Simulation of rock massif tension at ore underground mining

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Abstract
In the article the stresses in the elements of geomechanical system were determined. Methodology of research organization, massif management options and massif state control parameters optimization are described. Rock massif tension at ore underground mining is simulated.
Keywords: ROCK MASSIF, TENSION, ORE, UNDERGROUND MINING

In roach deposits developing a combination of induced geomechanical processes with natural processes violates the geodynamic equilibrium in upper crustal and activates the catastrophic events [1-5]. Stability of ore-containing massifs is determined by the level of stresses on the contour of stope ores, which is governed by voids filling with hardening mixtures after the evidence of this option effectiveness, for example, the method of photoelasticity [6-8]. The most complex is the mining of heavy ore deposits by combined opencast and underground methods. The criterion of combination effectiveness is the prevention of critical stresses [9-13]. Technique for organization of research includes the selection of the optically active materials; development of a device for patterns loading at different angles of force vector inclination based on the lateral thrust; results photoregistration devices [14-17]. Models were made from the optically active polyurethane with fringe value of 7,6 MPa for conditions: laying depth of mine working from the surface is 350m, the volumetric weight of overlying rocks is 3,0 t/m ^{3}. The stability of a given contour point is described by the condition

$$\sigma_1 - \sigma_2 \geq \sin\delta(\sigma_1 + \sigma_2) + \sigma_{rs} + (1 - \sin\delta), \tag{1}$$

where σ_1, σ_2- are the stresses in contour point; δ -is the angle of internal friction, 30^0; σ_{rs} – is the rock strength.

In-situ stress:

$$G_H = \gamma H \frac{G_M}{\sigma_{in}} \tag{2}$$

where γ – is the ore and host rocks density, t/m^3; H– is the stratification depth of the point from the surface, m; σ_{in} – is the stress in the model; G_M – is the stress in the model, MPa; G_H – is the in-situ stress, MPa.

For determining of stresses in the model the following expression is used:

$$\sigma_M = \sigma^{1.0} \cdot n, \tag{3}$$

where $\sigma^{1.0}$ = 0,1 kgf/cm^2 per one band; *n* – is the band number in point of interest of model.

Stresses in the model and in-situ are determined from the expression

$$G_H = \gamma H \frac{G_M}{k}$$

where *k*– is the similarity coefficient.

Condition of massif was investigated under conditions:

- horizontal stress 0,5; 1,0; 1,5;
- the force vector inclination angle to the vertical axis α = 0 for each value of horizontal stress;
- large fill modulus E = 0,1 MPa, host rock modulus – 1,4 MPa;
- options with cameras large fill and without it.

The options of massif control are characterized by stresses values, which are measured in cameras, interchamber pillars and on the vertical section of the camera.

For a coefficient of horizontal stress λ = 0,5 the maximum stresses in arch keystone zones and camera walls are equal to 7,6×7,5 = 57 MPa, and in arch pillar apex to 7,6 x 2 = 15MPa. The maximum compression stresses in interchamber pillar are 7,6×6,5=49 MPa.

For a coefficient of horizontal stress λ = 1,0 the stresses in arch keystone zones, camera walls and in arch pillar apex are equal to 7,6×6,5 = 49 MPa. In pillar the maximum stresses are reduced to 7,6×5,5 = 42 MPa.

For a coefficient of horizontal stress λ = 1,5 the stresses in arch keystone zones and camera walls are equal to 7,6 x 6,5 = 49 MPa, and in arch pillar apex to 7,6×8,5 = 64 MPa in contrast to 15 for coefficient of horizontal stress λ = 0,5.

The stresses in arch pillar was:

− for a coefficient of horizontal stress
λ = 0,5 7,6×5,5 = 41 MPa;

− for a coefficient of horizontal stress
λ = 1,0 7,6×13,5 = 102 MPa;

− for a coefficient of horizontal stress
λ = 1,5 7,6×18,5 = 140 MPa.

The maximum stress at the camera contours and keystones of arch pillar are developed with a coefficient of horizontal stress of 1,5 (Table 1).

Table 1. The stresses in the elements of geomechanical system, MPa

Thrust coefficient	Open mined-out area	Filled with hardening mixture
Arch pillar of block		
0,5	3	2
1,0	7	5
1,5	13	9
Left arch keystone		

0,5	5	6
1,0	4	5
1,5	3	4
Right arch keystone		
0,5	5	5
1,0	5,5	6,5
1,5	6	8

Optimization of the massif state control parameters is often a decisive factor in ensuring the efficiency of deposits development [1, 5, 7, 18].

Conclusions

The level of technogenic stresses is determined by simulation on low molecular materials with results photodetection. The most stress have an arch pillar of cameras. Large fill of cameras reduces the stress level up to 2 times. In options without large fills in interchamber pillars the stress concentration is close to critical.

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Complex approach to implementation of filling emulsion explosives Ukrainit in underground conditions

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