



Engineering Sciences Section - 2013

C17 Seatbacks: Rigid or Yielding?

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The goal of this presentation is to discuss the philosophy of seatback design, whether the automobile front seatback should yield rearward or remain upright during a rear-end collision. The answer will become apparent after the discussion.

This presentation will impact the forensic science community by showing how results of three case studies and prior research should provide seat designers and decision makers with information to improve seatback designs and regulations.

This presentation will demonstrate that automotive seat designers must consider human tolerance, not federal standards, when setting seatback yield strength.

The federal standard for seatback strength is set so low that a lawn chair can pass it. Two groups are divided on front seatback design to protect occupants from rear line-of-force impacts. One group propounds that seatbacks should yield rearward to minimize forces on the body and reduce whiplash. The other group advocates a strong seatback that stays upright and contains occupants in the seat.

Whole body tolerance to +Gx impact was established experimentally in 1958. Captain Beeding recorded 82.6g on his chest accelerometer when he decelerated from 32.8mph to stop with a peak acceleration of 40.4g.

Crash data recorders, installed in race cars in the 1990s, recorded +Gx accelerations of up to 110g when the cars impacted the hard retaining walls. Drivers survived with recoverable injuries.

Human tolerance to +Gx acceleration was established and confirmed with human tests and recorded crashes with the Indy race cars.

Three case studies will show a comparison between rigid and yielding seatbacks and answer the title's question.

Case One: Both southbound lanes of a divided parkway were backed up for 1¹/₂ miles. At the front was a truck with a large load that had stopped to measure the height of an overpass. A 1999 four-door sedan was the last vehicle in line in the outside lane with a mini-van just in front of it. Both vehicles were almost stopped on a small bridge.

A 26-foot-long two-axle truck was traveling in the outside lane with the cruise control set at 70mph. The driver claimed he did not see the stopped traffic in front of him in time to stop and impacted the rear of the sedan. This collision caused the sedan to go airborne, impact the left guard barrier, and rotate 180 degrees. The truck continued on, crashing into the rear of the mini-van, pushing it forward.

The rear half of the sedan was severely crushed up to the B-pillar where the truck rode up over the sedan's bumper. This sedan was equipped with energy-management front seats and the seatback remained upright. The female driver got out of her car with minor injuries.

The mini-van's rear gate and quarter-panel were pushed up to the rear wheel on the left side while the right rear quarter-panel was barely deformed.

The female driver's seatback yielded rearward until it hit the rear seat cushion. She ramped up the reclined seatback, receiving a left occipital skull fracture, subarachnoid hemorrhage with possible coup-counter coup lesion, closed head injury, and left forearm fracture.

Case Two: A large 2002 four-door SUV was traveling at highway speed when the left rear tire detreaded. The vehicle swerved to the right and rotated clockwise as it left the right side of the highway. It slid off the highway until it hit a tree just behind the left B-pillar. The Principal Direction Of Force (PDOF) was between 7:00 and 8:00 at a delta V of approximately 17mph.

The left rear door and structure behind the B-pillar deformed against the driver's seatback, keeping it upright. The female driver was uninjured but the male front seat passenger's seatback yielded rearward and left. He impacted the rear seatback between the two rear seat passengers and sustained a T8 spinal cord transaction with paraplegia. The two male rear seat passengers had minor injuries.

Case Three: A 1994 four-door sedan was stopped in a line of cars when it was hit from the rear by a mid-size foreign SUV. The sedan's air bag deployed when the car was pushed forward into the rear of a vehicle in front of it. Due to a faulty seat recliner mechanism, the seatback collapsed rearward. The male driver ramped rearward into the rear seatback, resulting in quadriplegia from fractures.

Seatback, Rigid, Yielding