# A COMPREHENSIVE DESIGN ANALYSIS OF SAFETY HELMET FOR TWO WHEELER MOTOR CYCLE

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**Abstract**

Each year nearly nine hundred persons die in head Injuries and over fifty thousand persons are severely injured due to non-wearing of helmets. In this Paper a review of different work to conceptually design a motorcycle helmet for improved thermal comfort, visibility, safety with adjustable interior form considering rider's ergonomics with new material named Fiberglass reinforced plastic (FRP) etc., are recognized. For analysis The simulation software 'ANSYS' and 'CATIA' are used to analyze the helmet. The maximum force of 30 kN is applied on the helmet to study the model in static and dynamic conditions. The re-enactment has been done for the static condition for the boundaries like complete distortion, strain energy, Von-Mises pressure for various cases.

**KEYWORDS**: Helmet, Deformation, Strain energy, Equivalent elastic strain, Fiberglass reinforced plastic.

## I. INTRODUCTION

Powered two wheeler (PTW), including motorcycle, safety is a major global issue. Although the incidence rates for motorcyclist injury and death have decreased over decades, the absolute number of cases has been increasing as a result of increased motorcyclist exposure.[1] Motorcycle helmets are one method for preventing head injury in motorcycle crashes.[2,3] Geographical regions and countries have unique systems in place that regulate the supply and use of motorcycle helmets. A central element of these systems are motorcycle helmet standards. Standards are referred to with regards to both sale and on-road use. Standards are critical in terms of providing motorcyclists with effective helmets. However, Standards do not assess all aspects of helmet use or performance.[4,5] Consumer rating programs can address a range of usability and performance issues that affect motorcyclist safety.[5] The paper assists in identifying how usability assessments can be applied in consumer information programs and what elements might be significant as far as helmet solidness at the mark of marketing. The 2011 IRTAD report highlighted that despite reductions in mortality rates for PTW operators, the relative risk remains much greater for PTW groups than passenger car occupants; in European countries the relative rate is between 17 and 20 times in some countries.[1] In the USA motorcycle fatalities comprised 14% of the total road fatalities in 2010. [1] In other regions, PTW fatalities represent the majority of road fatalities, e.g. 71% in Cambodia and 59% in Malaysia. [1] Helmet use has been shown to be effective in preventing head injury. A 2008 Cochrane review of motorcycle helmet estimated that helmets reduce the risk of head injury by 69% and death by 42%.

A study of trauma centre admissions found that helmets were associated with a significant reduction in intracranial injury likelihood of 66% amongst motorcyclists.[6] Therefore, an important element of a road safety system is helmet use.[1-6] Helmets need to fit well and be comfortable.[7] Maintaining the positional stability of a motorcycle helmet in general use and a crash is a fundamental performance requirement. [7-10] Helmet stability is assessed in many helmet standards, but ergonomic surveys of motorcyclists have shown that helmet design and the user influence helmet stability.[4,7] A survey of 216 motorcyclists found that "the size of the in-use motorcycle helmets didn't compare well to the anticipated size dependent on head measurements, in spite of the fact that motorcyclists were generally satisfied with solace and fit."[7] The forces required to displace each wearer's helmet were also observed to be low, around 25 N. [7] The paper will examine the relationships between the assessment of helmet stability with volunteers and other usability assessments. The paper will report on how these assessments are incorporated into the Consumer Rating and Assessment of Safety Helmets (CRASH) and general relationships between Safety Scores and Ergonomic Scores.

From now on, a helmet is the best guarded stuff that is achievable to wear while riding a motorcycle, being the most effective means of protection offered to motorcyclists. Albeit a few issues can be called attention to about bike head protectors, similar to the way that their use diminishes motorcyclist vision and expands neck wounds, cruiser caps were found to lessen the danger of death and head injury in motorcyclists that slammed, thus helmet's advantages and its utilization is exhorted by a few investigations (Abbas et al., 2012; Brown et al., 2011; Deutermann, 2004; Forman et al., 2012; Liu et al., 2008; NHTSA, 2008, 2011; Sarkaret al., 1995; Subramanian, 2007; WHO, 2009). The accompanying meetings will give a definite outline on the advancements completed so far on the substance of protective helmet security innovation. Right off this, a brief and ordered presentation about bike helmet beginnings and advancement is introduced, trailed by a clarification of how a cap framework functions under an effect on secure the top of the client. In the wake of clarifying head protector works, the helmet principle parts configuration (shell and liner plans) effect on the helmet conduct under sway is talked about, from calculation to materials, their properties and thicknesses. A comparative yet less broadened investigation is accomplished for the remainder of head protector components .The parts of the fundamental bike helmet guidelines specifically caps configuration, assembling and test are clarified, and a summed up examination between them is completed.

The standards reviewed are ECE R22.05, Snell M2010, DOT FMVSS 218 and BSI 6658. In current protective cap principles tests no rotational impacts are estimated in the headform, in spite of the way that the most continuous extreme wounds in cruiser crashes are head wounds basically brought about by rotational powers that are most generally produced because of sideways outcome.[1] determined that when the glass fiber concentration increased in the processed ABS from 5 ,10, 20, 30 wt%, the tensile strength, tensile modulus was improved yet strain esteem brought down. Increasing the concentration of glass fibers also shows better bond between ABS and SGF. 12] Yusuke Miyazaki[2] discovered that in CATIA. He tracked down that the Nylon 4-6 plastic is acceptable rather than ABS plastic and effect ABS plastic for assembling well being protective caps by infusion forming .Terry Smith[3] carried out mould flow analysis on helmet by using plastic advisor which is a module g processes, have exciting potential towards improving bicycle helmet safety N. J. Mills[4] carried out three-dimensional finite element models [FEM] of the helmet segments and the test head structure were created utilizing MSC programming and material properties were surveyed. He concluded that there are a number of currently available materials from which energy absorbing [EA] liners could be fabricated thatcould improve the impact performance of the existing HGU-84/P helmet. FEA can be an effective tool for the analysis and design of both new and existing head protector designs.

S.P. Soe[5] discovered that cellular structure-based inner liners, manufactured via additive manufacturing forming ratio of the liner and the shell-thickness were varied, indicated that there is an optimum combination where the shell part fails without the liner bottoming, improving theshock absorption ability of a helmet.1Anil Kumar.[6] performed Finite-element analysis [FEA] for bicycle helmets making oblique impacts with road surface, to evaluate the linear and rotational accelerations of the headform. It was found that the predicted peak headform rotational accelerations depended on the effect site and heading, and turned out to be almost steady for an unrelated speed segment. Alyssa L. DeMarcoa[7] performed Sixty-five drop tests against the side of 10 different beanie helmets on to a flat anvil at impact speeds of 0.9–10.1 m/s. She found that acceleration attenuation improved with increasing thickness of the energy-absorbing liner. Protective cap reactions differed with froth thickness, froth material and potentially shell material .Helmy Mustafa [8] carried out the experimental impact test is carried out using 2-wire drop test facility in accordance to the AS/NZS 2063:2008. The result obtained from numerical model correlated well with those from physical drop impact test. F.L. Tan [9] Designed helmet cooling system using phase change material [PCM] to absorb and to store the warmth created by the attired head in order to accomplish comfort cooling for the wearer. The PCM protective cap cooling framework is straightforward and can possibly be carried out as a down to earth answer for give comfort cooling to the cruiser riders.

Mayank Singh Rajput [13] carried out numerical simulations to determine the impact resistance of Personal Armour System Ground Troops [PASGT] helmet. The KEVLARs cap can oppose a 9 mm full-jacketed shot going at 358 m/s. A.GILCHRIST [14] utilized a basic numerical model to clarify the outcomes got when head protectors are hit on the top. He concluded that while the helmets perform adequately during top impacts, the protection given at the sides, front and back of the cap is poor to the point that an overhaul is fundamental. Yeh-Liang Hsu [15] done experiments to established to simulate the conditions of a head wearing a helmet. By using better insulation techniques & adequate ventillation can improve the thermal properties of safety helmet. Amal Thomas[16] carried out impact analysis on GFRP composite helmet using ANSYS. Composite fibers have been successfully reinforced with the epoxy resin by simple and inexpensive hand lay-up technique. Reinforcement of composite fibers have good and comparable mechanical properties as conventional composite materials Occupational health and safety council manual-2004, Hong kong[17]. This manual provides guidance of basic knowledge about safety helmet. M. S. EL-Wazerya[18] developed E-glass fiber with random oriented reinforced polymer composite by hand lay-up technique with varying fiber percentages [15%, 30%, 45%, and 60% by weight percentage]. The impact of glass fiber rate on the mechanical properties like rigidity, bowing strength and effect strength was explored. The mechanical property like hardness, rigidity and flexural bowing strength of polyester resin has been improved by a great extent due to the presence of glass fiber hold up. Divakar H [19] tested ABS laminates with multiple layers of glass fibers for tensile, compression and bending according to the standard procedures. With addition of the glass fibre properties tensile & compression

## II. DESIGN ANALYSIS

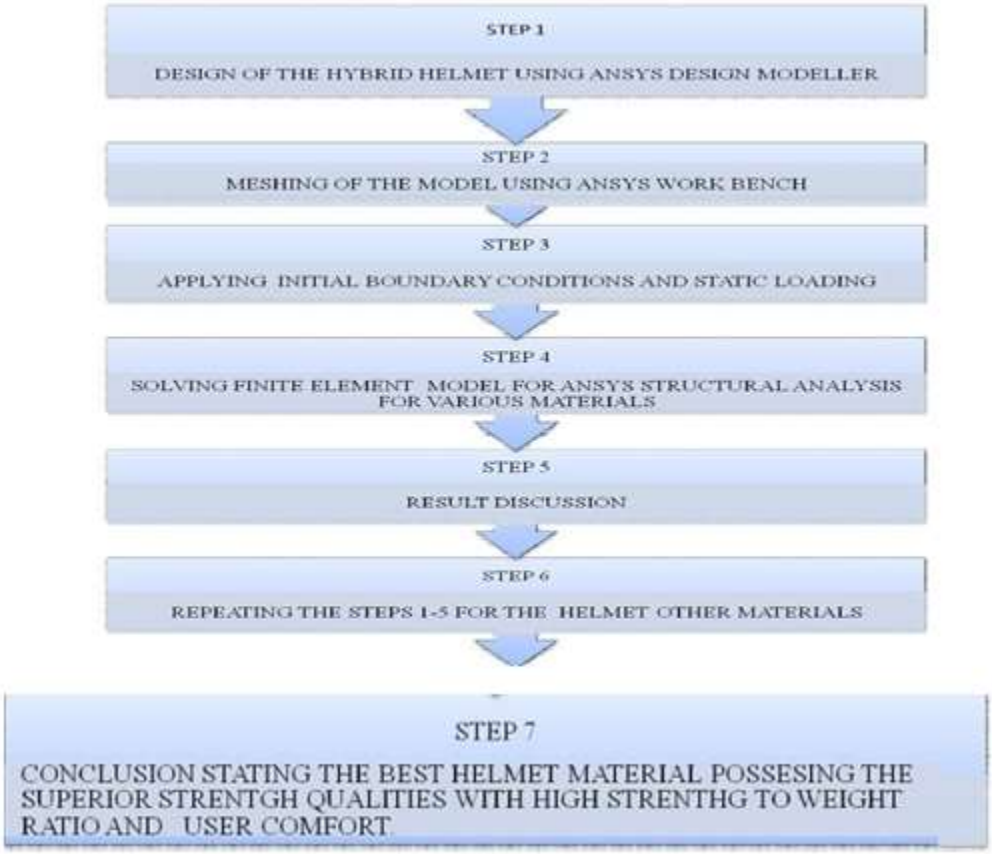



Fig.1PROCEDURE TO DESIGN AND ANALYSIS

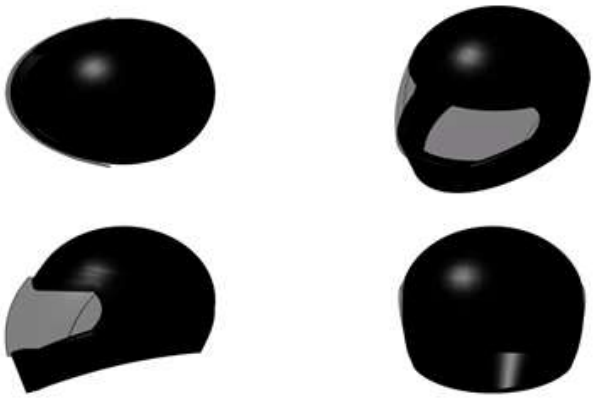
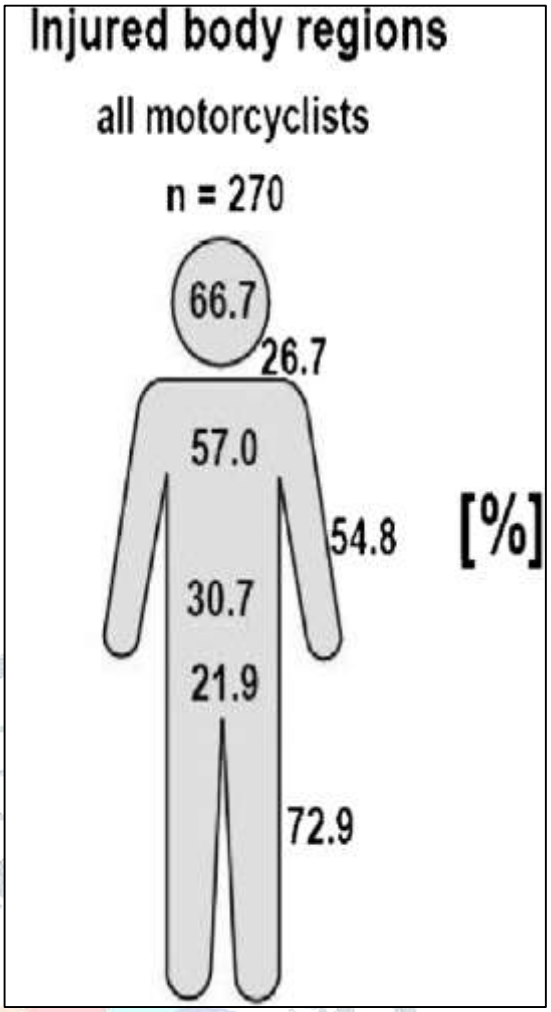


Fig.2DIFFERENT VIEW OF HELMET

| HEAD SIZE | HEAD SIZE | BIKE HELMET SIZE |
|---|---|---|
| 20½" | 52cm | S<br>20½" – 22"<br>52cm – 56cm |
| 20⅞" | 53cm | |
| 21¼" | 54cm | |
| 21⅝" | 55cm | |
| 22" | 56cm | |
| 22" | 56cm | M<br>22" – 23½"<br>56cm – 60cm |
| 22⅜" | 57cm | |
| 22¾" | 58cm | |
| 23⅛" | 59cm | |
| 23⅛" | 59cm | |
| 23½" | 60cm | |
| 23½" | 60cm | L<br>23½" – 25"<br>60cm – 64cm |
| 23⅞" | 61cm | |
| 24¼" | 62cm | |
| 24⅝" | 63cm | |
| 25" | 64cm | |




## III. RESULTS AND DISCUSSION

In this project the static structural and modal analysis has been done on the Aircraft wings. The limit condition for the static underlying examination is loads are applied at the tip of the tooth and all DOF condition at the top. ANSYS workbench joins the strength of our center item solvers with center item the board instruments important to deal with the venture work process. In ANSYS workbench, investigations are worked as frameworks ,which can be joined into project .The venture is driven by schematic work process that deals with the association between the frameworks .From the schematic you can connect with application that are local to ANSYS workbench and you can dispatch the application that are information in focused with ANSYS workbench, which means the interface stays discrete ,yet the information from the application speaks with the local ANSYS workbench information Native workspaces incorporate undertaking schematic designing information and plan investigation , information coordinated application incorporate the mechanical application [26-27].

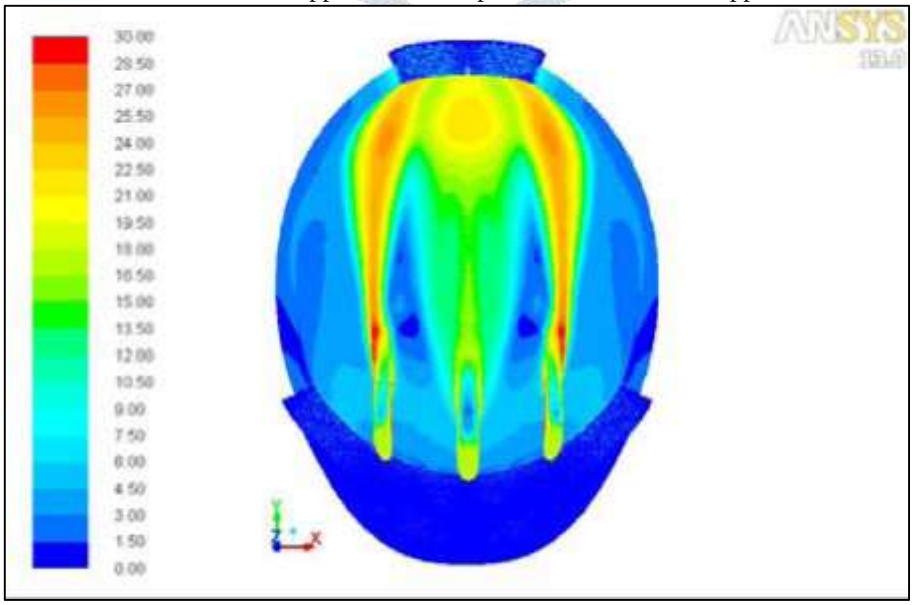



Fig.3 Helmet – Temperature distribution

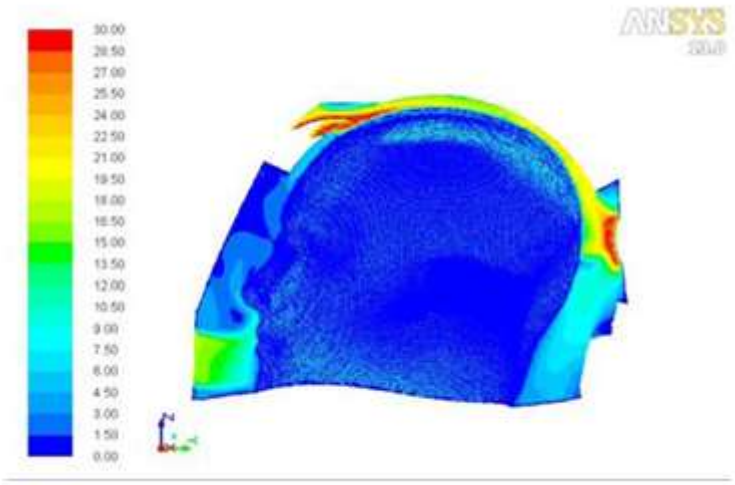


Fig.4 Helmet – Side view

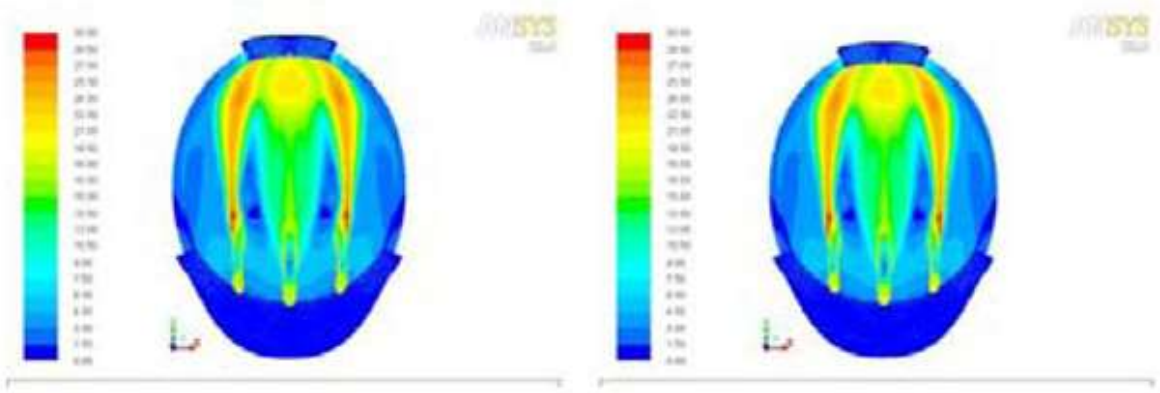


Fig.5 Comparison of velocity contours

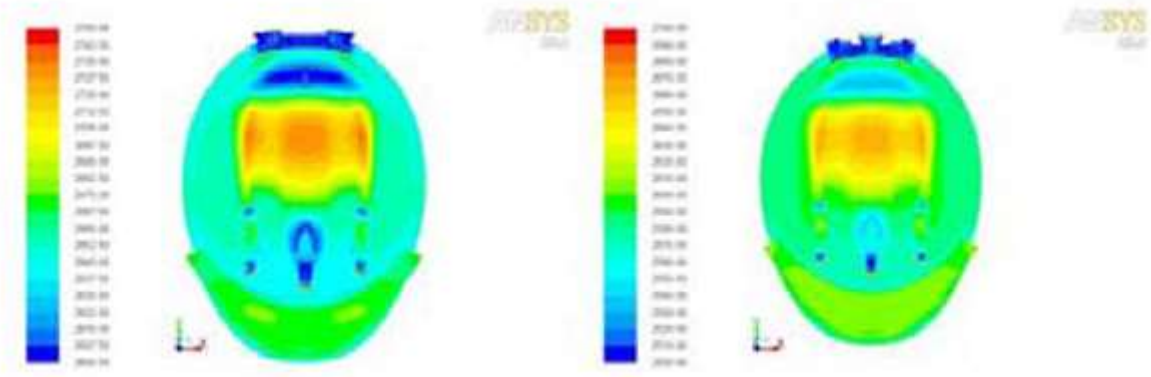


Fig.6 Comparison of pressure contours

## IV. CONCLUSION

The present work deals with the Geometrical Development of the Existing Helmet using Cad software tool and then the structural analysis of the existing model using ansys workbench linear analysis and the answers, deformation, Stress, Strain plot a were been compared with well-established results. At that point the Finite Element mathematical system was approved against two distinct arrangements of test results. The initially tended to the constitutive model of the extended polystyrene, the material liable for energy ingestion during sway; the second related to the head form's center of mass acceleration after the impacts defined in the existing model. Both were effectively approved. Then at the end of the helmet with superior strength, characteristics with low material cost will be achieved through the research. The requirement for improving current test techniques and head injury measures is unequivocally prescribed to diminish the openness to these sorts of head injury. The procedure of work is geometric displaying of a wheel in CATIA. Explicit Dynamic analysis for ABS 10 CFRP and EPS existing model under loading conditionsTo tackle the issue of the venture, a gritty limited component examination is proposed to decide the Total Deformation, Von misses Stress, Von Misses Strain and Velocity conditions in Explicit dynamic condition using the analysis software ANSYS WORKBENCH.

Modal analysis for ABS 10 CFRP and EPS Two wheeler safety Helmet ECE R22.05 model velocity 60Km/h on Under Impact (Front, side and Back) condition. To take care of the issue of the task, a definite limited component examination is proposed to decide the total Pressure under at each mode using the analysis software ANSYS WORKBENCH

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