

Preliminary Biofidelity Evaluation of GHBMC Pedestrian in Full Scale Impact against Generic Vehicle Buck

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I. INTRODUCTION

Pedestrian human body models (HBMs) are increasingly applied in procedures of safety performance rating, e.g., in the evaluation of active bonnets for pedestrian protection. This application requires the validation of HBMs against experimental tests [1]. Whole-body impacts against a generic vehicle front end such as the SAE buck [2] can be considered state-of-the-art tests to be used for that purpose. Previously the Total Human Model for Safety (THUMS) AM50 Version 4 has been assessed with respect to its biofidelity in such impacts [3]. In the presented study, the Global Human Body Model Consortium (GHBM)-owned GHBM simplified pedestrian model was evaluated against the same experiments. The analysis focused on the validation of head contact times (HCTs) as they are currently the most relevant measurement to be taken in the rating procedure.

II. METHODS

The GHBM M50 PS v1.4 in LSDYNA was used in this study. The simulations were set up in order to replicate the conditions of the impacts of post-mortem human subject (PMHS) against the SAE buck published in [2]. The human body model (HBM) was scaled and positioned to match the anthropometry and posture of PMHS 2,371 from [2]. To accurately replicate pre-impact conditions from the experiments, the HBM was settled with gravity before the subsequent impact simulation in order to consider residual stresses. To account for the uncertainties arising from experimental side, different parameter studies were performed aiming to investigate the influence of positioning and gravity. Elbow-to-elbow distance and heel-to-heel distance were altered in transverse and sagittal direction, while the knee-to-knee distance was changed in lateral direction. Those distances were aimed for a change of $\pm 5\%$ and $\pm 10\%$ in the positioning. The instrumentation equipment weight of 7.4kg in the PMHS test was represented in one simulation separately. The influence of gravity was evaluated by omitting gravity settling and considering gravity, but neglecting developed stresses. For all simulations the HCT was determined.

III. INITIAL FINDINGS

The comparison of all HCTs is depicted in Figure 1.

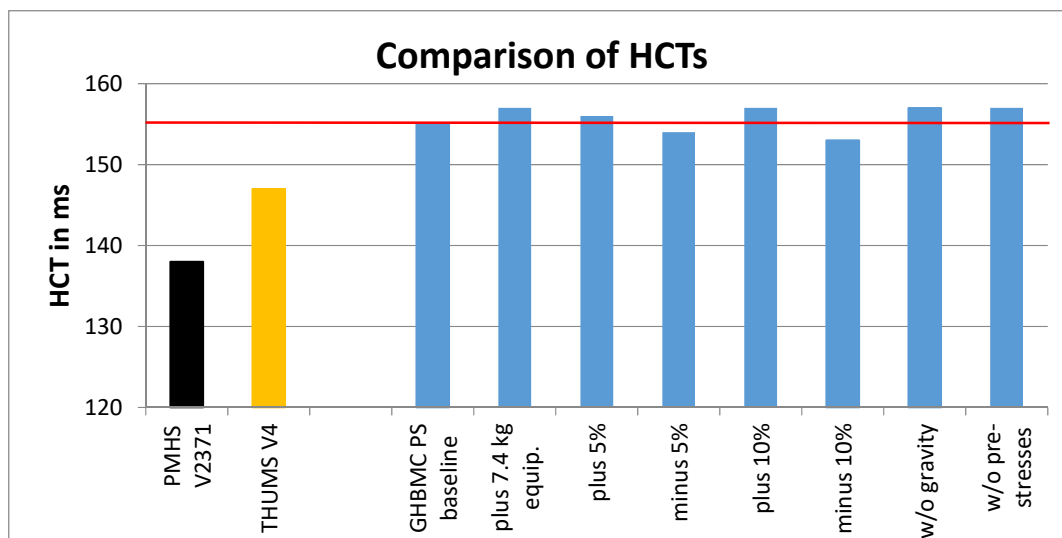


Figure 1 Comparison of HCTs: PMHS V2371 [2] in black, THUMS V4 [3] in yellow and GHBM PS in blue.

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Blue bars show the results of the parameter variation conducted within this study, the black bar the HCT of PMHS V2371 [2] and the yellow bar the HCT of THUMS V4 from [3]. The red line indicates the level of HCT of the baseline simulation with the GHBMCS PS model. The HCTs of the sensitivity study vary within +2ms to -2ms w.r.t. the baseline simulation. The baseline simulation with the GHBMCS PS model shows a HCT 8ms later than the according simulation with THUMS V4 by [3]. The delay of the HCT from this study w.r.t. PMHS 2371 is 17ms.

Figures 2 to 4 depict the position of the PMHS and the two HBMs at time $t=138\text{ms}$ (HCT for PMHS2371, prior HCT for the two HBMs). Both models exhibit a considerable lateral neck flexion compared to the PMHS at that stage. In addition the pelvis rotation differs between the two models with its orientation in the GHBMCS PS model being closer to the pelvis orientation in the PMHS.

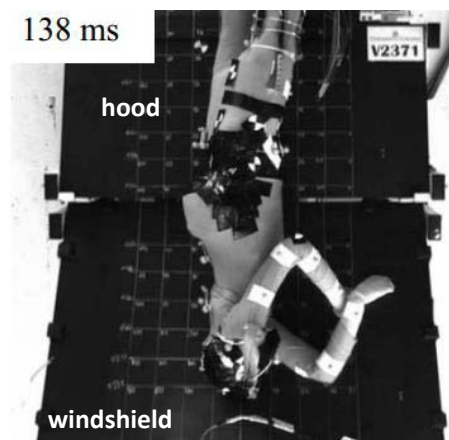


Fig. 2. Top view PMHS test [2]

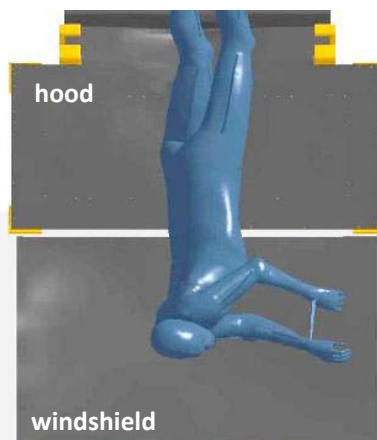


Figure 3 Top view THUMS V4 [3].

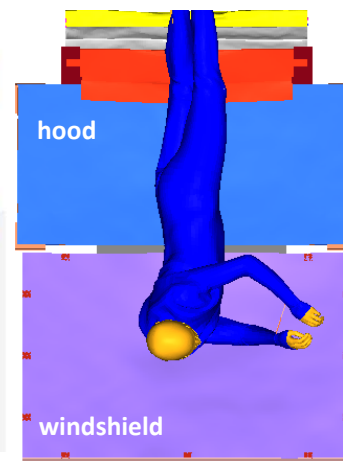


Figure 4 Top view GHBMCS PS.

IV. DISCUSSION

The present study seems to confirm earlier findings in [1] that gravity settling may be important to be monitored, yet not one of the most influential factors in full-scale pedestrian impact simulation. A similar conclusion may be drawn concerning the smaller positioning effects addressed in the presented study. Those parameters representing potential sources of uncertainty in HBM positioning following PMHS measurements, seem to be precisely enough captured within 5%.

The remarkable difference in head contact time between the two HBMs as well as the fact that both of them over-predict the HCTs, deserves more attention however. This highlights the need for precisely defined validation procedures and protocols. The issue of different amount of pelvis rotation of the two HBMs during the impact should be addressed in a closer comparison, as this is potentially relevant for all HBMs to be applied in this field.

V. REFERENCES

- [1] Klug C et al., IRCOB Conf Proc, 2017.
- [2] Forman J L et al., IRCOB Conf Proc, 2015.
- [3] Wu T et al., Traffic Injury Prevention, 2017.