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Mathematical Analysis of the Dependence of the Impact Resistance of Military Structures and Buildings on the Physical and Mechanical Properties of Materials

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Abstract:

A mathematical analysis of the dependence of the impact resistance of military structures and buildings on the physical and mechanical properties of materials is given and a theoretical foundation for the construction of buildings and structures in the future is given.

Keywords: construction, building, Silicate, ceramics, aerated concrete, reinforced concrete, tensile strength, average density, thermal conductivity, regression equation, correlation.

The strength of structures and buildings, durability, undamaged enclosures, heat and frost resistance, corrosion resistance, resistance to external and internal loads are crucial not only for the construction of the object, but also for what materials it consists of[1]. For example, since the coefficients of thermal expansion and cold compression of concrete (complex element) with reinforced concrete (Fe) element are very close, reinforced concrete construction is a harmonious (durable) building material.

Today, high demands are placed on structures and buildings. The main ones are:

- Occupy as little space (surface) as possible (then the height of the object increases).
- Using as few unique materials as possible (more use of hybrid materials). This leads to extensive comprehensive scientific research.
- From an economic point of view, to be relevant to the requirements of the market, etc.
- Military installations and buildings are subject to even higher requirements than civilian facilities.

Thus, it is necessary to take into account that the upper floors of high-rise buildings are made of lightweight materials that pass air well (diffusion phenomenon), absorb heat, are resistant to moisture and corrosion, and are subject to vibration due to a physical phenomenon[2].

As a matrix (a sufficiently studied building material), we take the walls of buildings and structures built of baked ceramic bricks and silicate baked bricks, the parameters of which are very close to it. New hybrid materials have been calculated: we will give a comparative assessment of aerated concrete and other scientifically studied building materials and compare them with the results of practice.

Let's denote the characteristics of the ceramic brick X_i, the characteristics of the silicate brick Y_i, respectively, and make up the first table.

Table 1 shows the characteristics of materials that play an important role in the construction of buildings and structures

Table 1

№	Physical size and size	X_i the wall is made of baked ceramic bricks	Y_i the wall is made of baked silicate bricks	A wall made of large-sized ceramic blocks	Aerated concrete wall
1	Compressive strength, kg/sm^2	125	150	128	15…30
2	Average density, kg/m^3	1350	1750	830	400
3	Thermal conductivity $Vt(m^{*\circ}K)$	0,40	0,95	0,21	0,1
4	Water absorption, %	13	13	12	>30
5	Frost resistance, cycles	35	35	50	25
6	Standard wall thickness, m	0,52	0,52	0,38	0,40
7	The cost of a wall of standard thickness, grn/m^2	~520	~390,00	~418,00	~480
8	The speed of construction of a wall of standard thickness, $hour/m^2$	>3	>3	~1,30	~0,88

Table 2 shows the characteristics of fired ceramic bricks

Table 2

№	Physical size and size	
1	Weight	2,4 … 2,7
2	Compressive strength, kg/sm^2	125
3	Average density, kg/m^3	1350
4	Thermal conductivity $Vt(m^{*\circ}K)$	0,40
5	Water absorption, %	13
6	Frost resistance, cycles	35

Table 3 shows the characteristics of the fired silicate brick

Table 3

№	Physical size and size	
1	Weight	3,7
2	Compressive strength, kg/sm^2	150
3	Average density, kg/m^3	1750
4	Thermal conductivity $Vt(m^{*\circ}K)$	0,95
5	Water absorption, %	13
6	Frost resistance, cycles	35

We find the regression line Y to X according to the data presented in Table 4

Table 4

№	X_i Ceramic Brick	Y_i Silicate Brick	X_i^2	Y_i^2	$x_i y_i$
1.	125	150	15625	22500	18750
2.	1350	1750	1822500	3062500	2362500
3.	0,4	0,95	0,16	0,9025	0,38
4.	13	13	169	169	169
5.	35	35	1225	1225	1225
6.	0,52	0,52	0,2704	0,2704	0,2704
7.	520	390	270400	152100	202800
8.	3	3	9	9	9
n=8	$\sum_{X_i} = 2046,92$	$\sum_{Y_i} = 2342,47$	$\sum_{X_i^2} = 2109928,43$	$\sum_{Y_i^2} = 3238504,173$	$\sum_{X_i Y_i} = 2585453,65$

From the table we get the ones below:

$$\sum_{i=1}^{8} x_i = 2046,92$$

$$\sum_{i=1}^{8} y_i = 2342,47$$

$\sum_{i=1}^{8} x_i^2 = 2109928,43$

$$\sum_{i=1}^{8} y_i^2 = 3238504,173$$

$$\sum_{i=1}^{8} x_i y_i = 2585453,65$$

$\bar{x} = 40,9384;$ $\bar{y} = 46,8494;$

↑ $\sigma_x^2 = 40522,61601;$

$\sigma_x = 201,3023;$

$\sigma_y^2 = 62575,21718;$

$\sigma_y = 250,1539;$

$C_{xy} = 49791,13$

A correlation table representing the ratio of Y to X and X to y

Table 5

№	X_i Ceramic Brick	Y_i Silicate Brick	$\bar{y}_x$	$\bar{x}_y$	$\bar{y}_x - \bar{x}_y$
1	125	150	150,14	123,02	27,12
2	1350	1750	1 655,33	1 396,14	259,19
3	0,4	0,95	-2,96	4,42	-7,38
4	13	13	12,52	14,00	-1,48
5	35	35	39,55	31,51	8,04
6	0,52	0,52	-2,81	4,07	-6,89
7	520	390	635,48	313,98	321,50
8	3	3	0,23	6,05	-5,81

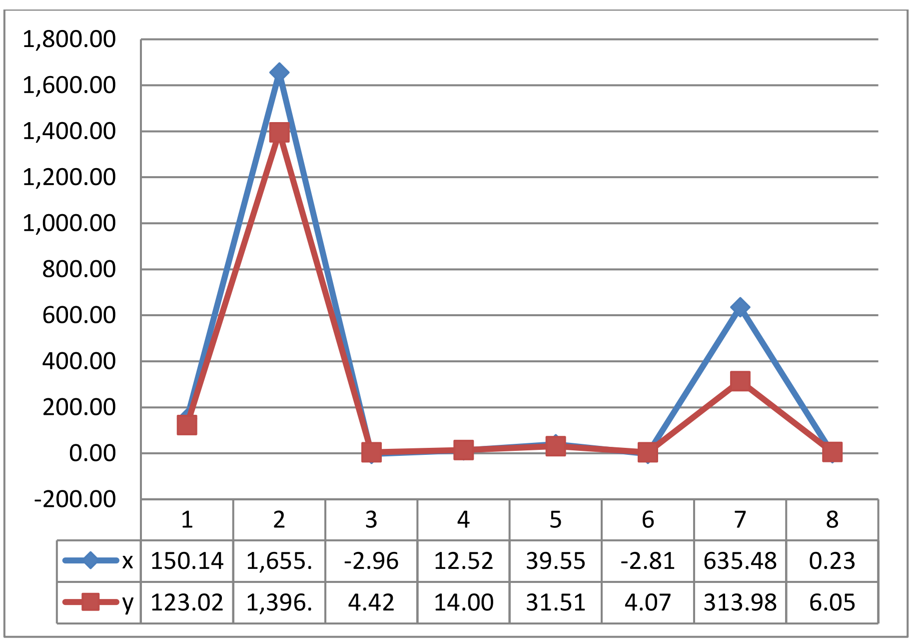

Figure 1

Figure 1 shows the results of regression equations for ripe ceramic and ripe silicate bricks.

The conclusions are that the properties of fired ceramic and fired silicate bricks used in the construction of buildings and structures have been mathematically analyzed. As a matrix (a sufficiently studied building material), the walls of buildings made of baked ceramic bricks and silicate baked bricks, very close in parameters to it, are accepted. New hybrid materials are calculated: a comparative assessment of aerated concrete and other scientifically studied building materials is given and the above results are obtained compared with the results of practice.

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