Pedestrian safety – collision with personal car and van vehicle

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The proceeding deals with the passive safety of personal car and van vehicles with the respect to pedestrian collision. The experimental and mathematical methods are used. Based on the executed experiment, there are created some mathematical models in commercial software packages. The computer simulations run on the commercial software packages. There was performed a sensitivity analysis and biomechanical criteria of injuries were evaluated. The optimisation process is focused on the shape of the front part of the vehicle. Biomechanical assessment is included with respect to the traumatological evaluation of road accidents.

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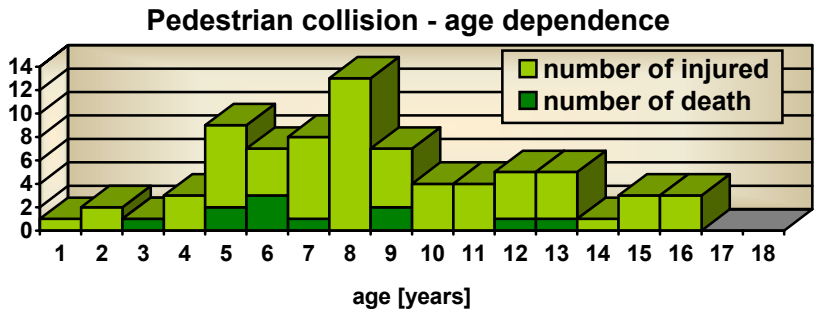
Introduction

The statistics of traffic accidents shows that problems of collisions of pedestrians with vehicles are very serious. The statistic data can be processed in many ways to try to find the reasons, which cause the most serious consequences. The real data taken from the local Trauma Centre from the years 1996-99 (total 85 hospitalised child pedestrians) show many relations. An example – Graph 1 – proves that beginning of school age is dangerous for child pedestrians as well the beginning of free/not attended movement. The analysis of the pedestrian crashes can be focused on children as pedestrians – and they seem to be most sensitive members of traffic.



Graph 1 – patients of trauma center

The design of real experiment and derivation of a mathematical model of a pedestrian collision with a vehicle and its use for the analysis of the collision is the goal of this paper. Generally, mathematical models can be used quite well within a certain data field, which is verified by a validation experiment. The execution of an experiment imitating a collision of a pedestrian with a car is very demanding, therefore we have used a vehicle of selected categories and used this validation experiment for simulations. The following theoretical analysis includes a sensitivity analysis of input parameters on the collision parameters. The monitored parameters include the shape of the front part and the size category of the pedestrian. A system MADYMO was the simulation tool in this case. In addition, the results verify a good compliance of simulations on different systems.

Description of the experiment

A collision of a dummy MANIKIN (producer: ÚSMD/DEKRA under a licence TNO – a dummy for testing of safety belts of cars) with a car at about 25km/h. The dummy is in the position with its face towards the colliding vehicle. The dummy includes two accelerometers, one in the cavity of the head and the other inside the chest, both are connected to an electronic recording equipment. The overview of the collisions with van vehicle (with vertical front part) and with personal car (and basic mathematical MADYMO model) are presented on fig. 1, 2.

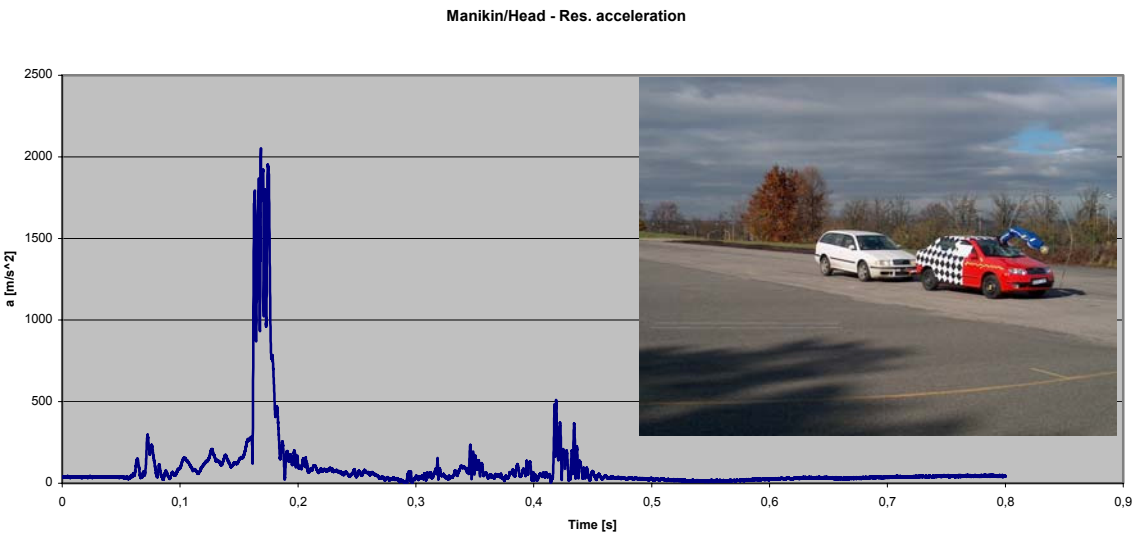


Fig. 1Experiment using a vehicle category M1

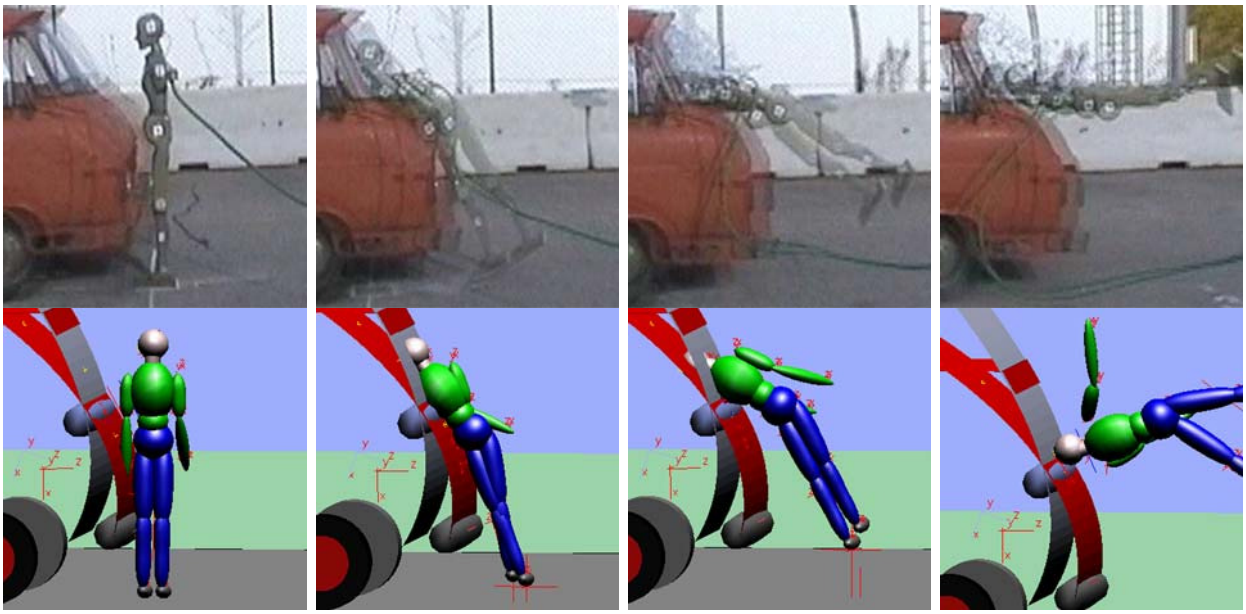


Fig. 2 Experiment using a vehicle category N1.

Conclusion

The similarity of the results of the PC simulation and the experiment prove the correctness of the use of the dummy for the PC simulation mathematical model compared with the one used for the experiment. The validated model – the adult pedestrian – shows the different kinematics of the movement depending on the vehicle front shape. Generally – the results are very sensitive on initial conditions. The strategy for simulation with derived models, i.e. child dummies, respected the validated vehicle data with the target to find the sensitive collision point, to describe the collision mechanisms and to simulate behaviour of a human body, i.e. to meet a requirement of a bio-fidelity. The results show the limits of passive technical measures and the solution of the problem should be found in the active and feed-back systems of intelligent vehicle.

References:

[1] Kovanda, J., Riva, R.: Vehicle-human interaction. Edizioni Spiegel, Milano, 1999
[2] Kovandová, H.: Passive safety of the vehicles and injuries in the special cases. PhD thesis of Czech Technical University, Praha, 2001
[3] Statistic year-book of Ministry of Interior, 1999-2002
[4] Zeman,J.: Research and activity reports of ÚSMD Dekra, Praha 2000-2003