C6 Passenger Seat Belt Forces During Ordinary Driving

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After attending this presentation, attendees will learn objective data regarding the magnitude of seat belt forces encountered during ordinary driving maneuvers and passenger movements. The usefulness of this data will be demonstrated in the evaluation of a potential seat belt buckle false latch problem through a case study.

This presentation will impact the forensic community and/or humanity by providing useful objective data on realistic seat belt forces than can be expected to be encountered in passenger seat belts during ordinary driving maneuvers and occupant movements. This data can be used to evaluate the performance or identify limitations to certain seat belt designs.

The restraining force for which the seat belt is designed to provide in a collision is well understood. However, there is little, if any, available data regarding the seat belt forces encountered in during everyday vehicle maneuvers. The measurement and the magnitude of seat belt forces encountered during ordinary driving will be presented. The usefulness of this data will be demonstrated in the evaluation of a potential seat belt buckle false latch problem through the following case study.

The left rear tire of an SUV traveling on an interstate delaminated causing the vehicle to yaw and leave the roadway where it rolled over three or more times before coming to rest on its wheels. The driver and front passenger seat belt use was confirmed by loading marks on the plastic covered latch plates. Less prominent loading marks on the rear passenger seat belt supported the front occupants unwavering accounts that the rear seat passenger was also seat belted. However, the rear seat occupant sustaining fatal head injuries when she was fully ejected during the rollover.

A false latch syndrome may be described as a condition that the buckle is either not latched or not completely latched even though the latch plate is physically inside the buckle. This can lead to the occupant perception that they are seat belted when in reality a seat belt force far below a restraining force would detach the latch plate from the buckle, leaving the occupant effectively unrestrained. Given the adamant accounts of seat belt use by the survivors and the evidence of seat belt loading, the possibility of a seat belt buckle false latch was investigated.

Researching the National Highway and Traffic Safety Administration's (NHTSA) consumer complaint's database for this year make and model of SUV revealed 13 separate complaints of seat belts unexpectedly releasing while driving, failing to stay buckled, or unbuckling during a collision. Each of these complaints is consistent with a false latch syndrome. It is noted that according to Mitchell Collision Estimating Guide, this SUV was essentially unchanged over

the 1995 to 2001 model years. However, the seat belt buckles were changed after the first year. In fact, due to the number and presumably the consistency of complaints, NHTSA opened a defect investigation regarding this SUV for buckle releases.

Inspection of the subject vehicle and its seat belts revealed that the side latch buckle spring was sufficiently stiff to hold the latch plate in place, even though the latch plate was not actually locked in place. As shown in Figure 1, using a seat belt tension transducer pulling straight up on the shoulder belt required approximately 25 pounds of shoulder belt tension to separate the unbuckled latch plate from the buckle. Preventing the webbing from passing through the latch plate, effectively eliminating wedging within the buckle, the shoulder belt tension required to separate the unbuckled latch plate from the buckle was found to be approximately 5 pounds.

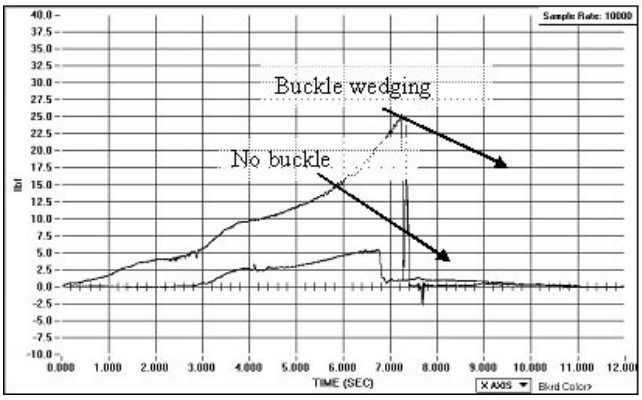

Figure 1. Shoulder belt tension to separate the buckle without occupant

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With a person within the seat belt, lesser shoulder belt tension forces would be expected since the latch plate would be pulled by both the lap belt and the shoulder belt similar to a pulley. Indeed, using a model much larger than the rear seat occupant, the shoulder belt tension required to separate the unlatched buckle within the range of 3.4 to 4.2 pounds was measured. Due to the increase in wedging within the buckle, greater shoulder belt tension would be expected for a smaller occupant.

To assess the magnitude of ordinary seat belt forces experienced during normal use in a vehicle, a preliminary study was conducted with an 11 year old male and a 15 year old male seated in the right front passenger seat of a Toyota Sequoia. A RA Denton model 6400 seat belt tension transducer was utilized with a TDAS Pro collecting at 10 kHz. As shown in figure 2, backing off a rounded curb, accelerating, stopping, turning, and running over speed humps, the shoulder belt forces rarely exceeded 3 pounds. During both demonstrations, shoulder belt forces were less than 3.2 pounds, even when the subjects were asked to lean forward a couple of inches.

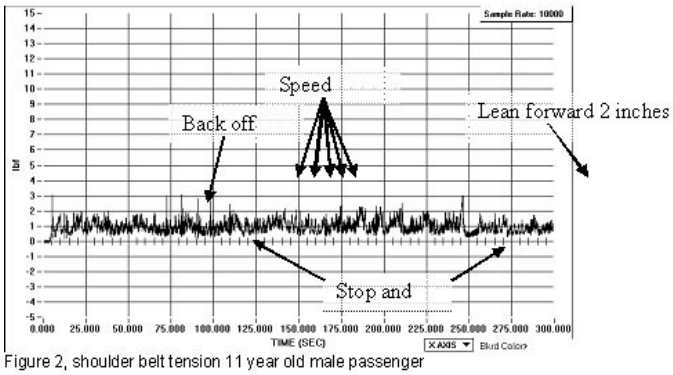

Figure 2, shoulder belt tension 11 year old male passenger

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Therefore, it would appear that even if the shoulder belt forces to separate an unlatched buckle were as low as that measured using an over-sized model, it would not be unreasonable to expect that an unlatched buckle could hold the seat belt on an occupant for some period of time, provided that there was not any unusual roadway obstacles, unusual vehicle maneuvers, or unusual occupant activities. Other possible mechanisms for seat belt release, such as inertial release were not investigated in this case.

The current study provides a useful objective data point for realistic seat belt forces than can be expected to be encountered in passenger seat belts during ordinary driving maneuvers and occupant movements. The above case study demonstrates the potential utility of seat belt tension measurements taken outside the crash environment in the evaluation of certain of restraint issues.

Seatbelt, Tension, False-Latch

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