Determination of the Head Injury Potential for a Pedestrian Struck by a Car with a Deployed External Airbag

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Abstract. According to statistics gathered in 2008 by the National Highway Traffic Safety Administration (NHTSA), over 60,000 pedestrians were injured in traffic accidents in the USA [2]. When a pedestrian is struck by a car moving at a speed of 35 miles per hour, the injuries are likely to be fatal as a result of the impact of the pedestrian’s head with the windshield or the frame of the car. A team, led by crash specialists at Cranfield University, has devised a new design of an external airbag which is fitted under the hood [4]. Unlike other airbags that are designed to protect the driver and passengers, this system is purely aimed at improving the pedestrian safety.

1. Introduction
The Head Injury Criterion (HIC) is a measure of head injury in an impact. It can be useful in assessing the safety related to vehicles and pedestrians. The HIC value has a tolerance or threshold value of 1000 above which the injuries is implied to be fatal [1]. In this study, the impact scenario is reconstructed using a validated non-linear finite element model of a car (Geo Metro) and a 50% hybrid III Anthropomorphic Test Dummy (ATD) in the LS-DYNA finite element code [3]. An external airbag is designed and mounted on the outside base of the windshield and the design is imported into the Finite Element environment. The HIC value is evaluated for various speeds to illustrate any improvement with the deployment of airbag. A graph is plotted for various HIC values, with and without the external airbag and compared. The simulation results for various speeds are also examined for any change in position of the head with respect to the windshield, and to investigate the speeds where the availability of external airbag cannot save the pedestrian either (at high speeds).

Figure 1 and 2 shows the finite element simulation of pedestrian impact with a small car, with and without airbag.

3. Limitations
1. This method is not suitable for all types of pedestrians, e.g; children, elderly and pedestrians of varying sizes etc.
2. The concept of external airbags is shown to protect pedestrians only up to a certain speed limit.
3. For large type of vehicles, such as pick-up trucks and SUV’s, the external airbag may not be a viable design.
2. Results & Analysis

As observed, for different impact speeds, the external airbag dramatically reduces potential head injuries. From the simulations at different speeds, it is observed that the potential head injury also increases at every specified speed studied. Also, from the simulation, it may be observed that as the speed of the vehicle decreases, the position of the head with respect to the windshield changes. The head moves towards the base of the windshield with decreasing speeds. When the speed increases, it moves away from the base of the windshield. This can be extended to assess the point where the head is more likely to strike on the car.

The analysis also includes:

1. The graphical results illustrate that the external airbag fails to protect the pedestrians from fatal injuries at speeds over 33mph.
2. The results below 15 mph are not considered since sudden deceleration at those speeds will not trigger the airbag deployment.
3. The results might vary for different airbag design.

4. Conclusions

When the pedestrian is struck by a car, depending on the speed of the car, and position and height of the pedestrian with respect to the car, the pedestrian will strike different front parts of the car. So, the external airbag is modeled such that when it explodes it covers the possible area where the pedestrian is likely to get struck. The deployment of external airbag dramatically reduces the potential head injuries for the pedestrians as it cushions the surface of impact. However, with the increase in the speed of the car, the efficiency of the external airbag is studied. It is observed that, though the HIC value decreases compared to the scenario of no external airbag, the value exceeds the threshold value of 1000 at speeds over 33 mph which means the injuries would be fatal.

References

[3] “www.lstc.com”-Simulation tool used to reconstruct the impact scenario and also to model the airbag