DESIGN AND ANALYSIS OF A HELMET USING GLASS FIBRE REINFORCED COMPOSITE MATERIAL

A Project Report submitted in partial fulfilment of the requirement for the award of the degree of

BACHELOR OF ENGINEERING

In

MECHANICAL ENGINEERING

Submitted by

GUDLA SRAVYA	**(314126520065)**
BHAMIDIPALLI VENKATA AKHIL KUMAR	**(314126520017)**
BAGADI DILIP KUMAR	**(314126520009)**
EALLETI RAJEEV	**(314126520048)**
CHENNA JEEVANA GEETHA	**(314126520028)**

Under the guidance of

M.N.V.KRISHNAVENI, M.E

Assistant professor

PRAGNANAM BRAHMA

ANITS

DEPARTMENT OF MECHANICAL ENGINEERING

ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY AND SCIENCES

(Autonomous)

(Affiliated to A.U, Approved by AICTE & Accredited by NBA, NAAC with 'A' grade)

DEPARTMENT OF MECHANICAL ENGINEERING

ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY AND SCIENCES

(Autonomous)

(Affiliated to A.U, Approved by AICTE & Accredited by NBA, NAAC with 'A' grade)

PRAGNANAM BRAHMA

ANITS

CERTIFICATE

This is to certify that the project work entitled "DESIGN AND ANALYSIS OF A HELMET USING GLASS FIBRE REINFORCED COMPOSITE MATERIAL" is a bonafide work carried out by G.SRAVYA (314126520065) , B.V.AKHIL KUMAR (314126520017) , B.DILIP KUMAR (314126520009) , E.RAJEEV (314126520048), CH.J.GEETHA (314126520028), during the year 2017-2018 under the guidance of M.N.V.KRISHNAVENI, M.E., Assistant professor, in partial fulfilment of the requirement for the award of the degree of Mechanical engineering, Anil Neerukonda Institute Of Technology And Sciences, Visakhapatnam.

Project Guide

M.N.V.KRISHNAVENI , M.E
Assistant Professor

Approved by

24.4.18

Dr.B.NAGARAJU
Head of the Department
Dept. of Mechanical Engineering
ANITS, Sangivalasa
Visakhapatnam

PROFESSOR & HEAD
Department of Mechanical Engineering
ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY & SCIENCES
Sangivalasa 531 162 VISAKHAPATNAM Dist A P

THIS PROJECT IS APPROVED BY THE BOARD OF EXAMINERS

INTERNAL EXAMINER:

Dr. B. Naga Raju
M.Tech,M.E.,Ph.d
Professor & HOD
Dept of Mechanical Engineering
ANITS, Sangivalasa,
Visakhapatnam-531 162.

EXTERNAL EXAMINER:

ACKNOWLEDGEMENTS

It is a great pleasure to express our gratitude and indebtedness to our Project Guide M.N.V.KRISHNAVENI, M.E., Assistant Professor, Department of Mechanical Engineering , ANITS for her guidance,encouragement, moral support and affection throughout our work.

We are thankful to the management of ANITS & Principal Prof. T.V.HANUMANTHA RAO, for sharing his valuable knowledge for the completion of the work. And also thankful to Dr.B.NAGARAJU, HOD of Mechanical for his moral support. We would also like to thank our friends at Anits for their whole hearted support.

We would like to express our sincere thanks to all the teaching and non-teaching staff of mechanical engineering department for their direct and indirect help in completing this thesis work.

We shall be failing in our duty if we forget to thank all other people who helped us in completing of this project work.

ABSTRACT

Helmet plays a vital role for the safety of the rider and hence it has to be designed with due considerations for stresses and deformations that cause brain damage which effects the safety of the rider. In this project a 3D model helmet has been designed in CATIA for modeling. In a regular helmet there will be three layers- the outer shell, the liner and comfort padding.

In this parametric study of modeling the helmet the critical positions of impact was identified. The three layered helmet was analysed for different material compositions. In this design combination, glass fibre composite material and Acrylonitrile Butadiene Styrene (ABS) are considered.

In this project, the effect of dynamic impact loads on the helmet under velocities of 20m/sec (72kmph) and 30m/sec (108kmph) which are the real time conditions were studied.

When compared Acrylonitrile Butadiene Styrene with the three different combinations of glass fibre reinforced composite material, the best material for helmet that can resist more stresses, strains and deformations. With increase in the density of the material ,mass increases.

CONTENTS

ACKNOWLEDGEMENT	
ABSTRACT	PAGE NO
LIST OF FIGURES	
CHAPTER-1: INTRODUCTION	1
1.1 How a helmet works	2
1.2 What helmets don't do	3
1.3 Motor cycle helmet material and function	3
1.3.1 Does the color of a helmet matter	3
1.4 Types of helmets	4
1.5 Helmet use is effective at reducing head injuries	5
1.6 International support for helmet Wearing	6
1.6.1 Helmet programmers are effective at getting helmets on heads	6
1.7 Hospital cost are reduced by helmet use	8
1.8 The mechanism of head injuries	9
1.8.1Bicycle helmets decrease the risk of head and brain injuries	11
1.8.2 Helmet laws: the effect of repeal	12
1.9 Fabrication of composites	14
CHAPTER-2: LITERATURE REVIEW	18
CHAPTER-3 : MODELLING	26
3.1 Helmet Design	27

CHAPTER-4:DESIGNING

4,1 Introduction of Catia 29

4.2 Commands 30

4.2.1 Panning Objects 30

4.2.2Rotating Objects 31

4.2.3Zooming 32

4.2.4Moving the Tree 32

4.3 Terminology 33

4.4 Design procedure 34

CHAPTER-5:ANALYSIS

5.1 Introduction 46

5.1.1 Material properties 47

5.2 Procedure 48

CHAPTER-6: RESULTS 53

CONCLUSIONS AND SCOPE OF FUTURE 59

REFERENCES 60

LIST OF FIGURES

	PAGE NO
Fig 1.1 Components of a helmet	2
Fig 1.4 Types of helmet	5
Fig 1.7 Comparison of wearing and non wearing of helmet	8
Fig 1.8 Structure of the head and brain	9
Fig 1.8.1 Types of injuries	10
Fig 2.1 Helmet drop tower	20
Fig 2.2 Different oblique test methods and angled impact surface	23
Fig 3.1 Standard Dimensions of various parts in Helmet	27
Fig 4.2.2 Rotation of the object	31
Fig 4.4 Ellipse	34
Fig4.4.1sweep	35
Fig 4.4.2 sweep and plains	35
Fig4.4.3 Split	36
Fig 4.4.3.1 Drawing arc	36
Fig4.4.4 sphere	37
Fig4.4.4.1 Arc point	37
Fig 4.4.5 Extrude the line	38
Fig4.4.6Split 2	38
Fig4.4.7 split and sweep	39
Fig4.4.4.1Arc point	39
Fig 4.6 Split and thickness of helmet	40
Fig 4.7 split and thickness of helmet	41

Fig 4.8 offset and thickness of helmet 41

Fig 4.9 Final sketch 42

Fig4.10All Views 43

Fig4.11Assembly 44

Fig 6.1 Total deformation (time Vs deformation) (velocity 20m/s) 53

Fig 6.2 Total equivalent elastic strain (time Vs strain) (velocity 20m/s) 54

Fig 6.3 Total equivalent stress (time Vs stress) (velocity 20m/s) 55

Fig 6.4 Total deformation (time Vs deformation) (velocity 30m/s) 56

Fig 6.5 Total equivalent elastic strain (time Vs strain) (velocity 30m/s) 57

Fig 6.6 Total equivalent stress (time Vs stress) (velocity 30m/s) 58

CHAPTER-1

INTRODUCTION

CHAPTER-1

INTRODUCTION

Helmet plays a vital role in driving the motorcycles now a days. The main purpose of a motorcycle helmet is safety to protect the rider's head during impact, thus preventing or reducing head injury and saving the rider's life. Some helmets provide additional conveniences, such as ventilation, face shields, ear protection, etc....

In 2008, a systematic review examined studies on motorcycle riders who had crashed and looked at helmet use, the review concluded that helmets reduce the risk of head injury by around 69% and death by around 31%.About 31 thousand people die and 1.6 million people are injured every year. Motorcyclists are less protected against road accidents than the users of some other vehicles. Road accident injuries are a major public health problem and a leading cause of death and injury around the world. Injuries to head and neck many times prove to be fatal or else it leads to coma or a severe trauma to the rider. To reduce the fatality rate and improve the safety, the designs of helmet become vital.

Different helmets do different things. There are hard hats on construction and heavy-industry heads; football helmets on athletes' heads, and Kevlar caps on military heads. None are interchangeable. Motorcycle helmets are very sophisticated and specialized for the activity. They have been developed carefully and scientifically over the years.

Four basic components work together to provide protection in the motorcycle helmet:

1)outer shell, 2)Impact-absorbing liner 3)Comfort padding; and 4) Retention system.

The outer shell, usually made from some family of fiber reinforced composites or thermoplastics like Polycarbonate. This is tough stuff, yet it's designed and intended to compress when it hits anything hard. That action disperses energy from the impact to lessen the force before it reaches your head, but it doesn't act alone to protect you.

Inside the shell is the equally important impact-absorbing liner, usually made of expanded polystyrene (commonly thought of as Styrofoam). This dense layer cushions and absorbs shock as the helmet stops and your head wants to keep on moving. Both the shell and the liner compress if hit hard, spreading the forces of impact throughout the helmet material. The more impact-energy deflected or absorbed, the less there is of it to reach your head and brain and do damage. Some helmet shells delaminate on impact. Others may crack and break if forced to take a severe hit; this is one way a helmet acts to absorb shock. It is doing its intended job. Impact damage from a crash to the non-resilient liner may be invisible to the eye; it may look normal, but it may have little protective value left and should be replaced.

The comfort padding is the soft foam-and-cloth layer that sits next to your head. It helps keep you comfortable and the helmet fitting snugly. In some helmets, this padding can even be taken out for cleaning.

The retention system, or chin strap, is very important. It is the one piece that keeps the helmet on your head in a crash. A strap is connected to each side of the shell. Every time you put the helmet on, fasten the strap securely. It only takes of couple of seconds. To ride without your helmet secured would be as questionable as driving without your seatbelt fastened.

1.1 HOW A HELMET WORKS:

A helmet aims to reduce the risk of serious head and brain injuries by reducing the impact of a force or collision to the head. A helmet works in three ways: It reduces the deceleration of the skull, and hence the brain movement, by managing the impact. The soft material incorporated in the helmet absorbs some of the impact and therefore the head comes to a halt more slowly. This means that the brain does not hit the skull with such great force. It spreads the forces of the impact over a greater surface area so that they are not concentrated on particular areas of the skull. It prevents direct contact between the skull and the impacting object by acting as a mechanical barrier between the head and the object. These three functions are achieved by combining the properties of four basic components as shown in (Fig.1)

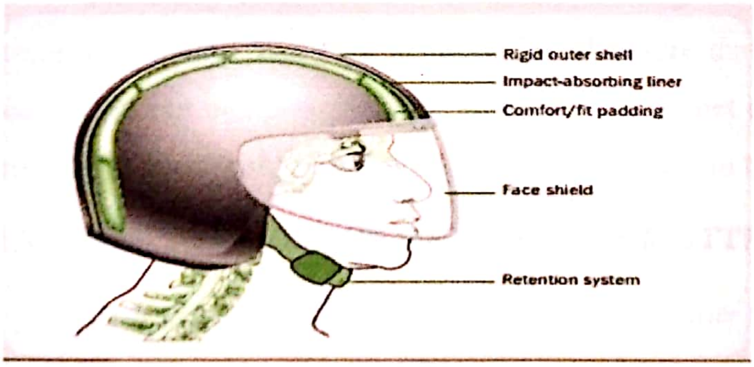


Fig 1.1 Components of helmet

1.2 WHAT HELMETS DON'T DO:

Helmets are designed to reduce the chances of head, brain, and facial injuries occurring, but are not designed to prevent injuries to other parts of the body. To reduce the likelihood of injuries to other parts of the body, the following strategies can be employed

Appropriate clothing can be helpful to reduce other types of injuries (for example, jacket and trousers of particular materials which cover arms and legs completely, sturdy shoes or boots, gloves which give a better grip and protect the hands in the event of a crash).

Obeying the laws of the road, including adhering to speed limits and not driving while drunk are behaviours that will reduce the chance of a motorcyclist being involved in a crash, and thus their likelihood of incurring any type of injury.

1.3 MOTOR CYCLE HELMET MATERIAL AND FUNCTION:

In addition to meeting the previously described functions and conforming to standards (to be discussed in Module) a helmet needs to be designed to suit the local weather and traffic conditions. The following are some of the considerations usually addressed by helmet designers:

Materials used in the construction of a helmet should not degrade over time, or through exposure to weather, nor should they be toxic or cause allergic reactions. Currently, the plastic materials commonly used are Expanded Poly-Styrene (EPS), Acrylonitrile Butadiene Styrene (ABS), Poly Carbon (PC) and Poly Propylene (PP). While the material of the helmet shell generally contains PC, PVC, ABS or fibre glass, the crushable liner inside the shell is often made out of EPS – a material that can absorb shock and impact and is relatively inexpensive. However, helmets with EPS liners should be discarded after a crash, and in any case users should replace such helmets after 3–5 years of use.

Standards often set the minimum coverage of a helmet. Half-head helmets offer minimal coverage. Full-face helmets should ensure that the wearer's peripheral vision and hearing are not compromised. To ensure that a helmet can absorb the shock of a crash, the crushable liner should be between 1.5 cm and 3.0 cm in thickness.

1.3.1DOES THE COLOUR OF A HELMET MATTER

Research in New Zealand has examined whether the colour of a helmet affects the risk of a crash .The study compared motorcycle drivers who had been involved in motorcycle crashes that led to hospital treatment with those who had not (as a control group), while examining the colour of the helmets worn by all study participants .The results showed that higher proportions of drivers who had been involved in crashes reported wearing black helmets, while fewer reported white helmets .Compared with wearing a black helmet, use of a white helmet was associated with a 24% lower risk of crash .Similarly, having a "light-coloured" helmet compared with a "dark-coloured" one was associated with a 19% lower risk of a crash .The researchers concluded that some 18% of crashes could be avoided if non white helmets were eliminated similarly, 11% could be avoided if all helmets were not "dark".

Although the results of the study cannot necessarily be generalized to other settings or countries, it seems reasonable to assume that there is greater protection from white helmets as opposed to black ones, and from lighter-coloured ones generally as against darker ones. The study therefore suggests that policies encouraging white and lighter-coloured helmets can help prevent motorcycle crashes.

1.4 TYPES OF HELMETS:

FULL FACE HELMETS:

These helmets offer facial protection in addition to impact protection. Their principal feature is a chin bar that extends outwards, wrapping around the chin and jaw area. Extending above the jaw, there is a vision port that allows the wearer maximum range of sight, in line with the requirements for peripheral and vertical vision.

OPEN FACE HELMET:

Open-face helmets give standard protection from impact with their hard outer shell and crushable inner liner. Compared to the full-face type, they offer only limited protection for the jaw and chin area. They may or may not have retractable visors to protect the eyes.

HALF HEAD HELMET:

These helmets provide protection by means of a hard outer shell and a crushable inner liner. They do not offer protection for the chin or jaw area and are rarely equipped with visors. The half-head helmet may or may not have ear flaps attached to the retention system.

HELMETS FOR TROPICAL:

These are helmets specifically designed for South Asian and South-East Asian countries with extremely hot and humid climates. They are actually half-head helmets with ventilation holes to provide a maximum flow of air so as to reduce the heat. Their extreme lightness of weight is achieved by using semi-rigid vacuum-forming PVC material.

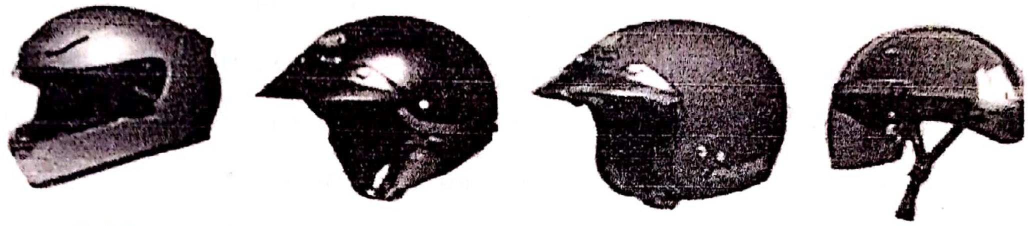


Fig 1.4

1.5 HELMET USE IS EFFECTIVE AT REDUCING HEAD INJURIES:

Wearing a helmet is the single most effective way of reducing head injuries and fatalities resulting from motorcycle and bicycle crashes. Motorcyclists who do not wear helmets are at a much higher risk of sustaining head injuries and from dying from these injuries. In addition, riders who do not wear helmets place additional costs on hospitals (see boxed example below), while the disability that results from these head injuries incurs costs at an individual, family (or carer) and societal level.

There is considerable research that has been conducted on the effects of wearing a helmet on the risk of a head injury as a result of a collision. The results show slightly different effects, depending on the study type, population, situation etc. Consequently it is useful to examine this research collectively in what is known as a systematic review on the topic of interest. Systematic reviews of studies are a means of objectively examining the evidence for a particular claim (in this case, helmet use in preventing head injury) and combining the results in a way that minimizes any bias. Reviewers conducting such reviews search widely for all the studies on the topic and include those of a sufficiently high methodological quality.

When the data from all the studies included in the review are summarized, the result should provide a more accurate estimate of the effect of the intervention than is possible from individual studies.

1.6 INTERNATIONAL SUPPORT FOR HELMET WEARING:

International recommendations provide strong support for countries to implement programmes that legislate for mandatory helmet use. Some countries may use the international policy environment and international law as a means of providing the necessary impetus for developing national policies on helmet use .International agreements can also be used by civil societies to advocate for helmet law reform in their own countries.

The World report on road traffic injury prevention recommends that all countries, regardless of their level of income, follow several good practices, including "set-ting and enforcing laws requiring riders of bicycles and motorized two-wheelers to wear helmets".

In 2004, the World Health Assembly adopted Resolution WHA which recommends Member States "especially developing countries, to legislate and strictly enforce wearing of crash helmets by motorcyclists and pillion riders". The World Health Assembly resolution is an international agreement that can be used by those wishing to influence policy on helmet use as a basis for obtaining political support for this measure .In particular, such a resolution has direct relevance for ministries of health, who, by adopting WHA resolutions undertake to support the principles enshrined in them.

United Nations General Assembly Resolution "Invites Member States to implement the recommendations of the World report on road traffic injury prevention including those related to the five main risk factors, namely the non-use of safety belts and child restraints, the non-use of helmets, drinking and driving, inappropriate and excessive speed, as well as the lack of appropriate infrastructure" .

1.6.1 HELMET PROGRAMMERS ARE EFFECTIVE AT GETTING HELMETS ON HEADS:

Laws making helmet use compulsory are important in increasing the wearing of helmets, especially in low-income and middle-income countries where helmet-wearing rates are low, and where there are large numbers of users of motorized two-wheelers.

There have been many studies that have evaluated the impact of motorcycle helmet laws on helmet-wearing rates, head injury or death. When mandatory helmet laws are enforced, helmet-wearing rates have been found to increase to 90% or higher .when such laws are repealed, wearing rates fall back to generally less than 60% .

The pattern is similar with regard to the effects of such laws on head injuries. A number of studies have shown that the introduction of helmet laws reduce head injuries and death, while many studies demonstrate that an Increase in head injuries and death results when helmet laws are repealed. For example, a number of studies in Texas, USA, have shown that introducing comprehensive motorcycle helmet legislation is associated with a decrease in injuries and fatalities. In one of these studies there was a decrease in injury rates of between 9–11% while another showed more striking reductions of 52–59% in head injuries and fatalities.

Conversely, repeal of helmet legislation in Florida led to increases of between17.2%–20.5% in both fatalities and fatality rate. It is clear that introduction of full legislation (that is, applying to the whole population) is associated with a significant decrease in head injuries and deaths. There is a clear imperative for policymakers to legislate and enforce motorcycle helmet wearing at a population level. Weak or partial legislation that mandates helmet wearing for those less than 21 years, without medical insurance or only on certain types of roads does not effectively protect those at risk and should be upgraded to comprehensive coverage.

However, it is important to note that most studies that examine the impact of motorcycle helmet laws have been conducted in high-income countries where legislation when introduced is heavily enforced, and motorcycle helmet quality is high.

Although it seems very likely that the introduction of motorcycle helmet wearing legislation in low-income or middle- income countries will decrease fatality rates among motorcyclists at a population level if helmet-wearing rates are high, there are several unknown factors. Availability of high-quality helmets is not widespread across such countries and the effectiveness of the available helmets is also unknown.

Enforcement is also a factor that must be considered. In low-income and middle-income countries where police resources are constrained and community attitudes to helmet wearing are not supportive of legislation, effective enforcement requires widespread government support.

Legislation is most likely to work where high-quality helmets are accessible and affordable, where enforcement is comprehensive and there is widespread community education on the benefits of helmet use.

It is therefore important that when motorcycle helmet wearing legislation is introduced in low-income and middle-income countries, there is effective enforcement, a ready supply of affordable helmets of appropriate quality (which meet international or country standards), and widespread education campaigns for both community and police. It is also imperative that the evaluation of such legislation is planned prior to implementation, so that evaluation of the effectiveness of the intervention may be carried out.

1.7 HOSPITAL COST ARE REDUCED BY HELMET USE:

Researchers in Michigan, USA, studied the impact of motorcycle helmet use on patient outcomes and cost of hospitalization .Despite Michigan's mandatory helmet law, 19% of the 216 patients included in the study were not using helmets when they crashed, allowing the researchers to compare costs among helmeted and unhelmeted riders .On average, helmet use led to average hospital costs that were about 20%, or US$ 6000, less than costs for those who did not wear helmets .For patients who were treated on an inpatient rehabilitation floor after leaving the trauma unit, average costs for unhelmeted riders were nearly twice those of helmeted riders, in part due to the fact they were kept in hospital longer .The results also confirmed earlier findings that riders without helmets were younger, suffered more head and neck injuries, and had higher overall injury severity scores .Failure to wear a helmet adds to the financial burden created by motorcycle-related injuries .The authors concluded that individuals who do not wear helmets should therefore be required to pay higher insurance premiums .

Not wearing a helmet	Wearing a helmet
increases the risk of sustaining a head injury; increases the severity of head injuries; increases the time spent in hospital; increases the likelihood of dying from a head injury.	decreases the risk and severity of injuries by about 72%; decreases the likelihood of death by up to 39%, with the probability depending on the speed of the motorcycle involved; decreases the costs of health care associated with crashes.

Fig 1.7 Comparison of wearing and non wearing of helmet

1.8 THE MECHANISM OF HEAD INJURIES:

An appreciation of the anatomy of the head is important in understanding the mechanism of injuries to the head and brain. Briefly, the important anatomical information about the head to note is the following:

1) The brain is enclosed within a rigid skull.

2) The brain "sits" on bones that make up the base of the skull.

3) The spinal cord passes through a hole in the underside of the brain.

4) Under the skull, adhering to the bones, is a tough tissue called the dura that surrounds the brain.

5) Between the brain and the dura is a space containing cerebrospinal fluid that protects the brain tissue from mechanical shock.

6) The brain "floats" in the cerebrospinal fluid but it can only move about 1 millimetre in any direction.

7) T he skull is covered by the scalp, which provides some additional protection.

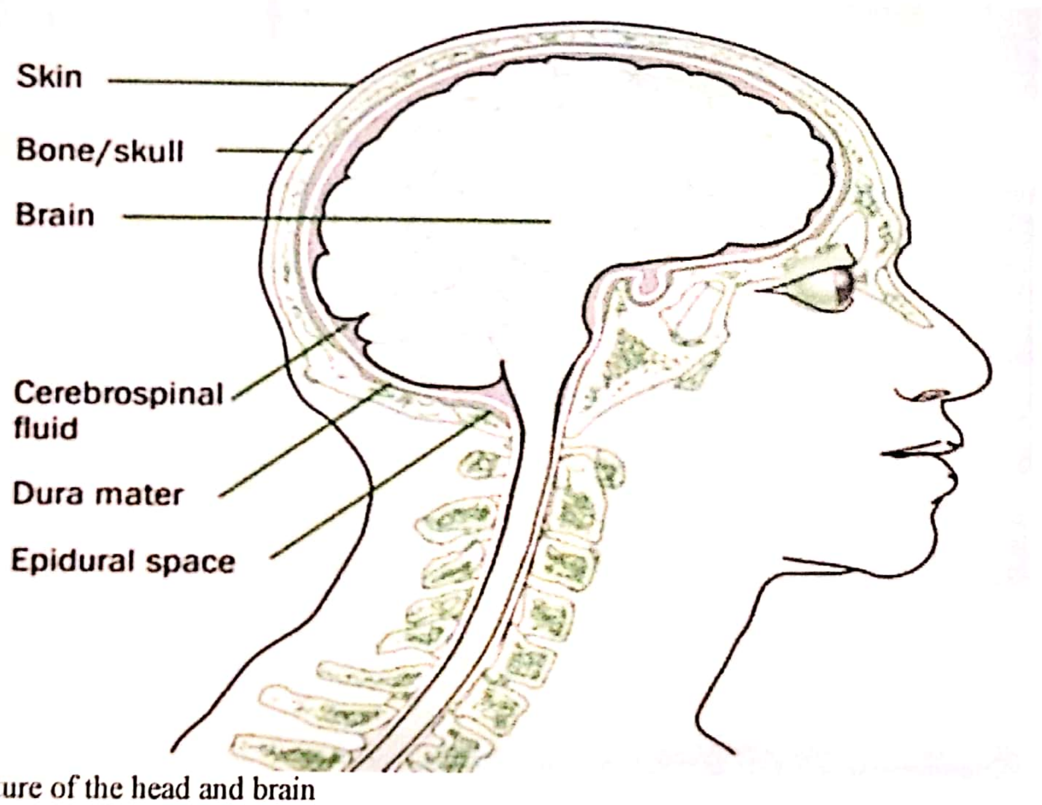


Fig 1.8 structure of the head and brain

During a motorcycle or bicycle crash there are two principal mechanisms of injury to the brain: through direct contact and through acceleration–deceleration. Each mechanism causes different types of injuries.

When a motorcycle or bicycle is involved in a collision, the rider is often thrown from the cycle. If the rider's head hits an object, such as the ground, the head's forward motion is stopped, but the brain , having its own mass , continues to move forward until it strikes the inside of the skull. It then rebounds, striking the opposite side of the skull.

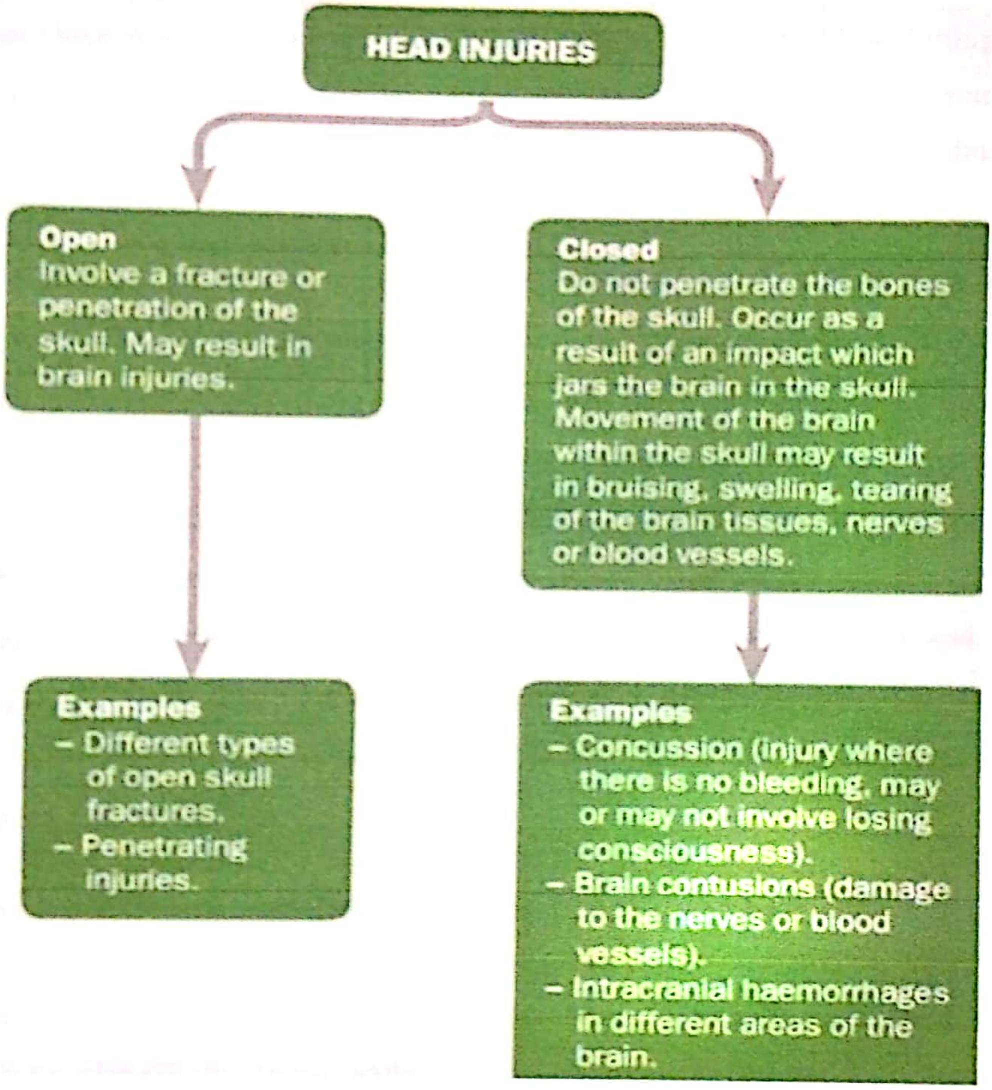


Fig 1.8.1 Types of head injuries

1.8.1 BICYCLE HELMETS DECREASE THE RISK OF HEAD AND BRAIN INJURIES

Bicycles are an important means of transportation in many parts of the world . They are Accessible , economical and non-polluting . With a growing recognition of the problem of obesity and lack of physical activity in many countries , bicycling offers a enjoyable means of recreation and vigorous physical activity . The promotion of bicycle use is therefore to be encouraged widely. Bicycling , though, does have associated risks . Approximately two-thirds of serious injuries to cyclists requiring hospitalization and three-quarters of cyclists'deaths are due to head injuries.These injuries can occur from falls following a loss of control,from hitting a hole in the road, or from colliding with another bicycle or a motor vehicle. Head injuries are a major source of disability everywhere, and create an enormous burden on the victims' families and on society.

Prevention of head injuries is thus an important goal.Studies over the last 15 years in the United States, Europe, Australia and New Zealand indicate that bicycle helmets are very effective in decreasing the risk of head and brain injuries.There have been five case control studies of helmet effectiveness , in which individuals who sustained head or brain injuries through a bicycle crash were compared to those who received injuries not involving the head . Taking all the studies together, it was found that wearing a helmet decreased the risk of a head injury by 69%. Head injury is a broad term and includes injuries tothe scalp, the skull and the brain. Considering brain injury alone –the most serious type of injury helmets decrease the risk of brain injury also by 69%and the risk of severe brain injury by 79%.Helmets.appear to be similarly effective for all age groups.

Including young children and older adults .One concern expressed is that helmets might not beeffective for people hit by motor vehicles while ridingtheir bicycles. The studies, though, indicate that helmets are equally effective for crashes involving motor vehicles as for those that do not.Helmets are also effective in preventing injuries tothe middle and upper portions of the face – the areaabove the upper lip. Helmets decrease the risk ofinjuries to this part of the face by about two-thirds,probably because of the "overhang" of the helmet.

The fact that helmets are effective in preventing a potentially devastating injury should inform public policy. Different types of programmes have been foundeffective in promoting helmet use, especially amongchildren. These consist of educational programmes, programmes to reduce thecost of helmets, and legislation mandating helmet use.Such programmes should carry a single, clear message Wear Helmets and be disseminatedwidely to people in many different settings.Helmets can usually be provided at a reducedcost through bulk purchases or through arrangements between non governmental organizations,manufacturers and retail outlets. Legislation hasbeen shown to be effective in increasing helmet use in a number of countries , including the United States and Australia . All injuries should be considered to be preventable.This is clearly the case with head injuries related to bicycling.

1.8.2 HELMET LAWS: THE EFFECT OF REPEAL

The enactment of motorcycle helmet laws is under the jurisdiction of individual states, and has been the subject of on going debate on the balance between personal freedom and public health. Those opposed to mandatory helmet laws argue that such laws infringe upon their individual rights . On the other hand, those who support them argue that since society bears the burden of the financial costs of motorcycle crashes, there is a public interest in and a justification for legislating for helmet use. Over the years, states have variously enacted, repealed, and re-enacted "universal" motorcycle helmet laws–laws applying to all riders of motorcycles.

In 1996, a federal policy tying motorcycle helmet laws to the receipt of government funding led to 47 states enacting universal helmet laws. After this policy was withdrawn the following year, though,many states quickly repealed their helmet laws, or amended them so that they applied only to young riders.

The consequences of these repeals of helmet laws have been as follows:

1)Observed helmet use in a number of states dropped from nearly full compliance while the law existed, to around 50% after repeal.

2)In several states, there were immediate and dramatic increases in the numbers of motorcyclists without helmets who were involved in crashes.

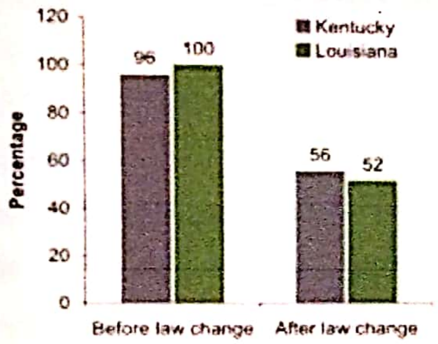
3) Deaths of riders under the age of 21 increased even though the law still applies to these users.In Florida, deaths to these young riders increased by 188 percent.

4) Increases were recorded in head injuries and fatalities among motorcycle users. For example,the rate of motorcyclist fatalities rose by 37% and 75% in Kentucky and Louisiana, respectively, following the repeal of their mandatory laws.

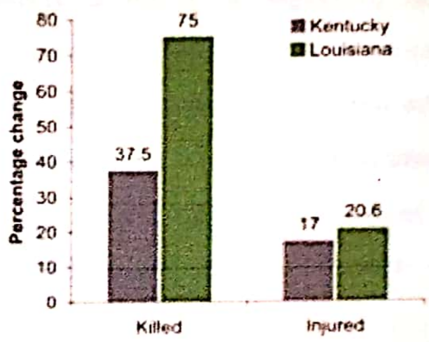
5) Associated with the increase in severity of head injuries was an increase in the costs of treating them. For example, in Florida the total gross acute care costs charged to hospital-

admitted motorcyclists with head, brain or skull injury more than doubled, from US$ 21 million to US$ 41 million,adjusted for inflation. The average costs per case rose from US$ 34 518 to US$ 39 877 in the 30months after the law change.

The pattern of evidence from the states that have altered their laws on helmet use indicates that motorcycle helmets reduce the severity of injuries incurred in a crash; that the repeal of helmet laws decreases helmet use; and that states that repeal universal helmet laws experience an increase in motorcycle fatalities and injuries.



Observed helmet use before and after repeal of helmet law in Kentucky and Louisiana



Change in fatality and injury rates two years after helmet law repeal in Kentucky and Louisiana

1.9 FABRICATION OF COMPOSITES

Hand lay-up is the most widely used fabrication technique employed in the reinforced plastic industry. It is normally used for relatively short runs, but it has also been adapted successfully for series production. It is a production method which takes full advantage of the two most important characteristics of Polyester resin i.e. that it cures without heat and without pressure.

Briefly the mould surface is prepared by polishing to whatever degree of surface finish is require, then a Release Agent is applied. The next step is to apply a resin rich surface (Gelcoat). After this has cured sufficiently liquid Polyester Resin is brushed onto the gelcoat surface, Glassfibre Mat is placed on the top and each layer is then impregnated with resin . The laminate is then allowed to cure at room temperature and the dependant on conditions and the type of the resin used,the cure time can vary from 1 hour to 4 hours – see Catalyst Mixing Chart.

1. The first step is to prepare a suitable mould.

2. Apply a film of Release wax polish (silicone free) to the mould surface, keeping the quantity to a minimum. This is then polished out with a fine cloth to a high polish. Some types of wax used to be left to harden but all waxes must be used to manufacturer's recommendations.

3. A film of polyvinyl alcohol solution (PVA) is applied evenly, by spray or sponge, over the whole of the mould surface and allowed dry at room temperature . Because of its low viscosity , a PVA solution will drain from vertical sections and accumulate in sharp corners where it may that long time to dry . If this is not prevented and the moulding is laid up too soon , it will almost certainly stick and some damage may be done to the mould.

4. The durability of GRP moulding is mainly dependant on the quality of its exposed surface. Every possible precaution must be taken to prevent fibres from coming too near the surface where they be liable to be attacked by moisture. This is achieved by providing a resin rich area on the working surface of the laminate.

5. The next step in the process is the layup of the glass fibre reinforcement (Chopped Strand Mat) with the Polyester resin. Laying up can be started as soon as the gelcoat has hardened sufficiently to withstand solvent attack from the laminating resin. The simplest way of checking this is to touch the back of the Gelcoat lightly with a clean finger. If the Gelcoat feels slightly tacky, but the finger comes away perfectly clean, then the gelcoat is just at the right stage for laminating. Sometimes a Glass Tissue may be laminated next to the gelcoat in anti-corrosion applications. This also helps to cut down the risks of the glass fibre pattern showing on the Gelcoat surface.

6. Chopped strand fibre glass mat is the most usual reinforcement although Woven Roving can be used. Woven Roving however should have at least 2 layers of the reinforcement mat between them and the gelcoat otherwise the 'chequered' pattern of the rovings will show through. Woven rovings should not be used adjacent to one another because they have poor inter laminar adhesion. Consequently at least one layer of the reinforcement mat between the layers of woven rovings is recommended. The reinforcement should be prepared before the laminating begins. It can be cut to size and tailored if necessary with a scissors or a sharp knife. The amount of resin required can be calculated by weighting the glass fibre to be used for the moulding. For chopped strand mat the resin: gloss ratio is usually between 3:1 and 2:1 by weight. (25-33% glass by weight) – see Material Calculator.

7. At this stage Pigment is added to the resin (if desired). A quantity of pigment paste is mixed into the resin preferably with a mechanical mixer to achieve even dispersion . The majority of resins used are pre-accelerated and only require the addition of Catalyst to activate them before use.The quantity of Pigment, will have been obtained from information supplied with the resin, which will give quantity of catalyst for a given working temperature to achieve the desired pot life.

8. A liberal coat of resin is brushed over the gelcoat as evenly as possible and the first layer of the glass is pressed firmly into place and consolidated with a Brush or Paddle Roller . The resin will impregnate the gloss mat quite rapidly ad dissolve the binder which holds the fibres

together.The mat will thus conform readily to the contours of the resin should be applied on top of the mat until it is fully impregnated because this may lead to air bubbles being trapped . When the laminate is contains air bubbles it is a milky colour (this is true only of course if the laminate is made using unpigmented resin). As the air is being released the colour of the laminate will change to the natural colour of the resin . When a Brush is used , or impregnated it should be worked with a stippling action not moved sideways across the surface. The normal brushing action will displace the fibres and distribute them unevenly . Consolidation of the laminate is quicker with a Paddle Roller that a brush. Adjacent pieces of Chopped Strand Mat should be overlapped by tearing rather than cutting.

9. Subsequently layers of resin and glass mat are applied until the requires thickness has been built up (see Material Calculator) , taking care that overlaps are staggered to prevent local excessive thickening, causing uneven cure and shrinkage. Each layer must be worked until it is completely impregnated. Where a thick layer of laminate is required no more than four layers of the resin and glass mat should be applied without allowing the resin to reach the state of gelation and most of the exotherm to take place. This is to avoid a build-up of exotherm which may result in either cracking on the surface of the gelcoat, pre-release of the moulding due to excess shrinkage or discolouration of the pigmented resin.

10. During the layup operation, it is possible to incorporate wood and metal straighteners, also fitting and sandwich materials such as paper honeycomb, Polyurethane Foam or balsa wood. This lamination should not take place until the main laminate has passed the 'green stage' i.e. cured to a certain degree, otherwise the addition of ribs etc. will cause localised excess shrinkage and on mould release there will be found to be a 'ripple' on the gelcoat opposite the fitting.

11. When a smooth finish is required on the reverse side of the moulding i.e. the working side, a suitable Glass Tissue can be used as the final layer of reinforcement. This will give a finish which is not as coarse as Chopped Strand Mat and can look attractive when painted.

12. After the resin, has gelled it is in a soft rubbery state and green for a limited period. In this condition the laminate can be quickly trimmed by hand with a sharp knife to the dimensions of the mould and suitable trim edges can be built into the mould for this purpose.

13. The moulding is allowed to cure either at normal room temperature (20°C) or in a warm room (30-40°C).

14. After removal from the mould the moulding should be allowed to mature for a few days or given a post cure, after 24 hours at ambient, at approximately 60-100°C from 1-4 hours dependant on the final environment of the finished moulding. In many cases, it is advisable to post cure in a jig to avoid distortion.

15. The polyvinyl alcohol film (PVA) is finally removed by washing from the surface of the moulding using soap water.

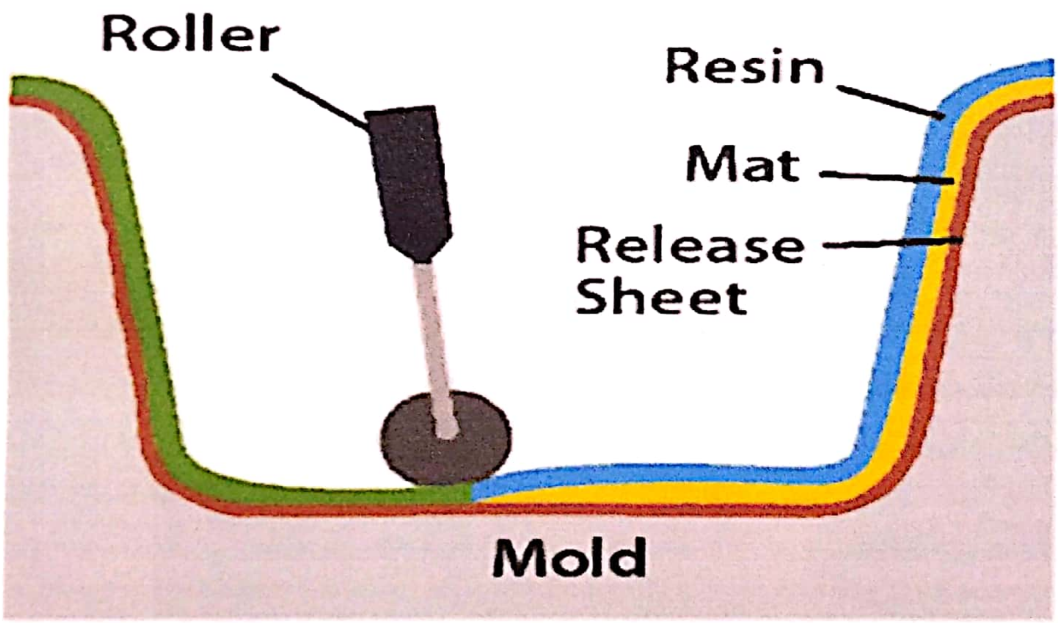


Fig 1.9 Fabrication of composites

CHAPTER-2
LITERATURE REVIEW

CHAPTER-2

LITERATURE REVIEW

Puneet Mahajan [1] In this paper various ventilation models in helmets were investigated .The helmet with ventilation was crushed at 9m/s velocity whereas without ventilation it crushed at 10m/s .Pressure and stresses in the brain were investigated and found not to change significantly due to the presence of grooves in the helmet. Composite studies, Delamination between the plies was not observed at low impact velocities Matrix tensile and compressive damage were observed at 7.5 m/s and 9.0 m/s velocities. 2% energy was absorbed by the cohesive layer at 9m/s velocity .Composite shell didn't absorb much energy compared to ABS shell. And experiments were performed on open-face helmets Impact analysis with Metal foam shell was carried out and found the lower contact forces on the head compared to ABS shell. The weight of the shell is reduced by 73% with low-density metal. VonMises stress in the brain is lower with metal foam.

Danial Lanner and Richard Coomber[2] This paper describes both a numerical and an experimental approach to measuring the ballistic and blunt impact protection offered by military helmets. The primary purpose of military helmets is to protect users from ballistic impact but modern military helmets contain a liner that protects against blunt force as well. Altering ballistic shell stiffness, lining the shell with material of different density, even separating the liner from the shell so that they can move independently, all affect the transfer of stress to the head and the resulting strain experienced by the brain.

The results of this study suggest that there is potential for a helmet that protects the user from both blunt and ballistic impact that can be further improved by implementing an energy absorbing sliding layer, such as the MIPS system, between the shell and the liner to mitigate the effect of oblique impacts.

Gibson [3] This work is based on a dimensional analysis and has shown that the ration of the cell wall thickness to the length of cell determines the foam mechanical properties. The dominant mechanism for foam linear elastic deformation is the elastic bending of the thick cell walls. In the plateau phase of deformation which dictates energy absorption:

(i) Elastic cell wall buckling leads to nonlinear elastic behavior.

(ii) Plastic collapse is due to the stress exceeding the polymer yield stress value.

(iii) Brittle crushing occurs when the surface stress exceeds the failure stress.

During the densification process, the modulus of the foam is equivalent to that of the base polymer when the voids have been compressed.

Andrew Post ,Anna Oeur and T.Blaine Hoshizaki [4] The nature of this injury can be influenced by the mass of the impacted, velocity, compliance, and direction of impact. As a result it is important to characterize how American football helmets perform against these impact characteristics. The purpose of this research is to examine how an American football helmet performs across velocities and impact angles which can occur in the sport of American football. The methods used a combination of Hybrid III head form impacts combined with a finite element modelling approach to find the brain deformation variables known to be associated with conclusion. The results indicated that the American football helmets performed best at 5.5 and 7.5 m/s. At 9.5 m/s.

The brain deformation metrics showed a sharp increase in risk of concussion. Also, the region of the brain with the largest magnitude deformation shifted with differing velocities. The results indicate that current football helmet designs should expand the energy absorbing capacity of the shell and liner to accommodate these impact conditions.

Mazdak Ghajari [5] In this paper, the methods of the European, American, British, Australia and New Zealand and Snell (M2010) standards for evaluating the impact absorption performance of motorcycle helmets are described and compared. The compared features are the test apparatus, impact initial conditions, impact points, impact output and the approva l

limit. This comparison reveals that these standards adopt the same method for evaluating the impact performance of helmets, which is positioning the helmet on a metal head form and dropping them onto a rigid anvil. During impact, the linear acceleration of the centre of gravity of the Head form is measured; the approval criterion is based on this acceleration.

Several studies on the relevance of this test method to real-life accidents are reviewed and their main findings are summarized. The review includes studies on the interaction between the head and neck during helmet head impacts and those on assessing the performance of helmets during oblique impacts by using rotational acceleration, along with linear acceleration. It appears that in both areas, more research needs to be carried out to be able to influence current standards.

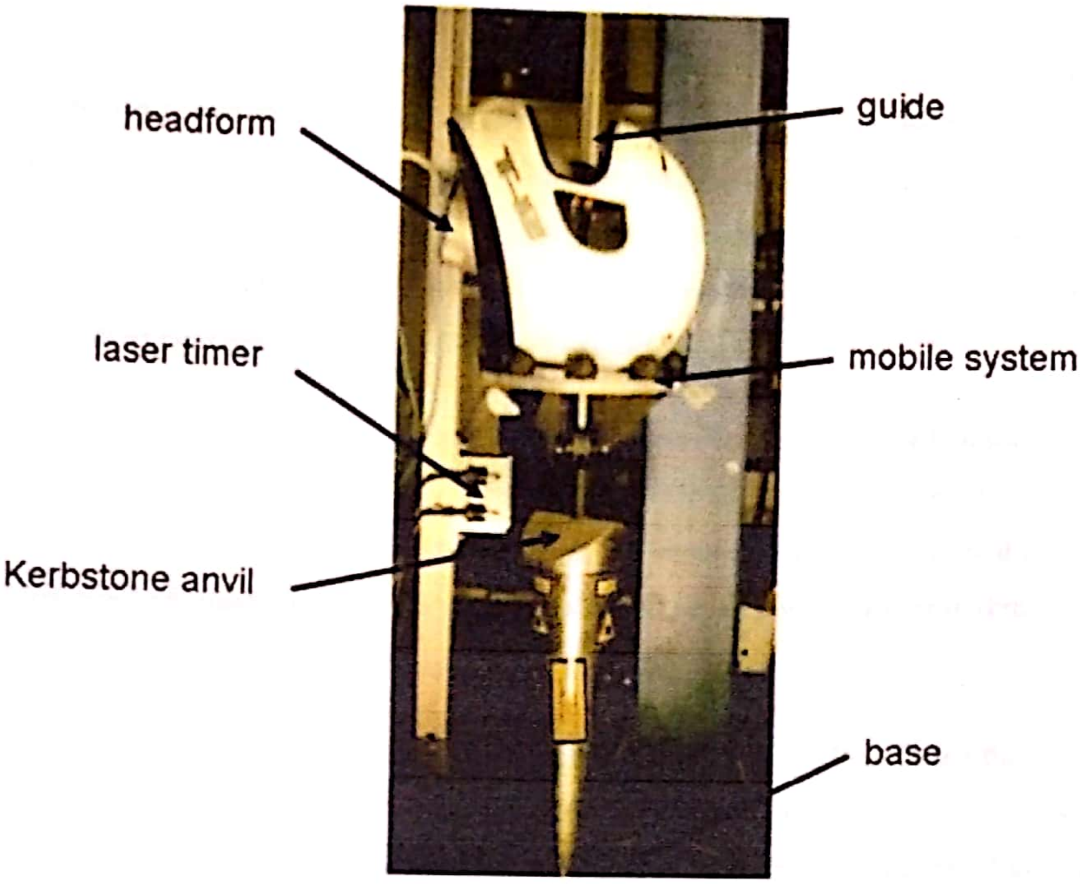


Fig 2.1 Helmet drop tower

K.Anil Kumar and Y.Suresh Babu [6] All helmets attempt to protect the user's head by absorbing mechanical energy and protecting against penetration. Their structure and protectie 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. Wearing an appropriate safety helmet significantly reduces the risk of injury or even death. Protective headwear could save your life. At present strength of the helmet using industry is less due to improper filling of material, uneven pressure distribution and blow holes. The aim of the project is to increase the strength of industrial helmet by making the modify material in existing one.

In order to achieve the objective of the project, the work is carried out in three stages. In the first stage a parametric model is designed by using 3D modeling module in Pro-Engineer software. After designing the helmet, mould flow analysis is carried out on helmet by using plastic advisor which is a module in pro/E. Mould flow analysis is used for finding material filling, pressure distribution, air traps, and weld lines during the injection molding process at constant pressure and different temperature ranges. In the second stage, after completion of the mould flow analysis impact analysis is done on industrial helmet by using COSMOS software for the three different type materials from different heights.

V.C.Satish Gandhi [7] 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 the helmet 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 Misses 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.

Terry Smith,John Lenkeit and Jim Boughton [8] This paper describes an alternative method for helmet design using finite element analysis (FEA). While previous research has illustrated the use of FEA as a tool to simulate standard helmet tests, the objective of this research was to use FEA as a tool to optimize the performance characteristics of the energy absorbing (EA) liner of an existing Navy helicopter pilot helmet (i.e., the HGU-84/P). Three dimensional finite element models (FEM) of the helmet Components and the test head form were developed using MSC software and material properties were estimated from published data and physical tests. A 6.0 m/s flat anvil impact was then simulated at three different sites on the helmet using MSC. Dytran software and these simulations served as the baseline. Full scale impact tests were performed with an exemplars helmet in order to confirm the validity of the simulations as well as the helmet shell and liner material properties.

F.M.Shuaeid,A.M.Shamouda,M.M.Hamdan,R.S.Radinumar,M.S.J.Hashmi[9]The main objective of this paper is to formulate a methodology, which could be for material selection and basic design of motor cycle helmet. Two methods are presented. The first one is based on energy absorption on cushioning curve principle, which is used primarily for packaging design. The work could divided into two parts one is quick energy density comparison method and another is basic helmet design method where principles of mechanics were involved. The second one is mainly two procedure in which one is based on selection from all the available foams, the best is chosen .The another one is more refined solution, which deals with how we can optimize the selection of material, foam density and thickness to maximize the efficiency of helmet performance.

Tamilmaniraj.V and Santhosham [10] In This paper defining the term safety in helmet we need to improve the strength through material and provide a closed surface with less ventilation. It is desired for safety on crash but asthma patient cannot wear the closed helmet for long time so to overcome that a helmet is designing with SOLID WORKS surface model and analysis is carried out in Ansys and CFD fluent 14.5 workbench. Starting from engineering analysis, a model for engineering optimization is developed. Then, we use the survey data collected from the class to develop a microeconomics (demand) model to predict the sales when our products hit the market. At the meantime, we also conduct a deep literature survey to address how we couple customers' demand with our design and manufacturing processes so that our cost estimation model is refined.

P.Viswanadha Raju,Vinod Banthia,Abdul Nassar[11]Two-wheeler is one of the common mode of transportation in India. Being inherently unstable the two-wheelers are more prone to accidents, and account for 10,000 to 15,000 deaths every year. Head hitting the pavement is the main cause of injury and fatality. Hence, use of crash helmet, which reduces the risk of severe brain injury is generally mandated in most of the major cities. To be effective, these helmets have to meet standard impact performance criteria. The resulting enclosed shell design, makes the use of these helmets in hot and humid weather conditions very uncomfortable. Heat stress causes rider discomfort, increasing chances of rider loosing concentration. Providing better ventilation around the head inside the helmet can alleviate the discomfort felt by the rider. In the present work, Computational Fluid Dynamics (CFD) simulation was used to design improved air flow path inside the helmet to enhance the ventilation around rider's head.

The routing of the grooves was designed to also reduce the drag created by the flow around the helmet. Impact absorption test, specified by Bureau of Indian Standards (BIS) was simulated for the redesigned helmet. The head deceleration levels were found to be well within the limits specified by the standards.

Peter Hlldin and Sven Kleiven[12] Injury statistics show that accidents with a head impact often happen with an angle to the impacting object. An angled impact will result in a rotation of the head if the friction is high enough. It is also known that the head is more sensitive to rotation than pure linear motion of the head. CEN has initiated the work to design a new helmet test oblique or angled impact test method a helmet test method that can measure the rotational energy absorption in a helmet during an angled impact. This paper presents a short
t

summary of possibilities and limitations on how to build a helmet test method that can measure the rotational energy absorption in a helmet during an angled impact.

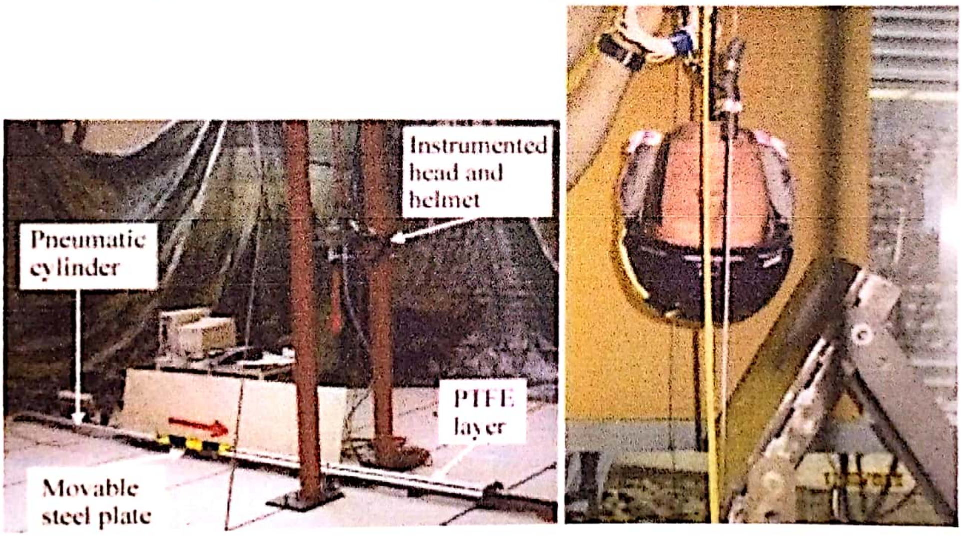


Fig 2.2 DIFFERERNT OBLIQUE TEST METHODS AND ANGLED IMPACT SURFACE

From the above work it is observed that analysis is carried out on whole helmet in the present study, the analysis was done over the two layers of helmet in ansys with different positions are carried out.

CHAPTER-3
MODELLING

CHAPTER-3

MODELLING

CONSTRUCTION OF HELMET:

Modern helmets are constructed from plastics. Premium price helmets are made with fiberglass reinforced with Kevlar or carbon fiber. They generally have fabric and foam interiors for both comfortand protection. Motorcycle helmets are generally designed to distort in a crash (thus expending the energyotherwise destined for the wearer's skull), so they provide little protection at the site of their first impact, butcontinued protection over the remainder of the helmet. Helmets are constructed from an inner EPS "Expanded Poly styrene foam" and an outer shell to protect the EPS. The density and the thickness of the EPS is designed tocushion or crush on impact to help prevent head injuries. Some manufacturers even offer different densities tooffer better protection. The outer shell can be made of plastics or fiber materials. Some of the plastics offer verygood protection from penetration as in lexan (bulletproof glass) but will not crush on impact, so the outer shell will look undamaged but the inner EPS will be crushed. Fiberglass is less expensive than lexan but is heavy andvery labor-intensive. Fiberglass or fiber shells will crush on impact offering better protection. Somemanufacturers will use Kevlar or carbon fiber to help reduce the amount of fiberglass but in the process it willmake the helmet lighter and offer more protection from penetration but still crushing on impact. But this can bevery expensive.

3.1 HELMET DESIGN

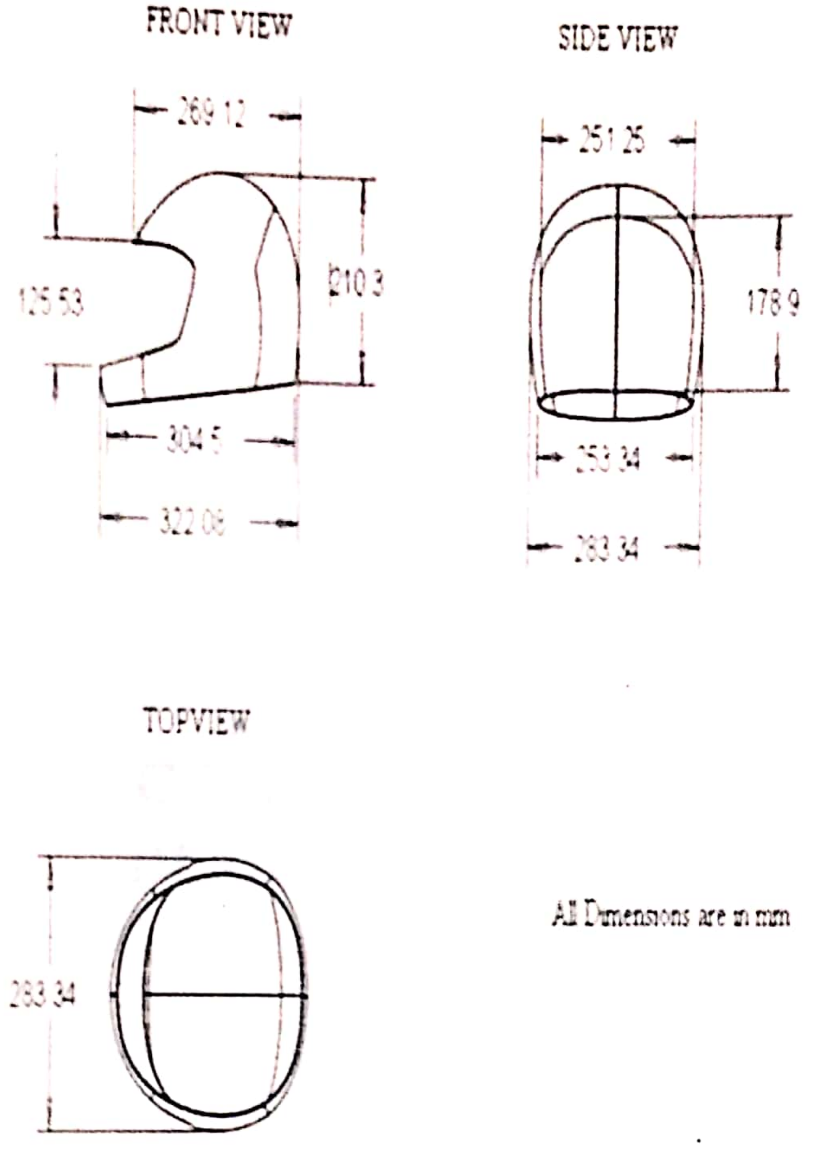


Fig 3.1 Standard Dimensions of various parts in Helmet

CHAPTER-4
DESIGNING

CHAPTER-4

DESIGNING

4.1 INTRODUCTION TO CATIA

CATIA, stands for Computer Aided Three-dimensional Interactive Application, CATIA is the most powerful Knowledge based and widely used CAD (computer aided design) software of its kind in the world. CATIA has been created by Dassault Systems of France and is marketed & technically supported worldwide by IBM.

CATIA is being used by designers, manufacturing facilities, assemblers, architects, industrial engineers etc . Have a Look around you . Everything and Anything you see had to be designed before manufacturing.

The desk you are using, the chair you are sitting in, your daily use appliances, your car, your home etc . The list is almost endless . Nearly everything is being designed on computers . CATIA plays a major role in the design process . CATIA is being used by the majority of automotive and aerospace industries for automobile and aircraft products and it's a uxiliaries and tooling design . Thousands of engineering companies throughout the world over are using CATIA . A Company using CATIA has suppliers using CATIA too , thus making CATIA a Essential tool.

The most commonly CATIA users are generally Aerospace , Appliances, Architecture, Automotive, Construction, Consumer Goods, Electronics, Medical, Furniture, Machinery, Mould and Die, and Shipbuilding industries.CATIA has played a major role in NASA's design of the various Space equipment's. Beside this CATIA has also been used as Vital tool for designing "jet-fighter" aircraft,aircraft carriers,helicopters,tanks &various other forms of weaponry extensively used by the Defense Sector.

CREATION OF FILE:

1)First, open a CATIA file.

2)Launch CATIA if it is not already launched

3)Click on the Close button

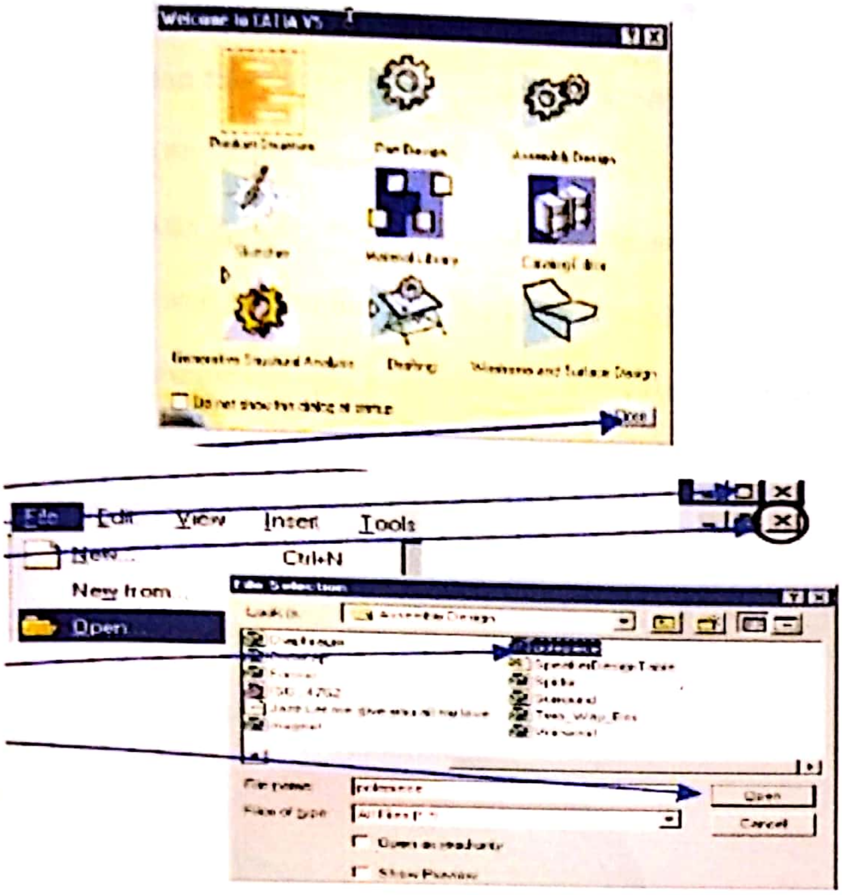
4)Maximize the CATIA window

5)Close the Product1 window

6)Open the file .CAT Part under the...\DATA\Assembly Design\ directory

Select the .CAT Part file

1)Click on the Open button



4.2COMMANDS:

4.2.1Panning Objects:

It's important you practice using the mouse.

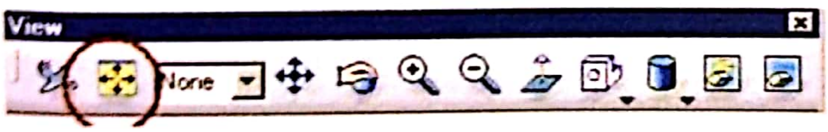
1.Position the cursor anywhere on the screen

2. Press and Hold Mouse Button 2 (MB2)

3. Move the mouse where you want to drag the part

4.The cursor will change to a cross

5.If the part disappears, get it back with the Fit-All-In icon in the View toolbar



4.2.2Rotating Objects

1. Position the cursor anywhere on the screen

2. Press and Hold mouse button 2 (MB2)

3. The axis appears in the center of the screen

4. Press and Hold mouse button 1 (MB1) while keeping MB2 Pressed.

5. The cursor changes to a hand and a red circle appears Representing a virtual space ball.

6. Move the mouse to rotate the part.

7. The cursor will change to a cross.

8.To change the rotation axis, click once on MB2 on the element.

that you want at the Centre of the screen.

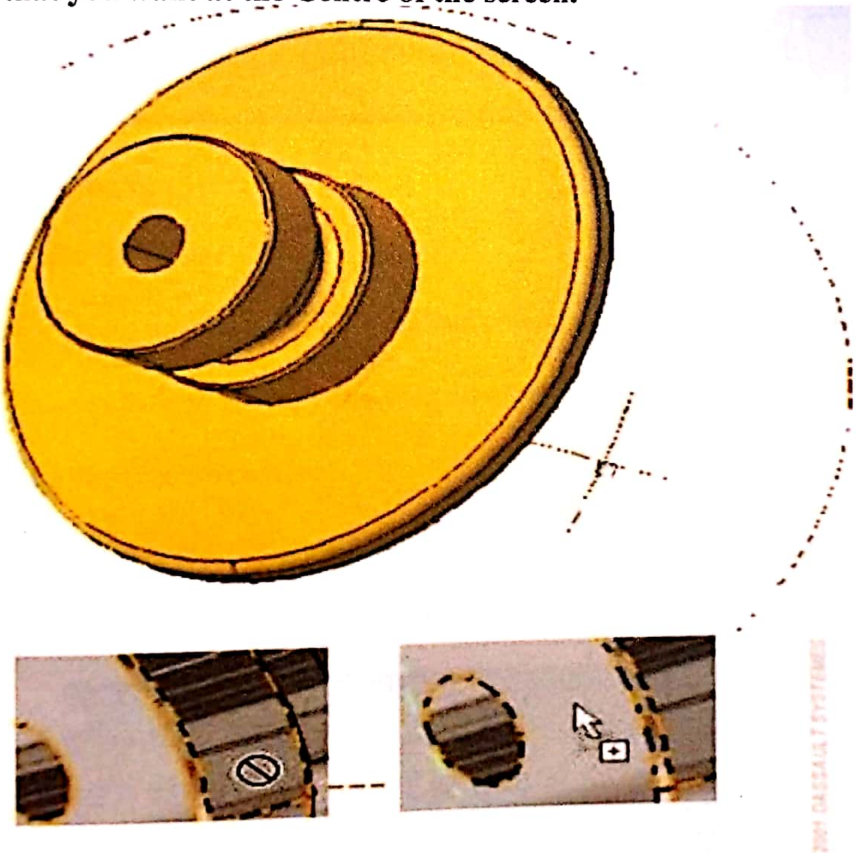


Fig 4.2.2 Rotation of the object.

4.2.3Zooming:

1. Position the cursor anywhere on the screen

2. Press and Hold mouse button 2 (MB2)

An axis and a circle appear in the centre of the screen

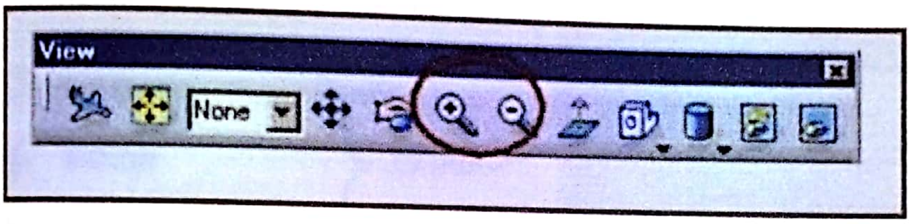
3. Press and release MB1 while keeping MB2 pressed

The cursor changes to a double arrow

4. Move the mouse up to zoom in

5. Move the mouse down to zoom out

To zoom step by step click on + and – icons in the View TOOL BAR



4.2.4Moving the Tree:

Using the Scrollbar

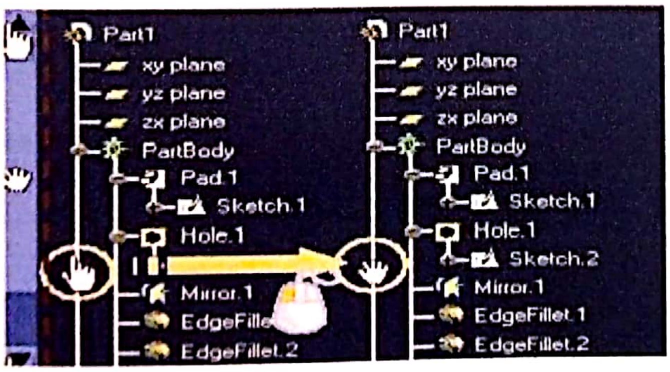
1.When and only when the size of the tree exceeds the window you can use

2. The scrollbar to display the tree downward or upward

Moving the tree anywhere

3.Click up arrow to display the top of the tree

Click down arrow to display the bottom of the tree



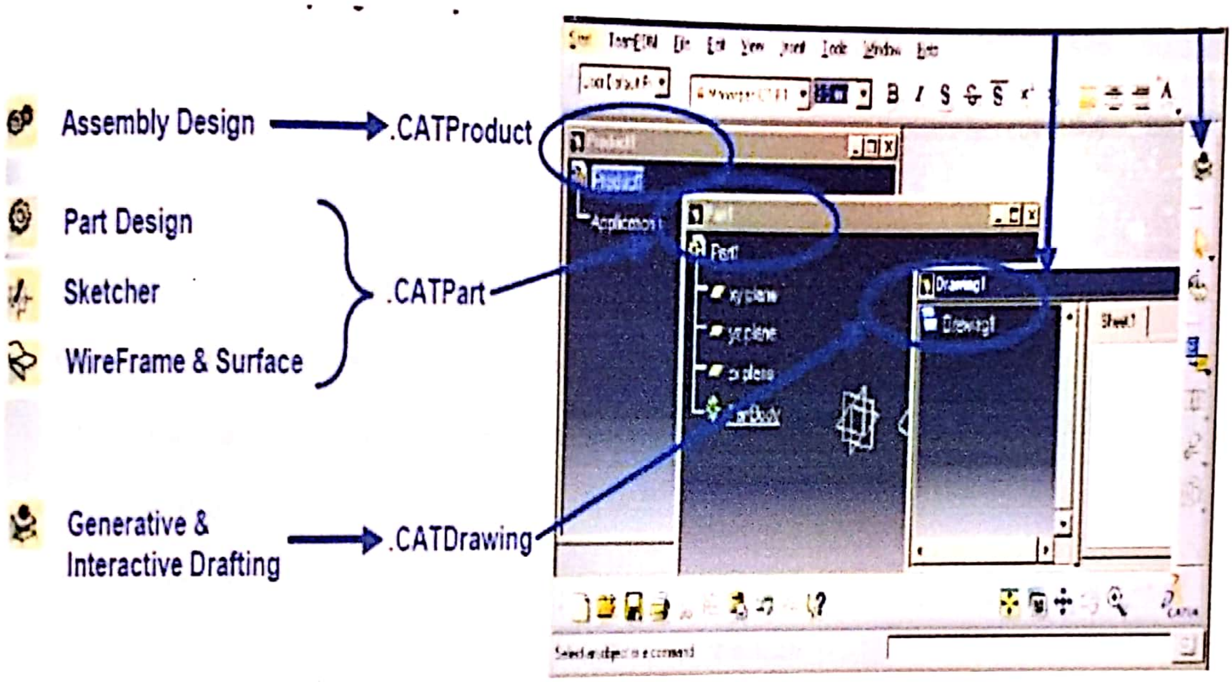
CATIA Documents

1.When working in CATIA you can create, modify and save geometries within documents

2.Documents are containers

3.Different Types of Documents

The type of document depends on the workbench you use to create and modify a geometry :

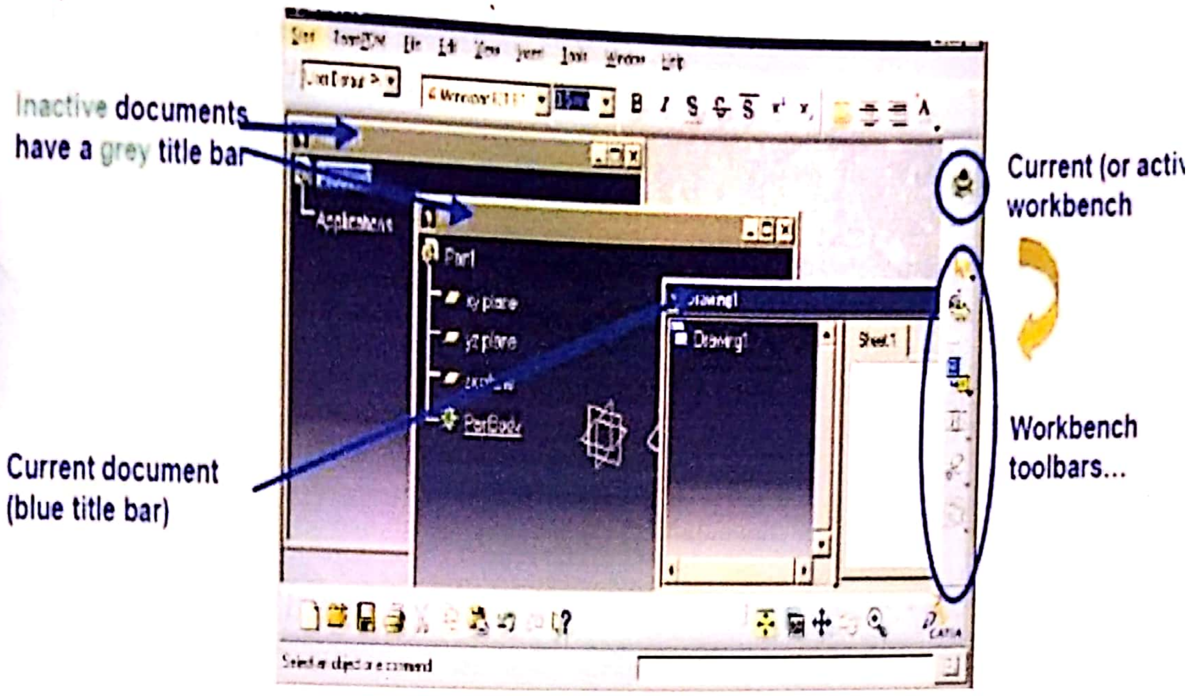


4.3Terminology:

1.A Product Structure is a way to structure and organize your products logically. You can navigate within the structure and work on its different components

2.A Document is a file including data you can create and manage with the associated workbench (specific extension)

3.A Workbench is a set of tools that allows you to create and manage your



4.4 DESIGN PROCEDURE:

Open a new Part : Start + Mechanical Design + Part Design

1.Select a plane, a Solid face, or a Planar Surface to Sketch on

2.Access the Sketcher Workbench

3.Select the ELLIPSE icon and draw a sketch as shown

4. Click and release MB1 where you want to start a line

5. Click MB1 where you want to finish the line

6.Hold MB1 then move the mouse and release MB1 to draw an ellipse.

Double-click when you want to finish your profile

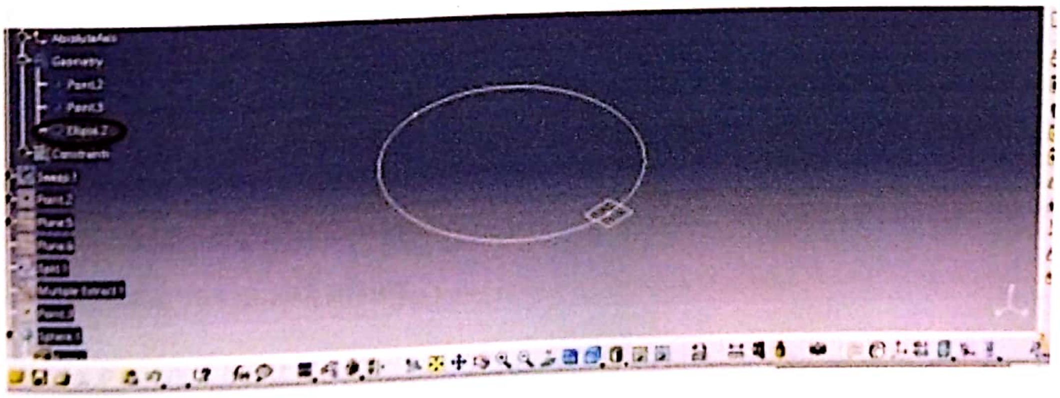


Fig 4.4 Ellipse

7.Click the sweep icon and select the ellipse sketch.

Fig 4.4.1 Sweep

8.Create a plane on the surface of ellipse as shown in below figure.

Fig 4.4.2 sweep and plains

9.Click the split icon,and split the ellipse as shown in figure 4.4.3

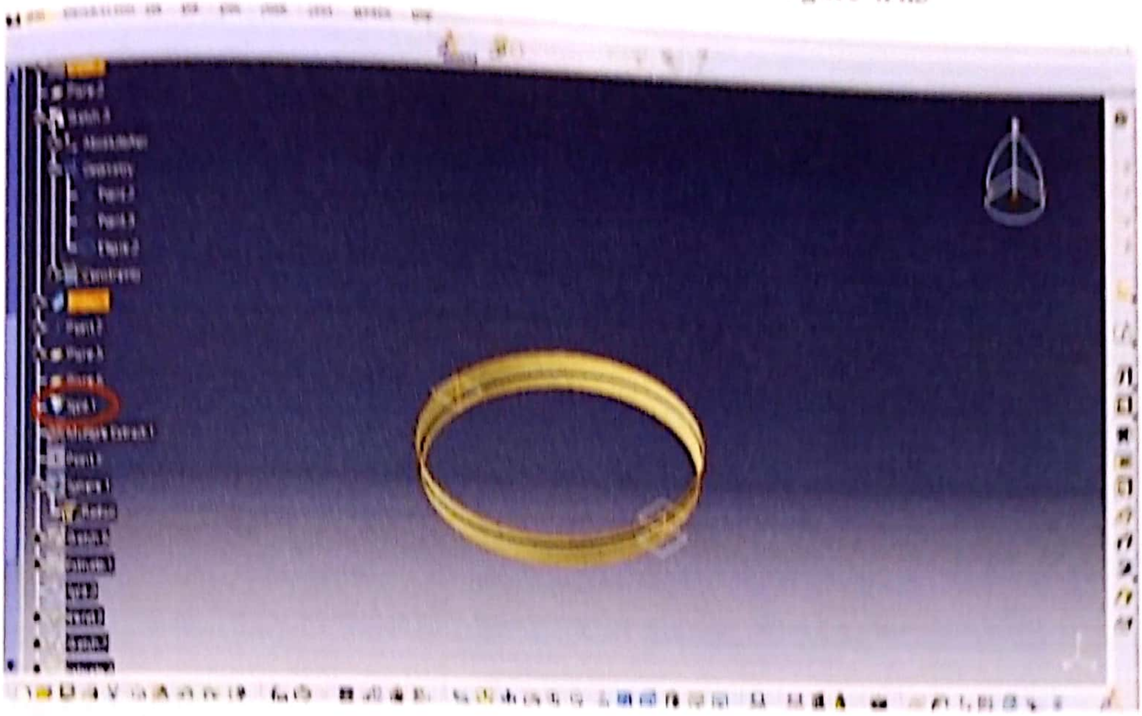


Fig 4.4.3 Split

10.After split,draw an arc from the bottom surface.

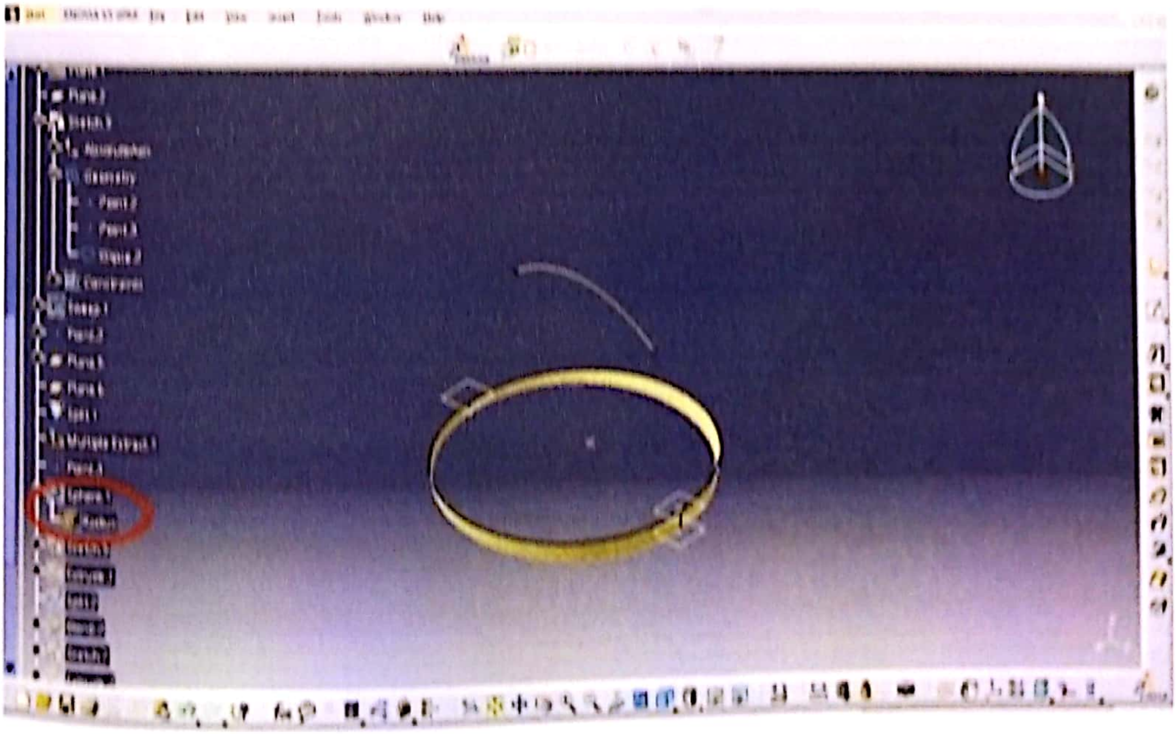


Fig 4.4.3.1 Drawing arc

11.Create an sphere(Fig4.4.4) with the help of already drawn arc as shown in fig (4.4.3.1)

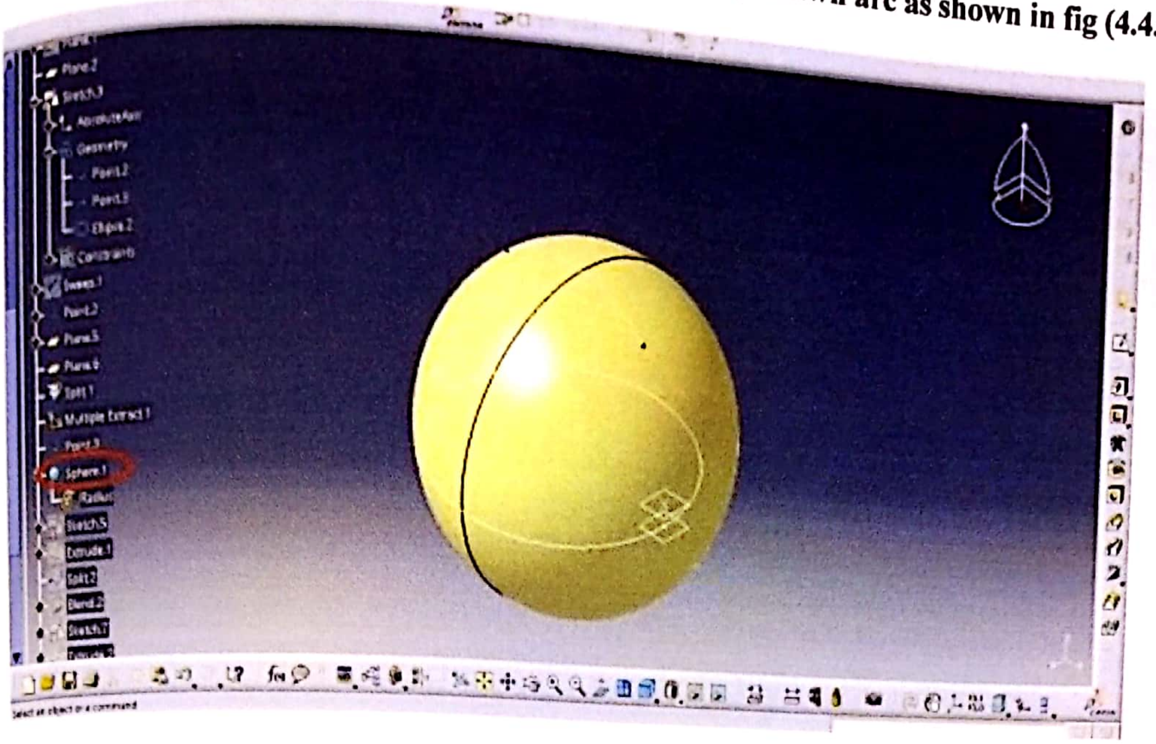


Fig 4.4.4 sphere

12.Draw a line from the point of arc as shown in figure (Fig 4.4.4.1)(with 10^0 inclination)

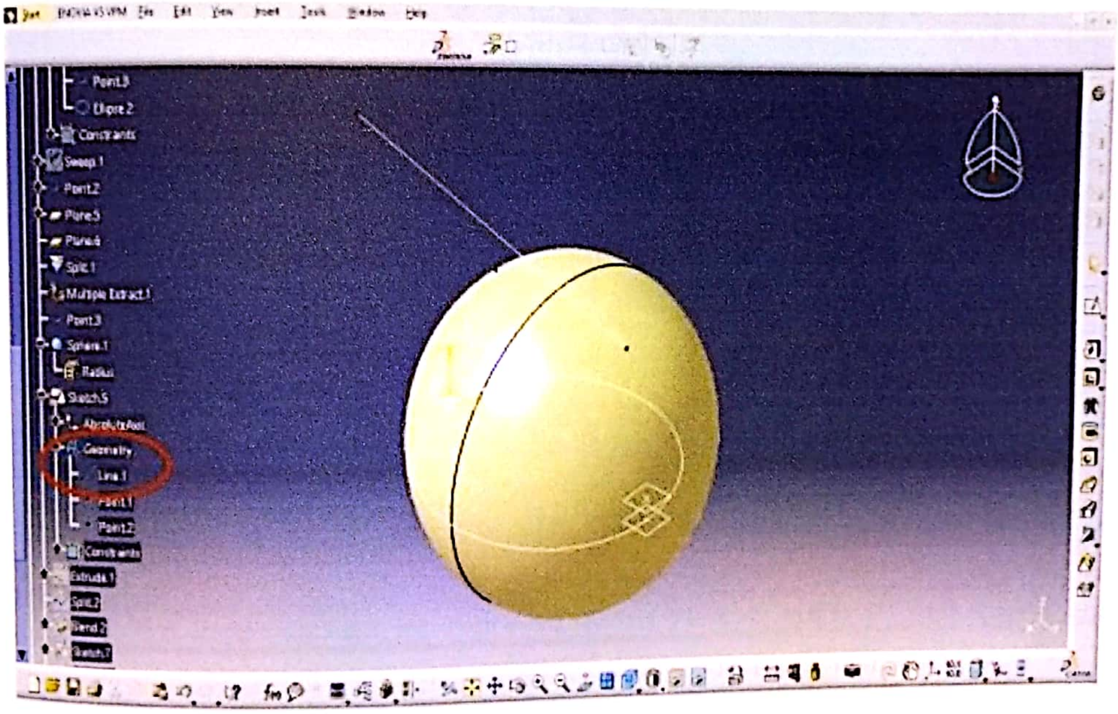


Fig 4.4.4.1 Arc point

13.Click on extrude icon,and select the line (as shown in figure 4.4.5)

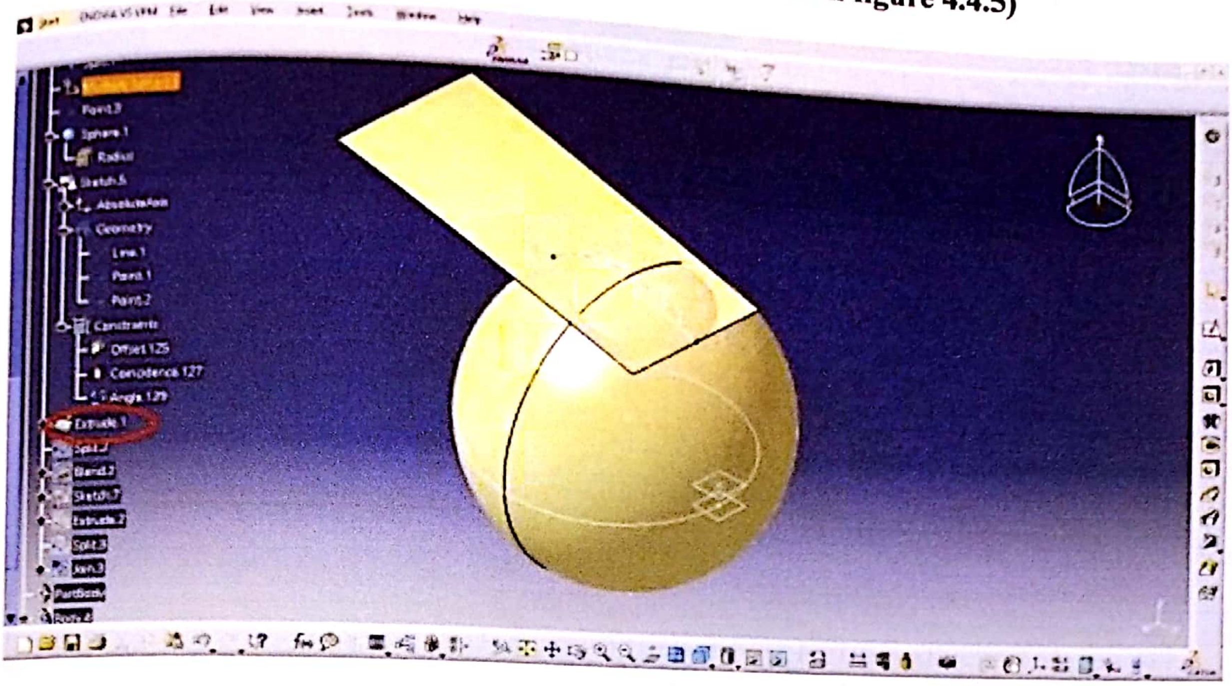


Fig 4.4.5 Extrude the line

14.Click on split icon and select the upper surface and sphere as shown in (fig4.4.6)

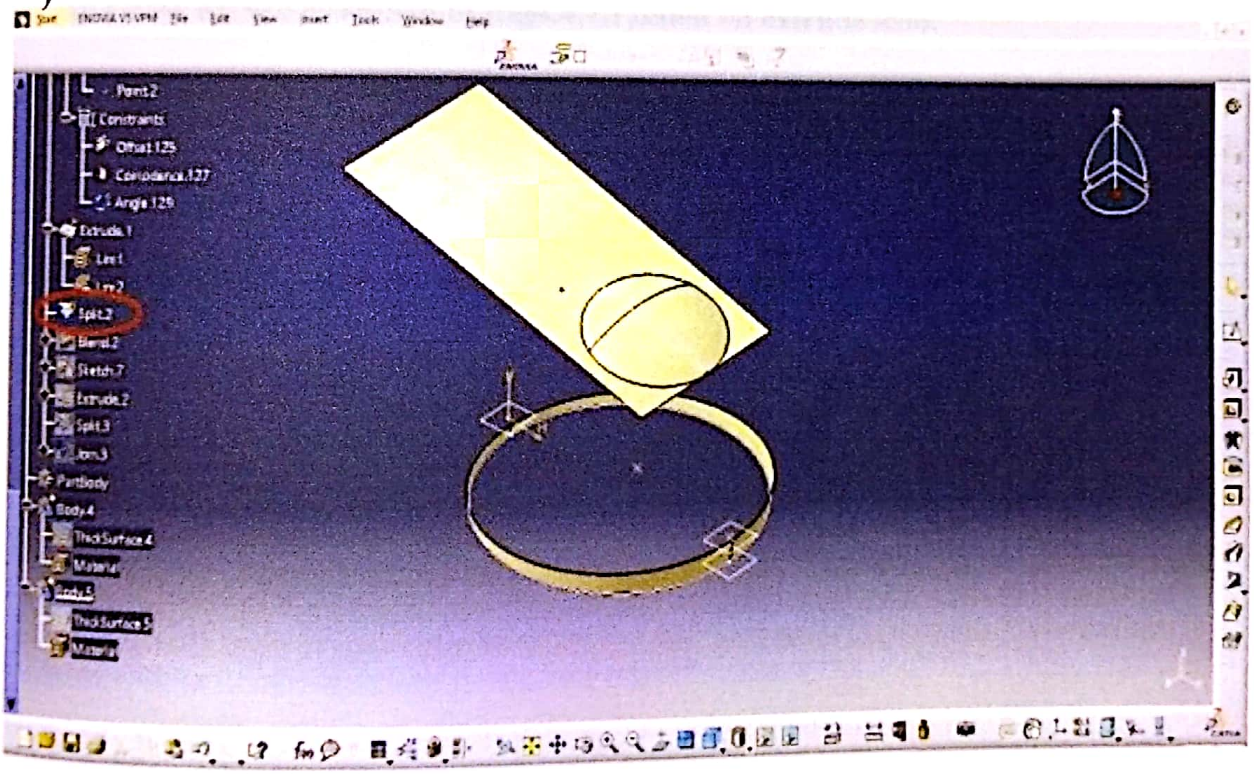


Fig 4.4.6 split 2

15..Click on blend option ,and Select all the portions as shown in above (figure4.4.6)

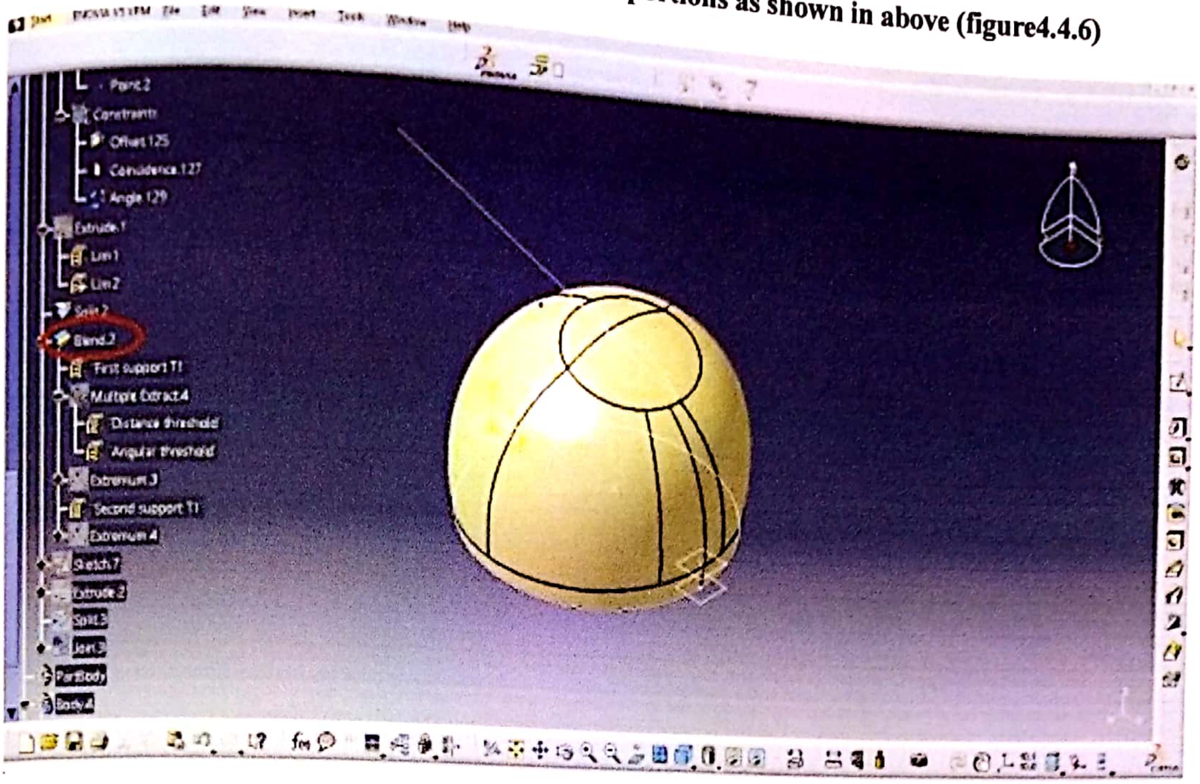


Fig 4.4.7split and sweep

16.Draw an arc as shown in (fig4.4.7.1),click on extrude icon.

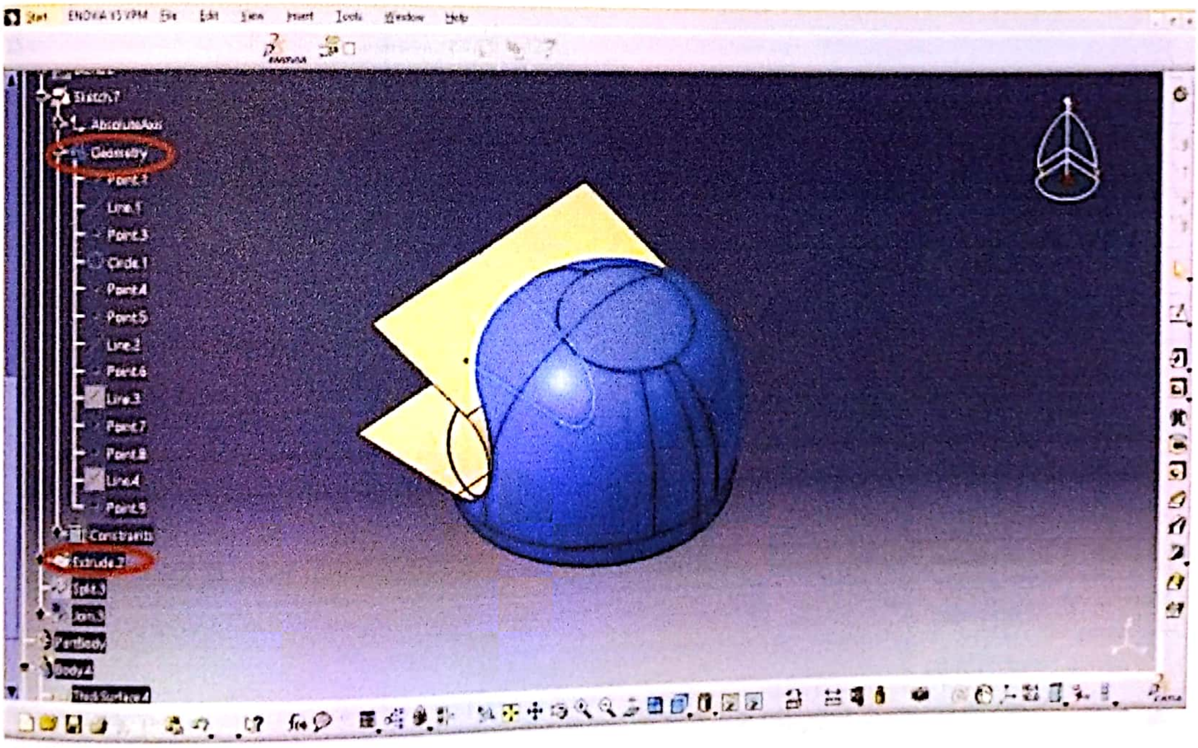


Fig 4.4.7.1 Arc extrude

17.Click on split icon and select the removed portion.

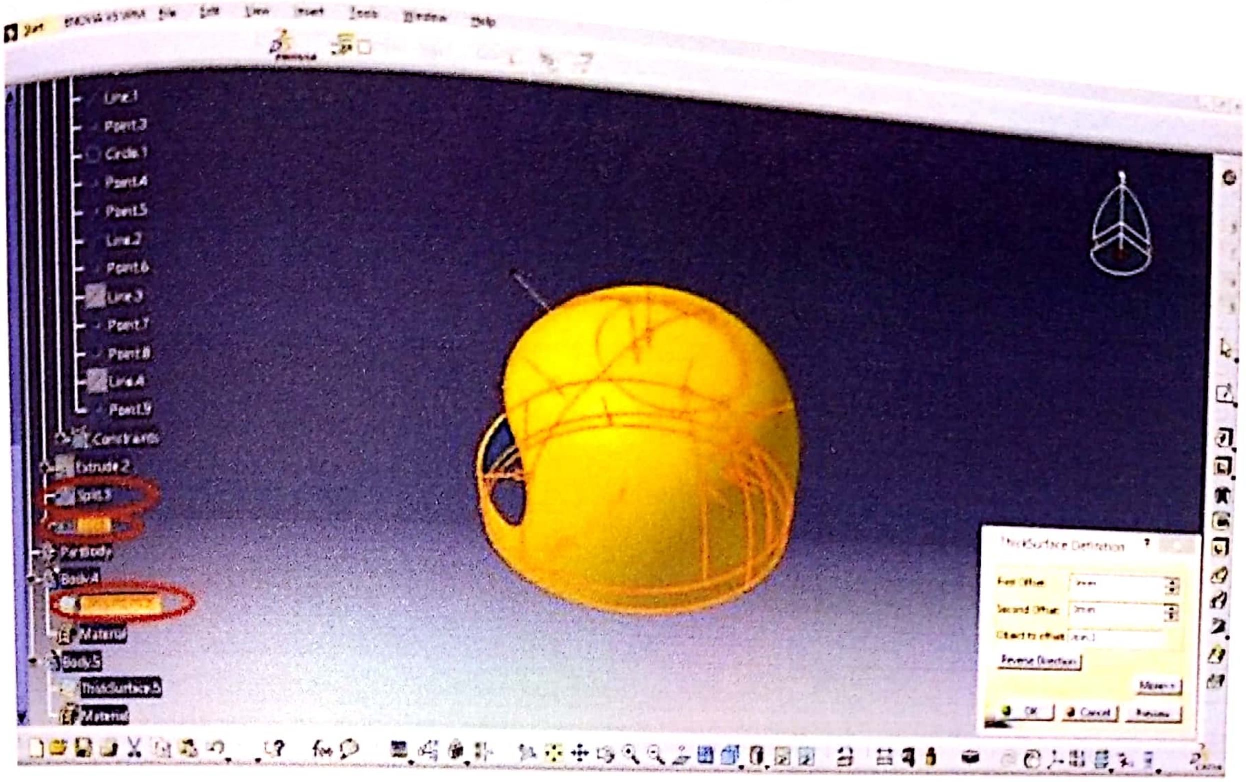


Fig **4.6** Split and **thickness of helmet**

18.Click on join icon, to join all the 3 separate parts

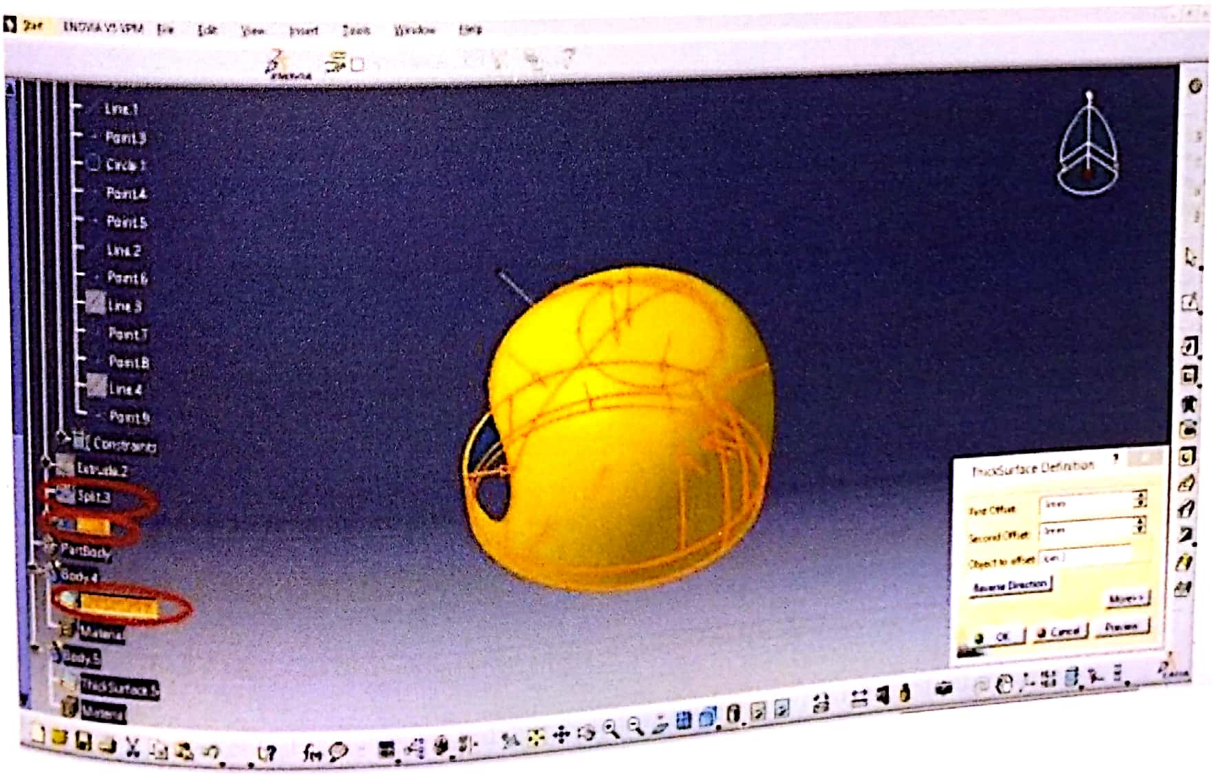


Fig 4.6.1 Joining 3 parts

19.Click on thickness icon,and apply for whole helmet as shown in command box.

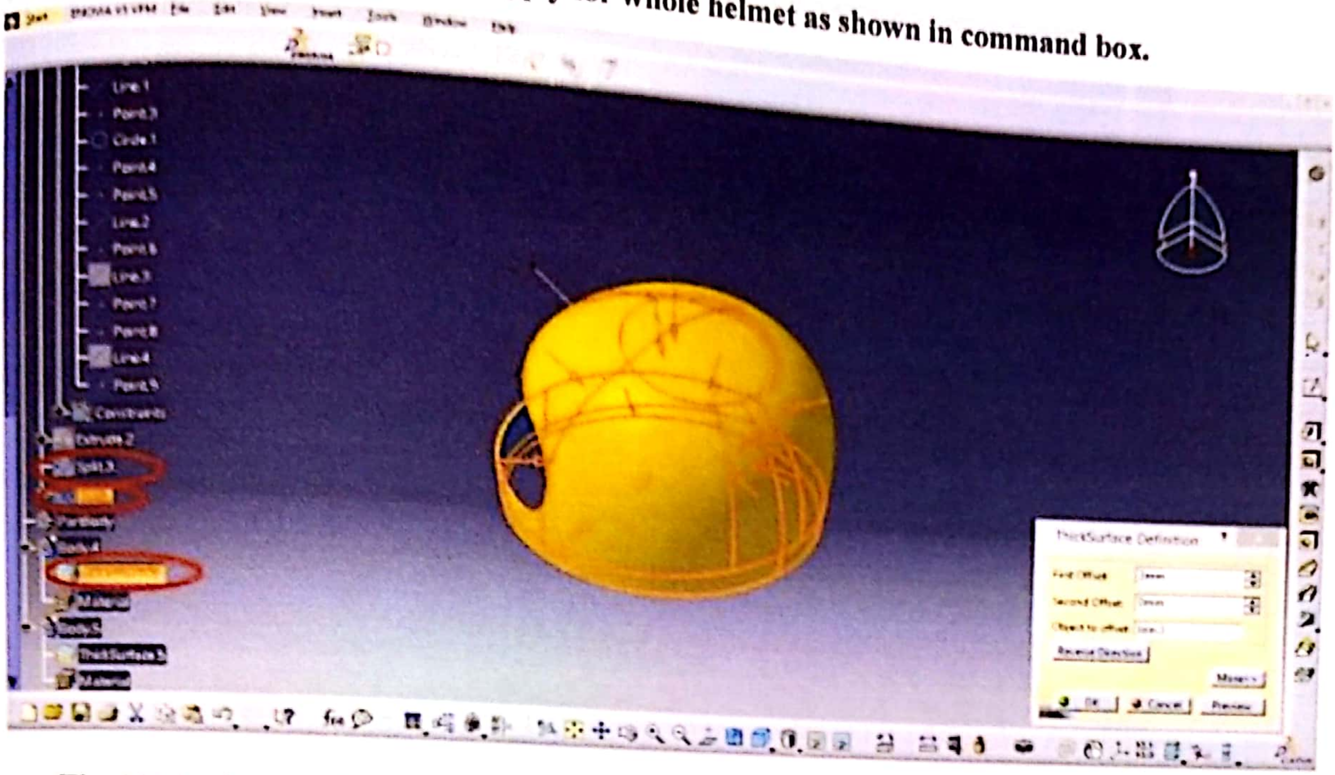


Fig 4.7 Assign thickness for whole helmet(4mm)

20.Give the offset(-3mm) as shown in command box.

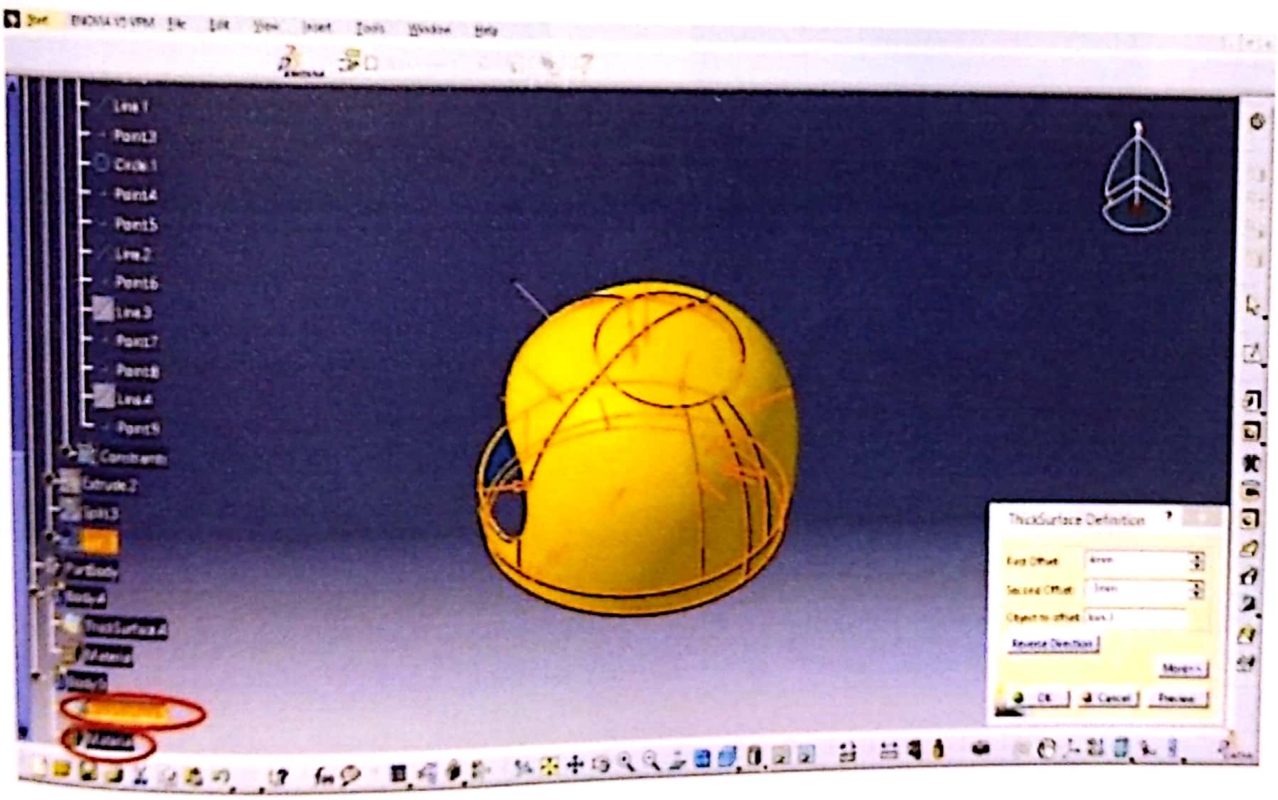


Fig 4.8 offset and thickness of helmet

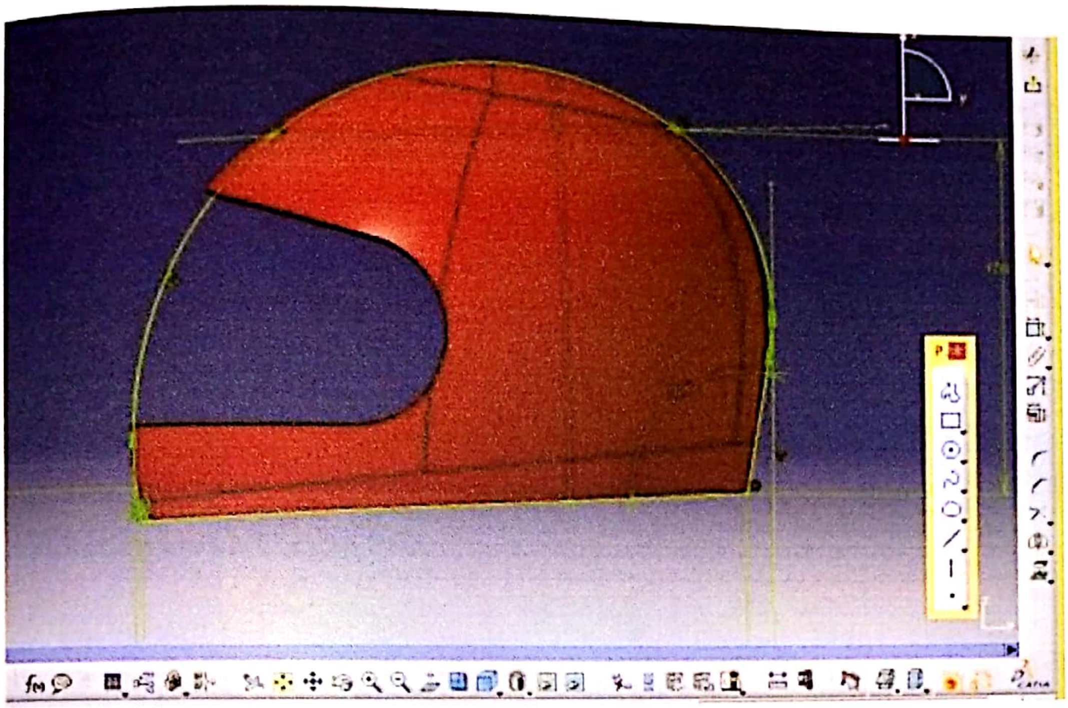
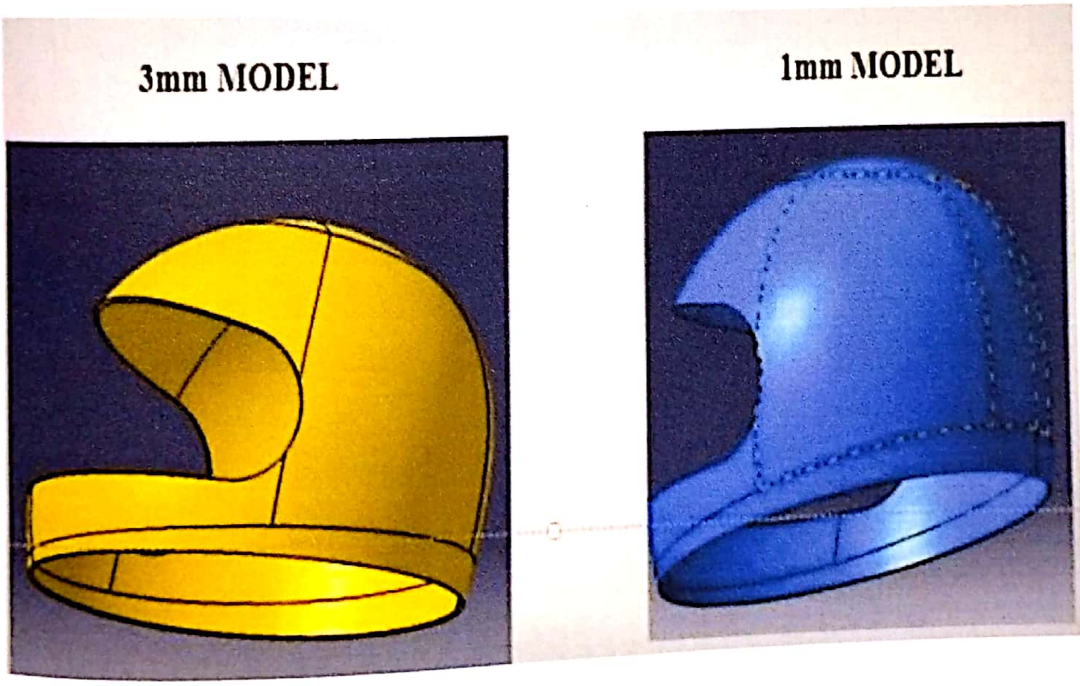


Fig 4.9 FINAL SKETCH



ALL VIEWS:

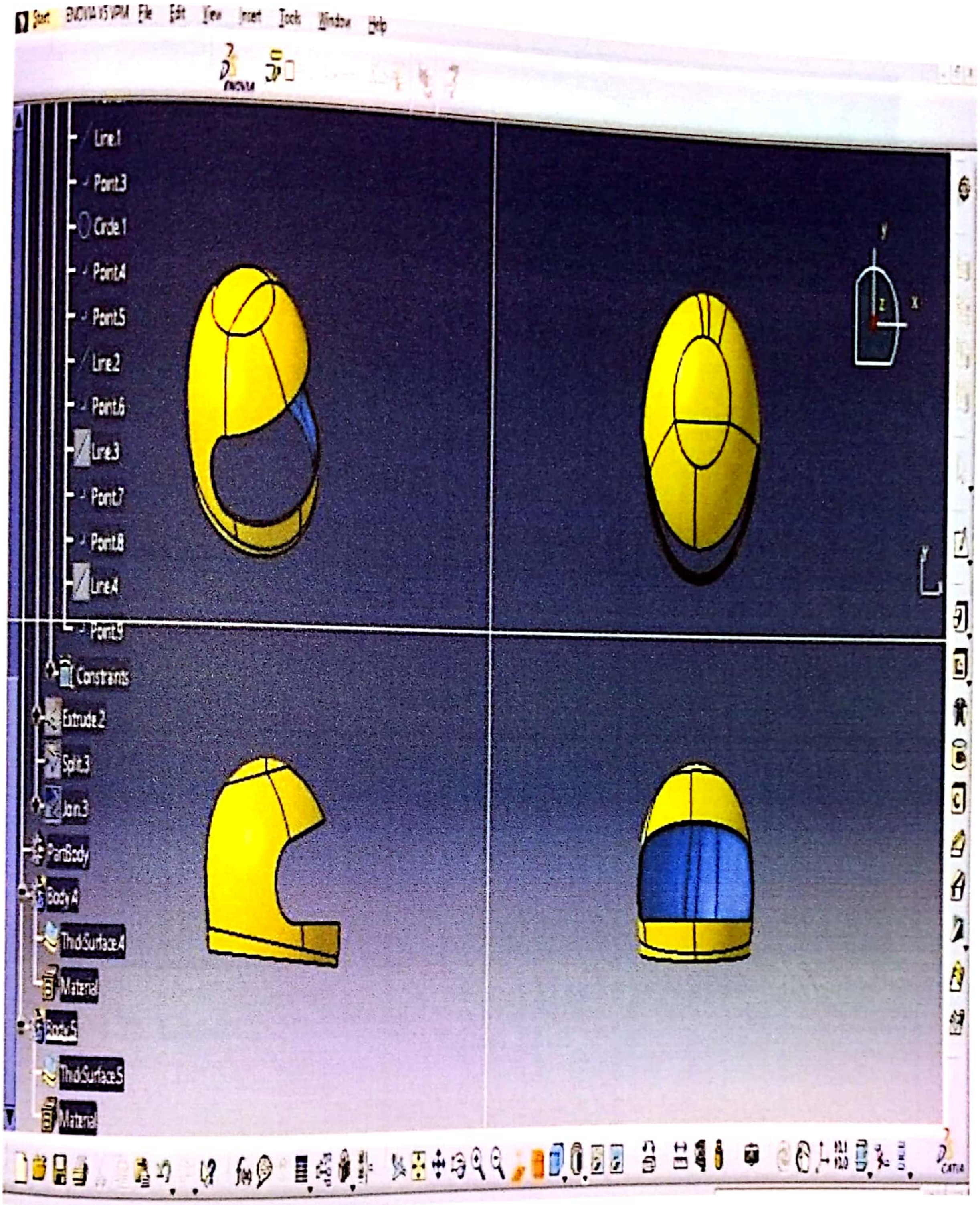


Fig 4.10 All Views

ASSEMBLY:

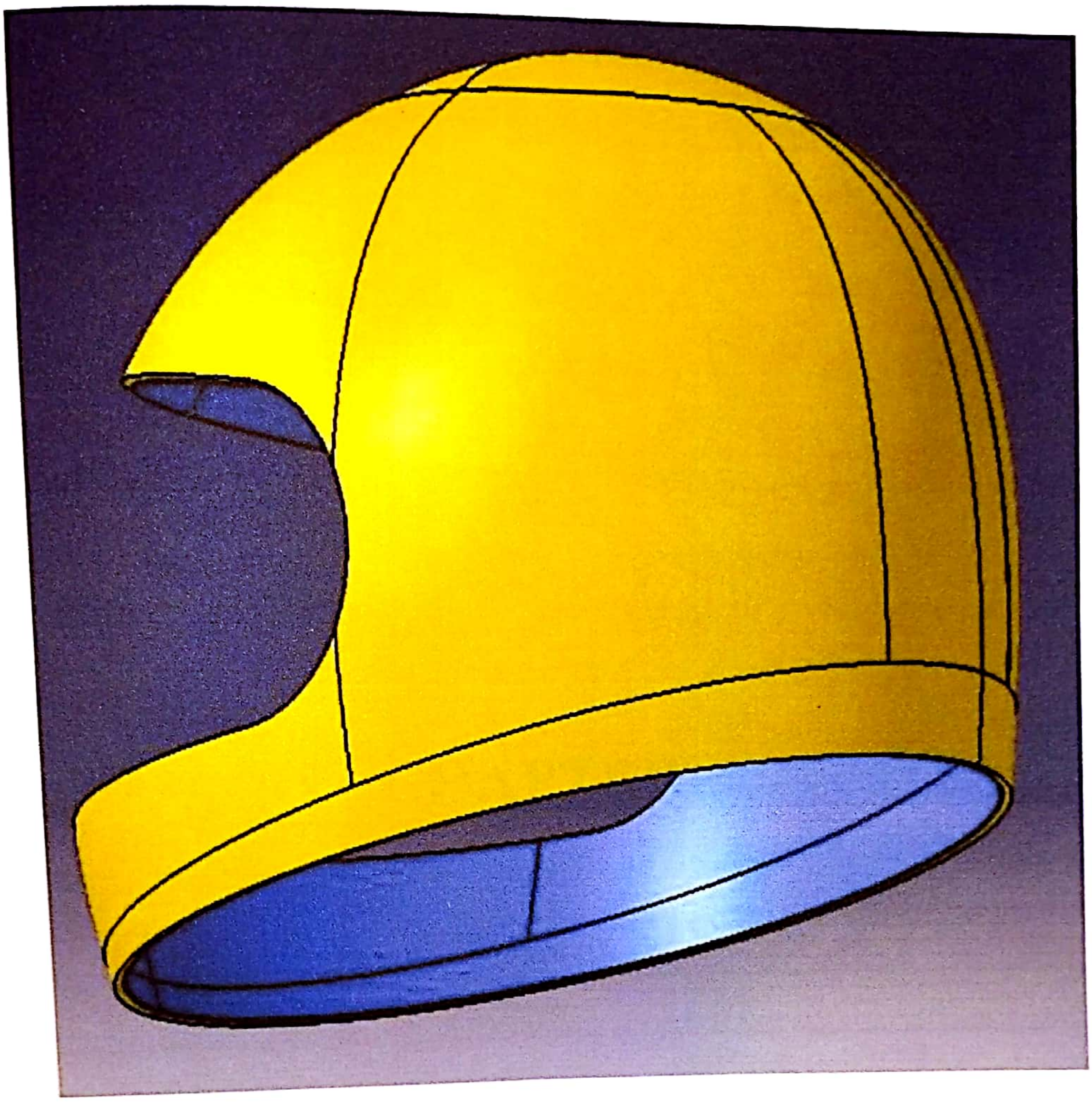


Fig 4.11 Assembly

CHAPTER-5

ANALYSIS

CHAPTER-5

ANSYS

5.1 INTRODUCTION:

ANSYS is a finite element analysis (FEA) software package. It uses a preprocessor software engine to create geometry. Then it uses a solution routine to apply loads to the meshed geometry. Finally it outputs desired results in post-processing.

Finite element analysis was first developed by the airplane industry to predict the behaviour of metals when formed for wings . Now FEA is used throughout almost all engineering design including mechanical systems and civil engineering structures.

The analysis capabilities of ANSYS include the ability to solve static and dynamic structural analyses,steady state and transient problems, mode frequency and buckling Eigen value problems,static or time varying magnetic analyses and various types of field and coupled field applications . The program contains many special features which allow non-linearity or secondary effects to be included in the solution such as, plasticity , large strain , hyper elasticity , creep, swelling, large deflections, contact , stress ,stiffening temperature dependency, material anisotropy and radiation . As ANSYS was developed , other special capabilities such as , sub structuring, sub modelling, random vibration, kinetostatics, kinetodynamics, free convection fluid analysis, acoustics, magnetic, piezo-electrics,coupled field analysis and design optimization was added to the program.These capabilities contribute further to make ANSYS amultipurpose analysis tool for varied engineering disciplines.

ANSYS is used throughout industry in many engineering disciplines. This software package was even used by the engineers that investigated the World Trade Center collapse in 2001.

Material properties

Expanded poly styrene(Inner layer)

Density =61.6kg/m^3

Youngs modulus =28Mpa

Poisons ratio =0.1

composite (outer layer)

Density =1610kg/m^3

Youngs modulus =20124Mpa

Poisons ratio =0.286

Acrylonitrile Butadiene Styrene(ABS)(outer layer)

Density =1200kg/m^3

Youngs modulus =2700Mpa

Poisons ratio =0.35

Polycarbonate(outer layer)

Density =1055kg/m^3

Youngs modulus =2200Mpa

Poisons ratio =0.42

5.2 Procedure:

1) Create an Explicit Dynamics (ANSYS) Analysis System Project

2) Select the units system and define the materials

3) Import and mesh the armor geometry

4) Define analysis settings, initial conditions, boundary conditions and body interactions.

5) Solve and review the results

Start ANSYS Workbench and follow the sequenced steps using the abbreviations shown below:

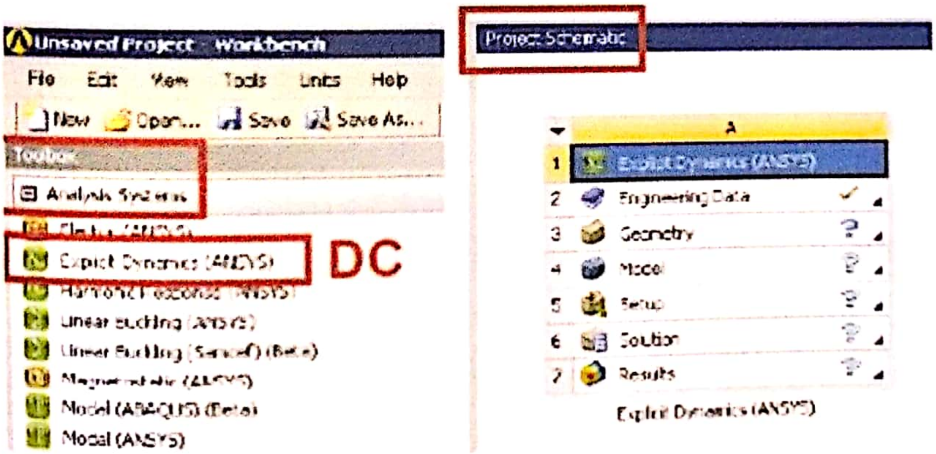
DC= Double Click with Left Mouse Button.

SC= Single Click with Left Mouse Button.

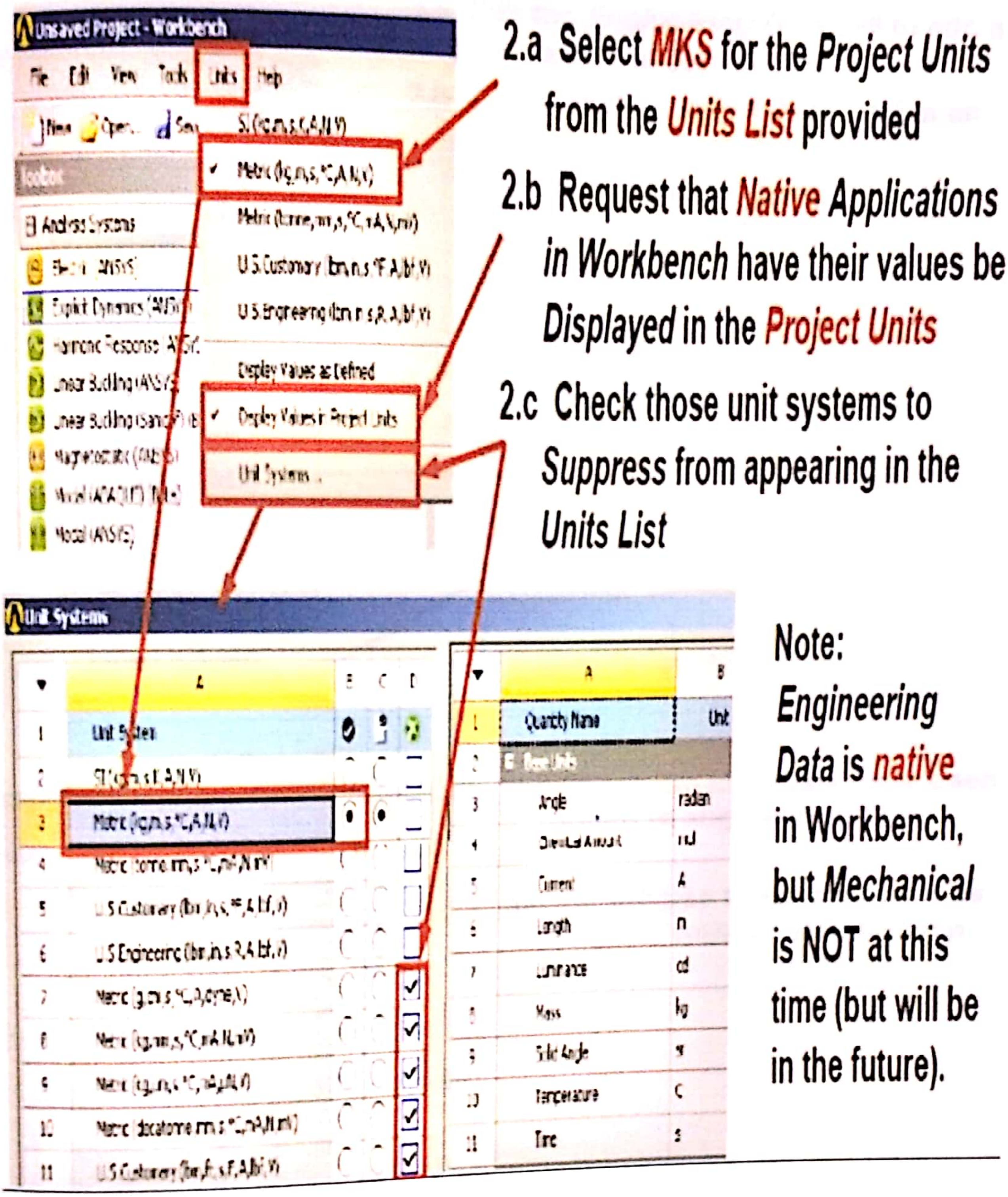
RMB= Right Mouse Button Selection.

D&D= Drag and Drop = Hold Left Mouse Button down on item while dragging it to new location and then release it (i.e., Copy or Move)

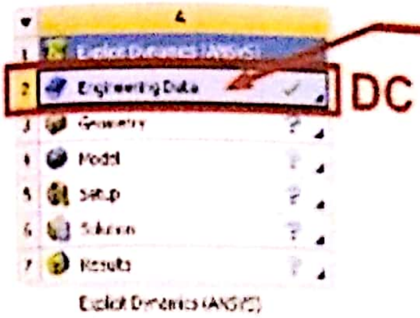
1. Create an ANSYS Explicit Dynamics Analysis System Project



STEP-2 Specify the projuct units:



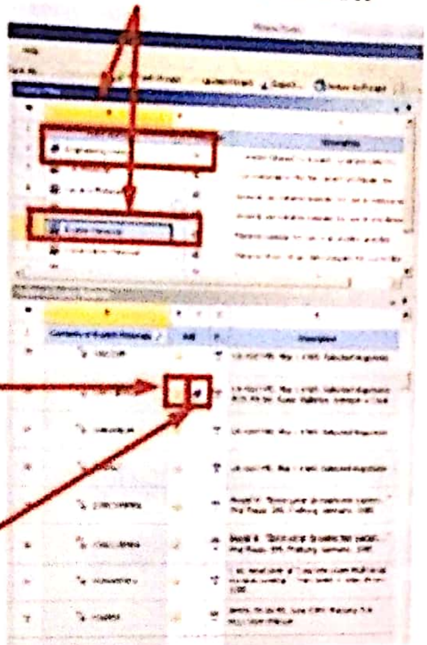
Step-3 Define Engineering data materials



Explicit Dynamics (ANSYS)

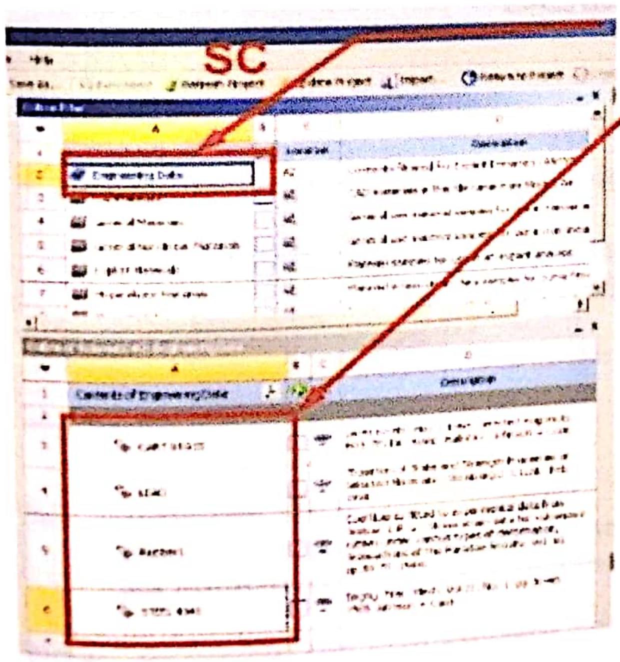
3.a Edit the *Engineering Data* cell to add a material to the default library.

3.b Select explicit materials to load in an existing material model.



3.c Scroll down and add CART BRASS, LEAD, RUBBER1 and STEEL 4340

The book symbol confirms it has been added

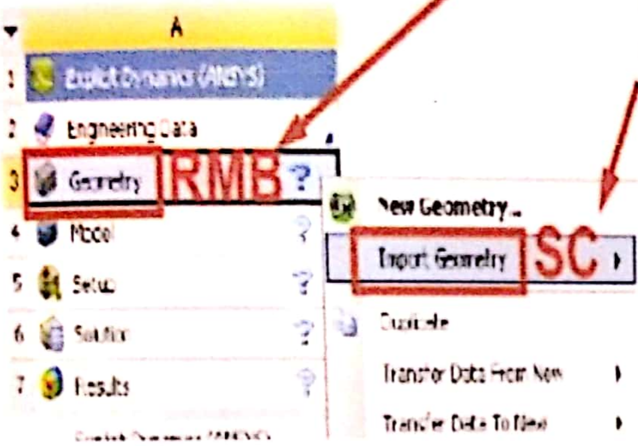


3.d Check the materials have been added to engineering data

3.c We will use these materials as they are without modification

Step-4 Import the Geometry

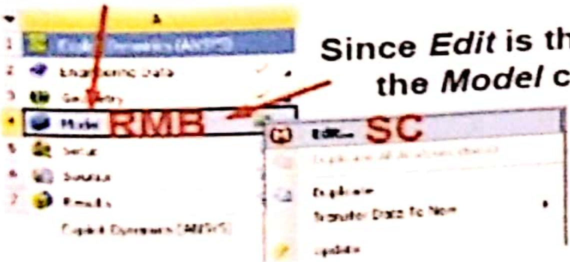
4.a Import the geometry by the procedure shown. Do ***NOT*** Double Click on the "***Geometry***" cell ...



4.b ***Browse*** to the DesignModeler 11.0 SP1 geometry file named:

Step-5 Edit the model in mechanical

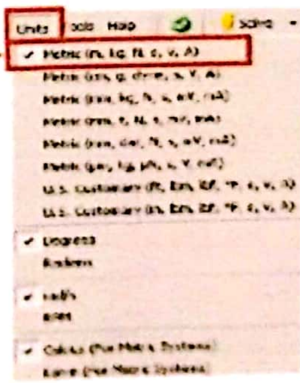
5.a *Edit* the model in Workbench Mechanical.



Since *Edit* is the default action, double-clicking on the *Model* cell is also acceptable here.

5.b Select the *MKS Units* system

Recall that Mechanical *is not native* in Workbench, so the Units here *may not match* the Project Units



Note: Although the unit system used for data entry and post-processing is the MKS system, the actual unit system used by the AUTODYN solver is the mm-mg-ms system, because it provides higher accuracy. This will be shown later when the *Analysis Settings* are discussed.

51

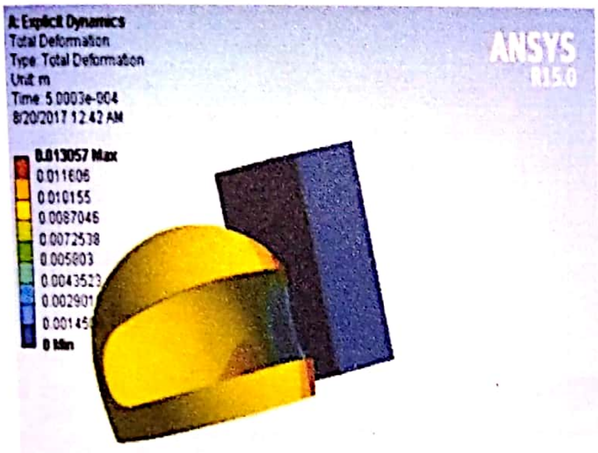
CHAPTER-6
RESULTS

CHAPTER-6
RESULTS

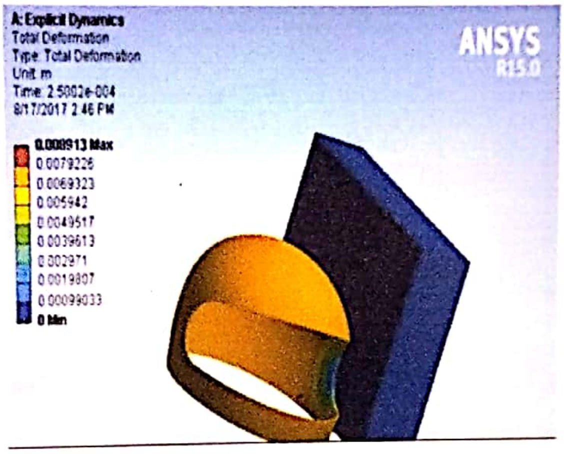
Analysis was carried out in explicit dynamics with input velocity of 20m/sec and 30m/sec with respective to the material properties and the corresponding stress strain and deformation is obtained.

<u>**The deformation values on the helmet for the pc and eps, abs and eps, composite and eps material at 20m/sec are shown in fig 6.1. The maximum deformation values are 0.0132m,0.0089m, 0.00141m.**</u>

PC AND EPS



ABS AND EPS



COMPOSITE AND EPS

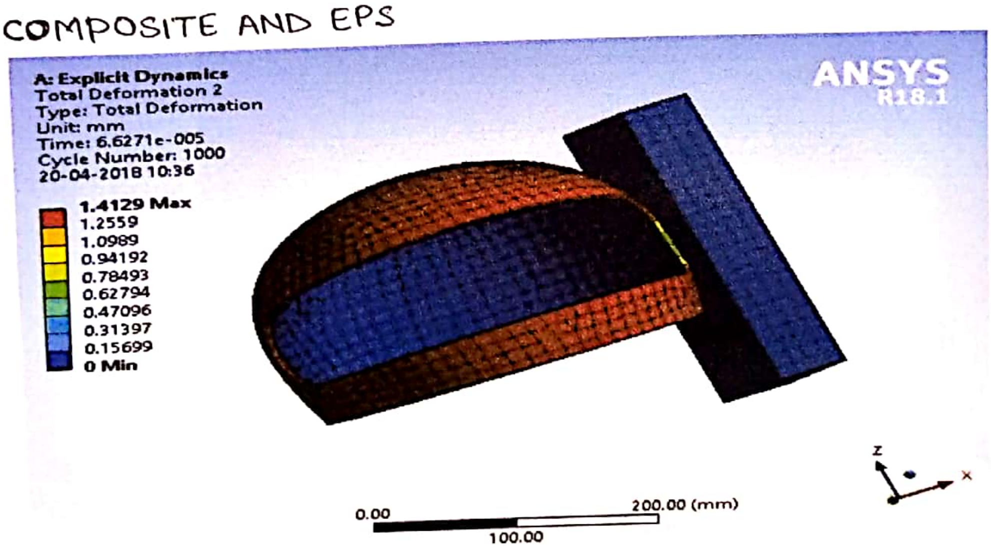
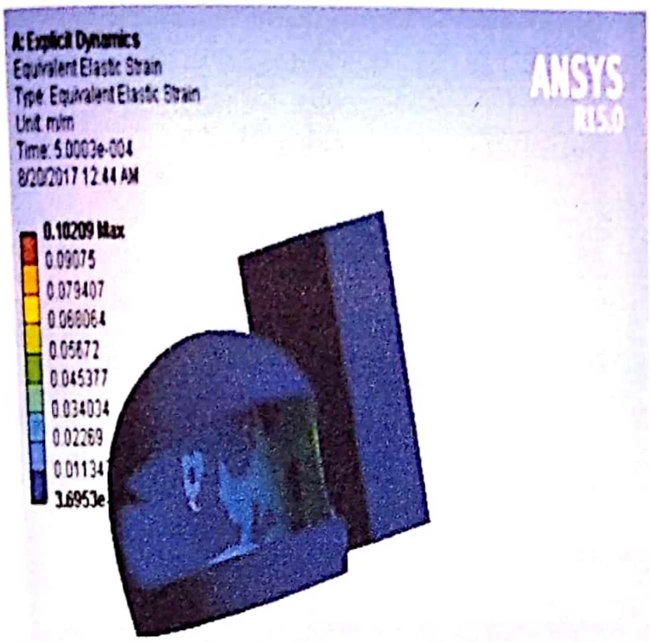


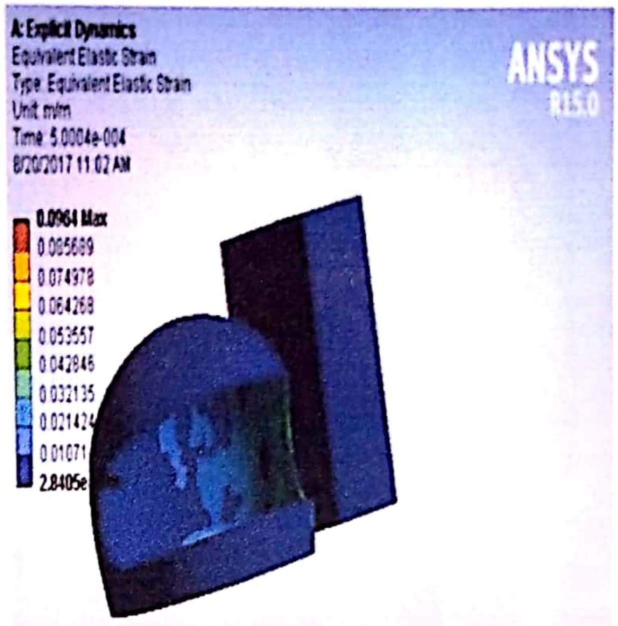
Fig 6.1 total deformation

The total equivalent elastic strain values on the helmet for the pc and eps, abs and eps , composite and eps at 20m/sec are shown in the fig6.2. The maximum total equivalent strain values are 0.102,0.096,0.3003.

PC AND EPS



ABS AND EPS



COMPOSITE AND EPS

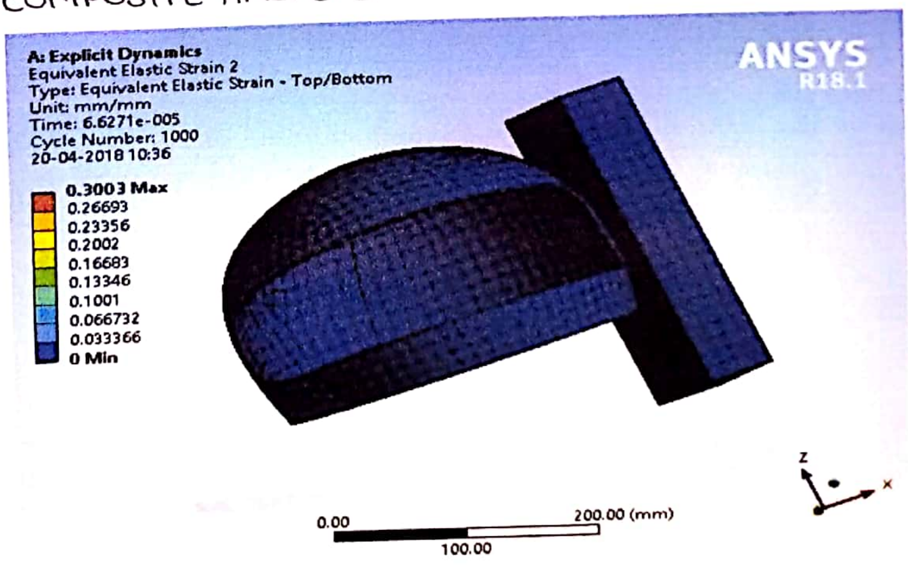
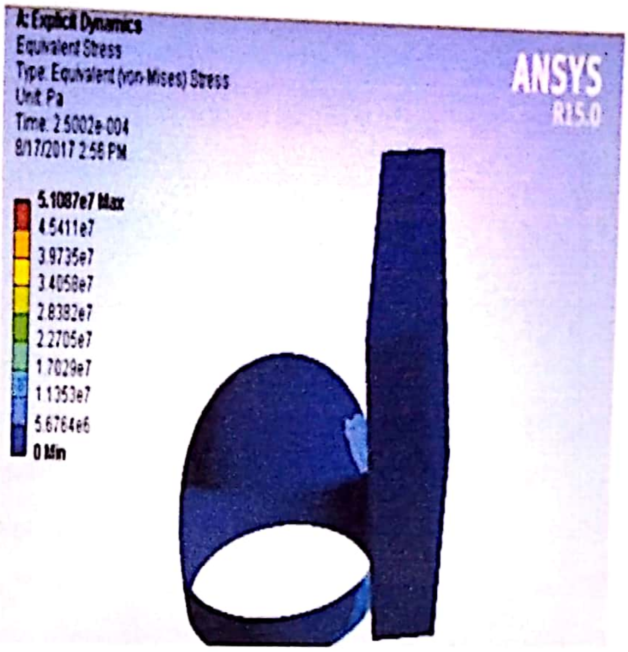


Fig 6.2 total elastic strain

The total equivalent stress values on the helmet for the pc and eps, abs and eps , composite and eps at 20m/sec are shown in the fig6.3. The maximum total equivalent stress values are 52.4Mpa, 51.0Mpa, 107.2Mpa.

PC AND EPS

ABS AND EPS



COMPOSITE AND EPS

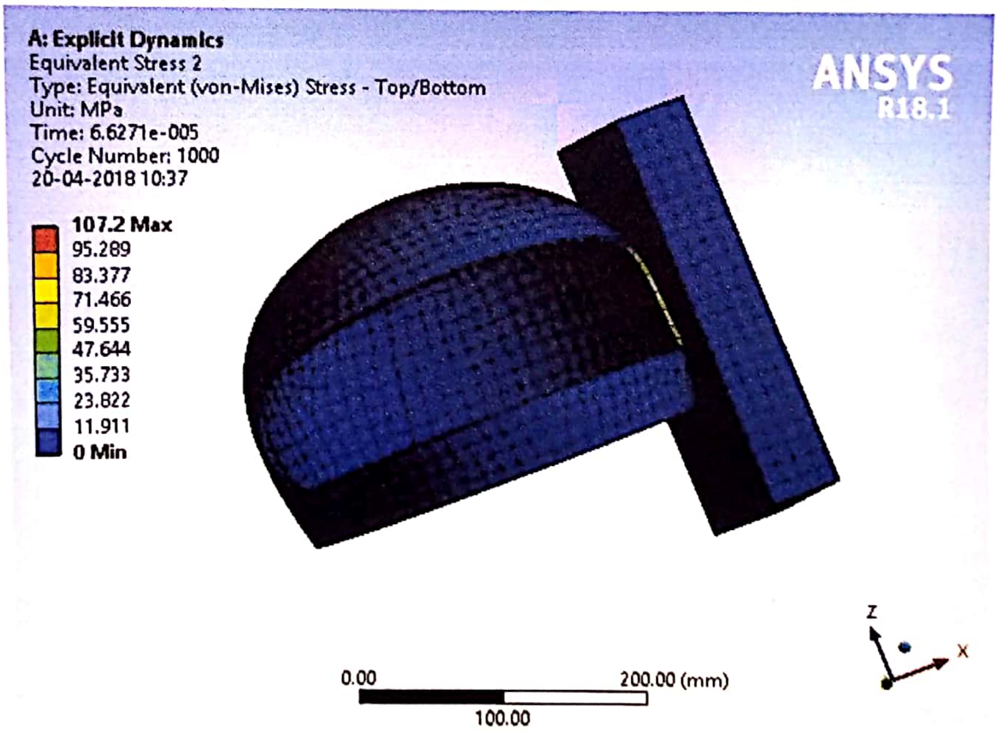
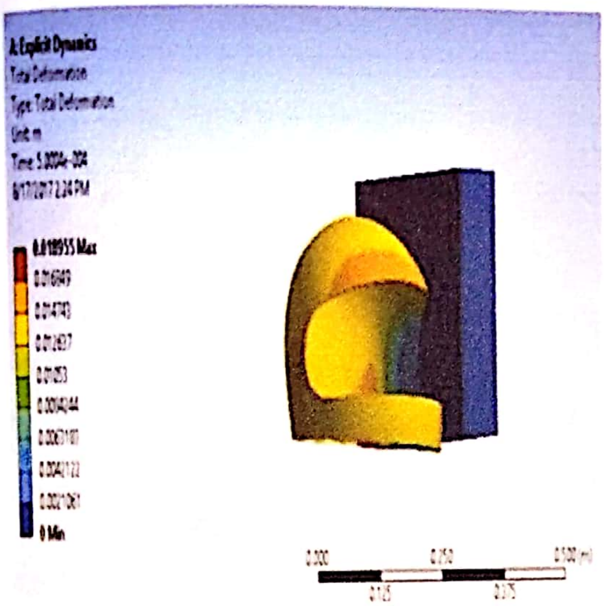


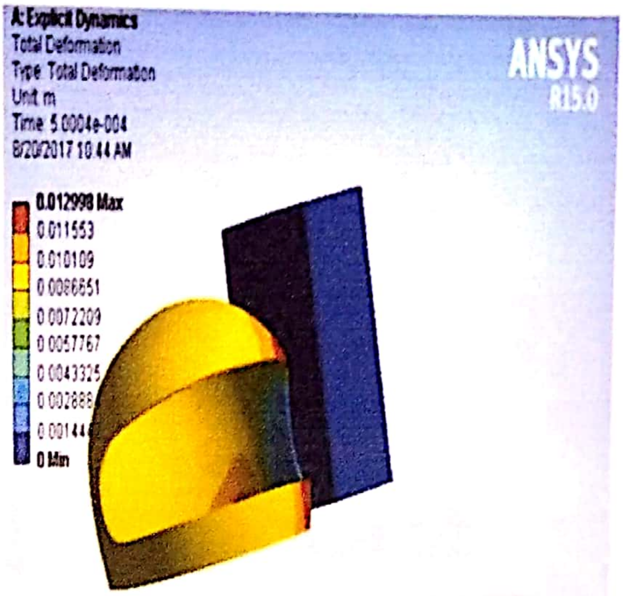
Fig 6.3 total stress

The deformation values on the helmet for the pc and eps, abs and eps, composite and eps material at 30m/sec are shown in fig 6.4. The maximum deformation values are 0.0189m, 0.0129m, 0.0022m.

PC AND EPS



ABS AND EPS



COMPOSITE AND EPS

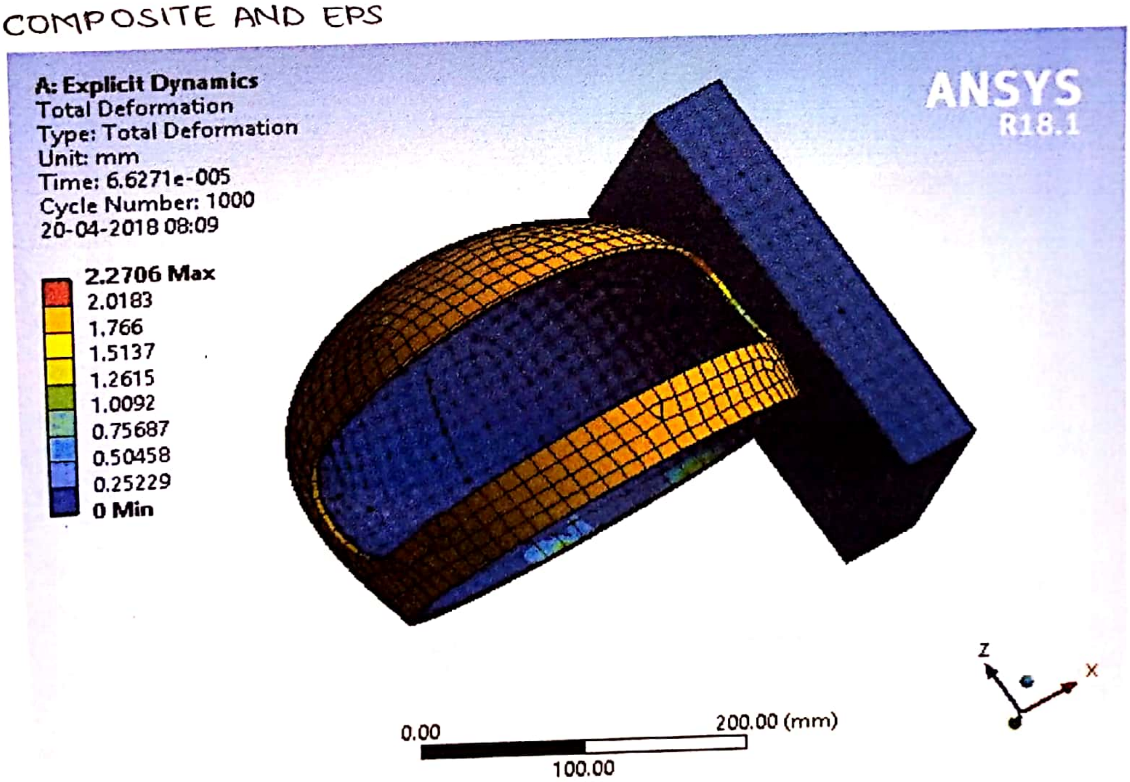
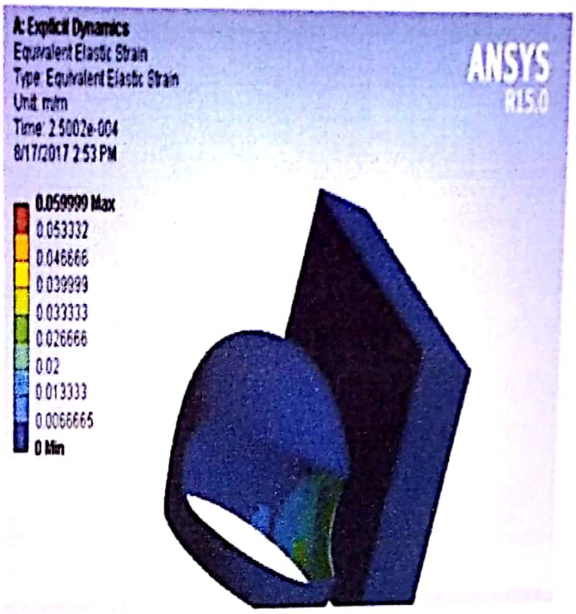


Fig 6.4 total deformation

The total equivalent elastic strain values on the helmet for the pc and eps, abs and eps , composite and eps at 30m/sec are shown in the fig 6.5. The maximum total equivalent strain values are 0.29, 0.059, 0.4347

PC AND EPS

ABS AND EPS



COMPOSITE AND EPS

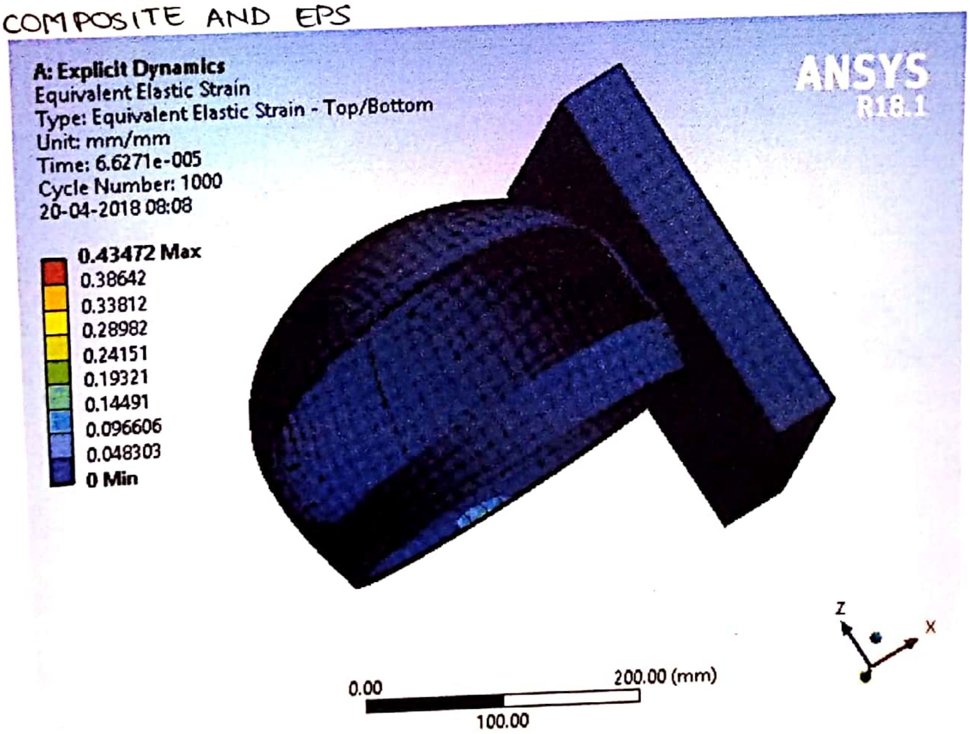
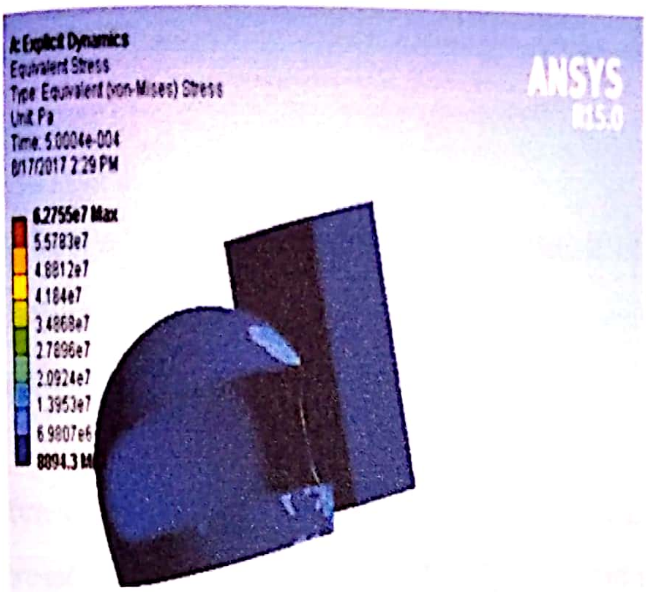


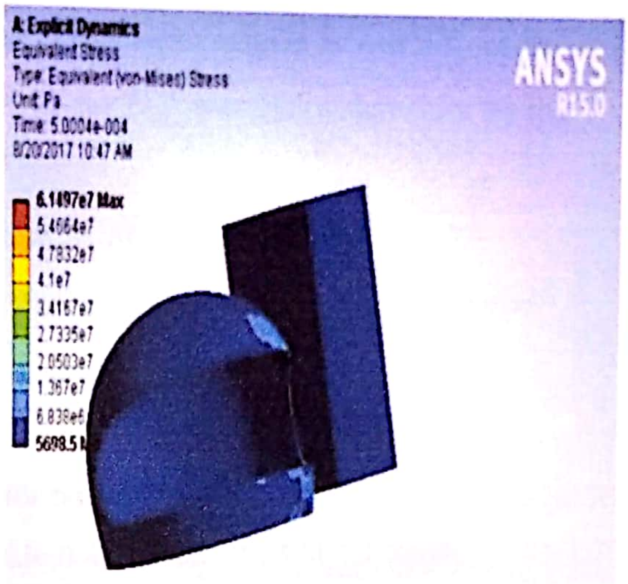
Fig 6.5 total elastic strain

The total equivalent stress values on the helmet for the pc and eps, abs and eps , composite and eps at 30m/sec are shown in the fig6.6. The maximum total equivalent stress values are 62.7Mpa, 61.4Mpa, 157.4Mpa

PC AND EPS



ABS AND EPS



COMPOSITE AND EPS

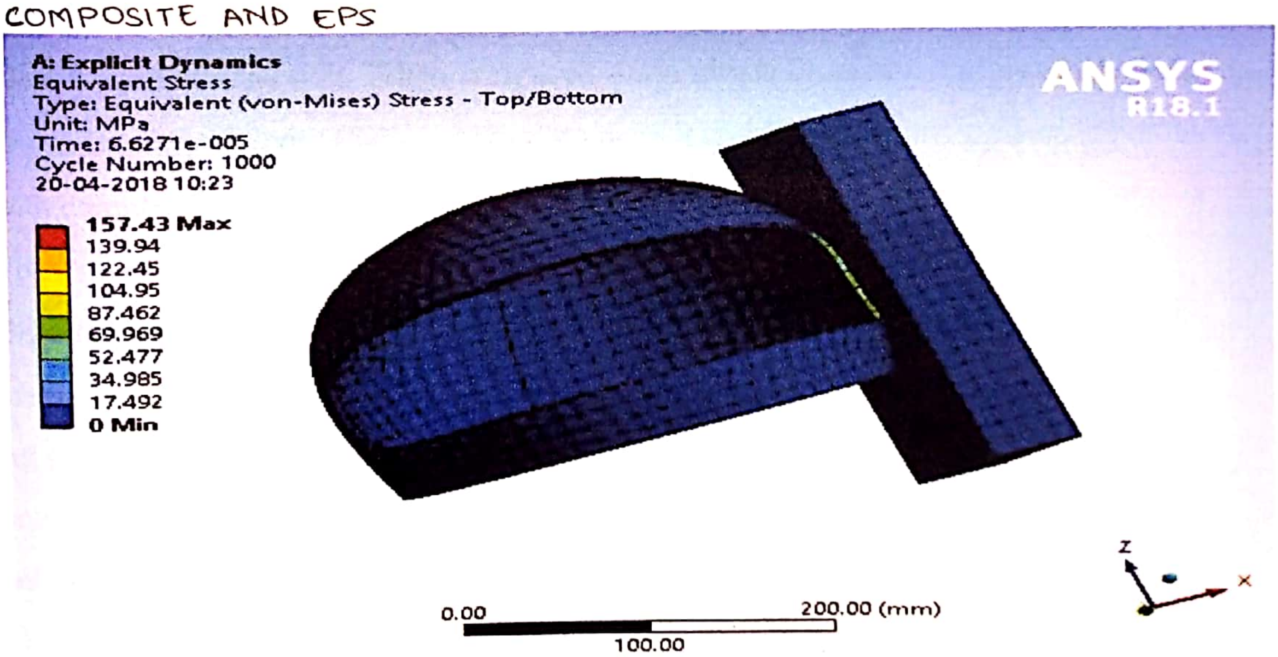


Fig 6.6 total stress

Conclusions and Scope of Future

In this parametric study, the model was developed for two layers of helmet .The helmet model isgenerated in Catia with specified dimensions and analysis is carried out in ansysworkbench 15 ,the main objective is to list out the best material which suits for th e helmet .

On testing the model at velocity 20m/s (72kmph) and 30m/sec (108kmph).The VonMises stresses, deformations athorizontal impact are obtained ascritical for composite and EPS Combination .Under horizontal impact the different obtained values for helmet are the Von-Mises stress (velocity at 20m/sec): 107.2Mpa, elastic strain: 0.303 , Deformation :1.412mm. The Von-Mises stress(velocity at 30m/sec):157.4Mpa, elastic strain:0.434, Deformation:2.270mm.

Thus it is concluded that, When compared Acryl nitrate Butadiene Styrene(ABS) and Expanded Poly Styrene (EPS) , Poly carbon(PC) and Expanded Poly Styrene (EPS) with compositeand Expanded Poly Styrene (EPS),compositeand EPS combination is th e best material for helmet and it can resist more stresses , strains and deformation.

Density is directly proportional to mass, With increase in the density of the material, mass also increases.

As density of composite is more compared with Acryl nitrate Butadiene Styrene and poly carbon , composite can resist more amount of stress and mass of the helmet is minimum.

The future scope of work can be a more precise modelling of helmet with Composite materials and adjustable foam technology can be extended at the rear side of the helmet.

REFERENCES

[1] *Puneet Mahajan, Two Wheeler Helmets with Ventilation and Metal Foam, Defence Science Journal, Vol.58, No.2, March 2008, pp 304-311 O 2008, DESIDOC*

[2] *Danial Lanner and Richard Coomber, a numerical and an experimental approach t o measuring the ballistic and blunt impact protection offered by military helmets. Performance and Design February 15, London, UK HPD-2011-1.*

[3] *Mechanism for foam linear elastic deformation is the elastic bending of the thick cell walls, Gibson.Engineering and Technology,International Journal of Mechanical Aerospace, Industrial and Mechatronics Engineering Vol:6 No:1, 2013*

[4] *The influence of velocity on the performance range of American football helmets. Andrew post, Anna Oeur, T. Blaine Hoshizaki and Michael D. Gilchrist,, proceedings of the 1st International Conference on Helmet Performance and Design February 15, 2013, London, UK HPD-2013*

[5] *Mazdak Ghazari and Ugo Galvanetto, Virtual and experimental testing of helmets MRTN-CT-2006-035965 MYMOSA*

[6] *Anil Kumar. K, Y. Suresh babu., Design and Analysis of Industrial Helmet., International Journal Of Computational Engineering Research Vol. 3 Issue. 12. ISSN 2250-3005, 2013.*

[7] *V.C.Sathish Gandhi Analysis of Motor Cycle Helmet under Static and Dynamic Loading., World Academy of Science, Engineering and Technology. International Journal of Mechanical Aerospace, Industrial and Mechatronics Engineering Vol:8 No:1, 2014.*

[8] *Terry Smith, John Lenkeit and Jim Boughton. Application of finite element analysis to helmet design. Dynamic research INC, Torrance, California, USA.*

[9] *F.M.Shuaeid, A.M.S Hamouda, M.M.Hamdan, R.S.Radin Umar, M.S.J.Hhmi "A new motorcycle helmet liner material: The finite element simulation and design of experiment optimization" Materials and design, Volume 28, Issue 1, 2007, Pages 182-195.*

[10] *Tamilmaniraj.V and Santhosham, Prediction of Mechanical Properties of a Motorcycle Helmet using Ansys and CFD fluent 14.5 workbench. International Journal of Science Technology and Management, Vol No.04, Issue No.04, April 2015. Issn: 2394-1537.*

[11] P.Viswanadham Raju, Vinod Banthia, Abdul Nassar., Design of Streamlined Motorcycle Helmet With Enhanced Head Protection. SAS Tech Journal, Volume 8, Issue 2, September 2009.

[12] The development of next generation test standards for helmets. Peter Halldin and Sven Kleiven , Proceedings of the 1st International Conference on Helmet Performance and Design February 15, London, UK HPD-2013-1