ANALYSIS OF MOTORCYCLE HELMET WITH STATIC LOADING

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Abstract: Each year nearly nine hundred persons die in head injuries and over fifty thousand persons are severally injured due to not wearing of helmets . In motor cycle accidents,the human head is exposed to loads exceeding several times the loading capacities of its natural protection. In this work, an attempt has been made for analysing the helmet with all the standard data. The simulation software 'ANSYS' is used to analyse thehelmet with different conditions such as bottom fixed-load on top surface, bottom fixed–load on top line, side fixed–load on opposite surface, side fixed–load on opposite line and dynamic analysis. The maximum force of 19.5 kN is applied on the helmet to study the model in static and dynamic conditions. The simulation has been carried out for the static condition for the parameters like total deformation, strain energy, von Mises stress for different cases. The dynamic analysis has been performed for the parameter like total deformation and equivalent elastic strain. The result shows that this values are concentrated in the retention portion of the helmet. These results has been compared with the standard experimental data proposed by the BIS and well within the acceptable limit.

Index Terms –**Helmet, deformation, strain energy, equivalent elastic strain**.

I. INTRODUCTION

Helmets have been used as a primary form of protection for a long time, by protecting the head against weapons' strikes and any kind of penetration. Thus, the primary helmet's function was the reduction of head injury mainly in combats. An example is the helmet represented in Fig. 2. Following the evolution of societies, the materials and the construction techniques used in helmet's manufacture became more advanced. Moreover, helmets evolved and diversified with the emerging of new needs of head protection against any kind of impact.

In the early 1900s, with the widespread introduction of the motorcycle, the need of a crash helmet arises. Initially, motorcycle helmets were no more than leather bonnets, first used in racing and usually worn with goggles. These skull caps were adapted from earlier aviators whose main goal was to keep the head comfort and so almost no protection was provided to the head. Thus, the problem of the non-existence of a crash helmet persisted. From this point, helmets evolved based on the understanding of what a helmet should do, in other words, the understanding of the biophysical characteristics of the head and the development of kinematic head injury assessment functions. Therefore, it was realized that a hard outer shell was needed to distribute the applied force and thereby reduce the localization of the impact load, improving the force distribution and thus, diminishing the likelihood of skull fracture. Moreover, the evolution of materials science was also crucial to helmets evolution.A motorcycle helmet is the most common and best protective headgear to prevent head injuries caused by direct cranial impact. Primarily, the helmet purpose is understood as head protection against skull fractures, and modern helmets are usually efficient in this sense. Another main purpose of motorcycle helmets is the prevention of brain injury, since brain injuries are often very severe and result in permanent disability or even death. Thus, the purpose of protective helmets is to prevent head injury by decreasing the amount of impact energy that reaches the head, reducing the severity or probability of injury. Besides protecting the head in motorcycle crashes, helmets keep the head comfort by cutting down the wind noise and acting like a shield against wind blasts, bad weather conditions and any kind of object. They protect the head in case of accident by absorbing the impact and cushion the head to extend the time of impact. In order to have a perception of how a helmet behaves during an impact it is necessary to understand all the mechanisms involved. Helmets can be divided into two major parts depending on the main role of each one. There is a hard outer shell that distributes the impact force on a wider foam area reducing the localization of the impact load, increasing the foam liner energy absorption capacity and consequently reducing the total force that reaches the head and the likelihood of injuries like skull fractures. Besides resistance to penetration, the helmet is the initial shock absorber in an accident. The other main part is the inner liner, which is generally made of an excellent absorbing impact energy material to reduce the inertial loading on the head (by slowly collapsing under impact) and thus, reducing the likeliness of injuries, especially brain injuries, due to induced accelerations.

MATERIALS PROPERTIES USED FOR MOTORCYCLE HELMET

S.No	Material	Density	Young's Modulus	Poisson Ratio
1	Kevlar	1400	3E+10	0.2
2	Polycarbonate plastic	1200	2.6E+09	0.37
3	ABS	1.05e+06	2.3E+9	0.35
4	Carbon Fibre	1.78e+9	7E+10	0.1

II. SOFTWARE

The software will start (by default) with all toolbars docked to the edges of the main window. The toolbars contain buttons, which when clicked, open the various information windows or operate features in the software. The toolbars and windows can be freely moved around inside the main program window, to create your own screen layout.

A. INRODUCTION TO CATIA

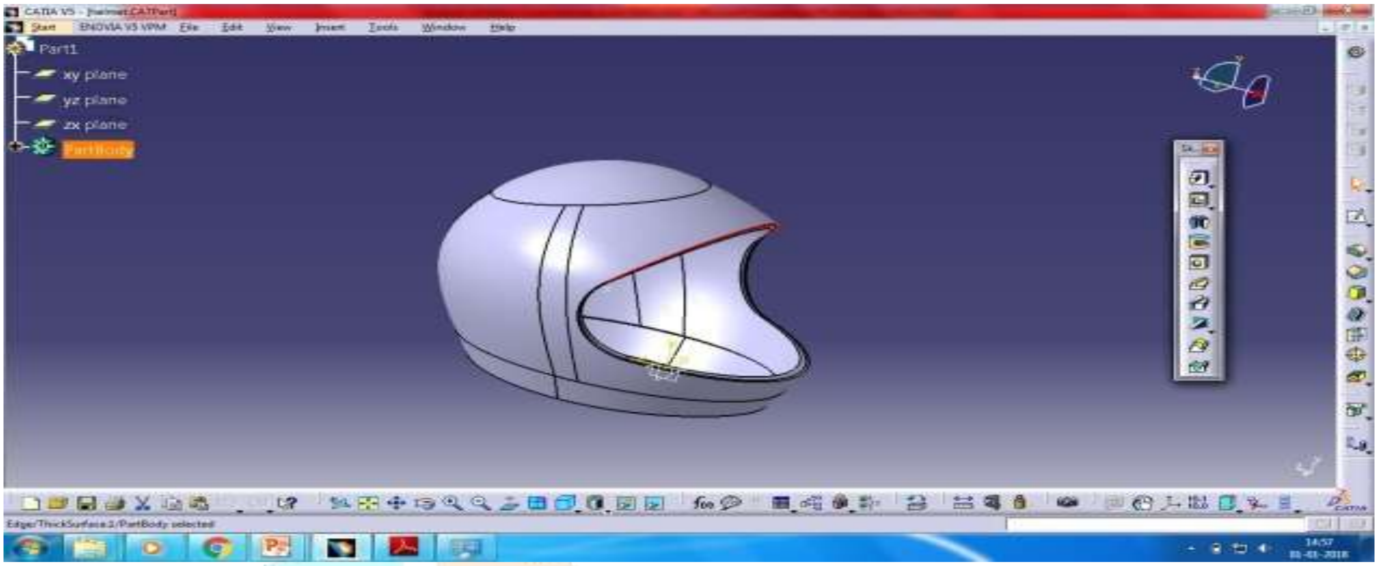
CATIA started as an in-house development in 1977 by French aircraft manufacturer Avion Marcel Dassault, at that time customer of the CADAM software to develop Dassault's Mirage fighter jet. It was later adopted by the aerospace, automotive, shipbuilding, and other industries. Initially named CATI (*conception assistée tridimensionnelle interactive* – French for *interactive aided three-dimensional design*), it was renamed CATIA in 1981 when Dassault created a subsidiary to develop and sell the software and signed a non-exclusive distribution agreement with IBM. In 1984, the Boeing Company chose CATIA V2 as its main 3D CAD tool, becoming its largest customer. In 1988, CATIA V3 was ported from mainframe computers to UNIX. In 1990, General Dynamics Electric Boat Corp chose CATIA as its main 3D CAD tool to design the U.S. Navy's Virginia class submarine. Also, Lockheed was selling its CADAM system worldwide through the channel of IBM since 1978. In 1992, CADAM was purchased from IBM, and the next year CATIA CADAM V4 was published. In 1996, it was ported from one to four UNIX operating systems, including IBM AIX, Silicon Graphics IRIX, Sun Microsystems SunOS, and Hewlett-Packard HP-UX. In 1998, V5 was released and was an entirely rewritten version of CATIA with support for UNIX, Windows NT and Windows XP (since 2001). In the years prior to 2000, problems caused by incompatibility between versions of CATIA (Version 4 and Version 5) led to $6.1B in additional costs due to years of project delays in production of the Airbus A380. In 2008, Dassault Systèmes released CATIA V6. While the server can run on Microsoft Windows, Linux or AIX, client support for any operating system other than Microsoft Windows was dropped. In November 2010, Dassault Systèmes launched CATIA V6R2011x, the latest release of its PLM2.0 platform, while continuing to support and improve its CATIA V5 software. In June 2011, Dassault Systèmes launched V6 R2012. In 2012, Dassault Systèmes launched V6 2013x. In 2014, Dassault Systèmes launched 3DEXPERIENCE Platform R2014x and CATIA on the Cloud, a cloud version of its software.

B. INTRODUCTION TO ANSYS WORKBENCH

ANSYS mechanical is a finite element analysis tool for structural analysis including linear, nonlinear and dynamic studies. This computer simulation product provides finite elements to model behavior and supports material models and equation solvers for a wide range of mechanical design problems. ANSYS mechanical also includes thermal HYPER LINK and coupled analysis capabilities acoustics, piezoelectric, thermal –structural and thermos electric analysis.

III. DESIGN OF MOTORCYCLE HELMET:

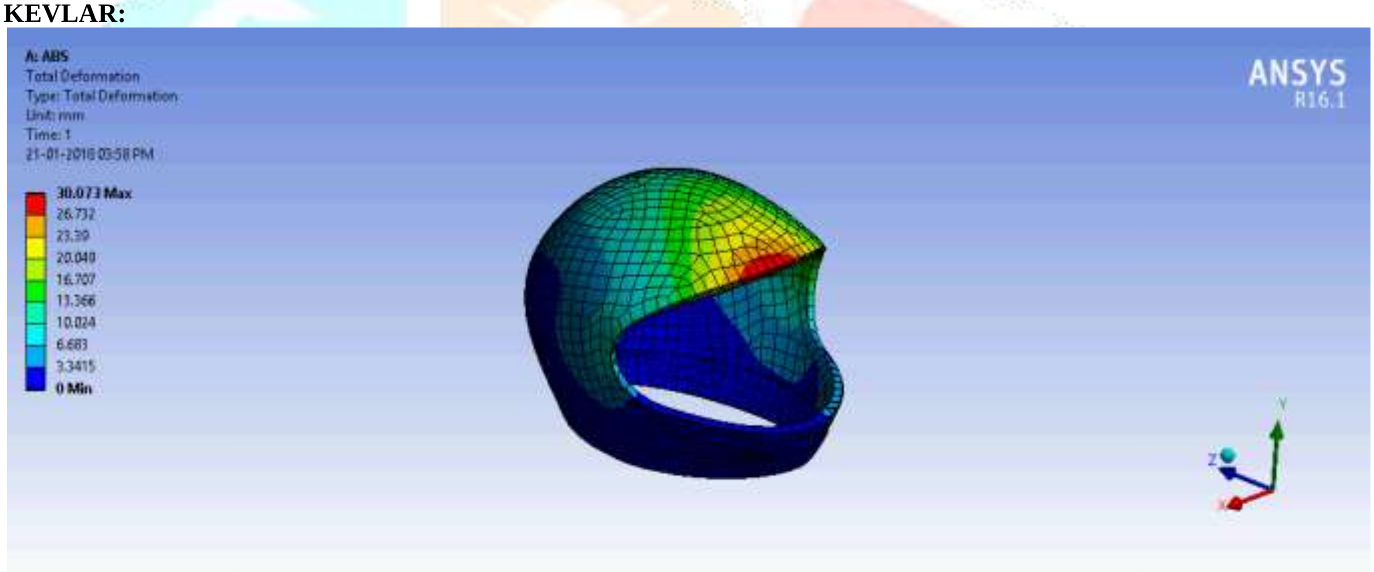
HELMET DESIGN ACCORDING TO THE STANDARD DATA:



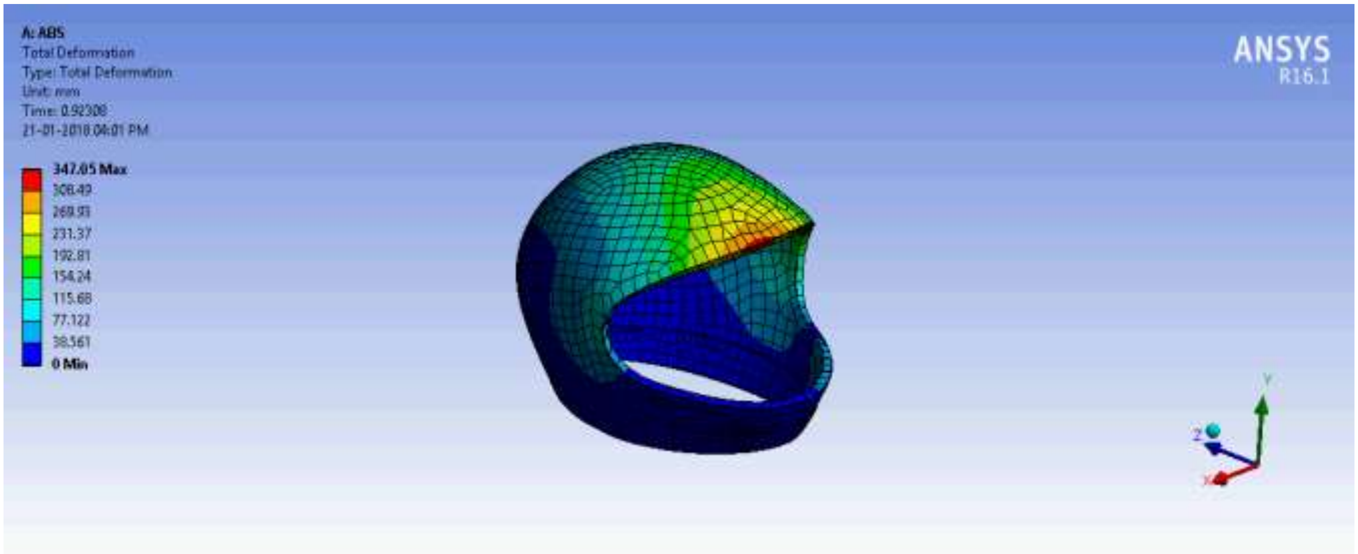
IV. RESULT AND DISCUSSION:

ANALYSIS OF HELMET WITH DIFFERENT MATERIALS:

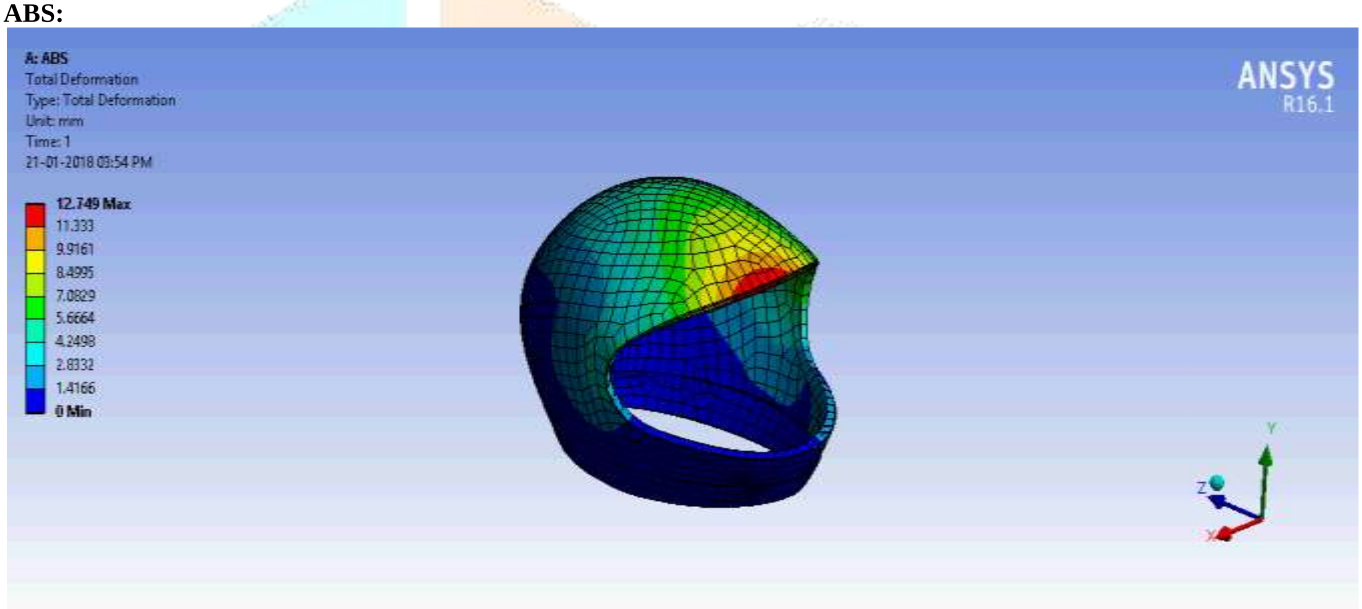
KEVLAR:



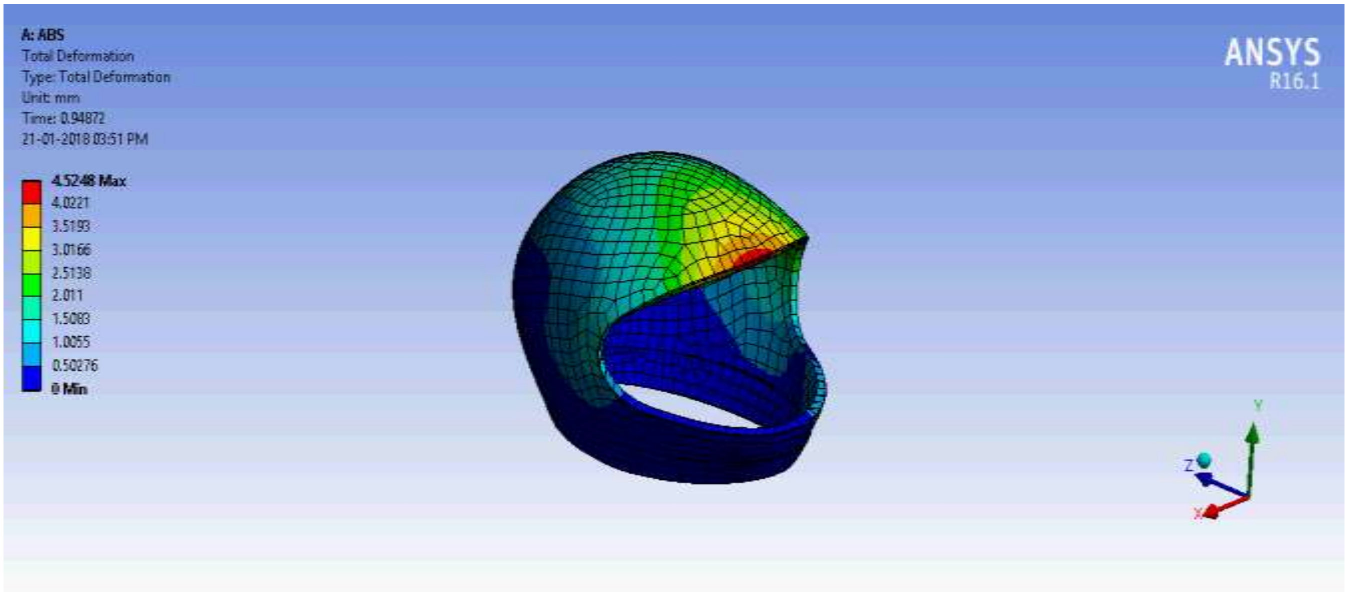
POLYCARBONATE:



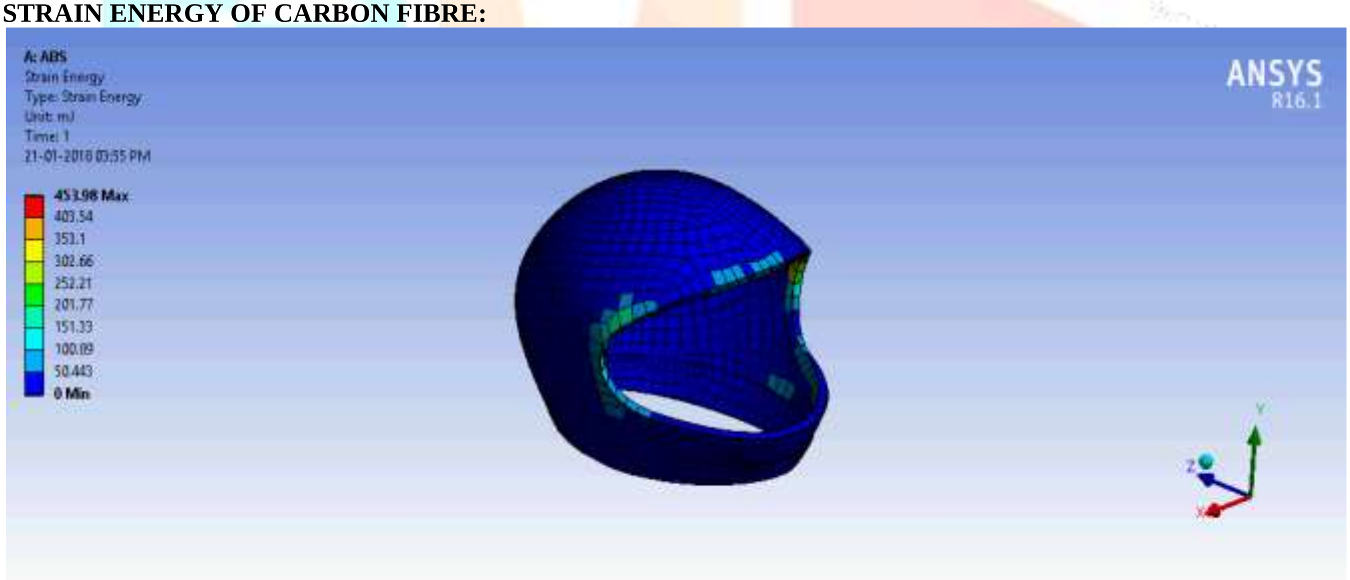
ABS:



CARBON FIBRE:



STRAIN ENERGY OF CARBON FIBRE:



VI.CONCLUSION

Deformation of all cases are plotted above, which shows that case – 1 and4 has less deformation so energy transfer to the head is high, which cause serious injuries.shows the strain energy graph, that case – 1 and 4 has absorbed less strain energy that is maximum force is transmitted to head.The design and analysis of helmet has been carried out in "ANSYS" for static and dynamic conditions. The study has been made for different cases. The results from the various cases shows that chin (retention system) side of the helmet (Case 1 and 4) has undergone less strain energy and deformation. In this case the rider meet an accident, the head injury is very serious. So special attention should be needed in chin side of the helmet to reduce serious injuries.

TABLE:
RESULT OF STRESS, DEFORMATION:

S.No	Cases	Boundary Conditions	Total Deformation(mm)	Strain Energy(J)	Equivalent von mises stress(Pa)
1	Case 1	Bottom fixed and load on top area 20 kN	2.749	14.647	1.223 x 109
2	Case 2	Bottom fixed and load on top line 20 kN	3.5061	48.2	2.340 x 109
3	Case 3	Bottom fixed and load on Side area 20 kN	9.3394	10.647	2.145x 109
4	Case 4	Bottom fixed and load on Side line 20 kN	2.749	14.647	1.223 x 109

VII. REFERENCES

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