Influence of the Use of an Additional External Protective Structure on Decreasing the Deformation of the Floor Plate as a Result of the Detonation of an Explosive under a Vehicle

Marek Świerczewski[1 a)], Grzegorz Sławiński[1 b)], Piotr Malesa[1)]

[1]*Military University of Technology*
Department of Mechanics and Applied Computer Science
Gen. Witolda Urbanowicza Street 2, 00-908 Warsaw, Poland

[a)] marek.swierczewski@wat.edu.pl
[b)] grzegorz.slawinski@wat.edu.pl

Abstract. The article presents the effects of the shock wave on the model of a light wheeled armoured vehicle. The aim of tests was to check the influence of the use of an additional external protective structure on decreasing the deformation of the floor plate occurring as a result of the detonation of an explosive. The explosive has been detonated under the vehicle in accordance with the STANAG 4569 requirements [1,2]. In order to test the effectiveness of the proposed design solution, numerical calculations using the finite element method with the ALE formulation [3] have been conducted. Thanks to such an approach, it was possible to reflect the following processes: deformation, wave propagation, interaction with the structure and the response of the additionally used protective system.

INTRODUCTION

Current military conflicts in Europe (fights in Eastern Ukraine), in Africa (the war in Somalia) or in Asia (the conflict in Syria) show that heavy weapons such as tanks, howitzers and heavy artillery are being replaced by mobile weapons. Heavy armoured equipment is more and more often replaced by wheeled armoured vehicles which are characterised by high mobility and effectiveness on the battle field. Such a vehicle type is most often characterised by the modular design, thanks to which it is possible to quickly transform one vehicle variant into another one depending on the needs.

The fast increase of wheeled armoured vehicles which are used by different armies and their common use in day-to-day patrol actions during stabilisation missions result in the fact that they are exposed to the effects of the majority of enemy's fire means, including also anti-tank mines and, more and more often, improvised explosive devices (IED).

The aim of the paper was to test the influence of the use of an additional external protective structure on decreasing the deformation of the floor plate occurring as a result of the detonation of an explosive under a vehicle. The effects of the shock wave have been tested on a vehicle without and with a protective system.

TEST OBJECT

The increasing number of wheeled armoured vehicles in stabilisation missions and military conflicts was the reason for choosing this vehicle type to check the effectiveness of the use of an additional protective system. Due to the high cost of experimental test, the paper is limited to numerical calculations in which a simplified model of the light armoured vehicle, presented in Fig. 1a, has been used. In all analysed variants, the detonated explosive has been located towards the vehicle in accordance with Fig. 1b.

a) b)

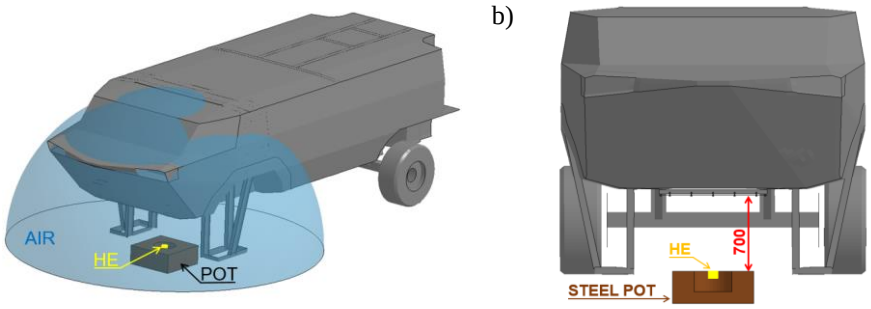

FIG. 1. a) The LAV model and the area imitating the space in the Euler domain, b) The location of the explosive towards the vehicle

RESULTS OF CALCULATIONS AND SUMMARY

In order to verify the correctness of the prepared numerical model, the validation of the model with the results of the experimental tests has been conducted. For that purpose, the results of the measurement of the floor plate acceleration have been compared and presented in Fig. 2.

The model prepared this way has rendered it possible at the next stages of tests to check the influence of the use of an additional external protective structure on decreasing the deformation of the floor plate occurring as a result of the detonation of the explosive with the mass from 0.5 to 6 kg under the vehicle Increasing the mass of the explosive has shown a significant difference between the referential system and the protective system – Fig. 3. The obtained results have confirmed the effectiveness of external protective systems in energy absorption and decreasing the deformation of the floor plate. [4].

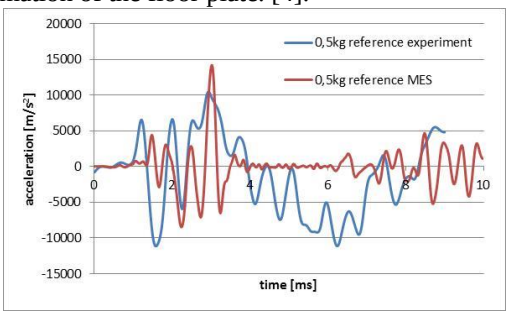

FIG. 2 The comparison of acceleration values on the floor plate registered for the explosive of 0.5 kg detonated under the vehicle

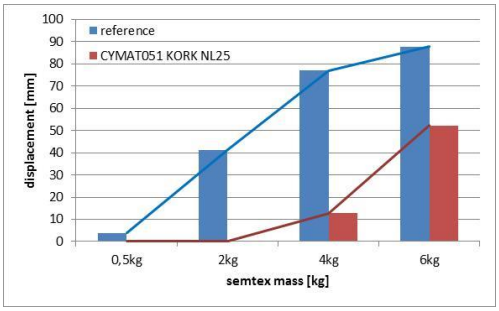

FIG. 3 The comparison of the displacement of the floor plate for the vehicle with and without the protective system

REFERENCES

1. AEP-55 Procedures for Evaluating the Protection Levels of Logistic and Light Armoured Vehicle Occupants for Grenade and Blast Mine Threats Level, NATO/PFP Unclassified, Vol. 2.
2. AEP-55, Procedures for Evaluating the Protection Levels of Logistic and Light Armoured Vehicles for KE and Artillery Threats, NATO/PFP Unclassified, Vol. 1.
3. Hallquist J.O.: LS-Dyna. Theory manual, California Livermore Software Technology Corporation, 2003.
4. Grzegorz Sławiński, Marek Świerczewski, Piotr Malesa, Risk assessment regarding the injuries of the lower limbs of the driver of a military vehicle in the case of an explosion under the vehicle. BIOMECHANICS 2018, AISC 831, pp. 1–15, 2019

ACKNOWLEDGMENTS

The research has been conducted within project No. DOBR-BIO4/022/13149/2013 ‘Improving the Safety and Protection of Soldiers on Missions Through Research and Development in Military Medical and Technical Areas’ supported and co-financed by NCR&D, Poland.