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Determining the Length of Anchors for Vertical Works

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ABSTRACT:A methodology for calculating anchor support for vertical shafts of mines has been developed. The article describes how to determine the length of the castle part of the anchor, the length of the anchor itself. This takes into account the length of that part of the anchor, which is concluded between the base of the cone of influence of the anchor and the boundary of the zone of possible outfalls. In addition, it includes calculating the installation density of anchors for round and quadrangular trunks, determining the thickness of sprayed concrete.

KEY WORDS: rocks, workings, sandstone, stress, deposits, cross-section, depth, massif, fortress, coal, trunk, anchor, lining, density, circle, four-angle, thickness, spray concrete.

I.INTRODUCTION

In mining operations, the largest costs of material resources and time require the construction of underground structures, mines and tunnels for various purposes, as well as the fastening of mine workings, which is the most complex and time-consuming process. The range of issues related to the lining problem includes assessment and prediction of rock stability in outcrops; the choice of the type of support used, corresponding to the mining and geological conditions, design, technology and mechanization of its construction; finding the optimal, from the point of view of cost savings and safety of the miners, parameters of the applied support.

An analysis of a large number of literary sources on the practice of building underground structures shows that it is the type of lining, technology, and the mechanization of its construction that determine the speed of mine workings and greatly affect the quality of tunneling. However, despite the results achieved, in the problem of supporting mine workings, technology and the mechanization of its construction there are still many pressing issues that are far from being resolved and therefore require further development.

As mentioned above, one of the key issues in the problem of supporting underground structures is the assessment and forecasting of rock stability in outcrops. Since it is precisely the state of the capital and preparatory mine workings that, ultimately, the normal operation of the mechanisms and the safety of the miners depends. In accordance with this, the aforementioned large funds are spent to maintain the mine workings in operational condition, which all increase with increasing depth of field development, deterioration of mining and geological conditions. For example, the costs of maintaining mine workings in coal mines exceed 90% of their cost[1].

These factors indicate the relevance and urgent need to develop methods for assessing the stability of workings in various mining and geological conditions, the implementation of scientifically based forecasts of changes in the status of workings subjected to various static and dynamic loads. In this case, changes in the conditions of field development and methods for choosing the optimal means of increasing rock stability in outcrops should be taken into account. These measures should be aimed at ensuring normal mining conditions, depending on their purpose.

Recently, the study of rock stability issues in outcrops has received considerable attention from scientists and engineers. As a result, a significant number of scientific articles and monographs appeared devoted to the coverage of this issue and various methods for solving it. Along with theoretical methods for studying the stability problem, methods based on the widespread use of field and experimental data are also known.

II. SIGNIFICANC OF THE SYSTEM

The next problem in hanging the stability of the rocks around the workings is the choice of the type of lining, which should be effective for mining and geological conditions, where it is used. Currently, to increase the stability of the

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rocks and the maintenance-free maintenance of the workings, the creation and implementation of new support structures is carried out, which have a greater bearing capacity and lower metal consumption. In this regard, over the past few decades, they began to use a new type of combined roof support, which consists of anchor and spray concrete supports. Anchor support, as an independent one, has been used in mining practice for a long time, not only for securing underground mine workings, but also for holding steep slopes in mountainous areas and quarry sides during open cast mining. Sensing tensile and cutting forces, anchors contribute to increased stability and thereby increase the bearing capacity of rocks and ensure the maintenance of an unstable part of the massif. When choosing a certain type of anchor support, an important role is played by such factors as the structure and physico-mechanical characteristics of the rocks, the depth of development, the distance between the strata, the degree of disturbed ™ and the water content of the deposits, configuration, dimensions, purpose and duration of the Service, development conditions, expense, cost, scarcity and strength properties of anchor support materials. Therefore, the calculation of the parameters (the length of the anchors and the density of their installation) of the anchor support, taking into account these factors, which ultimately lead to savings in material resources and installation time, remains relevant today.

III. LITERATURE SURVEY

On the other hand, the scope of anchors as an individual roof support is currently limited by a number of geological, technical and economic factors. Anchor support does not protect mine workings from the action of a wet mine atmosphere and water seeping into them. In strongly fractured rocks, the installation of anchors with a density accepted in practice does not ensure the fastening of individual parts of the fragmented massif, and therefore does not contribute to the formation of the load-carrying capacity of the structure. All these disadvantages dictate the use of anchor supports in combination with other supports that contribute to the formation of a load-bearing structure, in particular, spray concrete. When spraying concrete under pressure, cement particles with small fractions of sand are clogged into voids and cracks in the rock surfaces, restoring the crushed edge layer of the rocks. As a result of this, an additional structure is included in the system of forces counteracting the displacement of the massif — the restored rock cover. The resulting additional lining works in a single system with spray-concrete coating, forming a structure with high load-bearing capacity. In addition, by creating a more regular surface of the mine increases its stability. Due to the high adhesion of spray concrete to the rock, the support lining is prevented from slipping along the excavation contour, which sharply reduces bending moments, increasing the load-bearing capacity of the structure.

IV. METHODOLOGY

The modern support of horizontal and vertical shafts must meet the following requirements:
-Increased adhesion between the structural blocks in the part of the rock mass, immediately adjacent to the output contour,
- Isolation of the walls of the workings from the effects of weathering agents in order to prevent an increase in the size of the zone of possible dumps over time,
- Perception of random loads from individual structural blocks or their parts that have lost contact with the rock mass.
Based on the above properties of anchor and spray concrete supports and the practice of their use in mining, it can be concluded that the listed requirements for supporting shafts of vertical shafts are most fully satisfied by the combined anchor-spray concrete support. At the same time, anchors sharply increase the adhesion of rocks in the marginal area due to the bonding of individual structural blocks. A slight increase in the cohesion of the rocks in the surface layer, and also the stability of the rock mass around the mine, also occurs when spraying concrete is applied, since part of the solution penetrates into open cracks and fills them. At the same time, the spray-concrete coating partially fulfills the functions of the supporting lining [2].
The cause of explosions and seismic vibrations are the earth's crust.At present, the most successfully and more fully performed calculations of supports for the action of static loads, compared with calculations for the action of dynamic and seismic. But, despite this, it cannot be argued today that perfect methods for calculating supports for even static loads have been created. In such conditions, issues of assessment, forecasting and ensuring the stability of mine workings are key in the mechanics of rocks that have been intensively developing in recent years and the practice of mining.
For the entire period of existence of the preparatory and capital workings, methods for assessing their stability, oriented for use in various mining and geological conditions, are of paramount importance. Despite this, the unsatisfactory accuracy of the created calculation methods to date necessitates the development of new and improved methods and the fulfillment of forecasts on the stress-strain state of mine workings subjected to various force factors caused, in particular, by the action of rock pressure, blasting, gravity and seismic forces, as well as forces of tectonic origin.

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Numerous articles and monographs on various aspects of this problem, various approaches and methods for solving it testify to the reality of the idea expressed. This article indicates that the use of anchor support as an individual is impractical. This is due to a number of factors of a technical, geological and economic nature. Geological factors, among other things, include fracturing, watering and strength of the rocks containing the production, significant size of the crushed rocks, and others. Technical factors include, for example, the difficulty of drilling wells in rocks, the coefficient of strength of which is quite large (more than 9-10). These difficulties in most cases are associated with the use of low-performance mechanization tools when drilling a well under an anchor.

In connection with these and other disadvantages of anchor lining, it becomes necessary to use it in combination with other types of lining, for example, spray concrete. In this case, the method of calculating the combined lining consists of determining the parameters of the anchor and spray concrete lining, taking into account the conditions for their joint work. The calculation of the parameters of the anchor support for the roof of horizontal workings is performed by known methods described in many publications.

On the other hand, there are almost no publications on the calculation of the parameters of anchor support for vertical trunks of round and quadrangular cross sections. Therefore, we have developed a methodology for calculating such supports for shafts of vertical shafts. It consists of methods for determining the length of the castle part of the anchor and the length of the anchor. This takes into account the length of that part of the anchor, which is concluded between the base of the cone of influence of the anchor and the boundary of the zone of possible outfalls. In addition, it includes calculating the installation density of anchors for round and quadrangular trunks, determining the thickness of sprayed concrete.

To create a sound calculation model for determining the anchoring strength, it is necessary to carry out a large amount of research on the interaction of the castle part of the anchor support with the massif. These studies should be based on the use of the parameters of various methods of fixing anchors, the properties of the materials used and the design features of the castle. In the practice of securing mine workings, anchors and anchor structures are used depending on the purpose of the mine and specific mountain conditions and rock type.

Due to this need, numerous types of anchors have appeared, having various designs from various materials (wooden, metal, polymer, etc.). Therefore, we will not dwell on the description of various types of lining, but we will investigate metal and reinforced concrete anchors, which are mainly used in mining operations[3].

V. EXPERIMENTAL RESULTS

The length of the anchors used in the vertical shafts of the mines is determined based on the following principles. The length of the anchors in the walls of the barrel l should be calculated based on the condition that it consists of three parts: l_z - the length of the castle part of the anchor, which should be buried in the rock mass beyond the contour of possible collapse by an amount that ensures the operability of the lining; l_b - the length of the anchor per area of the destroyed rocks; l_o - the length of the part of the anchor that is enclosed between the base of the cone of influence and the boundary of the zone of possible outfalls (Fig. 1), i.e.

$$l = l_z + l_b + l_o \qquad (1)$$

The angle of influence of the anchor is denoted by θ, and the angle of bedding by - φ.

The radius of the zone of possible outfalls is denoted by - b.

Then from fig. 1 it follows that $\frac{b}{l_b} = \sin\varphi$ or $l_b = \frac{b}{\sin\varphi}$ (2)

We assume that the performance of the AB anchor is ensured if the volume of the cone of influence of the IRR is completely located in the zone of undestructed rocks. In this case, there is also another zone EF, within which the radius of the cone of influence covers some part of the zone of possible dumps. The length of the anchor coming to this zone is denoted by l_o.

From the above diagram it follows:

$$l_o = \frac{r}{tg\varphi} \qquad (3)$$

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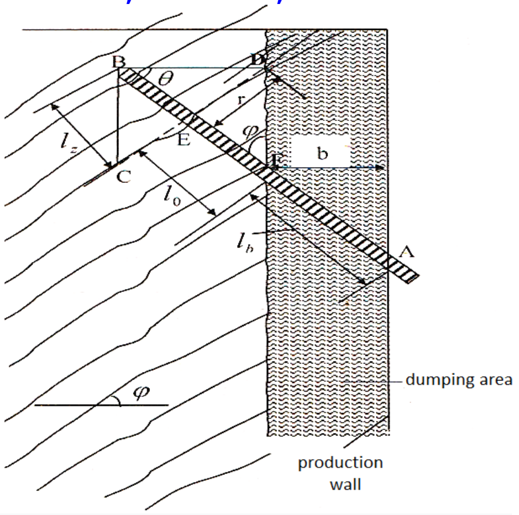

Fig.1. Determining the length of the anchors used in the shafts of vertical shafts: l_z - the length of the castle part of the anchor; l_b - length of the anchor; l_o - the length of the part of the anchor that is enclosed between the base of the cone of influence and the boundary of the zone of possible outfalls; θ - angle of influence of the anchor; φ - bedding angle; b - radius of the zone of possible outfalls; r - radius of the cone.

On the other hand, from the triangle BED we find

$$r = l_o * tg\varphi$$

Since $tg^2\varphi = 2\lambda$, where λ -is the lateral coefficientformula defined by

$$\lambda = \frac{\nu}{1-\nu} \quad (4)$$

where: ν - is the Poisson's ratio of the rock, then substituting the last expression in (3) for l_o we obtain the following formula:

$$l_o = \frac{\sqrt{2\lambda}}{tg\varphi} * l_z \quad (5)$$

Substituting the obtained expressions for l_b and l_o (2) and (5) in (1) we will have:

$$l = l_z + \frac{b}{\sin\varphi} + \frac{\sqrt{2\lambda}}{tg\varphi} * l_z \quad (6)$$

or

$$l = \frac{b}{\sin\varphi} + \left(1 + \frac{\sqrt{2\lambda}}{tg\varphi}\right) * l_z$$

VI. CONCLUSION AND FUTURE WORK

The obtained formula, unlike the known ones, allows one to determine the length of the anchor taking into account the bedding angle and the lateral thrust coefficient, through which the deformation properties of the rocks containing the mine are taken into account. In the case of $\varphi = 90^0$ this formula takes the form:

$$l = b + l_z \quad (7)$$

and is used in calculating the length of the anchors used when attaching the roof of horizontal workings [4].
In this sense, the resulting new formula (6) is a generalization of the well-known formula (7) and is more universal.

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