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DESIGN FABRICATION AND CAMPARATIVE ANALYSIS OF INDUSTRIAL SAFETY HELMET USING GLASS FIBERS REINFORCED WITH EPOXY RESIN

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ABSTRACT

Now-a-days, safety is very important in various on-site industries like manufacturing, construction & power generation industries. To escape the worker from head damage, wearing of industrial safety helmet in on-site industries has become obligatory according to OHSAS 18001[Occupational Health and Safety Assessment Series]. Hence the resisting possessions of safety helmet should be high to hold out against the fortuitous circumstances. This project focuses on scrutinizing and comparing the fabricated industrial safety helmet using composite material which is make by us, with existing industrial safety helmet. The fabricated safety helmet shall be figure out in both practically and theoretically processes. In practical examining the fabricated helmet shall go through the component testing which was specified by BIS 2925 [Bureau of Indian Standards]. In theoretical the results of the practical test will compared in FEA (Finite Element Analysis) using ANSYS 19 R3 software on prototype and existing models. This project talk about the outline of safety helmet constructional attributes, definition, types and choosing of suitable composite material.

Keywords: Industrial safety helmet, FEA, BIS, Composite material, OHSAS

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1. INTRODUCTION

Safety measures must be a very crucial issue in on-site work place activities, either organizations or in factories. It is after all, not a run-of-the-mill office job and requires some precautionary measures. The high safety precautions taken by Labours or workers then it may has less chance to occur fortuitous and personal damages at a construction or on-site industries. The brain is the crucial part of the human being that is veiled in bone. This by judgement of bio-environment states the life-preserving by protecting a very necessary part of human being. Safety helmet deserves the top place in personal protecting equipment for human brain, but the worker utilize the safety helmet after aware of fortuitous circumstances. Therefore the safety Helmet shields the lives and lessen the threats for human brain. Our project focuses on scrutinize and comparing the fabricated on-site safety head shield using hand lay-up method composite material which is make by us, with existing industrial safety helmet to grooming the strength of the existing helmet.

2. LITERATURE REVIEW

Vishal Shinde, Amit Desai, Subir Khan [1] they compared the polycarbonate helmet with HDPE helmet in theoretical form using catia for design and ansys for analysis purpose.

Bureau of indian standards IS 2925-1984 second edition [2] for specifications of industrial safety helmet and standard process of testing methods of industrial safety helmet.

Ankuloria [3] determined that when the glass fiber concentration increased in the processed ABS from 5, 10, 20, 30 wt%, the longitudinal streching strength, young's modulus was groomed but strain value decreased. Increasing the close attention of glass fibers also shows good adhesion between ABS and SGF. 12]

Yusuke Miyazaki [4] discovered that when foaming 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 the shock absorption ability of a helmet.

Anil Kumar. K [5] carried out mould flow analysis on helmet by using plastic advisor which is a module in pro/E. He found that the Nylon 4-6 plastic is good instead of ABS plastic and impact ABS plastic for manufacturing safety helmets by injection moulding process.

Terry Smith [6] carried out three-dimensional finite element models [FEM] of the helmet components and the test head form were developed using MSC software and material properties were estimated. He concluded that there are a number of currently available materials from which energy absorbing [EA] liners could be fabricated that could 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 helmet designs.

S. P. Soe [7] discovered that cellular structure-based inner liners, manufactured via additive manufacturing processes, have exciting potential towards improving bicycle helmet safety.

N. J. Mills [8] performed Finite-element analysis [FEA] for bicycle helmets making oblique impacts with a 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 impact site and direction, and became nearly constant for a tangential velocity component.

Franklin, Glen A [9] the motive of this examining, was to find the impact of bike helmet use on patient outcomes and cost of hospitalization, in a state with an obligatory helmet law. Failure, to wear a helmet due to financial burden, are creating the motorcycle fortuitous circumstances. Therefore, individuals who do not wear helmets should pay higher insurance premiums.

Amal Thomas [10] discusses about penetration scrutinizing on GFRP composite helmet using ANSYS. Composite fibers have been successfully reinforced with the epoxy resin by easy method of hand lay-up technique. Reinforcement of composite fibers have good and comparable mechanical features with traditional composite materials.

Occupational health and safety council manual-2004, Hong kong [11]. This manual provides guidance of basic knowledge about safety helmet.

3. SELECTION OF MATERIAL

Selection of material is very important step in fabrication of the product because it has to withstand the impact strength of a heavy object fall from high heights. So we are selected epoxy resin which is thermosetting plastic as matrix and glass fiber uni-directional as reinforcement.

3.1. Epoxy Resin

Epoxy is a highly flexible compare with all other resins and it has an extensive level of properties and processing competences. It displayes very low shrinkage, low shrinkage is very important because in a liquid form when you try to use a resin and when the resin gets cured; that means, to say when it is completely liquid is converted in to solid, the shrinkage if it is very less than the shape whatever you want you can easily get it done, if there is a shrinkage than this can be happening 3 dimensionally and it is little difficult to control the output.

But as far as the epoxy seems the shrinkage is very low it gives excellent adhesion with various substrate and it will give very high strength, epoxy is highly used in resin matrix for many applications from aerospace to sports, there are different grades of epoxies with different level of capabilities to touch different applications; the epoxy just by tweaking the small percentage or just by changing amorphousness to semi crystallinity. So, you try to get new properties.

The epoxy resin have the advantage on all other thermosetting resins these are the. So, it is the volatile matters during curing is one of the biggest things, it has low curing shrinkage it has outstanding resistance to chemical and solvent, it has excellent bond capability by using different types of fillers fibers and substrate.

3.2. S-Glass Fibres

Glass fiber is very economical and it has been in the market for quite a long time. Glass fiber is the most widely used fiber reinforced composite. It can be in a roving, it can be in an in a sheet form, it can be in a 3-dimensional form also. The glass material have high hardness, moderate stiffness, transparency and chemical resistance. In extra feature to that, the glass in a fiber form has very high strength and good flexibility.

So, because of this high strength and flexibility glass fibers are used in polymer matrix composite. As I told this glass fiber, when it is wetted with polymer they do not have a good adhesion. So, we always do a silent coating on top of this glass fiber so that, they get locked to the cross-linking and get a proper adhesion. Many structural components like PCBs and other wide range of products are manufactured using glass fiber reinforced composites.

4. DESIGN, FABRICATION AND ANALYSIS

A prototype of industrial safety helmet shape was prepared in CATIA software and dumped in ANSYS 19 R3 version. A specimen penetration force of 14715 KN and shock absorption load of 3715 N was applied on both existing material safety helmet and composite material safety helmet prototype. Specification of prototype: 202mm inner diameter, 205mm outer

diameter, 3mm thickness, 365mm of total length, 240mm of total width, 194mm of total height.

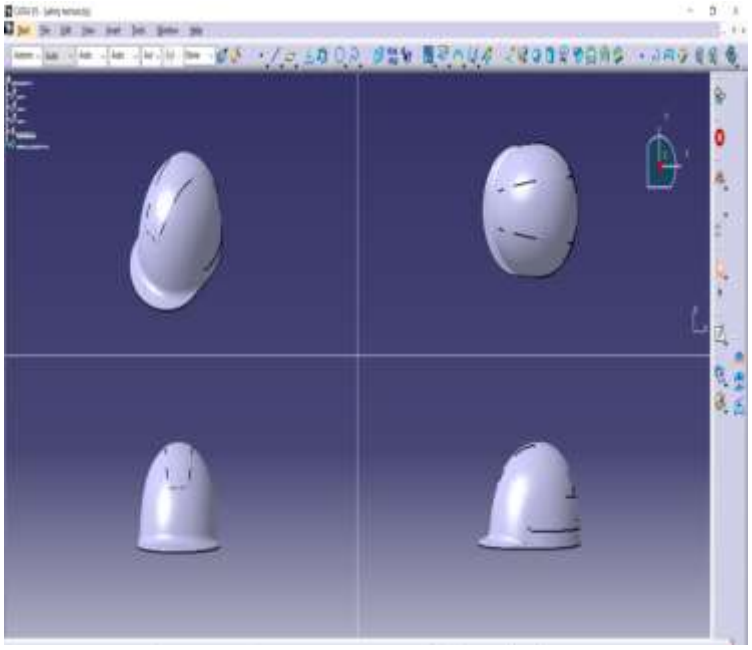

Figure 1 Prototype of safety helmet in CATIA software

4.1. Manufacturing of Industrial Safety Helmet

We fabricated the industrial safety helmet by adding the 30% S-glass fibres as reinforcement and 70% Epoxy resin as matrix using hand lay-up method with gel coat (non-sticky material between mould cavity and safety helmet work piece). The mould for safety helmet is prepared from existing helmet using glass fibres and epoxy resin. Afterwards fabrication safety helmet under go through component test such as Penetration test, Shock absorption test, Electric resistance test, Flammability test in Laboratory.

Figure 2 Mould cavity for Safety helmet

Figure 3 Fabricated Industrial Safety Helmet

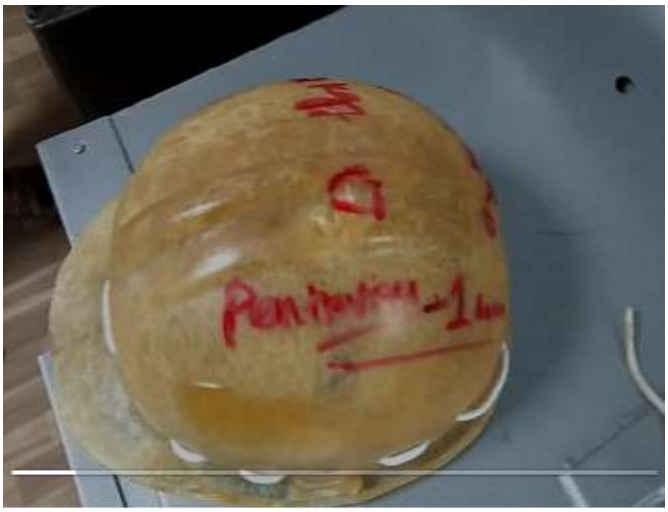

Figure 4 Tested safety helmet with marked the deformation in penetration test.

4.2. ANSYS: Total Deformation of Prototype Helmet

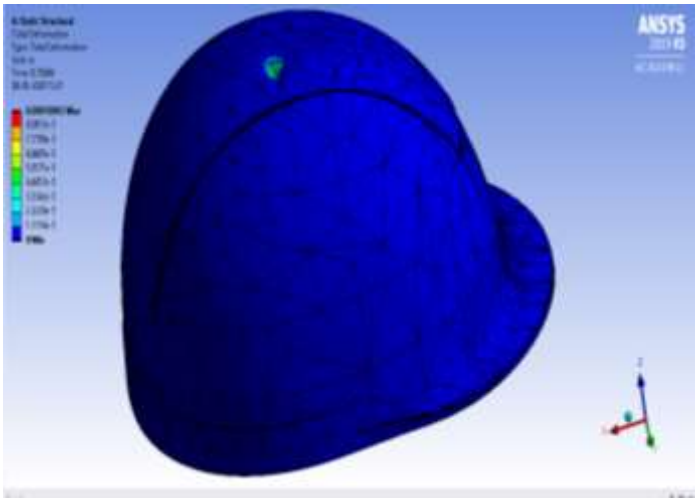

Figure 5 Impact analysis on prototype safety helmet of COMPOSITE material

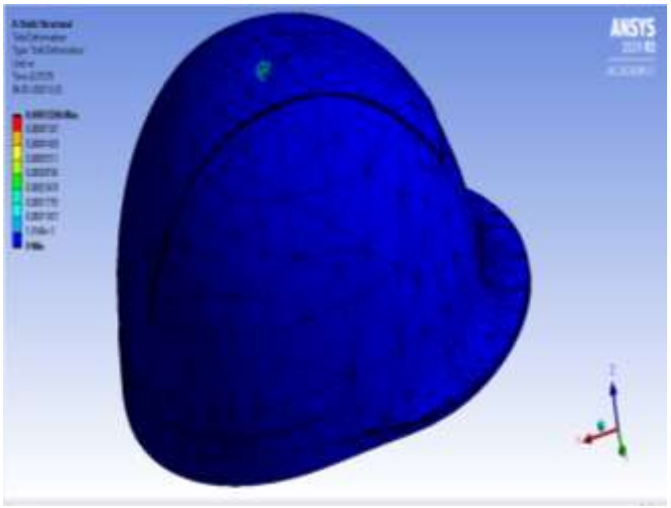

Figure 6 Impact analysis on prototype safety helmet of Existing material

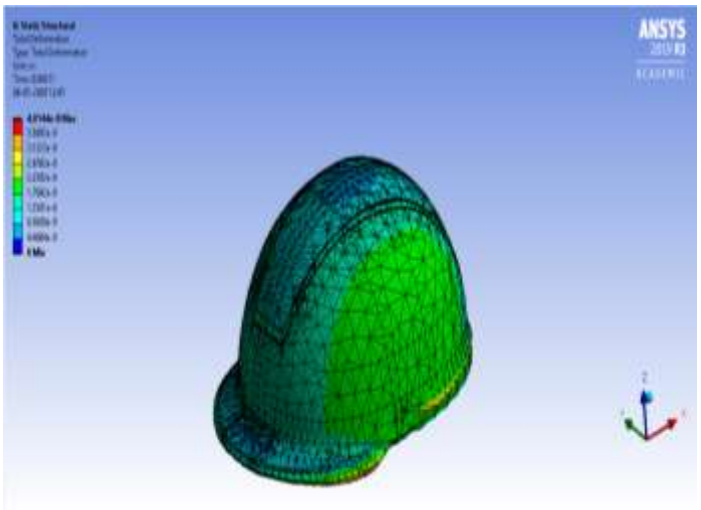

Figure 7 Shock absorption analysis on prototype safety helmet of COMPOSITE material

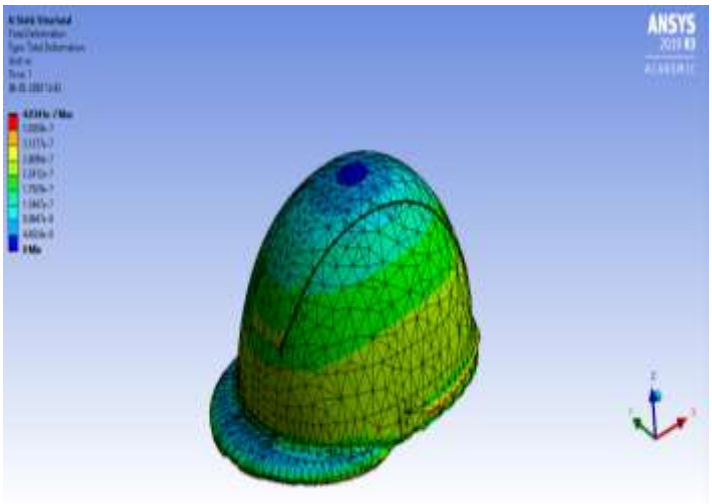

Figure 8 Shock absorption analysis on prototype safety helmet of Existing material

5. CONCLUSION

Even though the geometric specifications of both prototype helmets are same and same impact load and shock absorption load was applied on both helmets. But the maximum total deformation of HDPE is 0.0005 m and maximum total deformation of COMPOSITE material is 0.0001 m of impact analysis. The maximum total deformation of HDPE is 4.034*10^-7 m and maximum total deformation of Composite material is 4.01*10^-8 of shock absorption analysis in ANSYS software. In practical testing result of composite material helmet Penetration test deformation of helmet is 0.001m, shock absorption test load withstand 3734 N, No burning in Flammability test and No leakage current in electric resistance test. Practical testing of existing safety helmet penetration test and shock absorption test is 0.004m and 2647 N respectively; remaining test results are as same as composite material helmet.

Therefore in the ANSYS examination and Practical test displays that the epoxy resin with glass reinforced material safety helmet gives better mechanical strength than the existing material.

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