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Məqaləyə istinad: Əliyeva Ş.Ş. Bərabərsizliklər mövzusunun tədrisində Geogebra proqramının istifadəsi. Elmi Əsərlər/Scientific works, AzMİU, s.141-145, N2, 2024
For citation: Aliyeva S.S. Using the Geogebra program in teaching inequalities. Elmi Əsərlər/Scientific works, AzUAC. p.141-145, N2, 2024

Redaksiyaya daxil olma/Received 11.10.2023
Çapa qəbul olunma/Accepted for publication 11.01.2024

http://doi.org/10.58225/sw.2024.2-146-152

OPTIMAL SHORT DURATION OF FLOW CONSTRUCTION PRODUCTION

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Abstract. In this article, the issue of the optimal duration of construction and installation work and the optimal number of manga is considered. Until now, calculations are carried out more in the equation of optimal duration with two unknowns offered to us, and as a result, a more optimal version of the workers' movement graphics was not obtained. It is possible to obtain the optimal manga number with the equation of the optimal duration through the already proposed formula. Three numbers close to the obtained optimal duration is accepted, the optimal manga number is calculated and the production norm is compared. As a result of the calculation, it is determined that when the optimal duration is between K_{opt} and $\sqrt{a}$, the production norm is more than 100%. This means that the worker performs the daily work routine excessively.

Key words: optimal duration, optimal number of manga, production norm, stress in block

AXINABƏNZƏR TİKİNTİ İSTEHSALATININ OPTİMAL QISA MÜDDƏTİ

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Xülasə. Bu məqalədə tikinti-quraşdırma işlərinin optimal müddəti və manqanın optimal sayı məsələsinə baxılmışdır. İndiyə qədər bizə təklif olunan iki məchullu optimal müddətin tənliyində hesabat işləri daha çox aparılır və nəticədə fəhlələrin hərəkət qrafiki daha optimal variantı əldə olunmurdu. Artıq təklif oluna düstur vasitəsilə optimal müddətin tənliyi ilə optimal manqa sayıda əldə etmək mümkündür. Alınmış optimal müddətə yaxın üç rəqəm qəbul edib optimal manqa sayı hesablanıbvə istehsalat norması müqayisə edilmişdir. Hesabatlar nəticəsində müəyyən olunmuşdur ki, optimal müddət K_{opt} və $\sqrt{a}$ arasında olduqda, istehsalat norması 100%-dən artıq olur. Bu o deməkdir ki, fəhlə gündəlik iş rejimini artıqlaması ilə yerinə yetirir.

Açar sözlər: optimal müddət, optimal manqa sayı, istehsalat norması, tutaqdakı gərginlik

Introduction. The main issue of the science of construction production is to build buildings and facilities of high quality, quickly and cheaply. This subject is required to look for ways to construct buildings and facilities with high quality, quickly and cheaply, and to bring out the relationships that form the basis of these ways and generalize them to be applied in practical work. Construction production is a unity of scientific theories of technology, organization and economics. One of the issues of technological science is the methods of researching and determining the optimal technology for building and putting into use any building and facility. As we know, buildings and facilities can be completed in different ways. The most modern of these is the flow work method, in which the building and the facility are divided into blocks, and after the work brigade has completed its work in the first block, it moves to the second block. In the first block comes a brigade who perform the next process. As we know, the construction-installation process is the basis of the construction industry, and the duration of the buildings and facilities depends on the duration of the construction-installation processes.

Research methodology. One of the most modern methods of ensuring continuity of work and efficient use of resources in the construction industry is possible through the application of flow theory. [5]. As it is known, the optimal duration of the construction processes in the flow work method is given by the method of successive approximation, but in this article, the value of the optimal duration is given by the method of finding the average value of the function z=y/x of the spatial object formed by the hyperbola curve. Finding the average value of a function in a double integral is found by the ratio of the volume expressed by the function to the area of integration. Finding the optimal duration of complex technological processes of monolithic reinforced concrete work was chosen as a research issue.

Discusion. There is such a relationship between the block duration of the construction-installation process and the number of professional mangas performing the process, provided that the technology of flow construction production remains constant.

1. When the decisive force performing the process is a manual mechanism [1].

$$X = \frac{q}{b} \bullet \frac{1}{y} \qquad (1)$$

2. When the decisive force performing the process is a machine mechanism

$$X = \frac{M}{y_m} \qquad (2)$$

Here x - duration, with day

y – number of professional manga

q – the labor capacity of the process in the block

b – numerical composition of professional manga

M – machine capacity of the process in a block

y_m – the number of machines or systems of machines of a type that carry out a process

If we accept $\frac{q}{b}$ = a, we can write x= $\frac{a}{y}$ from formula 1. (3)

Equations 2 and 3 are the equations of the hyperbola curve.

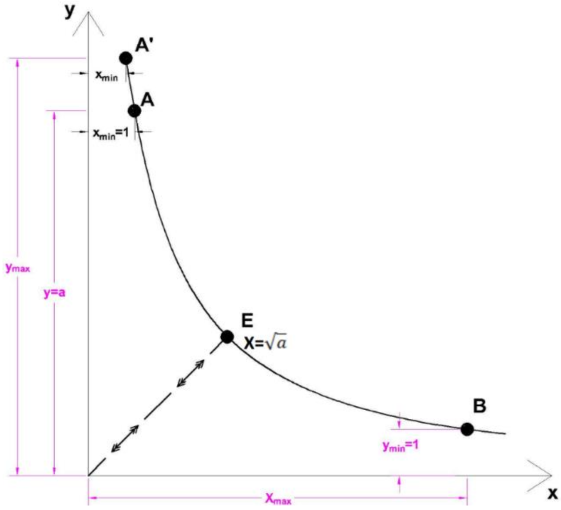

Figure 1. The dependence curve between the duration in the block and the number of manga [1]

In the equation of the hyperbola curve, y is the independent variable and x is the dependent variable. Theoretically, y varies between zero and infinity, and x varies between infinity and zero. Since y is the number of mangas or some kind of machines in life, y can be at least one manga y_{min}=1 manga or machine, and at most the number that can be placed in the block, i.e. $y_{max}=\frac{F}{f}$, $y_{max}=\frac{F}{fm}$.

Here F- is the area of the working zone of the block, with m^2.

f and f_m - are the area of the workplace required for the free operation of a manga and a machine, with m^2.

When y_{min} and y_{max} are known, the minimum X_{min} and maximum X_{max} of the process block can be determined. So, $x_{min} = \frac{a}{y_{max}}$ $x_{max} = \frac{a}{y_{min}}$.

When the construction production is carried out in a flow work method in an extremely short period of time (between point A and A'), the construction work becomes more expensive as a result of the increase of the second group of indirect costs, as well as the loss of labor and machine time and idleness in labor activity. Therefore, it is not convenient to carry out the construction work at the level of the shortest period, especially for massive constructions. Extending the period of construction production to the extreme (point B) is also not favorable, because in such a condition the coefficient of use of construction machinery will decrease, and moreover, the work may become more expensive due to the increase of the first group of indirect costs [2]. Therefore, the construction duration cannot be allowed to be extended to an extreme extent. Thus, it is clear that the construction-installation process has two unfavorable duration. One of them is X_{max} and the other is X_{min}. Each of the duration in between (A and B) can be the duration of the construction installation process. Only in one of these periods is there such a situation that the block is maximally and usefully provided by labor tension. There is no useless excess tension or it is minimal. In the case of providing the block with useful labor tension, all the labor spent is useful. There is no downtime at work, no unnecessary tension, and labor productivity is higher than all possible levels.

The period corresponding to the maximum useful labor stress of the building installation process is called the optimal period. Undoubtedly, this optimal duration X_{opt} should be at a certain level between the average state ($x=\sqrt{a}$, point E) and the duration corresponding to the maximum labor stress (x=1, point A).

Taking into account the above, let's consider the value of the optimal duration between points A and E on the graph. If y manga have completed a certain construction installation process in a block for x days, this means that they collectively expend $\frac{j}{x}$•y labor power energy each day.

Here j - is the amount of energy consumed by one manga in x days in terms of calories.

Then y manga spends $\frac{\frac{j}{x} \cdot y}{j}$ = z amount of labor in unit j per block in one day. From here it is obtained that $Z = \frac{y}{x}$ (4).

Here, z-y is the amount of unit of work force or energy consumed by manganese in a block in one day, each unit of which is j kilograms. The quantity Z (quantity of j) indicates how well the block is supplied with working energy or tension.

The equation $Z = \frac{y}{x}$ is the equation of the tension of the place (block) with work energy depending on the number of mangas in time. The graphic expression of this equation is a spatial body with a curved surface, and the projection of the line of the body on the vertical plane is a hyperbola curve.

Analyzing equation 3, it was found that the independent variable quantity y actually varies from one to a, and x varies accordingly from a to one. On the other hand, the quantity z can vary from $\frac{1}{a}$ to a in terms of being a unit of labor.

The above opinion can be explained in words like this. When the construction-installation process is carried out by a manga, the work stress on the block is minimum and as a result, the duration is extended to the maximum due to lack of labor force. As the number of manga y increases, so does the workload, and the duration begins to shorten. When the number of manga is finally maxed out, the block becomes extremely tense. Therefore, the duration is minimized. The extremely short duration corresponding to the Z_{max} tension should be such a duration in the X_{max} range that when the block is operating at that level, the tension is neither over nor under.

If the tension in the block is at $Z_{average}$ between Z_{min} and Z_{max}, then the block will be normally loaded and all the labor will be converted into construction work without residual and loss. The duration corresponding to this level of the $Z_{average}$ quantity is the optimal duration of the process in the block.

The signs of optimum duration are that useful labor stress is at a maximum and useless labor is at a minimum. To determine the optimal duration, we must first determine the value of the $Z_{average}$ quantity.

Let us assume that the $Z_{average}$ quantity we are looking for is a hyperbola and its projection on the XY plane of the curve representing the central axis of the spatial body of equation 4 corresponds to point C, If we denote the projection of point C' on the XY plane with coordinates X_c, Y_c, Z_c of point C by C' (X_c, Y_c), we can write that what we are looking for is $Z_c=Z_{average}$ $X_c=X_{opt}$.

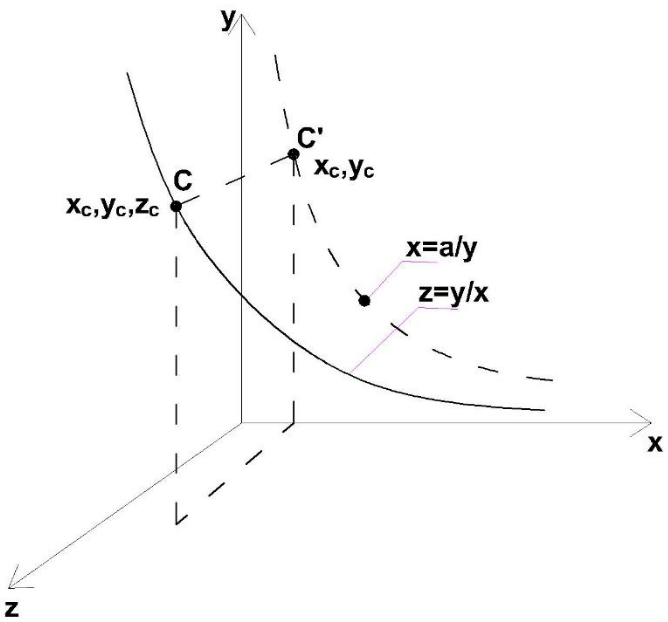

Figure 2. Workplace stress curve [2]

Since the function Z=$f(x,y)$ is a continuous function, the average value of the function between Z_{min} and Z_{max} is given by the expression $Z_{average} = \frac{V}{S}$.
Here V- is the volume expressed by the function
S- is the field of integration.

V=$\iint f(x,y)\,dx\,dy$ S=(a-1)(a-1)

$$Z_{av} = \frac{V}{S} = \frac{\iint f(x,y)\,dx\,dy}{S} = \frac{\int_1^a \int_1^a \frac{y}{x}\,dx\,dy}{S}$$

$$Z_{average} = \frac{\frac{a^2-1}{2}\ln a}{(a^2-1)^2} = \frac{a+1}{a-1}\frac{\ln a}{a}$$

One of the coordinates of point C in space, Z_c= $Z_{average}$ tension in the block, X_c is the work force of manga working during the day as much as Y_c, which completely supplies the block and becomes a non-residual product. If the process in the block is performed by more manga than Y_c, the tension will increase and the duration will be shorter than X_c. However, part of the labor force will be spent ineffectively without being transformed into a product. Therefore, it can be argued that the most productive amount of labor force per block is Y_c, and the most favorable optimal duration of manga is X_c days.

$$X_c = \frac{a}{y_c} \qquad Z_c = \frac{y_c}{x_c}$$

$$Z_c = Z_{avarage} \qquad X_c = X_{opt}$$

$$K_{opt} = \sqrt{\frac{a-1}{a+1}\frac{2a}{\ln a}} \tag{5}$$

In a building with blocks of same sizes, the optimal duration of complex technological processes of concrete work is required.

Table 1. Labor capacity indicators [3]

The name of the work	Unit of measurement	Volume of work	Labor capacity	Composition of manga	a	K_{opt}	N_{opt}
Building a framework	m^2	778	40	2	20	3.476	5.754

Installation of the armature frame	tn	13	85	2	42.5	4.651	9.139
Pouring the concrete mixture into the structure	m^3	110	20	2	10	2.666	3.751
Removing formwork from concrete	m^2	778	15	2	7.5	2.386	3.143

We cannot construct a linear graphic with the obtained optimal duration and number of manga. Because the number of manga should only be a integer number, and the optimal duration should be a integer or a half number.

We will compare these statements according to the obtained optimal duration and choose the most optimal one. We will find the number of manga according to the values of small integer, medium number and large integer corresponding to K_{opt} values obtained in the table and draw a linear graphic. It should be noted that when K_{opt} rounds to a large integer, it must be $K_{opt}<\sqrt{a}$. A linear graphic and a workers' movement graphics are drawn according to the optimal duration and number of manga. In the end, we will choose the most optimal one after calculating and comparing the inequality indicator and the production norm of the workers' movement graphics [3,4] .

Table 2. Duration and optimal number of manga [4]

	Building a framework			Installation of the armature frame			Pouring the concrete mixture into the structure			Removing formwork from concrete		
K_{opt}	3	3,5	4	4	4,5	5	2	2,5	3	2	2,5	2,5
N_{opt}	7	6	5	11	10	8	5	4	3	4	3	3
Production norm	95.24	95.24	100	96.59	94.44	106.25	100	100	111.1	93.75	100	100

Table 3. Inequality indicator and production norm of the workers' movement graphics [4]

	1st option	2nd option	3rd option
Building a framework	95,238	95,238	100
Installation of the armature frame	96,591	94,444	106,25
Pouring the concrete mixture into the structure	100	100	111,11
Removing formwork from concrete	93,75	100	100
Inequality indicator of the workers' movement graphics	0,503	0,596	0,603

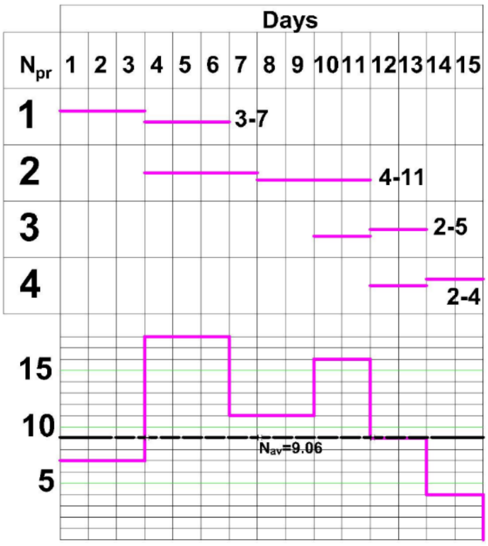

Figure 3. Linear graphic of the 1st option [4]

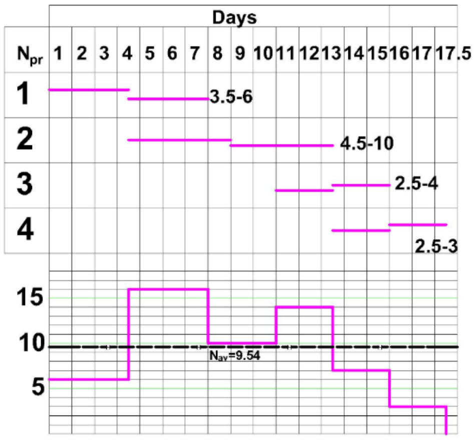

Figure 4. Linear graphic of the 2nd option [4]

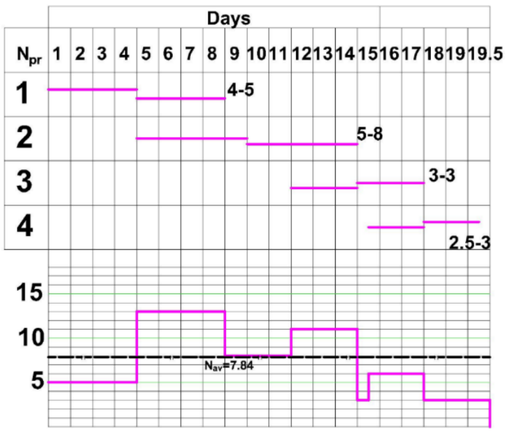

Figure 5. Linear graphic of the 3rd option [4]

According to the results of the inequality indicator of the workers' movement graphics and the production norm prices, it can be said that the price of the optimal duration is not the most optimal option to continue the calculation based on the price obtained from the formula (5). The optimal duration is an integer and a half number between K_{opt} and $\sqrt{a}$ (closer to $\sqrt{a}$).