D39 Shared Anchor Seat Belt Buckle Self-Release

Kurt D. Weiss, MS, Automotive Safety Research, Santa Barbara, CA 93111-2326*

Learning Overview: After attending this presentation, attendees will understand about a seat belt-restrained occupant in a Sports Utility Vehicle (SUV) who was ejected and fatally injured in a rollover collision. The physical evidence will be detailed, and the mechanism of inadvertent seat belt buckle release will be clearly explained.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by illustrating how a shared anchor seat belt component design can be susceptible to inadvertent release.

Federal safety standards require that seat belt assembly hardware shall be designed to prevent attachment bolts and other parts from becoming disengaged from the vehicle while in service.[1] Failure of seat belts at or near the anchor points can render vehicle occupants unrestrained and particularly vulnerable to ejection. It is not uncommon for two adjacent seat belt assemblies to share an attachment bracket and anchor point. A previous study demonstrated how a design change of a shared anchor buckle component subjected to reasonably anticipated forces resulted in catastrophic failure and occupant injury in a rollover collision.[2] The current study highlights another shared anchor design that is susceptible to inadvertent release.

Four occupants of an SUV were northbound at approximately 65mph. A vehicle eastbound at approximately 26mph failed to stop at a stop sign and struck the SUV in the left rear corner. After the initial contact, both vehicles began to yaw counterclockwise. The SUV tipped on its right-side wheels and overturned on the passenger side, leading 4¾ times. By all accounts, the occupants of the SUV were wearing their type-2, lap and shoulder belts. Physical evidence, one in particular, a paint transfer to the seat belt webbing matching the vehicle's exterior color, validated claims of belt use for the second-row left occupant.

Despite this fact, the left rear occupant was ejected and sustained a fatal blunt force head trauma, including skull fractures, brain hemorrhages, and near-complete transection of the brain stem. Occupant ejection while wearing a seat belt is not a unique occurrence.[3-5]

Vehicle inspection revealed the second-row left buckle was a shared anchor component with the adjacent center buckle.

The left buckle is attached to a stiff metal bracket whereas the center buckle is attached by a webbing strap. When installed, the left buckle is slightly recessed while the center buckle lies atop the seat cushion.

In this case, the second-row left and center seats were both occupied at the time of collision.

Design considerations of seat belt buckles involve such things as comfort, convenient access, and performance. It was proposed that the second-row buckle design met some vehicle manufacturers' specified resistance to opening when probed with varying diameter balls (e.g., General Motors® 40mm, Nissan® 40mm, Ford® 38mm, and Toyota® 35mm ball). Yet, the preponderance of evidence indicated the second-row left buckle was most likely inadvertently released during the collision.

Closer examination revealed curious artifacts to the plastic cover of the left buckle.

Furthermore, the lower corner of the adjacent center buckle has a smaller diameter than the balls used in resistance to opening testing. Several new exemplar components were obtained and tested. The elongation of the attachment webbing of the center buckle under reasonably anticipated tensile forces was demonstrated. Alignment of the buckle housing allowed for its lower corner to interact with the adjacent left buckle. Therefore, it was correctly concluded that interaction of the adjacent buckles in use at the time of collision caused inadvertent buckle release that resulted in the ejection and fatal injury of the second-row left-seated occupant.

Reference(s):

1. *Federal Motor Vehicle Safety Standards*, Part 571, Number 209, Seat Belt Assembly Anchorages.
2. Weiss, K.D., Broadhead, W.G. Forensic Testing of Shared Anchor Seat Belt Components. *Proceedings of the American Academy of Forensic Sciences*, 56th Annual Scientific Meeting, Dallas, TX. 2004.
3. Renfroe D.A. Rollover Ejection While Wearing Lap and Shoulder Harness: The Role of the Retractor. *Society of Automotive Engineering*, SAE Technical Paper 960096, 1996.
4. Weiss K.D., Paver, J.G. Forensic Examination of an Unwanted Seat Belt Release in a Rollover Collision with Occupant Ejection. *Proceedings of the American Academy of Forensic Sciences*, 63rd Annual Scientific Meeting, Chicago, IL. 2011
5. Weiss K.D. Forensic Analysis of a Seat Belted Occupant Ejection in a Rollover Collision. *Proceedings of the American Academy of Forensic Sciences*, 65th Annual Scientific Meeting, Washington, DC. 2013.

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