Strategies for improving the protection of weapons and military equipment

Підходи до підвищення рівня захищеності озброєння та військової техніки

Boris Melnyk [A]

Corresponding author: Candidate of Technical Sciences, Head of the Research Department for the Development of Armaments and Military Equipment, e-mail: melnikboss1@gmail.com, ORCID: 0000-0002-5635-0099

Andriy Veretnov [A]

Candidate of Technical Sciences, Head of the Research Department of Problems of Resource Recovery and Repair of Weapons and Military Equipment at Industrial Enterprises, e-mail: weretnow5_5@ukr.net, ORCID: 0000-0003-0160-7325

Iryna Novikova [B]

Senior researcher of the research department of the Institute of Logistics and Support of Troops (forces), e-mail: irina_nov@ukr.net, ORCID: 0000-0003-4854-0682

Борис Мельник [A]

Corresponding author: к.т.н., начальник науково-дослідного відділу розвитку озброєння та військової техніки, e-mail: melnikboss1@gmail.com, ORCID: 0000-0002-5635-0099

Андрій Веретнов [A]

к.т.н., начальник науково-дослідного відділу проблем відновлення ресурсу та ремонту озброєння та військової техніки на підприємствах промисловості, e-mail: weretnow5_5@ukr.net, ORCID: 0000-0003-0160-7325

Ірина Новікова [B]

Старший науковий співробітник науково-дослідного відділу інституту логістики та підтримки військ (сил), e-mail: irina_nov@ukr.net, ORCID: 0000-0003-4854-0682

[A] Central Research Institute of Armaments and Military Equipment of the Armed Forces of Ukraine, Kyiv, Ukraine
[B] National Defence University of Ukraine, Kyiv, Ukraine

[A] Центральний науково-дослідний інституту озброєння та військової техніки Збройних Сил України, Київ, Україна
[B] Національний університет оборони України, м. Київ, Україна

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Purpose: there are directions strategies for improving the protection of weapons and military equipment.

Method: for the purpose of the research of development and the primary design features of armored combat vehicles, international technical assistance aimed at ensuring protection against weapons of destruction. The classification of armored combat vehicles by weight and dimensions and the peculiarities of approaches to increasing their level of protection are outlined. The experience of the Republic of South Africa, NATO member states, the Russian Federation, and the defense industry of Ukraine in developing armored combat vehicles with an increased level of protection is examined.

Findings: the article explores analyze the trends in the development of weaponry and military equipment received as part of international technical assistance, specifically focusing on ways to enhance their protection against means of destruction.

Papertype: theoretical.

Мета роботи: є напрямки підвищення рівня захищеності озброєння та військової техніки.

Метод дослідження: для реалізації мети дослідження розглянуто напрямки розвитку та основні конструктивні особливості бойових броньованих машин, міжнародної технічної допомоги, щодо забезпечення захисту від засобів ураження. Визначено класифікацію бойових броньованих машин за масо-габаритними показниками та особливості підходів щодо підвищення їх рівня захищеності. Розглянуто досвід Південно-Африканської Республіки, країн членів НАТО, російської федерації, оборонного-промислового комплексу України щодо розроблення бойових броньованих машин з підвищеним рівнем захищеності.

Результати дослідження: у статті проведено аналіз тенденцій розвитку зразків озброєння та військової техніки, які надійшла в рамках міжнародної-технічної допомоги, а саме шляхи підвищення їх захищеності від засобів ураження.

Тип статті: теоретична.

Key words: weapons and military equipment, repair and restoration bodies, restoration, security system, level of protection, explosive objects, means of destruction.

Ключові слова: озброєння та військова техніка, ремонтно-відновлювальні органи, відновлення, система забезпечення, рівень захищеності, вибухонебезпечні предмети, засоби ураження.

1. Introduction

The deployment of military units from the Armed Forces of Ukraine (AFU) to counteract the armed aggression of the Russian Federation (RF) is driven by new conditions in armed conflict and the extensive application of new models of weapons and military equipment (WME) received as international technical assistance (ITA) from partner countries (Dachkovskiy, V., Diadechko, A., Kondratiuk, I., Sampir, O., Pavlov, D., 2022; Analysis of anti-terrorist operation, 2014).

The analysis of the application of Ground Forces' Weapons and Military Equipment (WME)

in the modern warfare of the Armed Forces of Ukraine has revealed that the evolution of weaponry necessitates the exploration of new and more effective means to enhance the protection of WME models. Additionally, the issue of safeguarding personnel from explosive devices has become increasingly pertinent.

Contemporary theory on the protection of WME against anti-tank means, including anti-tank mines, holds a prominent position both in the exploration of WME development directions and in the development and modernization of existing WME models (Dachkovskiy, V., 2019).

2. Materials and Methods

Analysis of repelling the armed aggression of the Russian Federation against Ukraine revealed that, despite their high level of protection, the main drawback of such design features is the increased overall dimensions, reduced maneuverability, a high center of mass leading to an increased risk of overturning, and limited mobility in rural (urban) areas, hindering the overcoming of barrier boundaries, etc. Nevertheless, these design features help preserve the lives and health of the crew and personnel inside.

3. Results and Discussion

A number of works have been devoted to the study of the development of weapons and military equipment, in particular, work (Lysyi, M., Mysyk A., Dachkovskyi, V., Horbachova, Y., 2019) analyzes the current state of weapons and military equipment samples based on statistical data obtained during the anti-terrorist operation. The author considers the issue of maintaining the combat capability of troops (forces) by providing modern models of weapons and military equipment. Paper (Dachkovskyi, V., Horbachova, Y., 2021) describes the current state of development of weapons and military equipment with an increased level of security. Thus, paper (Grinenko, O. I., Ustymenko, O. V., Kutovyi, O. P., 2016) highlights the views on the existing system of supplying the Armed Forces of Ukraine with weapons and military equipment, draws attention to the timely adoption of motivated and informed decisions on reforming the supply system, and paper (Grubel, M. G., Kraynyk, L. V., Khomenko, V. P., 2018) substantiates the relevance of studying the design features of MRAP weapons and military equipment, considers the main design differences of weapons and military equipment in terms of security and how the level of security affects tactical and technical characteristics. Paper (Deulgaonkar, V. R., 2018) deals with the development, evaluation, and improvement of a vehicle platform. Paper (Koval, V. V., 2010) analyzes the typical wheeled models of weapons and military equipment used by the ground forces to perform their tasks and reveals the main trends in their development.

The analysis of military operations conducted in the late twentieth and early twenty-first centuries reveals a significant shift in the effectiveness of unprotected vehicles in combat. During the Second World War and the Korean War, the United States incurred up to 5% of its total losses from explosive ordnance, sabotage, and attacks by reconnaissance groups (SRGs) (Open'ko, P., Kobzev, V., Vasiliev, V., Uhrynovych, O., Diachenko, V., 2021). However, these losses surged to 34% in Vietnam and 27% in Somalia (Kostyuk, V. V., Rusilo, P. O., Varvanets, Y. V., Kalinin, O. M., 2016). The lessons learned from combat operations in Iraq and Afghanistan underscored that over 35% of weapon and military equipment losses were attributed to hand-held anti-tank weapons, engineered ammunition, improvised explosive devices (IEDs), and small arms fire (Boyko, G. O., Bisyk, S. P., 2014). The troops faced the most substantial losses of weaponry and military equipment from industrial explosive devices (engineered ammunition) and improvised explosive devices. Unarmored vehicles were particularly vulnerable, rendering them nearly impossible to restore. Even armored vehicles proved susceptible to more powerful IEDs (Telelym, V. M., Zahorim, O. M., Stryzhevskyi, V. V.).

In the early 21st century, as the tactics of guerrilla warfare prevalent in Afghanistan and Iraq

influenced the world's leading armies, they adopted the expertise of South African engineers. This led to the inception of the MRAP (Mine Resistant Ambush Protected) program, which focuses on developing Armored Personnel Carriers (APCs) with high protection against explosive blasts and robust ballistic protection (Telelym, V. M., Zahorim, O. M., Stryzhevskyi, V. V.).

The United Kingdom, during the deployment of troops in Afghanistan, also utilized the experience of the South African military. Companies like BAE Systems, GM, and others acquired licenses for the production of South African armored vehicles, creating updated versions based on them (Lysyi, M., Mysyk A., Dachkovskyi, V., Horbachova, Y., 2019).

A common characteristic of all such specimens of military equipment used in the modern warfare of the Ukrainian Armed Forces is that they are designed to enhance the crew's protection from damaging factors during explosive incidents. Hence, the main feature of the hull of these vehicles is a wedge or trough-shaped bottom reinforced with additional armor plates. This design helps reduce the force of the explosion by dispersing the shock wave on both sides of the hull.

In 2007, the U.S. armed forces acquired approximately 3700 examples of MRAPs with various types of anti-mine protection, of which 2700 were sent to Iraq (Telelym, V. M., Zahorim, O. M., Stryzhevskyi, V. V.). Another feature of MRAPs developed worldwide is that they are primarily based on the chassis of standard production vehicles. This ensures high standardization and significantly reduces the cost of MRAPs. In the U.S., MRAP models such as Caiman, MaxxPro, and Cougar gained widespread use.

MaxxPro MRAPs with enhanced anti-mine protection, manufactured by the American company Navistar, were adopted by the U.S. military in 2007. MaxxPro is a modified version of the International general-purpose truck (Tereshchenko, A. M., Prylypa, O. O., Bakhmat, V. G.). The use of a serial chassis allowed for rapid mass production of protected MRAP models. The vehicle is equipped with a 6-person combat compartment protected by a V-shaped bottom plate. There is information that MaxxPro can protect the crew from ground detonation of explosives weighing up to 7 kg. The total weight of the MRAP model is 14 tons, and a similar design is applied to the German ATF Dingo. These MRAP models are fitted with additional armor from the Israeli company Plasan Sasa, bulletproof glass, and further protected by mesh screens. The vehicle body and chassis are connected by bolted joints, allowing them to be manufactured in different locations and quickly reassembled in field conditions. The vehicle is produced in several versions, including transport, engineering, medical, reconnaissance, and command vehicles, with three variants: the first category MRAP I (MaxxPro), the second category MRAP I (MaxxPro XL), and MRAP II MaxxPro Plus. All three variants are based on a common chassis. The MaxxPro Plus variant is equipped with an explosive device detection and deactivation system, increased engine power, payload capacity, and uses ceramic armor with the modular Frag Kit 6 protection system, providing protection against explosively formed penetrators (Kotsiuruba, V., Dachkovskyi, V., Kurtseitov, T., 2021).

The Golan MRAP (Mine-Resistant Ambush Protected) sample was developed as a result of cooperation between 2 companies RAFAEL (Israel) and PVI (USA). The Golan was adopted by the Israeli army as a V-shaped hull, steel-armored, monocoque-constructed vehicle designed to provide protection against improvised explosive devices (IEDs). The vehicle's body is made of armored steel, offering defense against projectiles with armor-piercing cores of 14.5mm and 20mm calibers. The sides of the main hull are fitted with hybrid reactive armor designed to protect the vehicle from RPG-7 rocket-propelled grenades. The roof armor plates provide protection against projectiles with a caliber of 12.7mm and 7.62mm with armor-piercing bullets at angles of 25° and 40° relative to the normal, respectively. Mesh screens are installed for additional protection of the rear and armored glass from RPGs. Golan can withstand a mine explosion of up to 7 kg under the vehicle and 17 kg under the wheel in TNT equivalent (Dachkovskyi, V., Datsenko, I., Golub, V., Sedov, S., Kondratiuk, I., Pavlov, D., Mazurenko, V., Kovalov, O., 2022).

The Marauder combat armored vehicle, manufactured by Middle East Defence Systems

(MDS), a subsidiary of the Jordanian company King Abdullah II Design and Development Bureau (KADDB), and the South African company Paramount Group, is designed for convoy escort and personnel transport. The vehicle was developed in the Republic of South Africa, with serial production taking place in Jordan and at facilities in other client countries. The monocoque body made of armored steel with a V-shaped hull provides ballistic protection at Level 2 according to STANAG 4569 standard and Level 3b and 4a for mine protection (Lysyi, M., Mysyk A., Dachkovskyi, V., Horbachova, Y., 2019).

The Australian company ADI Limited produces the Bushmaster 4x4 mine-protected armored personnel carrier. This vehicle is designed in six models: transporter, command, ambulance, technical assistance, fire support, demining and self-propelled mortar. The Bushmaster APC is in service with the Australian Armed Forces and is exported to other countries. A variant with a 6x6 wheel configuration is also being developed. Both types of combat support vehicles provide protection for the crew against shockwaves, small arms and shrapnel. Other variants include universal vehicles as well as specialized vehicles adapted for specific combat missions.

The highly mobile and modularly designed Dingo 2 armored personnel carrier was developed by Krauss-Maffei Wegmann (KMW) on the all-wheel-drive chassis of the Unimog 5000 (manufactured by Daimler Chrysler), and it is an upgraded version of the armored vehicle Dingo, which has been in service since 2000 and actively used in foreign operations. The APC can transport 8 persons, providing ballistic and anti-mine protection corresponding to Level 3 of STANAG 4569 (Lysyi, M., Mysyk A., Dachkovskyi, V., Horbachova, Y., 2019). A high level of ballistic protection is achieved through the use of specialized armored steel and composite materials.

Meanwhile, an analysis of the Russian-Ukrainian war has revealed that the Russian Federation utilizes armored combat vehicles categorized into 3 classes. Light armored vehicles include vehicles like the "Tigr" (GAZ-233114) and its counterparts. Medium armored vehicles fall into the "Volk" class, while heavy armored vehicles belong to the "Typhoon" class, based on KamAZ and Ural trucks (Dachkovskiy, V., Diadechko, A., Kondratiuk, I., Sampir, O., Pavlov, D.,2022).

With the onset of Russian aggression against Ukraine, the domestic defense-industrial complex also developed a "line" of armored vehicles, which can be categorized into three classes based on size and weight. Light armored vehicles include the "Spartan" (based on the Ford chassis), "Cougar" (based on the Toyota chassis), "Bars-8" (Dodge Ram pickup platform), "Bars-6" (constructed on the KIA Military chassis), and "Kozak" (Land Rover Defender). In the medium class, there is the Kraz Shrek with a 4x4 wheel formula, "Kozak-2" based on the IVECO Cargo 4x4 chassis, and heavy Kraz Fiona with a 6x6 wheel formula, providing protection at Stanag 4569 Level 2. The Kraz "Hurricane", with an 8x8 wheel formula, is claimed by the manufacturer to have protection at STANAG 4569 Level 4 (Grubel, M. G., Kraynyk, L. V., Khomenko, V. P., 2018).

In addition to the already developed AFVs, taking into consideration the experience of the Joint Forces Operation, a number of authors have proposed other technical solutions to increase their level of protection. Therefore, in (Kotsiuruba, V., Dachkovskyi, V., Kurtseitov, T., 2021), it is proposed to increase the crew's protection against IEDs by using an armored capsule installed inside the hull of the sample of weapons and equipment, and in (Lysyi, M., Mysyk A., Dachkovskyi, V., Horbachova, Y., 2019), it is proposed to create protection based on the use of a multilayer armored barrier. However, these methods of increasing the security of the SLBM require additional theoretical and experimental research. In addition, the experience of the Joint Forces Operation in the Donetsk and Luhansk regions showed that the troops (forces) used protective screens to increase the security of the Armored Fighting Vehicle, as proposed in (Grubel, M. G., Kraynyk, L. V., Khomenko, V. P., 2018), but the use of protective screens alone will not provide full protection for personnel.

Therefore, all the approaches considered for enhancing the protection level of armored vehicles (AMEs) are primarily determined by the requirements for crew (troop) protection, and only

secondarily by the requirements for preserving the vehicle's operability.

Ensuring the preservation of the crew's lives and health can be achieved by meeting several conditions: the first condition involves minimizing dynamic loads transmitted during the explosion of the armored vehicle to the attachment points of crew seats or troops; the second condition involves avoiding contact with the ground during maximum dynamic deflection.

4. Conclusions

Thus, one of the most serious threats to armored vehicles in typical local conflicts is represented by explosive devices and kinetic impact munitions, accounting for over half of the losses of armored vehicles. To ensure a high level of protection for armored vehicles, a comprehensive approach is needed, incorporating both design and structural solutions, as well as the application of specialized equipment, including energy-absorbing crew seats. Additionally, armored vehicle models with high protection levels have already been created and actively used in modern conflicts. However, MRAP-type armored vehicle models have both advantages and significant drawbacks that need to be addressed.

In the future, based on the conducted research, it is necessary to carry out theoretical and experimental studies to determine the most effective ways and methods to enhance the protection level of WME samples.

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6. Competing interests

The authors declare that they have no competing interests.

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