PRELIMINARY INVESTIGATION OF DYNAMIC LOADS OF THE CREW OF THE ARMOURED PERSONNEL CARRIER DURING FRONTAL CRASH

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Abstract

On the work one described chosen problems concerning of threats of the crew of the armored personnel carrier with dynamic loads during crushing the obstacle. One paid attention on the lack of regulations regulative this problems. One described the general construction, and also worked out model of the armored personnel carrier and crashed object. To the modeling one used the software LS-DYNA, using the method of finite elements. One gave also conditions for carrying out the numeric research.

On the work one placed example results of numerical tests, deformations and stresses in the hull of the vehicle and in the crashed gate. One placed also example-courses of the speed and accelerations of chosen elements of the vehicle and people inside. On the basis on received results of simulation research one evidenced high level threats of the crews, liable to be effective with serious offences, particularly of the head and the spine. One qualified also directions and the range of further works targeting the improvement of the safety of the crew, in this taking into account the use of investigative dummy man. To further research one proposed models of dummy man Hybrid III, which for the necessity of taking in to consideration of additional elements of the equipment of soldiers (eg. the helmet, the weapon, the bullet-proof vest) must be however properly modified. One pointed also on the necessity of working out the additional protective devices and also formulate the methodology of the experimental research.

Keywords*: armored personnel carrier, impact, passive safety, computer simulation*

1. Introduction

The goals of Armed Forces are always under continuous transformations. Except carrying out of the classical activities during war-conflicts, more and more often are used they to the realization of police-preventive and of patrol-interventionist within the framework of stabilization and peacekeeping missions. Together with the change of the idea of the using of armies must parallel follow continuous change in exploited armament and the military equipment so, fulfill they assignments. To tasks these, included also in tactical-technical requirements for vehicles, one ought to number crushing of other such objects as enclosures, gateways, light fortifications (wire entanglements, barricades) and also the precipitation of other vehicles with road for the purpose of the obtainment of passing. During carrying out research [1, 2] one ascertained that a serious limitation of the possibility of crushing was not herself construction of the vehicle, but the threat of the crew, consequential with high-level of the loads by inertia forces during the impact into the obstacle. As contrasted with passenger cars in which the zone of controlled squashing absorbs the

important part of the energy of the impact [3], in military vehicles whose the construction base on the rigid frame or the self-bearing hull, there is lack of technical solutions, that lessen effects of the impact.

In the area of civilian cars are worked out regulations, regulative the resistance of the construction on head-on and side. collisions To them one can certainly number the Regulations 33, 94 and 95 ECGs UN which qualifies manners of carrying out tests, as well as underlie admittances of vehicles to road operations. For the fact that exempt military vehicles are from certification of approval research, mentioned above regulations do not find to them uses. The lack is simultaneously other settlements, because also the problems of the crash of the military vehicle into the obstacles and elaboration of the methodology of the estimations of the exposures of the crews on his results is noticed more and more often.

2. The object of research

A main element of the armored personnel carrier is the self-bearing hull. Is made he usually as the element welded from steel armor plates. On the hull are assembled all additional devices and elements. Shapes of lulls are in most cases similar to accepted under construction of tanks. The front plate of the armor is inclined under the large angle. Enlarges this the thickness of the plate on the horizontal direction of the flight of the bullet and diminishes the probability of the perforation. Side-plates of vehicles depending on their sizes are placed under different angles. Largely they are considerably inclined, though in some constructions are applied plates situated normally to the bottom of the vehicle. Reason for this is a necessity of the obtainment of the space for some systems, crews and the troops. In the upper armor plate are located mounting holes to the assembly of the turret, covers over motor and transmission sections as well as hatches over driver compartment and troops compartment. The hull is party of the driver, crew, troops as well as motor and transmission compartments.

To model investigations was accepted the vehicle modeled on the four-axial armored personnel carrier. The discrete model of the vehicle together with crushed gate is presented on Fig. 1.

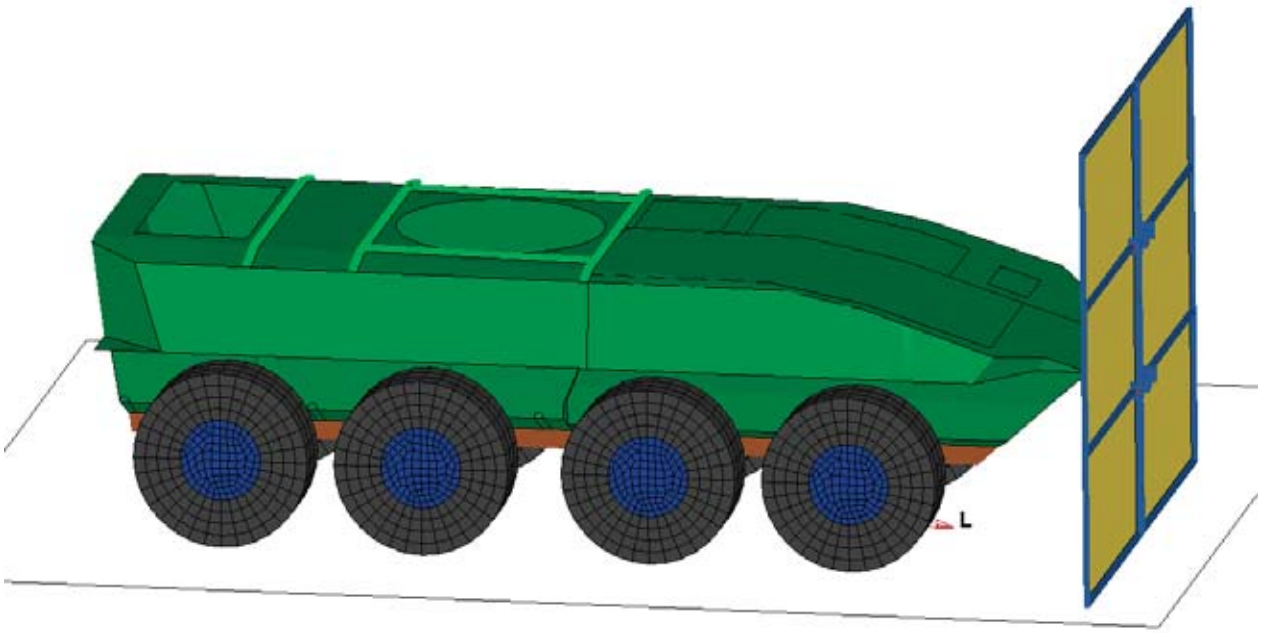

Fig. 1. Model of the vehicle

The model was built at the use of shell elements with four and three kinematic pairs. Main elements mapped equipments (drive unit, the turret, batteries, petrol tanks, etc.) became at the use of mass-elements. Additionally inside the vehicle one placed the mass copying the seat together

with the driver. It is fixed at the use of spring and damping elements to the hull of the vehicle. Made possible this the estimation of dynamic loads acting on the driver. In the case of the gate, one applied the model of material taking into account the possibility of his destruction after exceed of the established level of the deformation of the element. To the analysis one applied the software LS-DYNE, using the method of complete elements.

3. Results of numerical tests

An aim of the carried out research was qualitative and quantitative estimation of deformations and stresses in the hull of the vehicle and accelerations acting on men being found in his interior. Numeric research were realized for three cases:

a) crushing of the gate with the initial velocity 5 m/s,
b) crushing of the gate about the smaller endurance (performed from shaped bar about the smaller cross-section) with the initial velocity 5 m/s,
c) crushing of the gate (such as in the case „a") with the initial velocity 10 m/s.

On Fig. 2. was presented deformations and stresses in the construction in the moment of the break of bolts junctive of the wing of the gate, and on Fig. 3. stresses in the forepart of the hull of the vehicle received for the case „a").

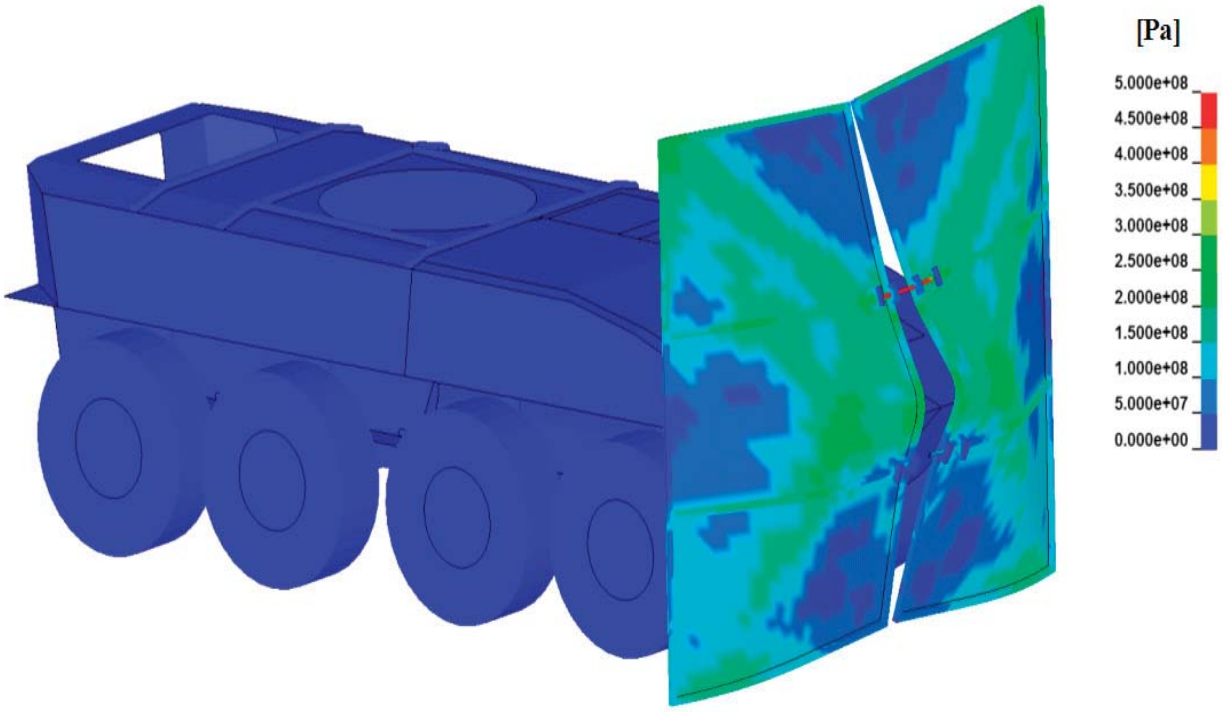

Fig. 2. Deformations and stress in the moment of the break of the gate

On Fig. 4. was presented deformations and stresses in the construction after overcoming of the gate.

On the basis of obtained results one can ascertain that in all analyzed variants, for the form and the thickness of plates, the impact of the vehicle into the gate does not cause more threatening results for the construction of the hull - do not follow in him permanent deformations. In all situations followed instead considerable deformations of the gate, the break of bolts junctive both wings and then their opening.

From the point of view of the purpose of the work, is a lot prior however the estimation of the exposure of impact loads of the crew being found inside the vehicle. On Fig. 5. was presented

courses of the toward movement velocity of the vehicle for three analyzed situations. In figure one placed both the speed of the vehicle and the speed of additional mass, appointed contractually as „the driver”.

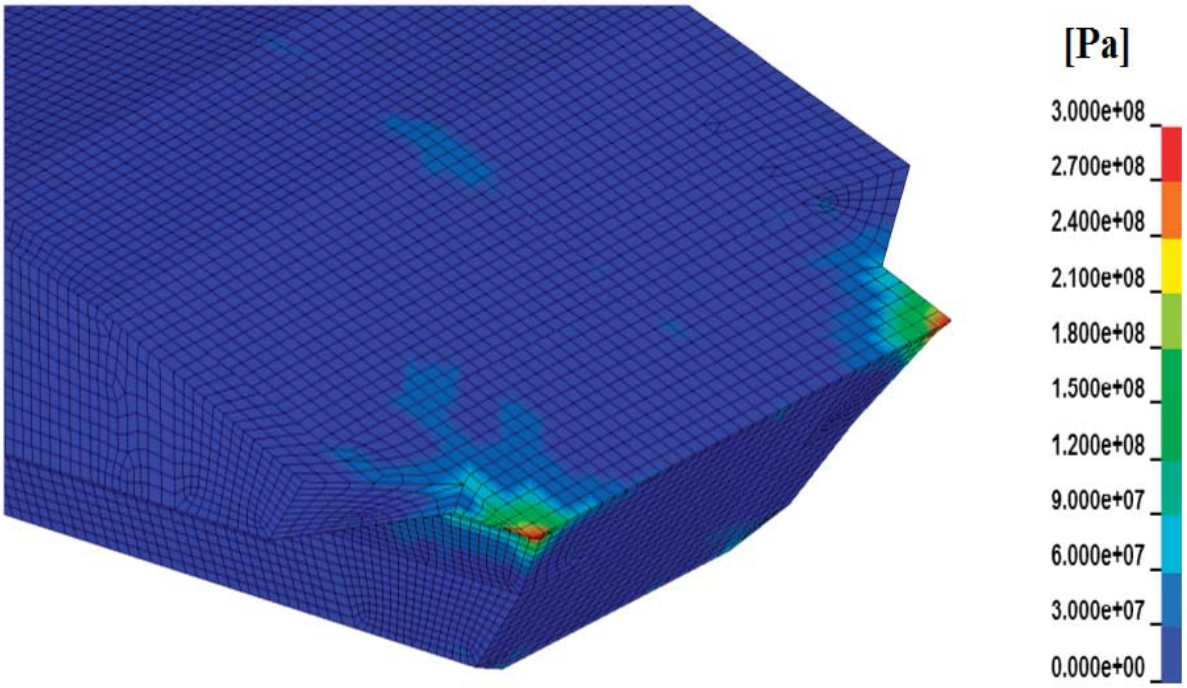

Fig. 3. Stresses in the forepart of the hull

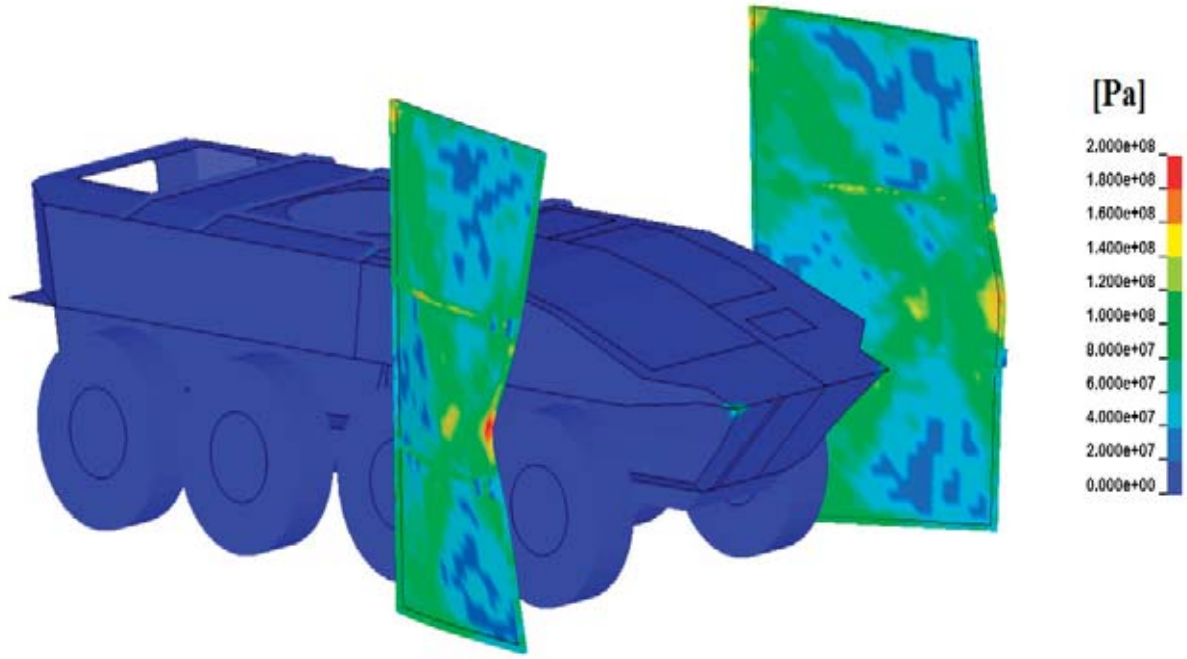

Fig. 4. Deformations and stress after overcoming of the gate

On Fig. 6. was presented „drivers” toward accelerations during crushing of the gate with the initial velocity 5 and 10 m/s. Enlarging of the speed self-evidently causes the enlargement of the

value of accelerations. Himself by they are characterized with the besides greater variability. Slowing-down can however cause the stop of the vehicle on the obstacle.

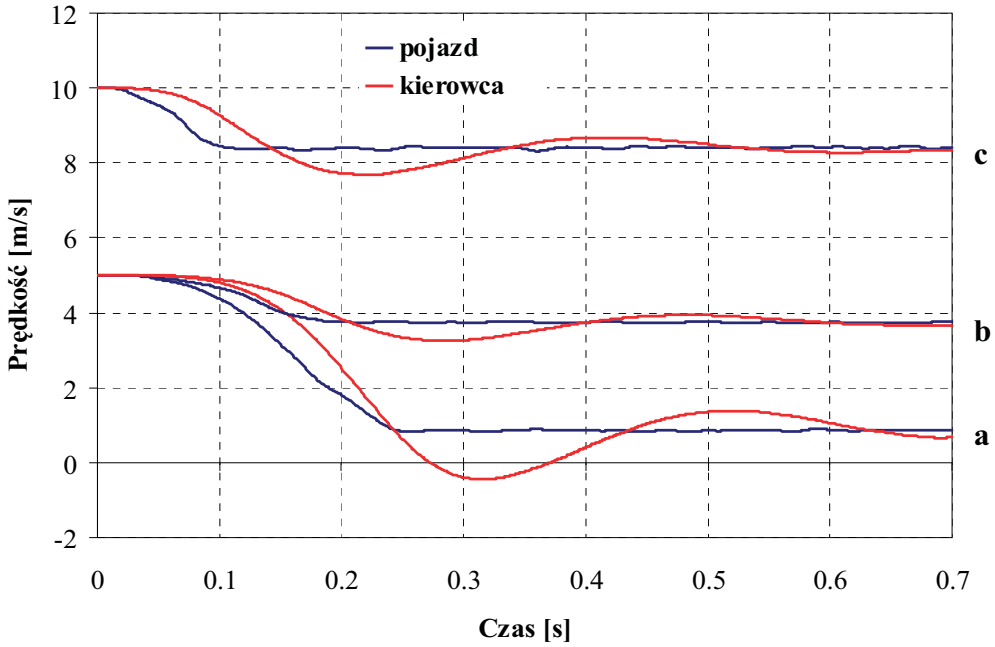

Fig. 5. Speed of the vehicle and the driver

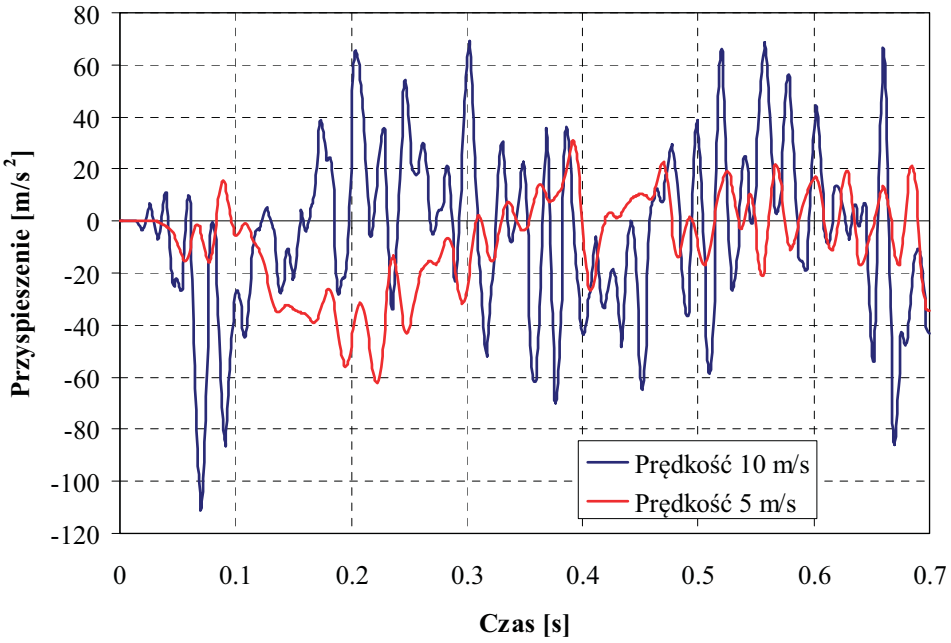

Fig. 6. Driver's acceleration during impact of the vehicle with velocity 5 and 10 m/s

4. Summary

On the work one presented results of preliminary researches of the resistance of the construction of the armored personnel carrier and its drivers on loads resulting crushing of the gate. Obtained results of numeric simulations univocally show that this kind of obstacles does not determine the greater threat for the construction of the hull. Stresses do not exceed the border of the plasticity, and the hull does not surrender to permanent deformations. A lot a sizable problem are loads of the crews. In spite elastic fastening of the seat of the driver and the partial mitigation of the impact, the acceleration depending on the initial velocity exceeds 6 - 11 g. Creates this serious threat of bodily injuries, and particularly of cervical circles. Advisable it would seem the

realization of this type of tasks with as least speed. Unfortunately, in some situations, can this make impossible the overcoming the obstacle.

One ought to make allowance for also the fact that except the driver and commanders of the vehicle, in the typical personnel carrier it is located about eight soldiers. Their seats, for the necessity of quick escape from the vehicle through rear door, are situated along side faces of the vehicle (Fig. 7a - the interior of the crew compartment of the armored personnel carrier Rosomak). Additionally, an often only element fastening are only pelvic (belts of three - or four-punctual troublesome in buttoning by the soldier carrying complete equipment) belts which in the situation of the frontal impact are not in a position effectively to protect people. From this also the reason to the analysis one ought to subject also loads acting on the crew.

a) b)

Fig. 7a) - Interior of the crew compartment of the armored personnel carrier, b) - Hybrid III dummy model

For the purpose of the definition of accelerations acting on men inside the vehicle, to further research one ought to apply models universally practical in collision tests , investigative dummies. On Fig. 7b is presented one of possibly to the use the discreet model of the dummy Hybrid III [4]. For the fact that in progress of performing fighting exercises, soldiers are provided with additional equipment characterizing themselves with the considerable mass (eg. the helmet, the bullet-proof vest, the weapon), requisite seems the introduction certain of modifications, consisting in to the adding of models for these additional elements.

Initial results testify also about the necessity of the working out and the usage in vehicles of additional technical devices, targeting the mitigation of the shock during impact into the obstacle. An important problem is also to work out the methodology of research from this area with reference to vehicles introduced on the equipment of the army and the police.

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