IMPACT OF SPEEDS ON DRIVERS AND VEHICLES — RESULTS FROM CRASH TESTS

INTRODUCTION

Despite numerous studies reporting the negative impacts of increased speeds on roadways, many states have steadily raised their posted speed limits. In response to these concerns, the AAA Foundation for Traffic Safety initiated a multi-phased study to investigate the effect of posted speed limit changes on traffic safety. The first phase entailed gathering feedback from traffic engineers on how posted speed limits are set and what factors they consider in changing posted speed limits (Research Brief). The second phase, which is the subject of this study, entailed a collaborative effort with the Insurance Institute for Highway Safety (IIHS) and Humanetics Innovative Solutions to examine how vehicle crashworthiness and occupant protection degrade as impact speed increases. Towards this, three vehicle crash tests were conducted.

KEY FINDINGS

Overall, as the crash speed increased, the additional occupant compartment deformations and higher crash energy resulted in higher peak injury measures recorded by dummy sensors over the entire body region. Key findings included the following:

Vehicle response

- **Kinetic energy:** The increased impact speed of 10 mi/h in Test 2 and 15.9 mi/h in Test 3 corresponded to an increase in kinetic energy of 54% and 95%, respectively, relative to Test 1.
- **Compartment intrusion:** Test 1 had minimal occupant compartment intrusion. Test 2 resulted in some deformation of the driver side door opening and to the instrument panel and footwell (brake pedal). In contrast, the occupant compartment was significantly compromised in Test 3, narrowing the driver door opening by 4 inches and having 5 to 16 inches greater interior intrusion than in Test 1.
- **Steering wheel:** In Test 1, there was minimal movement of the steering wheel (1 inch both forward and upward) because of the dummy loading the steering wheel through the airbag. In Tests 2 and 3, there was some rearward movement of the steering wheel (1 inch and 3 inches, respectively) and large upward movement (4 inches and 7 inches, respectively), which compromised the position of the airbag.

Injury measures from the dummy

- **Head:** Severe injury measurements for the dummy were observed only in Tests 2 and 3. The higher energy combined with the large upward movement of the steering wheel resulted in the dummy's head going through the deployed airbag (also known as "bottoming out"). This caused the dummy's face to make hard contact with the steering wheel rim, hub, or both and produced high values on the Head Injury Criterion that are indicative of a high risk (52% – 67%) of facial fracture and severe brain injury.

ABOUT

Founded in 1947, the AAA Foundation for Traffic Safety in Washington, D.C., is a nonprofit, publicly supported charitable research and education organization dedicated to saving lives by preventing traffic crashes and reducing injuries when crashes occur. Funding for this report was provided by voluntary contributions from AAA/CAA and their affiliated motor clubs, individual members and AAA-affiliated insurance companies, as well as from other organizations or sources.

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- **Neck:** Test 3 showed a high value of peak neck tension, which corresponds to a 19% risk of a serious neck injury.
- **Chest:** Peak accelerations to the dummy's chest increased with test severity, but the maximum chest compression was similar between the three tests. There was no indication of severe chest injury in any of the tests.
- **Lower extremities:** Loads to the dummy's lower extremities and, as a result, the likelihood of fracture to the long bones in the lower leg (tibia, fibula, or both) also increased with impact speed.

IMPLICATIONS

These results show that the impact speeds in Tests 2 and 3 increased the kinetic energy to a level that exceeded the capacity of the vehicle's energy-absorbing structures. The remaining crash energy transferred to the occupant compartment and resulted in increased injury severity in the test dummies.

According to National Highway Traffic Safety Administration, the injury measures from the baseline test (Test 1) represent a 15% risk of serious or worse overall injury. In contrast, the result from Test 2 indicates a 59% risk, while the result from Test 3 indicates a 78% risk of serious or worse overall injury. This implies that the driver's survival likelihood in the vehicles of Test 2 and 3 would be considerably lower than that of the Test 1 vehicle.

METHODS

Following the IIHS test protocol, the crash tests were set up and executed between October 28 and 30, 2019. The following summarizes details of the tests:

- **Test type:** Tests were conducted at a moderate overlap frontal impact crash mode. In this mode, 40% of the maximum width of the test vehicle crashed into a deformable barrier on the driver side with the forces concentrated on the driver side of the vehicle. This test setup simulates a head-on, partial-overlap crash between two vehicles of the same weight and size travelling at the same speed.
- **Crash speed:** Tests were conducted at three different impact speeds—40 mi/h for the baseline test (Test 1) and 50 mi/h and 55.9 mi/h for two higher speeds (Test 2 and Test 3, respectively).
- **Test vehicle:** Three 2010 Honda CR-V EX vehicles were selected as they represented the average age of vehicles (11.8 years in 2019) on today's U.S. roadways and earned the top rank in crash test ratings. All three had comparable specifications including manufacture date, vehicle mileage, and drive type.
- **Barrier type:** Test vehicles were crashed into a barrier face that was fixed and composed of aluminum honeycomb materials.
- **Crash test dummy type:** This study used a Hybrid III 50th percentile male dummy positioned in the driver seat to represent an average-sized male driver. The dummy in each test was instrumented to record measures from the head, neck, chest, thighs, and legs.

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