IOP Conference Series: Earth and Environmental Science

PAPER • **OPEN ACCESS**

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To cite this article: V N Kalmykov *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **272** 032070

IOP Conf. Series: Earth and Environmental Science **272** (2019) 032070 doi:10.1088/1755-1315/272/3/032070

Evaluation of the Stressed State of the Rock Massif and the Renovated Shaft Support of the Skipova Shaft of Sibay Branch of Uchalinsky Ore Mining and Processing Enterprise

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Abstract. The results of the evaluation of the stressed state of the rock massif and mine support of the Skipova trunk in the 200-400 m are presented by the modeling method, as well as the bearing capacity of the combined mine shaft support. Investigations of the corrosion intensity of the surface of the metal net of the "Skipova" trunk were performed.

1. Introduction

The passage of the mine shaft "Skipova" was started in March 1987 and was carried out by the Gaisky Mine Construction Management. The total depth of the trunk with a sump of 773 m. The diameter of the trunk in the light is 7.5 m, in the penetration of 8.1 m, the cross-sectional area of the trunk is 44.2 m 2 and 51.5 m 2, respectively. Reinforcement of the barrel is rigid with a lateral two-way arrangement of the conductors relative to the lifting vessel and a frontal arrangement of the conductors relative to the counterweight.

The shootings are made of I-beams №36M, conductors - box of 160x160mm.

For a period of continuous operation, the trunk is equipped with a one-kilo-lifter with a counterweight. A single-storeycageofthetype 41HB-4,5.

As the object of research, the site of securing the stem was chosen. Skipovaya in the mark of 200-400m. In general, along the route, the trench of the trunk of the rock is fractured, fragmented, filled with chlorite, carbonate, quartzite. Coefficient of strength on the scale of Professor Protodyakonov M.M. makes 15-19, the water inflow is in the range of 3.7 - 10.2 m3 / hour.

Visual inspection of the mine shaft support before the repair work showed that during 200 m there are leaks, water jets in watercut points, there are shells of considerable size - 2-10 m2, depth 100-250 mm. In the places of cold joints of concrete support there are significant detachments of concrete.

The state of the concrete is unsatisfactory and is characterized by the presence of protracted chemical processes (the transition of the aggregate from the solid to the gypsum, pasty state), which led to the destruction of the concrete to the loose state, which must be completely removed to ensure the adhesion of the repair compositions. The depth of the disturbance is commensurate with the design thickness of the concrete support, which led to the emergence of an emergency situation.

2. Relevance, scientific significance of the issue with a brief review of literature

The surveys of the barrel support performed by UniprommedOJSCin June 2003 and the STC Science and Practice Ltd. in September 2010 [1] established that on the previously reinforced section of the trunk 40-200 m there is a flow of water from the anchorage that flows down the inner wall of the barrel support. The barrel support in the interval 40-200 m is in a satisfactory condition and does not require repair.

According to the project developed by UralGeoProject for the production of works (hereinafter referred to as the PPW) "Bringing to safety of the concrete support of the vertical shaft of the Skipovaya mine in the 200m ÷ 408m marks" [2], during repairs of the support in the main period, the following types of work are planned:

a) installation of water-collecting rings and laying of a water discharge pipeline;
b) bringing the emergency area of the concrete support into a safe state;
c) friction of the destroyed surface of the support;
d) drilling of holes;
e) fixing sheets of metal mesh with anchors.

The installation of water-collecting rings, according to the PP, should be made at minus 211 m, minus 310 m, minus 387 m in order to prevent further entry of aggressive water from the upper sections to the trunk supports, and drainage of water from the water-collecting rings is carried out to the horizons 309 m and 389 m via the ø89x4.5 mm pipeline. , fixed to the trunk reinforcement with clamps.

The safety of the emergency section of the concrete support of the vertical shaft of the Skipovaya mine in marks 200m ÷ 408m is provided by means of an installation along the perimeter of the barrel of metal grid sheets with a size of 2900 x 1600mm. With a wire diameter of 5 mm., The cell size is 40x40 mm.

The destruction of the destroyed surface of the barrel support is planned to be done with the help of revolving crowbars and MO-type hammers, and the material is dropped into the sump part of the barrel.

Drilling of holes for anchors SPAK, diameter of the hole 32 mm, depth of the hole 1.5 m according to the requirements of the PPR must be made by hand perforators of the type PP-63.

Fastening of sheets of a metal grid is necessary for carrying out to the established steel-polymer anchors.

Each sheet of metal mesh should be attracted by 7 anchors: 4 (four) anchors are located at the edges (at a distance from the edges of the grid 100 mm), 2 (two) anchors are located in the middle of the long side of the metal mesh at an equidistant distance (1350mm) relative to the side anchors, 1 one) anchor in the center of the metal mesh. Vertically, the distance between the contour anchors should be 1.4 m.

3. Formulation of the problem

Currently, the choice of the type of support and the determination of its parameters in the workings falling into the zone of influence of clearing works is carried out according to the recommendations of specialized organizations. The choice of the type of support is preceded by the definition of the stability category of the mountain massif. The assignment of output to one or another category of stability is made by a geotechnical engineer [3-10].

According to [5], the stability of outcrops of ores and rocks is determined by the Barton empirical method (Q-rating), which assesses the influence of such factors as strength and quality of rocks, depth of development, cross-section of excavations and stress state in the surrounding massif, number and condition of cracks in including the degree of their change.

Unstable zones include: IV-V categories of stability of the mountain massif; zones of faults and tectonic disturbances; areas of metamorphosed rocks.

In the IV category of the mountain massif, mainly combined structures consisting of anchors, metal mesh and spattered concrete or arched metal supports from the special profile of the SVP are used [11-15].

Under the conditions of the Orlovskoye mine, a large number of options for fixing mine workings

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in unstable zones have been tested. All options ensure the stability and normal functioning of mine workings in accordance with their field of application, but significantly reduce the speed of workings, increase the cost of fastening and do not have the required versatility.

As a result of the examination of the Skipovaya trunk condition, a visual inspection of the state of the concrete shell after cleaning has been carried out, and the residual thickness of the concrete support and the distance between the anchors have been measured. The strength characteristics of the concrete support are evaluated. As a result of a visual inspection, it was revealed that a damaged layer of concrete had been stripped at the repaired area. There are caverns in which the removal of concrete is made on the entire thickness of the support.

For a comprehensive analysis of the state of the rock massif and shaft support of the trunk in the 200-400 m mark, it is necessary to assess the stress state by the modeling method.

4. Theoretical part

Estimation of the stressed state of the rock massif and shaft support of the trunk was carried out by modeling using the ANSYS software.

ANSYS - the universal software system for finite-element analysis, developed for solving linear and nonlinear, stationary and non-stationary spatial problems of solid mechanics and mechanics of structures, and mechanics-related fields [16-18].

The software package allows you to determine the three-dimensional voltage and load produced in several ways, they summarize with tselyayu produce an equivalent voltage, which is called the stress of von Mises.

Equivalent stresses according to Mises () are determined by the formula

(MPa): $$\sigma = \sqrt{0.5 \cdot ((\sigma_1 - \sigma_2)^2 + (\sigma_3 - \sigma_2)^2 (\sigma_1 - \sigma_3)^2)} \qquad (1)$$

where σ_1, σ_2, σ_3 – main stresses, MPa.

Due to the wide spread of fracture modulus values, two mutually perpendicular fracture, three categories of stability, with different average sizes of structural blocks 2000 mm, 1000 mm, 200 mm, 100 mm are taken into account in the calculation.

In the process of modeling, the geomechanical situation was investigated for the most unfavorable variants – mount. 300, mount. 400 m.

The first option is characterized by the following conditions:

- horizon - 300 m; σ_1 = 8,08 MPa;σ_2 =4,44 MPa; σ_3 =4,04 MPa.
- fracture - two mutually perpendicular fracture systems, the distance between the cracks is 1000 mm and 2000 mm.

5. Practical significance, proposals and results of implementation, the results of experimental studies

Figure 1 shows the distribution of stresses for the shaft barrel without fastening (a) and with the installation of anchors and a metal grid (b) indicating the zone of destruction of the contour of the development by tensile and shear forces.

a) b)

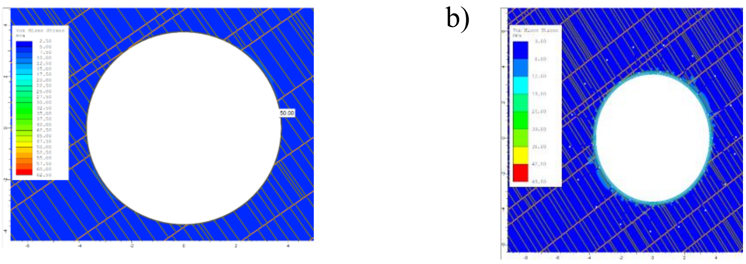

Figure 1. Distribution of stresses in the rock mass: a) in the absence of support; b) when they are fixed with steel-polymer anchors, with a rod diameter of 22 mm, a metal grooved mesh with a 40x40 mm cell. and a rod diameter of 5 mm.

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The maximum stresses at modeling of a vertical shaft of a mine taking into account a fracture without application of a support are 62,5 MPa and are of local character. The voltage output is 12-20 MPa.

In places of increased stress, local destruction of the walls of the vertical shaft of the shaft is possible, as a result of which the shaft of the shaft may lose its stability.

After the installation of the support, the maximum stresses, as compared to the loose workings, decreased from 62.5 to 48.0 MPa.

Just as in the previous version, in places of increased stress, local destruction of the rock wall of the vertical shaft of the mine is possible.

Figure 2 shows the section of the trunk fixed by: a) anchors, metal mesh and concrete layer, 100 mm thick, b) anchors, metal mesh and a layer of concrete, 200 mm thick.

a) b)

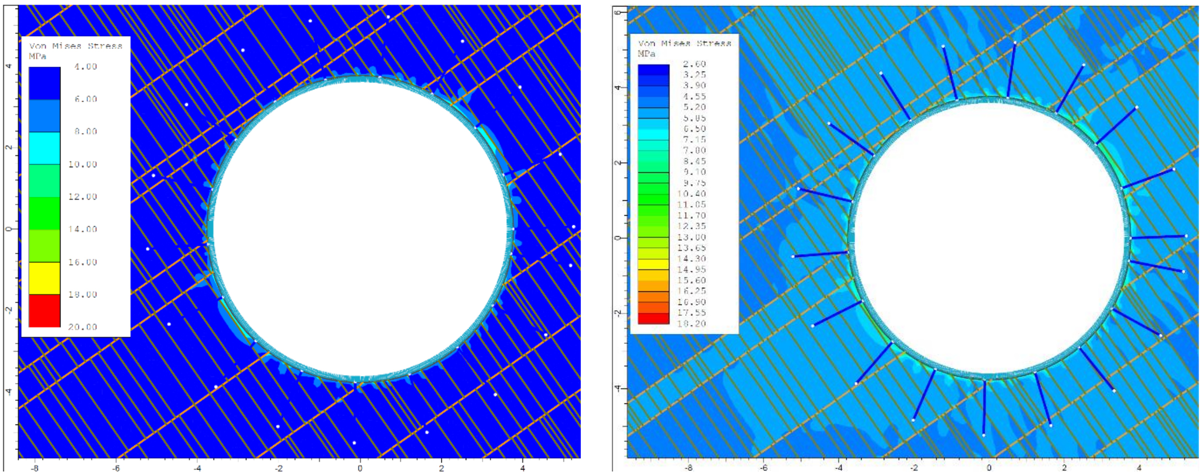

Figure 2. Distribution of stresses in a rock massif with their fixation: steel-polymer anchors, with a rod diameter of 22 mm, a metal grooved mesh with a 40x40 mm cell, a rod diameter of 5 mm., A) a concrete layer thickness of 100 mm; b) the thickness of the concrete layer is 200 mm.

The maximum stress along the contour of the mine shaft, fixed by anchors and a metal mesh, and also with shotcrete, 200 mm thick. amounted to 18.2 MPa. With these options for securing the output as shown by the analysis of the stability factor diagrams, the vertical barrel will be in a stable state.

Reduction of the concrete support layer to 100 mm leads to the growth of local maximum stresses up to 25 MPa, while there are no local zones of destruction of the trunk.

6. Conclusion

As a result of a visual inspection, it was revealed that a damaged layer of concrete had been stripped at the repaired area. There are caverns in which the removal of concrete is made for the entire thickness.

The strength strengths of the concrete shell allow us to conclude that the cleaning of the concrete base basically allowed the destruction of the destroyed concrete layer and leaving its entire layer. The average strength of the concrete shell was 19.3 MPa with a design strength of at least 32.5 MPa.

The average value of the destroyed layer is 160 mm. at a design thickness of 300 mm. Thedistancebetweentheanchorscorrespondstothepassport.

The results of the simulation of the geomechanical situation at depths of 200-400 m for the variant of the greatest jointing of the rocks showed that at present the stability of the trunk is ensured by the use of an established combined support based on anchors and a metal mesh. The use of the dependence of the stability factors on the support parameters indicates that it was determined by the intensity of the erosion processes leading to a decrease in the thickness of the concrete support and bars of the metal grid [19-20].

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