Integrated Sustaining Technogenic Mountain Structures

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Abstract. The problems of controlling the stability of man-made mountain structures presented in the form of open pit and underground workings in the development of mineral deposits in Kazakhstan. Recommendations to improve their resistance to the development of activities and production monitoring tool. Relevance of research is characterized by an increase in depth of field development and the transition to the combined production of minerals from the open method on underground.
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Introduction.

Problems of dynamics of the Earth's crust due to the engineering activity, one way or another connected with the extensive development of mining operations and increase their depth. In the short term, up to 70% of ore quarries will have a depth of more than 250 m, and in some cases from 300 to 500 m.

The overall evaluation of the stability of benches, pit, waste dumps should be borne in mind that in the real world they are exposed to a large number of factors that can be grouped into two categories: natural and mining engineering. The combination of these fac tors determines the strength of the rock mass and the conditions of its deformation.

Existing methods of assessment and justification of the nature of stress-strain state of based on traditional classical basis, but with increasing depth of mining operations engineering-geological situation is complicated and is accompanied by a qualitatively new manifestations of violating the safety of mining operations and the environment.

In recent years, a significant step in addressing the sustainability of mining slopes. But despite the significant achievements of domestic and foreign scholars in the field, the problem is still not solved because of the complexity and diversity of geological features of deposits at this stage.

In assessing the interaction of rocks with different structures, become important structural features of the rock mass, as fracture strength and the forecast of their properties. The work is focused on the study of patterns of change in the strength properties of rock masses with their depth and development on this basis of new technological means to ensure the sustainability of buildings.

The main content of the work.

Office of the stability of rock slopes of various engineering structures including quarries have been engaged as a separate domestic and foreign researchers, and the whole organization [1-5].

But despite the significant achievements of domestic and foreign scholars in the field, the problem is still not solved because of the complexity and diversity of geological features of deposits. Summarizing the analysis of issues related to the stability of the pit walls, it is possible to chart the research slopes of mountain ranges in order to develop techniques and methods for the assessment and management of their stability (Figure 1).

It is from this position of the goal, substantiated the idea, formulated research problems. Experimental facilities and the introduction of the study of objects and the challenges of sustainability quarry slopes were deposits of the Republic of Kazakhstan. [6]

Methods of study of fracturing of the rock mass is divided into direct and indirect.Among the indirect methods for prediction of fracture array become widespread methods based on the determination of the parameters of the physical fields in a given area of the rock mass.

On the basis of the known theoretical propositions developed reliable ways of assessing the disturbance of rocks that will resolve the issue of operational control of their condition and sufficient for the solution of problems of geomechanics detail perform zoning career fields by a factor of disturbance. For large-scale studies of disturbance of rock masses, the definition of the boundaries and sizes of homogeneous and identification of potentially unstable areas benches and pit is proposed to use teplometrichesky method comprising registering the intensity distribution of the thermal radiation of the controlled object, and based on the relationship we have identified the parameters of the thermal radiation of the rock mass (the intensity of infrared radiation) and the characteristics of its violation (weak or strong fracture).

The method differs from similar other ways to improve accuracy and speed measurement with simplicity and usability, while providing multi-drop and simultaneous measurement processes.For registration of the radiation intensity and determination of thermophysical properties of rocks we have developed a device, a block diagram of which is shown in Figure 2.

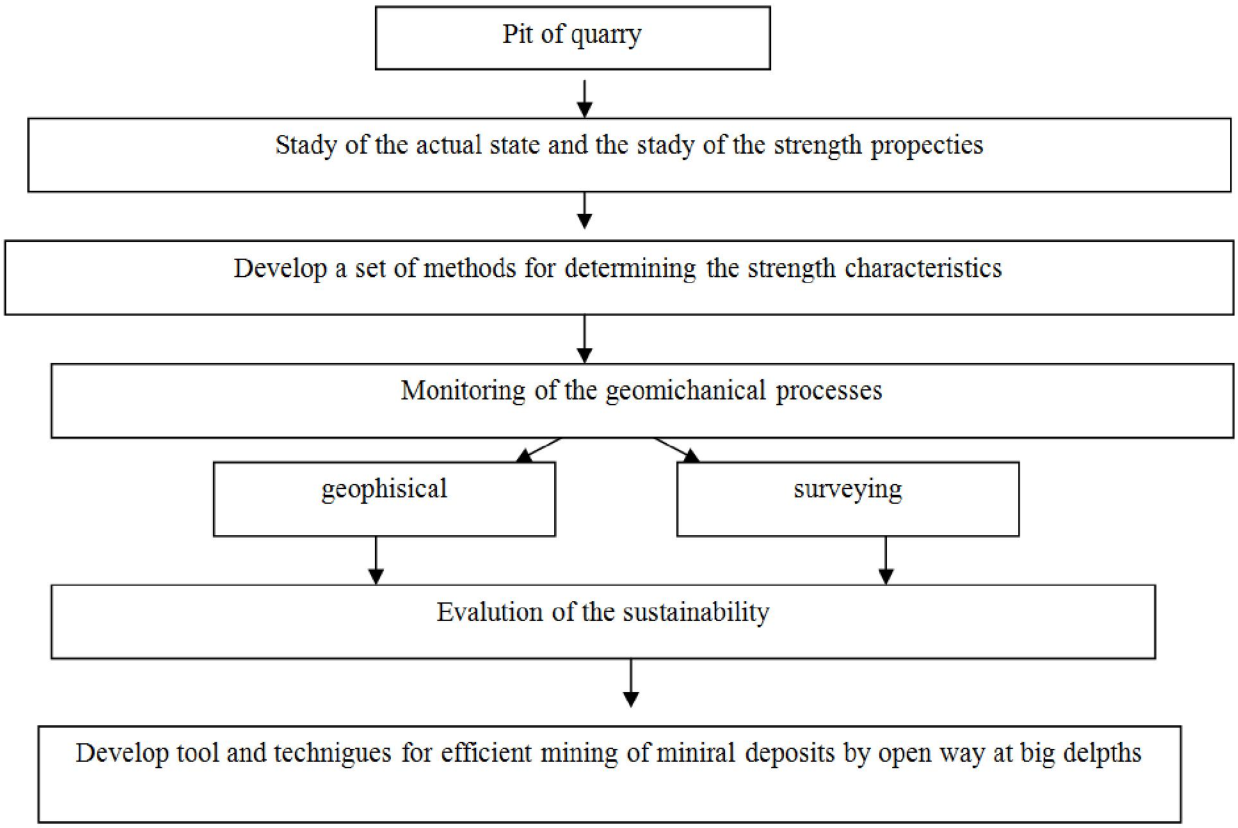
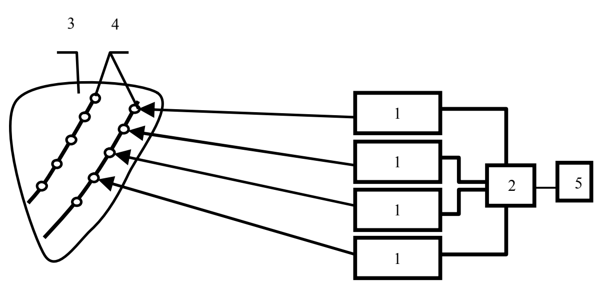


Figure 1 - Scheme of Studies



1 - Thermometers; 2 microprocessor; 3 mountain range; 4 - hole; 5 output device registration

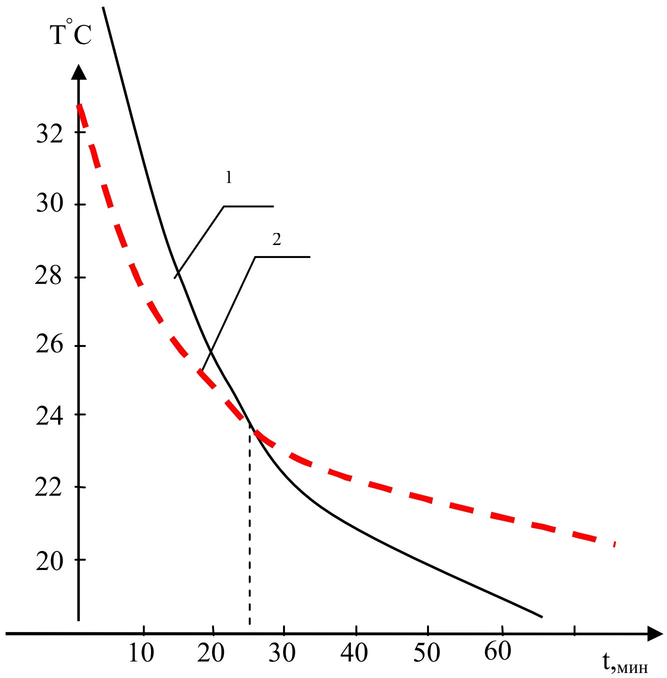
Figure 2 - Functional diagram of the device for certain violations of the array

The results of measurements in the quarries Akzhal deposit showed that the observed feature of the difference in the nature of the cooling sections, depending on the fragmentation of rocks, in general, conserved (Figure 3).In the initial period of fractured land cools faster than the monolithic array.

Then fractured portion cools slower monolithic, which is due to the fact that the deep layers of the fractured portion of the array retain more heat due to the smaller coefficient of thermal conductivity of the surface layer. Thereafter, the area under the curves from the reference point to the line of intersection of the curves and the temperature difference of the areas. The maximum value of the difference of areas served to establish the potentially unstable areas of rock mass [7].

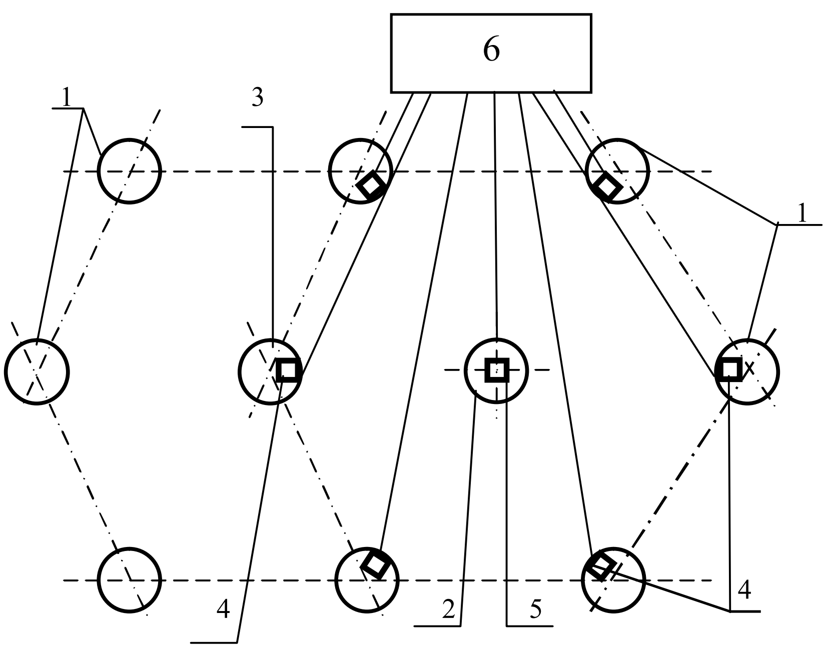
The test results of integrating a number of schemes to determine the areas under the curves 1, 2, 3 have shown that the use of them in a manner convenient to automate the processes of measuring and machining data obtained.

The value of the crack opening is set by the developed ultrasonic method comprising sounding controlled object and the definition of the transmission coefficient (A) of the elastic waves through the object. The value of A is determined by a monotonic increase in the amplitude of the emitted ultrasonic signal to A and Figure 4 is a functional diagram of an ultrasonic method.



1 - The process of cooling small cracks area array; 2 - the process of cooling strong cracks area array.
Figure 3 - Graph of temperature changes in the rock mass during the cooling

Application of the method makes it possible to simultaneously six dimensions, which consequently accelerates research massif and completeness of the study.



1 - Wellbore; 2 and 3 - the top corner of the hexagon; 4 - receivers of ultrasonic waves; 5 - emitter of ultrasonic waves; 6 - multi-microprocessor
Figure 4 - Functional diagram of an ultrasonic method

According to the results of the acoustic sounding rock samples obtained dependence shown in Figure 5.

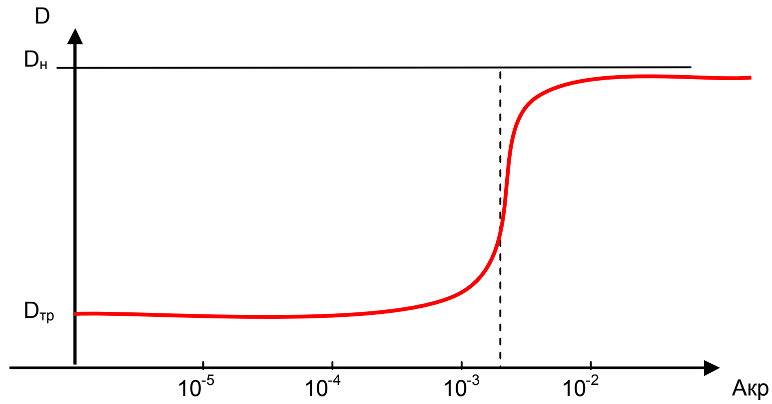


Figure 5 - Change the value of the transmission coefficient of elastic waves (D) on the amplitude of the transmitted signal (A)

When the ultrasonic wave passes through a crack having a width comparable to the wave length, then the change in amplitude of the transmitted wave. By an abrupt increase in the transmission coefficient D ultrasound trial of a crack in the controlled object, and the amplitude of the emitted ultrasonic wave A cr corresponding to an abrupt increase in the transmission coefficient, determine the magnitude of the crack opening (λ) By the formula:

$$\lambda = A \cdot e^{-\delta l_0} \quad (1)$$

Wherein A - amplitude of the radiated ultrasonic waves;

δ - the coefficient of the ultrasonic attenuation in the sample;

l 0 - the distance from the point of excitation of the ultrasonic wave to crack.

The value of the crack opening λ can be expressed in units or in units of length.In this case, A is determined by the product of the peak reading voltmeter U cr and K coefficient cr conversion radiator. The novelty of the developed methods confirmed by the patents R EPUBLIC Kazakhstan [7,8].

One of the main stages of the study the stability of slopes quarries was to study the physical and mechanical properties of rocks.

The interrelation between the velocity of longitudinal ultrasonic waves V_O by a factor of rock strength on M.M.Protodyakonov f.To determine the velocity of propagation of longitudinal waves in the laboratory, we have prepared samples of a separate, different types of rocks, taken from different horizons at the studied fields.Based on a detailed analysis based on observations, as well as literary sources other ore deposits we have established graph-analytic dependence of the velocity of longitudinal ultrasonic waves V_O with the strength of rocks f and this relationship is expressed by the following formula.

$$f = 0{,}45V_0^2, \quad (2)$$

Where: V_O - velocity of longitudinal ultrasonic waves is expressed in km / s.

Figure 6 shows the dependence for determining the coefficient of the fortress of the greater speed of 1.5 km / s for rocks of any composition.

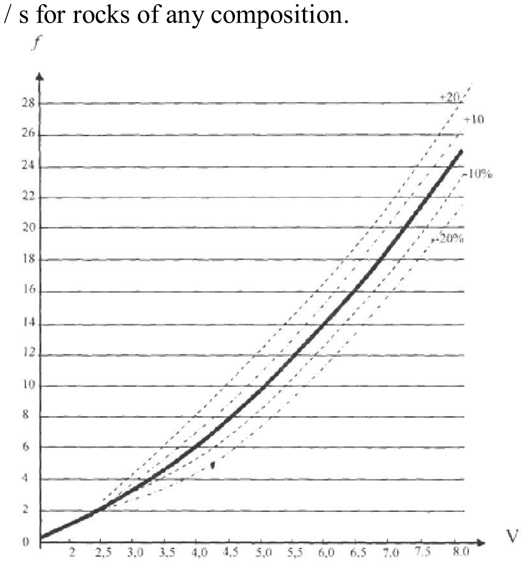


Figure 6 – Graphic analytical dependence to determine the coefficient of the fortress f rocks velocity V of ultrasonic waves.

The postulated relationship *f* and V_O puts on a real basis for the decision cottages associated with the study of the spatial distribution of the strength properties of rocks, the dynamics of their changes under the influence of natural factors and the impact of Engineering.

The level of stress $R_м$, corresponding to the ultimate strength of the rocks in the array is an important strength characteristic of rocks. Tensile strength of the rocks in the array is determined by the formula:

$$R_m = \sigma_{сж} \cdot \lambda_c , \qquad (3)$$

Where: $\sigma_{сж}$ - rock strength in compression in the sample;

with λ_c - coefficient of structural weakening.

With the aim of finding common patterns of variability of the strength properties of rocks in the array method of mathematical statistics and correlation analysis summarizes the properties of the host rocks and deposits Akzhal set of graph-analytical relationships between density, adhesion, strength and depth of rocks.

Figure 7 shows the results generalize the experimental work on the definition of change of the linear dimensions of the structural units of the depth of their occurrence in the bowels by quarries, analytical dependence of which are shown in Table 1.

Akzhal; 2 Sayak; 3 Zherek; 4 -Rodnikovoe

Figure 7 - Change in the average size of the building

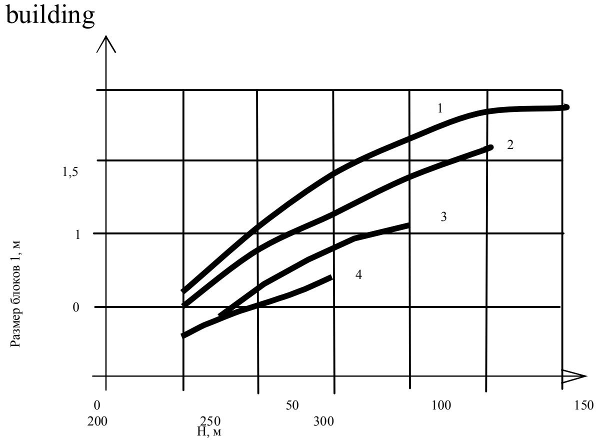


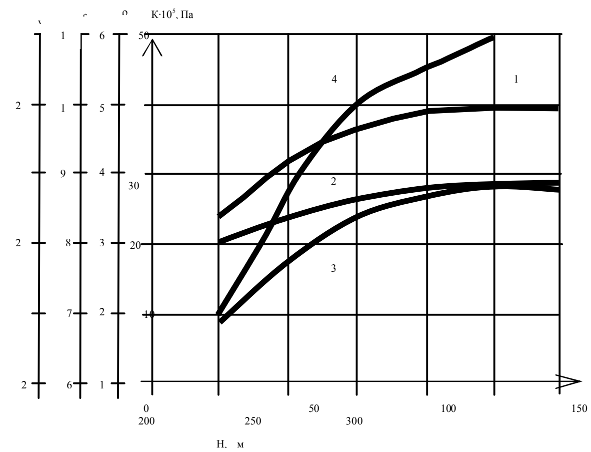
Table 1 - The relationship between the size of the structural changes in the wall rocks with the depth of their occurrence

Quarries	№ Fquations functions formula	Value of reliability	The limits of the oleph
Akzhal	$l_{ср}$=0,025+0,012 H-0,00002H^2 (4)	$r_к$=0,75	300<H<50
Sayak	$l_{ср}$=0,23+0,006 H-0,000002H^2	$r_к$=0,87	250<H<50
Zherek	$l_{ср}$=0,12+0,005 H-0,00001H^2 (6)	$r_к$=0,79	200<H<50
Radnikovsky	$l_{ср}$=0,11+0,004H (7)	$r_к$=0,90	200<H<50

To find the common patterns of variability in strength properties of rocks, summarizes a number of fields, and also established Graphic analytical relationship between the average density, adhesion, strength of rocks and their depth (Figure 8 and Table 2).

Curves of changes in the properties of rocks carried by the average indicators in depth in 50 m. Qualification and reliability dependency determination made by the formulas of mathematical statistics. To create a rational observation station geomechanical analysis was performed, which included zoning and prediction of stress-strain state of the massif.

Their stability is analyzed by solving the problems of the theory of elasticity, obtained by numerical methods, mainly using the finite element method. Zoning massif with the layering, fracturing and faulting of the array revealed six stretches of (Three on the north, and three on the south side) with similar conditions of stability.



1-clutch - k; 2- angle of internal friction ρ; 3-strength - f; 4 - medium

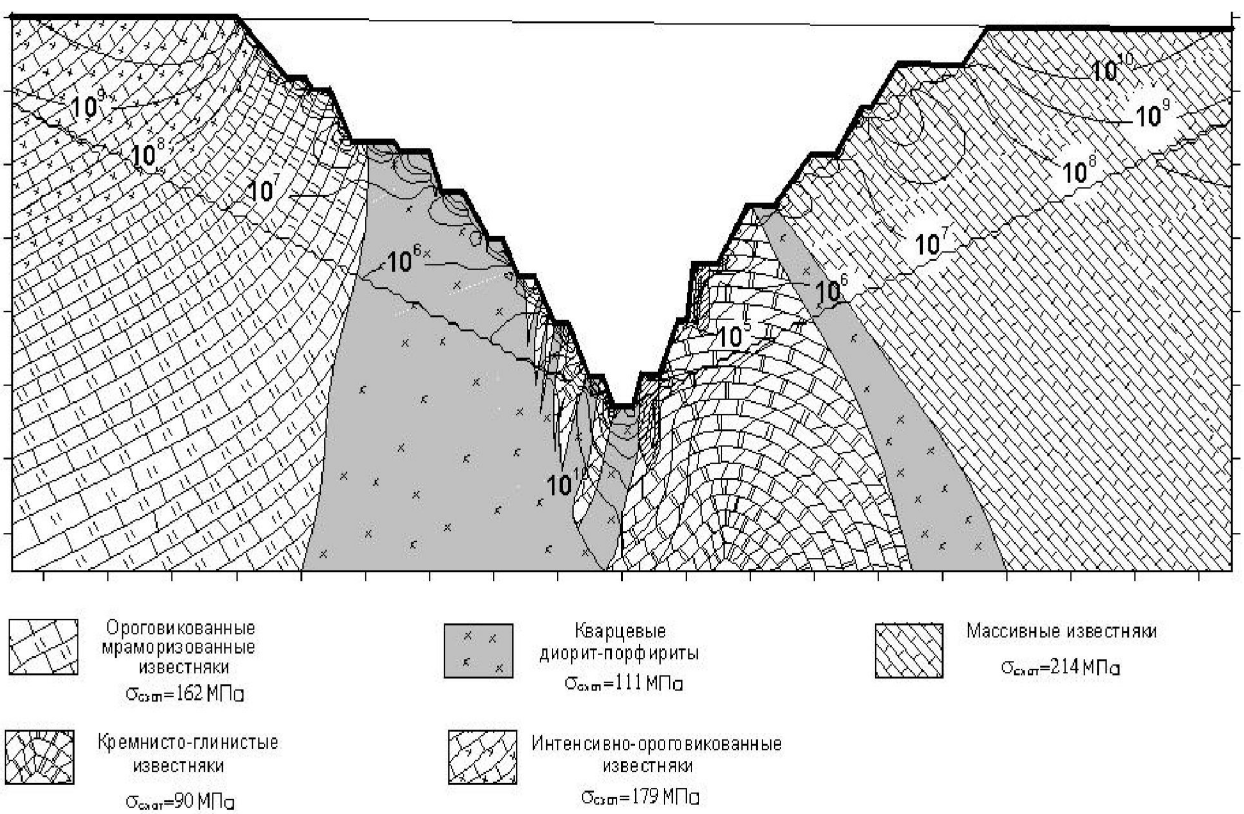
Figure 8 - dependence of the strength properties of massive limestone with their depth at Akzhalskom career.

Length of all the breaking strain on the front, as a rule, exceeds the height of the deformed shoulder 2-5 times. This indicates that the effect (clamping) on the stability of the lateral ledges of rocks that are in the limit position, is effective only as long as the length of the disturbed portion exceeds its height. Therefore, the inception of the workers of frames along the contour career allows you to monitor the stability of the beads throughout their length, and established network is used as a basis for the expansion of the observations.

Investigation of the distribution of isolines durability massif career "Akzhal" in the observed depth shows (Figure 9), that it really is possible to allocate the prism of the collapse, in which the most actively occurring deformation and disintegration processes. With increasing depth increases the risk of caving in ledges. Forming surface starts sliding upwards.

Table 3. Parameter values used in sensitivity analysis

The study of quantity	Eguation functions	№№ formula	Value of realiability	Limits of action
Grip on crack k, *Па*10^5*	k =14,5 + 0,2H – 0,0004H^2	(8)	0.88	300<H<50
The angle of the internal its friction r, degree	ρ = 25,5 + 0,1H – 0,0002H^2	(9)	0,90	250<H<50
Castle rock f	f =6,15+0,018H–0,00003H^2	(10)	0,89	300<H<50
Density breed g, t/m 3	γ =2,36+0,0038H–0,000008H^2	(11)	0,88	250<H<50



9-Distribution contour longevity massif on the career of "Akzhal"

Of course, that the findings are specific to career "Akzhal." Time education and the sliding surface configuration depends primarily on the nature (strength of the rocks composing with bead array of fracture, the presence of faults and the others). And mining-technical factors (depth of reference works, the angle of slope of career, technology of open cast mining and etc).

The application of this technique will allow at least a first approximation to assess the stability massif, given the depth of mining and associated time elapsed since the beginning of the outcrop of rock mass.

Instrumental surveying observations are the primary means of obtaining information about deformations pit and the most reliable basis for the prediction of their stability. Observation, analysis and interpretation of the results of observations can be used: to determine the values of displacements, strains, velocities of deformation process and boundaries of the deformation; set the type of breaking strain massif rocks; establish the relationship between the factors that determine the stability massif, and the process of deformation of the pit and to determine the quantitative relationships between them; determine the critical value of deformation prior to the beginning of the active phase of deformation for various geotechnical rock units; exercise control over the conduct of mining operations on the deformed sections of boards and dumps; determine the effectiveness of against deformation events.

The observations were made with the strong points of the geodetic network laid on the edge of the pit. To improve the accuracy and efficiency of alignment measurement, we made improvements vantage point, namely, the surface of the existing metal plate was welded new item other metal plate with tripod screw, which allowed for fast and accurate alignment, as well as to exclude the use of tripods (Figure 10).

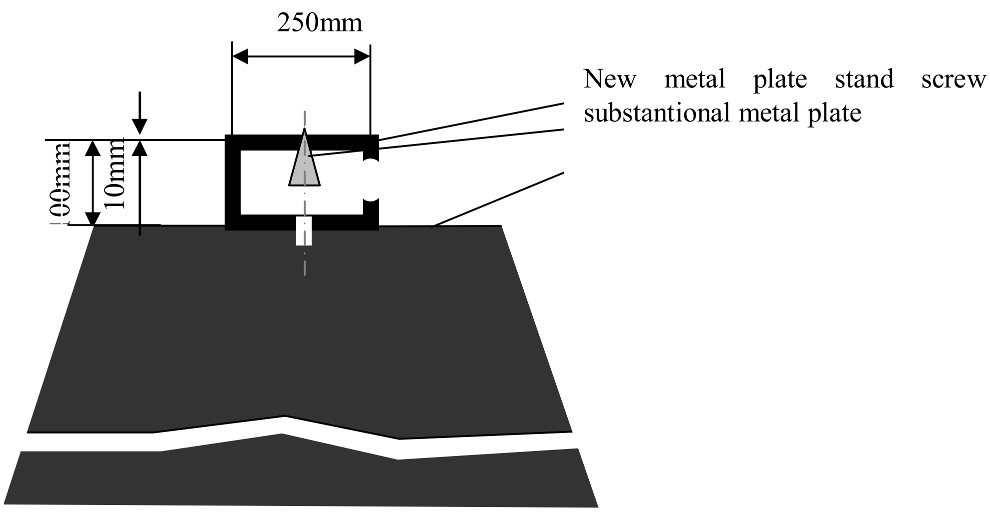


Figure 10 - Advanced vantage point

Observations of the absolute deformation boards on the objects under investigation were carried out on the profile lines observation station devices of new generation. Repeated geodetic measurements were made tachometers company Leika TS110 and TS1206 in combination with reflectors installed on a permanent basis, as well as laser tape measures in the inaccessible areas of career. [9] For each profile line drawn sheet vertical and horizontal displacements of the frames, as well as graphs of displacement.

To automatically receive the proposed software package (software package CREDO running operating systems from Microsoft: Windows 95/98, Windows 2000 because at the moment it is the most popular and available operating systems, as well as the program has a modern graphical user interface).

Results of field observations of the deformation of slopes quarries have shown that this process has a certain period of time within which the behavior of this process remains unchanged. This allows you to select the specified time intervals in separate stages, to formulate their definitions and set the parameters by which they are characterized.

Effective methods for controlling the stability of slopes associated with hardening of the rock mass and dusty surfaces. Created solution to strengthen fractured rocks with a low cost, sufficient fluidity for filling small cracks and adhesion to rocks, high strength. The solution contains cement, filler and water. The filler used tails OF BGMK. Parallel has been researched and prepared a new composition for strengthening reinforcement strongholds nab lyudatelnoy station in wells, allowing the wastes as well as the mining industry and to increase the strength and frost resistance of the resulting material [10-13].

Conclusion.

Developed new automated methods for isolating weak tectonic disturbances portions of pit and methods of allocation parameters joint systems based on cluster analysis and display them on rectangular diagrams that provides zoning pit according to their degree of disturbance.

Effective methods for controlling the stability of slopes associated with hardening of the rock mass and dusty surfaces. Created solution to strengthen fractured rocks with a low cost, sufficient fluidity for filling small cracks and adhesion to rocks, high strength.

Results of the study to clarify the parameters of stable boards and steps to limit and developed "Guidelines for assessing the stability of the pit walls Akzhal's field" [14], which have been introduced into production in the form of regulations.

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