.com

Dr. D.SREENIVASULU REDDY*
Associate Professor, Department of mechanical Engg. MTIET, Palamaner, India
dsreddympl@gmail.com

Mr. RAM MOHAN B*
Asst. Professor, Department of mechanical Engg.MTIET, Palamaner, India
rammohan.sachin@gmail.com

Manuscript History
Number: **IJIRAE/RS/Vol.05/Issue11/NVAE10081**
Received: 23, October 2018
Final Correction: 02, November 2018
Final Accepted: 15, November 2018
Published: **November 2018**
Citation: REDDY, K., REDDY, S. & MOHAN, R.(2018).Design and FE Analysis of Hybrid Motor cycle Helmet. IJIRAE:: International Journal of Innovative Research in Advanced Engineering, Volume V, 374-382.
doi://10.26562/IJIRAE.2018.NVAE10082
Editor: Dr.A.Arul L.S, Chief Editor, IJIRAE, AM Publications, India

Abstract— The present work deals with the geometrical development of the existing helmet using CAD software tool and then the structural analysis of the existing model using ANSYS workbench linear analysis and the results, deformation, stress, strain plots was been compared with well established results. Then the alternative model with other combinations was been developed and analyzed for the structural analysis and the results was been compared with the existing helmet. At the end the helmet with superior strength, characteristics with low material cost will be achieved through the research.

Keywords: helmet; deformation; stress; strain; structural analysis;

I. INTRODUCTION

The helmet is protective gear used to protect head from major injuries during accidents. Helmet mainly protects the skull and brain during fatal accidents. So the main theme of the helmet is to safe guard the rider or the skilled operator during accidents. It is very important for the motorist to wear helmet during the riding of the vehicle as its very common these days that the small to major accidents keeps happening not because of the riders speed may be because of the surroundings, modern roads, busy schedule of the society and some uncertainties on road. So the accidents are unavoidable but we have to be more careful. But still we should have clear knowledge of the injuries those might cause fatal death of the rider. Hence the helmet is the must for the rider safety. Then next to this the comfort of the rider throughout the journey is also very important concern for the helmet industry to gain best market for their own product. So to meet the main concerns of the rider it's most important to develop the best comfort with a light weight, high strength, and high impact resistant and better aesthetics for the rider[1]. The helmets are mainly used to safe guard the head from injury hence the design concept of the helmet is very useful topic to discuss at this point. Helmets find its use in various fields. Based on the applications the helmets are basically designed to protect the head from various environmental conditions[2]. Hence the designing of the helmet starts with the idea of the helmet material, size, comfort and the ability to withstand the desired load with minimum deformation without damaging the head. So the application fields also impact the design strength, weight, shape and size of the helmet [3].

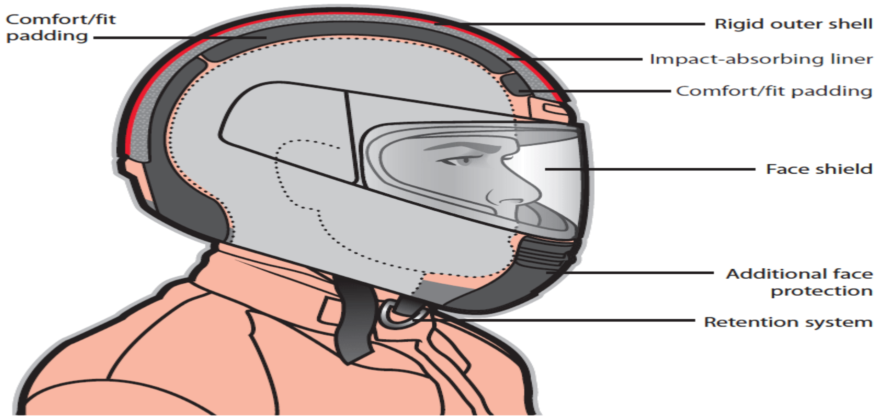


Figure 1 The basic constructions of helm

II. OBJECTIVES AND METHODOLOGY

OBJECTIVES OF THE WORK

1. To achieve the composite helmet over existing helmet with superior strength.
2. To select the proper combination of the composite this could exhibits the superior strength with low weight.
3. To optimize the helmet for max strength and reduction of the material.
4. To design hybrid composite helmet with better comfort, safety and aesthetics.

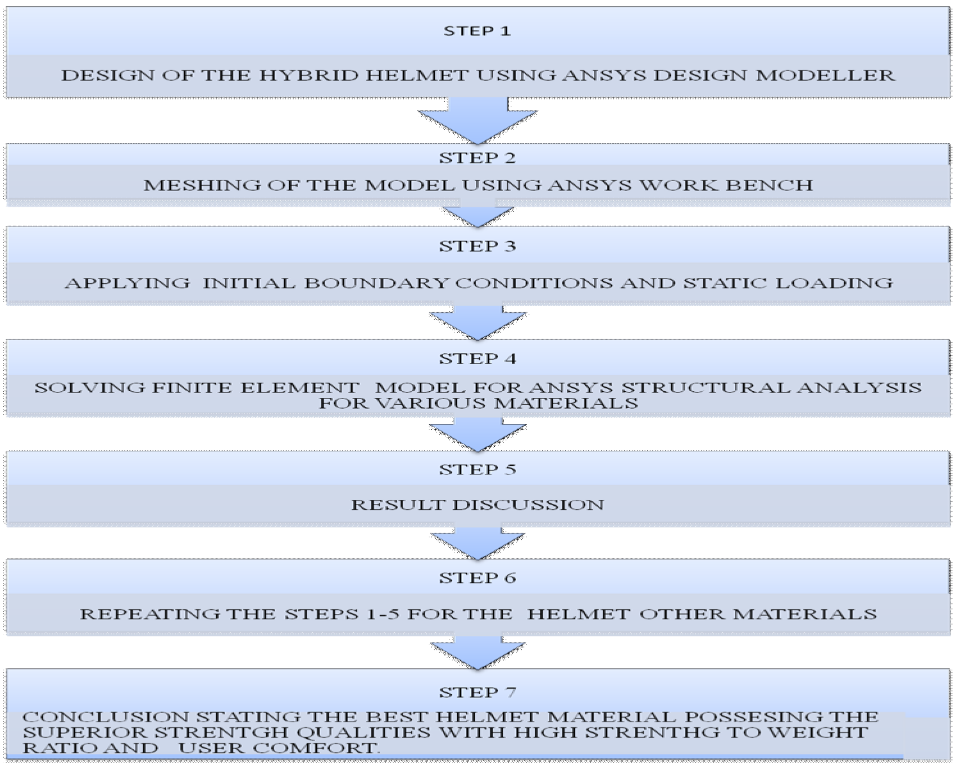
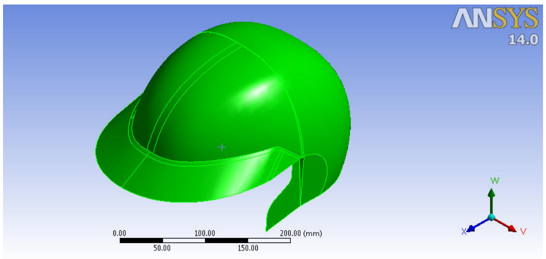


Fig 2. Block diagram

III. DESIGN OF HYBRID HELMET

This chapter presents the new addition to design is the hybrid version of the half and 3/4th helmet. The helmet covers the full head from the rear head base and it specially covers the ears, eyes from the dust, air flow and sunlight. Gives more comfort than the full-face helmet and protects more than the half helmet. Specially the helmet is user friendly to handle and easy to wear. The geometry of the helmet has been designed using ANSYS Design Modular tool as per the drawings using the surface commands in the tool box and the surface has been given the thickness of 3.5mm.

The below figure shows the isometric view of the helmet



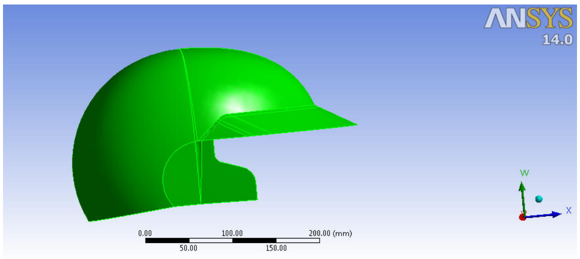
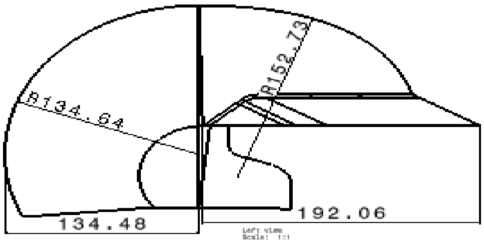


Figure 3 : Depicts the isometric view of the CAD model of Hybrid helmet

Figure 4: shows the front view of hybrid helmet



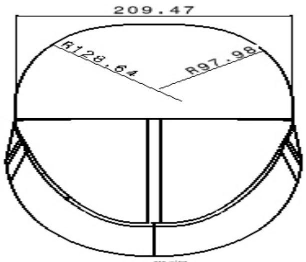


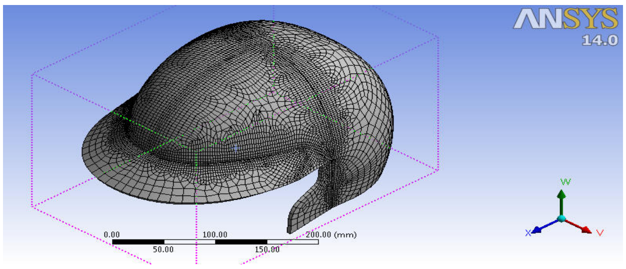
Figure 5 Depicts the front view of hybrid helmet as per the drawing

Figure 6 Depicts the top view of hybrid helmet as per the drawing

IV. FE ANALYSIS OF HYBRID COMPOSITE MOTOR CYCLE HELMET

4.1 Mesh generation of hybrid helmet geometry.

The CAD geometry has been imported to ANSYS work bench then the surface of the geometry has been assigned with 3.5mm thickness basically to give real helmet model.Then from the engineering material property directory the required material properties have been created and assigned to the discretized model.The details of the mesh generations have been tabulated in the below table. The mesh quality is very important which totally gives the accurate results as the number of elements increased so mesh density increases the accuracy of the results but increases the computation time. So the analyst has to trade of between the elements and computational time.



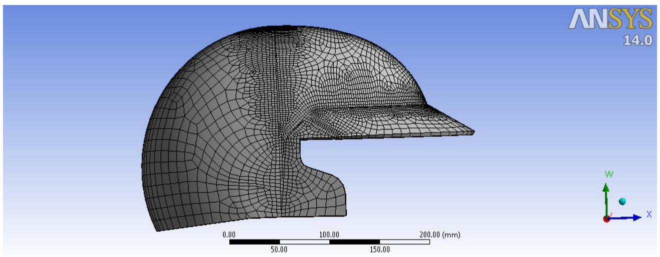


Figure 7 Shows the meshed Model of Hybrid helmet in Isometric View

Figure 8 Shows the meshed Model of Hybrid helmet in side view

4.2 Mesh details of hybrid helmet

Table 1 shows the mesh details of the hybrid helmet

Hybrid helmet geometry- Mesh details		
S.No	**Type**	**Details**
1	Mesh type	Course default
2	Element size	Default
3	Hexahedron and tetrahedron	3D mesh
4	Total number of elements	9981
5	Total number of nodes	10035

4.3 Materials chosen for the analysis

i. Polypropylene
ii. Polycarbonate
iii. Carbon Fiber Composite

Table 2 shows the properties of the hybrid helmet materials

S.No	Materials	Density in Kg/m³	Tensile strength in Mpa	Poisons ratio
1	Polypropylene	1140	55-83	0.4
2	Polycarbonate	1190	55-75	0.37
3	CFC	1600	150	0.15

4.4 Case 1-FE analysis of Hybrid helmet made of polypropylene shell material.

The structural analysis has been carried for the polypropylene material for the load cases 500N and 2000N, Von Mises stress and strains are obtained from the analysis and plotted as shown in the below figures.

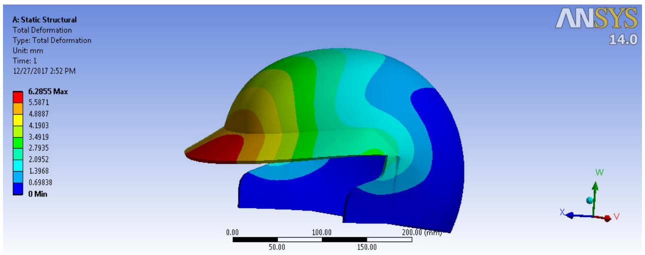


Figure 9: Shows the deformation of Polypropylene helmet for the load of 500N

The above figure shows the deformations plots of the polypropylene helmet shell material and deformation is found to 6.285mm

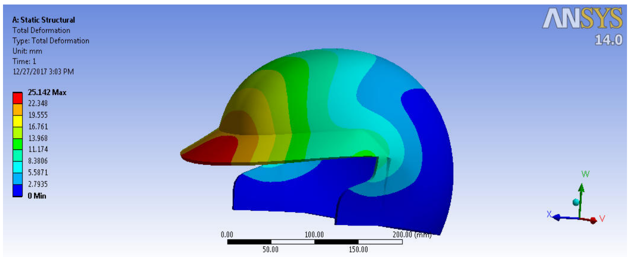


Figure 10: Shows the deformation of Polypropylene helmet for the load of 2000N

In the above figure the deformation is found to be 25.142mm

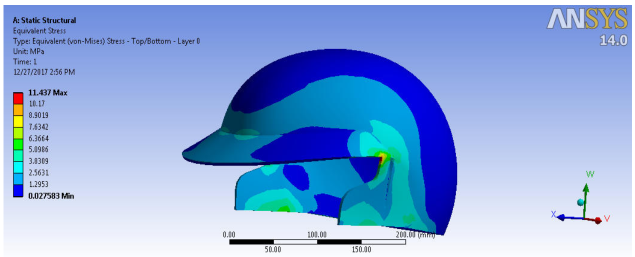


Figure 11: Shows the Von Mises stress of Polypropylene helmet for the load of 500N

In the above figure the Von Mises stress is found to be 11.43Mpa

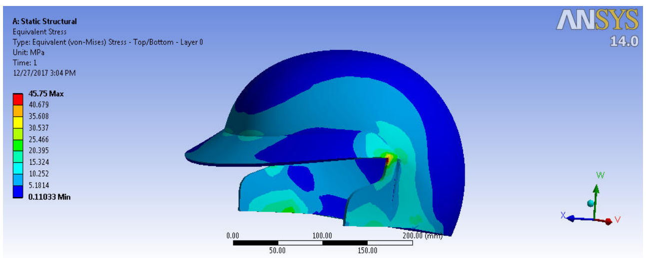


Figure 12: Shows the Von Mises stress of Polypropylene helmet for the load of 2000N

In the above figure the Von Mises stress is found to be 45.75Mpa

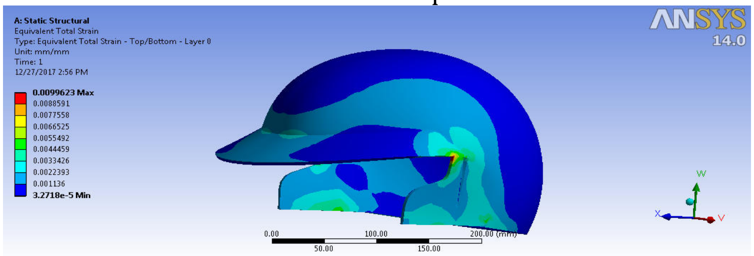


Figure 13: Shows the strain on Polypropylene helmet for the load of 500N

In the above figure the strain variation is 0.0099 mm/mm

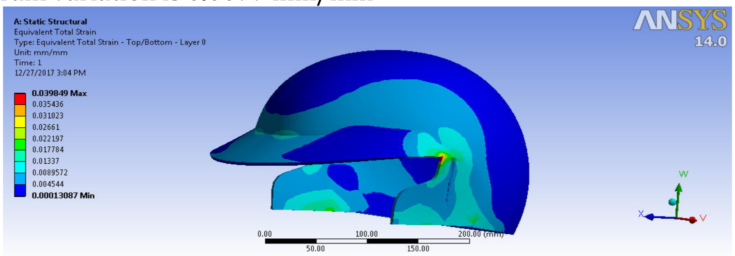


Figure 14: Shows the strain on Polypropylene helmet for the load of 2000N

In the above figure the strain variation is 0.0398mm/mm

4.5 Case 2-FE analysis of Hybrid helmet made of polycarbonate shell material

The structural analysis has been carried for the polycarbonate material for the load cases 500 N and 2000N. Von Mises stress and strains are obtained from the analysis and plotted as shown in the below figures

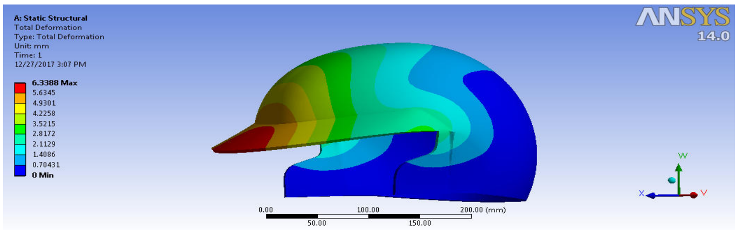


Figure 15: Shows the deformation of polycarbonate helmet for the load of 500N

In the above figure the deformation is found to be 6.33mm

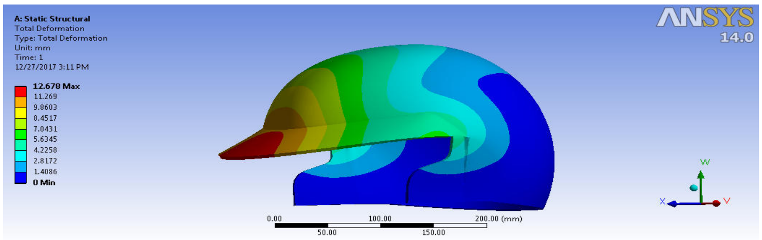


Figure 16: Shows the deformation of polycarbonate helmet for the load of 2000N

In the above figure the deformation is found to be 12.67mm

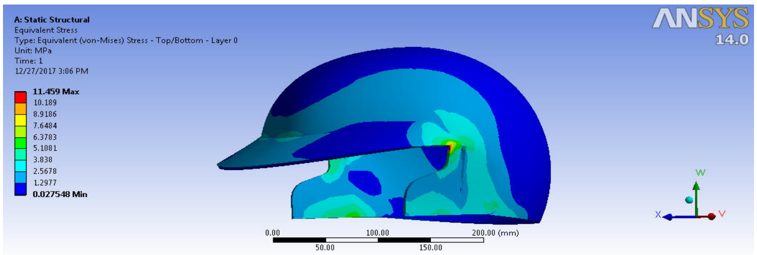


Figure 17: Shows the Von Mises stress of polycarbonate helmet for the load of 500N

In the above figure the Von Mises stress is found to be 11.46Mpa

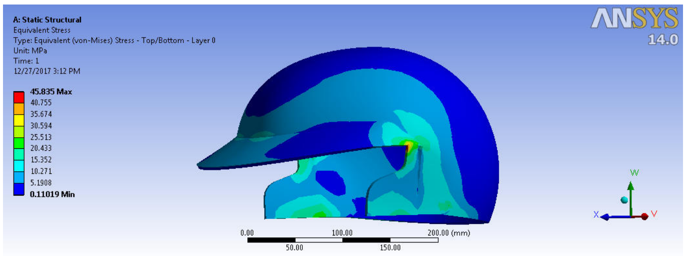


Figure 18: Shows the Von Mises stress of polycarbonate helmet for the load of 2000N

In the above figure the Von Mises stress is found to be 45.83 Mpa

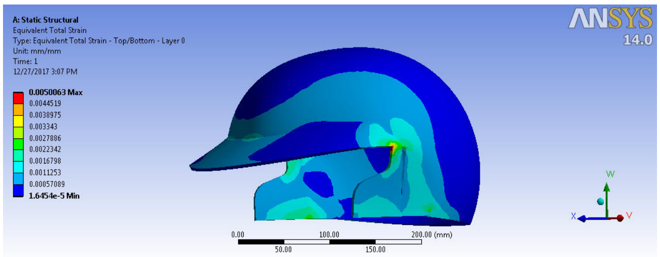


Figure 19: Shows the strain on Polycarbonate helmet for the load of 500N

In the above figure the strain variation is 0.005 mm/mm

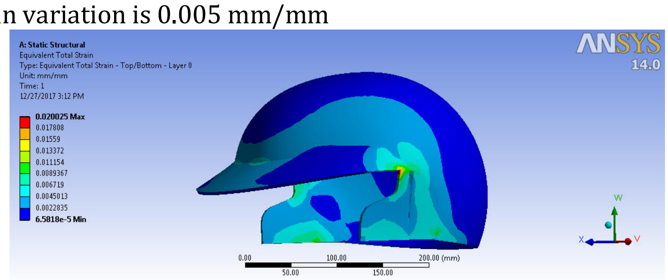


Figure 20: Shows the strain on Polycarbonate helmet for the load of 2000N

In the above figure the strain variation is 0.02 mm/mm

4.6 Case 3-FE analysis of Hybrid helmet made of CFC material.

In this case the structural analysis has been focused on the material which is more tough and having more impact resistance that is CFC Composite as the outer shell of the hybrid helmet. The properties of the CFC Composite are well published and the same material properties are used in the analysis.

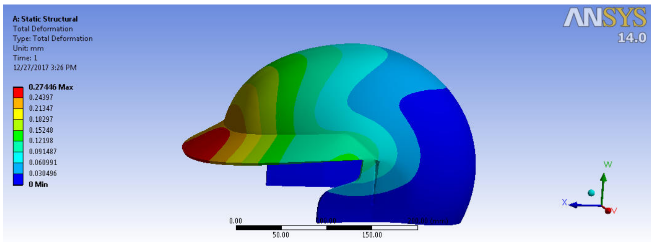


Figure 21: Shows the deformation of CFC material helmet for the load of 500N

In the above figure the deformation is found to be 0.0195mm

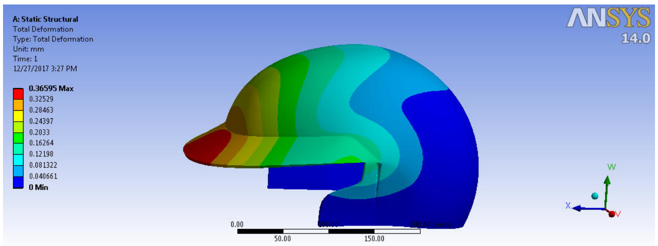


Figure 22: Shows the deformation of CFC material helmet for the load of 2000N

In the above figure the deformation is found to be 0.369mm

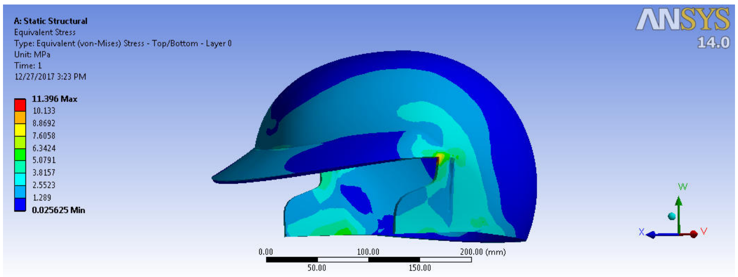


Figure 23: Shows the Von Mises stress of CFC material helmet for the load of 500N

In the above figure the Von Mises stress is found to be 11.39Mpa.

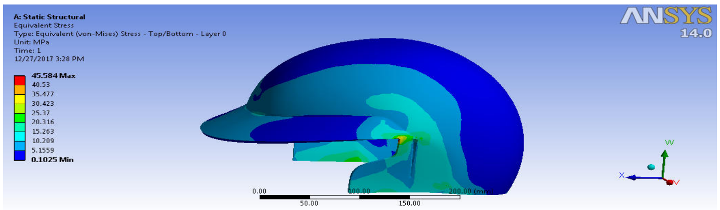


Figure 24: Shows the Von Mises stress of CFC material helmet for the load of 2000N

In the above figure the Von Mises stress is found to be 45.58Mpa

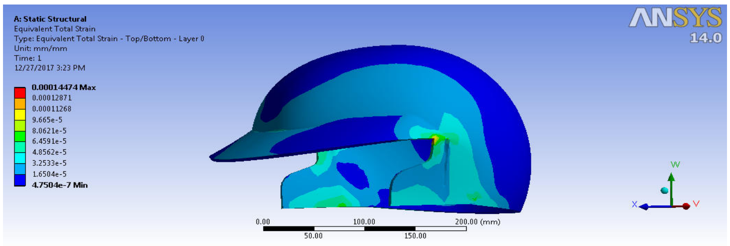


Figure 25: Shows the strain on CFC material helmet for the load of 500N

In the above figure the strain variation is 0.000144 mm/mm.

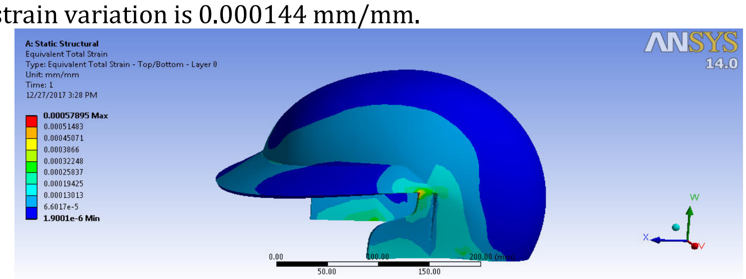


Figure 26: Shows the strain on CFC material helmet for the load of 2000N

In the above figure the strain variation is 0.000578 mm/mm

V. RESULTS AND DISCUSSION

The linear structural analysis has been carried on the three helmet materials as its mentioned in the previous chapter. From the structural analysis the following results have been obtained and are tabulated in the below tables

Tab 3: Shows the load versus deformation values for all the materials of the work and deformations are measured in mm

S.No	Loads in N	Polypropylene	Polycarbonate	CFC
1	500	6.285	6.33	0.0191
2	2000	25.142	12.678	0.3659

it's also quite noticeable that for both the composite the deformation being very less and this shows that the helmet with the material CFC shows much tough and have impact resistance to the applied load.

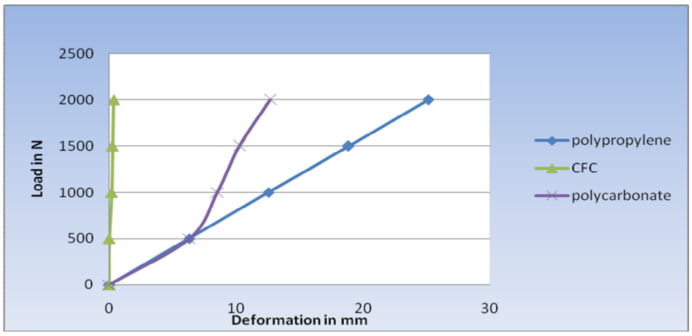


Figure 27 shows plot between load and deformation

Table 4 shows the load versus Von Mises stress values for all the materials of the work and stress are represented in Mpa

S.No	Loads in N	Polypropylene	Polycarbonate	CFC
1	500	11.437	11.459	11.396
2	2000	45.75	45.83	45.58

As the above table shows us the Von Mises stress values for the load cases of the work and its seen that the stress levels being almost same.

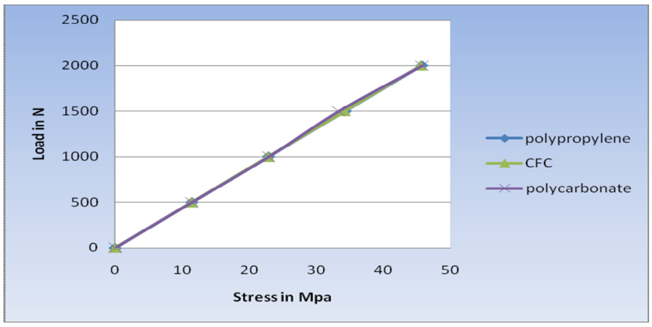


Figure 28 shows plot between load versus stress

Table 5 shows the load versus strain values for all the materials of the work and strains are represented in mm/mm

S.No	Loads in N	Polypropylene	Polycarbonate	CFC
1	500	0.00998	0.005	0.000144
2	2000	0.0398	0.02	0.000578

We can see from the above table that the values of stains are almost similar compared with Other 2 existing materials

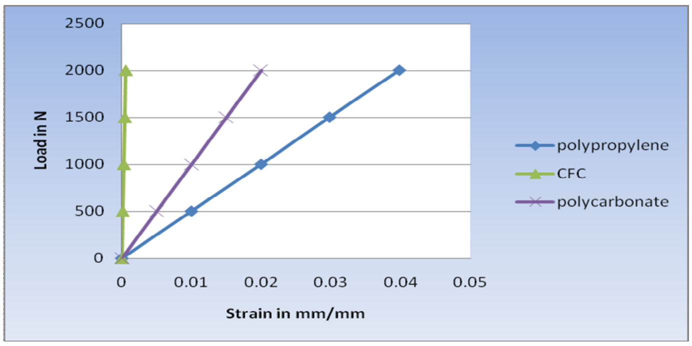


Figure 29 shows plot between load versus strain

VI. CONCLUSION

The design of hybrid helmet and its static structural analysis has been done for the materials considering the existing conventional helmet materials from the polypropylene shell material to polycarbonate shell material. Then in search of the better alternative helmet materials the other material that is CFC material also analysed for the various load cases. Since the CFC are very low weight and have high impact resistance compared with already existing materials, the same is seen through the FE simulation von Mises stresses almost remain same in the previous material as well as in CFC and the deformation and strain being in the same range, hence CFC composite makes place for the hybrid helmet alternative material over the existing materials.

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