Theoretıcal research of reınforced concrete materıals and theır applıcatıon ın the preparatıon of long-term support zones

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Abstract- This article is devoted to a theoretical study of reinforced concrete materials and their use in the construction of long-term strongpoints. The relevance of this research lies in the development of modern methods for determining the strength of reinforced concrete materials as their primary indicator. This is driven by the necessity of using such materials and opens up prospects for their application in the military field. The paper presents a physical and mathematical method for determining the strength of reinforced concrete materials. approaches **Theoretical methods were used. The innovation lies in the integration of physical and mathematical approaches to studying the strength of materials, which allows for the preliminary determination of the use of reinforced concrete materials for military purposes. Determining the strength of reinforced concrete materials, as a scientific result, has important practical implications for the preparation of long-term strongholds.**

Key words-reinforced concrete, permanent firing points, pillbox, hardness module, military fortification.

I. INTRODUCTION

Reinforced concrete strongpoints are defensive military fortifications designed to protect personnel, observation and fire control equipment, equipment, artillery, aircraft, unmanned aerial vehicles, etc. from attack. Unlike blockhouses, which are usually located above ground, shelters are almost always underground. They were widely used during World War I, World War II, and the Cold War for command posts, weapons storage, and warehouses. Shelters can also be used for protection against tornadoes. They must prevent injury to those sheltering within. The shelter door must be at least as strong as the walls. Shelters that are occupied for long periods must be provided with ventilation and air conditioning. Such posts can be destroyed using explosives and various weapons.

The word "bunker" is a Scots word meaning "bench, seat", which was recorded in 1758 as a shortened form of the word "bed". The word may also have Scandinavian origins: Old Swedish bunker means "boards used to protect a ship's cargo". In the 19th century, the word was used to describe a coal bunker in a house or a storage room below the deck of a ship, as well as a sand-filled depression built to protect against hazards. Many underground bunkers were built and used during World War I and World War II, as well as the Cold War[1]

Currently, the Russian Army requires mobile shelters of various sizes, capable of accommodating eight personnel in special operations zones, due to their lighter weight. These mobile shelters are made of spiral-corrugated metal pipes. They protect personnel from high-explosive shells. A mobile shelter with a metal structure weighing 1.8 tons, a diameter of 2 to 2.2 meters, and a heating stove buried in the ground can withstand impacts from 152-mm shells [2].

In the US Army The reinforced concrete panel shelter consists of three types of reinforced concrete slabs, designed to be used as an observation post or a protected firing point for 3-4 soldiers. The dimensions of the Type I slab are from 214 to 243 cm; Type II slabs have the same dimensions from 214 to 243 cm; the dimensions of the Type III slab are 304x274 cm. The thickness of the shelter is 15.24 cm, and it can accommodate mortars of up to 82 mm caliber, howitzers of 105 mm caliber. The concrete arched (semicircular) bunker is also designed to be used as a protected firing point for 4 soldiers. The bunker, measuring 45.7 x 20.3 cm, 1.82 m high and 15.24 cm thick, is designed to withstand small arms fire of up to 7.62 mm caliber, mortar shells of up to 82 mm caliber and howitzers of 105 mm caliber. It protects against shell fire [3].

One of the pressing issues is the study of reinforced concrete materials used in the manufacture of long-term supports.

II. DETERMINATION OF THE MODULUS OF HARDNESS OF REINFORCED CONCRETE MATERIAL

When studying the mechanical properties of reinforced concrete, it is necessary to calculate the Young's modulus and the modulus of elasticity. It is known that Young's modulus is the stress required to stretch the material to its full length $E = \frac{\sigma}{\varepsilon}$, where E is Young's modulus (Pa), σ - Stress (Pa), ε -relative strain (dimensionless). For calculating the shear moduli, K bulk elasticity and HN - hardness modulus of reinforced concrete.

$$G = \frac{Y}{2\cdot(1+\nu)},\ K = \frac{Y}{3\cdot(1-2\nu)},\ HN = G\cdot A\cdot e^{-B\cdot T}$$

you can use G the formulas [5]. Here G is the shear modulus, ν is the Poisson's ratio [6, 7, 8], K is the bulk modulus of elasticity, HN is the modulus of hardness, A is a constant value $A = 0{,}0807$, the value of the exponential parameter B is equal to $B = 2.204 \cdot 10^{-3}$1/K. T the temperature of the reinforced concrete material was taken into account in the calculations [6]. The calculation results $T = 300^0 K$ are given in Table 1.

Table 1. Calculated values of some mechanical parameters of reinforced concrete materials

No	Name	Value
1	Poisson's ratio	0.2
2	Young's modulus	200 GPa
3	Shear modulus	83 GPa
5	Modulus of elasticity under volume loading	111 GPa
6	Hardness modulus	3.47 2 GPa

III. CALCULATION OF THE THICKNESS OF A REINFORCED CONCRETE WALL LONG-TERM SUPPORT AREAS FOR VARIOUS TYPES OF WEAPONS

Let us assume that M, υ, D and m artillery shells, armed unmanned aerial vehicles, missiles, aerial bombs, etc. are the mass, speed, cross-sectional diameter, and mass of the weapon's explosive, respectively. Let's consider the issue of protecting a reinforced concrete shelter from artillery shells, UAVs, missiles, aerial bombs, etc. [6]. When hitting a shock-resistant shelter, moving artillery shells, UAVs, missiles, aerial bombs, etc. move with decreasing acceleration, and the thickness of the shelter h having covered the distance, he stops. At that moment, he P_1 collides with a shock-resistant shelter. P_2 general impact due to the pressure generated by the explosion$P = P_1 + P_2$ This has the same effect as the sum. If we consider the modulus of elasticity of the soil and the material, then PThe pressure resistance condition can be written as:

$$P \le Hm + Hp \quad (1)$$

Here Hm and Hp are the hardness modulus of the material and soil respectively. Using formulas of simple kinematics and dynamics, P_1 we can determine and P_2:

It is known that. $P_1 = \frac{F_1}{S} = \frac{Ma}{S}$from $\upsilon^2 = 2ah$ the formula $a = \frac{\upsilon^2}{2h}$. Then $P_1 = \frac{M\upsilon^2}{2hS}$it follows. $P_2 = \frac{F_2}{S}$From this $F_2 = \frac{E}{h}$it follows. $E = m \cdot E_1$Since then $P_2 = \frac{E}{h\cdot S}$we obtain. Then condition (1) takes the form

$$\frac{M\upsilon^2}{2hS} + \frac{E}{hS} \le Hm + Hp \quad (2)$$

can be written as: From this, $h$the thickness of the station's reinforced concrete wall can be determined:

$$h = \frac{M\upsilon^2 + 2E}{2\cdot S(Hm+Hp)} \quad (3)$$

where M is the mass of the moving object, m is the amount of explosive, υ is the shape of the moving object, h is the thickness of the concrete shelter material, S is the cross-sectional area (or end face) of the moving object. The cross-sectional area (or vertex) of a moving object (projectile or missile) $S = \frac{\pi D^2}{4}$ can be calculated using the formula. Here D is the diameter of the cross-section (or tip) of the moving object, E_1 is the amount of energy

released during the explosion of 1 kg $4{,}184 \cdot 10^6 C$ of TNT, F_1 and F_2 accordingly, are the forces acting on the reinforced concrete material as a result of the explosion of artillery shells, missiles, UAVs, aerial bombs and explosives in motion.

Computer calculations.

When carrying out calculations, taking into account the values of the elastic moduli of reinforced concrete and the soil layer of 3.472 GPa and 0.059 GPa, respectively, as well as the properties of artillery shells, UAVs, aerial bombs, etc., the values of energy and pressure arising from the explosion of explosives, as well as the thickness of the reinforced concrete shelter material can be calculated using the formulas given above [7, 8, 9, 10]. The calculation results are presented in Tables 2 and 3.

Table 2. Calculation of cover thickness for different types of weapons

Serial number	Name	Weight (kg)	Speed (m /s)	Cross-sectional diameter (m)	Amount of explosive (kg)	Explosion energy (C)	Cross-sectional area of the projectile(m^2)	Explosion pressure (Pa)	Wall thickness (m)
1	82mm artillery shell	3.1	211	0.082	0.4	1,673,600	0.00528 0	1.06E+09	0.095
2	105mm artillery shell	14.97	750	0.105	1.38	5,773,920	0.008659	2.22E+09	0.332
3	120mm artillery shell	15:59	820	0.12	3.5 0	14,644,000	0.0113 10	4.32E+09	0.50 7
4	122 mm artillery shell	21.8	565	0.122	3,765	15,752,760	0.0116 90	4.49E+09	0.47 4
5	152 mm artillery shell	43.56	655	0.152	6.73	28,158,320	0.01814 6	5.17E+09	0.924
6	Bayraktar	37.5	100	0.16	6.5	27,196,000	0.020106	4.51E+09	0.11 2
7	Aviation bomb	500	40	0.5	160	669,440,000	0.1963 50	1.14E+10	2.7 30

Table 3. Calculation of cover thickness for different types of weapons
(taking into account the soil layer)

Serial number	Name	Weight (kg)	Speed (m /s)	Cross-sectional diameter(m)	Amount of explosive (kg)	Explosion energy (C)	Cross-sectional area of the projectile (m^2)	Explosion pressure (Pa)	Wall thickness (m)
1	82mm artillery shell	3.1	211	0.082	0.4	1,673,600	0.005281	1.06E+09	0.093
2	105mm artillery shell	14.97	750	0.105	1.38	5,773,920	0.008659	2.22E+09	0.327
3	120mm artillery shell	15:59	820	0.12	3.5	14,644,000	0.0113 10	4.32E+09	0.498
4	122 mm artillery shell	21.8	565	0.122	3,765	15,752,760	0.0116 90	4.49E+09	0.466
5	152 mm artillery shell	43.56	655	0.152	6.73	28,158,320	0.01814 6	5.17E+09	0.909
6	Bayraktar	37.5	100	0.16	6.5	27,196,000	0.020106	4.51E+09	0.11 0
7	Aviation bomb	500	40	0.5	160	669,440,000	0.1963 50	1.14E+10	2,684

III. CONCLUSİON

The construction of long-term reinforced concrete support points can be economically justified.

Using the above method, it is possible to calculate the wall thickness values for long-term reinforced concrete support nodes that are resistant to impact and pressure arising from the explosion of explosives for various types of weapons.

The approximate pressure created by the impact of various weapons and the detonation of explosives is 1.1 GPa. It can reach 5.2 GPa. This poses a very significant risk to personnel working inside a permanent strongpoint and the equipment used. The estimated wall thickness of a reinforced concrete strongpoint to protect against each type of weapon can range from 0.093 meters to 2.73 meters. The obtained results can be used in the manufacture of long-term supports for reinforced concrete materials.

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