Technical science and innovation

Volume 2020 | Issue 3 Article 15

9-30-2020

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Recommended Citation

Mahmudov, D.R.; Kadirov, V.R.; Karimov, SH.V.; and Hamraev, Y.R. (2020) "RESEARCH OF THE INFLUENCE OF TECHNOLOGICAL FACTORS ON THE STATE OF THE SIDES OF DEEP QUARRIES," *Technical science and innovation*: Vol. 2020: Iss. 3, Article 15.
DOI: https://doi.org/10.51346/tstu-01.20.3-77-0079
Available at: https://btstu.researchcommons.org/journal/vol2020/iss3/15

UDC 622.83.551

RESEARCH OF THE INFLUENCE OF TECHNOLOGICAL FACTORS ON THE STATE OF THE SIDES OF DEEP QUARRIES

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***Annotation**: The article considers the influencing technological factors of mining operations on the state of the quarry sides. In technological processes, the stability of the sides of rock and semi-rock rocks and the value of the angle of inclination of the sides is most affected by drilling and blasting operations. It is determined that effective technological schemes in the zone of residual deformations should be carried out taking into account the geological structure of the contour array. Changing the opening scheme is associated with the development system and mining mode. To ensure the safety of the sides of deep quarries, several variants of schemes, crevice formation in the contour zone and methods for controlling deformation processes are recommended.*

***Keywords:** fracturing, quarry, ledge, side, board, drilling and blasting, massif, impulse, development system, stability, drilling of over*.

As you know, ensuring the stability of quarry sides is a very urgent problem. An increase in the volume of open-pit mining operations is associated with a number of features of ensuring the stability of slopes. Among them are the following [1-2]:

1. the increase of economically viable depths of public works;
2. interdependence of slope stability with the development system and mining mode;
3. the need to change the parameters and configuration of slopes during the operation of quarries;
4. determining influence of technological factors;
5. maintaining the slopes of the sides of the quarry in a stable state;
6. creating normal working conditions for mining and transport equipment

The issues of stability are solved in the conditions of unique diversity of mining and geological conditions in a very strict economic framework when determining both the maximum depth of open-pit mining and the slope angles of the slopes of the sides on the limit contour [6-8]. The stability of slopes is considered by most experts as a result of mountain pressure. Along with the commonality of a number of issues of ensuring the stability of slopes, there are also differences, and this is primarily due to the peculiarities of the geological structure of deposits, development technologies and requirements for the extracted raw materials. For example, quarries for the extraction of non-ferrous metals and iron ores have a lot in common both in terms of the range of engineering and geological conditions, and in terms of development technology. High value of non-ferrous metal ores in terms of development technology.metals and iron ores have a lot in common both in terms of the range of engineering and geological conditions, and their development involves the use of expensive anti-landslide measures, while in the conditions of iron ore quarries they may be economically impractical, etc [3-5].

This example shows that the transfer of research results is possible when taking into account not only the geological features, but also all the factors that determine the stability of the sides of quarries. Depending on the purpose of the slope section of the quarry side and the time of its existence, there are five groups of slopes:

- slopes of opening workings;
- permanent boards near protected objects;

- permanent boards that do not contain transport communications;
- temporary-permanent boards;
- the slopes of the working ledges.

The angles of the slopes of ledges vary from 25-30 to 90 and they are determined structurally and are for working sides and berm and platforms for various purposes-10-25, for permanent sides and slopes of trenches, from 15 to 45-60.

Taking into account the time, the state of the slope and its purpose, it is recommended to vary the coefficient of stability margin from 1.1 for the ledges of the working sides of quarries opening workings. Recommended safety factors for slope quarries are shown in table 1. [12].

Table 1

Safety factors of stability of the pit slope

Group	Slope characteristics	Service time	Anti-reformation measures	Recommended safety factor
I	Slopes of opening workings, sections containing stationary devices (conveyor and skip lifts, tunnels, inclined shafts, etc.)	Almost the entire life of the quarry (40-50 years)	Any technical possible and economically feasible	1,3-1,5
II	Permanent boards near which protected objects are located-safety gates at reservoirs, localities, highways, etc.	Same	Determined by technical and economic calculations	1,2-1,4
III	Permanent boards that do not contain transport communications	As the limit polygons are drawn	Overhanging, filtration prigruzka, upland ditches, drainage, in some cases, sown grasses, shotcrete	1,2-1,3
IV	Temporary-permanent boards	10-15 year	for a slope, the additional load of the filter, drainage	1,15-1,2
V	Working ledges	Several months	As a rule, it is regulated by the height and angle of inclination, as well as the parameters of the equipment used; drainage; in exceptional cases, loading with filtering material (sarbaysky quarry)	1,1-1,2

A group of technological factors that determine the behavior of rocks in the sides is the method of opening, the development system.

The development system is the procedure for performing overburden, mining, and mining preparation work. Direction of development of mining works in space it is necessary to choose taking into account engineering-geological structure of the massif and the slope stability of working benches and pit walls should be evaluated complex technological parameter - the speed of podvigina front mountainous works. For both working and non-working boards, it is important to take into account their design parameters, shape in the plan and profile.

Therefore, it seems effective to adopt a rational mining regime based on the results of engineering and geological zoning of quarry fields. However, as practice shows, the slope angles of the sides when calculating the volume of overburden and mining operations were taken without taking into account the variability of engineering and geological conditions of the quarry fields [9-11]. At the same time, changes in the strength characteristics of the rocks of the onboard array over time were not taken into account, which caused a decrease in the reliability of determining the reserve coefficient and the true determination of the volume of Stripping operations.

Recently, a lot of research has been carried out, the purpose of which was the engineering and geological zoning of quarry fields according to the conditions of stability of slopes and the development of mining and technological solutions for the selection of mining systems and management of slopes using special methods. When assessing the stability of slopes, we used conditional instantaneous indicators of rock strength, taking into account the coefficients of structural weakening of the massif.

Among the technological processes, drilling and blasting operations have the greatest influence on the stability of slopes of rock and semi-rock rocks and on the value of the angle of inclination of the sides [16].

The explosion seems to model in miniature an earthquake, the epicenter of which is located at the place where the EXPLOSIVE charge is laid. a voltage pulse equal to (10-30)10 MPa occurs on the surface of the charging chamber during an explosion. Under the influence of this pulse, a shock wave occurs in the rock, the voltage of which decreases sharply as it moves away from the center of the charge, reaching a value of 250-180 MPa at a distance of five charge radii, and 30-180 MPa at a distance of 20 radii. Near the charge, the following zones are formed: plastic deformations, where the stress exceeds the strength limit of rocks under compression; elastic-plastic deformations, in which the destruction occurs due to defects in the structure of the rock mass, and the stress exceeds the tensile strength of the structure defects; cracking and elastic vibrations. Near the last row of wells, there is sometimes a pin zone, where large cracks with displacement appear after the explosion.

Many quarries currently use the technology of forming a preliminary gap on the design contour of the ledge to protect the contour rocks from crushing and seismic impact of explosions; a screening gap is created by simultaneously blasting hose charges in wells drilled along the contour with an interval of 2.0 -3.0 m. However, blasting in the contour zone must be performed under certain conditions. The main condition is to ensure full water flow from the screening gap. For example, in the contour array of the Muruntau quarry there are zones of intensely fractured rocks and areas of dehydrated rocks, so in these areas, preliminary crevice formation does not give the desired effect.

Taking into account the above, instrument arrays can be divided into two categories:

1. areas of the instrument array where pre-crevice formation is an effective means of protection from mass explosions;
2. sections of the instrument array where the use of the pre-crevice method does not produce the desired effect.

Therefore, the choice of effective technological schemes for cutting in the zone of residual deformations should be carried out taking into account the geological structure of the contour array and based on the technical and economic calculation of the depth of the quarry, at which it is economically feasible to use pre-crevice gasification, is determined by the formula 1

$$H \geq \frac{2C_3}{C_B(ctg\alpha - ctg\alpha_3)\sin\alpha_3}, (1)$$

When C_3 - the cost of 1 m of slope cutting, taking into account the costs of drilling and blasting a contour row of wells, sum;

C_B - cost of extraction of 1m overburden rocks, sum;

α - angle of inclination of the quarry side without contour blasting, deg;

α_3 - the angle of inclination with the use of contour blasting, deg.

Therefore, taking into account the above, an important factor to consider when zoning the instrument array is the design depth of the quarry. According to the research results, it is economically feasible for NMMC quarries to use them at a design depth of more than 250 m.

As the depth of the quarry increases, the nature of the stress distribution in the rock mass changes. the greatest concentration of shear stresses occurs along the side of the quarry and at the bottom of the slope, which partially changes the overall field stress and creates dangerous deformations. It should be noted that the destruction, as a result of drilling and blasting operations, penetrates deep into the massif and affects the stable condition of the sides of the quarry. For example, drilling wells of the order of 3 m significantly destroys the upper part of the slope of the future horizon and along it, the safety and transport berms become less stable.

Mass explosions near the limit contour of the Board create a zone of partial crushing of rocks, extending 60-70 m from the explosion site, sharply weakening their strength and speeding up the process of weathering. In addition, significantly changes the stress state of the array, which reduces the bond strength of the weakest species on the surface of the array and with a small stability margin leads to a sudden collapse of large sections of the pit walls.

As practice shows, application of special methods of mining and blasting to ensure the stability of opencast solved, depending on the geological structure of the array privatnogo and mining conditions of the quarry. It should be noted that the surfaces of structural weakening of rocks significantly affect the width of the fracture zone. Therefore, the seismic safety methods used at the Muruntau quarry ensure the safety of structures in the quarries with sufficient reliability.

To ensure the safety of the sides of deep pits, it is recommended to use methods for controlling deformation processes associated with changes in the opening scheme, development system and mining mode.

The most widely used methods in mining practice are [13]:

1) In rock and semi-rock formations: doubling and straightening of stationary ledges on the project contour and reducing the impact of mass explosions in the contour zones.
2) Abandonment of safety gates in order to preserve industrial structures located within the quarry field.
3) Pressure relief shafts for protection against deformation of rocks.
4) Tape the pillars to control the stability of internal dumps composed of water-saturated sandy-clay rocks.
5) Temporary loading of the working Board with overburden rocks.
6) Changing the opening scheme and the direction of movement of the mining front in adverse mining and geological conditions.
7) Controlled collapse of ledges using their unstable state.
8) Inclined safety berm when setting the side to the limit position.
9) Changing the design of the quarry side.

Ways to reduce the impact of mass explosions m. b. are divided into:

Methods for changing the parameters of blasting operations in the contour zones with the same order of their development. These methods have the greatest application. The design and mass of the charge changes. The contour explosion schemes are used in the following variants: smooth explosion (charges of the contour series explode after the main crushing charges), pre-crevice formation (charges of the contour series explode first). For smooth blasting, the parameters are set: the distance between the boreholes of the contour series is 2-3 m; their charge and diameter is 2-4 kg/m, 80-100 mm. The distance from these wells to the edge of the ledge is 2-3 m. The method of creating a cutting gap is effective. To do this, along the future contour of the slope, a number of boreholes are drilled, which are blasted simultaneously with the last row of wells. The distance between the rows of boreholes and boreholes is 4-4. 5 m. the diameter of the boreholes is 42 mm. The distance between the holes is 0.4-1.2 m. the charge in the hole is 1.5-4 kg.

- Methods with a change in the order of working out of contour zones with unchanged parameters of blasting operations (flank movement of the face, the method of cross-cutting, the method of short blocks).

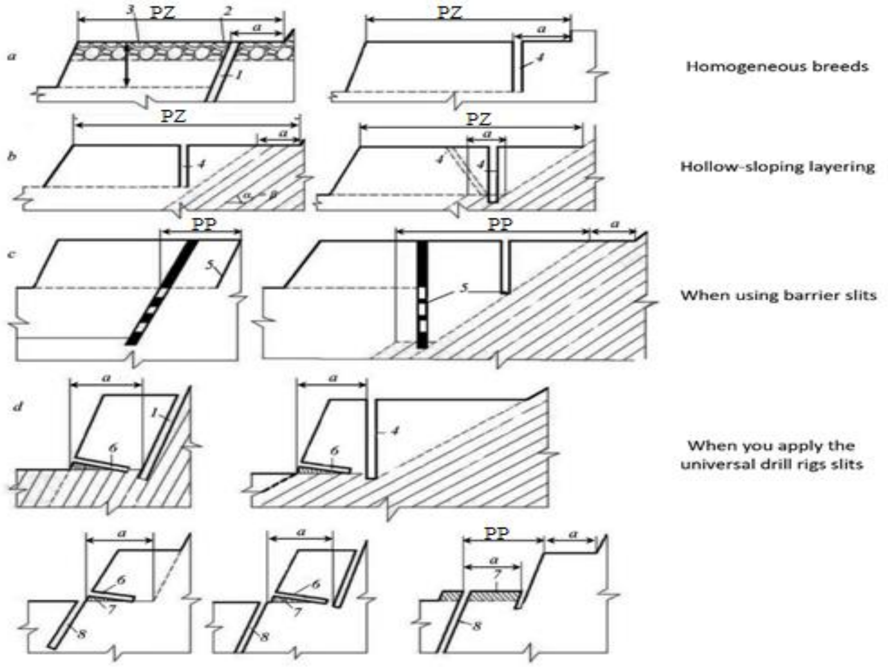

Fig. 1. Diagrams of the location of protective slits in the contact zone (PZ):
1-inclined screening slot, 2-discharge funnel, 3-drilling rigs zone, 4-barrier vertical or inclined (4') slits, 5-clamped combined slits, 6-cut-off slot, 7-pillar, 8-contour wells with an ejection funnel in the pillar, a- the width of the berm, PP- contour line band.

The simplest way to protect against deformations of rocks is to create safety shafts from the broken rock mass. The shape of a rolling piece of rock is assumed to be spherical of radius R. The calculation of the shaft parameters is based on the following movements of the piece:

- Rolling out a piece of rock from the height H of the overlying slope with a steepness α to the shaft with the speed of its possible destruction.
- The ability to fly with a Bouncing piece of rock. where the experimental constants take the values: k1=0.09 m, k2=0.21-0.26 m.

The range of free rolling of a piece to the horizon can be determined from:

$$L = \frac{H \cdot R}{k_2}\left(1 - \frac{k_1}{R \cdot tg\alpha}\right), \qquad (1)$$

where k1=0.09-0.16 m and k2=0.21-0.26 m are experimental values that depend on the rolling surface.

The speed at which a piece hits the shaft can be obtained from the energy balance of 1 / 24/:

$$V_k = \sqrt{V^2 - 2vgk_2 l / R}, \qquad (2)$$

where denoted: g=9.81 - acceleration of gravity, l-distance from the bottom edge to the shaft, V=0.71-inertia characteristic of the ball, V-the initial speed of rolling, determined from the expression:

$$V = \mu\sqrt{2gH}, \qquad (3)$$

Table 2

Values of the coefficient μ for the formula (3)

α°	μ	α°	μ	α°	μ	α°	μ	α°	μ	α°	μ
30	0.25	**40**	0.52	**50**	0.64	**60**	0.72	**70**	0.775	**80**	0.86
31	0.30	**41**	0.53	**51**	0.65	**61**	0.725	**71**	0.78	**81**	0.87
32	0.34	**42**	0.55	**52**	0.66	**62**	0.73	**72**	0.79	**82**	0.88
33	0.38	**43**	0.56	**53**	0.67	**63**	0.735	**73**	0.8	**83**	0.89
34	0.40	**44**	0.575	**54**	0.675	**64**	0.74	**74**	0.81	**84**	0.905
35	0.42	**45**	0.585	**55**	0.68	**65**	0.745	**75**	0.82	**85**	0.92
36	0.45	**46**	0.595	**56**	0.69	**66**	0.75	**76**	0.825	**86**	0.935
37	0.47	**47**	0.605	**57**	0.7	**67**	0.76	**77**	0.83	**87**	0.95
38	0.485	**48**	0.615	**58**	0.705	**68**	0.765	**78**	0.84	**88**	0.965
39	0.5	**49**	0.63	**59**	0.71	**69**	0.77	**79**	0.85	**89**	0.98

The height of the safety shaft is defined by the expression:

$$h = 2\rho^2 (L - l), \tag{4}$$

where ρ=0.3 is the rebound coefficient for the part.

The width of the safety shaft for a stable trapezoidal section is defined by the expression:

$$b = R \cdot \sqrt[3]{\frac{4V^2{}_k}{g \cdot tg\varphi \cdot k_2}}. \tag{5}$$

Thus, when conducting drilling and blasting operations of quarries, it is recommended to use the following schemes of protective cracks in the contour zone.

Reference

1. Rakhimov V. R., Morozov V. D., Kayumov Z. G. Strengthening of weakened sections of slopes, ledges, sides of quarries. Tashkent, "Fan", 2013. P. 12-36.
2. Results of MAX decoding, preliminary assessment of geodynamic and seismic activity of the "M" quarry territory. PGO Aerology report, VNIPI funds PT. Arch. №. A-893-91, 2018.
3. Seismic zoning of the territory of the USSR. Methodological foundations and regional map description, 1978, Bune V. E., Gorshkov G. P. M., Nauka, 2016. .P.24
4. Makhmudov D. R., Petrosov Yu. E. Production technology of drilling and blasting operations in deep open pit mines of Uzbekistan. Mining information and analytical Bulletin. - Moscow state University (Moscow), 2017. № 5. P. 331.
5. Wesseloo J. and Read J. Acceptance Criteria, in Open Pit Slope Design, CSIRO, Lieden, 2013. P. 221.
6. Rakhimov V. R., Murzaykin I. Ya. Determination of the neotectonic movements of rock blocks geodetic methods//J. Mountain Bulletin of Uzbekistan. No. 2. 2008.P.13-21
7. Finiston Open Pit mine (Super Pit gold mine). https://www.mindat.org/loc-192453.html/
8. Finiston Open Pit "Super Pit" Gold Mine. https://www.mining-technology.com/projects/superpitgoldmineaust/
9. Umarov F. Ya., Nasirov U. F., Petrosov Yu. E., Kadirov V. R. Managing the state of responsible engineering structures in deep quarries // Bulletin Tashkent state technical university, 2016. №1. P. 205-209.
10. Umarov F. Ya. Monitoring the condition of the slopes of the sides of a deep quarry Mountain information and analytical Bulletin. - Moscow state University (Moscow), 2013. № 5. P. 88.
11. Markov A.V. On the calculation of tectonic stresses in the earth's crust of South-Western Uzbekistan // Bulletin Tashkent state technical university, 2008. №4. P. 160-166.

12. Shemetov P. A., Umarov F. Ya.. Seismic safety technology of BWR in the near-contour area of the quarry and near critical structures Mining information and analytical Bulletin. - Moscow state University (Moscow), 2013. № 8. P. 221.
13. Methodological guidelines for observations of deformations of boards, sections and dumps, interpretation of their results and stability forecast. L., VNIMI, 1987. .P.45
14. Popov V. N., Shpakov P. S., Yunakov Yu. L. Managing the stability of quarry slopes. - Moscow. Gornaya kniga publishing house, 2008.P.112
15. Rakishev B. R., Shashenko A. N., Kovrov A. S. Geomechanical assessment of the stability of the sides of quarries and dumps. Almaty: "Gylym" NAS RK, 2017. - 234 p. ISBN 978-601-323-103-7.
16. Report on research work. Assessment of the geomechanical state of the pribortovogo array of the "M" quarry with consideration of influencing factors on the basis of geodynamic zoning - Tashkent state technical university, 2008. P. 160-166.
17. Soren K., Budi G., Sen P. Stability analysis of open pit slope by finite difference method //International journal of Research in Engineering and Technology, 2014. Vol. 3. Iss. 5. P. 326.