Three Recommendations to Improve Crashworthiness Ratings

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ASRI has three Crashworthiness Recommendations:

1- Control the shoulder belt routing routing in frontal tests
2- Use the Thor Dummy in all frontal tests.
3- Use injury criteria and weighting factors that reflect injury priorities on the road

Shoulder Belt Positioning with the Hybrid III

Chest compression is universally accepted as the preferred metric for assessing chest injury risk.

In the case of the Hybrid III family of adult dummies, chest compression is measured by a single chest deflection gauge at the centerline of the dummy's sternum.

The way the shoulder belt crosses the chest may make little difference to a person, but it makes a large difference to the measurement of the chest deflection at a single point on the chest of a dummy.

The way the belt crosses the chest is highly dependent on the adjustment of the upper anchorage (D-ring).

The position of the D-ring is not prescribed in current NCAP testing protocols.

Instead, the vehicle manufacturer is allowed to specify which adjusted position of the D-ring is to be used in the test.

As a result, over 90% of recent frontal NCAP tests were conducted with the D-ring in the uppermost position.

When the D-ring is in the uppermost position, the shoulder belt rubs the neck and is well away from the chest deflection gauge.

This high belt routing greatly reduces the magnitude of the chest deflection and the chest injury risk.

In cooperation with IIHS, we replicated of an NCAP test, but with the D-ring in the lowermost rather than in the uppermost position.

The chest injury risk for the passenger dummy increased from less than 1% to 15% in the case of a 35 year old male, and from 0.6% to 45% in the case of an elderly female [Digges, Dalmotas, Prasad, and Mueller, 2017].

The injury risk changes noted above illustrate how fake safety benefits are being realized by simply altering the shoulder belt positioning procedures as permitted in the current Frontal NCAP.

In the short term, this could be remedied by a requirement that the lowermost anchorage location become the default position.

The next highest position(s) could be specified in the event any portion of the belt is off the shoulder.

For the 5th female passenger, we recommend that the position of the seat should be immediately changed from the current foremost position to the mid-position.

This change would make the testing environment more field relevant.

A promising alternative to control belt routing would be the use of rib-eye instrumentation on the 5th dummy.

Sled tests that we will report in a 2019 ESV paper indicate that the rib-eye or IR-TRACC instrumentation can show the degree to which the belt is off-set from the center gage.

The rib-eye readings could provide a basis for penalizing poor belt routing.

Controlling shoulder belt routing would close a large loophole in the NCAP test procedure that is producing misleading chest injury risk measurements.

Use the Thor Dummy in Frontal NCAP Tests

35 years ago I started work on the Thor dummy.

At that time I was Director, Office of Vehicle Research at NHTSA.

One reason I initiated the advanced dummy work was because the Part 572 dummies were not sufficiently sensitive to encourage the best safety systems.

The H II and H III could differentiate between the presence or absence of air bags, but could not differentiate between the levels of safety provided by various kinds restraint systems.

In 1975 I had overseen the crash testing of air belts by young Navy volunteers up to 32.5 mph without injury. They were willing to go to 35 mph, but I was not.

The max severity of any volunteer test for a conventional force limited belt was under 30 mph.

When we tested cadavers in conventional belts at 30 mph, massive (fatal) rib fractures occurred.

As a follow-up to the air belt tests, we tested two cadavers at 47 mph.

One specimen had some rib fractures but they were undisplaced and mostly confined to the external rib surface.

The second the specimens had only one rib fracture that was attributed to terminal external cardiac massage.

The contrast between the injuries from conventional belts at 30 mph and air belts at 47 mph suggests that air belts would be beneficial to all ages but especially to seniors.

Tests with Part 572 dummies by NHTSA and others have not shown the benefits of air belts that we saw in human volunteer and cadaver tests.

The Thor dummy family has improvements in chest biofidelity and instrumentation that are designed to measure the safety differences that were observed in the human tests.

After 35 years of development, it is time to federalize the Thor 50^{th} and 5^{th} dummies and use them to encourage the improvements in restraint systems that are needed to offset the decline in safety caused by the increases vehicle stiffness.

Apply Weighting of the Risk for each Body Region by the Field Prevalence for that Body Region

We believe that the NCAP test injury risk measurements for each body region should be relevant to injury risks in similar real world crashes.

As a minimum, the risks measured for each body should be in the same order as the injury risks in the field

Failure to do this may encourage the safety optimization for a body region where there are few injuries at the expense of one where there are many.

A methodology for developing body region risk curves and weighting factors based on field performance was contained in an earlier ESV paper (Digges, K., Dalmotas, D., and Prasad, P., ESV 2013).

The methodology develops a correlation between injury risks measured in NCAP crash dummies and injury risks observed in crashes of similar vehicles on-the-road.

Dummy risk curves and weight factors can be selected to agree with equivalent populations in the real world crashes.

The 2013 paper suggests that the current criteria requires optimization of the neck at the expense of the chest where serious injuries are more frequent.