INTERIOR FRONTAL CRASH PROTECTION FOR PASSENGER CARS AT HIGH DELTA-V – POSSIBILITIES AND LIMITATIONS

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Abstract

The purpose of this study was to analyse the possibilities to design an effective interior restraint system for the driver of a passenger car subjected to fully distributed frontal crashes in the speed range of 56 to 80 km/h (35 to 50 mph). In order to limit the research area the issue of structural integrity of the occupant compartment will not been addressed in this study. In other words it has been assumed that the frontal crush zone is large enough to absorb the kinetic energy and that the occupant compartment is not heavily deformed.

A computer model of a driver restraint system including an airbag, a seat belt, knee padding, seat and a steering wheel with column has been developed with a 50%-ile crash test dummy as the driver. The computer model results have been validated by means of mechanical sled tests.

A decelerating sled has been used for all the mechanical testing. The sled has been equipped with a mock-up of the frontal section of the occupant compartment of a passenger car including the steering wheel, steering column, seat and the driver restraint system consisting of an airbag, a knee restraint and a three-point seat belt.

The crash pulse at 50 km/h, used in simulation and experimentation, has been selected to be representative for a mid size car from the nineties. To assess a realistic crash pulse for a high velocity fully distributed frontal crash with a mid size car from that period a crash test was performed at 80 km/h.

A number of input parameters describing the restraint system have been selected for a two level variation analysis using design of experiment technique (fractional factorial design at two levels). The restraint configurations defined in the matrix have been run through the computer model at 50 and 80 km/h impact velocities.

The variables with the greatest effect on the dummy response have been identified. Some of the restraint system configurations have also been tested on the mechanical sled.

The results show that, for a given crash pulse, it is possible to design an interior restraint system with a low risk of injury at 80 km/h impact given that no significant intrusions into the occupant compartment occur.

The importance of tuning the characteristics of the restraint systems to the condition at hands i.e. the crash severity to achieve improvements in driver protection is also demonstrated.