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Next Steps for the IIHS Side Crashworthiness Evaluation Program

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ABSTRACT – IIHS has been conducting side impact crash tests since 2003. To understand how the side crashworthiness program can be enhanced, an ongoing research effort is focused on understanding the correlation between IIHS ratings and driver death rate. In addition, the performance of good-rated late-model vehicles has been assessed in higher severity side crash tests. The purpose of this short communication is to summarize the ongoing work and potential next steps toward developing a new crash test procedure or updating ratings criteria to further advance side crashworthiness.

INTRODUCTION

The Insurance Institute for Highway Safety (IIHS) began publishing results of its side crashworthiness evaluation program in June 2003 (IIHS, 2003). In the IIHS side crash test, SID-IIs dummies are placed in the driver and left rear seating positions of the subject vehicle and a moving deformable barrier (MDB) strikes the left side of the vehicle at 50 km/h (IIHS, 2017). The IIHS MDB was designed to represent the front end of a midsize SUV or large pickup truck, but with a mass (1,500 kg) closer to a small SUV or midsize car. The test evaluation criteria include assessments of dummy injury measures, head protection (especially important when few vehicles had standard head-protecting side airbags), and structural intrusion of the occupant compartment.

IIHS vs. real-world crash severity

When the IIHS side crash test was conceived, it was considerably more challenging to vehicle structure and restraint systems than other regulatory and consumer information tests that were being conducted. The MDB was heavier, had a higher ride height (compared with the NHTSA and Euro NCAP MDBs), and had a chamfered front end. The combination resulted in B-pillar loading and intrusion that was more severe and matched real vehicle-to-vehicle crash deformation better than other MDBs that were being used at the time. Although the IIHS test was considered very severe for its time, an early comparison of the IIHS side test with real-world vehicle-to-vehicle side crashes indicated that 30–55% of serious injury (MAIS 3+) crashes and 75–90% of fatal side crashes exhibited more intrusion than the IIHS crash test configuration (Arbelaez et al., 2005).

Side crashworthiness trends

Auto manufacturers in the U.S. responded quickly to the IIHS side crash test ratings, and the result was improved vehicle side structures and near universal adoption of side airbags as standard safety features by 2009. Prior to 2003, side airbags were not available on most vehicle models or only available as an optional safety feature. An analysis by Teoh and Lund (2011) found that among vehicles equipped with head-protecting side airbags, drivers in good-rated vehicles had a 70% lower risk of death in left-side impact crashes than drivers of poor-rated vehicles.

Since 2014, over 95% of new vehicles rated by IIHS earned a good side crash rating. In 2016, 40% of registered vehicles had the good rating, and this proportion of good-rated vehicles will continue to increase as older vehicles are retired from the fleet. Side crash fatalities dropped significantly from 2003 (almost 10,000 deaths) to 2010 (5,250 deaths). Despite the improvements made in side crash protection and the continued increase of good-rated vehicles in the fleet, side crash fatalities have increased slightly in recent years.

Can good-rated vehicles get better?

An IIHS analysis of serious and fatal injury crashes of good-rated vehicles identified ways in which these differed from the IIHS side crash test. Test changes that could address these differences included a forward-shifted impact point (relative to the existing IIHS configuration), increased test severity, an assessment of far-side occupant injuries, and modified injury criteria (Brumbelow et al., 2015). A follow-up IIHS study concluded that a higher severity crashworthiness evaluation would be more likely to drive improvements in the current fleet than one with a forward-shifted impact point (Brumbelow et al., 2017).

The purpose of this short communication is to summarize the on-going work focused on determining the next steps for the IIHS Side Crashworthiness Evaluation Program. This effort includes evaluating more stringent vehicle structure and injury criteria and/or developing a new test configuration.

The ongoing work at IIHS is split into three main areas that include: (1) analyzing real-world driver death risk as a function of measures obtained in the IIHS side crash test, (2) comparing the IIHS MDB geometry with late-model SUVs and pickup trucks, and (3) conducting crash tests of late-model vehicles to determine their range of performance in an increased severity test and to reevaluate whether the IIHS MDB is a valid surrogate for the trucks and SUVs (light truck vehicles [LTVs]) it is intended to represent.

ONGOING RESEARCH

Real-world driver death risk

Teoh and Lund (2011) found that good IIHS side crash test component ratings were associated with lower driver death risk in real-world left-side crashes than poor ratings. This analysis was repeated using 2000–2016 calendar year data and vehicle model years through 2016, with a focus on individual crash test metrics (structure and dummy measures) instead of rating categories (good, acceptable, marginal, poor).

Preliminary results indicate that lower structural intrusion and dummy measures to the head, torso, and pelvis were associated with lowering the death risk considerably. Table 1 shows how reductions in crash measures correlate to reductions in real-world death risk. If the existing test configuration is maintained, adjustments to the structure and injury criteria will be based on those measures with the most potential for reducing death risk in real-world crashes.

Table 1. Percent changes in real-world left-side impact death risk associated with the IIHS side crash test

Test measure	Reduction in measure	Reduction in death risk
B-pillar intrusion	10 cm	25%
HIC-15	100	8%
Maximum shoulder deflection	10 mm	10%
Average rib deflection	10 mm	12%
Maximum rib deflection	10 mm	12%
Maximum rib deflection rate	1 m/s	9%
Maximum rib V*C	0.5 m/s	14%
Acetabulum force	1 kN	7%
Iliac force	1 kN	9%
Combined pelvic force	1 kN	8%

Is the IIHS barrier still geometrically representative of SUVs and trucks?

The average vehicle mass for cars, SUVs, and trucks has continued to increase for the past 20+ years, with an average SUV mass 400 kg higher than the current IIHS MDB (Figure 1). Front-end profiles of pickups and SUVs were measured for comparison with the IIHS MDB. The geometry of late-model pickups is similar to the pickups used in the original development of the MDB, but measures show that SUVs have become more carlike, with a greater number of swept-back designs rather than boxy front ends that were typical two decades ago (Figure 2).

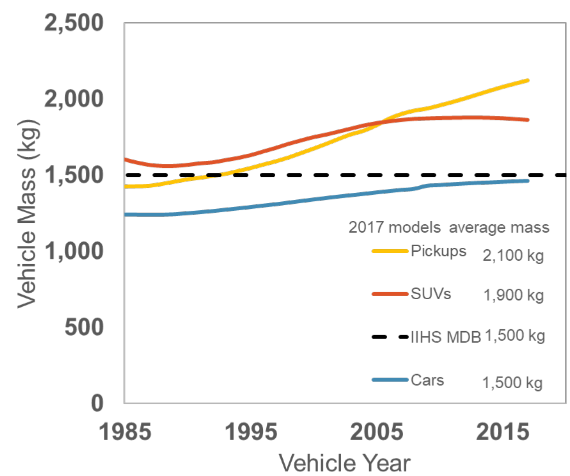

Figure 1. Vehicle mass over time

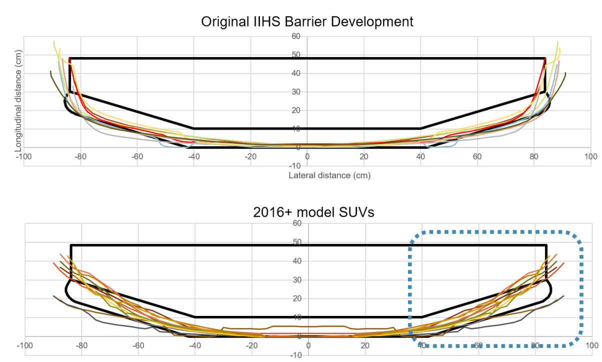

Figure 2. Comparison of SUV front-end geometry to the IIHS MDB; 1999 – 2000 models (top) and 2016 – 2018 models (bottom)

Side crash performance: heavier and faster striking vehicles

To assess whether the IIHS MDB is a valid LTV surrogate, a series of 60 km/h crash tests were conducted with a large pickup truck, midsize SUV, and a 1,900 kg IIHS MDB as the striking vehicle. The struck subject vehicles included two midsize sedans and two midsize SUVs with a range of structural measures observed in the IIHS test (Table 2).

Table 2. Barrier-to-vehicle and SUV/truck-to-vehicle crash test matrix

Test Matrix, all tests conducted at 60 km/h				
Struck vehicle		Striking vehicle		
Vehicle ID	50 km/h posttest B-pillar to seat CL distance (cm)*	IIHS MDB (1,900 kg)	Large pickup truck (2,200 kg)	Midsize SUV (2,000 kg)
Car 1	22	X	X	X
SUV 1	32	X	X	X
Car 2	15	X		
SUV 2	14	X		

CL=centerline
*The minimum measurement for a good structure rating is 12.5 cm.

Preliminary analyses of the crash test results indicate that the vehicle deformation patterns and injury measures differed between the IIHS MDB and other striking vehicles. The striking LTVs produced greater peak intrusion with more localized intrusion at the front and rear doors than the modified MDB (Figure 3). Compared with the baseline 50 km/h IIHS results, tests with a striking LTV resulted in elevated pelvis and femur injury measures, whereas the modified MDB tests had elevated head and torso injury measures.

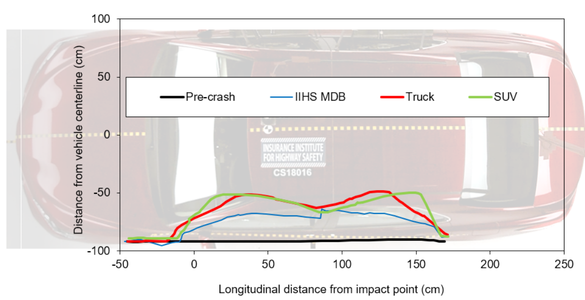

Figure 3. Exemplar vehicle side deformation patterns shown on Car 1 from impacts with the three different striking vehicles

All four of the good-rated struck vehicles exhibited increased injury measures and decreased occupant compartment space in the higher severity IIHS MDB test (1,900 kg and 60 km/h) than in the baseline IIHS MDB test (1,500 kg and 50 km/h). However, the range of performance among these vehicles in the higher severity test correlates with the range of intrusion measured in the baseline tests.

NEXT STEPS FOR THE IIHS SIDE RESEARCH PROGRAM

IIHS expects to publish the first phase of this research program in the fall of 2018.

The initial assessment of these efforts suggests that the side crashworthiness of vehicles could be improved by applying more stringent evaluation criteria to the current test. Alternatively, or in addition, a higher speed test with a heavier MDB could encourage designs that extend current levels of protection to higher severity crashes. Doing so would necessitate modifying the MDB to make it more representative of modern SUVs and pickups.

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