Investigation of Armoured Personnel Carrier Crew Subjected to Impact Load

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Abstract. The paper presents a safety problem of soldiers' in the line of duty in the missions regions. They are extensively exposed to the opponent's activities while the troop carriers in service more and more frequently do not provide sufficient protection of the crew. Therefore, the paper attempts to evaluate the effects of explosive materials on the safety of armoured personnel carrier (APC) crew. A four-axis APC was adopted for numerical tests. The basic assumptions adopted to build its model were given. The models of a driver's seat and a seat for landing troops were described. There were also given the coefficients for evaluation of an exposure level for combat vehicles occupants. For modelling, LS-DYNA software was applied. The paper contains the selected results of numerical tests of the effect of explosive charges placed on the side of the vehicle.

INTRODUCTION

Multi-axis special vehicles are intended to accomplish specified tasks not only during regular combat operations but also within peace-keeping or stabilisation missions. Despite their appellation, those operations are also carried out under a condition of constant threat. The main threats [1], [2], [3] resulting from this type of operations are fire means of different type, including anti-tank missile launchers and explosive charges resulting from a so-called land mine war, where the threats are mines or improvise explosive devices (IED).

The main objective of the work was to evaluate the effects of an explosive charge on the crew of the wheeled armoured personnel carrier for four masses of explosive charges (20, 40, 60 and 100 kg TNT) placed on the left side of the vehicle.

RESEARCH OBJECT

Simulation tests were carried out based on a model of a four-axis APC. In the tests, there was determined behaviour of the carrier structure and tests dummies during explosion of an explosive charge placed on the left side of the vehicle. Location of the charge in respect to the APC is shown in Fig. 1. The centre of the charge is between the second and the third wheel (at a distance of 850 mm from the axis of the second wheel) at the height of 1 m from the ground. A distance of charge from the side surface of the carrier was equal to 4 m. In order to determine loads interacting on crew members, a carrier model was completed with models of test dummies Hybrid III. A 50-centile model of a seated man, representing good mapping of a mean in population of men, was adopted to the tests. The applied model [7] was developed and verified by Livermore Software Technology Corporation – a producer of LS-DYNA software. The calculations were carried out in LS-DYNA system using a finite element method [9].

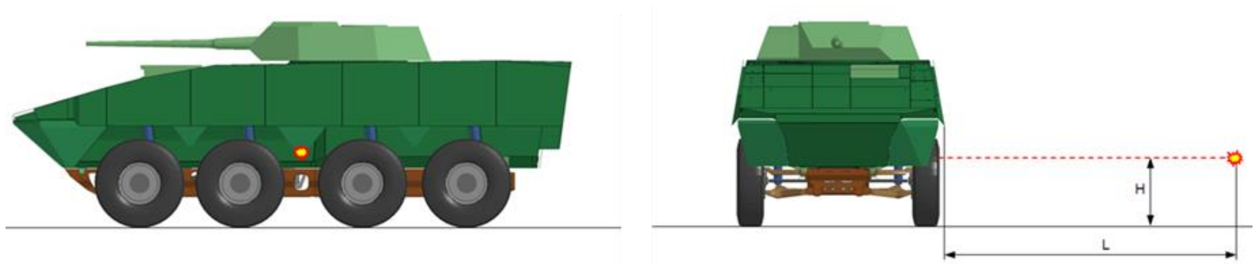

FIGURE 1. Location of the explosive charge in respect to the carrier body

CONCLUSION

Despite big masses of charges, pressures interacting on the structure elements of the APC were, however, lower than in the case of the charges placed directly under the carrier. For all variants of loads, there were not recorded more serious damages. For charges of 40, 60 and 100 kg TNT, detachment of more and more panels of the additional armour was observed. However, it did not cause damage of the armoured plates of the vehicle body.

Due to the position of the charge and place of pressure wave interaction, its main effects include angular displacement of the whole APC body in respect to longitudinal axis. Most of the energy was transmitted transferred onto the whole vehicle body causing its motion as a rigid body.

Due to the direction of load, in more adverse situation was the test dummy in the driving compartment was at a disadvantage, which results from the fact that a human organism is less resistant to the interacting accelerations. Another threat is smaller free space. Even relatively small movements of the dummy in the driving compartment can lead to the contact with the elements of the inside equipment.

Analysing the obtained results, it should be stated that a driver of the carrier is exposed to greater loads. It is proved by both values of head accelerations and forces interacting in the upper section of the spine as well as by forces in lower limbs. Taking into consideration the calculated HIC_{15} and DRIz coefficients defining a level of a direct threat of a head and a spine, it should be stated that the analysed sizes of charges do not pose a direct threat. It is additionally proved by the results of neck loads presented with the use of cumulated forces values. A test dummy in the crew compartment was subjected to smaller loads. For all variants of charges masses, a basic constraint was pushing the dummy back by a seat backrest. In certain circumstances, at the lack of headrest, such interaction could lead to serious neck injuries. However, for the analysed charges, there was observed smoothing of the load through stretching the canvas material covering the seat as well as plastic deformations of the seat itself.

ACKNOWLEDGMENTS

The study was supported by the Ministry of Science and Higher Education, Poland, as a part of a research project No. DOBR-BIO4/022/13149/2013, realized in the period 2013-2019. This support is gratefully acknowledged.

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