MODELLING OF THE PHENOMENON OF AN EXPLOSION UNDER THE INNER WHEEL ARCH OF THE LIGHT ARMOURED VEHICLE

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1. Introduction

Over many years of fights in Afghanistan, due to significant dominance of the forces of the North Atlantic Treaty Organisation (NATO), the partisan hit squads of that country have developed an effective and very cheap method of destroying the vehicles of the NATO forces, namely Improvised Explosive Devices (IED). The use of IEDs in fights against armies which are well-equipped with conventional weapons and armoured vehicles has been named an asymmetrical conflict. IEDs have become a main threat for military transports and patrols which keep stability in a given region. The level of dynamic loads results from the amount of an explosive detonated under a vehicle or within its area. Due to significant diversity of threats and different mass of explosives, the values of forces, moments and acceleration which may occur in the case of the detonation of normalised explosives are strictly defined for a given level of protection against mines in Annex B of the STANAG 4569 standardisation agreement and in Volume 2 of the AEP-55 test procedure entitled: “Procedures for evaluating the protection level of armoured vehicle” volume 2, “Mine threat”.

2. Materials and methods

This study concerns the tests of the effects of the shock wave on the vehicle’s construction loaded with the wave of pressure coming from the detonation of an explosive under the front inner wheel arch. Multi-variant numerical analyses have been conducted based on a validated model and on the basis of the results of experimental tests. The numerical model of the hull of the light armoured vehicle has been selected for numerical analyses and subjected to the effects of the shock wave coming from the detonation of TNT explosives of various mass. Numerical simulations have been conducted using the LS-Dyna calculation code. The detonation and loading with the shock wave have been conducted by using the built-in CONWEP option.

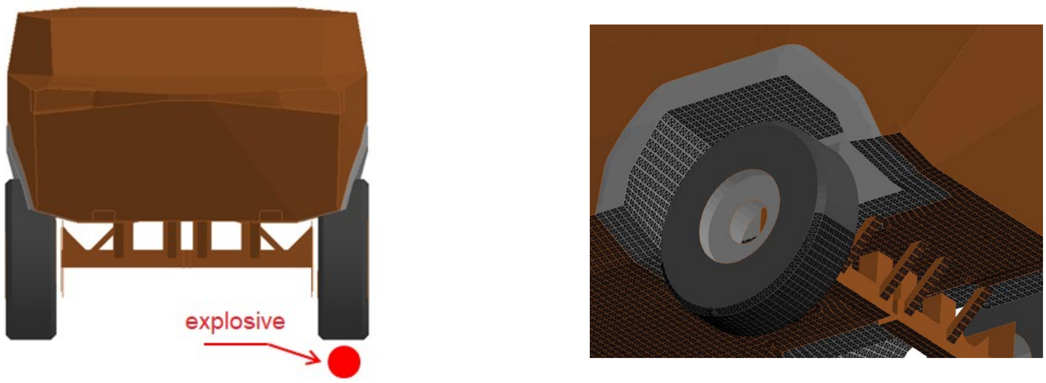

Fig. 1. The location of an explosive in relation to the vehicle (a) together with the place of loading the vehicle’s construction (b)

The aim of using the FEM numerical method was to render it possible to correctly test the effects of an explosion on the vehicle’s construction. The conducted numerical analyses have rendered it possible to learn about the consequences of those effects on the elements of the hull and also to select weak points in the construction.

3. Results

The results of the numerical calculations regarding the displacement of the inner wheel arch, measured using a comb, have been depicted in Table 1. The displacement of the inner wheel arch has been presented within a range. The distance of the comb's leaf which has been deformed constitutes the lower limit, whereas the distance of the leaf which has not been deformed as a result of the contact between the wheel and the comb constitutes the upper limit. The permanent deformations of combs have been depicted in Fig. 2.

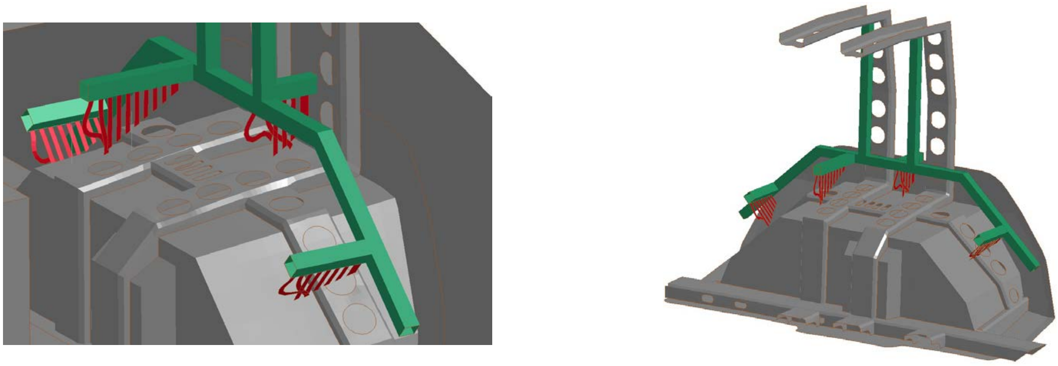

Fig. 2. The view of the deformed leaves of the combs

Left inner wheel arch, version A – numerical calculations				
Comb No.	L1	L2	L3	L4
Displacement within the range	20.7-37.69	19,55- 31.7	18.99-31.39	7.89-21.28

Table 1. The results of the total deformations of inner wheel arches obtained using the comb method – the results of the numerical calculations

3. Summary

The FEM model of the light armoured vehicle has been developed as a result of the conducted analyses and then, the model has been validated on the basis of the results of experimental test. Satisfactory consistency of the results of the numerical simulations and the experimental tests has been obtained. The stress-strain of the material in the vehicle's inner wheel arch has been assessed and the weak points of the vehicle's construction have been indicated. Those weak points should be modified or secured by additional protection systems, i.e. energy-absorbing panels.

As part of the conducted tests, also the impact of those additional energy-absorbing systems has been tested on the validated FEM model. The aim of the energy-absorbing panel was to decrease the acceleration affecting the vehicle and thus its occupants. The obtained results constitute the basis for further advanced numerical analyses.

6. References

[1] AEP-55, Vol. 1, Edn. 1, Procedures for Evaluating the Protection Levels of Logistic and Light Armoured Vehicles for KE and Artillery Threats, NATO/PFP Unclassified, 2005.

[2] AEP-55, Vol. 2, Edn. 1, Procedures for Evaluating the Protection Levels of Logistic and Light Armoured Vehicle Occupants for Grenade and Blast Mine Threats Level, NATO/PFP Unclassified, 2005.

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