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Design And Analysis of Aluminum Honeycomb Structure for Helmet Shell

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Abstract - *Numbers of road accidents are increasing as the number of vehicles are increasing in the roads. About 30% of the total road accidents accounts for 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 .The human head is exposed to heavy impact loading against natural protection. In this work, investigation is done to improve strength and shock absorption capacity of helmet by replacing general helmet shell material with aluminum honeycomb structure. Here an attempt has been made for analyzing the helmet with all the standard data. The simulation software 'ANSYS' is used to analyze the helmet with different conditions such as bottom fixed load on top surface, bottom fixed -load on top line, side fixed –load on opposite surface, side fixed-load on opposite line. Aluminum honeycomb sandwich construction has been recognized as a promising concept for structural design of light weight systems. A sandwich construction, which consists of two thin facing layers separated by a thick core, offers various advantages for design of weight critical structure.*

***Key Words*: *Aluminum honeycomb, Helmet, Ansys*.etc…**

1.INTRODUCTION

A helmet is a type of safety measures used in various sections of the dangerous segments of use. A helmet is used in different sectors such as road safety as a safety gear while two wheeler driving, industrial work etc. Helmets are widely used by two wheeler riders to protect their head during the accidents or falls. The Motorcycle helmets have a hard outer shell that prevents penetration and distributes the impact force on a wider foam area, increasing the liner capacity to absorb energy and therefore reduce the load that reaches the head. To design a functional helmet, it is important to analyze the structure of helmets. The main helmet components are the foam linear and the shell. Basically, the function of the foam is to absorb most of the impact energy, while the function of the shell is to resist penetration of any foreign object from touching the head and resulting in direct skull damage, and to distribute the impact load on a wider foam area thus increasing the foam linear energy absorption capacity. The helmet must be designed to provide the user with the most lightweight, form fitting system, while meeting other system performance requirements. This can be achieved through a complete analysis of the system requirements. The force resistance test is the main criteria for shell thickness determination and, in fact, resulting in a helmet with a thicker shell and consequently a weight of about 6 to 8 times as compared to the foam liner. If a thicker shell is chosen, the strength will increase, unfortunately, as well as cost and weight or an alternative material should be considered. For analysis its better result helmet design and material property has been tested and compared with standard. To provide comfort to the person who is wearing it.

In order to understand basic structure of helmets we must know some of the basic definitions and terminologies used in helmets.

A. **Protective Helmet**- A helmet primarily intended to protect the wearer's head against impact. A helmet is a type of safety measures used in various sections of the dangerous segments of use. A helmet is used in different sectors such as road safety as a safety gear while two wheeler driving, industrial work etc.

B. **Shell**-It is the most rigid part of the helmet which gives its general shape. A hard part of the helmet, which provides the strength and toughness, to the whole of a helmet structure.

C. **Protective Padding**-Protective padding is a soft material placed to absorb the impact shocks and its energy. As the name suggests it protects the head of the person who is wearing the helmet through shock reduction through its soft padding.

D. **Comfort Padding**-The material is similar in nature to the protective padding; this type of padding is provided to provide comfort to the person who is wearing it. To provide comfort is the whole sole purpose of this type of padding.

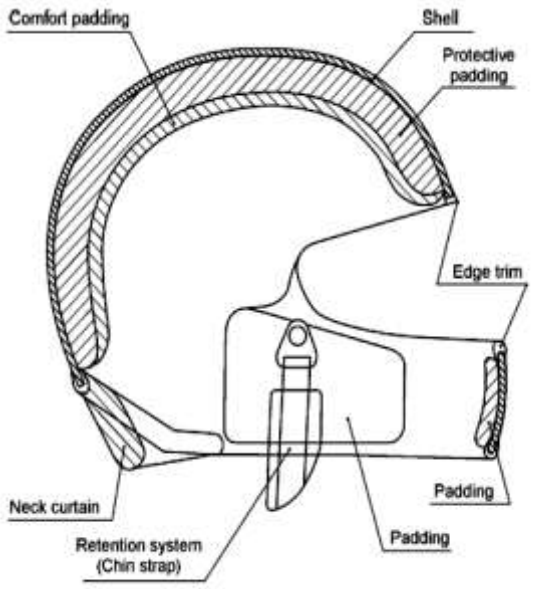

Fig. 1.1:- Helmet Schematic.

E. **Retention System**-A system which keeps the helmet and head at a stable position is called retention system. It includes devices which are there for adjustment of the system or comforting the person who is wearing it.

F. **Chin Strap**-It is a strap which is placed under the jaw to support the chin for proper stable position of the head.

G. **Chin Cup**-It is a cup like structure in the chin strap which holds the chin for proper position.

H. **Peak**-Peak is an extension of the shell which is covered throughout the helmet.

I. **Lower Face Cover**-It is an integral, detachable and movable part of the helmet which covers the lower part of the face.

J. **Protective Lower Face Cover**-It is an integral, detachable and movable part of the helmet which covers the lower part of the face which is intended to protect the chin of the rider from impact.

K. **Non Protective Lower Face Cover**-It is an integral, detachable and movable part of the helmet which covers the lower part of the face and it does not protect the chin of the rider from impact.

L. **Visor**-Visor is that transparent part of the helmet through which a rider is able to see. It is a screen for the eyes.

II. SYSTEM DESCRIPTION

As per standard dimensions defined by IS, helmet has been created in modeling software "CREO". The main purpose that the design serves is to be tested upon loading conditions and their variations when the material parameter changes. The design given below is a testing model that has been created by taking accounts of the actual designs of the helmets that are being used in today's world. The dimensions specified are as follows:

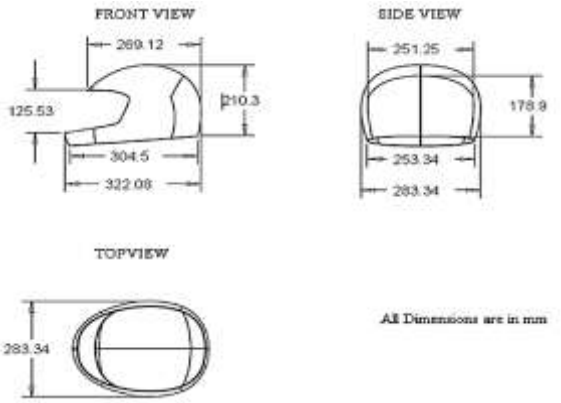

Fig. 3.1.1:- Standard dimension of various parts in helmet.

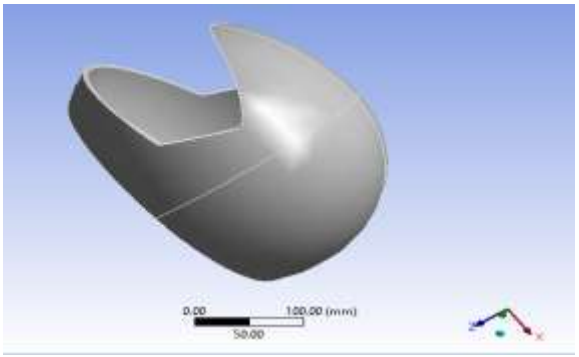

Fig. 3.1.2:- CAD Model.

III. DYANAMIC ANALYSIS FOR DIFFERENT MATERIALS

In this type of analysis drop test is conducted in which the helmet is subjected to a large impact force and time of impact is bound to few milliseconds. Impact absorption capacity is determined by recording against time the acceleration imparted to a head form fitted with the helmet, when drop in guided free fall at a 50m/s velocity upon a fixed stainless steel anvil. The results obtained are as follows:-

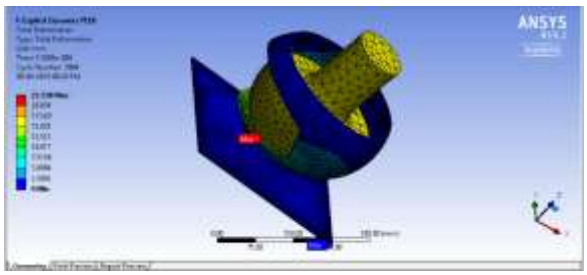

Fig. 4.2.1:- Explicit Dynamics -Total Deformation(PEEK)

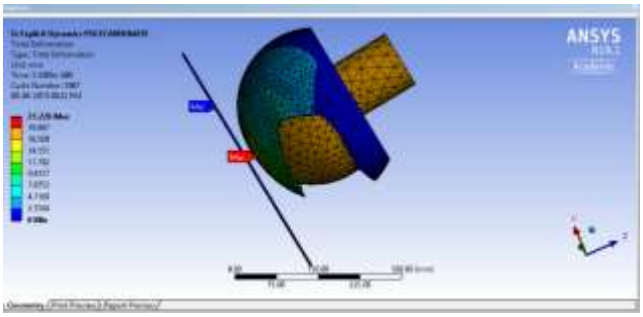

Fig. 4.2.2:- Explicit Dynamics -Total Deformation(POLYCARBONATE)

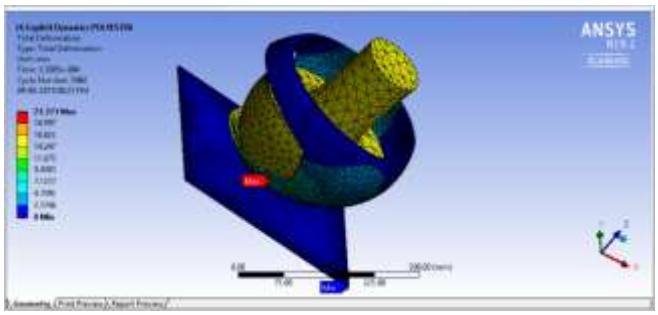

Fig. 4.2.3:- Explicit Dynamics -Total Deformation(POLYSTER)

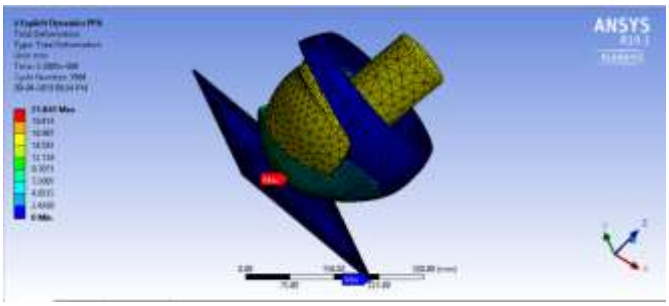

Fig. 4.2.4:- Explicit Dynamics -Total Deformation(PPA)

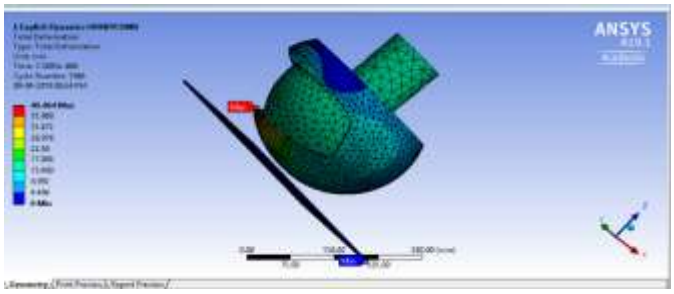

Fig. 4.2.5:- Explicit Dynamics -Total Deformation(HONEYCOMB)

IV. RESULT TABLE

Table 1:- Result of Explicit Dynamics

Material	Explicit Dynamics(Total deformation) of head form in m
PEEK	2.269e-2
POLYCARBONATE	2.0823e-2
POLYESTER	1.6082e-2
PPA	2.4468e-2
ALUMINIUM HONEYCOMB	3.04e-2

V. CONCLUSION

From above comparative study and analysis of results of different materials, we can say that the given aluminum honeycomb composite may replace the existing helmet shell material in future.

- Analytical results of aluminum honeycomb composite has better results than existing shell material of helmet.
- Comparison of results with similar studies shows that properly developed finite element model by a geometrically realistic human head can lead to acceptable results in impact simulation of the head protected by a helmet.
- Dyanamic deformation for aluminum
- honeycomb material is higher as compared to other shell material so the energy absorption capacity of aluminum honeycomb is higher.
- Strength to weight ratio for aluminum honeycomb sheet is higher as compare to other material used in helmet shell.
- Weight of helmet reduced considerably.

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