Small mobile fortification system for quick installation

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Abstract. Unfortunately, today local armed conflicts practically do not fade in many points of our planet. Also Ukraine is among such points. The nature of the armed conflict happening in the similar "burning" points received the name of «hybrid» war. In such war there is no obvious front line, deeply echeloned defence and other attributes «classical» wars of the last years. Such war is characterized, in addition, separate armed collisions in the most various, sometimes absolutely unexpected, places. Problem of protection of the military personnel, which have necessary in accordance with the circumstances should be defended not the equipped dominating height with rocky or frozen soil, still remains unresolved. Today attention of the scientific different countries (the USA, Great Britain, Poland) working as in the sphere of individual protection of the military personnel, (bullet-proof vests, helmets and so forth), and in the sphere of small fortification and protection of military equipment, so-called «non-Newtonian» liquids attract. It occurs owing to their specific properties which it was today possible to use for increasing of bulletproof of a barrier. In this aspect authors solve a problem of development of the mobile parapet of fast expansion.

1. Introduction

By researchers it is established that for all history of existence of mankind numbering, at least, the millennia only 200 years (totally), the world did not shake the military conflicts.

Here and today with regret it should be noted that local armed conflicts practically do not fade in many points of our planet. Also Ukraine is among such points. The nature of the armed conflict happening in the similar "burning" points received the name of “hybrid” war. In such war there is no obvious front line, deeply echeloned defense and other attributes “classical” wars of the recent years. Such war is characterized, in addition, separate, sudden armed collisions in the most various, sometimes absolutely unexpected, places.

Quite often, the device of the traditional weapon emplacements received by usual mining, “digging” to the earth is impossible owing to a number of circumstances (availability of rocky soil at the dominating height, existence of an essential layer of frozen soil in winter conditions and also lack of enough time).

The modern military science tries to offer mobile fortification constructions of fast expansion to respond to the requests modern “hybrid” wars. The last system who found the apply in Ukraine, is the
American system consisting of the tarpaulin cubic form filled by soil with the help of the excavator. For obvious reasons such system cannot be carried to tactical, arranged directly before a fight. Requirement in rather big (5-10 m$^3$) amount of soil-filler and excavator does this system suitable only for arrangement of so-called check points.

Problem of protection of the military personnel, which have necessary in accordance with the circumstances should be defended not the equipped dominating height with rocky or frozen soil, still remains unresolved. Individual protection equipment – bullet-proof vests and helmets do not solve an arrangement problem even of the simplest weapon emplacement: devices of a parapet and minimum entrenchment.

In this article an attempt of the solution of this problem – is made to protect human lives during military collision. Authors find this problem relevant. Absolutely obviously that a profession of the builder, equally as a profession of the materials scientist-bUILDER, or the builder of other profile, since ancient times was considered and remains the most peace profession. And in this sense of a research of authors remain in line with all-Christian precepts of rather human lives, as well as in line with all other world religions.

Today attention of the scientific different countries (the USA, Great Britain, Poland) working as in the sphere of individual protection of the military personnel, (bullet-proof vests, helmets and so forth), and in the sphere of small fortification and protection of military equipment, so-called «non-Newtonian» liquids attract. It occurs owing to their specific properties which it was today possible to use for increasing of bulletproof of a barrier. In this aspect authors solve a problem of development of the mobile parapet of fast installation.

2. The analysis of literature and installation of the problem
For designing of effective tactical protection it is necessary to gain as much as possible detailed imagination about the nature of interaction of a fast-moving object (in this case – bullets) with a barrier.

As often also it happens, researches in this area were divided into theoretical and experimental. For modeling of shock impact on components of engineering constructions distribution was gained by phenomenological models of Mises, Hill, Johnson-Cook, Preston-Tonks-Vallas, Cai-Wu, Yamada-Sang, Hashina, Bunch, etc. [1-11].

Pilot studies of nature of interaction of a bullet with a barrier are also very extensive [1-11] that considerably is explained by variety of designs of bullets: usual without steel core, the bullets which are turning on the steel core in the design, armor-piercing, incendiary, tracer, etc.

According to us, the most universal result when designing a tactical mobile parapet can be achieved taking into account the nature of interaction with a bullet barrier with the steel core inside.

All aforesaid allows to organize when designing a composite barrier adequate «repulse» at each stage of interaction of a bullet with elements of a mobile parapet.

3. The Purpose and tasks of investigations
The purpose carrying out of research is development and designing of a mobile parapet of fast expansion for quick arrangement of a fire point. And, during design of the main element of the bulletproof panel of the parapet by authors set a task at the expense of the analysis of all stages of interaction of a bullet with a barrier to provide by use of the corresponding materials and methods of designing adequate counteraction of a barrier at all stages.

For achievement of the above-stated purpose the following tasks was solved: to pick up the materials and the corresponding constructive forms providing the maximum repulse against fast-moving object (bullet) at each stage of interaction with a barrier (according to modern ideas of physics of the process and the available material); to provide production of prototypes of the main element and to check viability of the theoretical representations put in them by direct assessment of bulletproof; to propose the constructive solution of the mobile parapet of the fast expansion suitable for a practical using.
4. Main material

Interaction of the flying bullet with a barrier lasts extremely short time, fractions of a second. In this regard, it would be expedient to pick up the material capable to react to influence of a bullet. It is obvious that speed of reaction of a material has to be up extremely high, i.e. at the level of standard forces.

The most impressive example of such interaction is the modern protective guard of the welder. In usual condition, the glass of a guard is absolutely transparent. But once the electric spark lights up, or it is even simple to strike a match as glass instantly becomes dark. Here kind of there is no obvious physical contact, obviously expressed impact of bodies. (Though at the molecular level, impact photons, of course exist). Reaction of protective glass happens practically to the speed of light.

At the level of mechanical contact, only owing to it, similar reaction in the form of instant change of mechanical properties is shown non-Newtonian liquids, known long ago, but demanded by the scientists working on problems of bullet protection, relatively recently.

Properties of “liquid armor” to instantly harden and create obstacles for further mechanical influence will be used by authors when designing a basic element of a mobile parapet (the ballistic panel).

Figure 1 presents the general view of the suggested mobile parapet and Figure 2 presents the structure of the ballistic panel of the mobile parapet. The rejecting and splitting up screens are designed to apprehend blow of a cover and “turn on” non-Newtonian liquid before the core of a bullet makes contact with the first screen.

The hardened reinforced non-Newtonian liquid acts as the basis for the first leaf and will absorb a little most part of kinetic energy than at its absence. Further the core gets into the camera with non-Newtonian liquid.

![Figure 1. General view of the suggested mobile parapet.](image)

The review and testing of various non-Newtonian liquids allowed to come to conclusion that optimum structure for climatic conditions of Ukraine is non-Newtonian liquid on the basis of two components: polyethylene glycol (perhaps PEG 200 or 600) and filler from silicon dioxide nanoparticles (SiO₂). Some problem is made by that circumstance that nanoparticles of dioxide of silicon are very expensive.
Therefore, we accepted as filler the polypropylene fiber 50 mm long (figure 3) delivered by the domestic industry and also use of heavy-duty fiber is possible HLV-54 and fibers Monerte Fiber. Good results were shown by also wavy fiber Multi Chem (50 mm).

The researches conducted in the British VAE Defensive Corporation showed that the protective element from non-Newtonian liquid ceases to perform the protective function if this segment of a ballistic plate is punched as its contents will just follow through a bullet opening. In order to avoid it the reinforced non-Newtonian liquid of a mobile parapet is put in the camera of the ballistic panel in special elastic polyethylene capsules which under a body weight fall, taking the place damaged (figure 4).

**Figure 2.** Structure of the ballistic panel of a mobile parapet.

**Figure 3.** Polypropylene fiber.

**Figure 4.** Filling of the camera of the ballistic panel with polyethylene capsules with non-Newtonian liquid.

5. **Tests of bulletproof**

Bulletproof – ability of a barrier to resist to through punching by bullets and lack at the same time of the dangerous to the person secondary striking elements.

For tests of bulletproof samples, fragments of the ballistic panel of 50×50 cm in size were made. The distance of firing of samples was chosen proceeding from the description of tactics of storm of defensive of the opponent given by the general Gerasimov: «From a distance of 40-50 meters the attacking infantry ceases fire that one resolute throw to reach the opponent's trenches. From a distance of 20-25 meters
they are using of the hand-grenades. Further the shot in an emphasis and defeat of the enemy cold weapon follows».

Considering the aforesaid, the distance of firing of samples of the ballistic panel was accepted equal 50 meters. Defeat of samples was carried out in the shooting range of military unit from Kalashnikovs of caliber of 7.62 mm and 5.45 mm. 10 shots were made by each type of ammunition. In two cases it was established perforation of the splitting-up screen by ammunition of 5.45 mm (figure 5). Main characteristics of the bullet 5.45 (76x) are mass of the bullet 3.4 g, and initial velocity of the bullet 890 m/sec.

Figure 5. The standard type of a steel-copper bullet that was used for test.

Regardless of type of the fibres for non-newtonian liquids the ballistic panel have shown impressive halting effect. The specific destructions of the body of the bullet existed depending from the type of the applicable fibres. For instance, when fibres was made from winding high-strengthening wires, existed crushing the body of the bullet, but in some cases even internal steel bar, on separate fragments, which already could not penetrate cameras with the non-newtonian liquid. Thus, as a result of test firings it is established that bulletproof of samples of the ballistic panel at the distance of 50 m is provided.

6. Discussion of results

Based on the conducted researches it is established that the general concept of structure and designing of a mobile parapet appeared to the viable and meeting needs of combat units in the conditions of local clashes. As a result of tests and the analysis of different types of non-Newtonian liquids the compounding and a type of reinforcing which is most meeting the requirements of profitability and climatic conditions of Ukraine is defined. Mobile parapet is made of ordinary constructions steel that provides its cost efficiency. Owing to the limited sizes of a shooting gallery there was impossible a conducting firing of samples of the ballistic panel from the distances exceeding 50 meters. According to experts for ammunition of caliber of 5.45 mm with a supersonic initial speed the effect of increase in penetrative ability of a bullet at a distance of 200-300 m is quite often observed. To check existence of similar effect so far it was not presented possible. As well as it was not succeeded to conduct firing by ammunition of larger calibers so far – from 12.7 mm owing to a number of the organizational reasons. Researches in this direction will be continued.

In addition, carrying out the further researches directed to decrease in mass of a mobile parapet and optimization of compositions of non-Newtonian liquids is planned. At the end of the researches, carrying out official certified tests is planned for bulletproof according to state standard in the specialized accreditation centers.

7. Conclusions

Today in Ukraine are absent the mobile fortification system of the quick installation, capable to function in any climatic, weather and soil condition, as well as on any relief of terrain, including any mountains and other difficult available places.

The existing American system, requiring filling by big amount of the soil, much have well proved to be itself during installation of block-posts, but turned out to be absolutely unfit for decision of quick operative-tactical tasks.
The mobile fortification system of quick installation, using effect of non-Newtonian liquid is offered by authors at first. Using the non-Newtonian liquids in system of ballistic protection is found in zone of raised attention of the military researches all over the world.

As a result of the conducted researches the design of a mobile parapet of fast expansion offered by authors with the ballistic panel filled with the reinforced non-Newtonian liquid confirmed the viability and bulletproof.

The possibility of use in elements of the ballistic panel of ordinary construction steel grades is confirmed that allows to make the system economic at mass production. Also the composition of non-Newtonian liquid based on polyethylene glycol with reinforcing by a polypropylene fiber confirmed the efficiency.

The mobile fortification system of quick installation allows to modify and optimize its defensive characteristic without any constructive changing, that greatly enlarges the lifetime and period of moral diligence.

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