Preliminary assessment of the MADYMO Pedestrian Model for Predicting Pedestrian Ground Contact Kinematics

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I. INTRODUCTION

Pedestrian ground contact injuries are poorly understood. Existing work has focused on multibody model predictions [1-3] and accident data evaluation [4], but models are not validated for ground contact and in accident data the kinematics are generally unknown. Post-mortem human subject (PMHS) tests provide a means to assess whole body kinematics as a first step prior to modelling injury outcomes. Only limited information on pedestrian ground impact could be obtained from previous PMHS tests [5, 6]. The wider aim of our research was to perform a series of pedestrian PMHS tests to study ground contact in detail and provide validation metrics for the MADYMO pedestrian model. In this short paper, preliminary results of the first PMHS test and simulation attempt are presented.

II. METHODS

Cadaver Test

A vehicle impact test with a Peugeot 307 striking a male PMHS (174 cm tall, mass 66 kg) at 30km/h was conducted in LAB, Aix-Marseille University in France (Figure 1). The vehicle was braking at impact. Six 3D accelerometers were used, one embedded in the mouth and five screwed on different bone regions to capture the local accelerations. In addition, markers were used to optically track body segment trajectories. Five high speed cameras were used to record the whole pedestrian trajectory which covered an approximately 10m space.

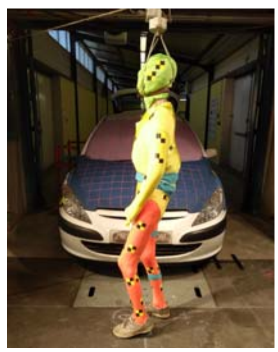

Fig. 1. Set-up of vehicle-PMHS impact test.

Multi-body Model Reconstruction

The impact test was reconstructed using the MADYMO 50th percentile male pedestrian model. The dimensions of the vehicle model were obtained from [7]. The vehicle displacements in X (horizontal) & Z (vertical) displacement and angle of pitch were captured from the videos and used as model inputs.

III. INITIAL FINDINGS

Figure 2 shows the overlap sequences of the PMHS test and the MADYMO simulation. Note: The PMHS and the MADYMO model are at the same height, apparent difference was due to the out of plane motion and the tendering of the cameras. Figure 3 (a) and (b) show the comparison of forehead trajectories in the x (horizontal) and z (vertical) directions, respectively. The maximum displacement of the marker on the PMHS forehead was 7m in the x direction, while in MADYMO, the displacement was 8.29m. In the Z direction, the MADYMO model dropped to the ground earlier than the PMHS and it bounced approximately 0.7m high after the ground contact. By comparison, the PMHS dropped on the ground with only slight bounce.

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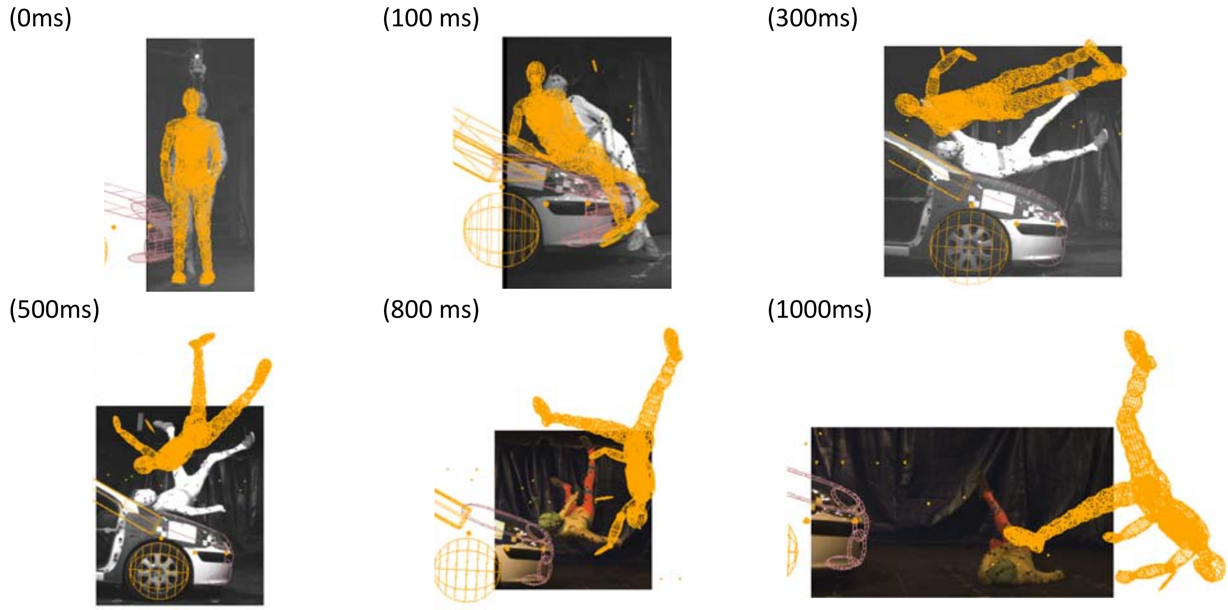

Fig. 2. Sequence of vehicle-pedestrian impact (PMHS test and MADYMO simulation).

(a) (b)

Fig. 3. Comparison of head positions in direction of X, Z between PMHS test and MADYMO output

IV. DISCUSSION

The comparison of impact sequences in Figure 2 shows there is still a kinematics difference between the PMHS and the MADYMO models. These differences are largest after head windshield contact and previous modelling has only focused up to head windshield contact [8]. The rebound from the windshield and the ground are clearly areas for improvement in the modelling. As Figure 3 (a) shows, the forehead trajectories were similar in the first 200 ms, after that, the difference increased between the two curves. As Figure 3 (b) shows, the head-windshield impact happened 25 ms earlier in the PMHS test than that in the MADYMO reconstruction. In terms of pedestrian-ground contact, the multi-body model bounced higher than the PMHS. The energy absorption in the contacts with the vehicle and the joint restraint characteristics in the pedestrian model are key to establishing realistic kinematics. Current work is aimed at optimising the vehicle contact modelling and assessing the repeatability of nominally similar PMHS tests and the relationship between bonnet leading edge height and pedestrian ground contact kinematics. Further DOE analysis could identify how to modify the parameter variations and explain the model kinematics.

V. REFERENCES

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