GEOMETRIC MODELING THE COMPRESSIVE STRENGTH THE SAMPLES OF AERATED CONCRETE AFTER HEAT-HUMIDITY PROCESSING

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Summary. This work analyzes the effectiveness of existing methods of mathematical modeling and the proposed method of geometric modeling the physical and mechanical properties of building materials, implemented in Bn-calculation. According to the existing plan matrix experiment to determine the tensile strength in compression aerated samples received sequence analysis of dependencies, which allows to determine the physical and mechanical properties of building materials, depending on two parameters: electric field intensity and duration electrotreatment.

Key words: **geometric model, BN-calculation, tensile strength in compression, electrostatic field strength, duration of electric treatment, response surface, the plan matrix**

Formulation of the problem. An important component of modern research in every branch of science and technology is the processing and analytical description of the obtained in the experiment dataset. Especially it is actual for research of properties of multicomponent systems, which include a variety of building materials. For them, the urgent task is to determine the optimal composition of materials to obtain the required physical and mechanical properties. It should be noted that to study the properties of building materials and optimization of their composition wide popularity among the domestic scholars use the methods of mathematical statistics and computer simulation, and geometric modeling play a role of a visualization of the results of research. Meanwhile, in many cases, placing in conformity with any process or phenomenon is a geometric object which is obtained on the basis of available experimental data array, it is possible to obtain results of much higher quality than obtained by other methods of mathematical and computer modeling.

Generally, under the model of an object refers to another object, the individual properties of which fully or partially match the properties of the original object. In this case, you need to understand that a mathematical model is absolutely full can. It is always limited and should be responsible solely to the purposes of modeling, reflecting as much the properties of the source object as necessary for this particular study. Therefore, when evaluating the efficiency of the simulations always raises the question of the adequacy of the obtained models. The adequacy of the model is evaluated on the closeness of results of calculations experimental data. To assess the adequacy of the models obtained on the basis of mathematical statistical methods, using the appropriate criteria of adequacy (e.g., Fisher criterion), showing how the resulting mathematical model differs from the values of experimental data, which are the initial data of the simulation. Based on the above, we can conclude that such deviations are always to a greater or lesser extent. A large gathering of experimental data, when geometrically we have a point cloud, this approach is justified because it allows to evaluate the nature of the process, but with a small amount of experimental data, it gives a very significant error. On the other hand, methods of geometric modeling, you can create geometric objects with specified properties. Geometrically this means that the object must pass through the points, each of which corresponds to its value from the experimentally obtained dataset. The advantage of this approach is the complete absence of deviations from the original data, since this condition was originally founded in the properties of a geometric object at the stage of its formation.

Analysis of recent research. Before solving the problems of optimization? based on the model, it is important to ensure its adequacy. Otherwise, the results of optimization can be considered questionable. Were analyzed by the authors[1, 2] the results of mathematical modeling of physico-mechanical properties of modified degaetano based on regression analysis and justification of the choice of mathematical apparatus – bn-calculus [3] for geometric modeling of physico-mechanical properties of modified degaetano and their analytical description.

This article is a continuation of the work of the authors compared with the effectiveness of methods of mathematical modeling of physico-mechanical properties of building materials. So in the work [4] we study the dependence of the limit of compressive strength of concrete samples after heat-moist processing (HMP) by the strength of the electrostatic field and the duration of electrobraid. This work is notable for the fact that for the solution of problems of mathematical modeling and optimization are used not only the regression analysis, but other methods of mathematical and computer modeling. Despite the presence of considered in [4], various modeling techniques, their result can be considered satisfactory but not the best when compared with the results obtained based on methods of geometric modeling.

The article goals. To develop a geometric model of dependence of ultimate strength in compression of samples of aerated concrete after HMP from of tension of the electrostatic field and the duration of electrobraid, and also to compare the obtained results with other methods of mathematical and computer modeling.

Main part. For a start, we will analyze available experimental data obtained in work [4]. We will restructure this dataset in accordance with the duration of electrobraid. The result is presented in a modified array of the experimental data in table 1.

Table 1

The plan-matrix of the experiment and the varied values

№	Values of factors of variation				The average value of the optimization parameter
	Coded		Natural		
	The tension of electro-static field E, кВ/см	The duration of electrobraid, τ, min	The tension of electro-static field E, кВ/см	The duration of electrobraid τ, хв	The limit of compressive strength samples of concrete after НМР, Rсж, МПа
1	-1	-1	1,0	10	5,06
2	0	-1	1,5	10	5,03
3	+1	-1	2,0	10	4,39
4	-1	0	1,0	20	5,14
5	0	0	1,5	20	6,79
6	+1	0	2,0	20	4,24
7	-1	+1	1,0	30	5,02
8	0	+1	1,5	30	4,46
9	+1	+1	2,0	30	4,26

As we can see from table 1, the limit of compressive strength of concrete depends on two factors: the intensity of the electrostatic field and the duration of electrobraid. From a geometrical point of view, the object is defined by two parameters, is the compartment surface, situated in three-dimensional space. To build such a surface we used the method of rolling the simplex [5] and selected from nine available points, which correspond to the natural values of the factors of variation and the average value of the parameter optimization, three guide bars, which correspond to the duration of electrobraid 10 min, 20 min and 30 min. Let use the point-equation of an arc of a parabola of the second order, which passes through three given points in advance [6], for parabolic interpolation of the experimental data. The choice of the parabolic interpolation is due to the number of predetermined points of the arc of the curve and depends on the number of the experiments. Point equation of the guides Doug, consistent with the parameter will look like this:

$$M_{10} = A_1^{10}\bar{u}\ \ 1-2u\ \ + 4A_{1,5}^{10}\bar{u}u + A_2^{10}u\ \ 2u-1\ ,$$
$$M_{20} = A_1^{20}\bar{u}\ \ 1-2u\ \ + 4A_{1,5}^{20}\bar{u}u + A_2^{20}u\ \ 2u-1\ , \qquad (1)$$
$$M_{30} = A_1^{30}\bar{u}\ \ 1-2u\ \ + 4A_{1,5}^{30}\bar{u}u + A_2^{30}u\ \ 2u-1\ ,$$

where A_i^j – corresponds to the average value of parameter optimization to nd the tension of the electrostatic field and the second duration of electrobraid which are aligned in accordance with the plan matrix presented in table 1.

On these rails the parabolic arcs moving a simplex of three points , which define forming an arc of a parabola using the same point of the equation:

$$M = M_{10}\bar{v}\ \ 1-2v\ \ + 4M_{20}\bar{v}v + M_{30}v\ \ 2v-1\ . \qquad (2)$$

As a results we will received a series of point equations depending on two parameters, which define a compartment of a surface, which passes through nine given points in advance. Moreover , the value of a parameter which varies from 0 to 1, corresponds to the electrostatic field is varying in the range from 1 kV/cm to 2 kV/cm, and the value of a parameter which varies from 0 to 1, corresponds to the duration of electrobraid, which varies from 10 min. to 30 min. For software implementation, testing and visualization of the proposed sequence of the same type point equations we use the software package Maple (Fig. 1).

It should be noted that in figure 1 for correct displaying compartment response surface chosen different scales along the axes of the global Cartesian coordinate system.

Analyze the obtained results and compare them with the mathematical model obtained in work [4]. The results of the analysis present in table 2.

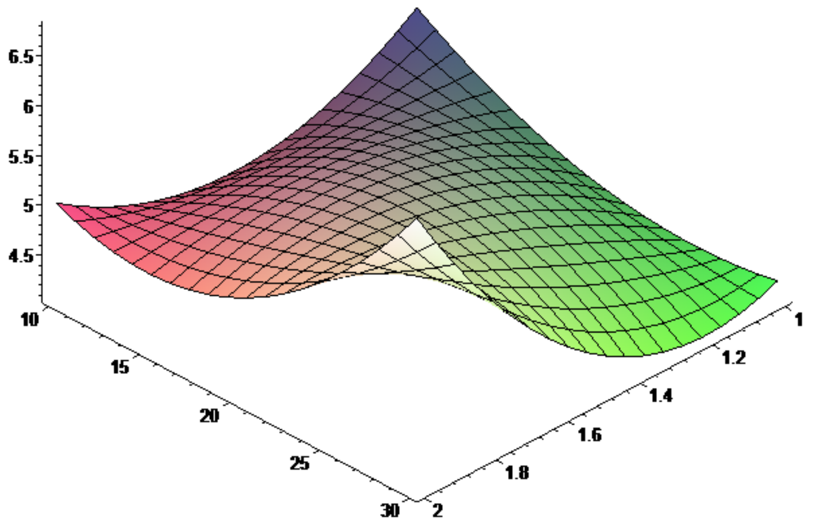

Рис. 1. Graphical visualization of response surface the relationship between the compressive strength of concrete samples after HMP from the tension of the electrostatic field and the duration of electrobraid

Table 2

Comparative analysis of mathematical modeling of the relationship between the compressive strength of concrete samples after HMP from tension of the electrostatic field and the duration of electrobraid

№ п/п	The tension of electro-static field, E, кВ/см	The duration of electrobraid, τ, хв	Межа міцності при стисканні зразків газобетону після ТВО, Rсж, МПа			Похибка, %	
			The natural values	The regression analysis	The geometric modeling	The regression analysis	The geometric modeling
1	-1	-1	5,06	5,119	5,06	1,2	0
2	0	-1	5,03	5,717	5,03	13,7	0
3	+1	-1	4,39	4,387	4,39	0,1	0
4	-1	0	5,14	5,455	5,14	6,1	0
5	0	0	6,79	6,053	6,79	10,9	0
6	+1	0	4,24	4,723	4,24	11,4	0
7	-1	+1	5,02	4,603	5,02	8,3	0
8	0	+1	4,46	5,201	4,46	16,6	0
9	+1	+1	4,26	3,871	4,26	9,1	0

As we can see from table 2 regression analysis gave a good result. His error does not exceed 17%. On the other hand, the geometric modeling of such errors is not available at all, because all necessary conditions have been laid already at the stage of formation of the compartment of the response surface. It should also be noted that in work [4] in the modeling process were involved not natural settings, and their corresponding coded factors of variation that makes it impossible to convert the simulation results in natural settings. In this case you lose the sense of simulation. In addition, in [4] shows monograms, which, according to the author, obtained on the basis of the program "Curve expert 1.3". The results obtained on the basis of this program [4] are not given, but rather a calculated correlation coefficient and standard error. If you compare this approach to modeling, it may be noted that even with low rates of error, it still has a place in contrast to the methods of geometric simulation, implemented in the bn-calculus.

Conclusions. We obtain a sequence of analytical dependences, which defines a geometrical model based on the limit compressive strength of samples of aerated concrete after HMP from of tension of the electrostatic field and the duration of electrobraid that allows to use the obtained model as a means of forecasting and gives the possibility of optimizing the parameters of the electrostatic activation of concrete mix. In addition, a comparison of the model with existing models, which confirms the effectiveness of application of methods of geometric modeling in the analytical description of the natural, technical and technological phenomena and processes.

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