



Engineering Sciences Section - 2015

D2 Enhanced Injury From Failure of Seats, Seat Belts, and Unsafe Vehicle Interiors

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The goal of this presentation is to inform investigators for police, medical, and transportation safety organizations of the hazards presented to vehicle occupants in collisions when seats and seat belts fail. Injuries can be enhanced when such failures allow occupant contact with hazardous structures within vehicle-occupant compartments. The combination of weak seats, slackened seat belts, and unpadding, force-concentrating structures presents extreme hazards to front and rear seat vehicle occupants.

This presentation will impact the forensic science community by educating field investigators, medical personnel, and safety researchers on how to better understand the hazards created when there is a combination of weak seats, slackened seat belts, and unpadding structures within vehicles. These hazards are not permitted in the front of vehicle-occupant compartments, and vehicle seat belts, airbags, and structural padding all combine to prevent such injuries in frontal impacts. No such protection is provided for rear impacts.

Front seat and belt failure in rear impact has been known to cause severe injury and death to both front and rear seat occupants. Several cases of predictable enhanced head and spinal injury have been discovered in vehicles where front seat and seat belt failure was combined with inadequately padded force-concentrating structures in the rear of vehicle occupant compartments. Causation of these enhanced injuries was proven by a combination of accident reconstruction, static testing, and dynamic testing. Prevention of injury by lightweight, technologically and economically feasible means was also demonstrated.

It has been known for decades that head impact into narrow, force-concentrating structures can result in skull fracture, brain injury, spinal injury, and death at much lower load levels than if those same structures were adequately padded or contoured to reduce their lethality. To reduce or eliminate such injuries, FMVSS 201, Occupant Protection from Interior Impact, has been part of the Code of Federal Regulations related to vehicle crashworthiness since 1967. It has required certain interior structures to be effectively padded, flattened, rounded, and otherwise made less lethal when contacted by vehicle occupants whether belted or unbelted. This is why dash panels and other vehicle interior trim is padded and why narrow, projecting controls and other structures have been eliminated in the forward areas of passenger vehicles.

Several contradictions to the well-known foregoing occupant protection principles have been discovered in late model vehicles, in which unpadding, force-concentrating structures have been placed into the path of vehicle occupant heads that are allowed to catapult rearward as a result of predictable front seat and belt failure. These dangerous conditions have occurred in vehicles produced by multiple manufacturers. There have been enhanced brain and spinal injuries and death caused to vehicle occupants that would otherwise not have occurred if the front seat had remained reasonably upright and, therefore, the belts and head restraints would have been effective at protecting the occupant; and if there had been energy-absorbing padding or elimination of the rigid, force-concentrating structures in the rear of the vehicle interior. Some of these force-concentrating rear interior structures are hazardous to all vehicle occupants, including those in the rear seats.

The reason these dangerous conditions are occurring in late model vehicles is that there are not occupant protection standards for rear impact, no dynamic seat or belt performance standards for rear impact, and there are no requirements for equivalent padded structures in the rear of vehicle interiors as those found in the front seating areas.

This study presents the forensic field investigations that have been conducted to identify these dangerous designs, as well as static and dynamic testing that discovered both the failure mode of the seats, head restraints and belts, as well as how to prevent such injuries. Improved seat and head restraint designs were incorporated in the static and dynamic testing to prevent any occupant contact with the force-concentrating structures. Alternative designs that would eliminate the force-concentrating structures in the rear of vehicles were also determined.



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This presentation will benefit the forensic science community by showing that these severe hazards exist, why they exist, how they create enhanced injury, and how those injuries can be prevented using lightweight, economically and technologically feasible means. Vehicle crash investigators will learn how to identify vehicle seat and belt failure, vehicle interior occupant contact witness marks, and associated forensic evidence that will allow more accurate assessment of occupant injuries in such circumstances.

Enhanced Injury, Seat and Belt Failure, Unpadded Vehicle Structure