



## Engineering Sciences Section – 2009

### **C4 Analysis of Seat Belt Performance in Rear Impact Crash Testing With Seat Failure**

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After attending this presentation, attendees will have a better understanding of the effectiveness of conventional vehicle anchored seat belts when combined with typical weak, collapsing seats during rear impact crash tests.

This presentation will impact the forensic community by showing how older test information, including work published 40 years ago; can still be of benefit in reaching a better understanding of how to protect people in vehicle crashes. The techniques of analyzing older test information, as well as interpretation of that information are presented.

Instrumented rear crash tests from the 1960's through the present were analyzed to determine amplitude and timing of peak vehicle crash pulse and seat belt loads relative to front seat occupant head and chest loads. This was done to determine whether the conventional vehicle- anchored seat belts were effective restraints when combined with typical weak, collapsing seats. Technical literature published in the 1960's and 1970's clearly indicated that conventional seat belts are not effective when vehicle seats collapse rearward. Some of the tests used to make these determinations were unavailable for analysis until recently.

The typical production front seat is far too weak to adequately and safely absorb foreseeable, predictable occupant loads in rear impact collisions. This was recognized by Stapp, Severy, and others in the 1950's and '60's. Typical production seats are so weak that the occupant's head usually does not make contact with the head restraint before the seat collapses. There are also hazards to rear seat occupants as a result of front seat collapse, particularly to children.

Recently, some of Severy's testing from the 1960's period, which was unavailable for public review for many years, was obtained. This has allowed comparison of his data and films with other rear impact research performed for NHTSA and others in subsequent years. Analysis of available test data and films has shown that in conventional collapsing seats, peak occupant head and chest loads precede peak loads on the lap belt in virtually every instance. The only exceptions found to date are where the lap belt is artificially snagged by the pelvis-to-femur joint and/or captured by the molded sitting pelvis of the test dummies. These dummy artifacts are not found in humans. In several tests, belted dummies exceeded Head Injury Criteria acceptable levels, while unbelted dummies did not. It is extremely unusual to have a restrained dummy incur significantly more severe injury than an unrestrained dummy in a conventional linear impact. In addition, the belted and unbelted dummy heads struck the vehicle interior at the exact same millisecond, proving no effective restraint by the belts. In many tests, the peak lap belt loads seen prior to peak head and chest loads, were less than 20 pounds. In an equivalent frontal impact, the peak combined seat belt loads are approaching 2000 pounds or more.

The forensic and biomechanical evidence found in vehicles, especially on seats and seat belts, in field investigations can be correlated to the results of these crash tests.

#### **Rear Impact, Crash Tests, Seat Belts**