Numerical Investigation of the Frontal Protection System for Pedestrian Safety Enhancement

Mariusz Ptak, Jacek Karlinski

I. INTRODUCTION

Frontal Protection Systems (FPS), also known as bull bars, have become a popular tuning accessory. The main motivation for installing a FPS on Sport Utilities Vehicles (SUV) is no longer the protection of the vehicle from damage during a collision. Nowadays, the metal welded tubing is thought to add some custom look to a vehicle's front-end. A number of studies have shown [1] that an improperly designed structure of a FPS can have a serious implication for pedestrian safety in a vehicle-to-pedestrian impact. However, the paper demonstrates that some commonly used modifications of FPS may decrease the injury parameters encompassed in the Regulation (EC) 78/2009 recorded from the legform impactor. Therefore, a FPS which can potentially clinch a pedestrian's leg during an accident can meet the type-approval requirements and be assessed as a pedestrian-safety device.

II. METHODS

The Finite Element (FE) calculations of FPS were conducted in the LS-DYNA explicit code. The FPS is fitted to the SUV through virtual constraints which mirror the physical FPS mountings. The strain-rate effect was included in the steel components, based on the Simplified Johnson-Cook model of material. The legform impactor test was conducted in accordance with (EC) 78/2009.

III. RESULTS

The virtual tests carried out by means of the numerical, certified FE lower leg showed that the "fork-type" FPS can significantly decelerate the impactor (Fig 1.). Thus, contradicting the general belief, it was proved that the FPS made of welded steel tubing might comply with the current type-approval requirements (Fig 2.).

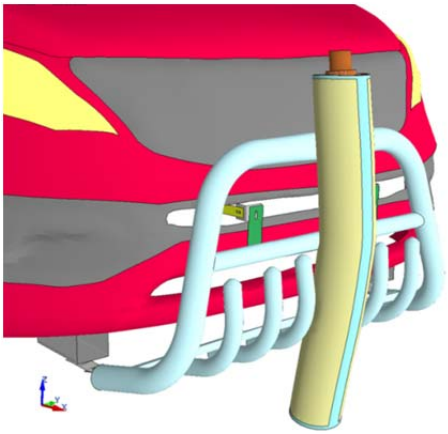

Fig. 1: FE model of vehicle equipped with FPS during legform impact test

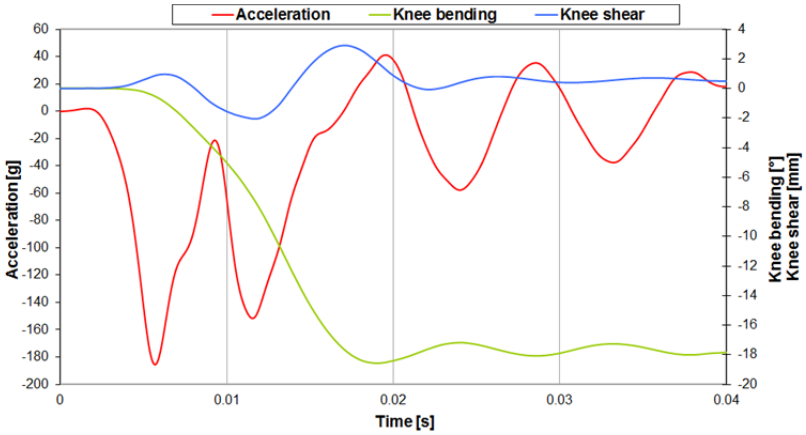

Fig. 2: Legform acceleration, knee bending, knee shear peak values are below (EC) 78/2009 type-approval thresholds

IV. DISCUSSION AND CONCLUSIONS

The research based on MADYMO coupled with LS-DYNA [2] indicated that some type-approved FPS, which complied with the applicable safety requirements, might actually be hazardous for pedestrians. The presented FPS is a good example of a structure which is relatively safe according to tests but can be dangerous in reality.

V. REFERENCES

[1] Anderson R. et al., CARS020, 2006.
[2] Ptak M et al., IRCOBI, 2012.

M. Ptak, PhD (tel: 0048 713202946; mariusz.ptak@pwr.wroc.pl) and J. Karlinski, PhD are both Research Scientists at Wroclaw University of Technology, Poland.