

Analytical and Mining Experimental Studies about the Character of Interaction on the Mechanized Supports of ZQY3600/12/28 at the Quang Hanh Mine in the Quang Ninh Coal Basin

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Abstract. Complex studies using measuring stations for working out inclined coal seams of medium thick with the use of longwall, combining in a certain extracting area of mining works and instruments for measuring the bearing rock pressure and the displacement of the roof rocks adjacent to the longwall. The parameters of stress intensity distribution were placed during the working out of the extracting area. Installation of reaction dynamics mechanized support along the strike of extracting area. Suggestion 3D-model shows stress-deformation state of the rock massif in all of extracting area.

1 Introduction

Researches of the interaction by the support with the massif are taken with the purpose of substantiation the parameters, obtaining data for an objective assessment of the influence of technological processes on the work of the face, studying the influence of mining and geological factors on the efficiency and safety of mining work. They are based on determining the value and character of the formation of rock pressure along the width and length of the mining district, which are included in the calculation for the justification of technological schemes [1, 2, 3, 4].

The most complete information on the interaction of the support with the massif can be obtained by the joint study of the value and character of the distribution of rock pressure on the support of development roads and its stressed status in the zone of influence of mining works. In this regard, comprehensive research is being applied, including the carrying out of both basic measurements (determining the character of the formation of loads on the support of the face) and additional measuring (determining the displacement of the rock contour of development roads, deformations and stresses in rocks and support) [5, 6].

While carrying out complex studies, measurement stations are used that unite in a certain area of mining works of complete organization and instruments for measuring the required parameters [7].

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2 Researches of the interaction by the support with the massif

To measure the value of the rock pressure on the mechanized support, to study the formation of loads on the supports and their pliability in the development workings, depending on the production processes, on 12.2017 at the Quang Hanh mine, studies were carried out in which the authors took a direct participation.

Experimental studies were carried out at the Quang Hanh mine during the development of seam 6, the face was equipped with mechanized support “ZQY3600 / 12/28” and shearer “MG132/320W”. Mining and geological conditions of the seam 6 are as follows: thickness of coal seam 2.4 m, dip of angle 20°, coal hardness according to M.M. Protodyakonov is $f = 1$ to 2, the density of coal is 1.6 T/m³. In the limit of seam 6, the immediate roof is represented by siltstone with a thickness from 2.7 to 19.1 m, average 9.4 m, medium strength, and the main roof is represented by sandstone with a thickness from 7.7 to 15.5 m, medium strength.

In the face, the measurement of the rock pressure on the mechanized support was carried out with the help of electron-recording manometers “YN60-60”, which were placed in 11 measuring stations along the length of the face on each 5 support (№.1, 6, 11, 16, 21, 26, 31, 36, 41, 46, 51).

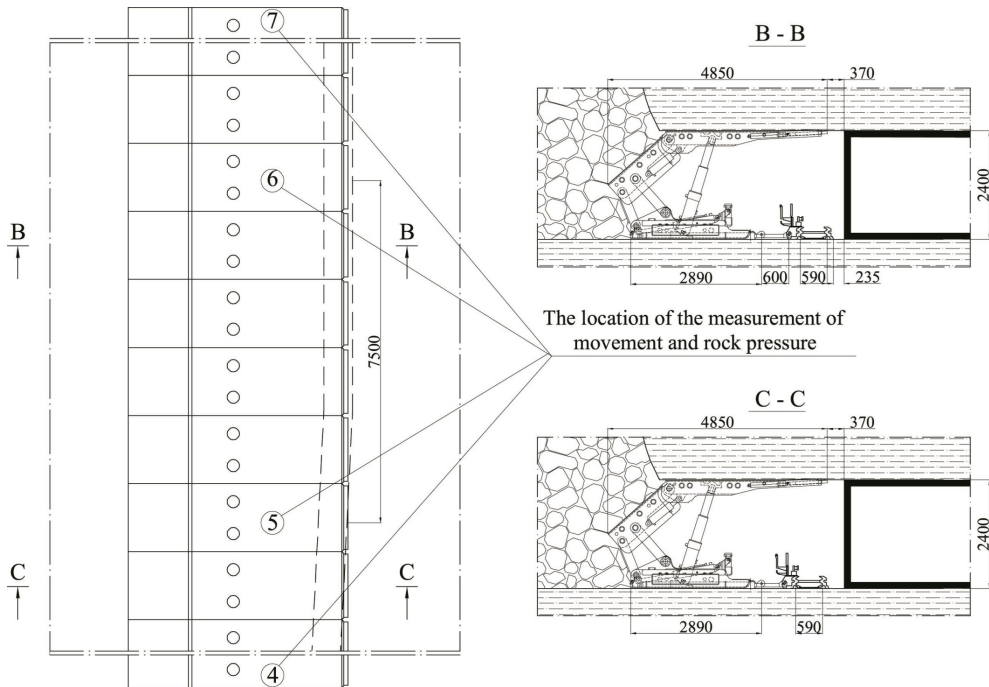


Fig. 1. Scheme location of the measuring stations in the longwall of the coal seam 6.

When the data obtained from the electronic selfrecording manometers “YN60-60” and using the Microsoft Excel program, graphs were drawn describing the character of the change in the reactions of support (support №. 31) along the strike and along the length of the face, depending on the productive processes shown in Fig. 2.

From the above result shown in Fig. 2, it can be seen that at the beginning of the rock pressure on the support №. 31 was 148.8 tons/support (18/12/2017) and as the coal was cut by the combine, an increase in the area of outcrop of the immediate and main roof occurred, which led to its bending and, as a consequence, an increase in the load on the support to

237.3 tons/support (23/12/2017) with a distance of 9.5m in comparison with cutting face to the pressure, which acted on the support reduced to 153.8 tons/support (25/12/2017).

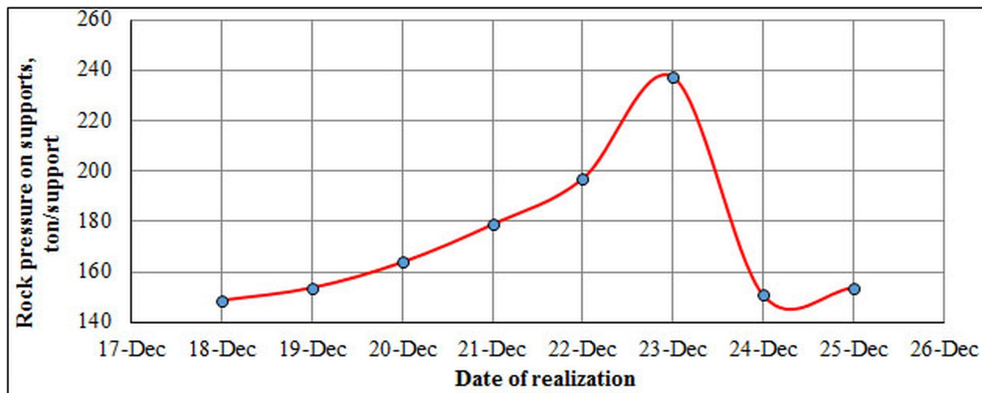


Fig. 2. Dynamics of reaction of mechanized support (No. 31).

After the initial fall of the roof, the pressure distribution along the face on the dip fluctuate within 148 to 166 tons per support. The dynamics of the change in the rock pressure along the length of the face is shown in Fig. 3.

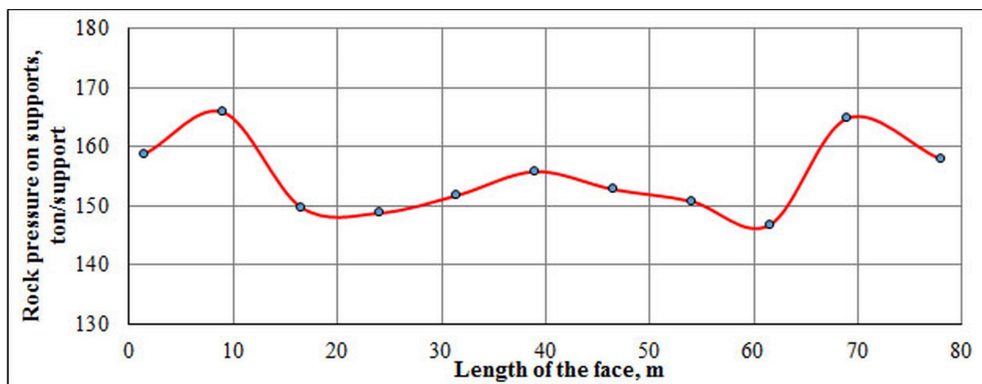


Fig. 3. Dynamics of rock pressure along the length of longwall.

The results of measuring the rock pressure on the support of the face during the applicable test show that, after setting the support in the working face and putting into operation, the pressure has the action on the support with increasing values. On the basis of the data obtained from 11 measuring stations, we built a 3D model based on the “Matlab program”, which is shown in (Fig. 4) visually showing the stress-deformation state of the rock massif on the entire area of the mining district.

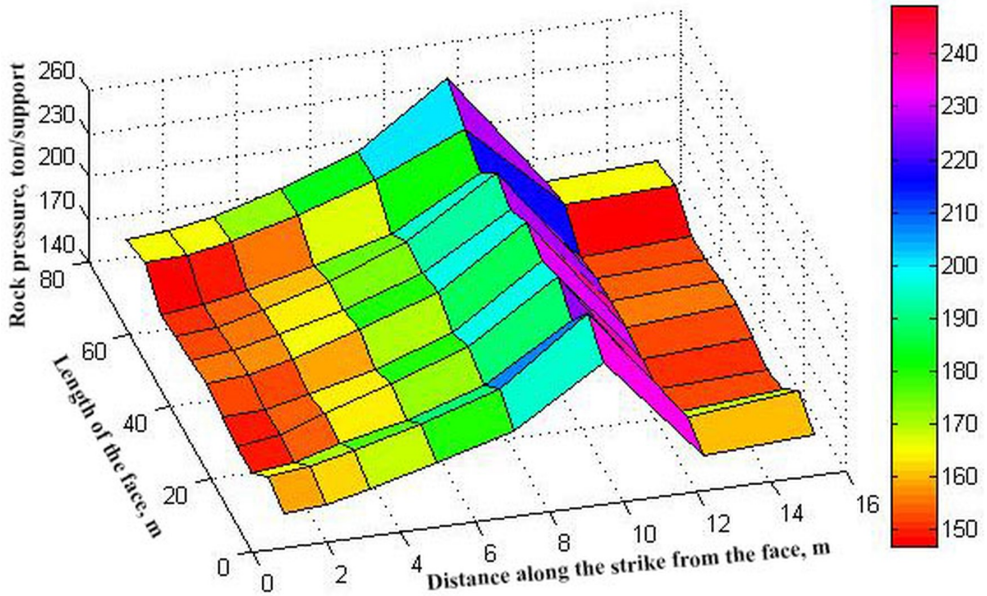


Fig. 4. 3D model of the intensity distribution of tension during the working off of the extracting district (seam 6 of the Quang Hanh mine)

Analyzing the result on the 3D model shown in Fig. 4, it can be seen that the step of fall of the main roof varies within the limits of 9 - 13 m, which correlates with the earlier research in the mines of the Cam Pha coal field [8].

The processing of the results of studies by the method of mathematical statistics (Fig.4) shows that, the curved surface constructed from the results of mine studies is objectively approximated by an equation with the form:

$$z = 5.23 \cdot 10^5 y^3 - 0.034x^3 + 4.19 \cdot 10^5 xy^2 + 48.83 \cdot 10^5 x^2 y - 62.54 \cdot 10^5 y^2 - 0.13x^2 - 0.013xy - 0.27y + 10.83x + 144.51$$

Where: z - rock pressure, T/support; x- distance along the strike, m; y- the length of the face, m.

Also, mine experimental studies were conducted with the purpose of studying the rock pressure and displacement of the roof and floor rocks of development workings in the adjoining to the face.

The results of measurements of the displacement of the roof rocks, shown in (Fig. 5), show that the speed of the roof displacement on the conveyor drift increases when the distance from the measuring stations to the face is reduced. This value increases slowly at a distance more than 30 m, and increases sharply from 0 to 10 m to the face of longwall.

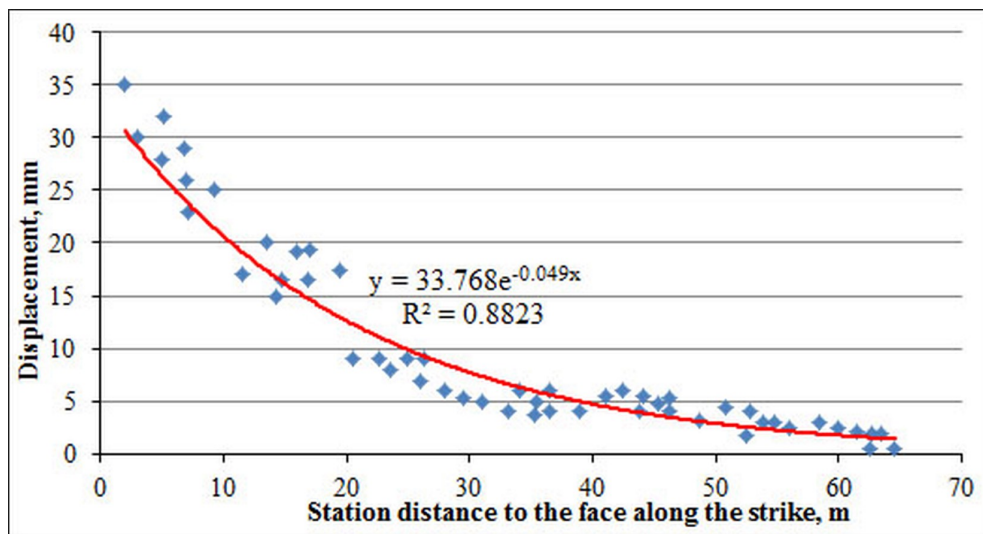


Fig. 5. Displacement the roof on the conveyor drift.

The results of measurements of the bearing pressure on the support using the Microsoft Excel program are shown in Fig.6.

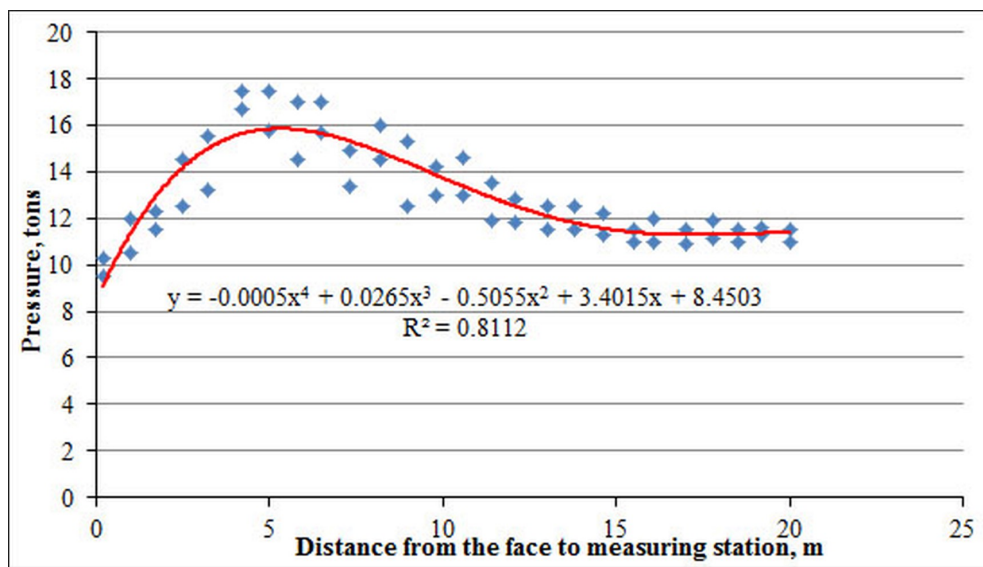


Fig. 6. The character of the formation of the rock pressure ahead of the face along the length of the conveyor drift.

The processing of the study results by the method of mathematical statistics (Figure 6) shows that, the curve constructed from the results of mine studies is objectively approximated by an equation with the form:

$$y = -0.0005x^4 + 0.0265x^3 - 0.5055x^2 + 3.4015x + 8.4503$$

Where: y - rock pressure, MPa; x-distance from the face, m

The correlation coefficient is very high, which indicates a large narrowness of the connection between the parameters studied.

It is seen from Fig.6 that the bearing rock pressure on the support of the conveyor drift along the strike of the extracting area varies unevenly. The maximum of the bearing rock pressure is located at a distance from 2.5 to 8 m ahead of the face and is from 13 to 15.8 tons. At a distance of 15m from the face, the bearing rock pressure approaches the initial and stable in value 11.5 tons, which does not contradict earlier studies [8, 9].

4 Conclusions

A software module has been developed which implements the algorithm for constructing a 3D volumetric stress intensity distribution model throughout the area of the extracting district, which allows foreseeing potentially dangerous zones and more consciously conducting mining works.

On the basis of mine experimental and analytical studies carried out, progressive variants of methods for preparing and working out reserves of inclined coal seams are proposed, which consist of combining in time and separation in space, the technological schemes for mining works in the working of reserves of inclined coal seams with mechanized technology, allowing to optimize spatial planning solutions when working out extracting district and parts of the mine field.

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