INVESTIGATING VEHICLE OCCUPANT INJURY OUTCOMES IN THE PRESENCE AND ABSENCE OF AIRBAGS BY MODELLING OCCUPANT KINEMATICS

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ABSTRACT

An airbag is designed to minimise injury to an occupant during a crash by absorbing the occupant's kinetic energy, thereby reducing his/her velocity within milliseconds of the impact. Numerous statistical studies have demonstrated that a clear relationship exists between impact direction and injury reduction due to airbags. However, the interaction that occurs between a seatbelt, deploying airbag, and a human in motion calls for further investigation given that airbags do not always protect an occupant from serious injury. The objective of this study was to investigate airbag effectiveness and human kinematics during three particular crashes by using a combination of real-world data, computer simulations and crash-tests.

Three real-world cases where the drivers were involved in a far-side, a near-side and a frontal impact were selected. In each case, the occupant suffered significant injuries despite the presence of a deployed far-side, near-side and frontal airbag respectively. A crash test reconstruction package was used to simulate each of the crashes, then the resulting crash pulse was applied to a MADYMO occupant dummy computer model. Injury data from the dummy model were compared to both the injury values from the mechanical dummy in a crash test and to the injuries sustained by the real-world occupants. Once the dummy computer model was able to reflect the kinematics of the crash test dummy and accurately predict head and thoracic injuries (when compared to the real-world occupant), the injury outcomes for the dummy computer model in the absence of airbags were investigated.

The severity of head and thoracic injuries to the occupant in the near-side impact and frontal impact were found to increase in the absence of the near-side and frontal airbags respectively. The far-side airbag failed to soften any vehicle-to-occupant contact during the far-side impact due to the kinematics of the crash, hence no increase in injury severity was observed in the absence of the airbag. Conclusion: This study actively demonstrates that computer modelling can be successfully employed to investigate occupant kinematics and evaluate safety feature effectiveness during various impact types. The beneficial effects of airbags are most apparent when the kinematics of the crash allows occupant-to-airbag contact.

Keywords

Airbag; occupant kinematics; real-world crashes; modelling; head injuries; thoracic injuries.