Effect of Seatback Recline on Occupant Model Response in Frontal Crashes
Hongnan Lin, Bronislaw Gepner, Taotao Wu, Jason L. Forman, Matthew B. Panzer

Introduction

- The introduction of new highly automated vehicles holds the promise to influence occupant seating behavior and seat design.
- The increased seatback recline angles may challenge occupant restraint systems currently available in the vehicle fleet.
- It is currently unknown if current occupant injury assessment tools are capable of simulating these novel postures and predicting the resulting occupant responses and restraint interactions in realistic manner.

Objective

Assess the usability and performance of the Global Human Body Model Consortium (GHBMC) owned 50th percentile male detailed occupant model (GHBMC M50-0) and simplified occupant model (GHBMC M50-0S) in various reclined seating positions in frontal collisions.

Methods

Environment model

- Vehicle model and RMDB
  - 2012 Toyota Camry with 3 reclined seats [4]
  - Research moving deformable barrier [2]
  - Frontal impact

Restraint system

- Passenger airbag (PAB), curtain airbag (CAB), side airbag (SAB)
- Standard D-ring seatbelt, seat-integrated D-ring seatbelt

Occupant model

- GHBMC M50-0 [3]
  - Designed to predict injuries based on tissue-level criterion.
  - GHBMC M50-0S [1]
  - A derivative model of M50-0.
  - Not intended to predict crash induced injuries based on tissue-level criterion.
  - Obtain kinematics from accelerometers or deflection sensors.

Human body model instrumentation

- Assessing tri-axial linear accelerations and velocities of head, cervical spine (C1), thoracic spine (T1, T8 and T12) and pelvis.
- Measuring tri-axial angular accelerations and velocities of head, cervical spine (C1), thoracic spine (T1, T8 and T12) and pelvis.
- Evaluating reaction forces between occupants and surrounding vehicle parts.

GHBMC M50-0/OS positioning

Method

- Pre-simulation

Challenge

- Both models are too stiff to settle into seatback under gravity without additional forces.

Results

Kinematics

- GHBMC M50-0S
- GHBMC M50-0

Discussion

- The GHBMC M50 models were too stiff to allow the HBM to settle into the seat under gravity without applying additional forces.
- In semi-reclined and reclined postures, both GHBMC M50 models submarined resulting in the lap belt sliding over the anterior iliac spine. M50-0S displayed greater pelvis backward rotation compared to the M50-0 model.
- Compared with the standard belt, seat-integrated D-ring belt caused more pelvis backward rotation in the matched posture.
- GHBMC M50-0S exhibited a greater flexion angle compared to the M50-0 model.

Conclusions

1. Effect of seatback recline on human body model usability, restraint interaction, and occupant kinematics in simulated frontal collisions was investigated.
2. Both models tended to exhibit submarining with the lap belt sliding over the pelvis and directly loading into the abdomen.
3. Different coupling definitions between pelvis, lumbar spine and flesh might potentially explain the different kinematics in both models.
4. Generating reference data to assess the bio-fidelity of the models in this type of loading scenario in future.

References


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