F2010-C-112

MULTI-VARIABLE EXPERIMENTAL MATCHED-PAIR COMPARISON OF REAR IMPACT OCCUPANT PROTECTION PERFORMANCE OF STRONG BELT-INTEGRATED VEHICLE SEATS VERSUS WEAKER NON-BELT-INTEGRATED TYPES

[1]Saczalski, Kenneth*, [2]Pozzi, Mark, [3]Burton, Joseph, [4]Saczalski, Todd
[1]Environmental Research & Safety Technologists, USA, [2]Sandia Safety Sciences, USA, [3]Burton & Associates, USA, [4]TKS Recon, USA

KEYWORDS – Rear Impact, Seat Performance, Occupant Protection, Injury Risk,

ABSTRACT - The seatback and seat system are the main source of occupant protection in rear-impacts. The most common commercially available adjustable vehicle front seat systems can be categorized into three main groups: the weaker single recliner (SR) seats, without shoulder belts attached to the seatback (i.e. a single seatback recliner mechanism located on either the inboard (IB) or outboard (OB) side of a seat cushion and seatback junction), with ultimate rear-load strength levels of only about 3.2 kN; the stronger dual recliner (DR) seat types with a recliner located on each side of the seat cushion and seatback junction (also without shoulder belts attached), having strength levels of about 6.5 kN; and, the much stronger "belt-integrated" seats (BIS), where the shoulder and lap restraints are mounted to the seatback and seat cushion structures, and having strength levels that reach as high as 20 kN. The above seats groups are used in various vehicle types and within each of the above seat groups there are differences in construction (i.e. tubular frames versus formed sheet metal, etc.). In addition, different size occupants, both front and rear-seated, like children, use these seat types and are likely to be exposed to a wide range of rear impact severities.

In this study an efficient multi-variable experimental method (i.e. high-low factorial) was used to compare the occupant protection capabilities of the above seat types over a wide range of parameters (i.e. occupant sizes, occupant orientations, impact severities, vehicle types, etc.). Over 50 dynamic rear-impact crash tests were used to compare front occupant head and neck injury risk and seat protection performance for the different seat types in side-by-side "matched pair" test configurations of the weaker SR and DR seat types when compared with the much stronger BIS designs for wide ranges of the parameters noted. Vehicle types tested included minivans, sedans and an extended cab pickup truck. Front surrogate sizes ranged from a small female of 50 kg weight on up to larger male surrogates ballasted to 110 kg. Impact severities ranged from as low as about 12 kph up to 55 kph speed changes. A "composite" average of the SR seat injury response was used to "predict" DR seat performance, and compared well with actual DR test data. Biodynamic response "ratios" and head and neck injury risk comparisons, along with statistical evaluations, were made from the "matched pair" front seated surrogate measures to compare performance of the various seat types. Some tests were also run with rear child surrogates located behind the SR, DR and BIS seat types. The dynamic test results of the seat comparison study indicated that, regardless of the seat construction details and vehicle types, the weaker SR seats showed substantially similar low occupant protective levels that posed a high risk of injury to both the front seated occupants and rear seated children, in comparison to the BIS types. Head injury risk levels of the rear-seated child located behind both the SR and DR type seats were especially much lower than those of the front adult injury risks levels, starting at speed changes as low as "school zone" limits of 25kph for front seated adult sizes of 80 kg and greater.