

The influence of rock interlayer location on the stress-strain state of the rock massif near the underground mine

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Abstract. The results of a numerical study of rock deformation near the preparatory mine working during underground mining of coal seams of a complex structure are presented. The evaluation of the stress-strain state of rocks with the location of rock interlayer within the coal seam is performed: in its upper, middle and lower parts.

1. Introduction

A diverse structure of coal seams prevails within the coal-bearing areas of the mines in the south of Kuzbass, [1]. There is a significant variability in the conditions of seams position even within the same extraction site of a mine field. The mechanical properties of coal and rock interlayers in the seams, fracturing, deformation and strength characteristics of rocks in the immediate roof and seams soil change drastically.

For example, at mine “Osinnikovskaya” (Kuzbass) during mining seam E_5 the interlayer of hard rock is observed, which increases the stability of the edge part of the seam. Under the influence of mining works the strained rocks in the roof, soil and coal in the seam are subjected to additional deformation, which can lead to a negative manifestation of rock pressure.

2. Methods of research

Laboratory experiments with the use of equivalent materials were carried out to establish the influence of rock interlayers on the rocks deformability [2]. According to the experiments results it can be stated that the values of the vertical displacements near the working with a rock interlayer decreased with respect to the displacement value near the working with no interlayer [3].

It is proposed to evaluate the influence of the rock interlayer in the seam on the parameters of the stress-strain state (SSS) with the help of CoalPillar computer software [4] intended for modeling the processes of change in displacements, stresses and deformations under the influence of structural seam heterogeneity, natural stress fields and mine workings in the coal and rock massif.

The calculations of SSS parameters of the rock massif in the vicinity of the mine workings are performed in conditions of plane deformation. The dimensions of the calculated area along the width are assumed equal to 600 m, in height – 485 m; the working depth in the mined seam is 350 m. The fragment of the calculation scheme of the problem is shown in figure 1.

On the contour of the model the following boundary conditions are accepted:

- on the left and right boundaries of the calculation area the horizontal displacements equal to zero;
- at the lower boundary of the model the vertical displacements equal to zero;
- the upper limit of the calculation area is free from external load.



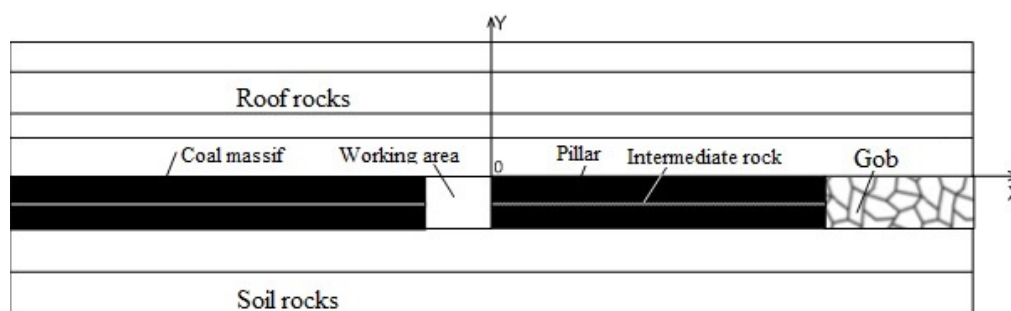


Figure 1. Fragment of the calculation scheme.

For computational experiments the mining and geological conditions of the mine “Osinnikovskaya” (seam E₅) were used. The seam thickness was 3.25 m. Its position was horizontal. The coal strength in the seam was 11 MPa, aleurolite interlayer was 0.5 m with a compressive strength of 30 MPa. The origin of the coordinates is the point of intersection from the axis of the right wall of the working with the roof of the developed seam.

The working with a width of 5 m, height 3.25 m is guarded by the coal pillar 30 m in width from the influence of the gob 210 m in length. SSS modeling of the massif was performed, and the location of the rock interlayer relative to the seam roof and soil was varied. Four options of the model are considered (table 1).

Table 1. Calculation options for modeling.

Option No.	The presence of a rock interlayer in the seam	Location of the interlayer	Distance from the seam roof to the rock seam, m
1	absent	-	-
2	rock interlayer of aleurolite with thickness 0.5 m	in the upper part of the seam	0.5
3	rock interlayer of aleurolite with thickness 0.5 m	in the middle part of the seam	1.5
4	rock interlayer of aleurolite with thickness 0.5 m	in the lower part of the seam	2.25

To establish the influence of the rock interlayer on the SSS of the rock massif in the vicinity of the preparatory working, the characteristic points (figure 2) are indicated, the coordinates of which are given in table 2.

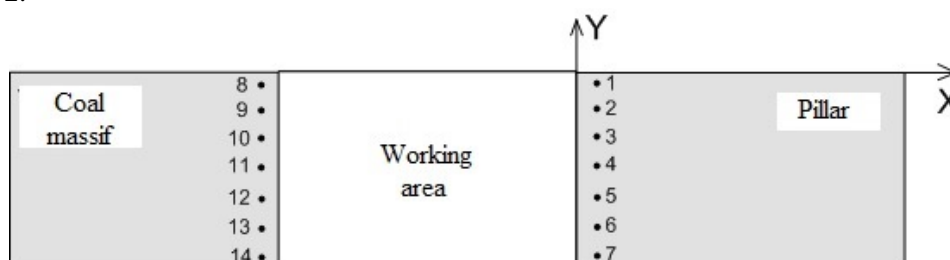


Figure 2. Arrangement of the characteristic points.

Table 2. Coordinates of the characteristic points.

Coordinates of points	Number of the characteristic point													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
x, m	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-5.2	-5.2	-5.2	-5.2	-5.2	-5.2	-5.2
y, m	-0.1	-0.6	-1.1	-1.6	-2.1	-2.6	-3.1	-0.1	-0.6	-1.1	-1.6	-2.1	-2.6	-3.1

3. Results and discussion

Qualitative differences were found in the distribution of horizontal stresses while solving the problem in the elastic formulation (figure 3, table 3) in the boundary sections of the pillar, i.e. in the walls of the working and in the boundary part of the seam from the side of the gob.

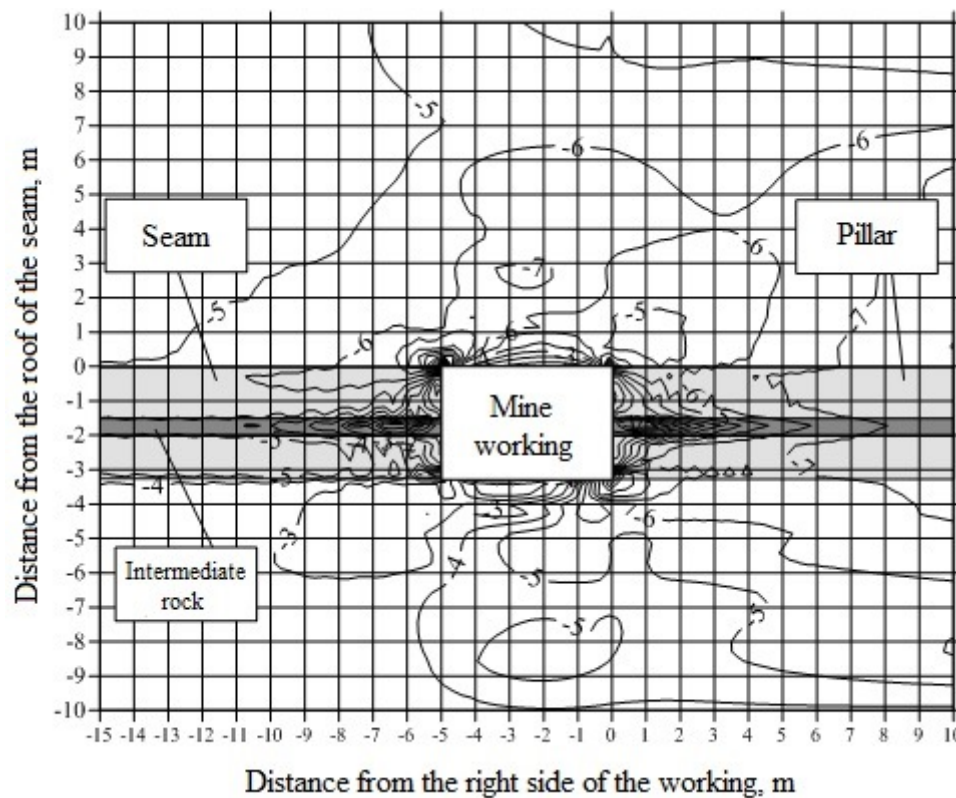


Figure3. The isolines of horizontal stresses distributions, MPa (option 3 with the location of the rock interlayer in the middle of the seam).

Table 3. Calculated parameters of the stressed state of the rock massif in the vicinity of the mine working at different locations of the rock interlayer in the seam.

Position of the characteristic point of calculation	Parameter name	Point No.	Model No.			
			1	2	3	4
in the right wall of the mine	horizontal stresses, MPa	No.1	-4.8	-4.9	-4.7	-4.7
		No.2	-0.68	1.7	-0.68	-0.65
		No.3	-0.18	-1.5	-0.72	-0.19
		No.4	-0.13	-0.26	0.3	-0.22
		No.5	-0.28	-0.3	-0.79	1.2
		No.6	-1.3	-1.4	-1.4	-1.2
		No.7	-12	-11	-11	-12
in the left wall of the mine	horizontal stresses MPa	No.8	-7.5	-7.7	-7.5	-7.6
		No.9	-0.082	2.5	-0.26	-0.18
		No.10	-0.1	-1.8	-0.87	-0.11

No.11	-0.037	-0.19	0.31	-0.21
No.12	-0.19	-0.22	-0.35	0.72
No.13	-0.85	-0.89	-0.93	-0.63
No.14	-6.6	-6.5	-6.6	-6.8

The figure shows that the presence of the rock interlayer in the seam clearly changes the pattern of stress isolines in comparison with the operation of the working in the seam of simple structure.

4. Conclusions

The proposed methodology for estimating the stress-strain state of the rock massif in the vicinity of the mine working, protected entirely by the pillar in seams of complex structure taking into account the influence of mining works, allows the expected convergence of the roof and soil to be predicted, as well as the working walls, depending on the geological conditions of their operation, and gives the opportunity to use the results of SSS research for the geomechanical justification of the parameters of mining systems in the undeveloped deposits at the design stage.

References

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