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SUBSTANTIATION OF GENERAL ACCOUNTING SPECIALIZED ARMORED WHEEL VEHICLE FOR UNITS OF THE NATIONAL GUARD OF UKRAINE ON PUBLIC ORDER PROTECTION

It is noted that recently the use of armored wheeled vehicles by units of the National Guard of Ukraine in the course of performing assigned tasks has been significantly increasing. However, performing specific tasks related to the protection of public order requires special automotive equipment, which will be used for clearing blockages and barricades during mass riots, for crowd control, isolation of an area in case of emergency situations, etc. Known armored wheeled vehicles do not fully satisfy all the needs of the units of the National Guard of Ukraine.

The article substantiates the tactical requirements for a specialized armored wheeled vehicle for the units of the National Guard of Ukraine for the protection of public order. A variant of the layout of a four-axle armored wheeled vehicle with two rotary platforms that meets these requirements is proposed. A full-scale model of the specified wheeled vehicle is presented.

Keywords: *public order protection, armored wheeled vehicle, layout, rotary platform, requirements.*

Statement of the problem. The experience of war in the country since the beginning of 2022 convinces that the need for units, units and formations of the National Guard of Ukraine (NGU) and other law enforcement agencies in armored wheeled vehicles (AWVs), which are used when performing assigned tasks, is significantly increasing. They are used for border patrol, law enforcement, peacekeeping operations, demining, direct combat operations and evacuation of the wounded, etc. [1, 2].

In addition, according to [3], the service and combat (combat) activities of the NGU consist of preventive, security, regime, protective, isolation and restrictive measures and special actions carried out under normal circumstances, under extraordinary circumstances of peacetime and in wartime. Therefore, there is an increasing need to use special automotive equipment in law enforcement activities to clear blockages and barricades during mass riots, to restrain crowds by using water cannons and controlled hydraulic obstacles and fences in case of a threat to public safety, to isolate an area or area in case of emergency situations, etc. The use of known BKM in full does not satisfy all the needs of the NGU units.

Therefore, substantiating tactical requirements and developing a general accounting of a specialized armored wheeled vehicle for NGU units for public order protection is an urgent scientific and practical task in the military sphere.

Analysis of recent research and publications. An armored wheeled vehicle provides a wide range of tasks and is used in various military and law enforcement operations. Its feature is significant armor, which can protect the crew from automatic weapons and after the equipment is detonated, but this negatively affects maneuverability and stability against overturning. Therefore, the issues of creating and modernizing the BKM have been given attention in a number of scientific works.

The issue of the main trends in the development of weapons and military equipment, including BKM, common to all types of armed forces and implemented at the global level, is considered in the article [4].

The paper [5] presents the theoretical foundations and scientific provisions for the development of optimization models and mechanisms for effective search for a rational variant of specialized BKM by solving a system of equations containing indicators of combat, economic and operational efficiency, with the determination of production costs and the term of development of equipment. Unfortunately, insufficient attention has been paid to the development of requirements for specialized BKM for NGU units for the protection of public order.

The authors of the work [6] present the model range of BKMs that are put into service with the Armed Forces of Ukraine by PJSC "AvtoKrAZ", and their operational and technical characteristics. However, in this range there is no clearly defined promising family of BKMs that would fully meet the requirements and needs of the NGU, especially units that perform tasks in urban conditions.

In article [7], a maximally unified family of BKM based on an automobile platform with a single aggregate base is proposed, which will consist of three types of vehicles created on the basis of two-, three- and four-axle chassis, in order to further fulfill the tasks assigned to the Armed Forces of Ukraine.

The prospects for creating a line of domestic BKM for the NGU are considered in the publication [8]. And in the works [9, 10], indicators of the effectiveness of use and combat survivability of BKM during patrolling of populated areas are proposed. These indicators can be used to form requirements for the technical characteristics of BKM at the stages of their development and modernization, as well as for evaluating known BKM.

Therefore, the analysis of literary sources revealed that the problem of creating a specialized BKM for the NGU units for the protection of public order requires further research.

The purpose of the article is to develop tactical requirements for the general accounting of a specialized armored wheeled vehicle for units of the National Guard of Ukraine for the protection of public order and a possible variant of its layout.

To achieve the goal, it is necessary to solve the following tasks:

– to substantiate tactical requirements for specialized BKM for NGU units for public order protection;

– to propose a layout option for a four-axis BKM with two rotary platforms.

Summary of the main material. During special operations by NGU units to suppress mass riots, in particular in the city, BKM perform the following functions [8, 9, 10].

1. Dismantling obstacles and barricades created by offenders. The main attention is paid to such properties of the BKM as increased maneuverability in order to take a position to counter offenders and equipping with special engineering means.

2. Blocking roads and streets to isolate the area of mass unrest. During these actions, the maneuverability and stability of the BKM in the conditions of city streets, which are usually also contaminated with debris from the actions of offenders, also come to the fore.

3. Dividing the crowd into small groups using water cannons, using devices with annoying sounds, and other means.

4. Firefighting, evacuation of injured and wounded from the scene. As in previous cases, there is a need to increase the protection of the BKM from the actions of offenders, as well as increase the technical capabilities for maneuvering in confined spaces.

5. Transportation of personnel and personal protective equipment. BKM must have the technical capabilities to move through streets contaminated with debris from the actions of offenders and the territory of the city or area with destroyed infrastructure in order to maneuver in a timely manner to perform service and combat missions.

6. Use as command and staff vehicles and for communication. In the event of intensive changes in the operational situation, these BKMs must be able to maneuver in the shortest possible time in a city or area, regardless of road conditions or man-made factors.

In essence, the BKM must be protected from the use of weapons and explosive devices. In addition, despite the increase in mass, the BKM must be resistant to overturning and lateral skidding, have overall dimensions of the rolling stock, which make it possible to easily fit into the road dimensions and maneuver in urban and confined spaces, as well as meet the basic overall parameters of cross-country ability. Namely, the ground clearance, the angles of the front and rear overhangs, the longitudinal and transverse radii of the bridge passage, the external and internal turning radii, the turning width of the corridor, the angles of flexibility in the vertical and horizontal planes must be sufficient. To overcome natural obstacles, the sub-spring system must have adjustable clearance, and the transmission of the

special BKM must be designed with the requirements of an off-road vehicle.

One of the ways to solve the above-mentioned problems when creating special equipment for public order protection units is to use two rotary platforms for a four-axis BKM. Considering the results obtained in [11, 12, 13], the authors of this article proposed a variant of the layout of a four-axis BKM with two rotary platforms. The layout of the proposed BKM was carried out using the SolidWorks 2016 software package.

High maneuverability of the four-axle BKM chassis is achieved through the use of independent swivel platforms with individual traction control on each wheel.

The external 3D view of the rotary platform proposed in this study is shown in Figure 1.

The turntable (Figure 1) has a frame structure, which is equipped with an individual torsion suspension for each wheel, two modules of a stepped electromechanical transmission, which are connected to four-wheel reducers. To ensure the temperature regime of the electric transmission, liquid cooling radiators are provided. The turntable drive rotates the turntable relative to the body.

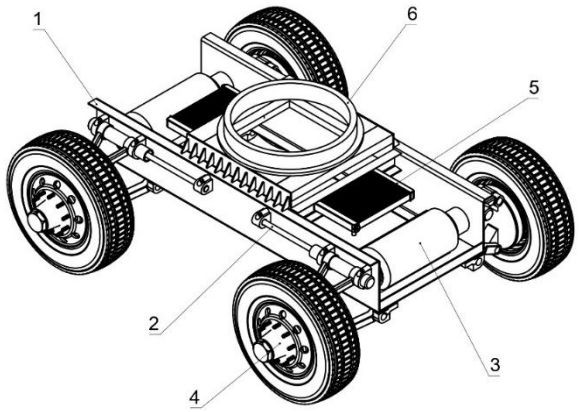
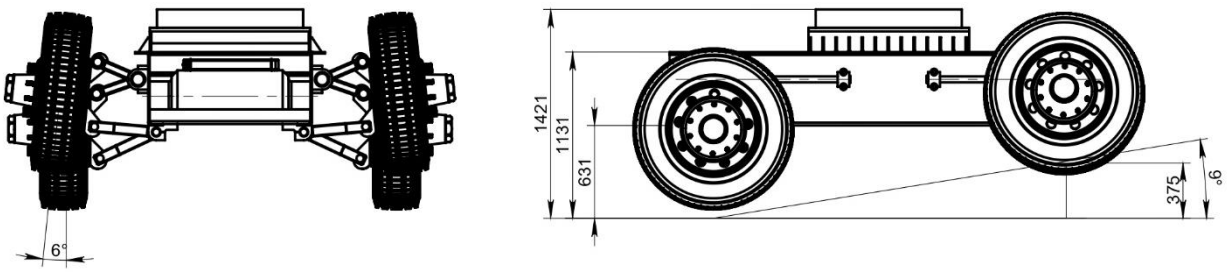


Figure 1 – External 3D view of the turntable: 1 – frame; 2 – torsion bar; 3 – step electromechanical transmission module; 4 – wheel with wheel reducer; 5 – radiator; 6 – turntable shoulder strap

The rotary platform is equipped with an independent torsion suspension with a torsion angle under load of up to 6 degrees (Figure 2 *a*), which provides a working stroke of the suspension in the range of up to 375 mm relative to the horizon (Figure 2 *b*). This significantly increases the maneuverability and cross-country ability of the four-axle BKM.



a *b*

Figure 2 – Possibility of changing the position of the wheels of the turntable

The characteristics of the rotary platform are given in Table 1.

The layout of the rotary platforms on the body of the four-axis BKM is shown in Figure 3.

Table 1 – General characteristics of the turntable

Characteristic	Value
Weight of the turntable, kg	2244
Wheel diameter, mm	1100
Wheelbase, mm	2450
Length of the rotary platform, mm	3000
Height of the rotary platform with shoulder strap, mm	1436
Width of the turntable, mm	1120
Width of the turntable with suspension, mm	1800
Ground clearance, mm	596
Torsion angle under load, degrees	0…6
Suspension travel, mm	0…375

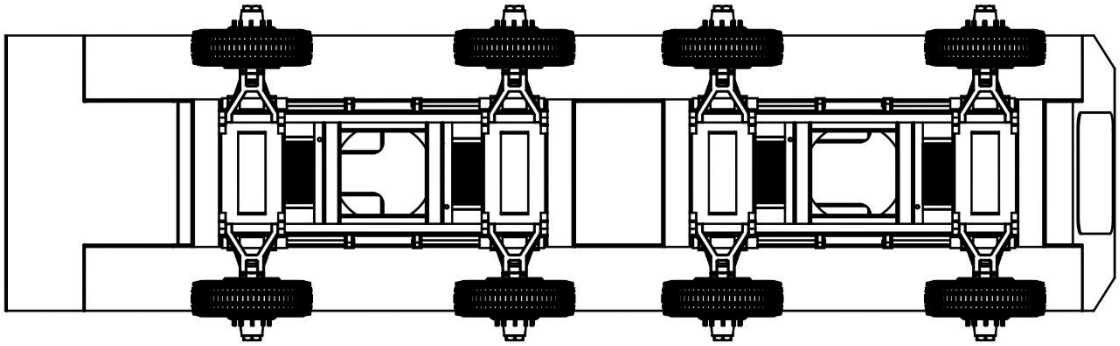


Figure 3 – Bottom view of a four-axle armored wheeled vehicle

The chassis shown is a serial hybrid in type. A 550-kW diesel engine is used as a power plant, which drives a traction generator. The chemical energy storage is a LiFePO4 high-voltage battery, which provides silent movement, chassis movement with an operational range of up to 50 km, as well as the accumulation of regenerative energy. The power distribution between the platforms is defined at 50:50, but can dynamically vary in the range of 10…90 in order to provide the necessary turning moments on the turning platforms.

Each traction electric motor is equipped with a high-voltage two-way inverter with microprocessor control. The EM61 engine with a rated power of 80 kW in the frequency range up to 12,000 rpm was chosen as the prototype of the electric motor. The electric motor drives a two-stage planetary transmission.

The transmission ratios are set at 25 and 5 for the first and second gears, respectively. The first gear is designed to overcome difficult road sections, gradient angles of 30°, as well as for dynamic acceleration. The second gear is designed for basic movement, which provides a maximum speed of movement on the highway of up to 110 km/h. The transmission has a modular design for each wheel. In order to minimize the dimensions and reduce the number of installed elements, the modules of the left and right wheels with electric motors are connected by a common housing.

The 3D model of the four-axis BKM is shown in Figure 4.The general characteristics of the four-axis BKM are given in Table 2.

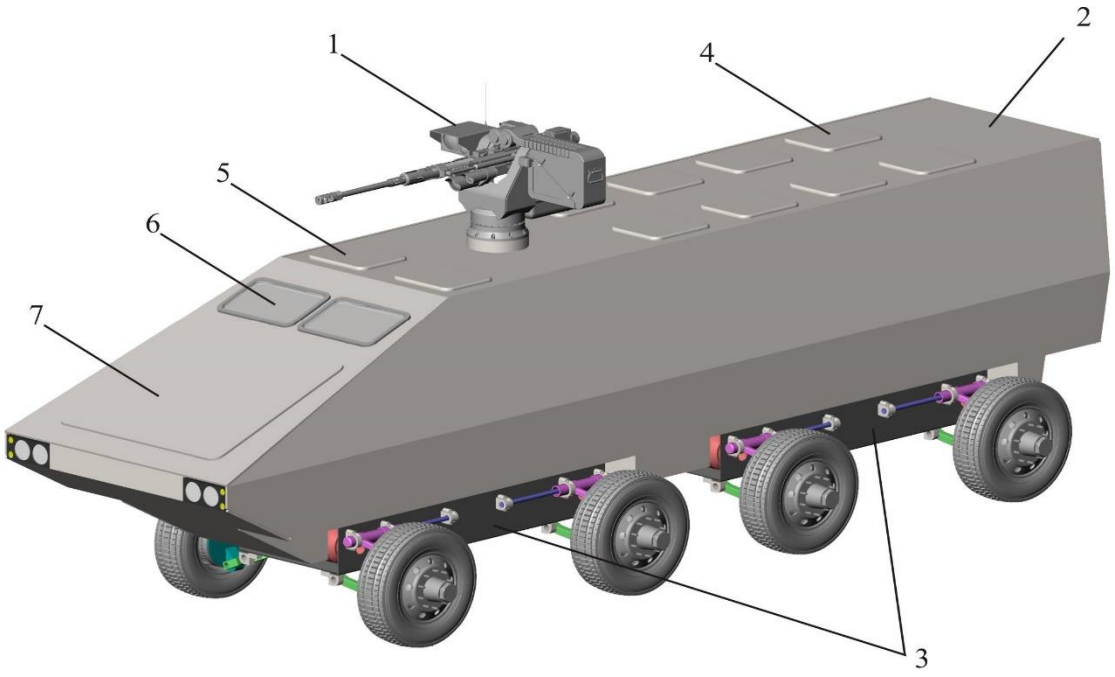


Figure 4 – External 3D view of the four-axis BKM: 1 – combat module; 2 – armored hull; 3 – electromechanical all-wheel drive rotary platform with torsion independent suspension; 4 – rear hatches; 5 – front hatches; 6 – armored windows; 7 – engine compartment hatch

Table 2 – General characteristics of the four-axis BKM

Characteristic	Value
Wheeled vehicle weight, kg	up to 25,000
Wheeled machine length, mm	10 125
Wheeled machine height, mm: – without combat module – with combat module	 3020 4379
Wheeled machine width, mm: – by body – on wheels	 2500 2564
Wheelbase of the machine, mm	6700
Distance between turntables, mm	1900
Front overhang angle, degrees	30
Ground clearance over the body, mm	800

At speeds above 30 km/h, the rear turntable is locked from moving around its axis to block oversteer. At speeds up to 30 km/h, the chassis control system provides lateral movement, crabbing and turning around the chassis axis by rotating the turntables in the event of individual adjustment of the traction forces on the wheels.

In order to ensure sufficient dynamic factor to overcome difficult road sections with a slope of up to 30º, as well as to ensure a maximum speed of at least 100 km/h, the installation of planetary two-stage gearboxes is envisaged.

The central part in ensuring the specified high maneuverability indicators is the modular design of the electromechanical transmission. The

transmission module contains two separate electric motors connected to two planetary step gearboxes. The transmission module provides for a structural design in the dimensions of the driving axle with a chassis with an 8x8 wheel formula.

The above-mentioned layout option for a four-axis BKM is implemented in practice in the form of a full-scale model, which is shown in Figure 5.

a

b

Figure 5 – Full-scale model of a four-axle armored wheeled vehicle with two rotary platforms: *a* – general view of the BKM model; *b* – view of the rotary platform

So, the article proposes a variant of the general layout of a four-axle armored wheeled vehicle, which has increased maneuverability and cross-country ability.

Conclusions

1. Analysis of the service and combat (combat) activities of the National Guard of Ukraine revealed the need to use special armored wheeled vehicles in law enforcement activities, which have increased characteristics of armor protection, maneuverability and cross-country ability. Known armored wheeled vehicles do not fully satisfy all the needs of the units of the National Guard of Ukraine.

2. The article shows that high maneuverability of a four-axle armored wheeled vehicle can be achieved through the use of independent rotary platforms with individual control of the traction force on each wheel. A variant of the layout of a four-axle armored wheeled vehicle with two rotary platforms is proposed and general technical characteristics are given. The layout of the armored wheeled vehicle was carried out using the SolidWorks 2016 software package. This variant of the layout of a four-axle armored wheeled vehicle is implemented in practice in the form of a full-scale model.

The direction of further research is to conduct experimental studies to establish the maneuverability and cross-country ability of an armored wheeled vehicle with two rotating platforms.

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ОБҐРУНТУВАННЯ ЗАГАЛЬНОГО ОБЛІКУ СПЕЦІАЛІЗОВАНОЇ БРОНЬОВАНОЇ КОЛІСНОЇ МАШИНИ ДЛЯ ПІДРОЗДІЛІВ НАЦІОНАЛЬНОЇ ГВАРДІЇ УКРАЇНИ З ОХОРОНИ ГРОМАДСЬКОГО ПОРЯДКУ

Зазначено, що останнім часом використання броньованих колісних машин підрозділами Національної гвардії України у ході виконання завдань за призначенням значно зростає. Проте

виконання специфічних завдань, пов'язаних з охороною громадського порядку, потребує спеціальної автомобільної техніки, яка використовуватиметься для розгородження завалів і барикад під час масових заворушень, для стримування натовпу, ізоляції району або місцевості у разі виникнення надзвичайної ситуації та ін. Відомі броньовані колісні машини у повному обсязі не задовольняють усі потреби підрозділів Національної гвардії України.

У статті обґрунтовано тактичні вимоги щодо спеціалізованої броньованої колісної машини для підрозділів Національної гвардії України з охорони громадського порядку. По суті, броньована колісна машина має бути захищена від застосування зброї і вибухових пристроїв. Крім того, незважаючи на збільшення маси, броньована колісна машина повинна бути стійкою від перекидання і бокового заносу, мати габаритні параметри розмірів пересувного состава, що дають можливість легко вписуватись у дорожні габарити і маневрувати в умовах міста й обмеженого простору, а також відповідати основним габаритним параметрам прохідності. Для подолання природних перешкод підресорна система повинна мати кліренс, що регулюється, а трансмісія спеціальної броньованої колісної машини має бути розроблена за вимогами позашляховика.

Одним із шляхів вирішення зазначених питань є створення спеціальної чотиривісної броньованої колісної машини з двома поворотними платформами. Запропоновано варіант компонування чотиривісної броньованої колісної машини з двома поворотними платформами, який задовольняє ці вимоги. Центральною частиною у забезпеченні заданих високих показників маневреності є модульна конструкція електромеханічної трансмісії. Трансмісійний модуль містить два відокремлені електродвигуни, що з'єднані з двома планетарними ступеневими редукторами.

Наведено 3D моделі і загальні характеристики поворотної платформи та чотиривісної броньованої колісної машини з двома поворотними платформами. Подано натурну масштабну модель зазначеної колісної машини.

Ключові слова: *охорона громадського порядку, броньована колісна машина, компонування, поворотна платформа, вимоги.*

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