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Study of the Stress State of the Massif Around Horizontal Mine Workings with a Vaulted Outline

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ABSTRACT: In this paper, we propose an analytical method for determining the stability state of an array around horizontal underground mine workings, taking into account the influence of normal and tangential stresses.

KEYWORDS: forecast, geomechanical state, rock mass, rock impact, stability, deformation, stress-strain state, collapse, rock pressure, mine workings, impact hazard, rock structures, geodynamic hazard, stress field.

I.INTRODUCTION

In order to predict the manifestation of rock pressure in a dynamic form, there are currently a large number of theoretical methods for determining the stress state of the massif around underground mine workings, depending on the shape of the underground mine workings.

This article proposes a solution to this problem based on the application of a mathematical model of the stress distribution around horizontal workings, based on the fundamental solutions for calculating structures on an elastic base.

A. Calculation model. Consider a heavy half-plane G with a cut, as shown in Fig. 1. The stress at each point of the region G will be determined by superposing the solution for a heavy half-plane without a cutout and a weightless half-plane loaded along the contour of the workings by fictitious forces P(S) and Q (S) distributed so as to ensure that the initial boundary conditions on the contour of the workings are met. At the same time, we have a solution:

$$\begin{aligned} \overline{\sigma_x} &= \sigma_x^0 + \sigma_x \\ \overline{\sigma_x} &= \sigma_y^0 + \sigma_y \\ \overline{\tau_{xy}} &= \tau_{xy}^0 + \tau_{xy} \end{aligned} \qquad (1)$$

where S - is the coordinate along the contour of the cutout,

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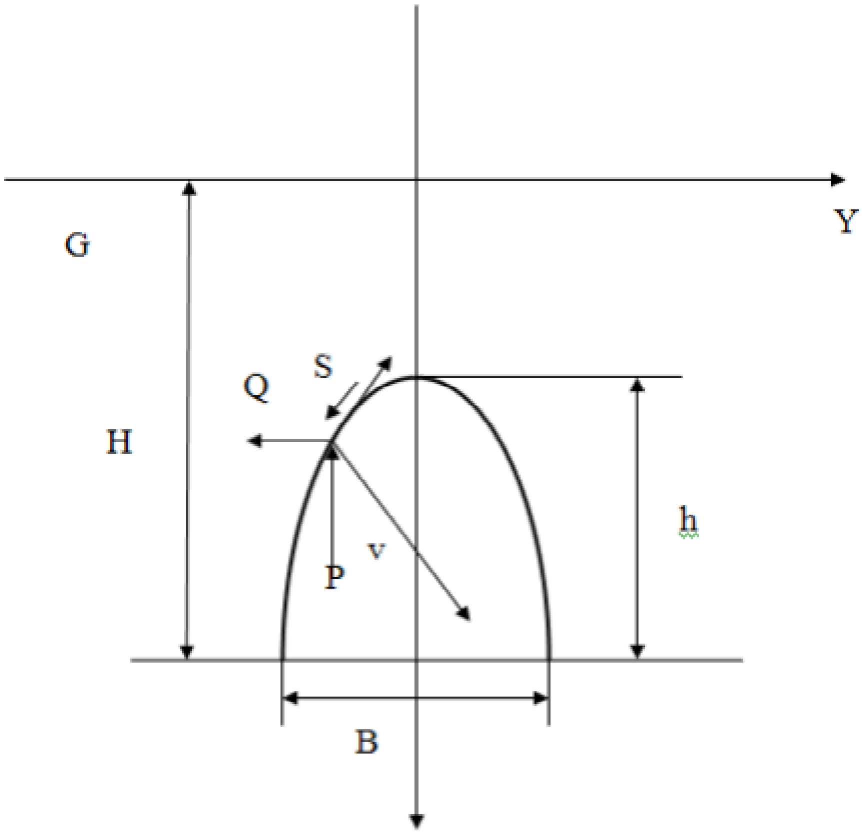

Fig. 1. Calculation scheme of the problem.

$\sigma_x, \sigma_y, \tau_{xy}$ – stress components for heavy half-plane without cutout.
$\sigma_x, \sigma_y, \tau_{xy}$ – stress components of a weightless half-plane loaded along the contour of the cutout. P(S) and Q(S).
The solution of the first problem has the form:

$$\sigma_x^0 = -\gamma x, \quad \sigma_y^0 = -\xi\gamma x, \quad \tau_{xy}^0 = 0, \qquad (2)$$

where $\xi = \frac{\nu}{1-\nu}$ - the coefficient of lateral expansion, which determines the Poisson's coefficients (ν).

The solution to the second problem will be found by setting the following distribution of fictitious forces on the contour of the cutout:

$$P(S) = a_0 + a_1 S + a_2 S^2, \quad Q(S) = b_0 + b_1 S + b_2 S^2, \qquad (3)$$

where a_0, b_0, a_1, b_1 - unknown factors, the values of which can be determined from the boundary conditions on the production circuit. The stresses at the point (x, y) of the weightless half-plane can be defined as integrals along the output contour:

$$\sigma_x(x,y) = \int_L [P(S) * \delta_{xp}(S,x,y) + Q(S) * \delta_{xa}(S,x,y)]ds$$

$$\sigma_y(x,y) = \int_L [P(S) * \delta_{yp}(S,x,y) + Q(S) * \delta_{ya}(S,x,y)]ds \qquad (4)$$

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$$\tau_x(x,y) = \int_L \left[P(S) * \delta_{\tau p}(S,x,y) + Q(S) * \delta_{\tau Q}(S,x,y)\right] ds$$

where L – the contour of production.

$\delta_{xp}, \delta_{xa}, \delta_{yp}, \delta_{ya}, \delta_{\tau p}, \delta_{\tau Q}$ – fundamental solutions for a weightless half-plane that determine the corresponding stresses at the point (x, y) of the half-plane from the action of unit forces (vertical direction – P and by horizontal lines - Q) at the point (S) of the production contour. For the analytical representation of these functions, we will use the expressions given in [1, 2].

B. Illustrations of calculations for two types of support outlines are carried out for the following conditions.

The parameters of arch support	Circular support	Tent support
The width of the workings on the soil (B), m.	3,75	4,45
Working height (h), m.	3,00	2,91
The radius of the upper layer (r), m.	2,73	2,64
Rack radius, m.	2,10	---
The length of the strut, m.	2,45	2,45

Arch support resistance N_s=220 Кн.
Characteristics of the rock mass:
Bulk weight: γ=2,6 т/м^3,
Density: γ=2,6 т/м^3
Depth of the working location H=435 м.
The system of oblique cracks with an angle of incidence:45^0.

C. Boundary conditions on the production circuit.

For points in the contour, Figure 1 shows the transformation formulas from the coordinate system (x, y) to the local coordinate system (ν,τ) have the form:

$$\sigma_0 = \bar{\sigma}_x * \cos^2\alpha + \bar{\sigma}_y \sin^2\alpha + 2\bar{\tau}_{xy} * \sin\alpha * \cos\alpha$$
$$\sigma_\tau = \bar{\sigma}_x * \sin^2\alpha + \bar{\sigma}_y * \cos^2\alpha + 2\bar{\tau}_{xy} * \sin\alpha * \cos\alpha \quad (5)$$
$$\sigma_{\nu\eta} = \left(-\bar{\sigma}_x + \bar{\sigma}_y\right) * \sin\alpha * \cos\alpha + \sigma\bar{\tau}_{xy}(\cos^2\alpha - \sin^2\alpha),$$

where α– the angle between the x and **ν** axes, counted counterclockwise.
Consider two cases of boundary conditions:
a) Free contour: at the same time

$$\sigma_\nu = \tau_{\nu\tau} = 0. \quad (6)$$

б) A working circuit that receives a uniform pressure R from the support:

$$\tau_{\nu\tau} = 0, \quad (7)$$
$$\sigma_\nu = -R.$$

To estimate the maximum R of names (at the attachment density of 2); for the conditions

$$R = 2 * N_S : \frac{B}{2} = 4 * \frac{N_S}{B} = \frac{880}{B}, \text{ либо}$$

Type of support	R, КПа
Circular	234,67
Hipped roof	197,75

The boundary conditions (7) are replaced by one integral condition, when the sum of the squared deviations along the entire contour is minimal, i.e.:

$$\int_L [[\tau_{\nu\tau}^2 + (\sigma_\nu + R)^2]]ds = min. \quad 8$$

By the minimum condition in (8) and taking into account the dependencies (1) – (5), we obtain a system of resolving equations for determining $a_0, a_1, \dots \dots \dots b_2$;

$$\int_L \left[\tau_{\nu\tau}\frac{\partial_{\nu\tau}}{\partial a_0} + (\sigma_\nu + R) * \frac{\partial\sigma_\nu}{\partial a_0}\right] ds = 0,$$

$$\int_L \left[\tau_{\nu\tau}\frac{\partial_{\nu\tau}}{\partial a_1} + (\sigma_\nu + R) * \frac{\partial\sigma_\nu}{\partial a_1}\right] ds = 0, \quad (9)$$

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$$\int_L \left[\tau_{\nu\tau}\frac{\partial_{\nu\tau}}{\partial b_2} + (\sigma_\nu + R) * \frac{\partial\sigma_\nu}{\partial b_2}\right] ds = 0.$$

The conditions for a free counter (6) are obtained from (9) by putting: R=0.

$$\int_L \left[\tau_{\nu\tau}\frac{\partial_{\nu\tau}}{\partial a_0} + \sigma_0 * \frac{\partial\sigma_0}{\partial a_0}\right] ds = 0,$$

$$\int_L \left[\tau_{\nu\tau}\frac{\partial_{\nu\tau}}{\partial a_1} + \sigma_0 * \frac{\partial\sigma_0}{\partial a_1}\right] ds = 0, \quad 10$$

$$\int_L \left[\tau_{\nu\tau}\frac{\partial_{\nu\tau}}{\partial a_2} + \sigma_0 * \frac{\partial\sigma_0}{\partial a_2}\right] ds = 0.$$

To solve the system of equations (9, 10), as well as to manipulate the knowledge of stresses of type (4), it is necessary to develop a special computer program.

According to the proposed method, a calculation model is constructed to determine the stress state of the array for horizontal workings with vaulted supports.

II.CONCLUSIONS

The article presents an analytical method for determining the stress state of a rock mass around a horizontal underground mine by a mathematical method, which consists in constructing a calculation model, then illustrating the calculations for two types of outlines and determining the boundary conditions on the contour of the mine. According to this method, there are prerequisites for creating a computer software product that allows you to quickly and with high accuracy determine the stress state of the array around the horizontal underground mine workings of a vaulted shape.

REFERENCES

1. Gorbunov – Posadov M. I. and others. Calculation of structures on an elastic base. - M.: Stroyizdat, 1984,-679 p.
2. Models of tectonic stress fields in a rock mass under conditions of underground mining of gold deposits. Mountain information and analytical bulletin. Moscow: 2017 special issue. pp. 23-36.
3. Assessment of the impact hazard category of the rock mass at the Charmitan field. Monitoring science and technology. Scientific and technical journal. 2019 No. 2. pp. 24-29.
4. Modeling of geomechanical processes in the conditions of underground mining of ore deposits. “Traditions and innovations of resource-saving technologies in mineral mining and processing. Universitas” Publishing Petroșani, 2019 (Монография) p. 170-195.
5. Analysis of the stress-strain state of the mountain range. Republican Scientific and Technical Conference " Mining and Metallurgical Complex: Achievements, Problems and Prospects of innovative development” Navoi. 2016. P. 14-15.
6. Four-stage multispectral GIS technology for geomechanical stability control of tailings dams. “Modern problems and prospects for improving the rational and safe use of the subsoil” International Scientific and Technical Conference, 10-12 May, 2018., pp. 192-194.
7. Analysis of methods and tools for predicting impact hazard. International scientific and practical conference "Scientific and personnel support of innovative development of the mining and metallurgical complex" on April 27-28, 2017, Almaty, pp. 84-88.
8. Geodesic and surveying observation in order to ensure the stability of the dams of the tailing dumps of the MOF AGMK by the nature of the geomechanical processes. International Journal of Research p-ISSN: 2348-6848. e-ISSN: 2348-795X. Volume 07 Issue 04. April 2020 p. 908-924.
9. Determination of the initial stresses of the rock mass of the Kochbulak deposit. The 6th International Scientific and Practical Conference of young scientists and students "Experience of the past-a look into the future". Tula, November 2-3, 2016, pp. 49-53.