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Prediction of the parameter of duration of works with the use of permanent formwork for low-rise buildings

Moustapha Assaad
PhD Scholar, Kharkiv National University of civil engineering and Architecture, Ukraine

***Abstract* – The article presents the results of investigation of organizational and technological factors on the duration of the device bearing structures of low-rise buildings that use of permanent formwork. The method of accounting influence factors using simulation.**

Keywords: **permanent formwork, a factor simulation model, expert evaluation.**

I. INTRODUCTION

In the development of design solutions for the construction of supporting structures of low-rise buildings using permanent formwork, there is a lack of scientific and methodological developments in forecasting technical and economic factors. It is well known that forecasting is a scientific study of the specific prospects for the development of a process. One of the indicators of the effectiveness of the construction process is the duration of the work, the forecasting of which is necessary to reduce the time and reduce the cost of construction [1].

With an increase in the totality of factors affecting the accuracy of the forecast, the main methods of forecasting are applied: statistical methods; modeling methods; expert assessment methods; evaluation by analogy; intuitive methods.
Simulation models are widely used to predict the technical and economic factors. In [2-7], various aspects of optimization parameters construction using computer hardware and relevant information technology. In valuation practice frequently used methods of expert estimates. In some cases, this is due to lack of information. In particular, one of the most common methods of collective expert assessments is the method of ranking. Ranking allows you to select from the test set of the most significant factors.

Experts were invited to make correct, independent decisions and evaluations - highly qualified specialists in the field of construction and design work with fixed formwork for the construction of supporting structures of low-rise buildings (walls and ceilings). In preparing for the assessment, 11 factors were formulated that affect the duration, with the possibility of addition and exclusion. The following organizational and technological factors were selected and evaluated using the survey method:

1 - The degree of combination of work;
2 - Floor height;
3 - Constrained construction site;
4 - Overlap area;
5 - Quality of preparation of structures of the underground part;
6 - The level of mechanization of work;
7 - Seasonality and atmospheric conditions of influence on the technological process;
8 - The expectation of elements of permanent formwork before laying;
9 - The ratio of the volumes of permanent formwork blocks and concrete laid;
10 - Turnover of warehouse space;
11 - The degree of security process fixtures for quality control work.

Assessment of the coherence of the views of experts was carried out using the coefficient of concordance (agreement) by the formula (1):

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$$\mathbf{K}_{conc} = \frac{\mathbf{K}}{\mathbf{K}_{\mathbf{max}}}, \qquad (1)$$

Where K_{conc} - coefficient of concordance;

K - Algebraic sum of the squares of the differences;

K_{max} - The maximum possible value of the sum of the squares of algebraic varieties.

The data that can be represented as a matrix (Table 1) were obtained by analyzing the standardized expert evaluations.

Table 1 - Matrix standardized survey ranks the expert group

experts			Factors, m											Di
			1	2	3	4	5	6	7	8	9	10	11	
			j1	j2	j3	j4	j5	j6	j7	j8	j9	j10	j11	
	i1	one	1.05	5.24	2.1	6.29	4.19	3.14	10.48	11.52	8.38	9.43	4.19	66
	i2	2	6.39	1.07	3.19	2.13	7.45	5.32	7.45	10.65	9.58	11.71	1.07	66
	i3	3	2	one	five	ten	3	four	9	eight	6	eleven	7	66
	i4	four	0.96	7.65	6.69	1.91	5.74	8.61	9.57	7.65	3.83	10.52	2.87	66
	i5	five	2	6	eight	four	3	7	9	eleven	five	ten	one	66
n	i6	6	5.32	7.45	2.13	1.07	8.52	10.65	3.19	4.26	11.71	6.39	5.32	66
	i7	7	6.71	2.24	4.48	3.36	7.83	10.07	6.71	11.19	1.12	8.95	3.36	66
	i8	eight	2	five	7	eight	3	four	6	ten	9	eleven	one	66
	i9	9	2	one	four	five	7	9	ten	6	eight	eleven	3	66
	i10	ten	10.68	2.91	1.94	7.77	3.88	0.97	8.74	9.71	4.85	8.74	5.82	66
	i11	eleven	1.74	9.55	3.47	5.21	8.68	6.95	7.82	7.82	6.08	7.82	0.87	66
Sj			40.84	49.11	48.00	54.72	62.29	69.71	87.95	97.79	73.55	106.55	35.5	
$\overline{S} = \frac{1}{2} n(m+1)$			66											
$d = S_j - \overline{S}$			-25.16	-16.89	-18.00	-11.28	-3.71	3.71	21.95	31.79	7.55	40.55	-30.5	
d^2			633.08	285.34	323.90	127.16	13.73	13.73	481.8	1010.4	56.97	1644.1	930.6	
$K = \sum_{g=1}^{m} d_g^2$			5520.75											
$K_{max} = \frac{1}{12} n^2 (m^3 - m)$			13310											
$K_{konk} = \frac{K}{K_{max}}$			0.415											

According to the results chart factors influence (Fig. 1) based assessments

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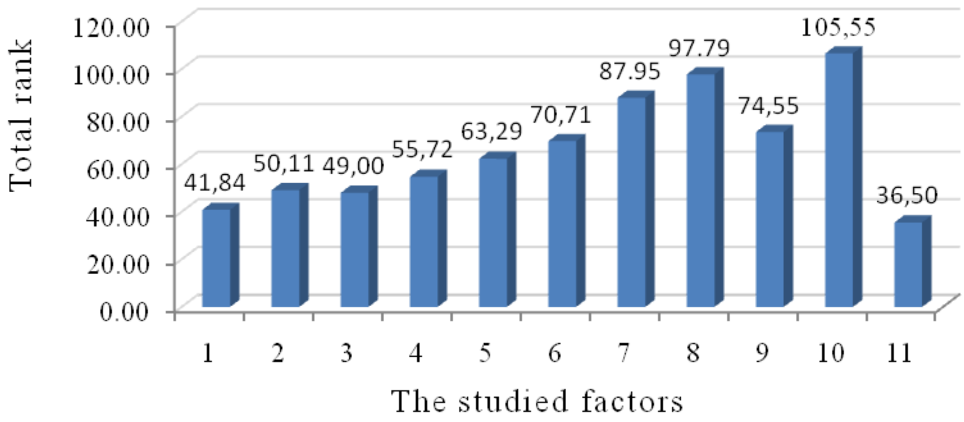

Fig. 1 - The total ranking and studied factors

The diagram shows that the last of the factors studied turnover worth of storage space, the total rank S_j = 105,55. In doing so, the most important are the following factors:

– Degree of security devices for process quality control of the works– 11 (S_j = 36,50);
– The degree of overlapping work– 1 (S_j = 41,84);
– Tightness of the construction site– 3 (S_j = 49,0);
– Performance Breakdowns bearing walls on the concrete tiers – 2 (S_j = 50,11);
– The overlap area– 4 (S_j = 55,72);
– Quality of construction of the underground part– five (S_j = 63,29);
– At level of mechanization– 6 (Sj = 70,71);
– Volume ratio of permanent formwork blocks and the laid concrete - 9 (S_j = 74,55).

To construct a simulation model for predicting the duration of work, we systematize these factors and use them in the construction of a multi-factor mathematical model. Bearing structures (walls and floors) of low-rise residential and administrative buildings were taken as objects of observation. To study the influence of organizational and technological factors on the duration of the work, a sample set of projects was considered. The method of developing a model is reduced to examining the effect of a change in the resultant factor Y under study in response to a change in its determining factor signs xi (i = 1, 2, ..., n) [8, 9].

As a result, we obtain a system of statistical data on changes in the factors being studied and corresponding results. After processing these data, we obtain the dependence of the resultant attribute Y on the change in the factor signs x_i, described by an equation of the form:

$$Y_x = b_0 + b_1 \cdot x_1 + b_2 \cdot x_2 \ldots b_n \cdot x_n, \quad (2)$$

Where b_1 – regression coefficients, which are determined on the basis of processing the initial data.
Then pair correlation matrix was constructed by using Statistical software package (Table. 2), factors that are closely related to the result and factors interacting with each other were identified. An analysis of the matrix of correlation coefficients shows that the factor of breaking down load-bearing walls into concrete tiers (factor x2) has the greatest impact on the duration of work (sign y), since it has the greatest value of correlation coefficient with an effective feature (r_{yx2} = 0,876).

Table 2 - Correlation matrix

	The correlation matrix								
	1	2	3	4	5	6	7	8	9
	Y	*X1*	*X2*	*X3*	*X4*	*X5*	*X6*	*X9*	*X11*
Y	1.000	0.459	0.876	0.309	0.199	0.566	0.104	-0,837	0.872
X1	0.459	1.000	0.437	0.289	-0,389	0.031	0.185	-0,573	0.433
X2	0.876	0.437	1.000	0.191	0.158	0.456	0.171	-0,762	0.645

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X3	0.309	0.289	0.191	1.000	-0,181	0.407	0.255	-0,363	0.256
X4	0.199	-0,389	0.158	-0,181	1.000	0.148	0.020	0.228	0.391
X5	0.566	0.031	0.456	0.407	0.148	1.000	-0,095	-0,601	0.371
X6	0.104	0.185	0.171	0.255	0.020	-0,095	1.000	0.127	0.016
X9	-0,837	-0,573	-0,762	-0,363	0.228	-0,601	0.127	1.000	-0,609
X11	0.872	0.433	0.645	0.256	0.391	0.371	0.016	-0,609	1.000

Thus, the analysis and other factors included in the model. The factors included in the multiple regression should explain the variation of the independent variable. The paper used the following methods for constructing a multiple regression equation: the elimination method, the inclusion method, step-by-step regression analysis.

After analyzing the table values of the regression coefficients, we can say that the coefficients for the variables x_1, x_2, x_3, x_4, x_5, x_6, x_9 are insignificant at the 5% significance level. From the model one should exclude the factor whose coefficient has the smallest absolute value of t-statistics, namely the factor of x_4(p-value 0.83, the value of t = -0,23).

After this, a new multiple regression equation was obtained:

$$\hat{y}_i = -287{,}76 - 95{,}98x1 + 54{,}46x2 - 10{,}8x3 + 129{,}29x5 + 102{,}18x6 - 42{,}52x9 + 367{,}6x11$$

(3)

The process of eliminating factors stops at that step, in which all regression coefficients are significant. After elimination of the variable x6, all other factors were weighty and included in the model. The final model includes the variables x_2, x_9, x_{11} (Table 3).

Table 3 - Calculated values final model

N = 14	Beta	Std.Err. of Beta	B	Std.Err. of B	t (10)	p-level
Intercept			-297,230	62,381	-4,765	0.001
x2	0.367	0.107	77,105	22,505	3.426	0.006
x9	-0,271	0.103	-28,581	10,883	-2,626	0.025
x11	0.470	0.087	347,008	64,622	5.370	0.000

As a result of the application of various approaches to the choice of factors, using the methods of correlation and regression analysis, a multifactorial regression model was built depending on the duration of work on the following factors:

- Factor of breakdown of bearing walls into concrete tiers;
- The ratio of the volumes of fixed formwork blocks and concrete laid;
- Degree of process security with devices for quality control of works:

$$\hat{y}_i = -297 + 77{,}1x_2 - 28{,}6x_9 + 347x_{11} \qquad (4)$$

The accuracy of the model is estimated using the average approximation error, which is equal to 8.6%, and means that the actual values of the duration of work differ from the calculated ones by an average of 8.6%. The proposed mathematical model allows forecasting the accounting of factors affecting the indicator of the duration of the

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construction of supporting structures of walls and floors of low-rise buildings in order to develop measures to reduce the duration.

REFERENCES

[1] Chernenko V.K. Construction Technology: Textbook / V.K. Chernenko, MG Yarmolenko, GM Batura et al.; for ed. V.K. Chernenko, MG Yarmolenko - K.: High school, 2002. - 430 p.

[2] Alkass, S., Alhussein, M., and Moselhi, O. 1997. Computerized crane selection for construction projects, Proc. 13th Annual ARCOM Conference, Association of Researchers in Construction Management, 427-436.

[3] Choi, C., and Harris, F. 1991. Technical Note. A model for determining optimum crane position, Proc. Institution of Civil Engineers, ICE Virtual Library, 627-634.

[4] Elbeltagi, E., and Dawood, M. 2011. Integrated visualized time control system for repetitive construction projects, Automation in Construction, 20 (7), 940-953.

[5] Philip, M., Mahadevan, N., and Varghese, K. 1997. Optimization of Construction Site Layout - A Genetic Algorithm Approach, Proc, 4th Congress Held in Conjunction with A / E / C Systems, ASCE, 710-717..

[6] Shapira, A., and Lyachin, B. 2009. Identification and analysis of factors affecting safety on construction sites with tower cranes, Journal of Construction Engineering and Management, 135 (1), 24-33.

[7] Kim, GB, Pilakoutas, K. and Waldron, P. 2008. Development of thin FRP reinforced GFRC permanent formwork systems, Construction and Building Materials, 22 (11), 2250-2259.

[8] Beshelev SD Mathematical and statistical methods for expert assessments / SD Beshelev, FG Gurvich. - 2 nd ed., Revised. and ext. - M.: Statistics, 1980. - 263 p.

[9] Adler Y. experiment in the search for optimum conditions / YA Adler, EV Markov, Y. Granovsky. - 2 nd ed., Revised. and ext. - M.: Nauka, 1976.– 279.

[10] Tyurin Yu.N. Statistical analysis of the data on the computer / YN Tyurin, AA Makarov; ed. VE Figurnova. - M.: INFRA-M, 1998. - 528 p.

AUTHOR BIOGRAPHY

Moustapha Assaad, PhD Student, Department of Civil Engineering, Kharkiv National University of Civil engineering and Architecture, Ukraine. Author of 5 scientific publications. Research interests:. KhNUBA, 40 Sumskaja, Kharkiv, 61002, Ukraine.