The Relationship Between the Manifestations of Rock Pressure and the Relative Deformation of Surrounding Rocks

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Abstract. On the basis of analysis of the manifestations of the rock pressure in domestic and abroad practice the authors have the aim to research above named manifestations in conditions of new coal deposits of Kuzbass (Erunakovskoe, Kazankovskoe etc.) and to form the normative document for mining in these conditions. Presents the results of the displacement contour of the benchmarks on the conveyor and ventilation drifts during the testing of the 34 layer on the "Tagaryshskaya" mine. The formed system of measuring points and applicable instruments is described. The relative deformation of the coal mass on the conveyor drift at the approach of the coal face is given. Thus, the relationship of the displacements and relative deformations with the manifestation of rock pressure is attempted by the authors.

1 Introduction

The development of new coal deposits of Kuzbass (Erunakovskoe, Kazankovskoe etc.), which are characterized by low strength and deformation properties of the surrounding rocks, increased water content etc. [1], makes it necessary to clarify of the geomechanical parameters recommended by the normative document [2], since it is not taken into account of geological and mining conditions of these new deposits. On this basis, the authors set an aim for further research in relation to the above-named new deposits to justify the rational parameters of coal mining technology in the suite and in the presence of undermining and overmining layers. Consequently, the development of similar normative document for these fields should be carried out more like mine and laboratory tests in compliance with similarity conditions in simulated mining suite's layers on physical models.

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Researches of the manifestations of the rock pressure in domestic and abroad practice are usually performed by means of the complex method, comprising an analytical stage, the mining operations modeling and field experiments.

As an example of international experience, the authors note [3], which used mathematical modeling system linking the drift movement after the coal face. And in [4, 5] the modeling of the excavation site and study of the process of forming the reference pressure zone ahead of the face of the complex are described. We have the foreign authors [6, 7, 8] for the local full-scale studies, it was noted that the length of the reference pressure zones do not exceed 15-20% of the depth of the development, and the values of the reference pressure may exceed the hydrostatic in 2-4 times.

From domestic work we should stay at work [9], which attempts to establish of the influence of coal face movement on the character of manifestations of rock pressure. But to justify such dependencies more research with the usage of physical models should be carried out.

In [10] the results of the joint influence of the high rock pressure zones from pillars (edge portions) of overmining layer and the basic pressure zone formed when the overmined layer is developing. It was noted that the greatest danger in the level of stress in the high rock pressure zones are indestructible interface pillars. On the basis of the research the location of developments outside the high rock pressure zones is recommended for specific conditions, however, such work is not enough for the development of normative documents.

Noteworthy is the work [11], which studied in detail the temperature field around the array of preparatory development and near the coal face. And recommendations on the usage of temperature changes to justify manifestations of rock pressure are issued, but this experience is hardly suitable when overmining or undermining layers in the suite are present.

Also the possibility of linking the manifestations of rock pressure with changes in relative deformations in the rock mass in the case of mining suites deserves the special attention. Under these conditions, when production face alignment is passing near of the undermining (overmining) measuring station, the recession of the relative deformations is indicating of the presence of tensile strain (unloading). Thus, the margin deformation of the overmined and undermined surrounding rocks is justified [12].

Based on the above analysis, the aim to research of manifestations of the rock pressure (on “Tagaryshskaya” mine for example) was set with a task of obtaining new data for comparison with the early known, as well as research data on physical models, to adjust and update the normative document.

Besides, in our studies, in the absence of development workings in the adjacent layers of suite, the possibility of studying the influence of the rock pressure manifestations on undermined and overmined developments was exclude, therefore, there is a need for additional research on physical models.

2 Materials and Methods

On the “Tagaryshskaya” mine researches were conducted in the period of mining of 34-3 layer (coal face 3) in the presence of the undermined layer 35 (interlayer thickness is 80 m) and overmined layer 33 (interlayer thickness is 90 m). The measurements were carried out on the path of displacement of the conveyor and ventilation drifts. In developing the layer 34 (m = 2.8 m, a = 5-8 grad, H = 320-340 m) in the coal face (Lv = 250m, Lpr = 2500m) by means of complex MKD. Coal mining was carried by KSV-460 miner. The immediate layer roof is the fine-grained siltstone (m = 9.0 m, f = 3-4), the main layer roof is also the fine-grained siltstone (m = 20.0m, f = 3-4). The average speed of the coal face movement was 2.5-3.5 m / day.

Conveyor and ventilation drifts in the roof are fixed by anchors with length 2.2 m and amount 6 anchors on the roof bar (l = 4.4 m), including 2 key anchors (with the presence of compliant washers) at the side of the ventilation drift and 1 key anchor at the side of the conveyor drift. The drift boards are fixed by SK anchors with length 1.8 m, one anchor on the sides with a distance along strike 1.0 m in alignment with the roof bars.

The displacement on the contours of the conveyor and ventilation drifts in the direction of "roof - soil" was carried out on the measuring point (MP1, MP2) 2 on each drift, and in the direction of the "side-by-side" it was carried out at 2 measuring points (MP3) [13]. Measuring of the displacement of deep and contoured frames carried out by the VNIMI method [14].

It should be noted that at the same time the observations on the caving pressure formation on the layer soil and on formation (bundles) of the layer roof up to the collapse (initial and subsequent), as well as monitored pressure change's character in the timber stands of the complex was executed.

These results are presented in other studies and considered in this case, since we consider only the relationship with the displacement on the contour of the conveyor and ventilation drifts.

Instrumental measurements of the deformation of rocks, surrounding of the development, carried out by means of the MIS-11 display rack with attachment dial (measurement accuracy ± 0.01 mm) or with a VNIMI micrometer stand.

The VNIMI micrometer stand is a rigid tubular unit, one end of which is pointed, on the other end the micrometer with division 0.01 mm is mounted. Rigid stand base is 800 mm and pull-out micrometer part is 25 mm.

The deformation measurements were carried out on a special measuring point (SMP) at a distance of about 500 m from the mining chamber, about 1.1 - 1.2 meters from the MP3 [13].

To equip SMP the pressed coal production in the wall was robed on depth 0.8 - 1.1 m. In the formed recess two boreholes were drilled up to 1.1 m. The distance between the holes was determined by base of micrometer rack or IMS-II rack and was 870 mm. The boreholes are concreted with metal benchmarks (d = 16 – 18 mm, l = 1.0 - 1.2 m) by means of BRC cement (fast setting, expanding).

The benchmarks had a recess with a diameter of 3 - 4 mm to fix the rack position and placed into the niche so that during the observations deformations normal to bedding were measured [12].

3 Results and Discussion

Displacement of the contour benchmarks on the conveyor drift began to manifest itself at the approach of coalface to the MP1 at a distance of 27 m, reached 33 mm and 29 mm respectively on the ventilation and conveyor drifts, and when coal face was approaching at 29 m to the MP2 displacement, reached 47 and 50 mm respectively on the conveyor and ventilation drifts.

On the MP3 displacements accounted for 11 and 15 mm respectively on the conveyor and ventilation drifts [13].

Table 1 shows the relative deformation $\varepsilon \cdot 10^{-4}$ of the coal mass, depending on the distance from the SMP to coal face, as on fig. 1 the nature of their manifestations is shown. Fig. 1 shows that the relative deformation is not exceeded the 25 value, that in comparison with extremely high performance for coal samples lower than in [13-15], since there is such an order of magnitude lower, therefore the relative deformations of the coal mass on the conveyor drift were in the range of elastic deformation, so there was not be destruction.

Table 1. The value of the relative deformation $\varepsilon \cdot 10^{-4}$ of the coal mass, depending on the distance from the special measuring point (SMP) to coalface *L*, m

The distance from the SMP to coal face *L*, m	-5	0	5	10	15	20	25	30	35
$\varepsilon \cdot 10^{-4}$	25	25	24	21	17	12	8	4	2

The transition of coal face over the SMP marked the relative deformations decline that indicates the presence of tensile strain (unloading). The considered nature of the deformations of the coal array is given as the ability to search control options and valid deformations of undermined and overmined rock mass in mining of suites of layers.

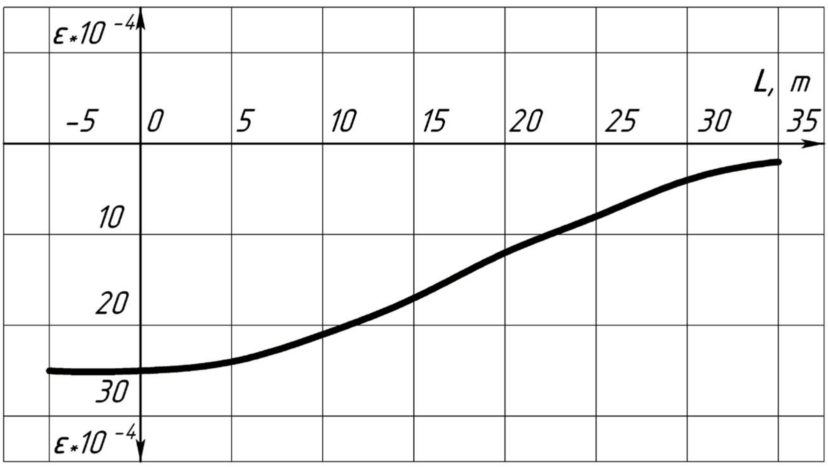

Fig. 1. The formation of the relative deformation $\varepsilon \cdot 10^{-4}$ of the coal mass, depending on the distance from the SMP to coal face L, m: $\varepsilon = \Delta l / l$, where Δl is the rock deformation, mm; l is the distance between benchmarks, mm.

It should be noted that the relative deformation compared with the displacement on the contour of the conveyor and ventilation drifts began to emerge not at 27-29 m from coal face, and at 36 m. It can be explained by the fact that the displacements on the MP1 were fixed at a distance of 240 m from the mining chamber and on the MP2 at a distance of 500 m from the mining chamber, so this fact can be explained that the movement came to the main roof of the layer.

4 Conclusion

The considered nature of the deformation of the coal array in combination with other methods is possible when selecting control options of valid deformations of undermined and overmined rock mass in mining suites beds is present, as concreted benchmarks for fixing of the strain can be stored in different places long period of time and can come in suitability for fixing the manifestations of the rock pressure and to prevent of destruction of the surrounding rocks.

In developing the normative document for the new Kuzbass deposits it needs to spend more like mine, and laboratory tests in compliance with similarity conditions in simulated mining suite's layers on physical models, so as the separate researches in the mining conditions (complex, lengthy and costly in time) is not enough to study objective lows of rock pressure manifestations at a wide variety of geological and mining factors.

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