Testing the Influence of Additional Energy-Absorbing Panels on the Behaviour of a Military Vehicle Loaded with the Shock Wave

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Abstract. Tests regarding the influence of using additional external energy-absorbing panels on the effects of the shock wave on a military vehicle have been presented in the paper. Based on the results of numerical simulations, the energy absorption of the protective system has been determined by specifying the decrease of the vehicle's global kinetic energy, the energy of vehicle's construction elements in places of contact with a crew member and the internal energy of the used energy-absorbing elements. The influence of the size of the explosive detonated under the vehicle (without and with energy-absorbing panels) on the measured values has been tested in analyses. Such a solution should not significantly increase the vehicle's mass, providing at the same time the basic protection against improvised explosive devices (IED) at the level specified in accordance with the STANAG 4569 NATO standard.

INTRODUCTION

According to the statistics prepared on the basis of the analyses of attacks on wheeled armoured vehicles in Afghanistan, it has been shown that improvised explosive devices (IED) constitute now the biggest threat to soldiers inside vehicles performing their tasks during peace and stabilisation missions. It is very difficult to detect and identify such means of destruction due to the wide range of explosives used to prepare them, their diverse structures and the initiation method of used explosives. Those characteristics are especially important in terms of their effects on the construction of unarmoured or lightly armoured vehicles which were not intended for protection against the effects of IEDs at the stage of designing them. In order to be able to effectively protect the vehicle and the crew inside it, it is necessary to conduct comprehensive numerical and experimental tests of the effects of the shock wave on the vehicle and to develop systems using different mechanisms to increase the safety level of soldiers [1].

The current development of experimental techniques and numerical methods together with the accompanying increase of calculation possibilities of modern computers render it possible to model numerous physical phenomena, including the detonation of an explosive and the effects of the shock wave on the vehicle and its critical elements, i.e. the hull, suspension and the crew. This has a direct influence on the increase of passive protection [2] by searching for new design solutions, including additional external energy-absorbing panels.

MATERIAL AND METHODS

This paper includes the results of the numerical analyses regarding the effects of the shock wave on the model of a wheeled armoured vehicle, coming from the detonation of an explosive placed under the vehicle. For that purpose, the discretisation of the geometrical model has been conducted using the Hypermesh software. The LS-Dyna software has been used for numerical calculations. The loading with explosion has been carried out using the built-in Conwep

option. The initial conditions corresponding to the experimental tests, which have been conducted using the real model of the body of the vehicle with the mass of almost 7 tonnes, have been assumed in the numerical simulations. Factors such as the mass of the explosive and the vehicle with or without an energy-absorbing panel (the referential variant) have been taken into consideration during the numerical analyses. The numerical models of the tested variants have been presented in Fig. 1.

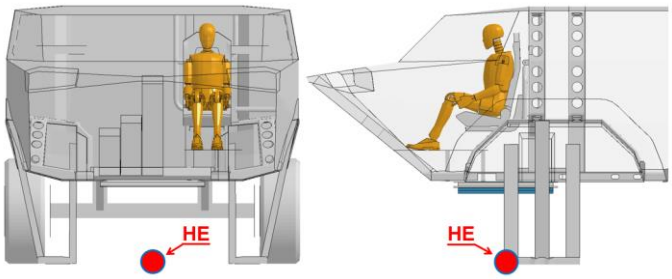

FIG. 1. The numerical model of the vehicle a) the referential system, b) the model with the energy-absorbing panel

RESULTS AND CONLUSIONS

The results obtained on the basis of the numerical simulations have rendered it possible to determine the influence of the use of energy-absorbing panels on the effects of the shock wave on the vehicle. It was possible to determine e.g. the decrease of the total kinetic energy of the vehicle caused by the effects of the wave of pressure as a result of using additional external protective systems (Fig. 2). In addition, the decreasing values of the kinetic energy of the elements having direct effects on soldiers inside the vehicle have been observed, which indicate the decreasing transfer of load coming from an explosion to the soldier. The observed decrease of the measured values is the evidence of a positive influence of the proposed systems on decreasing the risk of injuries in specific body parts. As a result of the numerical simulations, it was also possible to test the level of energy absorbed by the protective systems and thus it was possible to determine their energy absorption.

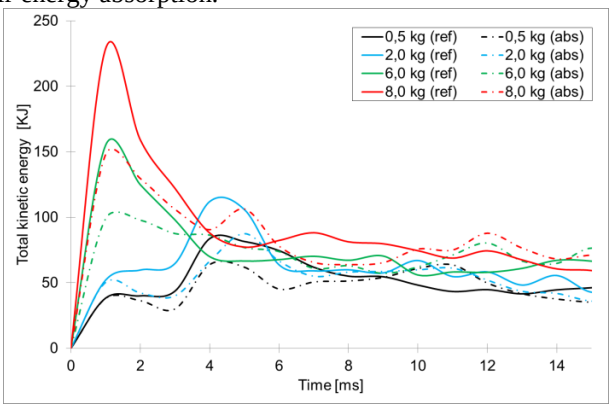

FIG. 2. Total kinetic energy of the vehicle caused by the effects of the wave of pressure

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