Evaluation of Injuries in Offset Frontal Pole Impacts

I. INTRODUCTION

D. Gierczycka-Zbrozek, D. Cronin

Pole impacts result in a significant number of injuries each year. In 2009, the Fatality Analysis Reporting System (FARS, NHTSA) reported 1759 fatalities resulting from crashes involving poles [1]. Specifically, frontal impacts are one source of costly KTH (knee-thigh-hip complex) injuries [2], where KTH injuries are often associated with significant injuries to other body regions [3]. The goal of this study was to apply advanced modelling methods to predict the severity of injuries associated with offset pole crash scenarios.

II. METHODS

A 50th percentile ATD (Hybrid III v7.1.6 50th percentile male, Humanetics Innovative Solutions Inc.) was integrated with a Ford Taurus 2001 FE model (NCAC) and validated against NHTSA frontal impact test data. The deformable pole model was validated by Lockhart et al. in pendulum impacts [4]. The rigid pole model followed the Ontario Provincial Standard Specification (2010). The impact location was varied left (driver side) and right (passenger side) from the vehicle centreline to the vehicle crush structure (570mm offset) and the potential for injury was evaluated using the Hybrid III with available injury metrics at an impact speed of 50 kph.

III. RESULTS

For the rigid pole, increased head and chest injury was predicted for passenger side offsets while an increased risk of KTH injury was predicted for driver side offsets. For the deformable pole, the predicted potential for KTH injury was negligible and the highest injury risk for head and chest was expected for offsets between the vehicle centreline and the crush structure. All the injury metrics were below the threshold values.

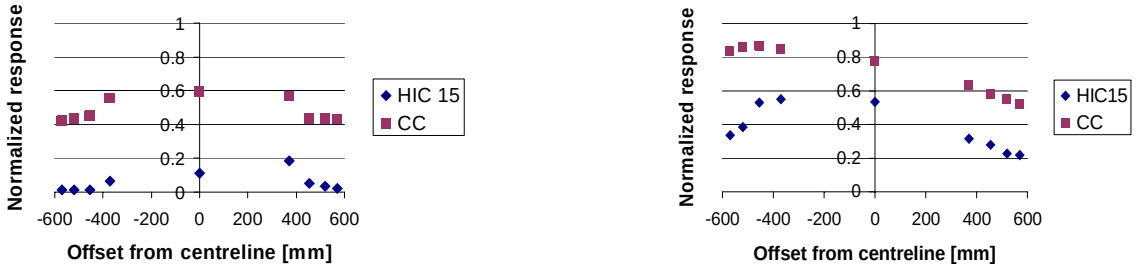

Figure 1: Deformable pole (left) and rigid pole (right) injury evaluation for the head and chest metrics. Negative values of the offsets are related to passenger side offsets, positive – to driver side offsets.

IV. DISCUSSION

The injury predictions for head, chest and KTH demonstrated consistent trends for the deformable pole. The peak values occurred between the vehicle centreline and crush structures. For the rigid pole, the increase of injury metrics for head and chest on the passenger side offsets was related to occupant interaction with the seatbelt and vehicle rotation. The KTH injury risk was elevated for the driver side offsets due to occupant compartment intrusion. Next steps include additional model validation for KTH and a refined parametric study to investigate injuries in offset crash scenarios at different impact velocities.

V. REFERENCES

[1] National Highway Traffic Safety Administration FARS, 2011. [2] Kuppa S et al, 18th ESV Conference paper no. 416, 2001. [3] Lee J et al, Acc Anal and Prev, 2010. [4] Lockhart P et al, Traf Inj Prev, 2012.

D. Gierczycka-Zbrozek (tel: 0048 22 2347992; fax: 0048 22 2347513; dgierczycka@meil.pw.edu.pl) is a PhD student in Mechanical Engineering at Warsaw University of Technology, Poland and visiting scholar at University of Waterloo, Canada. D. Cronin is Associate Professor, Dept. of Mechanical and Mechatronics Engineering, University of Waterloo, Canada.