

DESIGN, ANALYSIS AND FABRICATION OF MOTORCYCLE HELMET FOR EYEGLASSES USERS

Submitted in partial fulfillment of the requirements for the award of

Bachelor of Engineering degree in Mechanical Engineering

By

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INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of K. NAVEEN (Reg. No. 37150706) and S. SAKTHI RISHI (Reg. No. 36150163) who carried out the project entitled "**DESIGN, ANALYSIS AND FABRICATION OF MOTORCYCLE HELMET FOR EYEGLASSES USERS**" under my supervision from August 2020 to March 2021.

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1.

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DATE: 30.04.2020

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ABSTRACT

Number of road accidents are increasing along with the number of vehicles on the roads. About 30% of the total road accidents accounts as the motorcycle accidents. Total deaths of such motorcycle riders are mostly due to inappropriate safety measures adopted by the riders and one of which is not using helmets or using faulty helmets. As per a statement by helmet manufacturer about 90% of the total helmets used in India are faulty helmets. While wearing Eye Glass, we aren't able to put on helmets. So, we designed this helmet in such a way that helmet is inserted into head simultaneously with the presence of eye glass. It was designed using **CATIA V5**. The simulation software **ANSYS** is used to analyze the helmet with different conditions such as Bottom Fixed & Load on Top Area, Side Fixed & Load on Other Side Area, Side Fixed & Load on Front Area. The maximum force of 19.5 Kilo newton tolerance as per **British Standards Institution** standard. Load applied on the helmet to study the model for Impact. Then results are compared and observed which has lowest deformation & stress.

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CHAPTER 1

INTRODUCTION

1.0 HELMET

Motorcyclists are subjected to accidents more than other motorists. Head is a sensitive part in the human body and is very vulnerable to injury, often with severe ramifications. It is particularly prone to acceleration/deceleration and rotational forces as it is freely movable in three dimensions and is relatively in unstable position, supported only on neck muscles and ligaments. Road accidents are one of the major causes of fatalities in the world. Unlike the other vehicle users having seatbelts and airbags as protective equipment, the effective countermeasures to prevent head injuries in bicycle and motorcycle crashes is the use of protective helmet.

The fatalities in the motorcycle crash were high for the non-helmeted when compared to the helmeted. In the early 1900s, with the advent of the motorcycle, the need of a crash helmet arises. Primarily, the helmet purpose is meant to be understood as head protection against skull fractures, and modern helmets are usually efficient in this sense. Another main purpose of motorcycle helmet is the prevention of brain injury caused by the accelerations caused by the relative movement of the brain in the cerebral fluid.



Fig 1.0 full face helmet

Without a doubt, the most significant development in motorcycle safety since the introduction of the motorcycle itself has been the helmet. It's the single most essential piece of safety gear for motorcycle riders, dramatically reducing the odds of injury and improving the odds of survival in a motorcycle crash, not to mention protecting them from wind, rain, bugs, and debris while riding. For many riders these days, the idea of motorcycles and motorcycle helmets are inseparable. But it hasn't always been that way – the history of the motorcycle helmet has been a struggle, as the very idea of wearing a helmet has long been opposed by many riders, and the development of helmets has been slow as a result. In this article, we trace the development of the helmet from the early days of leather skullcaps and shellacked canvas shells, to the highly advanced equipment made of space age materials that protect our heads today.

1.1.0 The Roots of the Motorcycle Helmet

The first motorcycles weren't even motorcycles – they were “motorized bicycles” that were built for convenient transportation and not performance, and the very notion of needing any kind of protection aboard those cumbersome machines of the early 1900s was unheard of. But it wasn't long before motorcycles became faster, especially in racing – and with speed, of course, came injuries.

The first ever head protection for motorcycle racers was introduced over 100 years ago, in 1914. A British physician named Dr. Eric Gardner, who had been attending to a patient for concussion from a motorcycle accident, and commissioned the construction of an idea to prevent it – a shellacked canvas shell to cover the top of the head.

Gardner pushed for his invention to be used by racers in the Isle of Man TT, the premier motorcycle race of the day, and was successful; organizers of the race made head protection mandatory the same year, and an immediate reduction in concussions followed.



Fig1.2 Cyril Pullin, winner of the premier Senior class at the Isle of Man TT race in 1914, sporting an early motorcycle helmet made of shellacked canvas in the very first year the famous race required head protection.

The first ever “helmet” immediately proved its worth. But civilians still balked at the idea of wearing one of the odd-looking shells while riding; most riders used no head protection at all. Some opted to use padded leather caps similar to football helmets of the day, but these were marketed as a way to hold the hair in place and keep road grime out of it (plus, they just looked cool; then, as now, motorcyclists always want to look cool while riding!) A skullcap and goggles was about the most protection you’d see on any rider in the early 1900s. Isle of Man TT

1.1.1 The Birth of Motorcycle Safety

However, that began to change with the death of famous British military officer and diplomat T.E. Lawrence, aka “Lawrence of Arabia” in 1935. Having survived numerous military campaigns in the Arabian Peninsula, Lawrence was actually killed in a tragic motorcycle accident only miles from his home by a severe head injury. Lawrence was a national hero, and his untimely death brought attention to the danger of motorcycle riding – and ways to make it safer for the first time.



Fig1.3 the death of British national hero T.E. Lawrence from a head injury sustained in a motorcycle accident in 1935 brought about the first serious push in motorcycle safety, particularly with respect to head protection.

At the forefront of that effort was Dr. Hugh Cairns, a British physician who attended to Lawrence while he was in a six-day coma before passing away. Cairns was inspired by the event and began research into the high correlation between motorcycle accidents and head injuries, publishing the first ever report on the subject in a British medical journal.



Fig 1.4 Hugh Cairns was a British military officer and one of the attending physicians to T.E. Lawrence after the motorcycle accident that ultimately killed him. Cairns became driven to improve motorcycle head protection after seeing die from trauma, and eventually got the British Army to require helmets for dispatch riders during WWII.

His research led to him lobbying the British military aggressively for some improvements in motorcycle safety, especially since in those days, Motorcycle mounted 'dispatch riders' were still used widely for reconnaissance and communication. Cairns' efforts paid off in 1941, when the Army ordered all military riders to wear head protection, a "helmet" made of rubber and cork.



Fig 1.5 British dispatch riders gearing up for rides in 1941, with their rubber and cork motorcycle helmets as part of their issued gear.



Fig 1.6 A closer look at the “pudding bowl” style helmet in use during the 1930s and 1940s; this one is a version issued to British military motorcycle couriers.

1.1.2 The Beginning of the Modern Motorcycle Helmet

Still, over the next decade and a half, motorcycles became faster and faster, but head protection still had yet to become adopted by civilian riders. Most helmets of the day

were of the “pudding bowl” variety, simple half shells with a leather strap that provided a minimal amount of protection. But a big development came in 1953, when a professor at USC, C.F. Lombard, developed a revolutionary new form of head protection – a helmet that actually absorbed impact.



Fig 1.7 Roy Richter, former race car driver and founder of Bell Helmets. Bell has been at the forefront of motorcycle, bicycle, and automotive racing helmet innovation since the 1950

His design used three layers: a hard fiberglass outer shell, and impact-absorbing foam middle layer, and a padded inner liner for comfort. Lombard’s design was picked up by Bell, who created their model 500 using those safety principles along with styling cues from aviation helmets of the day. The Bell 500 was an instant hit, and that helmet marks the beginning of the era of the modern motorcycle helmet.



Fig 1.8 An early advertisement for the ground-breaking new Bell 500 motorcycle helmet from the late 1950s.

Helmets like the Bell 500 became standard equipment in racing, but still weren't well received by street riders. In the 1960s, however, popular opinion began to change and more riders began to use helmets, and in 1963, Bell again revolutionized the market with the first ever full-face motorcycle helmet the Bell Star. The Star was high-end and expensive, but offered more protection than anything else on the market in those days, using the same technology and materials as were found in the U.S. military's flight helmets and NASA's astronaut helmets at the time.



Fig 1.9 Motorcycle road racers in the 1960s, many of them using Bell Star helmets, the first ever full-faced helmets.

The Star hit the market at the right time too; only a year later, in 1964, the USDOT created the first-ever safety standards by which motorcycle helmets had to adhere to in order to be “street legal.” But the big boon to helmet makers was in 1966, when the US Highway Safety Act was passed by Congress, which specified that the states would be required to have helmet laws in place to get federal funds for highway development.



Fig 1.10 One of the most famous Bell Helmet users was legendary motorcycle stunt rider Evel Kneivel, who always wore a full-face helmet during his stunts



Fig 1.11 full face helmet accident (c. 1975)

Grudgingly, most states complied, with 47 enacting helmet laws in the following years. But the law was extremely popular and considered to be overreaching, and beginning with Michigan in 1968, a number of states actually rescinded their helmet laws in spite of the federal government. A new Congress repealed the law in 1975, and more than half of the participating states repealed their helmet laws too. But by that time, helmets had increased in popularity and were far more commonplace, and helmet technology continued to move forward. In the 1970s and 1980s, full-face helmets came into their own, with improvements in rider comfort like flip-up and tinted visors, later followed by the introduction of modular helmets, which combined the convenience of $\frac{3}{4}$ helmets with the safety of a full-face.

1.2 Head injuries are a leading cause of death and disability

Injuries to the head and neck are the main cause of death, severe injury and disability among users of motorcycles and bicycles. In European countries, head injuries contribute to around 75% of deaths among motorized two-wheeler users; in some low-income and middle-income countries head injuries are estimated to account for up to 88% of such fatalities. The social costs of head injuries for survivors, their families and communities are high, in part because they frequently require specialized or long term care. Head injuries also result in much higher medical costs than any other type of

injury, such that these injuries exert a high toll on a country's health care costs and its economy. Globally, there is an upward trend in the number and use of motorcycles and bicycles, both for transport and recreational purposes.

Indeed, most of the growth in the number of vehicles on the world's roads comes from an increasing use of motorized two-wheelers. Asian countries, in particular, are expected to experience a considerable rise in the number of motorized two-wheeler vehicles on their roads. This rapid growth in the use of motorcycles in many low income and middle-income countries is already being accompanied by a considerable increase in the number of head injuries and fatalities that will only continue to increase if present trends continue unchecked.



Fig 1.12 rider without proper gear

1.2.1The Anatomy of Human Head

An appreciation of the anatomy of the head is important in understanding the mechanism of injuries to the head and brain. The brain is enclosed within a rigid skull. The brain “sits” on bones that make up the base of the skull. The spinal cord passes through a hole in the underside of the brain. Under the skull, adhering to the bones, is a tough tissue called the dura that surrounds the brain. Between the brain and the dura is a space containing cerebrospinal fluid that protects the brain tissue from

mechanical shock. The brain “floats” in the cerebrospinal fluid but it can only move about 1 millimeter in any direction. The skull is covered by the scalp, which provides some additional protection.

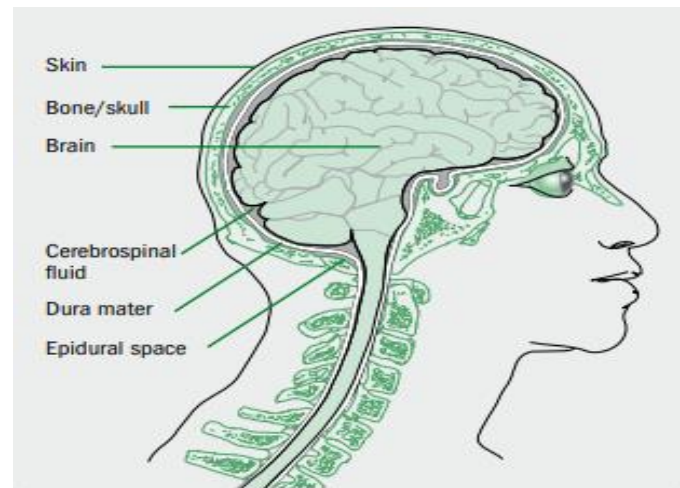


Fig 1.13 Structure of the head and brain

1.3.0 The Anatomy of the Safest Motorcycle Helmet

The motorcycle helmet is constantly evolving to keep up with technological advancements, including the use of lighter materials for reduced strain on the neck, additional padding for extra comfort, Bluetooth speakers to allow you to take advantage of your smartphone’s capabilities such as navigation, music or hands-free calling, and much more. Although motorcycle helmets continue to build out these innovative features, the core anatomy of the motorcycle helmet has remained the same for decades. There are four main components to the motorcycle helmet: the outer shell, impact-absorbing liner, padded comfort layer, and retention system/chin strap. The components of the helmet each serve a specific purpose and contribute to keeping your head safe.

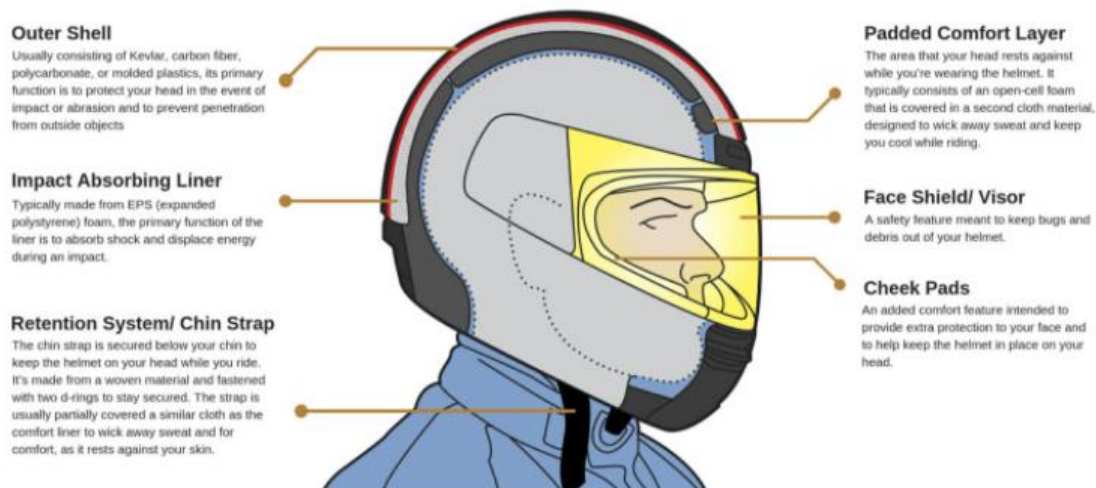


Fig 1.14 The Anatomy of the Safest Motorcycle Helmet

1.3.1 Outer Shell

The rigid, outer shell is the outermost, colored part of the helmet you view from the outside. Usually consisting of Kevlar, carbon fiber, polycarbonate, molded plastics, or a combination of those materials, its primary function is to protect your head in the event of impact or abrasion and to prevent penetration from outside objects, such as rocks, insects, etc.

1.3.2 Impact Absorbing Liner

On the inside of the outer shell is the impact-absorbing liner, typically made from EPS (expanded polystyrene) foam. The primary function of the liner is to absorb shock and displace energy during an impact. The outer shell keeps foreign objects from penetrating the helmet, while the inner layer keeps the energy of the impact from transmitting to your head. Some layers may be made from a single density foam, while other models include a dual-density layer (two layers combined) for added energy displacement during an impact.

1.3.3 Padded Comfort Layer

The padded comfort layer is the area that your head rests against while you're wearing the helmet. It typically consists of an open-cell foam that is covered in a second cloth material, designed to wick away sweat and keep you cool while riding. It is usually removable for cleaning purposes and is interchangeable to accommodate different head shapes. Check with your helmet manufacturer to see if they offer different comfort liner shapes to best fit your head shape.

1.3.4 Retention System/Chin Strap

The helmet retention system, also referred to as the chin strap, is secured below your chin to keep the helmet on your head while you ride. It's made from a woven material and fastened with two d-rings to stay secured. When properly secured, the chin strap should only allow for two fingers between the strap and your chin. The strap is usually partially covered a similar cloth as the comfort liner to wick away sweat and for comfort, as it rests against your skin.

1.3.5 Cheek Pads

Full-face and $\frac{3}{4}$ helmets have cheek pads inside of the helmet that rest against your cheeks. They are removable for cleaning and are customizable to accommodate different head shapes. They are an added comfort feature similar to the padded comfort liner, intended to provide extra protection to your face and to help keep the helmet in place on your head.

1.3.6 Face Shield/Visor

The face shield or visor is a safety feature meant to keep bugs, debris, and everything else out of your helmet. They're usually designed to be removable for cleaning purposes or to swap out for another shield/ visor. They come in customizable colors and tints for different riding environments. Be sure to ride with a clear visor in low light levels so you can see the road and environment clearly.

1.3.7 Vents

The ventilation system on the helmet is meant to keep the rider's head cool and to help evaporate off sweat as best as possible. Ventilation is more prevalent on full face and $\frac{3}{4}$ helmets but can vary by type depending on the manufacturer. Most vents have the option to open and close for different weather conditions. You may want it fully open during warmer months, fully closed during cooler months, and somewhere in-between during other parts of the riding season. They are adjustable, which makes them a good option for each individual rider's comfort.

CHAPTER 2

LITERATYRE SURVEY

- 1. Design and Analysis of the Motorcycle Helmet using Finite element analysis as per FMVSS 218, Varun Agrawal, Rohit Kumrawat, Jivya Jain, Shreyas Bute, Anil Lashkari, Ashish Solanki.** In this research work, detailed motorcycle helmet shell, padding, and foam were modeled with nonlinear material properties. Two cases were simulated based on foam padding stiffness to enhance the impact attenuation capability of the helmet. Finally they concluded that Foam stiffness was found to be a key player in acceleration reduction. The baseline case was not meeting the test requirements. With reduced foam stiffness, significant acceleration was reduced.
- 2. Design and Finite Element Analysis of Helmeted Head Form in Impact, Suddapalli Praneeth Babu, Dr. Chandana Srinivas.** This paper is intended to perform finite element analysis by and study the severity of the injury with and without helmet and the impact absorbing polystyrene with different shear modulus. The Impact absorption tests (drop tests) at three different points on head form were performed. The work also compares the deformations, velocities of the head form, accelerations that are obtained during the drop test according on the head form with and without the helmet and protective padding (liner) of different mechanical properties.
- 3. Finite Element Analysis of Protective Helmets using Different Material Parameters, Saurabh Singh, Hrishabh Singh.** This paper deals with the critical review of helmets that are available in the market and how are they performing to the standards of different testing scenarios. A comparative analysis has also been done taking four different materials and analyzing how they perform on a similar loading condition. Finally they concluded that the minimum

deformation observed was of the polyester material amongst the tested four materials and implies to be a better suitability for the use as helmets. In this present work motor cycle helmet is designed and modelled in 3D modelling software Pro/Engineer. The impact analysis is performed on the helmet when colliding to a target at different that faces the helmet on the front, right and back directions using COSMOS software. The materials used for the helmet is ABS and PVC. From the results it is stated that helmet made of PVC material is better when compare to ABC materials in terms of stresses and ABC material is better than PVC material in terms of deformation and strains.

4. IMPACT TEST ANALYSIS ON A 2-WHEELER HELMET USING 3D MODELLING AND ANALYSING SOFTWARE FOR TWO DIFFERENT MATERIALS.

Saroj Kumar Biswal , S.M.Shahrukh Rais, Karanam Krishnah. In this project, a standard motorcycle helmet is designed using CATIA V5. The impact test analysis is performed on the helmet using ANSYS at different speeds with 2 materials. Finally they concluded that PVC (Poly Vinyl Chloride) plastic material is better when compared to ABS (Acrylonitrile Butadiene Styrene) in terms of stresses developed. Hence, the shell part if manufactured with PVC will be able to withstand large stresses. ABS material is better than PVC in terms of strain and deformations occurred during colliding. Hence this material can be employed to provide lesser deformations during accidents.

5. Performance Analysis of Motor Cycle Helmet under Static and Dynamic Loading.

V. C. Sathish Gandhi, R. Kumara velan, S. Ramesh. In this research work Several studies have been conducted to evaluate the protective performance of helmets during direct head impact, with constant–rate compression and drop– impact tests which are typically used to investigate the protective contribution of individual helmet. The helmet design variations in terms of different variable other than head form linear acceleration and suggested that the model had optimized cost, weight and helmet size. The simulation models of helmet and human head to study the impacts on a protected and unprotected head in a typical

motorcycle. Even though people wear helmet, due to its inadequate quality, the neck pain was developed and glare in the visor are high. Hence it is essential to produce standard helmet with proper aero-dynamic shape to reduce the neck pain of the rider in the long journey paraded with anti-glare in the visor.

6. Comparison Tests of Motorcycle Helmets Qualified to International Standards, Collision and Injury Dynamics, Thom, David R. In this research work Thirty-two contemporary full-facial coverage motorcycle helmets consisting of 16 different models, two samples each, were destructively tested. Two anvil configurations were used: flat pavement and a narrow metal edge. These tests were not to determine compliance with any particular standard, but were designed to compare the helmets' performance under test conditions that resemble the impact threats riders most often face in street crashes.

CHAPTER 3

AIM AND SCOPE

3.0 Project objective

- To design a new helmet for the eye glasses users.
- To provide safety and comfort while wearing and removing helmet While wearing eye glasses.
- The helmet design is analysis and tested as pre the BIS (**British Standards Institution**) standard. The analysis is carried in the ANSYS. And the loads applied on helmet top area, side areas and front areas. It will show the TOTAL DEFORMATION and STRESS AND STRAIN ENERGY whether the helmet design is effective or any problem occurs.

3.1 project scope

This project design and analysis of motorcycle helmet for the eye glasses users. Design is done in CATIA V5 the motorcycle helmet is designed. The helmet is subject to load impact to check the deformation in the helmet using ANSYS

3.2 Present investigation

In our field research, we discovered that many people who wear glasses find it difficult to ride a motorcycle. Since there is no dedicated helmet for them on the market. As a result, they wear regular helmets like everyone else. However, it is inconvenient, and as a result, it leads to injuries. As a result, the aim of this project is to create a new motorcycle helmet for eye glass user that is both secure and comfortable. In order to eliminate the possibility of an accident.

CHAPTER 4

EXPERIMENTAL OR MATERIAL AND METHODS ALGORITHMS

4.0 Experimental of prototype model

As there is responsibility to safeguard ourselves from the accidents that occur while riding a two-wheeler. The main aim of this helmet is to give maximum comfort and protection to the users having eye glasses.

As we already discussed, there are many designs prior to this but the lack of improvement and simple mechanism and the comfort levels are dusted when compared to our prototype.

Finally we are going to fabricate our project in three steps as this is completely a hand made design the use of machines is kept as low as possible.

The three steps are:

Wood Sculpting

Expanded Polystyrene Attachment

Comfort Padding Layering



Fig 4.0 prototype view of the motorcycle helmet

4.1 Working methodology

The working methodology of this helmet is completely handmade and the machine usage is null when compared to the work the man force has done. This project is far more valuable for the time taken and the risks taken.

We started the project by designing a model using CATIA V5.

The design we prepared using this software is for riders who use eyeglasses while riding and the comfort levels are taken at most importance before designing the real time prototype.

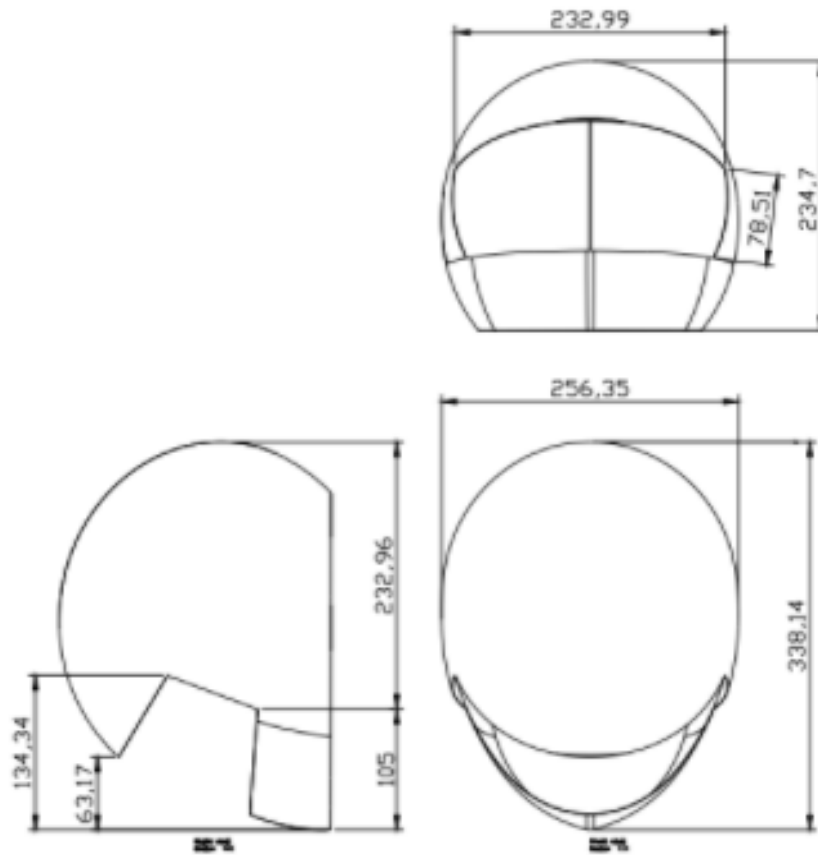
The analysis has been done using Ansys, the material that's been used for analysis is poly carbonate whereas we are using wood to make our prototype as it is cost efficient.

Firstly, we use a block of wood which is suitable for the helmet we are going to design from it. The complete process of sculpting is done using the masterclass sculpting skills of a person with at most accuracy and precision of a skilled individual.

Then the expanded polystyrene attachment is used as an impact absorbent and also prevents the shock upon the individual from the helmet.

Comfort padding layering is done to make the user get an even comfort while using the eyeglasses and makes sure the sweat generated during the ride is absorbed and on a plus side the padding is washable by which it provides a even more healthy option.

4.2 Design specifications



all dimension are in mm

Fig4.1 2d dimension of motorcycle helmet



Fig 4.2 Outer Shell



Fig4.3 Impact Absorbing Liner



Fig 4.4 Padded Comfort Layer

CHAPTER 5

RESULT AND DISCUSSION PERFORMANCE ANALYSIS

5.0 Introduction to Cad

Computer-aided design (CAD), also known as computer-aided design and drafting (CADD), is the use of computer technology for the process of design and design-documentation. Computer Aided Drafting describes the process of drafting with a computer. CADD software, or environments, provides the user with input-tools for the purpose of streamlining design processes; drafting, documentation, and manufacturing processes. CADD output is often in the form of electronic files for print or machining operations. The development of CADD-based software is in direct correlation with the processes it seeks to economize; industry-based software (construction, manufacturing, etc.) typically uses vector-based (linear) environments whereas graphic-based software utilizes raster-based (pixilated) environments.

5.1 CATIA

CATIA is a Para surface-based modeler, and uses a parametric element based way to deal with make models and congregations. Boundaries allude to limitations whose qualities decide the shape or math of the model or get together. Boundaries can be either numeric boundaries, for example, line lengths or circle distances across, or mathematical boundaries, for example, digression, equal, concentric, flat or vertical, and so on. Numeric boundaries can be related with one another using relations, which permits them to catch plan goal.

Plan aim is the way the maker of the part needs it to react to changes and updates. For instance, you would need the gap at the head of a helmet can to remain at the top surface, paying little mind to the tallness or size of the can. CATIA permits the client to indicate that the gap is an element on the top surface, and will at that point their plan goal.

Highlights allude to the structure squares of the part. They are the shapes and tasks that develop the part. Shape-based highlights regularly start with a 2D or 3D sketch

of shapes, for example, managers, openings, spaces, and so forth. This shape is then expelled or sliced to include or eliminate material from the part. Activity based highlights are not sketch-based, and incorporate highlights, for example, fillets, chamfer, shells, applying draft to the essences of a section, and so forth.

Building a model in CATIA as a rule begins with a splines sketch (in spite of the fact that 3D portrays are accessible for power clients). The sketch comprises of math, for example, focuses, lines, curves, conics (aside from the hyperbola), and splines. Measurements are added to the sketch to characterize the size and area of the calculation. Relations are utilized to characterize ascribes, for example, juncture, parallelism, oppositeness, and concentric section

The parametric idea of CATIA implies that the measurements and relations drive the calculation, not the reverse way around. The measurements in the sketch can be controlled freely, or by connections to different boundaries inside or outside of the sketch

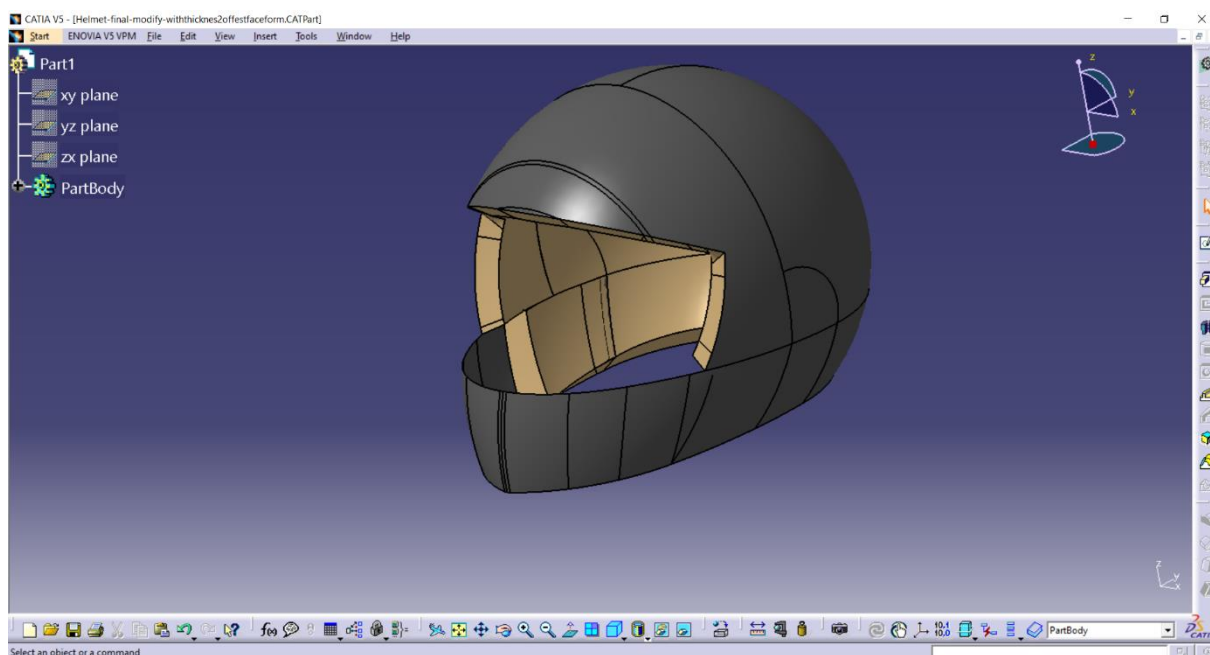


Fig 5.1 Design of the helmet for eyeglasses user

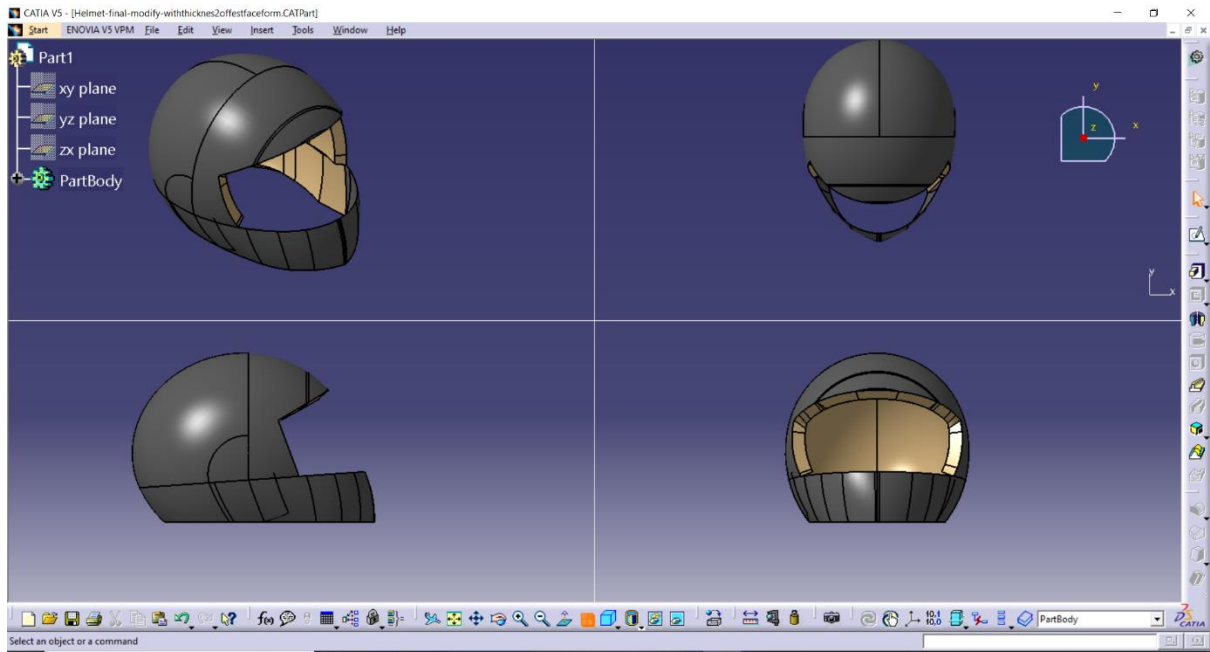


Fig 5.2 Design of helmet with top view, side view, front view and isometric view

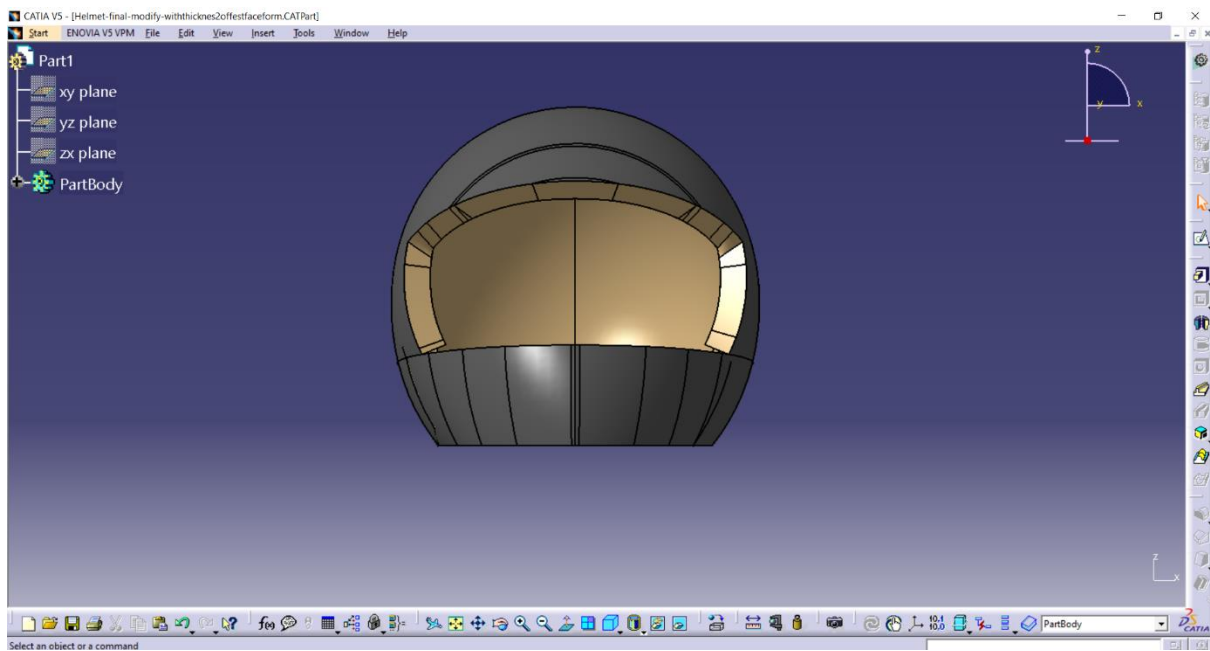


Fig 5.3 Front view of helmet

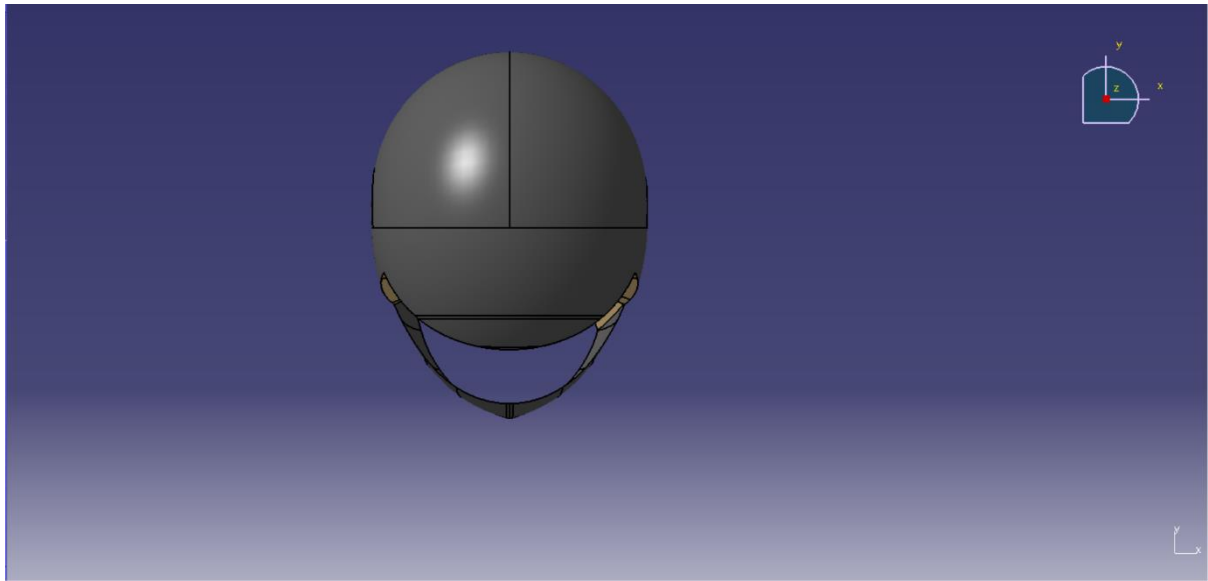


Fig 5.4 Top view of helmet

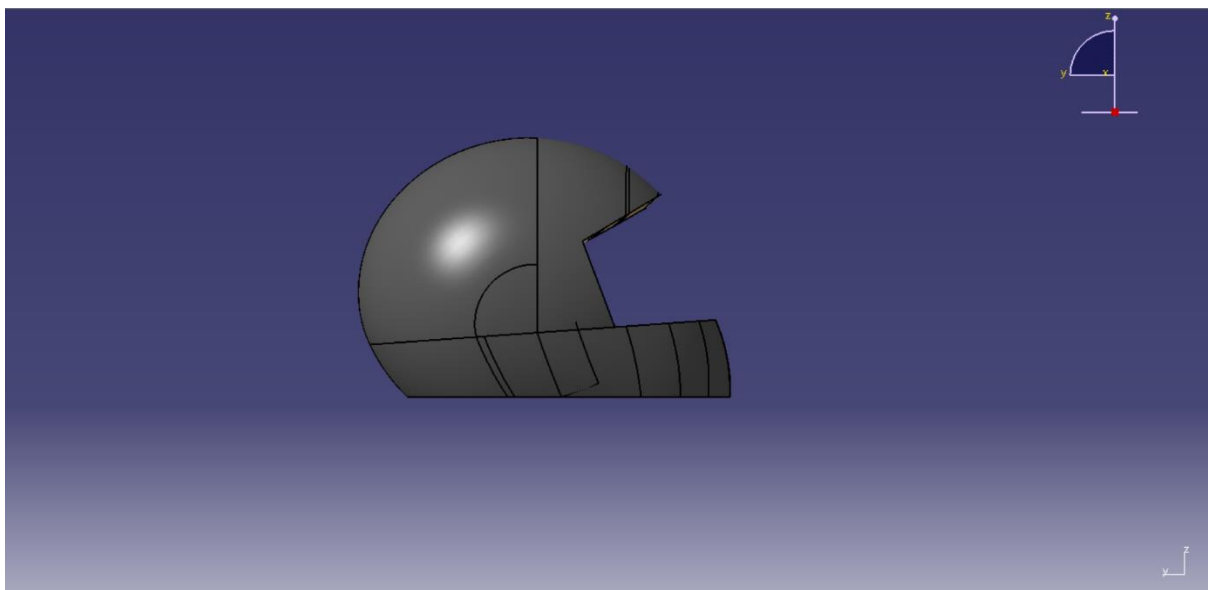


Fig 5.5 Side view of helmet

5.2 ANSYS

Ansys develops and markets engineering simulation software for use across the product life cycle. Ansys Mechanical finite element analysis software is used to simulate computer models of structures, electronics, or machine components for analysing strength, toughness, elasticity, temperature distribution, electromagnetism, fluid flow, and other attributes. Ansys is used to determine how a product will function with different specifications, without building test products or conducting crash tests. For example, Ansys software may simulate how a bridge will hold up after years of traffic, how to best process salmon in a cannery to reduce waste, or how to design a slide that uses less material without sacrificing safety.

Most Ansys simulations are performed using the Ansys Workbench system, which is one of the company's main products. Ansys users break down larger structures into small components that are each modeled and tested individually. A user may start by defining the dimensions of an object, and then adding weight, pressure, temperature and other physical properties. Finally, the Ansys software simulates and analyses movement, fatigue, fractures, fluid flow, temperature distribution, electromagnetic efficiency and other effects over time.

5.2.1 MATERIAL SELECTION

1. FIRST LAYER – SHELL – POLYCARBONATE

POLYCARONATE has better tensile strength, low density and low raw material cost. Out of which polycarbonate has better mechanical then ABS.

Density	1.20–1.22 g/cm ³
Youngs modulus	2.0-2.4 GPa
Tensile strength	55-75 MPa
Compressive strength	>80 MPa
Poisson ratio	0.37
Hardness - rockwell	M70
Izod impact strength	600-850 j/m

2. SECOND LAYER – EPS – EXPANDED POLYSTYRENE

the impact-absorbing liner, typically made from EPS (expanded polystyrene) foam. The primary function of the liner is to absorb shock and displace energy during an impact.

Density	0.96–1.05 g/cm ³
Youngs modulus	3000–3600 Mpa
Tensile strength	46-60 Mpa
Compressive strength	10 - 60 psi
Poisson ratio	.225

5.3 TOP LOAD ANALYSIS

In the condition the helmet is bottom face is fixed and the load is applied top surface of the helmet

5.3.1 Meshing

The process of simulation where complex geometries are divided into simple elements that can be used as discrete local approximations of the larger domain. The mesh influences the accuracy, convergence and speed of the simulation.

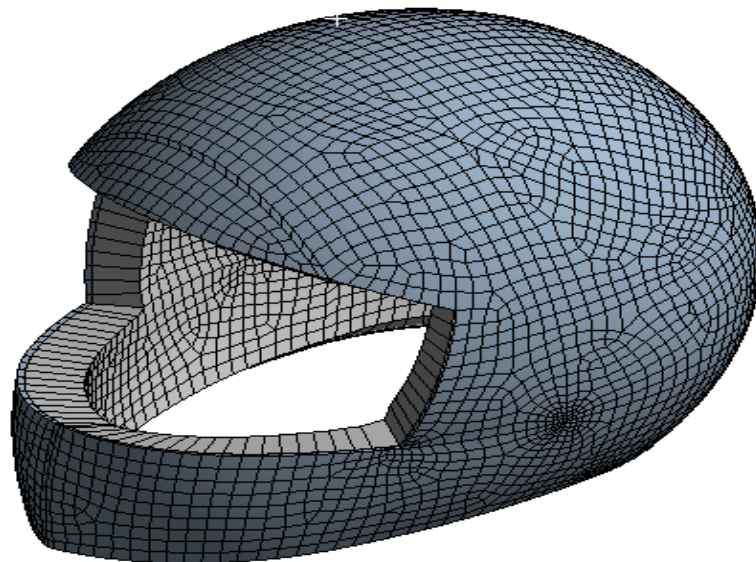


Fig 5.6 Meshing view

Statistics	
Nodes	45953
Elements	24379
Mesh Metric	None

Fig 5.7 meshing statistics

A: Static Structural
 Static Structural
 Time: 1. s
 07/03/2021 7:39 AM

A Fixed Support
B Fixed Support 2
C Force: 19500 N

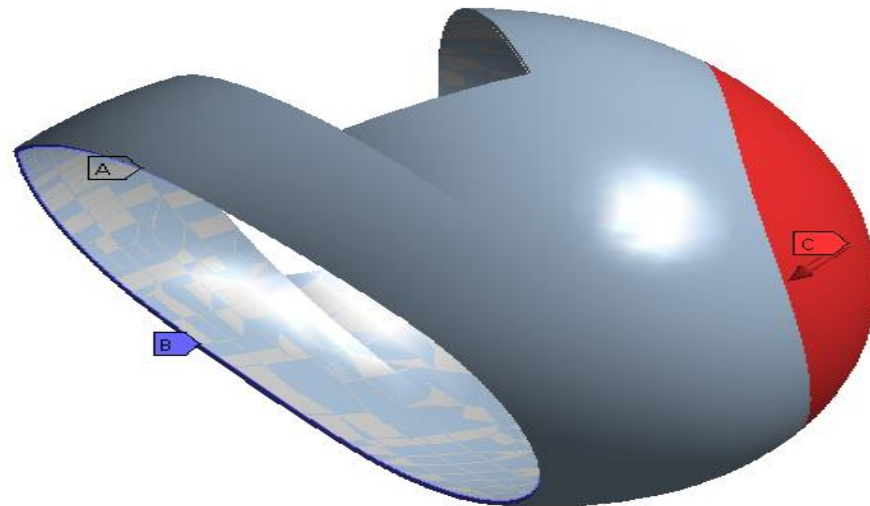


Fig 5.8 contact region of load in the top surface of helmet

5.3.2 Static structural

The determination of the displacements, stresses, strains, and forces in structures or components caused by loads that do not induce significant inertia and damping effects

A: Static Structural
 Equivalent Stress
 Type: Equivalent (von-Mises) Stress - Top/Bottom
 Unit: MPa
 Time: 1
 Custom
 Max: 93.598
 Min: 0.0035148
 07/03/2021 7:29 AM

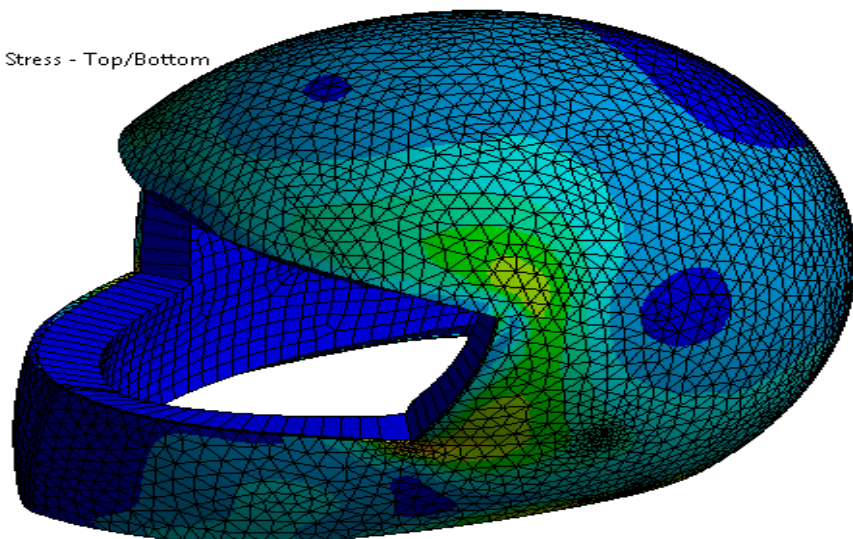
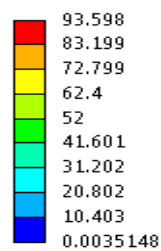


Fig 5.9 Static structural equivalent stress of top load analysis

Force Convergence

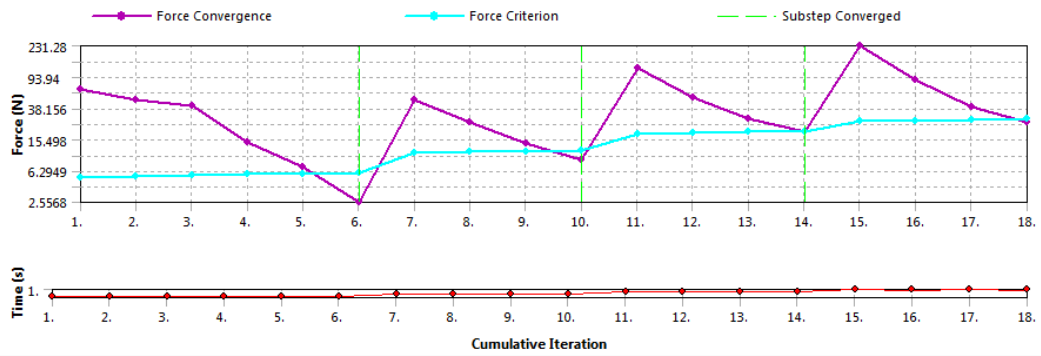


Fig 5.10 Force convergence of top load analysis

A: Static Structural

Strain Energy
 Type: Strain Energy
 Unit: mJ
 Time: 1
 Max: 195.46
 Min: 0.00047576
 07/03/2021 7:31 AM

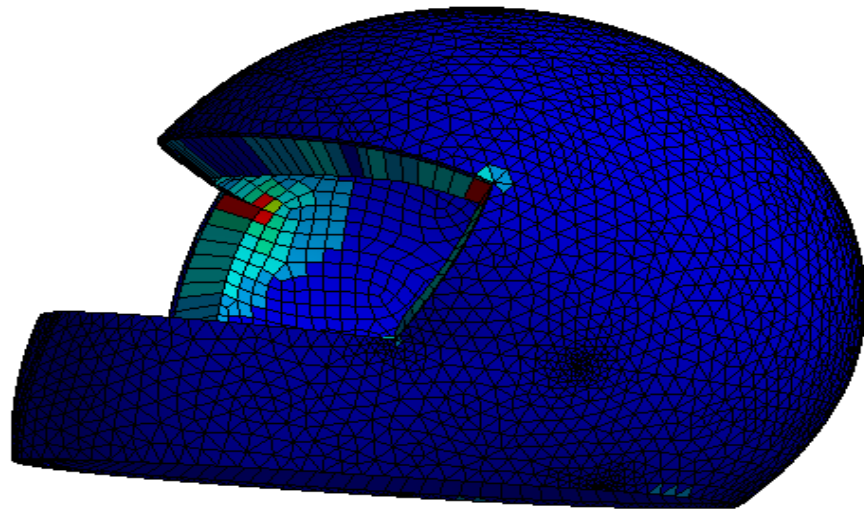
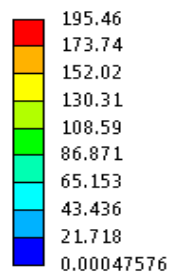


Fig 5.11 Strain energy of top load analysis

5.3.3 Total deformation

Directional deformation can be put as the displacement of the system in a particular axis or user defined direction. Total deformation is the vector sum all directional displacements of the systems.

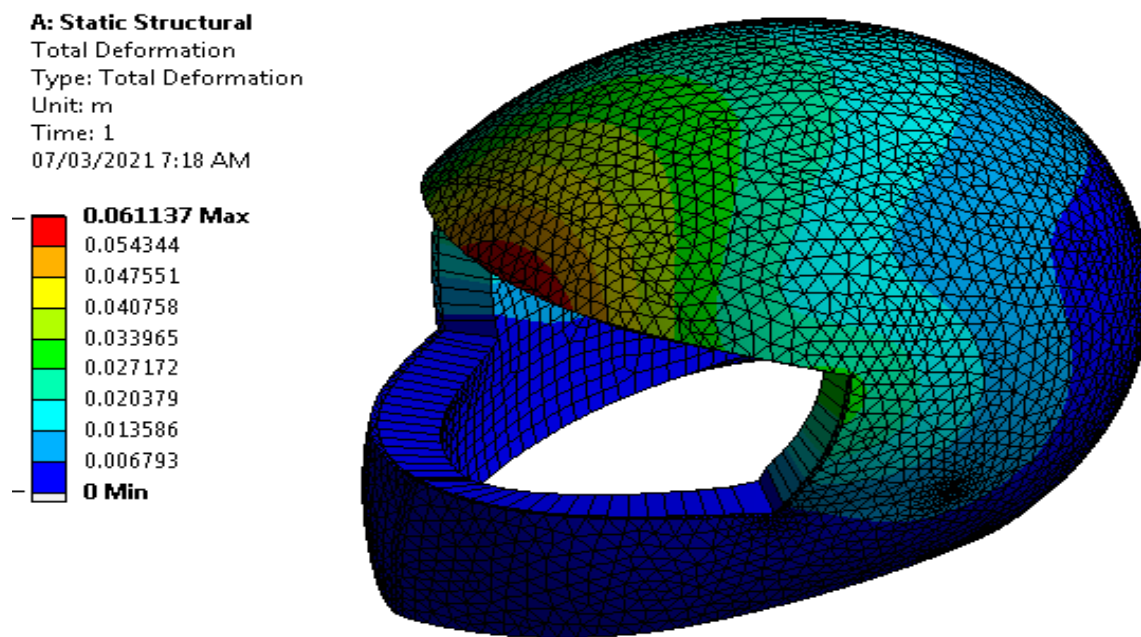


Fig 5.12 Total deformation of top load analysis

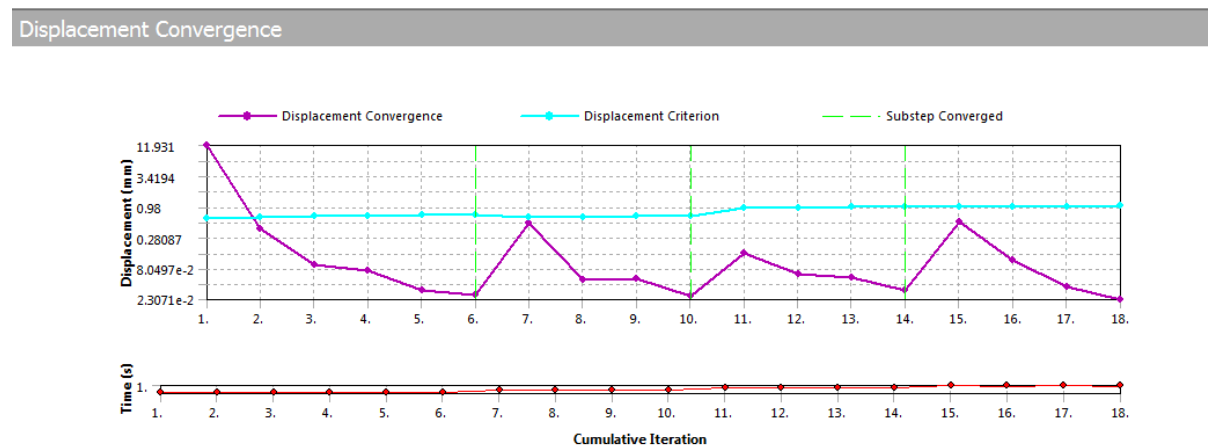


Fig 5.13 displacement convergence of top load analysis

5.4 HELMET ANALYSIS SIDE LOAD

In the condition the helmet is bottom face is fixed and the load is applied top surface of the helmet

5.4.1 Meshing

The process of simulation where complex geometries are divided into simple elements that can be used as discrete local approximations of the larger domain. The mesh influences the accuracy, convergence and speed of the simulation.

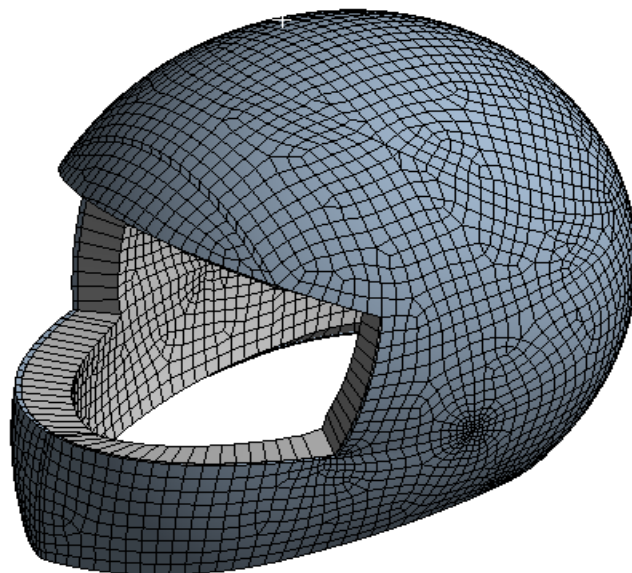


Fig 5.14 meshing of helmet

Statistics	
☐ Nodes	34198
☐ Elements	10516
Mesh Metric	None

Fig 5.15 meshing statistics

B: SIDE LOAD
 Static Structural
 Time: 1. s
 07/03/2021 6:48 PM

- A** Fixed Support
- B** Fixed Support 2
- C** Fixed Support 3
- D** Force: 19500 N

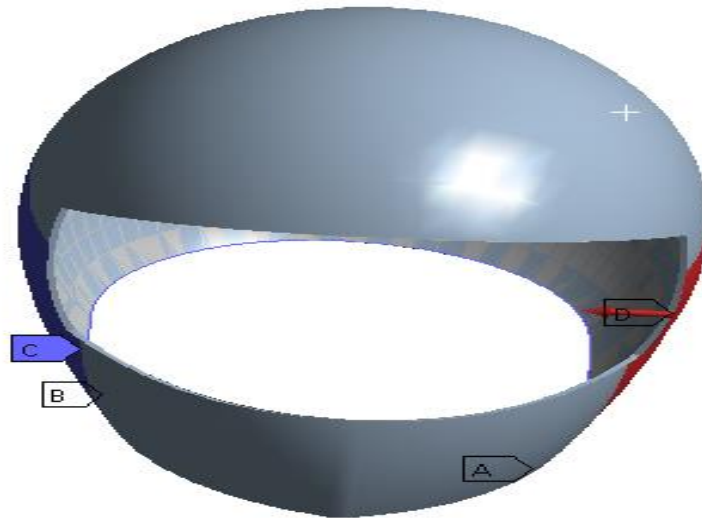


Fig 5.16 contact region of load in the side of helmet

5.4.2 Static structural

The determination of the displacements, stresses, strains, and forces in structures or components caused by loads that do not induce significant inertia and damping effects.

B: SIDE LOAD
 Equivalent Stress
 Type: Equivalent (von-Mises) Stress - Top/Bottom
 Unit: MPa
 Time: 1
 Custom
 Max: 99.79
 Min: 8.0093e-6
 07/03/2021 6:59 PM

- 99.79
- 88.702
- 77.615
- 66.527
- 55.439
- 44.351
- 33.263
- 22.176
- 11.088
- 8.0093e-6

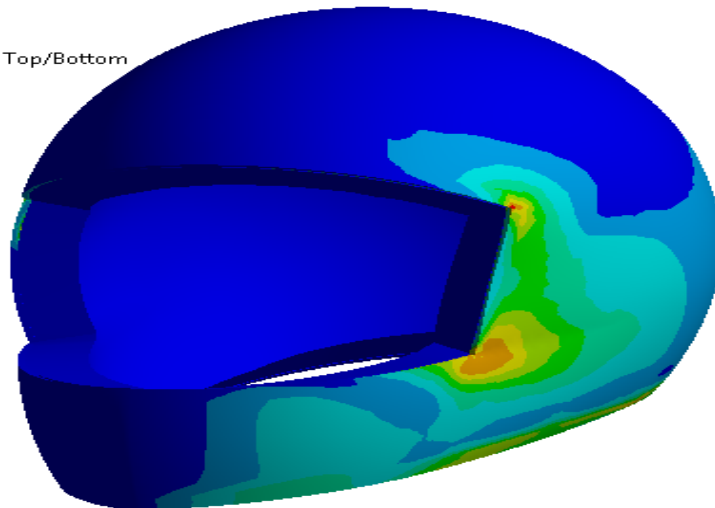


Fig 5.17 Equivalent stress of side load analysis

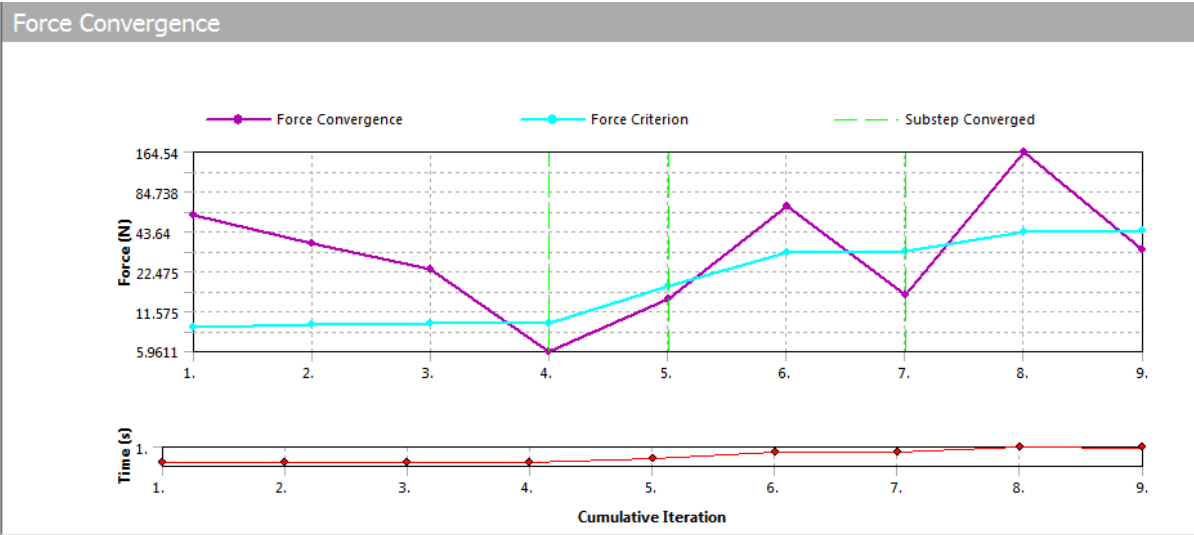


Fig 5.18 Force convergence of side load analysis

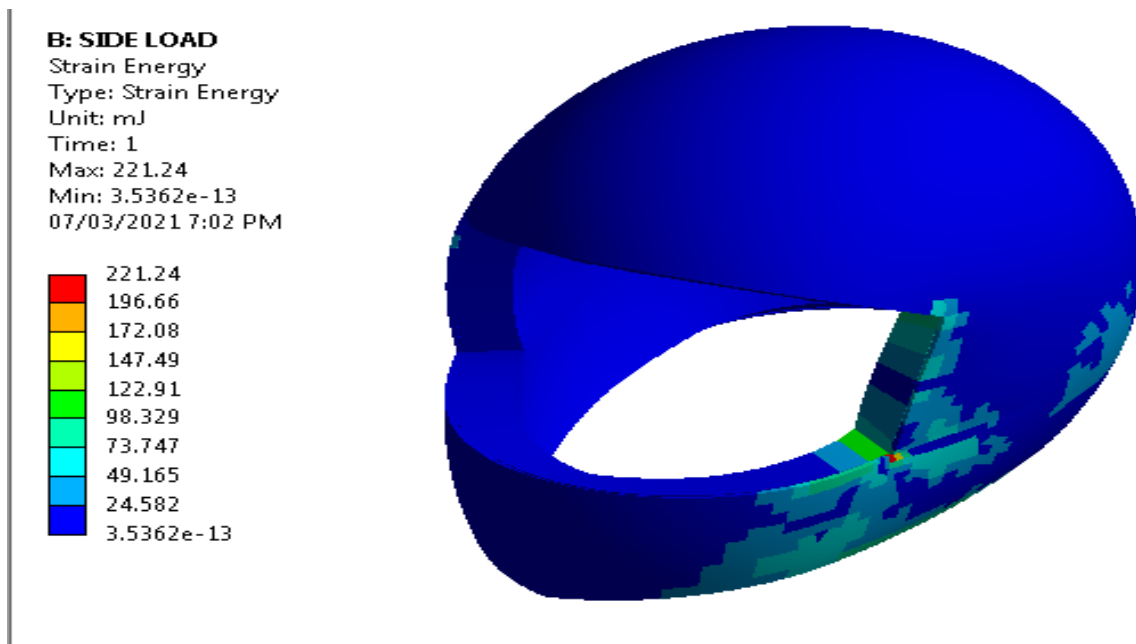


Fig 5.19 Strain energy of side load analysis

5.4.3 Total deformation

Directional deformation can be put as the displacement of the system in a particular axis or user defined direction. Total deformation is the vector sum all directional displacements of the systems.

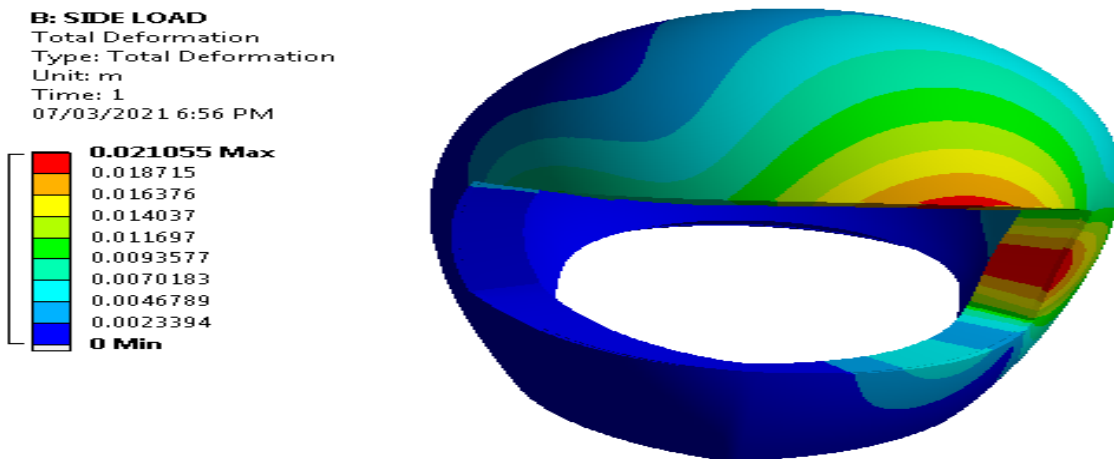


Fig 5.20 Total deformation of side load analysis

Displacement Convergence

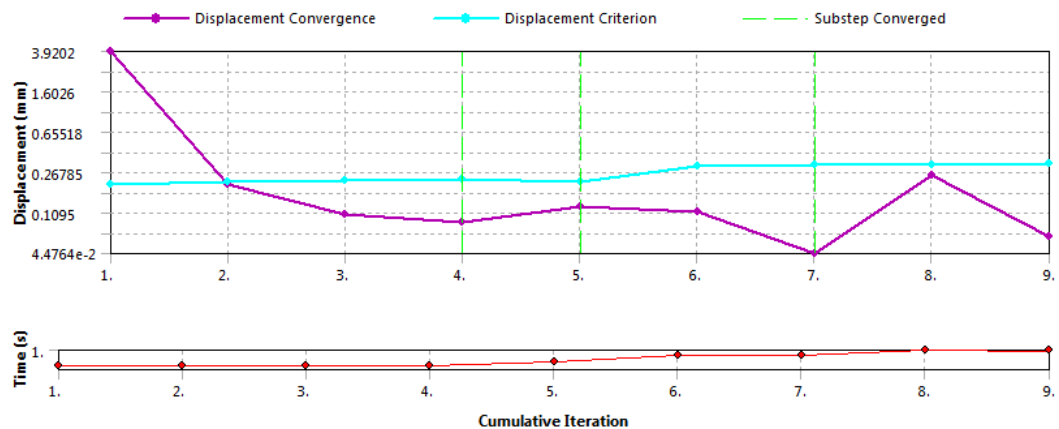


Fig 5.21 displacement convergence of side load analysis

5.5 FRONT LOAD ANALYSIS

In the condition the helmet is bottom face is fixed and the load is applied front surface of the helmet.

5.5.1 Meshing

The process of simulation where complex geometries are divided into simple elements that can be used as discrete local approximations of the larger domain. The mesh influences the accuracy, convergence and speed of the simulation.

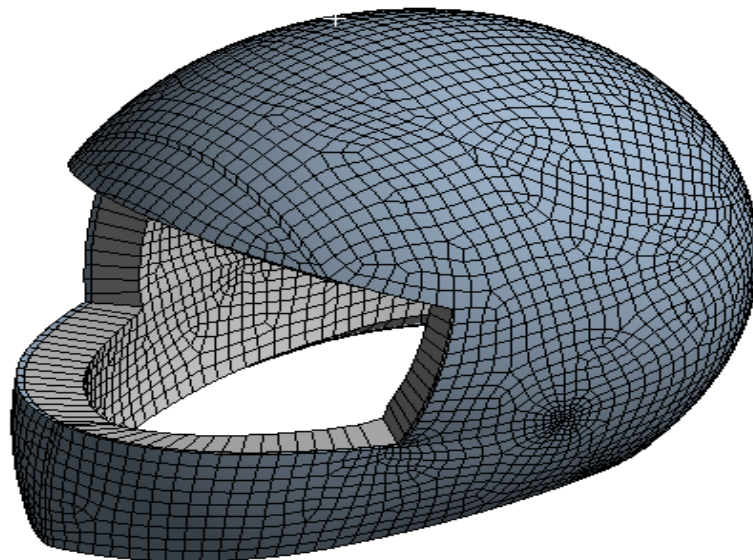


Fig 5.22 meshing of helmet

Statistics	
☐ Nodes	34198
☐ Elements	10516
Mesh Metric	None

Fig 5.23 meshing statistics

C: FRONT LOAD
 Static Structural
 Time: 1 s
 07/03/2021 9:14 PM

A Fixed Support
B Fixed Support 2
C Fixed Support 3
D Force: 19500 N

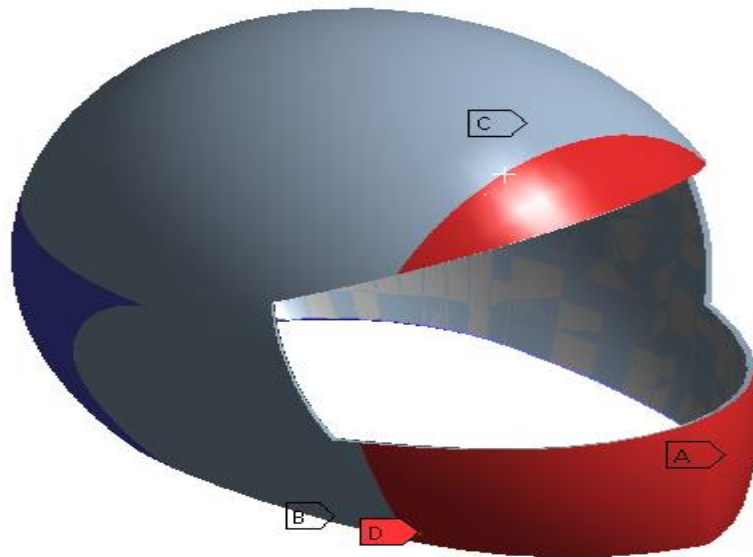


Fig 5.24 contact region of load in the front of helmet

5.5.2 Static structural

The determination of the displacements, stresses, strains, and forces in structures or components caused by loads that do not induce significant inertia and damping effects.

C: FRONT LOAD
 Equivalent Stress 2
 Type: Equivalent (von-Mises) Stress - Top/Bottom
 Unit: MPa
 Time: 1
 Custom
 Max: 0.31568
 Min: 1.3167e-5
 07/03/2021 9:18 PM

0.31568
0.2806
0.24553
0.21046
0.17538
0.14031
0.10523
0.070161
0.035087
1.3167e-5

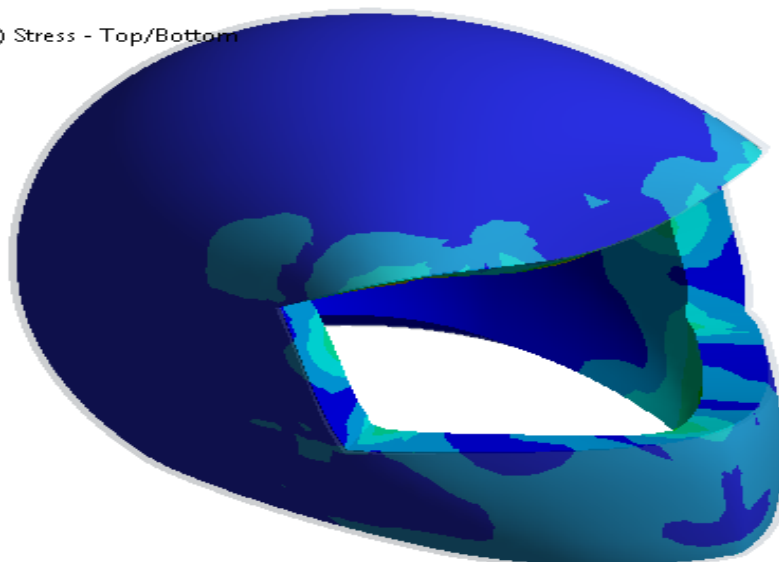


Fig 5.25 Equivalent stress of front load analysis

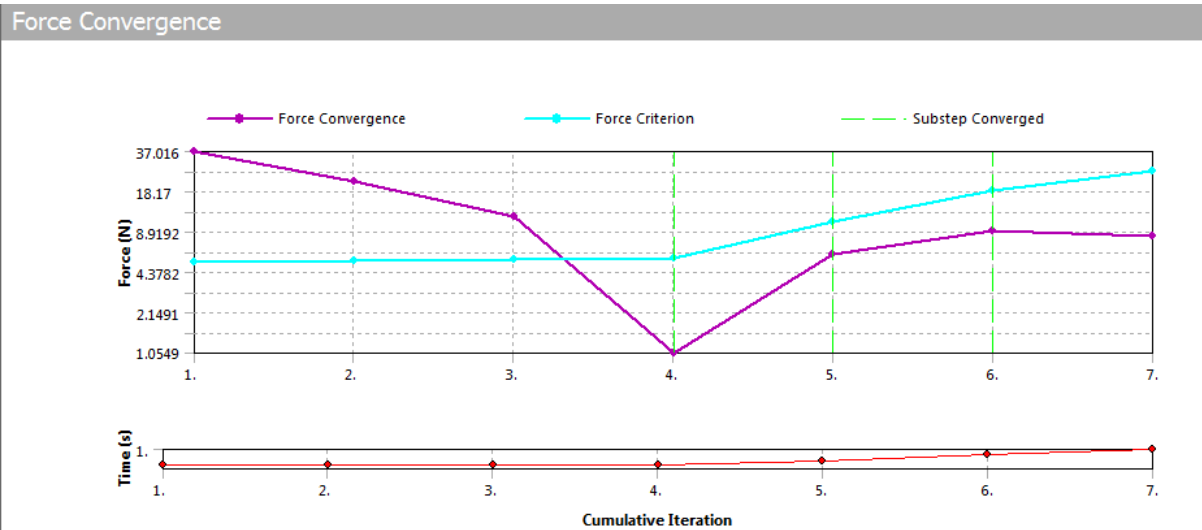


Fig 5.26 Force convergence of front load analysis

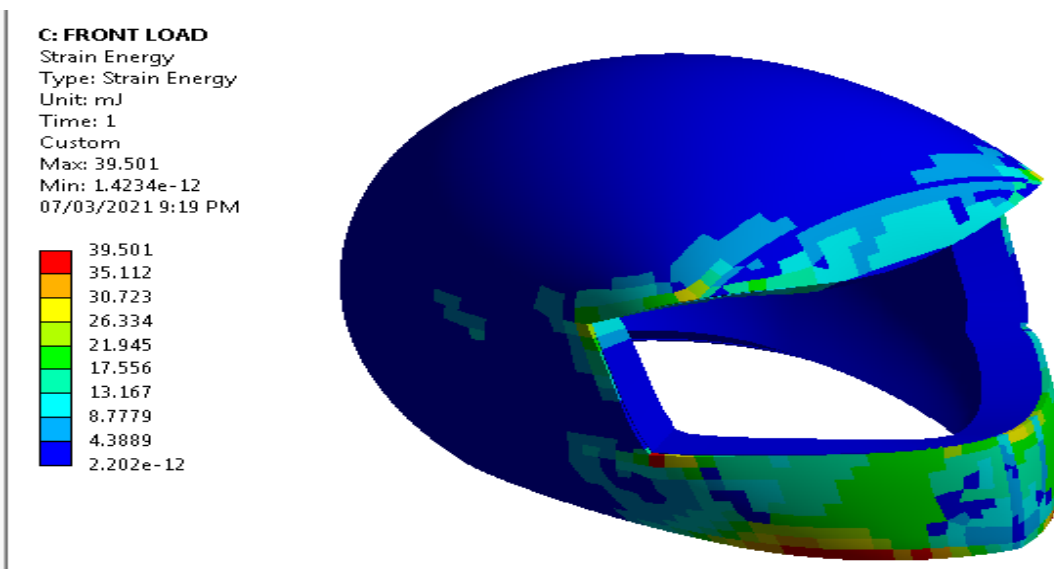


Fig 5.27 strain energy of side load analysis

5.5.3 Total deformation

Directional deformation can be put as the displacement of the system in a particular axis or user defined direction. Total deformation is the vector sum all directional displacements of the systems.

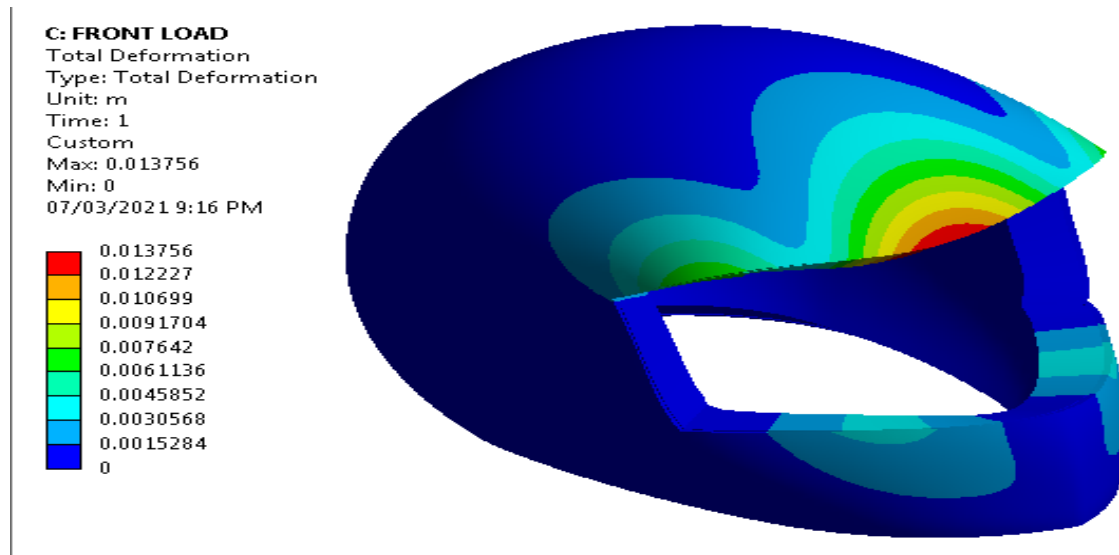


Fig 5.28 Total deformation of front load analysis

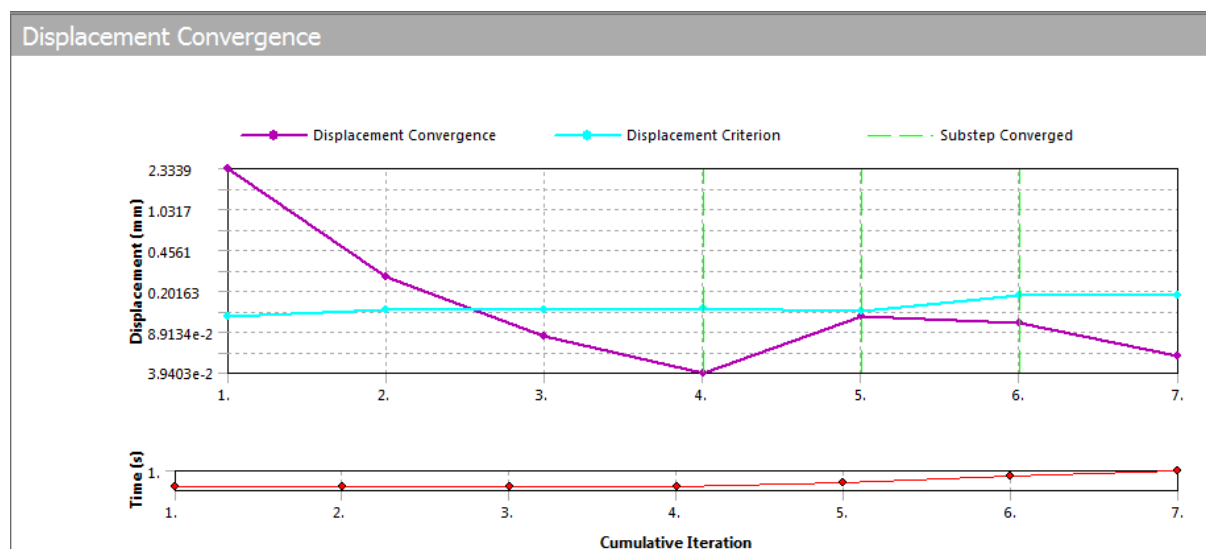


Fig 5.29 Displacement convergence of front load analysis

5.6 RESULT

S.NO	CASES	BOUNDARY CONDITON	TOTAL DEFORMATION (MM)	STRAIN ENERGY (MJ)	STRESS (MPa)
1	Case 1	Bottom Fixed & Load on Top Area 19.5KN	0.061	195.46	93.598
2	Case 2	Side Fixed & Load on Other Side Area 19.5KN	0.021	221.24	99.79
3	Case 3	Side Fixed & Load on Front Area 19.5KN	0.013	39.501	75.907

TABLE 5.1 RESULT

5.7 Advantages over existing model

- The helmet can easily wearable while wearing eyeglass.
- The helmet can easily remove while wearing eyeglass.
- Our helmet design can provide comfort while riding motorcycle with eyeglass
- Prevent falling of eyeglass inside of helmet also while riding.

5.8 future scope

The front face of the motorcycle helmet redesigned for more comfort and vents for air ventilation.

CHAPTER 6

SUMMARY AND CONCLUSION

6.0 Conclusion

In the project the motorcycle helmet is designed for the eyeglass users using CATIA V5 and analysed in the ANSYS. Were three cases are analysed.

1. In the first cases helmet bottom is fixed and load applied in top area of the helmet.
2. In the second cases load applied in the side area of the helmet and the bottom face is fixed.
3. In the third cases load is applied in the front area of the helmet and the bottom face is fixed.

In cases first and second has more effectiveness then standard requirement and undergone less deformation. In the cases third Were the front face of the helmet the less effective area of the helmet then the other area of the helmet. The helmet is with stand the load and passes the standard requirement. The helmet was wearable for the eyeglass user without any restraint while wearing the eyeglass and also removing the helmet while wearing the eyeglass without struggle.

- present design is provides comfort while wearing and removing the motorcycle helmet with eyeglass.
- Provide comfort while driving the motorcycle.
- Present design prevent the fall of eyeglass in-side motorcycle helmet.

6.2 Future Scope of Work

The following directions could be pursued for the future enhancement of the present project in

Terms of fully or partial (function specific) autonomous operation:

- The outer layer of the helmet is select different material to withstand more load.
- Redesign the front area of the helmet for more effective.
- The Impact Absorbing Liner On the inside of the outer shell is the impact-absorbing liner typically made from EPS (expanded polystyrene) foam can select different foam density or composite foam material.
- In the future work add more comfort and features in the helmet.

REFERENCES

1. Afshari, A. and Rajaai, S. M.: Finite element simulations investigating the role of the helmet in reducing head injuries, *International Journal of Simulation modeling*, 7, 1, 42–51, 2008.
2. Alam, F., Subic, A. and Akbarzadeh, A.: Aerodynamics of Bicycle Helmets, *The Engineering of Sport*, 7, 1, 337–334, 2008.
3. Bachynski KE, Goldberg DS (2014) Youth sports and public health: framing risks of mild traumatic brain injury in american football and ice hockey. *J Law Med Ethics* 42: 323-333.
4. Blair, K. and Sidelko, S.: Aerodynamic Performance of Cycling Time Trial Helmets, *The Engineering of Sport*, 7, 2, 371–377, 2008.
5. Bachynski KE, Goldberg DS (2014) Youth sports and public health: framing risks of mild traumatic brain injury in american football and ice hockey. *J Law Med Ethics* 42: 323-333.
6. Becker, Ed (2002). Comparisons (of) Snell M2000, DOT, BSI 6658-85 Type A and EN 22/05. Snell Memorial Foundation.
7. Boele-Vos MJ, de Craen S. A randomized controlled evaluation study of the effects of a one-day advanced rider training course. *Accid Anal Prev*. 2015; 79: 152-9.
8. Chang, L. Y.: Empirical analysis of the effectiveness of mandated motorcycle helmet use in Taiwan, *Journal of the Eastern Asia Society for Transportation Studies*, 6, 3629–3644, 2005.

9. Esmailnejad-Ganji SM, Karimi Nasab MH. Risk Factors for Fatal Traffic Accidents: A Narrative Review. *International Journal of Medical Investigation*. 2019; 8 (1): 1-9
10. Fang C, Le L, Ao Y, Zhen-Hong N, Qing-Jun Z, Yi G. Risk factors of motor vehicle road traffic injuries: A meta-analysis. *CJEBM*. 2014; 14: 1434-41.
11. Foroutan A, Heydari ST, Karvar M, Mohammadi L, Sarikhani Y, Akbari M, et al. Results of a Campaign for Motorcycle Helmets Advocacy in a City in Southwest of Iran; A Population-Based Intervention Study. *Bull Emerg Trauma*. 2019; 7 (4): 404-10.
12. Ford, Dexter (2005). *Blowing the Lid Off*. Motorcyclist Magazine, Primedia Publishing. June.
13. Gedda M. Traduction française des lignes directrices PRISMA pour l'écriture et la lecture des revues systématiques et des méta-analyses. *Kinésithérapie, la Revue*. 2015; 15 (157): 39-44.
14. Gale, A. and Mills, N. J.: Effect of Polystyrene Foam Liner Density on Motorcycle Helmet Shock Absorption, *Plastics and Rubber Processing and Applications*, 5, 2, 101– 108, 1985.
15. Gilchrist, A. and Mills, N. J.: Impact Deformation of ABS and GRP Motorcycle Helmet Shells, *Plastics and Rubber Processing and Applications*, 21, 3, 141–150, 1994.
16. Hansen K, Dau N, Feist F, Deck C, Willinger R (2013) Angular Impact Mitigation system for bicycle helmets to reduce head acceleration and risk of traumatic brain injury. *Accid Anal Prev* 59: 109-117.

17. Hurt, H.H. Jr., J.V. Ouellet & D.R. Thom. (1981). Motorcycle Accident Cause Factors and Identification of Countermeasures. Final Report to National Highway Traffic Safety Administration, U.S. Dept. of Transportation, PB 81-206443, 81-206450.
18. Hanssen, A. G., Girard, Y., Olovsson, L., Berstad, T. and Langseth, M.: A numerical model for bird strike of aluminium foam-based sandwich panels, *Int. J. of Impact Engg.*, 32, 1127–1144, 2005.
19. Ivancic PC (2014) Cervical spine instability following axial compression injury: A biomechanical study. *Orthop Traumatol Surg Res* 100: 127-13.
20. Ivers RQ, Sakashita C, Senserrick T, Elkington J, Lo S, Boufous S, et al. Does an on-road motorcycle coaching program reduce crashes in novice riders? A randomised control trials. *Accid Anal Prev*. 2016; 86: 40-6.
21. Johnson O, Adebayo A. Effect of Safety Education on Knowledge of and Compliance with Road Safety Signs among Commercial Motorcyclists in Uyo, Southern Nigeria. *Ghana Med J*. 2011; 45: 89-96.
22. Johnson OE, Owoaje ET. Effect of health education on the riding habits of commercial motorcyclists in Uyo, southern Nigeria. *West Afr J Med*. 2012; 31 (1): 39-46.
23. Kingsbury, H. B. and Rohr, P. R.: Structure Characteristics of Motorcycle Helmets, Society of Automotive Engineers, Inc, No. 810372, 1981.
24. Langlois JA, Rutland-Brown W, Wald MM (2006) The epidemiology and impact of traumatic brain injury. *J Head Trauma Rehabil* 21: 375-378.

25. Mills, N. J. and Gilchrist, A.: The Effectiveness of Foams in Bicycle and Motorcycle Helmets, *Accident Analysis and Prevention*, 23, 2–3, 153–163, 1991.
26. Mills, N.J., Wilkes, S., Derler, S. and Flisch, A.: FEA of oblique impact tests on a motorcycle helmet, *International Journal of Impact Engineering*, 36, 913–925, 2009.
27. National Highway Traffic Safety Administration. Traffic safety facts 2007 [Internet]. [cited 2019 Feb 27]. Available from: <https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/811002>.
28. Nubile, P.: Analytical design of antireflection coatings for silicon photovoltaic devices, *Thin Solid Films*, 342, 257–261, 1999.
29. ociąga, T. Jaruga, *Materiały niemetalowe*. Skrypty Politechniki Częstochowskiej, Czestochowa University of Technology Publishing, Czestochowa (2013).
30. Praveen, K., Pinniji, P. K., Bourdet, N., Mahajan, P. and Willinger, R.: New motorcycle helmets with metal foam shell, *IRCOBI Conference proceedings*, Bern, (Switzerland), 449–452, 2008.
31. Pinnoji, P. K. and Mahajan, P.: Impact analysis of helmets for improved ventilation with deformable head model, *IRCOBI Conference – Madrid (Spain)*, 159–170, 2006.
32. Rueda, M. A. F. and Gilchrist, M. D.: Computational analysis and design of components of protective helmets, *Proceedings of the Institution of Mechanical Engineers, Part P: Journal of Sports Engineering and Technology*, 226, 3(4), 208–219, 2012.

33. Toma, M., Njilie, F. E. A., Ghajari, M. and Galvanetto, U.: Assessing motorcycle crash-related head injuries using Finite Element simulation, *Int. J. simul mod el*, 9, 143–151, 2010.
34. Woratanarat P, Ingsathit A, Chatchaipan P, Suriyawongpaisal P. Safety riding program and motorcycle-related injuries in Thailand. *Accid Anal Prev*. 2013; 58: 115-21.
35. World Health Organization. Global status report on road safety 2018 [Internet]. Geneva: WHO; 2018 [cited 2019 Feb 6].
36. World Health Organization. Global status report on road safety 2016 [Internet]. Organisation Mondiale de la Santé; 2016 [cited 2019 Feb 6].
37. World Health Organization. Tuberculosis [Internet]. 2020 [cited 2020 Jan 14]. Available from: <https://www.who.int/news-room/fact-sheets/detail/tuberculosis>.
38. World Health Organization. Global status report on road safety: time for action [Internet]. Geneva: WHO; 2009 [cited 2019 Feb 6].
39. Wilson, D.: *Bicycling Science*, 3rd ed. Cambridge, MA: Massachusetts Institute of Technology, 110–120 and 174–205, 2004.
40. Žera J, Młyński R. Attenuation of outside noise by shotblasting helmets. *Arch Acoust*. 2004;29(2):347–58.

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DESIGN, ANALYSIS AND FABRICATION OF MOTORCYCLE HELMET FOR EYEGLASSES USERS Submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Mechanical Engineering By K. NAVEEN (REG.NO. 37150706) S. SAKTHI RISHI (REG.NO.37150163) / DEPARTMENT OF MECHANICAL ENGINEERING SCHOOL OF MECHANICAL ENGINEERING SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY (DEEMED TO BE UNIVERSITY) Accredited with grade "A" by NAAC JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI – 600119 MARCH 2021 / DEPARTMENT OF MECHANICAL ENGINEERING BONAFIDE CERTIFICATE This is to certify that this Project Report is the bonafide work of K. NAVEEN (Reg. No. 37150706) and S. SAKTHI RISHI (Reg. No.

36150163) who carried out the project entitled "DESIGN, ANALYSIS AND FABRICATION OF MOTORCYCLE HELMET FOR EYEGLASSES USERS" under my supervision from August 2020 to March 2021. Internal Guide Mr. S. LAKSHMISANKAR., M.E., (Ph.D.), Head of the Department Dr. G. ARUNKUMAR, M.E., PhD., Submitted for Viva voce Examination held on _____ Internal Examiner External Examiner DECLARATION We K. NAVEEN (36150706) and S. SAKTHI RISHI (37150163) hereby declare that the Project Report entitled "DESIGN, ANALYSIS AND FABRICATION OF MOTORCYCLE HELMET FOR EYEGLASSES USERS" done by us under the guidance of Mr. S. LAKSHMISANKAR, M.E., Ph.D.,

is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering degree in Mechanical Engineering. 1. 2. DATE: 30.04.2020 SIGNATURE OF THE CANDIDATE PLACE: CHENNAI ACKNOWLEDGEMENT I am pleased to acknowledge my sincere thanks to Board of Management of SATHYABAMA for their

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ABSTRACT Number of road accidents are increasing along with the number of vehicles on the roads. About 30% of the total road accidents accounts as the motorcycle accidents. Total deaths of such motorcycle riders are mostly due to inappropriate safety measures adopted by the riders and one of which is not using helmets or using faulty helmets. As per a statement by helmet manufacturer about 90% of the total helmets used in India are faulty helmets. While wearing Eye Glass, we aren't able to put on helmets.

So, we designed this helmet in such a way that helmet is inserted into head simultaneously with the presence of eye glass. It was designed using CATIA V5. The simulation software **ANSYS is used to analyze the helmet with different conditions such as Bottom Fixed** & Load on Top Area, Side Fixed & Load on Other Side Area, Side Fixed & Load on Front Area. The maximum force of 19.5 Kilo newton tolerance as per British Standards Institution standard. Load applied on the helmet to study the model for Impact. Then results are compared and observed which has lowest deformation & stress. _ TABLE OF CONTENTS _ _CHAPETER NO.

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CHAPTER 1 INTRODUCTION 1.0

HELMET Motorcyclists are subjected to accidents more than other motorists. Head is a sensitive part in the human body and is very vulnerable to injury, often with severe ramifications. It is particularly prone to acceleration/deceleration and rotational forces as it is freely movable in three dimensions and is relatively in unstable position, supported only on neck muscles and ligaments. Road accidents are one of the major causes of fatalities in the world.

Unlike the other vehicle users having seatbelts and airbags as protective equipment, the effective countermeasures to prevent head injuries in bicycle and motorcycle crashes is the use of protective helmet. The fatalities in the motorcycle crash were high for the non-helmeted when compared to the helmeted. In the early 1900s, with the advent of the motorcycle, the need of a crash helmet arises. Primarily, the helmet purpose is meant to be understood as head protection against skull fractures, and modern helmets are usually efficient in this sense.

Another main purpose of motorcycle helmet is the prevention of brain injury caused by the accelerations caused by the relative movement of the brain in the cerebral fluid. / Fig 1.0 full face helmet Without a doubt, the most significant development in motorcycle safety since the introduction of the motorcycle itself has been the mo. It's the single most essential piece of safety gear for motorcycle riders, dramatically reducing the odds of injury and improving the odds of survival in a motorcycle crash, not to mention protecting them from wind, rain, bugs, and debris while riding.

For many riders these days, the idea of motorcycles and motorcycle helmets are inseparable. But it hasn't always been that way – the history of the motorcycle helmet has been a struggle, as the very idea of wearing a helmet has long been opposed by many riders, and the development of helmets has been slow as a result. In this article, we trace the development of the helmet from the early days of leather skullcaps and shellacked canvas shells, to the highly advanced equipment made of space age materials that protect our heads today. 1.1.0

The Roots of the Motorcycle Helmet The first motorcycles weren't even motorcycles – they were "motorized bicycles" that were built for convenient transportation and not performance, and the very notion of needing any kind of protection aboard those cumbersome machines of the early 1900s was unheard of. But it wasn't long before motorcycles became faster, especially in racing – and with speed, of course, came injuries. The first ever head protection for motorcycle racers was introduced over 100 years ago, in 1914. A British physician named Dr.

Eric Gardner, who had been attending to a patient for concussion from a motorcycle accident, and commissioned the construction of an idea to prevent it – a shellacked

canvas shell to cover the top of the head. Gardner pushed for his invention to be used by racers in the Isle of Man TT, the premier motorcycle race of the day, and was successful; organizers of the race made head protection mandatory the same year, and an immediate reduction in concussions followed. / Fig1.2 Cyril Pullin, winner of the premier Senior class at the Isle of Man TT race in 1914, sporting an early motorcycle helmet made of shellacked canvas in the very first year the famous race required head protection.

The first ever “helmet” immediately proved its worth. But civilians still balked at the idea of wearing one of the odd-looking shells while riding; most riders used no head protection at all. Some opted to use padded leather caps similar to football helmets of the day, but these were marketed as a way to hold the hair in place and keep road grime out of it (plus, they just looked cool; then, as now, motorcyclists always want to look cool while riding!) A skullcap and goggles was about the most protection you’d see on any rider in the early 1900s. Isle of Man TT The Birth of Motorcycle Safety However, that began to change with the death of famous British military officer and diplomat T.E.

Lawrence, aka “Lawrence of Arabia” in 1935. Having survived numerous military campaigns in the Arabian Peninsula, Lawrence was actually killed in a tragic motorcycle accident only miles from his home by a severe head injury. Lawrence was a national hero, and his untimely death brought attention to the danger of motorcycle riding – and ways to make it safer for the first time. /Fig1.3 the death of British national hero T.E. Lawrence from a head injury sustained in a motorcycle accident in 1935 brought about the first serious push in motorcycle safety, particularly with respect to head protection. At the forefront of that effort was Dr.

Hugh Cairns, a British physician who attended to Lawrence while he was in a six-day coma before passing away. Cairns was inspired by the event and began research into the high correlation between motorcycle accidents and head injuries, publishing the first ever report on the subject in a British medical journal. / Fig 1.4 Hugh Cairns was a British military officer and one of the attending physicians to T.E. Lawrence after the motorcycle accident that ultimately killed him.

Cairns became driven to improve motorcycle head protection after seeing die from trauma, and eventually got the British Army to require helmets for dispatch riders during WWII. His research led to him lobbying the British military aggressively for some improvements in motorcycle safety, especially since in those days, Motorcycle mounted ‘dispatch riders’ were still used widely for reconnaissance and communication. Cairns’ efforts paid off in 1941, when the Army ordered all military riders to wear head protection, a “helmet” made of rubber and cork. / Fig 1.5

British dispatch riders gearing up for rides in 1941, with their rubber and cork

motorcycle helmets as part of their issued gear. / Fig 1.6 A closer look at the “pudding bowl” style helmet in use during the 1930s and 1940s; this one is a version issued to British military motorcycle couriers. 1.1.2 The Beginning of the Modern Motorcycle Helmet Still, over the next decade and a half, motorcycles became faster and faster, but head protection still had yet to become adopted by civilian riders.

Most helmets of the day were of the “pudding bowl” variety, simple half shells with a leather strap that provided a minimal amount of protection. But a big development came in 1953, when a professor at USC, C.F. Lombard, developed a revolutionary new form of head protection – a helmet that actually absorbed impact. / Fig 1.7 Roy Richter, former race car driver and founder of Bell Helmets. Bell has been at the forefront of motorcycle, bicycle, and automotive racing helmet innovation since the 1950. His design used three layers: a hard fiberglass outer shell, and impact-absorbing foam middle layer, and a padded inner liner for comfort.

Lombard’s design was picked up by Bell, who created their model 500 using those safety principles along with styling cues from aviation helmets of the day. The Bell 500 was an instant hit, and that helmet marks the beginning of the era of the modern motorcycle helmet. / Fig 1.8 An early advertisement for the ground-breaking new Bell 500 motorcycle helmet from the late 1950s. Helmets like the Bell 500 became standard equipment in racing, but still weren’t well received by street riders.

In the 1960s, however, popular opinion began to change and more riders began to use helmets, and in 1963, Bell again revolutionized the market with the first ever full-face motorcycle helmet the Bell Star. The Star was high-end and expensive, but offered more protection than anything else on the market in those days, using the same technology and materials as were found in the U.S. military’s flight helmets and NASA’s astronaut helmets at the time. / Fig 1.9 Motorcycle road racers in the 1960s, many of them using Bell Star helmets, the first ever full-faced helmets.

The Star hit the market at the right time too; only a year later, in 1964, the USDOT created the first-ever safety standards by which motorcycle helmets had to adhere to in order to be “street legal.” But the big boon to helmet makers was in 1966, when the US Highway Safety Act was passed by Congress, which specified that the states would be required to have helmet laws in place to get federal funds for highway development. / Fig 1.10 One of the most famous Bell Helmet users was legendary motorcycle stunt rider Evil Kneivel, who always wore a full-face helmet during his stunts / Fig 1.11 full face helmet accident (c.

1975) Grudgingly, most states complied, with 47 enacting helmet laws in the following years. But the law was extremely popular and considered to be overreaching, and beginning with Michigan in 1968, a number of states actually rescinded their helmet laws in spite of the federal government. A new Congress repealed the law in

1975, and more than half of the participating states repealed their helmet laws too. But by that time, helmets had increased in popularity and were far more commonplace, and helmet technology continued to move forward.

In the 1970s and 1980s, full-face helmets came into their own, with improvements in rider comfort like flip-up and tinted visors, later followed by the introduction of modular helmets, which combined the convenience of $\frac{3}{4}$ helmets with the safety of a full-face. 1.2 Head injuries are a leading cause of death and disability Injuries to the head and neck are the main cause of death, severe injury and disability among users of motorcycles and bicycles. In European countries, head injuries contribute to around 75% of deaths among motorized two-wheeler users; in some low-income and middle-income countries head injuries are estimated to account for up to 88% of such fatalities.

The social costs of head injuries for survivors, their families and communities are high, in part because they frequently require specialized or long term care. Head injuries also result in much higher medical costs than any other type of injury, such that these injuries exert a high toll on a country's health care costs and its economy. Globally, there is an upward trend in the number and use of motorcycles and bicycles, both for transport and recreational purposes. Indeed, most of the growth in the number of vehicles on the world's roads comes from an increasing use of motorized two-wheelers.

Asian countries, in particular, are expected to experience a considerable rise in the number of motorized two-wheeler vehicles on their roads. This rapid growth in the use of motorcycles in many low income and middle-income countries is already being accompanied by a considerable increase in the number of head injuries and fatalities that will only continue to increase if present trends continue unchecked. / Fig 1.12 rider without proper gear 1.2.1The Anatomy of Human Head An appreciation of the anatomy of the head is important in understanding the mechanism of injuries to the head and brain. The brain is enclosed within a rigid skull.

The brain "sits" on bones that make up the base of the skull. The spinal cord passes through a hole in the underside of the brain. Under the skull, adhering to the bones, is a tough tissue called the dura that surrounds the brain. Between the brain and the dura is a space containing cerebrospinal fluid that protects the brain tissue from mechanical shock. The brain "floats" in the cerebrospinal fluid but it can only move about 1 millimeter in any direction. The skull is covered by the scalp, which provides some additional protection. / Fig 1.13 Structure of the head and brain 1.3.0

The Anatomy of the Safest Motorcycle Helmet The motorcycle helmet is constantly evolving to keep up with technological advancements, including the use of lighter materials for reduced strain on the neck, additional padding for extra comfort,

Bluetooth speakers to allow you to take advantage of your smartphone's capabilities such as navigation, music or hands-free calling, and much more. Although motorcycle helmets continue to build out these innovative features, the core anatomy of the motorcycle helmet has remained the same for decades.

There are four main components to the motorcycle helmet: the outer shell, impact-absorbing liner, padded comfort layer, and retention system/chin strap. The components of the helmet each serve a specific purpose and contribute to keeping your head safe. / Fig 1.14 The Anatomy of the Safest Motorcycle Helmet

1.3.1 Outer Shell The rigid, outer shell is the outermost, colored part of the helmet you view from the outside. Usually consisting of Kevlar, carbon fiber, polycarbonate, molded plastics, or a combination of those materials, its primary function is to protect your head in the event of impact or abrasion and to prevent penetration from outside objects, such as rocks, insects, etc.

1.3.2 Impact Absorbing Liner On the inside of the outer shell is the impact-absorbing liner, typically made from EPS (expanded polystyrene) foam. The primary function of the liner is to absorb shock and displace energy during an impact.

The outer shell keeps foreign objects from penetrating the helmet, while the inner layer keeps the energy of the impact from transmitting to your head. Some layers may be made from a single density foam, while other models include a dual-density layer (two layers combined) for added energy displacement during an impact.

1.3.3 Padded Comfort Layer The padded comfort layer is the area that your head rests against while you're wearing the helmet.

It typically consists of an open-cell foam that is covered in a second cloth material, designed to wick away sweat and keep you cool while riding. It is usually removable for cleaning purposes and is interchangeable to accommodate different head shapes. Check with your helmet manufacturer to see if they offer different comfort liner shapes to best fit your head shape.

1.3.4 Retention System/Chin Strap The helmet retention system, also referred to as the chin strap, is secured below your chin to keep the helmet on your head while you ride. It's made from a woven material and fastened with two d-rings to stay secured.

When properly secured, the chin strap should only allow for two fingers between the strap and your chin. The strap is usually partially covered a similar cloth as the comfort liner to wick away sweat and for comfort, as it rests against your skin.

1.3.5 Cheek Pads Full-face and $\frac{3}{4}$ helmets have cheek pads inside of the helmet that rest against your cheeks. They are removable for cleaning and are customizable to accommodate different head shapes. They are an added comfort feature similar to the padded comfort liner, intended to provide extra protection to your face and to help keep the helmet in place on your head.

Face Shield/Visor The face shield or visor is a safety feature meant to keep bugs,

debris, and everything else out of your helmet. They're usually designed to be removable for cleaning purposes or to swap out for another shield/ visor. They come in customizable colors and tints for different riding environments. Be sure to ride with a clear visor in low light levels so you can see the road and environment clearly.

1.3.7 Vents The ventilation system on the helmet is meant to keep the rider's head cool and to help evaporate off sweat as best as possible. Ventilation is more prevalent on full face and $\frac{3}{4}$ helmets but can vary by type depending on the manufacturer.

Most vents have the option to open and close for different weather conditions. You may want it fully open during warmer months, fully closed during cooler months, and somewhere in-between during other parts of the riding season. They are adjustable, which makes them a good option for each individual rider's comfort.

CHAPTER 2
LITERATURE SURVEY Design and Analysis of the Motorcycle Helmet using Finite element analysis as per FMVSS 218, Varun Agrawal, Rohit Kumawat, Jivya Jain, Shreyas Bute, Anil Lashkari, Ashish Solanki.

In this research work, detailed motorcycle helmet shell, padding, and foam were modeled with nonlinear material properties. Two cases were simulated based on foam padding stiffness to enhance the impact attenuation capability of the helmet. Finally they concluded that Foam stiffness was found to be a key player in acceleration reduction. The baseline case was not meeting the test requirements. With reduced foam stiffness, significant acceleration was reduced.

Design and Finite Element Analysis of Helmeted Head Form in Impact, Suddapalli Praneeth Babu, Dr. Chandana Srinivas.

This paper is intended to perform finite element analysis by and study the severity of the injury with and without helmet and the impact absorbing polystyrene with different shear modulus. The Impact absorption tests (drop tests) at three different points on head form were performed. The work also compares the deformations, velocities of the head form, accelerations that are obtained during the drop test according on the head form with and without the helmet and protective padding (liner) of different mechanical properties.

Finite Element Analysis of Protective Helmets using Different Material Parameters, Saurabh Singh, Hrishabh Singh. This paper deals with the critical review of helmets that are available in the market and how are they performing to the standards of different testing scenarios. A comparative analysis has also been done taking four different materials and analyzing how they perform on a similar loading condition.

Finally they concluded that the minimum deformation observed was of the polyester material amongst the tested four materials and implies to be a better suitability for the use as helmets. In this present work motor cycle helmet is designed and modelled in 3D modelling software Pro/Engineer. The impact analysis is performed on the helmet when colliding to a target at different that faces the helmet on the front, right and back

directions using COSMOS software. The materials used for the helmet is ABS and PVC. From the results it is stated that helmet made of PVC material is better when compare to ABC materials in terms of stresses and ABC material is better than PVC material in terms of deformation and strains.

IMPACT TEST ANALYSIS ON A 2-WHEELER HELMET USING 3D MODELLING AND ANALYSING SOFTWARE FOR TWO DIFFERENT MATERIALS. Saroj Kumar Biswal , S.M.Shahrukh Rais, Karanam Krishnah. In this project, a standard motorcycle helmet is designed using CATIA V5. The impact test analysis is performed on the helmet using ANSYS at different speeds with 2 materials. Finally they concluded that PVC (Poly Vinyl Chloride) plastic material is better when compared to ABS (Acrylonitrile Butadiene Styrene) in terms of stresses developed. Hence, the shell part if manufactured with PVC will be able to withstand large stresses.

ABS material is better than PVC in terms of strain and deformations occurred during colliding. Hence this material can be employed to provide lesser deformations during accidents. Performance Analysis of Motor Cycle Helmet under Static and Dynamic Loading. V. C. Sathish Gandhi, R. Kumara velan, S. Ramesh. In this research work Several studies have been conducted to evaluate the protective performance of helmets during direct head impact, with constant-rate compression and drop- impact tests which are typically used to investigate the protective contribution of individual helmet. The helmet design variations in terms of different variable other than head form linear acceleration and suggested that the model had optimized cost, weight and helmet size.

The simulation models of helmet and human head to study the impacts on a protected and unprotected head in a typical motorcycle. Even though people wear helmet, due to its inadequate quality, the neck pain was developed and glare in the visor are high. Hence it is essential to produce standard helmet with proper aero-dynamic shape to reduce the neck pain of the rider in the long journey paraded with anti-glare in the visor. Comparison Tests of Motorcycle Helmets Qualified to International Standards, Collision and Injury Dynamics, Thom, David R.

In this research work Thirty-two contemporary full-facial coverage motorcycle helmets consisting of 16 different models, two samples each, were destructively tested. Two anvil configurations were used: flat pavement and a narrow metal edge. These tests were not to determine compliance with any particular standard, but were designed to compare the helmets' performance under test conditions that resemble the impact threats riders most often face in street crashes. CHAPTER 3 AIM AND SCOPE 3.0 Project objective To design a new helmet for the eye glasses users. To provide safety and comfort while wearing and removing helmet While wearing eye glasses. The helmet design is analysis and tested as pre the BIS (British Standards Institution) standard.

The analysis is carried in the ANSYS. And the loads applied on helmet top area, side areas and front areas. It will show the TOTAL DEFORMATION and STRESS AND STRAIN ENERGY whether the helmet design is effective or any problem occurs. 3.1 project scope This project design and analysis of motorcycle helmet for the eye glasses users. Design is done in CATIA V5 the motorcycle helmet is designed. The helmet is subject to load impact to check the deformation in the helmet using ANSYS 3.2 Present investigation In our field research, we discovered that many people who wear glasses find it difficult to ride a motorcycle. Since there is no dedicated helmet for them on the market. As a result, they wear regular helmets like everyone else.

However, it is inconvenient, and as a result, it leads to injuries. As a result, the aim of this project is to create a new motorcycle helmet for eye glass user that is both secure and comfortable. In order to eliminate the possibility of an accident. CHAPTER 4 EXPERIMENTAL OR MATERIAL AND METHODS ALGORITHMS 4.0 Experimental of prototype model As there is responsibility to safeguard ourselves from the accidents that occur while riding a two-wheeler. The main aim of this helmet is to give maximum comfort and protection to the users having eye glasses.

As we already discussed, there are many designs prior to this but the lack of improvement and simple mechanism and the comfort levels are dusted when compared to our prototype. Finally we are going to fabricate our project in three steps as this is completely a hand made design the use of machines is kept as low as possible. The three steps are: Wood Sculpting Expanded Polystyrene Attachment Comfort Padding Layering / Fig 4.0 prototype view of the motorcycle helmet 4.1 Working methodology The working methodology of this helmet is completely handmade and the machine usage is null when compared to the work the man force has done.

This project is far more valuable for the time taken and the risks taken. We started the project by designing a model using CATIA V5. The design we prepared using this software is for riders who use eyeglasses while riding and the comfort levels are taken at most importance before designing the real time prototype. The analysis has been done using Ansys, the material that's been used for analysis is poly carbonate whereas we are using wood to make our prototype as it is cost efficient.

Firstly, we use a block of wood which is suitable for the helmet we are going to design from it. The complete process of sculpting is done using the masterclass sculpting skills of a person with at most accuracy and precision of a skilled individual. Then the expanded polystyrene attachment is used as an impact absorbent and also prevents the shock upon the individual from the helmet. Comfort padding layering is done to make the user get an even comfort while using the eyeglasses and makes sure the sweat generated during the ride is absorbed and on a plus side the padding is washable by which it provides a even more healthy option.

4.2 Design specifications / all dimension are in mm Fig4.1 2d dimension of motorcycle helmet / Fig 4.2 Outer Shell / Fig4.3 Impact Absorbing Liner / /Fig 4.4 Padded Comfort Layer CHAPTER 5 RESULT AND DISCUSSION PERFORMANCE ANALYSIS 5.0 Introduction to Cad Computer-aided design (CAD), also known as computer-aided design and drafting (CADD), is the use of computer technology for the process of design and design-documentation. Computer Aided Drafting describes the process of drafting with a computer. CADD software, or environments, provides the user with input-tools for the purpose of streamlining design processes; drafting, documentation, and manufacturing processes.

CADD output is often in the form of electronic files for print or machining operations. The development of CADD-based software is in direct correlation with the processes it seeks to economize; industry-based software (construction, manufacturing, etc.) typically uses vector-based (linear) environments whereas graphic-based software utilizes raster-based (pixilated) environments. 5.1 CATIA CATIA is a Para surface-based modeler, and uses a parametric element based way to deal with make models and congregations. Boundaries allude to limitations whose qualities decide the shape or math of the model or get together.

Boundaries can be either numeric boundaries, for example, line lengths or circle distances across, or mathematical boundaries, for example, digression, equal, concentric, flat or vertical, and so on. Numeric boundaries can be related with one another using relations, which permits them to catch plan goal. Plan aim is the way the maker of the part needs it to react to changes and updates. For instance, you would need the gap at the head of a helmet can to remain at the top surface, paying little mind to the tallness or size of the can.

CATIA permits the client to indicate that the gap is an element on the top surface, and will at that point their plan goal. Highlights allude to the structure squares of the part. They are the shapes and tasks that develop the part. Shape-based highlights regularly start with a 2D or 3D sketch of shapes, for example, managers, openings, spaces, and so forth. This shape is then expelled or sliced to include or eliminate material from the part. Activity based highlights are not sketch-based, and incorporate highlights, for example, fillets, chamfer, shells, applying draft to the essences of a section, and so forth.

Building a model in CATIA as a rule begins with a splines sketch (in spite of the fact that 3D portrays are accessible for power clients). The sketch comprises of math, for example, focuses, lines, curves, conics (aside from the hyperbola), and splines. Measurements are added to the sketch to characterize the size and area of the calculation. Relations are utilized to characterize ascribes, for example, juncture, parallelism, oppositeness, and concentric section The parametric idea of CATIA implies that the measurements and relations drive the calculation, not the reverse way around.

The measurements in the sketch can be controlled freely, or by connections to different boundaries inside or outside of the sketch / Fig 5.1 Design of the helmet for eyeglasses user / Fig 5.2 Design of helmet with top view, side view, front view and isometric view / Fig 5.3 Front view of helmet / Fig 5.4 Top view of helmet / Fig 5.5 Side view of helmet

5.2 ANSYS Ansys develops and markets engineering simulation software for use across the product life cycle.

Ansys Mechanical finite element analysis software is used to simulate computer models of structures, electronics, or machine components for analysing strength, toughness, elasticity, temperature distribution, electromagnetism, fluid flow, and other attributes. Ansys is used to determine how a product will function with different specifications, without building test products or conducting crash tests. For example, Ansys software may simulate how a bridge will hold up after years of traffic, how to best process salmon in a cannery to reduce waste, or how to design a slide that uses less material without sacrificing safety.

Most Ansys simulations are performed using the Ansys Workbench system, which is one of the company's main products. Ansys users break down larger structures into small components that are each modeled and tested individually. A user may start by defining the dimensions of an object, and then adding weight, pressure, temperature and other physical properties. Finally, the Ansys software simulates and analyses movement, fatigue, fractures, fluid flow, temperature distribution, electromagnetic efficiency and other effects over time

MATERIAL SELECTION FIRST LAYER – SHELL – POLYCARBONATE POLYCARBONATE has better tensile strength, low density and low raw material cost. Out of which polycarbonate has better mechanical than ABS. Density 1.20–1.22 g/cm³ _Youngs modulus 2.0-2.4

GPa _Tensile strength 55-75 MPa _Compressive strength >80 MPa _Poisson ratio 0.37 _Hardness - rockwell M70 _Izod impact strength 600-850 J/m _ SECOND LAYER – EPS – EXPANDED POLYSTYRENE the impact-absorbing liner, typically made from EPS (expanded polystyrene) foam. The primary function of the liner is to absorb shock and displace energy during an impact. Density 0.96–1.05 g/cm³ _Youngs modulus 3000–3600 Mpa _Tensile strength 46-60 Mpa _Compressive strength 10 - 60 psi _Poisson ratio 0.225 _ 5.3

TOP LOAD ANALYSIS In the condition the helmet is bottom face is fixed and the load is applied top surface of the helmet

5.3.1 Meshing The process of simulation where complex geometries are divided into simple elements that can be used as discrete local approximations of the larger domain. The mesh influences the accuracy, convergence and speed of the simulation. / Fig 5.6 Meshing view / Fig 5.7 meshing statistics / Fig 5.8 contact region of load in the top surface of helmet

5.3.2

Static structural The determination of the displacements, stresses, strains, and forces in structures or components caused by loads that do not induce significant inertia and damping effects / Fig 5.9 Static structural equivalent stress of top load analysis / Fig 5.10 Force convergence of top load analysis / Fig 5.11 Strain energy of top load analysis 5.3.3 Total deformation Directional deformation can be put as the displacement of the system in a particular axis or user defined direction. Total deformation is the vector sum all directional displacements of the systems. / Fig 5.12 Total deformation of top load analysis / Fig 5.13 displacement convergence of top load analysis 5.4 HELMET ANALYSIS SIDE LOAD In the condition the helmet is bottom face is fixed and the load is applied top surface of the helmet 5.4.1

Meshing The process of simulation where complex geometries are divided into simple elements that can be used as discrete local approximations of the larger domain. The mesh influences the accuracy, convergence and speed of the simulation. / Fig 5.14 meshing of helmet / Fig 5.15 meshing statistics / Fig 5.16 contact region of load in the side of helmet 5.4.2 Static structural The determination of the displacements, stresses, strains, and forces in structures or components caused by loads that do not induce significant inertia and damping effects. / Fig 5.17 Equivalent stress of side load analysis / Fig 5.18 Force convergence of side load analysis / Fig 5.19 Strain energy of side load analysis 5.4.3 Total deformation Directional deformation can be put as the displacement of the system in a particular axis or user defined direction. Total deformation is the vector sum all directional displacements of the systems. / Fig 5.20 Total deformation of side load analysis / Fig 5.21 displacement convergence of side load analysis 5.5

FRONT LOAD ANALYSIS In the condition the helmet is bottom face is fixed and the load is applied front surface of the helmet. 5.5.1 Meshing The process of simulation where complex geometries are divided into simple elements that can be used as discrete local approximations of the larger domain. The mesh influences the accuracy, convergence and speed of the simulation. / Fig 5.22 meshing of helmet / Fig 5.23 meshing statistics / Fig 5.24 contact region of load in the front of helmet 5.5.2

Static structural The determination of the displacements, stresses, strains, and forces in structures or components caused by loads that do not induce significant inertia and damping effects. / Fig 5.25 Equivalent stress of front load analysis / Fig 5.26 Force convergence of front load analysis / Fig 5.27 strain energy of side load analysis 5.5.3 Total deformation Directional deformation can be put as the displacement of the system in a particular axis or user defined direction. Total deformation is the vector sum all directional displacements of the systems. / Fig 5.28 Total deformation of front load analysis / Fig 5.29 Displacement convergence of front load analysis 5.6 RESULT

S.NO	_CASES	_BOUNDARY	CONDITON	_TOTAL DEFORMATION (MM)	_STRAIN ENERGY (MJ)	_STRESS (MPa)
_1	Case 1	Bottom Fixed & Load on Top Area	19.5KN	0.061	195.46	93.598
_2	Case 2	Side Fixed & Load on Other Side Area	19.5KN			

_0.021 _221.24 _99.79 _ _3 _Case 3 _Side Fixed & Load on Front Area 19.5KN _0.013 _39.501 _75.907 _ _TABLE 5.1 RESULT 5.7 Advantages over existing model The helmet can easily wearable while wearing eyeglass. The helmet can easily remove while wearing eyeglass.

Our helmet design can provide comfort while riding motorcycle with eyeglass Prevent falling of eyeglass inside of helmet also while riding. 5.8 future scope The front face of the motorcycle helmet redesigned for more comfort and vents for air ventilation. CHAPTER 6 SUMMARY AND CONCLUSION 6.0 Conclusion In the project the motorcycle helmet is designed for the eyeglass users using CATIA V5 and analysed in the ANSYS. Were three cases are analysed. In the first cases helmet bottom is fixed and load applied in top area of the helmet. In the second cases load applied in the side area of the helmet and the bottom face is fixed.

In the third cases load is applied in the front area of the helmet and the bottom face is fixed. In cases first and second has more effectiveness then standard requirement and undergone less deformation. In the cases third Were the front face of the helmet the less effective area of the helmet then the other area of the helmet. The helmet is with stand the load and passes the standard requirement. The helmet was wearable for the eyeglass user without any restraint while wearing the eyeglass and also removing the helmet while wearing the eyeglass without struggle.

present design is provides comfort while wearing and removing the motorcycle helmet with eyeglass. Provide comfort while driving the motorcycle. Present design prevent the fall of eyeglass in-side motorcycle helmet. 6.2 Future Scope of Work The following directions could be pursued for the future enhancement of the present project in Terms of fully or partial (function specific) autonomous operation: The outer layer of the helmet is select different material to withstand more load. Redesign the front area of the helmet for more effective.

The Impact Absorbing Liner On the inside of the outer shell is the impact-absorbing liner typically made from EPS (expanded polystyrene) foam can select different foam density or composite foam material. In the future work add more comfort and features in the helmet. REFERENCES Afshari, A. and Rajaai, S. M.: Finite element simulations investigating the role of the helmet in reducing head injuries, International Journal of Simulation modeling, 7, 1, 42–51, 2008. Alam, F., Subic, A. and Akbarzadeh, A.:

Aerodynamics of Bicycle Helmets, The Engineering of Sport, 7, 1, 337–334, 2008. Bachynski KE, Goldberg DS (2014) Youth sports and public health: framing risks of mild traumatic brain injury in american football and ice hockey. J Law Med Ethics 42: 323–333. Blair, K. and Sidelko, S.: Aerodynamic Performance of Cycling Time Trial Helmets, The Engineering of Sport, 7, 2, 371–377, 2008. Bachynski KE, Goldberg DS (2014) Youth sports and public health: framing risks of mild traumatic brain injury in american

football and ice hockey. *J Law Med Ethics* 42: 323-333. Becker, Ed (2002).

Comparisons (of) Snell M2000, DOT, BSI 6658-85 Type A and EN 22/05. Snell Memorial Foundation. Boele-Vos MJ, de Craen S. A randomized controlled evaluation study of the effects of a one-day advanced rider training course. *Accid Anal Prev*. 2015; 79: 152-9. Chang, L. Y.: Empirical analysis of the effectiveness of mandated motorcycle helmet use in Taiwan, *Journal of the Eastern Asia Society for Transportation Studies*, 6, 3629–3644, 2005. Esmailnejad-Ganji SM, Karimi Nasab MH. Risk Factors for Fatal Traffic Accidents: A Narrative Review. *International Journal of Medical Investigation*. 2019; 8 (1): 1-9 Fang C, Le L, Ao Y, Zhen-Hong N, Qing-Jun Z, Yi G. Risk factors of motor vehicle road traffic injuries: A meta-analysis. *CJEBM*.

2014; 14: 1434-41. Foroutan A, Heydari ST, Karvar M, Mohammadi L, Sarikhani Y, Akbari M, et al. Results of a Campaign for Motorcycle Helmets Advocacy in a City in Southwest of Iran; A Population-Based Intervention Study. *Bull Emerg Trauma*. 2019; 7 (4): 404-10. Ford, Dexter (2005). *Blowing the Lid Off*. Motorcyclist Magazine, Primedia Publishing. June. Gedda M. Traduction française des lignes directrices PRISMA pour l'écriture et la lecture des revues systématiques et des méta-analyses. *Kinésithérapie, la Revue*. 2015; 15 (157): 39-44. Gale, A. and Mills, N. J.: Effect of Polystyrene Foam Liner Density on Motorcycle Helmet Shock Absorption, *Plastics and Rubber Processing and Applications*, 5, 2, 101– 108, 1985. Gilchrist, A.

and Mills, N. J.: Impact Deformation of ABS and GRP Motorcycle Helmet Shells, *Plastics and Rubber Processing and Applications*, 21, 3, 141–150, 1994. Hansen K, Dau N, Feist F, Deck C, Willinger R (2013) Angular Impact Mitigation system for bicycle helmets to reduce head acceleration and risk of traumatic brain injury. *Accid Anal Prev* 59: 109-117. Hurt, H.H. Jr., J.V. Ouellet & D.R. Thom. (1981). Motorcycle Accident Cause Factors and Identification of Countermeasures. Final Report to National Highway Traffic Safety Administration, U.S. Dept. of Transportation, PB 81-206443, 81- 206450. Hanssen, A. G., Girard, Y., Olovsson, L., Berstad, T.

and Langseth, M.: A numerical model for bird strike of aluminium foam-based sandwich panels, *Int. J. of Impact Engg.*, 32, 1127–1144, 2005. Ivancic PC (2014) Cervical spine instability following axial compression injury: A biomechanical study. *Orthop Traumatol Surg Res* 100: 127-13. Ivers RQ, Sakashita C, Senserrick T, Elkington J, Lo S, Boufous S, et al. Does an on-road motorcycle coaching program reduce crashes in novice riders? A randomised control trials. *Accid Anal Prev*. 2016; 86: 40-6. Johnson O, Adebayo A. Effect of Safety Education on Knowledge of and Compliance with Road Safety Signs among Commercial Motorcyclists in Uyo, Southern Nigeria. *Ghana Med J*. 2011; 45: 89-96. Johnson OE, Owoaje ET.

Effect of health education on the riding habits of commercial motorcyclists in Uyo, southern Nigeria. *West Afr J Med*. 2012; 31 (1): 39-46. Kingsbury, H. B. and Rohr, P. R.:

Structure Characteristics of Motorcycle Helmets, Society of Automotive Engineers, Inc, No. 810372, 1981. Langlois JA, Rutland-Brown W, Wald MM (2006) The epidemiology and impact of traumatic brain injury. *J Head Trauma Rehabil* 21: 375-378. Mills, N. J. and Gilchrist, A.: *The Effectiveness of Foams in Bicycle and Motorcycle Helmets*, Accident Analysis and Prevention, 23, 2-3, 153-163, 1991. Mills, N.J., Wilkes, S., Derler, S. and Flisch, A.:

FEA of oblique impact tests on a motorcycle helmet, *International Journal of Impact Engineering*, 36, 913-925, 2009. National Highway Traffic Safety Administration. Traffic safety facts 2007 [Internet]. [cited 2019 Feb 27]. Available from: <https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/811002>. Nubile, P.: Analytical design of antireflection coatings for silicon photovoltaic devices, *Thin Solid Films*, 342, 257-261, 1999. ociaga, T. Jaruga, Materialy niemetalowe. Skrypty Politechniki Czestochowskiej, Czestochowa University of Technology Publishing, Czestochowa (2013). Praveen, K., Pinniji, P. K., Bourdet, N., Mahajan, P. and Willinger, R.:

New motorcycle helmets with metal foam shell, IRCOBI Conference proceedings, Bern, (Switzerland), 449-452, 2008. Pinnoji, P. K. and Mahajan, P.: Impact analysis of helmets for improved ventilation with deformable head model, IRCOBI Conference – Madrid (Spain), 159-170, 2006. Rueda, M. A. F. and Gilchrist, M. D.: Computational analysis and design of compnents of protective helmets, *Proceedings of the Institution of Mechanical Engineers, Part P: Journal of Sports Engineering and Technology*, 226, 3(4), 208-219, 2012. Toma, M., Njilie, F. E. A., Ghajari, M.

and Galvanetto, U.: Assessing motorcycle crash-related head injuries using Finite Element simulation, *Int. J. simul mod el*, 9, 143-151, 2010. Woratanarat P, Ingsathit A, Chatchaipan P, Suriyawongpaisal P. Safety riding program and motorcycle-related injuries in Thailand. *Accid Anal Prev*. 2013; 58: 115-21. World Health Organization. *Global status report on road safety 2018* [Internet]. Geneva: WHO; 2018 [cited 2019 Feb 6]. World Health Organization. *Global status report on road safety* 2016 [Internet]. Organisation Mondiale de la Santé; 2016 [cited 2019 Feb 6]. World Health Organization. Tuberculosis [Internet]. 2020 [cited 2020 Jan 14]. Available from: <https://www.who.int/news-room/fact-sheets/detail/tuberculosis>.

World Health Organization. *Global status report on road safety: time for action* [Internet]. Geneva: WHO; 2009 [cited 2019 Feb 6]. Wilson, D.: *Bicycling Science*, 3rd ed. Cambridge, MA: Massachusetts Institute of Technology, 110-120 and 174-205, 2004. Zera J, Mlynski R. *Attenuation of outside noise by shotblasting helmets*. *Arch Acoust*. 2004;29(2):347-58.

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