The Influence of Test Conditions on the Results of Pedestrian Headform Impact Tests

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April 2012

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Abstract

Pedestrian headform impact tests are used to assess the relative level of danger that a vehicle poses to the head of a struck pedestrian. The tests are conducted using a dummy headform that is launched at specific locations on the front of a stationary vehicle. The conditions of the test are specified in the relevant test protocol, and include the mass of the headform, the impact speed, and the impact angle. There are test protocols for vehicle design regulations and for new car assessment programs, each of which may specify different test conditions.

Previous studies have not examined in detail the influence of the test conditions on the result of the test, as measured via the Head Injury Criterion (HIC). HIC is proportional to the duration and magnitude of the acceleration of the headform during the impact. In this thesis, a theoretical model of a linear spring is used to examine, in the simplest case, the influence that headform mass and impact speed have on HIC and peak dynamic displacement.

These relationships were also studied empirically using real test data. The empirical effect of impact speed on HIC was found to be similar to that predicted by the linear spring model, and the influence of headform mass was found to be slightly weaker than what was predicted theoretically. An effect of headform diameter was also found in the test data. In summary: HIC was found to increase with impact speed, and was found to decrease with increasing headform mass and diameter. Increasing the impact speed, headform mass or diameter resulted in higher peak displacements, leading to a higher likelihood of contact with harder structures beneath the outer vehicle surface.

These relationships were used to predict the compliance of sixty vehicles with the Global Technical Regulation on pedestrian safety, based on their results under the European New Car Assessment Program pedestrian testing protocol. The relationship between HIC and impact speed was also used to compare the performance of theoretical structures that meet different test criteria, across a published distribution of real crash speeds. An injury risk function for HIC was used to demonstrate how test performance at a single crash speed can be related to an overall real world injury risk.

The results presented in this thesis show that HIC and peak displacement can be extrapolated or interpolated from a single test to apply to a wider range of test conditions. This methodology, in its simplest application, can be used to predict how a tested structure performs under different test protocols. A more complex application of this methodology might be a new method for assessing vehicle performance, based on its performance across the full range of conditions encountered in real world pedestrian crashes.

Statement of originality

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List of publications

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Acknowledgements

First and foremost I would like to thank my two supervisors, Robert Anderson and Paul Hutchinson. Their guidance and expertise has been invaluable.

Several organisations have contributed financial or inkind support to this project, and I thank them for their support and for supporting pedestrian safety research. These organisations include the Australian Department for Infrastructure and Transport, the Australasian New Car Assessment Program (ANCAP), Toyota Motor Corporation, General Motors Holden and Hyundai Motors Australia.

I would like to thank my colleagues at the Centre for Automotive Safety Research for making it a great place to work and study. In particular I would like to thank Andrew van den Berg and Giulio Ponte from the impact laboratory and Jaime Royals, the CASR librarian. I would also like to thank fellow student Jeffrey Dutschke for many productive (and unproductive) discussions.

Finally I would like to thank my friends and family, who will probably be greatly surprised to hear that this is all done.