# Creating of Minefield Breaches with Artillery

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Abstract: This article describes research project about new approach to creating breaches in engineer obstacles by using artillery fire. In current russian-ukraine war can be observed massive use of explosive and non-explosive obstacles within position defence. Efficiency of attack of task forces is in this case directly influenced by their ability to overcome these obstacles. Main issue for the attacking force represents minefields which slow down and restrict manoeuvre and cause casualties. Breaches in minefields are created by units of combat engineers manually or by special mine clearing equipment. During that time is the unit threatened by the enemy, especially special engineering equipment is a priority target. The aim of the research is to propose and verify the possibility of using artillery as a mean to create breaches in engineer obstacles, especially in minefields, giving the attacking force alternative, contingency or emergency way of creating breach. The article introduces basic aspects of explosive obstacles and minefields, analyses tactical aspects of creating breaches in them and proposes possible approaches to solving the problematics by using artillery.

## 1 INTRODUCTION

Armed conflict in Ukraine confirms that position defence has still place in modern conflict. Defence areas and strong points are constructed in the whole width of area of operations (AOO). Defence positions are supported by massively creating explosive and non-explosive obstacles, mainly minefields. (Rolenec and Kopuletý, 2017. Sedláček and others, 2022) According to doctrinal model of Russian armed forces is minefield placed on the front edge of defence, in spaces between strong points and on the flanks in the whole depth of defence area. (Bartles and others, 2016)

According to public resources is apparent that Russian forces are using land mines to strengthen their position defence. In some areas of defence, the density of mines is ten times the calculation norms of the Russian army. Minefields are covered by planned artillery fires and represent huge issue for the attacking forces and their freedom of manoeuvre during attacking the first lines of enemy defence and deployment of the main attacking force.

The attacking unit in such situation usually loses initiative, its manoeuvre is restricted and comes under concentrated enemy fire. Using minefields multiplies combat force in the area in favour of the enemy. Current tactics counts on deploying units of combat engineers and creating breaches in obstacles by using their equipment. In ongoing RUS/UKR war evident that such equipment represents primary targets. (Rolenec and others, 2019)

During first and second world war procedures of creating breaches in engineer obstacles by using artillery fire were applied. After second world war were these procedures dismissed mostly because of requirements for high precision of artillery fire and ammunition consumption. Those factors are no longer valid, because of new automated fire control systems and new types of artillery ammunition. (Ivan and others, 2021)

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To understand the possibility of using modern artillery for creating breaches in minefields it is necessary to describe basics of surmounting explosive obstacles, minefields and basis of how artillery functions. (Rolenec and others, 2021).

# 2 EXPLOSIVE OBSTACLE

An explosive obstacle is an engineering obstacle, which is mainly composed of minefields. The destruction of units, the limitation of their maneuverer, the influence on the time management of the operation, the psychological effect, etc are main risks to attacking forces. Explosive obstacles in the form of securing the flanks of the formation, bridging any gaps arise in the battle formation and securing critical assets and objects for defence represent a significant advantage for the defending opponent.

## 2.1 Minefield

Minefield can be created manually, by minelayer or, as is widely used today, by remote delivery of mines. Remote delivery of mines consists in creating minefield from distance by tube or rocket artillery, mine launchers or air forces.

Tactical use of remote delivery of mines, which is applied in current war in Ukraine is based on laying mines in terrain directly in front of attacking forces, that have surmounted originally laid minefields. Another possible tactical use is in laying mines in immediate proximity of retreating forces, which complicates the retreat and simplifies destroying equipment and personnel.

Large scale use of remote delivery of mines in RUS/UKR war and using modern types of mines, which can be equipped with mechanisms against extraction represent important factor for tactical planning and successful execution of operation.

## 2.2 Mines

Basic types of landmines are:

- anti-personnel mines,
- anti-tank mines,
- off-route mines,
- special mines.

Current combat is characterised by using anti-personnel and anti-tank mines. Anti-personnel mines are designed to destroy personnel. Anti-tank mines are designed to damage and destroy tanks, armoured personnel carriers and other vehicles. Mines can be placed on the ground or below the surface and can be secured against extraction. The effect of artillery projectiles on target allows us to consider the possibility of destroying mines by utilizing the kinetic energy, energy of explosion (pressure wave) and dispersion of fragments after the explosion of the projectile. Effect of artillery projectile can be adjusted by different setting of fuse allowing it to explode under the surface thus destroying the mines placed under the ground for example.

# 3 TACTICAL ASPECTS OF CREATING BREACHES IN MINEFIELDS

Standard way of surmounting minefield consists in deploying units of combat engineers equipped to create breaches in enemy engineer obstacles in front of attacking units. The engineer units then create breaches in proximity of own troops using mechanical or explosive mine-clearing assets and if those are not available then they do it manually. (Cibulová and others, 2019)

This way of surmounting minefields has some significant flaws:

- Time consumption
- Vulnerability
- Loss of moment of surprise
- Restriction of movement

**Time Consumption** is affected by mine-clearing equipment, type of used mines, density of minefield, terrain and by possible cover of minefield by enemy artillery fire. Based on principles of artillery functions can be expected, that time consumption might be lower.

**Vulnerability** is caused by multiple factors. First is easy recognition of special mine-clearing equipment, which is caused by its construction. On modern battlefield filled by sensors is this factor critical. Detecting of such priority target will lead to its immediate destruction. Another factor of vulnerability is time of exposition of the equipment to possible enemy fire due to its work during creating the breach. (Kompan, 2018) Vulnerability of artillery in case of its deployment is given by its own firing. In the moment of the shot the firing position is disclosed and enemy counter-battery fire usually follows. (Rolenec and others, 2021)

**The Loss of Moment of Surprise.** The moment of surprise is one of the elementary prerequisites for achieving successful attack. Moment of surprise can cause confusion and makes it impossible to react

quickly and effectively to sudden change of situation. (Kompan and others, 2022) In the moment, when enemy is able to anticipate the direction of attack and possible areas of deployment of forces, attacking operation becomes much more challenging. Due to necessity of using special engineer equipment, that can be easily recognised, the defending forces are capable of foreseeing not just the direction of attack, but also the speed of advance and can react by calling in the fire support, manoeuvring with forces or by sending in the reinforcements. Breach created by artillery fire will be, from the point of view of moment of surprise, considered surprising and unexpected.

**Restriction of Movement** is one of the elementary factors, which allows defenders to effectively engage the attacking forces. During mine-clearing a thin corridor is created and units must move through this corridor to surmount the explosive obstacle. Defenders can easily concentrate fire on these units. In the moment, when the front vehicle is destroyed, surmounting of the explosive obstacle might be impossible. This risk can be partially lowered by creating the breach by using artillery based on how many artillery units are used and how wide the breach or how many breaches will be created. (Ivan and others, 2019, 2022)

It is obvious that problematics of surmounting engineer obstacles is one of the most important topics when it comes to modern conflicts. Risks that come from creating breaches in obstacles are huge and a variety of ways, equipment and procedures of realisation of creating breach, especially in well prepared defence with high density of engineer obstacles, might be an advantage. Preparing PACE plans is typical for many activities and in this case, it is also useful to have alternative, contingency or emergency way or means, which multiplies or replaces capabilities of special combat engineer equipment. This way and means can be provided by artillery, that can provide fire support in all conditions (24/7).

# 4 CREATING OF MINEFIELD BREACHES WITH ARTILLERY

Based on comprehensive assessment of the situation and findings from the RUS/UKR war it is clear that defence with the wide use of explosive engineer road barriers remains a prevalent defensive tactic. (Kompan and others, 2022) Instead of relying solely on one method, it is crucial to prepare a diverse array of approaches within PACE.

On this basis, the project Creating of minefield breaches with artillery (CMFBA) was defined.

## 4.1 Overall Project Concept

The primary objective of the project is to introduce an alternative, backup or emergency method of creating breaches in minefields within the PACE plan for such operations without the need to use specialized engineer equipment. To validate the efficacy of the proposed approach, it will undergo rigorous simulation tests within the MASA SWORD environment.

Currently, artillery units usually consist of barrel artillery units, mortar units and artillery rocket units. These units and their equipment hold great potential as feasible means to address the challenge of creating breaches in minefields. Because the barrel artillery is currently the most widely used artillery piece, is capable of firing curved, steep and flat trajectory projectiles and an extensive range of ammunition options, the initial phase of the project will center on harnessing the capabilities of artillery weapon sets.

The crucial factors for evaluating the possibility of using artillery assets in building a breach in minefields are the characteristics of the ammunition, particularly its effectiveness in neutralizing mines, the method of engagement, which directly impacts the consumption of ammunition, the probability of mine destruction, and the width of the breaches created.

Moreover, an integral facet of the assessment lies in evaluating the travers ability of the shelled terrain, gauged by the size of the passage formed after artillery fire, in order to assess the ability of the different types of equipment available to the mechanized battalions to traverse this area.

## 4.2 Munition

Standard high-explosive projectiles have mostly fragmentation and disruptive effects on target. These two factors also have key role in assessment of ability to neutralize mines and create breaches in minefields by using artillery. Fragmentation effect is given by dispersion of high number of fragments after explosion and their wounding or destructive effect on target. Disruptive effect is given by pressure of the blast, that disrupts the obstacle.

Artillery ammunition of medium calibre (152 and 155 mm) will have bigger potential for creating the breaches is engineer obstacles by artillery because of

bigger amount of blasting charge inside the shell. Bigger amount of blasting charge is connected with higher energy of pressure wave created by the explosion and by that with higher capability of destroying mines in bigger radius from centre of explosion.

## 4.3 Methods of the Attack

The method of the attack for the minefield area is an important factor in creating breaches in engineer obstacles by artillery fire.

In particular, the research team considers methods of the attack to be an appropriate method of the attack when creating breaches in engineer obstacles:

- Divided zone battery fire,
- Full zone fires,
- Target (sections, lines) separation. (Vajda, 2023)

When firing at targets by divide zone battery fires, artillery batteries conduct fire at all specified ranges and fire a limited portion of the planned rounds at each range. (Šustr and others, 2022)

Full zone fires target engagement consists of each battery firing at only one range and firing one-third of the planned projectile consumption at that range.

When target separation between batteries is used, batteries usually fire at the same time at predetermined targets. (Blaha and others, 2021)

An evaluation of the methods of the attack, together with the type and consumption of rounds, will enable the proper procedures to be determined for achieving effective passage formation in an engineer obstacle using artillery. This is currently provided by modern means of command systems and automated fire control systems of artillery units. (Mušinka and Uchaľ, 2021) The output will be a methodology for requesting fire and a procedure for executing artillery fire using suitable and effective method of the attack in FFE mission.

## 4.4 Mathematical Method

To verify the capability of artillery projectiles to destroy mines or to damage them enough so they will not be able to detonate we need to know if the pressure wave of explosion will be strong enough to neutralize the mines. For verification we must use the correct mathematical apparatus (figure 1 and 2), because realisation of the experiment would be impossible due to safety measures for artillery fire. Results of calculations will be compared to values of resistance of the anti-tank and anti-personnel mines against pressure wave. It is also necessary to assess the fragmentation effect on mines.

$$P_{so} = P_o \times \frac{808 \times \left[1 + \left(\frac{Z}{4,5}\right)^2\right]}{\sqrt{\left[1 + \left(\frac{Z}{0,048}\right)^2\right] \times \left[1 + \left(\frac{Z}{0,32}\right)^2\right] \times \left[1 + \left(\frac{Z}{1,35}\right)^2\right]}} \quad (1)$$

$P_{so}$ - maximal pressure of blast wave (Pa)
$P_o$ - atmospheric pressure (Pa)
Z - scale parameter

$$Z = \frac{R}{\sqrt[3]{w}} \quad (2)$$

Z-Scale parameter
R -distance from detonation (m)
w -amount of explosive (kg)

## 4.5 MASA SWORD Experiment

Verification and possibilities for use of proposed way of creating breaches in engineer obstacles is practically not possible. Because of that research team realizes multiple simulations in MASA-SWORD software, where three ways of surmounting engineer obstacles will be evaluated and compared.

- Units will avoid the explosive obstacle and bypass it.
- Units will surmount the explosive obstacle through breaches created by combat engineers.
- Units will surmount the explosive obstacle through breaches created by artillery fire.

### 4.5.1 Avoiding and Bypassing an Explosive Obstacle

After detecting a minefield, units choose to go round the roadblock with an outflanking manoeuvre of the enemy troops.

Advantages:

- Independence from specialized engineer assets
- Reduced risk of personnel and equipment loss due to mine activation

Disadvantages:

- High time consumption
- Loss of initiative
- Loss of the element of surprise

#### 4.5.2 Overcoming the Explosive Obstacle Through Breaches Created by Engineer Units

After detecting minefield, the attacking units deploy mine-clearing vehicles to the front of the formation and follow them while surmounting the minefield.

Advantages:

- Bigger certainty of clearing the mines
- Exact lay out of the breach.

Disadvantages:

- Need of combat engineer support
- Vulnerability of combat engineer vehicles
- Restriction of movement of forces
- Loss of moment of surprise

#### 4.5.3 Overcoming the Explosive Obstacle Through Breaches Created by Artillery

After detecting minefield, the attacking units call for fire support by artillery, which is supporting the task force. Artillery creates breaches in minefield by fire, mechanized units surmount the minefield and continue in the attack. Creating breaches in minefields by using artillery anticipates these advantages:

- Creating the moment of surprise
- Lowering amount of time demanded for creating the breach
- No need for special equipment

As disadvantages can be identified:

- Consumption of artillery ammunition
- Restriction of other planned fire missions
- Disclosure of firing position
- Lower certainty of clearing all mines

Experiment will be divided into two phases, during which the scenarios will be simulated with different size task forces.

In the first phase of the experiment the scenarios will be simulated with battalion size task force, that will attack area of defence of company. Second phase of the experiment will be simulated with brigade size task force, that will attack area of defence of battalion.

The outcome will be evaluation of variants from point of view of different areas of tactics. Evaluation will be mostly based on these criteria:

- Ammunition consumption
- Number of artillery effectors
- Time consumption
- Personnel losses
- Equipment losses
- Overall combat capability of own forces
- Overall combat capability of enemy forces

**Ammunition Consumption** - current standards of artillery fire do not define procedures for creating breaches in minefields. Based on mathematical calculations, probability of hitting the target and simulations, it will be necessary to determine ammunition consumption, that will be adequate for creating the breach.

**Number of Artillery Effectors** - this aspect will have to be determined not just because of detaching artillery for creating the breach, but also because of the change of amount of planned fire support for the given operation, meaning lowering the number of planned fire missions.

**Time Consumption** - will consist in creating timelines of all scenarios, dividing timelines into phases and comparing those timelines.

**Personnel Losses** - within this criterion losses of personnel on both sides in different scenarios will be compared.

**Equipment Losses** - procedure similar to criterion Personnel losses will be applied. Comparison will comprise losses of equipment on both sides during different scenarios.

**Overall Combat Capability of Own and Enemy Forces** - complete overview of losses and evaluation of combat capabilities of both sides within different simulated scenarios.

### 4.6 Project Workflow

It is obvious, that complexity and difficulty of this problematics and its connection to tactical planning, detaching of artillery forces, use of combat engineers and military art will demand large amount of time and work. The research team has defined probable timeline and milestones of a new project.

#### 4.6.1 Phase 1 (Short Term Horizon)

The initial phase focuses on several pivotal milestones. The first milestone entails investigating the feasibility of mine destruction through artillery fire. This necessitates conducting a series of mathematical calculations, initially focusing on one specific calibre and projectile type, to determine the effectiveness of destroying the chosen type of mine by an artillery fire. The fundamental condition under consideration will be the mine's placement on the surface and subsurface.

The second milestone in the first phase involves establishing the firing method when constructing breaches through minefields, as well as analysing the ammunition consumption based on the precision of

the fire and the probability of successful hits. Also, in connection with different ways of determining the firing data for firing.

The third milestone entails expanding on the findings from milestones one and two by considering different shell and mine types and the subsequent development of a methodology for conducting fire while creating breaches in minefields depending on the shells and mines used.

The first phase mainly centres on evaluation and verification of theoretical feasibility using mathematical tools, along with the application of artillery standards, procedures, and tactics.

### 4.6.2 Phase 2 (Midterm Horizon)

If the method of creating breaches in minefields proves mathematically feasible and applicable within artillery standards, it will be necessary to verify the effect of this method on the overall concept of the planned operation. This verification will involve conducting thorough simulations using the MASA SWORD platform within proposed scenarios. The first milestone is to precisely define each scenario and establish the basic criteria for each scenario entity so that reflects real-world conditions as closely as possible, and the results are applicable in practice. It will be necessary to work in close cooperation with the troop types, especially the Mechanized infantry and engineer troops, and to prepare accurate simulation models. The second milestone involves implementation of the actual simulations. When dealing with complex tactical situations, the research team implements a substantial number of simulations (in the tens of thousands) for the most accurate results. The third milestone focuses on a comprehensive evaluation of the options, analysing the impact on own forces and the potential consequences for the adversary. The fourth milestone involves augmenting the scenarios with other factors, such as terrain, weather conditions, unpredictable events within the tactical situation, etc.

### 4.6.3 Phase 3 (Long Term Horizon)

The long-term horizon is represented by the integration of the proposed method to the procedures and tactics of troop types and the gradual expansion of parameters in the operational area. As well as application of individual variants of scenarios and entities within the tactical situation aiming to achieve the greatest possible complexity, intensity, number of elements involved, a wide range of variants of the adversary's activities, etc. (Kompan and Hrnčiar, 2022) The outcomes of the simulations can be integrated into software which will be assisting commanders with tactical planning. The final step involves comparing the simulation results with real commanders' decision-making during the planning of operations with the need to create breaches in engineer obstacles.

## 5 CONCLUSIONS

Project Creating of minefield breaches with artillery (CMFBA) is based on knowledge gained from current war in Ukraine, which showed the fact, that position defence and massive use of engineer obstacles still has its place in modern conflict and can cause huge losses of personnel and equipment and can slow down or even stop the advance of attacking forces. The ability to react to development of combat situation, together with possibility of choice between variants represents indisputable advantage. It is for this reason, that NATO armies use the concept of PACE. This reason together with fact, that success of the attack depends among others on the ability to keep the speed of the attack, allowing manoeuvre and deployment of own forces and destroying the enemy on the front edge, lead the research team to conclusion, that proposed project will give commanders a tool, which allows them to fulfil these demands.

The project is currently in its initial stages, its contents and time schedule of research project were defined, and members of the team are currently working on first and second milestone of the first phase. At the same time working on the first milestone of the second phase has begun. Research team operates with hypothesis, that mathematical calculations will confirm the ability of artillery ammunition to destroy mines both on top and below ground and it will be possible to carry out planned simulations to verify its tactical use. In case of successful simulations confirming the usefulness of procedure, it will be a completely new approach to solving given problematics during combat situations.

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