Influence of Broken Condition and Instability of the Excavation Site Parameters on the Reliability of the Breakage Face

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Abstract. This article presents a method for determining the influence of disturbance and instability of the parameters of the excavation site on the reliability of the work of the treatment face. To determine the impact of disturbance and instability of the parameters of the excavation site on the reliability of the treatment face, a method was model for calculating the quantitative and qualitative characteristics of violations. The general assessment of the reliability of the operation of the technological scheme of treatment works in the dredging areas with changing mining and geological conditions is the sum of the partial estimates of its operation in the areas with stable and unstable operating conditions. The change in the readiness coefficient on the disturbed parts of the excavation site is determined, depending on the magnitude of the influence of geological disturbances on the rate of lava movement. The analysis of some results of the problem under study, obtained using the proposed methodology, is given. The dependence was established that the readiness coefficient decreases most intensively at large values of the ratio, and then the intensity of the decrease decreases towards smaller values.

1. Introduction

At the present time, when the requirements for the accuracy of the forecast for the efficiency of mining excavation fields have sharply increased, it is relevant to assess the reliability of the technological schemes of the treatment excavation (availability coefficient, probability of failure-free operation, etc.), both as a whole for the excavation field, taking into account changing mining and geological conditions, and on its individual parts [1-17]. An analysis of the trends in the economic and social development of the country, as well as the global energy complex, shows the continuing importance of coal in the fuel and energy balance of the main industrial countries of the world. The corresponding methodology is proposed.
2. Research objectives
The aim of the study is to establish the influence of the disturbance and the parameters of the excavation site on the reliability of the work of the treatment face. To establish the regularities of the development of geomechanical processes in the massif during the development of reserves in the dredging areas of high-performance mines to justify technological solutions to improve the reliability, safety and efficiency of mining operations [18-25]. Analysis of the results of the problem under study, taking into account the proposed methodology.

3. Materials research methods
The overall assessment of the reliability of the operation of the technological scheme of treatment works at the excavation sites with changing mining and geological conditions is the sum of the partial assessments of its operation at sites with stable and unstable operating conditions (with and without violations).

The total coefficient of readiness $K_g$ is the sum of the products of the coefficients of readiness of the system in areas without violations $K_{gbn}$ and with violations $K_{gn}$ the probability of the state of the treatment face $R_{bn}$ and $R_{n}$:

$$K_g = K_{gbn}R_{bn} + K_{gn}R_{n}$$ (1)

The probability of the state of the treatment face in areas without violations of $R_{bn}$ can be determined as the ratio of the time of operation of the lava in such areas to the total time of working out the site:

$$R_{bn} = \frac{L_u - L_n}{L_{bn}} - \frac{L_u - L_n}{V_{bn}} + \frac{L_n}{V_n}$$ (2)

where $L_u$ is the length of the excavation area, m;
$L_n$ - length of the disturbed part of the excavation area, m;
$V_{bn}$ - the speed of movement of the treatment face on the parts of the excavation site without geological disturbances, m / cm;
$V_n$ - the same for parts of the excavation site with geological disturbances, m/sm.

If the length of the disturbed part $L_n$ is expressed in terms of the length of the lava $l$, the length between the displaced wings of the formation $l_n$, and the angle of the line of disturbance to the strike of the formation $a$, we get:

$$R_{bn} = \left[ L_u - \left( \frac{l_n}{\sin a} - \frac{l}{\tan a} \right) \left( \frac{l_n}{\sin a} + \frac{l}{\tan a} \right) \right]^{-1}. $$ (3)

Probability of the state of the treatment face in areas with violations:

$$P_{n} = 1 - P_{bn} $$ (4)

The system readiness factor in areas with violations and taking into account the change in the length of the lava in the excavation area can be expressed by the following formula:

$$K_{gn} = \left( 1 + \frac{1-K_{gbn}}{K_{gbn}} + \frac{V_p \cdot 1080 \cdot \tau}{l \cdot V_{bn}} + \frac{V_p \cdot \tau \cdot l_{p} \cdot K}{100 \cdot l_{l}} \right)^{-1}, $$ (5)

where $V_p$ - the feed speed of the combine, m / min;
$\tau$ - width of the combine harvester, m;
$l$ - length of the lava, m;
$t$ - the rate of time for the reduction (extension) of the lava equipment per 1 m 2 of lava, min;
$K$ is a coefficient that takes into account that part of the stops (failures) associated with the change in the length of the lava falls on the repair and preparation shifts.

After setting the values of the corresponding indicators in formula (5), we get the value of the total system availability coefficient:

$$K_{gob} = \left(1 + \left[\frac{L_n - (L_n/\sin \alpha + (l/tga))}{(L_n/\sin \alpha + (l/tga))}\right]^{-1} v_n + R_{bn} + K_{gn}\right)$$

(6)

Below are some particular dependencies obtained according to the formulas given.

**4. Experimental investigations and analysis of their results**

Figure 1 shows the dependence of the total availability coefficient on the disturbance of the excavation site.

![Figure 1](image)

**Figure 1.** The dependence of the total readiness coefficient on the disturbance of the excavation site.

Change in the availability factor on the disturbed parts of the excavation site, depending on the magnitude of the influence of geological disturbances on the speed of lava movement $v_n/v_{bn}$ shown in Figure 2.

This is due to the fact that the very fact of the occurrence of a geological disturbance, although with a small amplitude, leads to a significant decrease in the movement of the treatment face.

The dependence of the readiness coefficient on the change in the length of the lava within the excavation area is shown in Fig. 3. With the currently achieved availability coefficients and average feed rates of harvesters, changes in the length of the lava by 10 m leads to a decrease in $K_g$ by 5%.

Figure 3 shows that the availability factor of the treatment face decreases towards higher values $\frac{V_n}{V_{bn}}$ and increases with decrease $\frac{V_n}{V_{bn}}$. 
Figure 2. Change in the readiness coefficient on the disturbed parts of the excavation site, depending on the magnitude of the influence of geological disturbances on the speed of lava movement.

Figure 3. The dependence of the readiness coefficient on the change in the length of the lava within the excavation area.

5. Conclusion
Thus, along with the precise determination of the location of the violation, information about the quantitative and qualitative characteristics of the violations (meeting angle, amplitude, etc.), as well as the variability of the length of the lava within the excavation area of the lava, the use of which makes
it possible to quantify the performance of the excavation columns, is of great importance. To determine the impact of disturbance and instability of the parameters of the excavation site on the reliability of the treatment face, a method was modeled for calculating the quantitative and qualitative characteristics of violations. The general assessment of the reliability of the operation of the technological scheme of treatment works at the excavation sites with changing mining and geological conditions is the sum of the partial estimates of its operation at the sites with stable and unstable operating conditions. The change in the readiness coefficient on the disturbed parts of the excavation site is determined, depending on the magnitude of the influence of geological disturbances on the rate of lava movement. The analysis of some results of the problem under study, obtained using the proposed methodology, is given. The dependence was established that the readiness coefficient decreases most intensively at large values of the ratio, and then the intensity of the decrease decreases towards smaller values.

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