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PEDESTRIAN HEAD IMPACT ANALYSIS

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ABSTRACT

Car-pedestrian accidents account for a considerable number of automobile accidents in industrialized countries. Head injury continues to be more concerned in Automobile impacts. Because the head is the most seriously injured part in many collisions including in pedestrian automobile collisions. Head injuries are the most common cause of pedestrian deaths in car to pedestrian collisions. To reduce the severity of such injuries international safety committee have proposed subsystem tests in which headform impactors are impacted upon the car hood. Pedestrian protection has become an increasingly important consideration in vehicle crash safety. Pedestrian-vehicle crashes cause a significant number of pedestrian fatalities and injuries globally. Computer models are powerful tools for understanding how to reduce the severity of injuries in such crashes. Headform impactors are used to test the behaviour of vehicle structures such as the hood.

In a pedestrian-vehicle impact, the kinematics and severity of pedestrian injuries are affected by the impact locations on the vehicle and body velocities after impact. The Head injuries cause a serious threat to life and recovery is often incomplete. Therefore, it is most important to evaluate injury risks to the head. The objective of this project is to analyze the pedestrian kinematics in a Pedestrian-Car accident scenario and determine the Head Injury Criteria (HIC) from the head resultant acceleration, for head impacts at various locations on the vehicle hood. This analysis shows the effects of variations in pedestrian height on head impact position and on the potential head injury risk to the pedestrian.

The hood and head form components are modeled and meshed in CAD software and preprocessor tool respectively and the simulation is done using solver.

The objective of project is to Optimize Bonnet to increase pedestrian safety. The main focus will be to design a bumper and bonnet front shape to reduce lower and upper leg injuries. The system

will be analyzed using computational codes like LS Dyna and Optimization tools like HyperStudy. Most pedestrian deaths occur due to the traumatic brain injury resulting from the hard impact of the head against the stiff hood or windshield. In addition, although usually non-fatal, injuries to the lower limb (usually to the knee joint and long bones) are the most common cause of disability due to pedestrian crashes.

Keywords: Hood, Head forms (Adults and Childs), Headforms to Bonnet Impact, HIC (Head Injury Criteria), Impact angles, EEVC WG10 (European Enhanced Vehicle Safety Committee)

1. INTRODUCTION

Definition of pedestrian- “A pedestrian is a person travelling on foot, whether jumping, jogging, walking or running. In some communities, those travelling using tiny wheels such as roller skates, skateboards, and scooters, as well as wheelchair users are also included as pedestrians. In modern times, the term mostly refers to someone walking on a road or sidewalk”.

Vehicle safety has become the most important issue in automobile design. Hence, manufacturers now incorporate numerous safety devices and features in vehicles, including airbags, energy-absorbing steering columns, side-door beams, etc. However, all efforts to improve safety devices focus on enhancing safety features for occupants. Notably, pedestrians are the third largest category of traffic fatalities. Thus, vehicle safety should not just focus on vehicle occupant safety: protecting pedestrians is an important field in traffic safety. Many countries and automotive manufacturers have recently been concerned with ways to reduce pedestrian fatalities and head injuries. Developing pedestrian-friendly vehicles is one solution for reducing the pedestrian fatality rate. To assess the degree of pedestrian protection of a Vehicle, it is necessary todevelop an efficient evaluation and analysis methodology to examine vehicles for pedestrian protection. The EEVC, IHRA and NHTSA have developed pedestrian subsystem test methods that assess vehicle capabilities to protect pedestrian.

2. LITERATURE SURVEY

In this section there is the description of the most importantresults presented in several paper and conference, comingfrom international committee for vehicle safety, FEMsoftware supplier, automotive industries, and research centre.Below we report the research results organized by topicsdivided in impactors modelling, and testing method.

2.1 Testing Methodology

The effect of the vehicle front design on pedestrian head impact responses and injury related parameters based on accident reconstructions and simulation analyses of car-pedestrian impacts has been determined. The results indicated that the head impact conditions in vehicle pedestrian collisions are dependent on the vehicle travel speed, the front shape, the size of pedestrians, the initial posture of pedestrian at the moment of impact.

2.2 Methodology

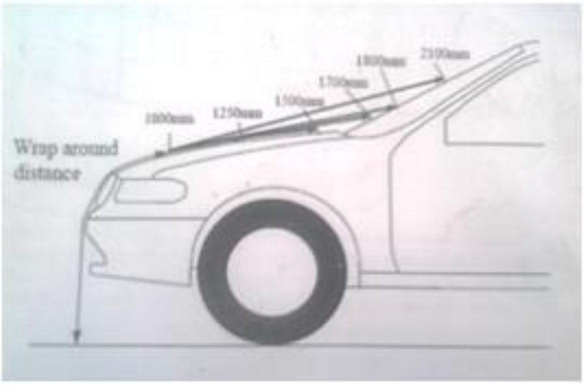
The first step is to choose the vehicle and create 3D model of the bonnet and head forms child and adult) has been created for the purpose of this study. These headforms were based on EEVC WG10. The same models are imported in Hypermesh for preprocessing. In preprocessing certain materials should be assigned to bonnet as well as the headforms. After assigning the material and material properties proper thickness is given to models. Boundary conditions such as constraints to the bonnet are specified. FE model of headform is used in simulation of impact to bonnet. Impact conditions were in accordance to them that were prescribed by EEVC WG10. The results of the headform to vehicle bonnet impact were compared to check the HIC values. The points on the bonnet are selected depending upon the impact angle as specified and the value of HIC is compared. To obtain a frame of reference for pedestrian head impact test conditions, it is necessary to know the impact points, impact speeds and impact angles for the pedestrian heads.

Wrap Around Distance

The WAD is good indicator of where head impacts are likely to occur on the bonnet. By use of the WAD, it can reasonably estimate where on a vehicle a child or adult pedestrian's head may impact.

Defining WAD

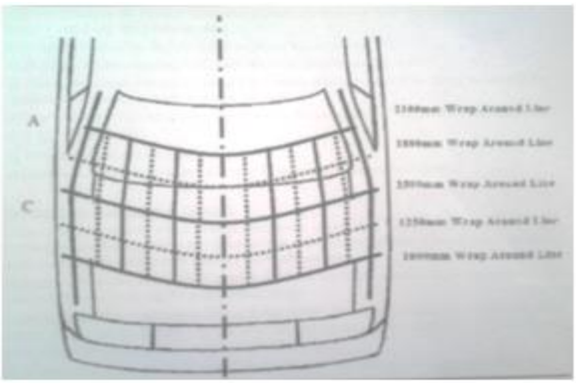
Mark on the bonnet top, windscreen, A-Pillars or roof (depending on the size and shape of the vehicle being tested) the 1000mm,1250mm,1500mm,1700mm,1800mm and 2100mm wrap around lines. These are the geometric traces described on the top of the bonnet by the end of flexibletapeorwire 1000, 1250,1500,1700,1800 or 2100mm long, when it is held in a vertical plane of the car and traversed across the front of the bonnet and bumper.



For Euro NCAP: The region between 1000mm and 1500mm will be scored in the child zone. The region between 1500 and 2100 mm will be scored in the adult zone.

For JNCAP: The region between 1000mm and 1700mm will be scored in the child zone. The region between 1700mm and 2100mm will be scored in the adult zone.

Division of Head Form Test Zones



3 HEAD IMPACTS

Two headforms are used to simulate this type of head impact: a child headform with a mass of 2.5 kg and an adult head form with a mass of 4.8 kg. The child headform strikes are to the front of the bonnet (wrap-around distance 1000mm to 1500mm) while the adult headform strikes are to the rear of the bonnet or beyond (wrap around distance 1500mm to 2100mm).

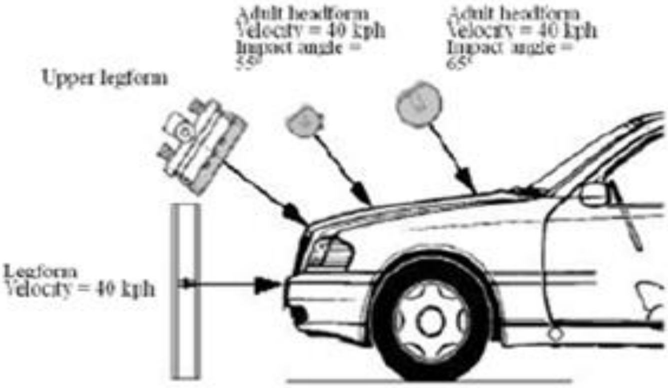


Fig1: Pedestrian Protection Concept of WG10

Fig2: Finite Element Models of Adult and Child head form

Fig3: Finite Element Model of Hood

Six tests are conducted with each headform, based on three equal transverse zones and two impacts within each zone. One impact location is chosen for highest injury potential, such as above engine parts, suspension mounting points or bonnet hinges. The other is chosen to be the least injurious. Where the left and right zones have similar structures judged to be the most injurious the next worst location is chosen for one of the zones.

If between one third and two thirds of a test zone for the adult headform test is found to be within the windscreen area then three default scores are assigned for the windscreen/a-pillar: one poor (a-pillar) and two good (glass away from dash) giving a score of 4. This is added to the three scores for impact tests to the bonnet. The impact locations in two of the bonnet zones are chosen for highest injury potential. The least harmful location is chosen for the third zone.

If more than two-thirds of the adult headform test zone is within the windscreen then only one impact test is usually conducted. Five default scores are assigned: two poor (A pillars) and three good (glass, away from dash) giving an adult headform score of 6. This is added to the score for the single test that is chosen for the highest injury potential in the centre zone. This is generally located at the lower centre of the windscreen where the headform is likely to contact the dash through the glass.

Accelerometers in the headform are used to determine Head Injury Criterion (HIC). Euro-NCAP assigns a red (poor) rating if the test results in a HIC of 1500 or more (HIC) is assumed but the deceleration curve is typically a spike of less than 8mins duration.

The Head Injury Criteria value can be calculated from the following

$$HIC = \left\{ \left[\frac{1}{t_2 - t_1} \int_{t_1}^{t_2} a(t)dt \right]^{2.5} (t_2 - t_1) \right\}_{max}$$

Where t1, t2 = any two arbitrary times during the acceleration pulse
a = Acceleration expressed in g

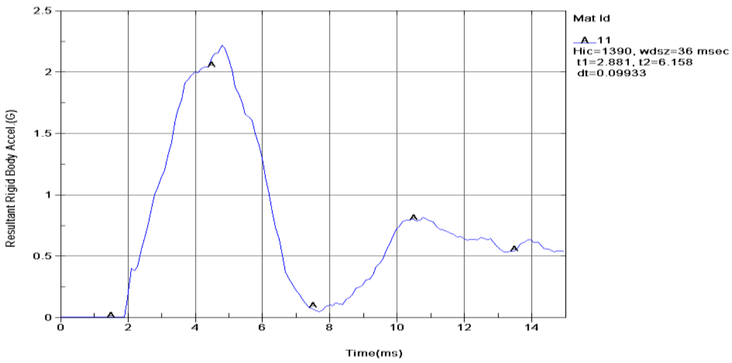


Fig: HIC Curve for impact angle 45^0

Substituting in the formula we get …
= [178.3]2.5*(6.158-2.881)
=424500.6*3.277/1000
=1391.1 ~ 1390
Similarly we may calculate HIC values for an impact angles 63^0, 68^0, 72^0.Then we get

Sl.no	Impact Angle	HIC in mm
1	45^0	1390
2	63^0	1400
3	68^0	1448
4	72^0	1493

SUMMARY

This work takes a look at pedestrian head impact mechanics and discusses possibilities in pedestrian protection, when impacting with compact passenger car. Headform impact response is observed when risk to head injury was assessed. Impact points were changed on the bonnet and by changing the impact angles. The HIC values are studied and the resultant displacement is calculated.

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