Advances in Military Technology
Vol. 18, No. 1, 2023, pp. 67-77
ISSN 1802-2308, eISSN 2533-4123
DOI 10.3849/aimt.01731

Increasing Survivability of the Battalion Command Post against Artillery Fire Using Antenna Extension

O. Rolenec,[1*] J. Záleský,[1] K. Šilinger[2] and L. Hampelová[1]

[1] *Faculty of Military Leadership, University of Defence, Brno, Czech Republic*
[2] *Cyber Forces Command, Brno, Czech Republic*

The manuscript was received on 11 May 2022 and was accepted after revision for publication as technical information on 13 February 2023.

Abstract:

The command post is a key element of the troop assembly that must be concealed and protected from the enemy. This paper examines the possible increase in survivability of a battalion command post from the effects of enemy artillery fire by deception prior to electronic signature detection by extending the antenna of radio communication assets. Using modelling, the areas of possible command post locations, the exact command post positions and the areas of artillery fire were marked in a geoprocessing tool. Statistical methods were then used to evaluate the success rate of command post destruction. Since there are no documents available that address this issue, the results of this research will allow an assessment of the effectiveness of this measure.

Keywords:

artillery fire, command post, deception, survivability

1 Introduction

In military operations, command posts are among the basic elements of the troop structure that enable command and control of subordinate units. They include personnel, equipment, information systems, and networks, guided by processes and procedures that assist commanders in the exercise of mission command [1]. This represents a multitude of computing equipment, power sources, and hundreds of metres of cables for continuous security of continuously large amounts of data, preferably in real time.

The destruction or disabling of a command post would give the enemy an undeniable advantage in combat. The enemy could exploit the inability to coordinate individual units in the combat zone to create a synergistic effect, thereby reversing, for

* *Corresponding author: Department of Engineer Support, Faculty of Military Leadership, University of Defence, Kounicova 156/65, CZ-662 10 Brno, Czech Republic. Phone: +420 973 44 37 05, E-mail: ota.rolenec@unob.cz. ORCID 0000-0001-9218-9389.*

example, an unfavourable force ratio or other factors unfavourable to him in his favour. Ultimately, this would mean not only an increase in personnel and equipment losses of friendly forces, but also the impossibility of accomplishing the given task leading to the total defeat of friendly forces. Therefore, the protection of command posts in any type of operation must be addressed.

There are a number of articles and publications devoted to the protection of current command posts. For example, the general structure of places of command is discussed in [2]. Optimizing the mobility, survivability, and interoperability of headquarters for the future fight is discussed, for example, in [3-5]. The topic of reducing the electronic signatures of command posts to enhance concealment from the enemy is addressed in [6]. Sustainability approach for military protective structures with a mention of specific protective structure is described in [7].

When it comes to the issues of artillery in the world, there are two main trends in the use of it. The use of artillery by NATO countries is governed by principles enshrined in alliance standardization agreements, which are not publicly available. Partial procedures are given, for example, in the US field manuals [8-10]. The procedures of non-NATO countries are usually based on different Soviet standards, which are also classified.

Furthermore, the studies on the blast resistance of protective structures are available [11-15]. In these types of research, the effect of blast energy on different types of construction materials used in protective structures is assessed. However, from a tactical point of view, they do not address the effect of artillery fire or aerial bombardment on specific types of protective structures. No documents are known from available sources that address the protection of the command post by deceiving its position by extending the antennas of the communications equipment.

For the purposes of this article, a model task force command post with dimensions of 50×50 m, which are common for battalion task force command posts in most NATO armies, is considered (due to the sensitivity of this military information, the Army's doctrinal values are not listed). This command post will then be affected by a model brigade artillery unit of battalion strength, which is designed to provide direct fire support to the mechanized brigade.

1.1 Motivation

The authors were inspired to write this article due to their practical experience from various national and international exercises. The problem of protecting command posts may be their construction with tents or the use of specially modified containers that provide no or minimal protection against enemy weapon fire. The advantage of the use of tents is the speed of their construction, or their relocation to another position, and the provision of more working space compared to protective structures built below ground level. Tent construction is also more advantageous in terms of the use of engineer forces and resources because it allows for time-saving deployment.

However, command posts constructed in this manner provide little or no protection against artillery fire, air strikes, or small arms fire and fragmentation effects. Meanwhile, experience from contemporary conflicts shows that the enemy is able to target a command post by using a combination of unmanned aerial vehicles and electronic signature detection as demonstrated by the conflict in Ukraine [16]. Thus, the enemy does not even need to decipher the communication between units, but using the strength of the signal he is able to predict the location of the command posts relatively accurately. This means that even with concealment of the individual elements of the command post with the use of modern camouflage devices [17] (e.g. multispectral camouflage covers designed for camouflage in the visible, infrared, and microwave spectrum) and observance of the camouflage discipline of all members, it is possible to detect the command post on the basis of its own communication activity.

1.2 Contribution and Organization of the Article

Based on the experience of the conflict between Ukraine and the pro-Russian separatists, some armies have modified their standard operating procedures for the construction of command posts and extended the antennas of their communications equipment to a designated distance to deceive the enemy about their actual position. The command post itself then communicates between its more distant elements using radios linked by cables so that no electromagnetic energy is radiated into the surrounding area. Therefore, based on electronic signature detection, the enemy may assume that the actual command post will be located near a circle, the radius of which is determined by the distance, to which the antenna is extended.

The aim of this paper is to verify, based on the modelling capabilities in a geoprocessing tool [18], whether the above-described approach to concealing the command post position has a desired effect to increase the survivability against artillery fire at a battalion command post. The results can then confirm or refute the meaningfulness of the measures implemented in the electromagnetic spectrum and contribute to a change in thinking, when designing procedures for the construction of command posts.

In the first part of the text, a short literature review related to the issues of the research is carried out. Next, the scenario of the combat situation, the determination of the command post location and the expected effect of the enemy artillery on this command post are described using modelling in the geoprocessing tool. The results of the tactical assessment of the terrain and the modelling performed allow the evaluation of the established hypothesis. The paper then ends by outlining additional areas for possible follow-up research.

2 Modelling

From a tactical standpoint, the defensive operation of a battalion facing a brigade attack will be considered. This force ratio is based on the basic doctrinal rules of warfare. Scenario development for assessing the survivability of a command post during an artillery fire is based on these basic premises:

- the command post is composed of tents that do not provide any level of protection against the effects of enemy weapons. The use of buildings or armoured vehicles is not anticipated,
- the command post has not been detected by visual reconnaissance, nor by reconnaissance assets operating in the microwave spectrum (radar), thanks to the observance of the rules of camouflage discipline, the use of multispectral camouflage nets and other camouflage measures,
- using electronic signature detection, the position of the antennas of the radio communication means corresponding in their characteristics to the battalion-type command post was determined,

- the entire military campaign has been going on for a long time, which has allowed the enemy to detect the standard operating procedures (SOPs) of friendly forces in the construction of command posts - the antenna is extended up to a certain distance from the command post.

Thus, the enemy knows the location of the transmitters, but has not revealed the exact location of the command post through other reconnaissance assets. However, based on his knowledge of SOPs, he is able to anticipate the possible location of the command post in the area of operations, given the protective and camouflage characteristics of the terrain, and to direct artillery fire at this anticipated location, since command posts will always fall into the high-value target category in operations. The area where the command post can be located and where the enemy can prepare artillery fire will be selected throughout the area of a circle with a radius corresponding to the distance, through which the antenna is extended and centered to the point of antenna placement, taking into account the terrain features and the area near the circle where the command post would most often be placed.

The area for the command post location should generally be characterized by the presence of wooded areas allowing for concealment and protection from enemy reconnaissance assets. The enemy will assume, for example, that the command post will be located mainly at the edge of the forest, with suitable access and exit routes, while the use of engineer work will allow for its concealment under vegetation, etc.

2.1 Artillery Fire Modelling

Brigade artillery will normally consist of one artillery battalion comprising three firing batteries with eight artillery weapon systems. Artillery battalions of some armies may also be supplemented by a rocket launcher battery. For the purposes of this article, an artillery battalion consisting of three firing batteries of self-propelled 152-mm self-propelled howitzers (24 in total), which are commonly used, particularly by the states of the former Soviet Union, will be assumed.

Since the assumed position of the command post has been determined by means of electronic signature detection, the enemy artillery will conduct an artillery fire mission according to the principles of conducting fire for effect at stationary unobserved ground targets. Therefore, no consideration is given to conducting fire adjustment, firing a control round, or correcting the first salvo of fire for effect. It is therefore assumed that the enemy artillery conducts one massive artillery fire mission (i.e. calculates the firing data for fire for effect, incorporating all known ballistic and meteorological firing conditions), and fires all munitions in a round-by-round mode (i.e. in the shortest possible time). At the same time, it is assumed, that the enemy has enough ammunition to be able to make a fire mission on the place where he assumes that the command post could be located.

Unobserved targets include those targets that cannot be visually observed by ground or aerial reconnaissance assets during fire for effect and thus the level of their elimination cannot be established. For this reason, ammunition consumption is determined by standards. Artillery may neutralize or destroy command posts by its artillery fire missions. In particular, targets that appear to be of high importance and that are uncovered or unarmored are being generally destroyed. In our experiment, therefore, the desired effect of artillery fire will be considered to destroy, while in real conditions neutralizing is not ruled out according to the combat situation.

Different numbers of guns (fire batteries) can be used to accomplish the same fire mission. Taking into account the importance of the target, the desired effect of artillery fire (destruction) and the dimensions of the battalion command post model, fire control for a full battalion effect (i.e. 24 pieces of 152-mm self-propelled guns) will be further considered. In realistic conditions, 2 (in the case of smaller command posts) or 3 firing batteries are used to conduct artillery fire mission on unobserved command posts, depending on the calculated ammunition consumption, the desired effect and the nature and dimensions of the target.

In terms of artillery fire, the command post will represent a group target, which is made up of a certain number of individual targets distributed unevenly over a certain area (in our case 0.250 hectares). The effectiveness of firing at a group target can be characterized by the mathematical expectation of the percentage of eliminated targets from a given group target set (M(a)). In the case of command post destruction, M(a) ≥ 35 % (max. 50 %) is required.

Artillery fire will generally be accompanied by two categories of errors – repetitive and non-repetitive errors. Repetitive errors are related to the preparation (calculation) of the elements for firing and can be eliminated. Non-repetitive errors scatter the explosions in the target area relative to its center (these are so-called dispersion errors to which the law of normal distribution applies). Dispersion errors basically ensure sufficient coverage of the target area by explosions and partly of its surroundings. Individual batteries and guns can also smoothly change the directions and ranges of the sights when firing at the target, thereby obtaining even coverage of the target area with explosions.

The enemy artillery fire mission at the battalion command post provides a surprise effect of artillery fire with a high density of fire. The fire mission will be executed in a "round-by-round" manner, which is a prerequisite for inflicting such high losses that it will be impossible to restore the command post or to maneuver it to another location. Since the command post will represent a target of relatively small dimensions (0.250 ha), then larger dimensions – 200 m wide and 200 m deep (like a square) – will be considered when calculating firing data, taking into account the usual principles for firing on group of unobserved area targets. These dimensions would correspond to an ammunition consumption of 150 rounds at a firing distance of 10 km, 160 rounds at a firing distance of 12 km, 200 rounds at a firing distance of 16 km, etc. This ammunition consumption would be divided among the individual guns, i.e. each gun would fire an amount of ammunition equal to the ratio of the total consumption and the number of guns (24), rounded up to the nearest whole number. Therefore, at firing ranges of 10 and 12 km, each gun would fire 7 rounds of ammunition, and at a firing range of 16 km, 9 rounds of ammunition. Artillery fire would be conducted with the smallest possible charge and the fuse set to fragmentation. Approximately 2 minutes will be required to fire the total ammunition lot. For the purposes of the experiment, it was assumed that the mentioned ammunition consumption provided 100 % mathematical expectation of elimination of unitary targets.

The authors have also assumed that artillery fire was conducted with high accuracy and hit the target in the red square measuring 200 × 200 meters, and that the detection of the antenna position was flawless.

2.2 Scenario Design and Experiment Realization

The creation of the tactical situation with the location of battalion command posts and the coordinates of artillery fires was developed thanks to the specializations of the authors of this article. The expert in engineer support made the location of the command post and antenna in the terrain using the map base in terms of the required protection, camouflage and use of the energy of the transmitting means. The expert in fire support control, in cooperation with the engineer officer representing the enemy, then, based on the determination of the position of the command post's transmitting means and knowledge of the specific procedures for the construction of the command post (distance of the antennas), determined the areas for firing by the brigade artillery, not knowing the location of the command post.

The aim of the following scenario generation and conducting the experiment is to confirm or refute the following hypothesis: Extending of communications antennas will reduce the risk of destroying the battalion command post by artillery fire. The destruction of the command post is considered to be the intersection of the modelled command post and the modelled artillery fire mission with a value of 35 % or more. The hypothesis will be tested at distances of 250 m, 500 m, 750 m and 1 000 m. It is assumed that the artillery fire covers the area of a square with a side of 200 meters.

In determining the positions of command posts and artillery fire zones, the authors of this article selected a total of 10 different antenna positions. From these locations, circles were marked at four distances ranging from 250 m to 1 km in 250 m increments, so in total 40 experimental model situations were created from which the required data were extracted.

A distance of 1 km was established as the limit of the battalion's ability to extend the antennas from the command post (when using a cable). At longer distances, the need for cables and engineer work (placing cables below ground level for protection) would already be at a level that is not close to the realistic capabilities of the troops. Furthermore, areas suitable for the location of the command post were marked in relation to its dimensions and terrain features.

The engineer officer marked the area where the command post was located. The artillery officer, independently of the engineer officer, marked the areas for artillery fire missions (the area in which he assumed that the command post might be located) in these documents. A comparison of the modelled scenarios was then made to determine whether the command post was destroyed or not. Figures 1-4 show an example of the resulting comparison for all four antenna extension distances. The blue square determines the command post position and the red square the artillery fire mission. The white polygons represent the potential location of the command post.

3 Discussion

Table 1 shows the values obtained from the scenario design described above. The first column indicates the antenna positions. For the sake of simplicity, individual positions are marked with the letters A to J. The next column shows the distribution for each position over the 4 antenna distances from the command post, ranging from 250 m to 1 000 m. For each position and distance, the values of the areas of the potential command post location, coverage of the areas of the potential command post location by artillery fire, the percentage of the hit of the command post and its possible destruction are also given.

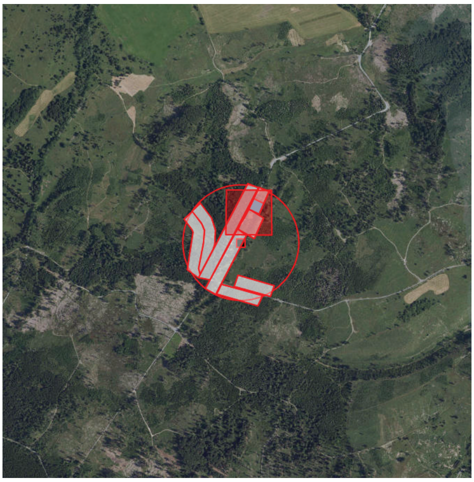

Fig. 1 Marking of artillery fire and place of command post with antenna extension up to 250 m

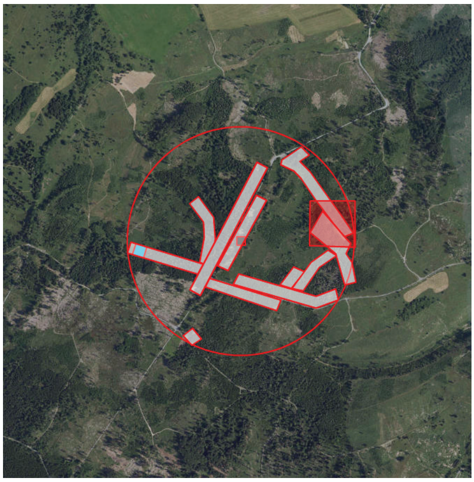

Fig. 2 Marking of artillery fire and place of command post with antenna extension up to 500 m

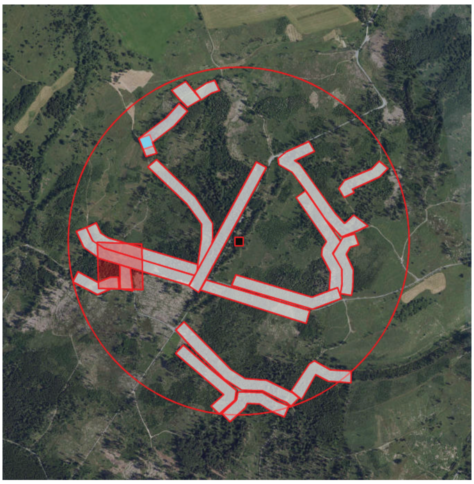

Fig. 3 Marking of artillery fire and place of command post with antenna extension up to 750 m

Fig. 4 Marking of artillery fire and place of command post with antenna extension up to 1 000 m

Subsequently, the analysis of the obtained data was carried out. A generalized linear model with a logit link was used to model the target destruction variable [19]. Only the variable antenna distance was found to be significant, which appears as a factor of 4 levels in the model. The first level (250 m distance) is included in the model as a constant term and the parameters for the other levels are related with respect to this constant. The model as a whole is significant according to the likelihood ratio test with a p-value of 0.036. The model correctly predicted 73 % of the values of the dependent variable target destruction. The results of the model are shown in Tab. 2.

DOI 10.3849/aimt.01731

Tab. 1 Values obtained from scenario design

Antenna position	Maximum distance of the antenna from the command post [m]	Area of potential command post location in [km^2]	Coverage of areas of possible command post location by artillery fire	% of command post hit	Command post destroyed
A	250	0.0295	0.0083	100	Y
A	500	0.1915	0.0103	100	Y
A	750	0.4273	0.0300	45	Y
A	1 000	0.8140	0.0190	0	N
B	250	0.1050	0.0220	100	Y
B	500	0.1670	0.0230	0	N
B	750	0.2920	0.0230	0	N
B	1 000	0.4753	0.0180	0	N
C	250	0.1040	0.0225	100	Y
C	500	0.1845	0.0220	0	N
C	750	0.3672	0.0272	0	N
C	1 000	0.5186	0.0190	0	N
D	250	0.0429	0.0110	65	Y
D	500	0.2283	0.0171	0	N
D	750	0.4484	0.0143	0	N
D	1 000	0.6139	0.0210	0	N
E	250	0.0483	0.0130	5	N
E	500	0.2017	0.0210	95	Y
E	750	0.4338	0.0151	0	N
E	1 000	0.6359	0.0140	0	N
F	250	0.0400	0.0234	100	Y
F	500	0.1456	0.0081	0	N
F	750	0.3160	0.0180	100	Y
F	1 000	0.3979	0.0210	100	Y
G	250	0.0264	0.0162	80	Y
G	500	0.1179	0.0180	0	N
G	750	0.6024	0.0240	95	Y
G	1 000	0.7659	0.0260	0	N
H	250	0.0309	0.0064	100	Y
H	500	0.1329	0.0170	100	Y
H	750	0.2469	0.0120	0	N
H	1 000	0.4889	0.0130	0	N
I	250	0.0531	0.0196	0	N
I	500	0.1878	0.0198	100	Y
I	750	0.5087	0.0120	0	N
I	1 000	0.7641	0.0100	0	N
J	250	0.0989	0.0230	0	N
J	500	0.3426	0.0136	0	N
J	750	0.8890	0.0280	0	N
J	1 000	1.3160	0.0230	0	N

Tab. 2 Model results (SE means standard error of the parameter estimate, t is value of test statistics of the parameter significance)

Antenna distance [m]	Estimate	*SE*	*t*	*p*-value
250	0.848	0.690	1.228	0.220
500	−1.253	0.945	−1.326	0.185
750	−1.695	0.976	−1.736	0.082
1 000	−3.045	1.260	−2.417	0.016

The results show that there is a statistically significant difference in the antenna placement at a distance of 1 000 m compared to 250 m. The *p*-value for the difference in the antenna location at 750 m versus 250 m is just above the selected significance level of 0.05 ($p = 0.082$). The coefficients for all distances are negative. This means that moving the antenna to a greater distance from the command post reduces the chance of destruction. The chance of destroying a target can be thought of as the ratio of the probability of destroying the target to the probability of not destroying the target, which can be calculated as 1 – the probability of destroying the target. The chance of destroying the target if the antenna is at a distance of 250 m is $e^{0.848} = 2.33$, hence the probability of destroying the target is approximately 70 % (2.33/(1+2.33)). By moving the antenna to a distance of 1 000 m, the chance of destroying the target is reduced to $e^{0.848} \times e^{-3.045} = 2.33 \times 0.048 = 0.11$. Hence the probability of destroying the target if the antenna is at a distance of 1 000 m is approximately 10 % (0.11/(1+0.11)).

From the data obtained and the statistical analysis performed, it can be concluded that the hypothesis: Extending of communications antennas will reduce the risk of destroying the battalion command post by artillery fire was confirmed through decreasing estimated odds of hitting the command post, however, the statistically significant reduction in odds was only for the 1 000 m distance.

4 Conclusions

The article dealt with the protection of the command post against enemy artillery fire by extending the antenna to four selected distances. To ensure the realism of the modelled scenarios, basic assumptions were made describing the design of the command post, its effective concealment from visual and radar reconnaissance assets, detection of the antenna position by electronic signature detection and knowledge of the procedures for antenna extension by the enemy. A total of 40 scenarios were created in the geoprocessing tool depicting the areas of potential command post locations in relation to terrain features. Then, a member of the engineer and artillery expertise independently marked the command post and artillery firing missions on each map, which allowed the success of destroying command posts by the enemy to be evaluated and thus the effectiveness of the proposed action.

The values obtained from scenario design show that when the antenna was deployed at 250 m, the command post was destroyed seven times, at 500 m four times, at 750 m three times and at 1 000 m once. From the tactical commander's decision-making perspective, a 250 m distance would be completely ineffective in building the command post, implying a high risk of destruction. At distances of 500 and 750 m, the risk of the command post destruction by artillery fire decreases, but it is still at a relatively high level, as confirmed by the statistical analysis. Only when extending the antenna to the highest selected distance, the risk level of the command post destruction would be at an acceptable level, allowing this method of concealing the command post from the enemy to be selected. Thus, the selected hypothesis was confirmed.

This type of research is unique and brings interesting findings in the field of protecting critical elements of troop compositions. However, modelling of other areas in the Central European region would be needed to strengthen the results. For a different type of landscape, the same procedure would have to be repeated. Thus, the paper offers guidance for unit headquarters to analyze the effectiveness of the proposed protection procedure. This analytical process could, for example, be incorporated into a war game that assesses variants of the actions of friendly and enemy forces.

Acknowledgement

This research was funded by the Ministry od Defence of the Czech Republic, grant LANDOPS "Conduct of Land Operations" and by the Ministry of Education, Youth and Sports of the the Czech Republic under specific research grant.

References

[1] DALZELL, S., C.M. SCHNAUBELT, M.E. LINICK, T.R. GULDEN, L.P. COLABELLA, S.G. STRAUS, J. SLADDEN, R. JENSEN, M. OLSON, A.G. DONOHUE, J.L. HASTINGS, H.A. REININGER and P. SPEED. *Main Command Post-Operational Detachments (MCP-ODs) and Division Headquarters Readiness*. Santa Monica: RAND Corporation, 2019. ISBN 978-1-9774-0225-7.

[2] ČERNÝ, J. Modular Structure of Command and Control for Operations Generation. *Economics and Management*, 2012, **2012**(2), pp. 114-122. ISSN 1802-3975.

[3] GREENBERG, M. *It's Time to Fix the Command Post: Optimizing Headquarters' Mobility, Survivability, and Interoperability for the Future Fight* [online]. 2020 [viewed 2021-12-12]. Available from: https://mwi.usma.edu/its-time-to-fix-the-command-post-optimizing-headquarters-mobility-survivability-and-interoperability-for-the-future-fight/

[4] HORTON, J. and T. THOMAS. *Adapt or Die: Command Posts – Surviving the Future Fight* [online]. 2020 [viewed 2021-12-13]. Available from: https://www.army.mil/article/235968/adapt_or_die_command_posts_surviving_the_future_fight

[5] HEININGER, C. *Army Designing Next-gen Command Posts* [online]. 2016 [viewed 2021-12-13]. Available from: https://www.army.mil/article/167807/army_designing_next_gen_command_posts

[6] KELLER, J. *Army Seeks to Reduce the Electronic Signatures of Command Posts to Enhance Concealment from the Enemy* [online]. 2020 [viewed 2021-12-13]. Available from: https://www.militaryaerospace.com/rf-analog/article/14182899/electronic-signatures-command-posts-concealment

[7] KIM, K. and Y. PARK. Development of Design Considerations as a Sustainability Approach for Military Protective Structures: A Case Study of Artillery Fighting Position in South Korea. *Sustainability*, 2020, **12**(16), 6479. DOI 10.3390/su12166479.

[8] *Field Artillery Cannon Battalion* [online]. 2015 [viewed 2021-12-01]. Available from: https://armypubs.army.mil/epubs/DR_pubs/DR_a/pdf/web/atp3_09x23.pdf

[9] *Tactics, Techniques, and Procedures for the Targeting Process* [online]. 1996 [viewed 2021-11-11]. Available from: https://www.globalsecurity.org/intell/library/policy/army/fm/6-20-10/

[10] *Tactics, Techniques, and Procedures for Field Artillery Manual Canon Gunnery* [online]. 1999 [viewed 2021-11-18]. Available from: https://ebin.pub/qdownload/fm-6-40-mcwp-3-1619-tactics-techniques-and-procedures-for-field-artillery-manual-cannon-gunnery.html

[11] ZEZULOVÁ, E., K. HASILOVÁ, T. KOMÁRKOVÁ, P. STONIŠ, J. ŠTOLLER and O. ANTON. NDT Methods Suitable for Evaluation the Condition of Military Fortification Construction in the Field. *Applied Sciences,* 2020, **10**(22), 8161. DOI 10.3390/app10228161.

[12] ŠTOLLER J. and P. DVOŘÁK. Field Tests of Cementitious Composites Suitable for Protective Structures and Critical Infrastructure. *Key Engineering Materials,* 2016, **722**, pp. 3-11. DOI 10.4028/www.scientific.net/KEM.722.3.

[13] ŠTOLLER J. and P. DVOŘÁK. Reinforced Concrete Frames under Distant Blast. *Key Engineering Materials,* 2017, **755**, pp. 229-235. DOI 10.4028/www.scientific.net/KEM.755.229.

[14] MAŇAS P., K. CIBULOVÁ and J. ŠAFRANKO. Protection of the Critical Infrastructure Areas – Remarks and Ideas, In: *2021 International Conference on Military Technologies (ICMT).* Brno: IEEE, 2021. DOI 10.1109/ICMT52455.2021.9502742.

[15] ALOGLA A., M. HELAL, M.M. ELSHAFEY and E. FATHALLAH. Numerical Analysis for Critical Structures Protection against Blast Loading Using Metallic Panels. *Applied Sciences*, 2020, **10**(6), 2121. DOI 10.3390/app10062121.

[16] STEW, M. *Army Looks to Disperse Command Posts to Boost Survivability* [online]. National Defence Industrial Association, 2020 [viewed 2021-12-11]. Available from: https://www.nationaldefensemagazine.org/articles/2020/10/22/army-looks-to-disperse-command-posts-to-boost-survivability

[17] *Multispectral Masking Covers* [online]. 2021 [viewed 2021-12-11]. Available from: http://www.bois-filtry.cz/multispektralni-maskovaci-pokryvy.php

[18] SEDLÁČEK, M. and F. DOHNAL. Possibilities of Using Geographic Products in Tasks of Military Engineering. *Challenges to National Defence in Contemporary Geopolitical Situation*, 2020, **2020**(1), pp. 145-155. DOI 10.47459/cndcgs.2020.18.

[19] McCULLOCH P. and J.A. NELDER. *Generalized Linear Models*. 2nd ed. London: Chapman and Hall, 1989. ISBN 0-412-31760-5.