To study the Occupant Protection during Frontal Crash using Simplified Dummy

Niranjan Gaikwad[1], Prof. Archana Nema[2]

[1]UG Student, Department of Mechanical Engineering, MIT School of Engineering, MIT-ADT University, Pune, Maharashtra, India
[2]Assistant Professor, Department of Mechanical Engineering, MIT School of Engineering, MIT-ADT University, Pune, Maharashtra, India

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Abstract - - *The study of the occupant in vehicle is the major phenomenon to ensure the safety of the occupant, crash analysis is done. The crash test dummy is then used to analyze the impact, safety and injury of the occupant. This is analyzed taking age, gender, BMI, seating position etc. into consideration. The effect of airbag and seatbelt on the impact, safety and injury is also been studied. The data of crash test and the crash simulations are studied. The purpose of this analysis is to study properties of dummy so as to consider injury mechanism of human. The dummy model HYBRID III composed of Steel and Aluminum has been used. This model is generally used for frontal crash and less useful for rollovers, rear impact, side impacts. This model gives high acceleration response. A typical ten years old, three years old or a grown man. The engine in the vehicle should be collapsible engine, so after the crash the engine should not go to the compartment occupied by the occupant. The bumper model in cars needs to be light weight as well as stronger enough to withstand the high energy, so the selection of the material is the crucial part. Crumple zones or crush zone is area of the vehicle which is designed to be deformed in a collision. Engine is generally located at crumple zone areas.*

Key Words: **HYBRID-III dummy model, 50 percentile male model and percentile child mode, collapsible engine, bumper model, Crumple zone.**

1. INTRODUCTION

Crash Analysis of vehicle is mainly done to ensure the safety of the vehicle as well as the safety of the occupant seating inside. The restraint system which typically includes the steering system, inflatable air-bag, seatbelt, seat. The restraint system somewhere plays an important role in the safety of the occupant and the passenger. The frontal crash usually leads to high damage of vehicle and high risk of injury to the occupant seating in the vehicle rather than the other collisions or crash. To improve the injury protection performance during the crash, many studies has been reported. The other purpose of Crash Analysis is to design the vehicle according the various parameters. Sometimes for crash test instead of destroying the vehicles, the FE (Finite Element) analysis is done. As it uses software there is no damage of the vehicle and no need of huge space. In this process the chassis is designed and tested by the software and according to that the deformation force and damage, it is analyzed and the materials properties is selected according to the requirement. The occupant dummy was positioned in a proper posture, with right elbow angles holding the steering wheel by shoulder adjustment in the restraint compartment, along with the seatbelt buckled. The injury measurement of the various body parts like head, chest, neck, legs, hips are taken into consideration according to their age, gender, BMI etc. Various types of sensors were utilized for the injury measurement on the various parts of the body. From the literature study, it was seen that women tends to get more hurt than the male occupants. During the crash test crumple zones acts as a cushioning effect, as it is crushed like a paper and absorbs energy during the impact to maintain safety. D. Bose in their literature mentioned about the injury trends in frontal crash and side collision which is to be done with the help of whole-body injury metric (WBIM).

2. METHODOLOGY:

2.1 Dummy Model

The dummy model used was HYBRID-III dummy model, which is quite similar to the realistic human. There are mainly three types of Hybrid-III dummy model, (H-III 50-percentile male model), (H-III 95-percentile female model), (H-III 50-percentile child model). This dummy is usually directed towards a specific age. This model mainly composed of steel and aluminum, and rubber for neck. The designing purpose of the Hybrid-III model is only for the frontal crash analysis and all measurements and assessment of injury were calibrated during these crashes. These dummies specially measure head, chest and neck acceleration, chest deflection. Several sensors are used in dummy model for detecting acceleration or risk of injury in the head, neck, legs, and torso. This model is specially used because it acts according to the different age of occupants. The 50-percentile child model uses three years old, six years old and ten years old child simulation. This dummy has high accuracy owing to physical based modeling techniques. The sensors used in the dummy model are as follows:

1) Tilt-sensor head PID22 (for head)
2) Tilt-sensor spine PID127 (for neck and spine)
3) Tilt-sensor pelvis PID564 (for pelvis)

The dummy model was usually provided for representing the realistic characteristics of occupant and evaluating them for betterment. To perform the crash test, the suitable dummy model has to be selected. The selected dummy should be placed in a proper position in the occupant compartment. The face of the dummy model should be marked with the color (particularly half face with blue and half with pink) in order to analyze the impact, the head collision in a particular area of the airbag when it is deployed. The crash was carries out at 36mph (56km/h). They are usually used to analyze the risk of injury in a particular body part like head, neck, legs, hips and chest. Age factor was considered during the chest injury. The purpose for using dummy model for crash test is to analyze the risk of injury, to reduce it and the safety of the vehicle for occupants. It has been stated that the people/occupant taller in height tends to get more hurt as compared to shorter occupant as their head clashes against the steering wheel upper part and their hands to get wrapped around the inflated airbag. The chest injury risk for older occupant was high than others. Higher or lower risk of injury of the occupant relies on their bone structure, soft tissues of human. The higher risk of thoracic injury is mostly seen in the older occupants during frontal crash. The effective use of seatbelts and airbags reduces the risk of injury as compared to the occupant not using this restraint. Though deployment of airbag and buckling of seatbelt are useful but in high injury of the occupant but due to this there is some thoracic or internal injury (if possible) and due to crash, there is also a blow to the neck. The FE model that accounts the properties of thoracic injury was developed by Japanese Automobile Manufacturing Association (JAMA) which was characterized by the age dependent.

If you are hitting a rigid wall or a moving vehicle then it should not stop so vehicle absorb the energy as much as it can. One technique for improving the protection is that the energy should be dispersed across the front end of the vehicle where there is no occupant, but it should have strong and rigid structure around the occupant who don't any energy to be dispersed or transferred and structures being pushed towards people sitting in the cabin or vehicle.

As shown in Fig 1, when vehicle is crashed the high amount of force or it tends to bend the whole bumper and also the area of the footrest of the occupant. Due to this there is high risk of injury to the occupant to his/her legs, hips and knees. At whatsoever speed the car crashes it should not deform till the footrest of the occupant in order for the safety of his/her legs. There are also high chances of occupant being killed in this type of vehicle deformation.

Deformation of bumper during crash:

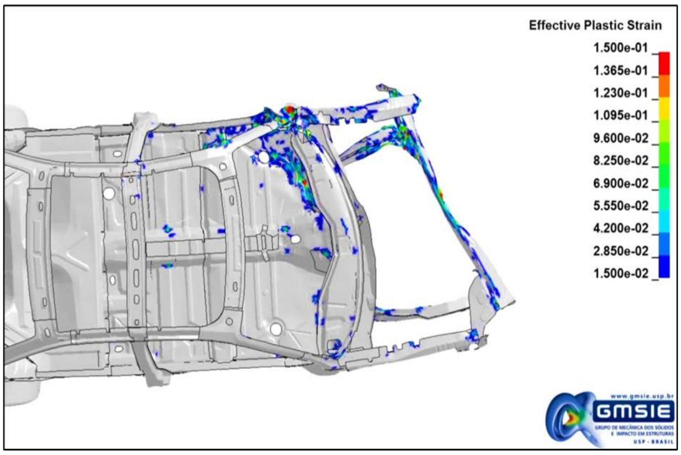

Fig-1: Dodge Neon

Fig-2: Toyota Yaris

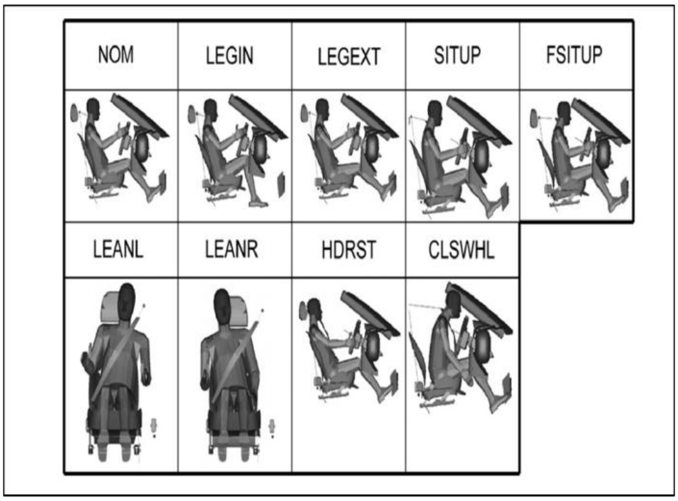

Fig-3: The different nine seating positions of the occupant.

Whereas in Fig 2, during crash there is low deformation of the footrest side. Here, there is high chance of occupant survival. The front portion of the vehicle during crash is known as crumple zone. It has to be deformed in order to save the occupant. The frontal zone of the car before �A� pillar is called a crumple zone. Crumple zones are designed to be weaker so as to get deformed by the crash.

3. Effect on injury due to seating positions

From Fig 3, the occupant positions were estimated, POS_{leanl} and POS_{situp} have lower injury at head and thorax body. Here properties like muscle bracing and seating posture have influence on the occupant kinematics as well as interaction of occupant with the dash board or interior of the vehicle. POS_{leanr} and POS_{clswhl} have high risk of may have high injury to head rather than other positions. Injury to the upper body increases when the upper body (mainly head) is near to the steering wheel. A suitable distance has to be maintained between steering and head or chest.

3.1 Effect on injury due to dummy parameters

According to the age, gender, body mass index (BMI), seating posture etc. in dummy to measure the risk of injury several sensors are fitted on the neck, head, leg (thigh, knee, ankles), there are high risk of injury in older occupants and women due to their soft tissues, whereas the male model has high risk of injury in the neck. Children of 3-6 years also have high risk of injury, so they are made to sit on a commercial seat tied to rear seat hook, properly and tightly buckled so during crash the child cannot be thrown forward and cannot come forward and get hurt. If the child is not wearing the seatbelt, then at the time of crash child can be thrown forward and may crash to the dashboard or at windshield, getting severely hurt or killed.

4. SCOPE

HYBRID-III (H-III 95 percentile male dummy model) dummy model is to be developing by companies/industries. HYBRID-IV dummy model is in developing stage. This is bio-mechanical dummy which will be developed until year 2025. It will help to identify the risk of injury in more and more detailed way. As it is bio-mechanical, the body structure, organs like lungs, heart or major vessels are immensely similarly too human. It will help to analyze external as well as internal risk of injury during crashes.

5. CONCLUSION

Considering the above information, the following has been concluded. The effect of airbags and seatbelts during the crash has been evaluated; from the study it is observed that there is high risk of injury for older occupants. There is also high risk of injury to women as they have soft tissues. Ages, gender, seating postures were evaluated during injury, and it has been confirmed that during crash for risk of injury seating postures has been an important factor. The chest deflection and forward motion of small occupant are less sustained as compared to the other elder occupant. Sometimes the rib fractures majorly occur along even before the torso comes in contact with the airbag. By the study it is understood that maximum risk of injury is mainly due to variability of seating postures. The injuries of dummy models were related to the real human bodies which were very similar. The risk of injury to occupant is typically based on the seating posture of the occupant or the body effect with restraint systems, mainly during the frontal crash, whereas the injury of the chest is normally affected by the occupant�s age, gender. Also, injury on the neck is high due to high blow to neck during frontal crash, as compared to the knee, hip or thigh. It seems that the injury of the children can be reduced with the help of commercial seats (external seats which is specially children of age from 2 years to 5 years) with properly buckling it to rear seat rods which are at the bottom back side of the seat. In commercial seats there is also provision for proper buckling to the child. By this method they cannot get any severe injury expect a little blow to the seat, due to high crash.

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