Assessment of Occupant Response in Frontal Bus Crash Sled Scenarios to Investigate Public Transportation Safety

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Introduction

- Improved understanding of occupant response to crash needed to enhance public transit occupant safety.
- Transport Canada initiated project to investigate public transit bus passenger injury risk using Anthropomorphic Test Devices (e.g. HIII).
- Sled tests indicate focal impact on the neck with the forward seat handrail.

Motivation of Study

- Validation of a Finite Element model of the experimental tests including the $HIII_{FE}$ will enable optimization of bus interior passive safety design.
- Simulations allow for the use of a Human Body Model (HBM), providing detailed insights into occupant injury risk.

Objectives

- Validate a simulation model of the experimental sled tests with the $HIII_{ATD}$.
- Compare kinematics and injury metrics of the $HIII_{FE}$ and HBM (GHBMC M50).

Methods

1) Model Generation and Boundary Condition

- A FE model of the experimental sled buck was created with an applied deceleration pulse matching that of the experiment.

2) Model Validation

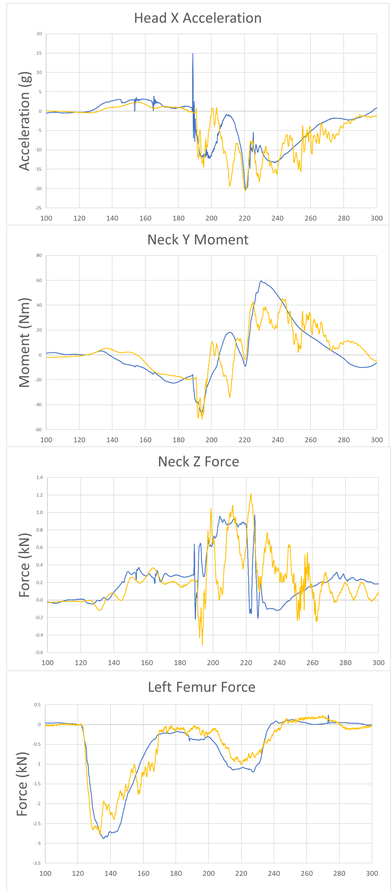
- Cross correlation analysis conducted using CORA to validate simulation model.

3) HIII ATD/HBM Comparison

- Kinematics and injury criteria for the $HIII_{FE}$ and HBM were compared to determine the biofidelity of the $HIII_{ATD}$.

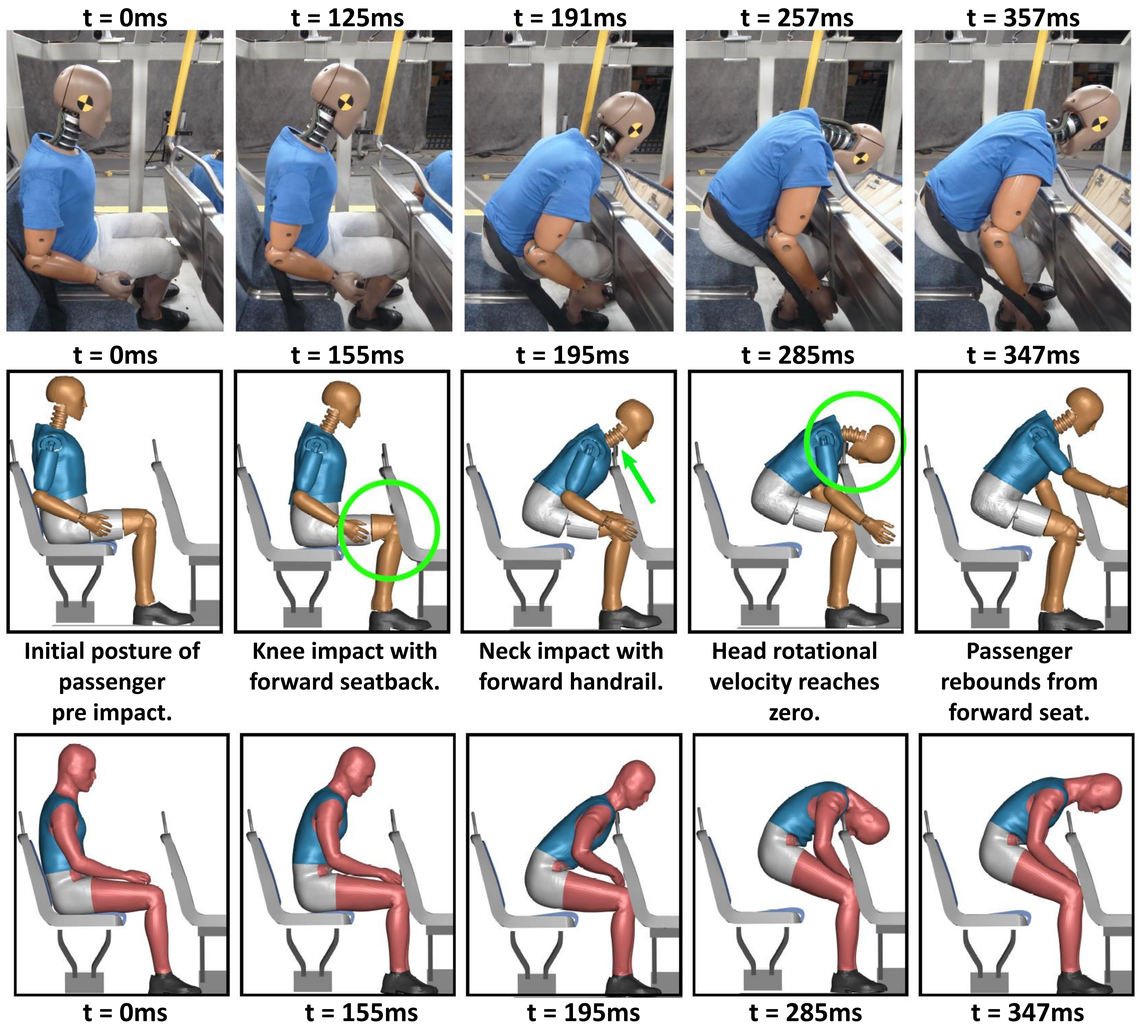
Results and Discussion

- Kinematics show a tendency for the $HIII_{FE}$ knees to impact the forward seatback, followed by forward motion of the thorax and impact of the neck on the handrail.
- Cross correlation (0.833 average) shows good agreement between experimental tests and $HIII_{FE}$ simulation.
- HIC, N_{ij}, CTI, and femur load predicted a low probability of severe injury.
- The HBM kinematics and injury criteria predictions agreed with the $HIII_{FE}$ in that both models indicated the potential for injury due to focal impact on the neck.



Metric	CORA Score
Head X-Acceleration	**0.888**
Chest X-Acceleration	**0.882**
Pelvis X-Acceleration	**0.948**
Head Y Rotational Velocity	**0.919**
Neck Y Moment	**0.759**
Neck X Force	**0.818**
Neck Z Force	**0.917**
Left Femur Force	**0.897**
Right Femur Force	**0.794**
Chest Displacement	**0.846**
Total Cora Score	**0.833**

Table 1: CORA values



Conclusion and Next Steps

- Cross correlation showed good results between experiments and simulations and predicted focal impact on the neck of the passenger.
- Next steps: Parametric analysis by varying the seat pitch, seat height, and passenger location (inboard/outboard)

Acknowledgements

GM Canada, compute canada, FCA Fiat Chrysler Automobiles, Transport Canada, Transports Canada, GHBMC Global Human Body Models Consortium, NSERC CRSNG, HONDA Honda R&D Americas