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CHOSEN DEVELOPMENT PROBLEMS OF WHEELED ARMOURED TRANSPORTERS

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Abstract

Modern wheeled armoured vehicles are constructed as multipurpose. Universal construction of vehicle is achieved in two separate ways: as specialized versions of vase model or by using exchangeable mission-modules. Realization of various tasks requires different equipment; ensure adequate level of protection and firepower. Increase of protection level, implementation of weapon systems, characterized by high firepower despite technological advancement in this field affect vehicles weight increase and therefore, it also affects requirements for other vehicle systems. Ensuring high mobility requires use of high power, turbocharged diesel engines, hydro mechanical transmission, hydro pneumatics suspension, possibility of clearance adjustment, use of central wheel pumping system enabling tire pressure change according to the surface on witch vehicle runs. This study gathers and compares characteristics of selected wheeled armoured personnel carriers and determines possible directions of development for future wheeled vehicles.

Keywords: *wheeled armoured transporter, construction development, tendencies*

1. Introduction

In recent years, significant interest increase in wheeled armoured vehicles is observed. Three directions are distinguished: increasing firepower, level of protection while minimizing vehicle weight. Common threats during foreign missions (e.g. Iraq, Afghanistan) shows necessity of improvement protection of vehicles in terms of anti-tank mine resistance (bottom plate), especially against improvised explosive devices – IED (bottom and side of vehicle) and anti-tank projectiles. Many projects were completed witch result was increased safety of armoured vehicles. Such result was obtained by installation of additional add-on armour and slat armour improving protection against missiles fired from light anti-tank rocket launchers. Example solution of slat armour for vehicle Piranha IIIC is shown on Fig. 1a (marked with „1“ symbol). Conception of add-on armour is shown on Fig. 1b (marked with „3“ symbol, vehicle basic armour is marked with „2“ symbol)

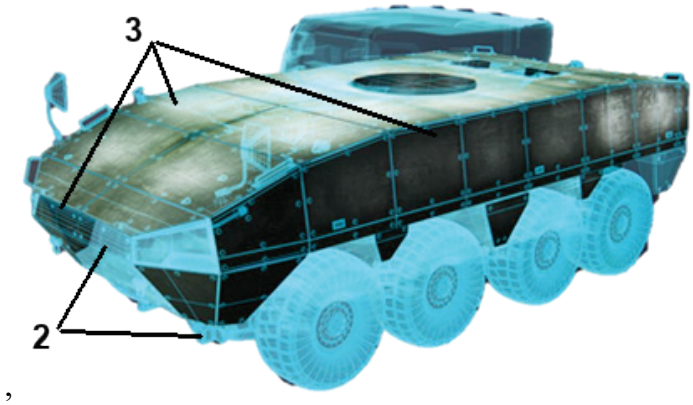
Main armament of wheeled armoured transporter carriers is cannons with loading automat with range of 20-40 mm calibre. Mostly used in such vehicles, like AMV Patria (Finland), BOXER (Germany), Bumerang (Russia) is 30 mm cannon. There also used machine guns, mostly 12.7 mm calibre, operated directly or remotely by designated operator.

Wheeled armoured transporters [4] nowadays can reach weight exceeding 36 t (e.g. BOXER vehicle). This is about four times weight increase compared to first wheeled armoured transporters entered into service after II World War (BTR-40, 4x4 drive system) and about three Times for vehicle with 8x8 drive system (BTR-152, Mowag Piranha I). When designing general construction layout, important criterion is crew and interior equipment safety increase. Such goal can be achieved by removing military system operators from the tower to the hull.

In order to obtain the highest possible level of protection for the crew and equipment, also installation of complex, large-calibre weapon systems, despite the use of advanced materials,

increases the weight of vehicle, affecting directly the operation of other vehicle systems. Over the years, about twice increase in the mass of wheeled armoured personnel carriers has been observed. Maintaining appropriate mobility of vehicles requires a significant increase in the power of the units driving them. For the vehicles under consideration, in the extreme case, this is about a threefold power boost to maintain the required maximum speed. Despite the development of advanced vehicle structures, the range of vehicles remains at a similar level. Tab. 1 consist basic vehicles characteristics.

a) slat armour [12]



,

b) add-on armour [13]

Fig. 1. Additional protection measures

Tab. 1. Wheeled APC mass and power [1, 5-11]

Wheeled APC	Production/ In service	Mass [t]	Engine power [kW]	Power to weight ratio [kW/t]	Speed [km/h]	Operational range [km]
OT-64 SKOT	1963	14.8	134	9.05	110	710
BTR 80	1984	13.6	194	14.26	90	600
AMV Patria	2004	24	400	17.77	100	750
Pandur II	2007	22	335	15.23	105	700
Piranha V	2010	30	430	14.3	100	1000

2. General characteristics of modern vehicles

General construction layout, equipment, and performance of wheeled armoured vehicles are determined by performed tasks, such as:

– infantry transport,
– first-line vehicles (direct support of tanks),
– second-line support vehicles (characterized by universal modular structure),
– as recognition, vehicles (equipped with special electronical and optoelectronic devices).

Universality of wheeled armoured personnel carriers, allowing implementation of various

customized versions is achieved by modular construction. There are two basic solutions according to modularity:

– base body construction, allowing for creation of multiple specialized versions,
– base body allowing for replacement of specialized modules.

In first case, at the design state, facilitating elements of construction that allows integration of various weapon systems are implemented, e.g. universal roof design allowing installing different dimensions weapon systems, characterized by greater weight and recoil force.

Optional use of an additional armour is also possible, according to planned mission profile and realized other tasks, such as medical evacuation vehicle, fire support vehicle. An example of this group is Advanced Modular Vehicle (AMV) Patria X360.

In second case, modularity is achieved in different way. Baseline body construction has in front part power unit and driver compartment – common to all variants. The rest of body is intended to install specialized exchangeable mission modules. Such approach allows for easy reconfiguration of vehicle role (fire support vehicle, command vehicle, medical evacuation vehicle), as result increasing universality of the vehicle structure. An example of this group vehicle is BOXER.

Figure 2 shows shapes of modern wheeled armoured personnel carriers. Characteristic feature is big similarity in terms of hull shape and interior organization.

a) APC Arma [17]

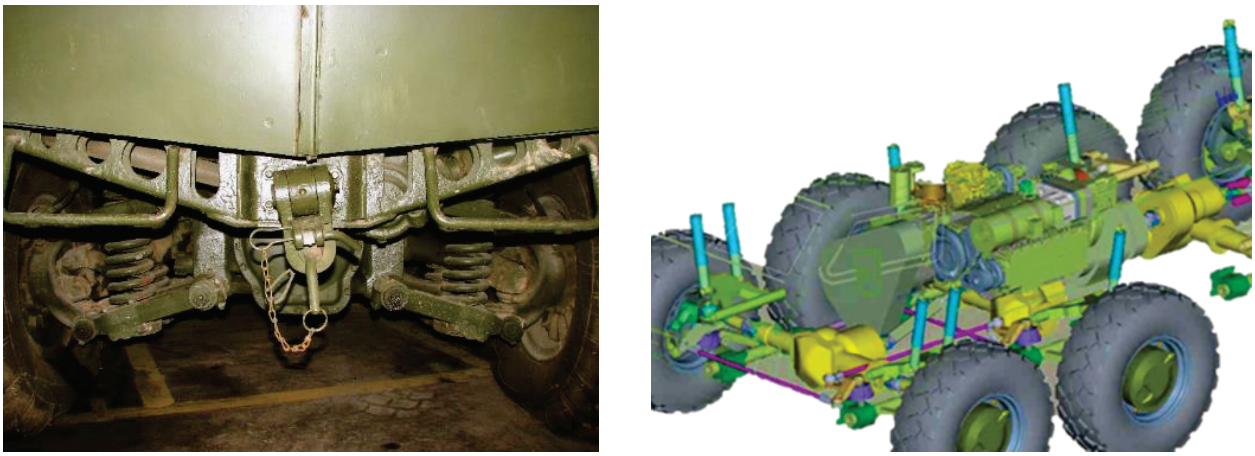
b) APC Boxer [18]

Fig. 2. Wheeled armoured personnel carrier: a) APC Arma, b) APC Boxer

The standard solution is general construction layout shown on Fig. 3. Power unit and driver compartment are located in the front of vehicle, respectively on right and left side. Middle and rear part is adapted for specialized versions, required by the profile of future tasks. In order to make repairs and maintenance easier power pack systems are used for drive system.

Fig. 3. Vehicle compartments: 1 – driver, 2- power unit, 3 – role-depended

Wheeled armoured personnel carriers, both on the battlefield and unconventional activities are expected to be multirole. In case of stabilization, mission (e.g. Iraq, Afghanistan) mobility is particularly important. It ensures minimum transportation time to conflict region or ability to conduct offensive actions and ensure certain protection level for both crew and interior equipment. Mobility is obtained through application of high power drive units with high torque, hydromechanical transmission, hydropneumatics suspension, central wheel pumping system allowing changing tire pressure according to the surface on witch vehicle runs. In order to improve vehicle manoeuvrability both for urban and field conditions, additional turn steering assist mechanism realized through braking of the wheels of one side of vehicle (left or right, depending on direction of turning, respectively left turn or right turn). Due to greater susceptibility to modifications, such as installation of additional armour, different weapon systems, most of multirole-wheeled vehicles have driveline system in the 8x8 configuration. Examples of suspension solutions are shown on Fig. 4a, for vehicle OT-64 SKOT, and on Fig. 4b for vehicle BTR-4 (Ukrainian development of Russian BTR-90 vehicle). Drivetrain parameters of selected wheeled vehicles in configuration 8x8 are shown in Tab. 2.



a)OT-64 SKOT [14] *b) BTR-4 [15]*

Fig. 4. Vehicle suspension

Future of military vehicles, according to [2. 3] is increasing firepower, combat effectiveness, as indicated by growing popularity of remote weapon stations (RWS), for both heavy machine guns and automatically loaded cannons, up to 40 mm calibre. A similar solution at designing weapon system proposes BAE Systems and NEXTER for French and British army – tower system with automatically loaded 40 mm cannon. This allows increasing safety of the crew (equipment operators). Development and implementation of security systems such as: detection of marking laser beam (remedy – firing smoke grenades), acoustic systems for the detection of place of origin firing (e.g. Raytheon BOOMERANG III, QinetiQ EARS) and providing solutions to automatized

shooting his position, application of active protection measures (Rafael TROPHY, Raytheon QUICK KILL) allowing to shoot down incoming RPG and armour-piercing missiles.

Tab. 2. Wheeled APC drivetrain [1, 5-11]

Wheeled APC	Transmission	Suspension	Clearance [m]	Steering system	Braking system
OT-64 SKOT	semi-automatic Wilson 5+1, detachable 1st and 4th axles	independent, double wishbone with coil springs and hydraulic shock-absorbers	0.46	1st axle	compressed air drum brake, dual-circuit
BTR 80	manual transmission with 5+1.	Torsion bar and hydraulic shock-absorbers	0.475	1st axle	hydraulic brake with pneumatic booster, dual circuit drum brakes
AMV Patria	ZF Ecomat 7HP902 automatic transmission with 7+1 gears	independent, hydropneumatics with optional height adjustment	height adjustable	1st and 2nd axle	Hydraulically operated disc
Pandur II	ZF ECOMAT 6HP602C, automatic 6+1 planetary gearbox with hydraulic converter and lock-up clutch	1st and 2nd axle: independent, upper longitudinal control arc, lower transverse control arm, coil springs and hollow rubber springs 3rd and 4th: independent torsion bars, hollow rubber springs	0.45	1st and 2nd axle	Hydraulic dual circuit brakes on each wheel
Piranha V	ZF-Ecomat automatic 7+1	semi-active, hydropneumatics suspension system, independent on all wheel stations with hydraulic shock absorbers	height adjustable	two front pairs of wheels and the rear wheels	Pneumatic double-circuit brake system with 6-channel ABS (Anti-lock Brake System)

3. Summary

In presented analysis, representative wheeled armoured personnel carriers were considered from a dozen armaments available on the market. Their common feature is shaping general construction layout to allow realization of different missions requiring change or modernization of standard equipment, depending on current situation.

Creation or modification process is usually preceded by numerical (model) research. One of problems to assess is impact load caused by weapon systems acting on vehicle during firing tasks. Fig. 5a shows M1128 Stryker with threaded cannon during sideways shot. Fig. 5b shows excerpt from numerical research conducted by authors of this article. The research object is advanced modular vehicle loaded with recoil force from large calibre cannon.

a) CV Stryker [16] *b) numerical research – CV AMV*

Fig. 5. Vehicles during shooting

Numerical research allows evaluating behaviour of vehicle structure in various applications, to indicate sensitive construction nodes, to determine impact on vehicle stability for different cannon elevation angle, shooting from hill using heavier weapon system with higher recoil force compared to typical vehicle weaponry. Authors of the publication are in process of numerical investigation of advanced modular vehicle capability to install large-calibre cannon. However, even best model research result requires verification with field tests.

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