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DEFINING THE BASIC CONDITIONS FOR THE APPLICATION LONGWALL PRINCIPE HORIZONTAL MERGER

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ABSTRACT

Getting coal using mechanized longwall on the principle of horizontal concentration in a single procedure, it can be successfully applied in mining coal seams very small thickness. For high calorific coal thickness of coal seam that can be successfully excavate this method is approximately 1.0m other coals to 5.0 m.

Result of extensive laboratory research presented in this study are related to the possibility of mechanized exploitation (mining application longwall) coal seams in the mine "Lubnica".

Key words: *exploitation, coal, mechanized hydraulic roof supports*

INTRODUCTION

The success of the exploitation of a coal deposit or any part thereof, is characterized by the selection of the technological process of excavation, which determines-defined, a set of technological operations related to the process getting coal [1,2].

It should be noted that the excavation of thick coal seams over 5.0 m, of the most versatile and also the most difficult area in the process of excavation, so that's why poses a dilemma of choice principles concentrations (horizontal or vertical approach) [3].

For solving this question have a a decisive impact geo-mechanical conditions under which must choose the proper method and technology of the application of appropriate machinery. The interaction of rock mass and mechanized hydraulic roof supports, is one of the primary conditions for successful application of MHP by exploitation of coal especially in the case of complex conditions of exploitation of coal layers [4].

THE BASIC PRINCIPLE ON PRINCIP HORIZONTAL CONCENTRATION

Because some of its benefits today in the world often make decisions that coal seam and a thick mined broad foreheads with the application of the principles of horizontal concentration-the so-called coal is in the bands as shown in Figure 1 [5].

In application of the principle of horizontal concentration for mining thick coal seams in several bands, alone technological process requires patošenje excavation, installation of steel mesh or allowing carbon plate of suitable thickness, in order to avoid breaking the tailings from the old excavation work at the following levels [6,7].

The main disadvantages of digging thick coal seams principle of horizontal concentration are:

- Creation of a large number of mining facilities,
- Frequent relocation (relocation) Equipment broad forehead, causing delays in the process of excavation and smaller excavated effects.

The very efficiency of mechanized hydraulic roof supports, largely depends on the adjustment of the structure of support natural and geological conditions exploitation [8].

In this work analyzed the results of detailed investigations of geotechnical characteristics of the rock mass in coal deposits "Lubnica" as well as modeling [7].

It is important to note that the modeling was done in terms of excavation floor panel of the first (main) coal seam, where the earlier excavation roof panel thickness of 5-6 where old work already consolidated, but it remains one of the most complex management models overlaying the mechanized mining of coal .

In all of the deposits between the roof and floor panel of coal seam there is dirt bands overburden, very little strength, the thickness of which is variable and ranges from 0.3-0.5 m.

THE METHODOLOGY AND RESULTS OF LABORATORY TESTS

Samples for laboratory physico-mechanical tests were taken in the form of blocks directly from mining facilities floor panel part of the first (main) coal seam. In this section, direct deposits overlaying makes fine-grained porous sandstone thickness of 0.3-0.5 m above which the coal panel thickness 0.5-0.8 m across that offers old work previously excavated part of the roof panel of the same coal seam.

All studies of physical and mechanical properties of the samples were performed on small samples of the methods that are standardized for each type of test mining according to the recommendations of the international society for rock mechanics (ISRM). Necessary tests are conducted on the number of samples, which provide medium preparation representative values of a trait for each section.

Average value of the surveyed properties, is calculated according to the formula of standard deviation and coefficient of variation medium data.

$$\sigma_{n-1} = \sqrt{\frac{\sum \Delta^2 \cdot Xi}{n-1}} \qquad K_{var} = \frac{\sigma_{n-1}}{\overline{X}} \quad [\%]$$

In summary Tables 1 and 2 presents the results of laboratory tests coal deposit series of the first coal seam.

Table 1. Physico-mechanical properties of coal and accompanying rock of the coal deposit Lubnice

Tag lithologic members	Uniaxial compressive strength σ_p (MPa)	Otpornost na zatezanje σ_p (MPa)	Tensile strength σ_f (MPa)	Cohesion C (Mpa)	The angle of internal friction φ°
The immediate roofpanel	8,11 $K_{var.}$=15,12%	0,79 $K_{var.}$=8,45%	3,18 $K_{var.}$=16,65%	1,25	38
Coal seam	19,48 $K_{var.}$=8,99%	2,01 $K_{var.}$=7,29%	4,65 $K_{var.}$=15,81%	2,90 $K_{var.}$=10,24%	35 $K_{var.}$=7,10%
Underlying lath	7,21 $K_{var.}$=7,55%	0,69 $K_{var.}$=8,35%	4,86 $K_{var.}$=6,23%	1,23	33
Immediate floor	9,32 $K_{var.}$=8,53%	0,87 $K_{var.}$=13,10%	4,98 $K_{var.}$=18,83%	1,78	36

Table 2 Physico-mechanical properties of coal and accompanying rock-of the coal deposit Lubnice - continuation of table 1

Tag lithologic members	Tangent modulus E_t (MPa)	Secant modulus E_s (MPa)	Module strain at fracture E_d^l (MPa)	Coefficient Poisona ν	Cutting resistance		The coefficient of friability f
					KL,┴(N/cm^2)	KF,┴(N/cm^2)	
The immediate roofpanel	480	270	240	0,21	383 $K_{var.}$=8,84%	58 $K_{var.}$=13,78%	-
Coal seam	614 $K_{var.}$=8,39%	354 $K_{var.}$=8,55%	325 $K_{var.}$=7,29%	0,33 $K_{var.}$=10,22%	1536 $K_{var.}$=12,25%	211 $K_{var.}$=15,33%	7,99 $K_{var.}$=15,53%
Underlying lath	519	330	318	0,36	510 $K_{var.}$=13,62%	65 $K_{var.}$=14,68%	-
Immediate floor	535	330	310	0,27	600 $K_{var.}$=21,37%	99 $K_{var.}$=8,66%	-

STRESS STRAIN CONDITIONS IN THE ROCK MASS AROUND EXCAVATION SITE

A large number of theories and hypotheses about power-deformity condition of rock massif near the longwell confirms that this is a complex issue and the current lack of a universal theory, that all mining-geological conditions had an acceptable application.

Introducing the stress-strain state around the longwall, it becomes very complicated wrought, primarily due to the dimensions of a wide longwall and its scope in the project area the rock mass. The diversity of rocks and their geotechnical properties around longwell, are problematic assumption of equalls isotropy and continuity excavation field.

That is why for many years the literature has faced many attempts to reach the realistic explanations of phenomena that occur in the rock mass near the longwall. Knowledge of these phenomena is crucial for the safe design and construction of exploitation, ie. determine the optimal dimensions of a longwall, a suitable choice excavation of support and governance roofing [1].

To determine the equation of bending immediate roof layers and the layout and size of pressure in coal seam mining with demolitions, adopts the following scheme budget figure 1. The immediate roof of part of the coal seam and barren interbeds thickness h, loaded with a uniformly distributed load more of lower metering deposits, lying on the bed, which we consider an elastic substrate. Above the mining area, the immediate roof of the console makes the length of 1.

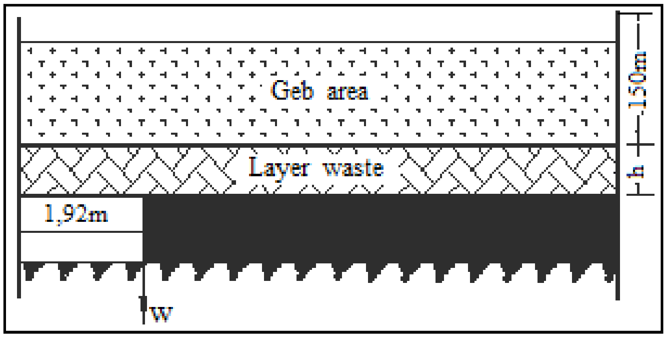


Figure 1 Scheme for the calculation

With distance from the forehead to the exploited layer and the roof caving, voltage can be changed by law, with the wavelength decreasing the amplitude of Figure 2

The wavelength is determined in the following manner:

$$2L = 2\pi\sqrt[4]{\frac{4 \cdot EJ}{C}}$$

A exploitative pressure can be expressed as:

$$\sigma_{z\max} = P_z\left(\frac{\pi \cdot l}{L} + 1\right)^2$$

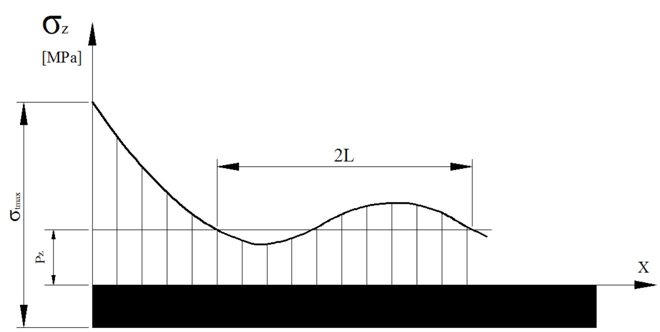


Figure 2 Distribution of stresses in the layer with demolition of roof panel

Taking into account the specific conditions of the mining field, mine "Lubnica", such as that future longwall placed under the old work with the given thin coal plate from about (0.3 to 0.5 m) in the ceiling of the longwall, it must meet the following condition:

$$\frac{h}{m} \geq \frac{25E}{3 \cdot E_c \cdot (1+v)^2}$$

- h = l,20 m, height allowed ceiling beams
- m = 2,5 m, height longwall
- E = 60 (MPa), modulus of compressibility of the old labor
- Ec = 610 (MPa), modulus of elasticity of coal seam
- v = 0,33, Poison coefficient of coal seam

$$\frac{11,0}{2,5} \geq \frac{25 \cdot 60}{3 \cdot 610 \cdot (1+0,33)^2}$$

$$0,48 \geq 0,46$$

So, if exploited layer mightiest low, with significant elastic modulus, and roof panel with old work, with a low modulus of elasticity, then the flow of power to the mining layer has the character of an exponential curve, Figure 3, and not the wave character [1].

Change the vertical load of coal bed in front of the worksite Tables 3.

Table 3 The increase vertical load in function of distance in front of the wide forehead

	The distance from the front											
σ_z(MPa) by the equation 11	x=0	2	4	6	8	10	12	14	16	18	20	30
	10,64	4,54	3,61	3,05	2,86	2,79	2,76	2,75	2,74	2,74	2,74	2,74

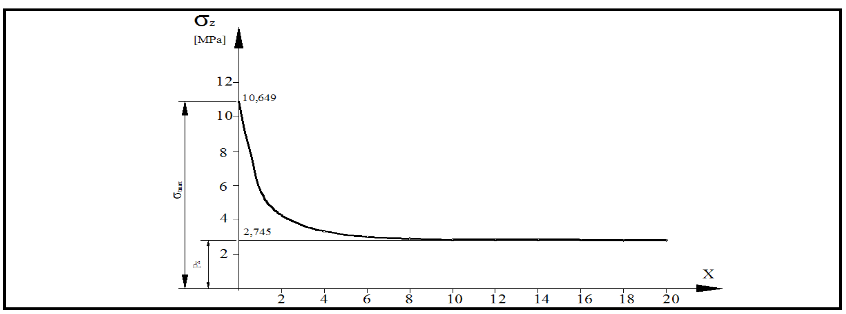


Figure 3 The exponential distribution of stresses in the coal seam in front of the worksite

DETERMINATION LOAD ON ROOF SUPPORTS EXCAVATION

Frame roof support

At low strength of rock core roof layers Support of should accept not only the burden of immediate roof layers equal to twice the Mightiest layer, but preferably obliquely slip immediateroof layers, under the influence of subsidence basic roof layers [1].

From the scheme Figure 4, it can be derived the following equation for determining the required specific resistance of roof support F (KN/m)

$$F = 10 \cdot \left[\frac{2 \cdot \cos \rho}{(1-\lambda)-(1+\lambda)\sin \rho} + \frac{\gamma \cdot M}{n-1} \right]$$

- c, cohesion immediate roof layers (KPa)
- ρ , angle of internal friction
- λ , coefficient of lateral pressure drilled layers
-

$$\lambda = \frac{\sigma_3}{\sigma_i} = \frac{1-\sin\rho}{1+\sin\rho}$$

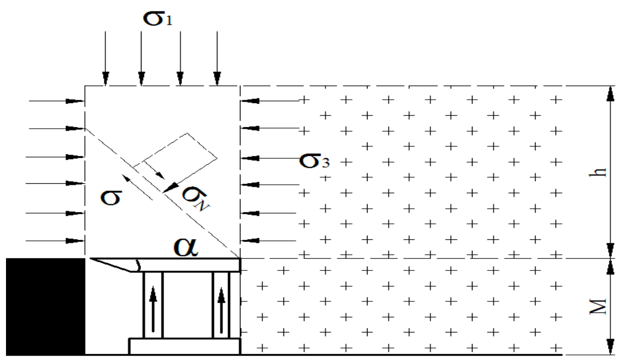


Figure 4 Computational scheme for determining the load the roof supports in low rocks roof layers

Thyroid roof slab

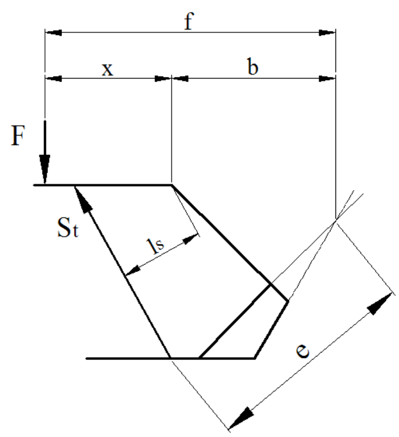


Figure. 5 Numerical scheme of section thyroid roof slab the principled range hydraulic column in the roof timber

Resistance to thyroid sections of support St., can be determined by the law of moments, Figure 5.

$$F \cdot x' - S_t \cdot l_s = Z \cdot l_z \ ; \qquad F' \cdot (x' \cdot b') = S_t \cdot e$$

$$x' = \frac{Z \cdot l_z + S_t \cdot l_s}{F'}$$

$$F' = \frac{S_t (e - l_s) - Z \cdot l_s}{b'}$$

STRESS – STRAIN ANALYSIS OF STRUCTURES EXCAVATED

In longwall mining of coal, the complexity of managing massive, among other things, reflected in the necessary stability of the roof slab in front of support and its good the level of destruction back support. In this particular situation, the problem is slightly more complex due to the excavation of the upper layer [7,8].

Roof seam of coal, which was previously excavated from under floor is a separate layer tufnog sandstone thickness of 0.4 meters. During the excavation of the roof layer, above the sandstone was left plate of coal thickness of 0.8 meters. The floor of the layer which is being prepared for mining thickness of 2.8 to 3.5 meters measured from the footwall sandstone interbeds of sandstone. Since that said dirt bands of sandstone insufficient strength necessary to determine the thickness of the plate beneath the coal sandstone interlayers, which will ensure the stability of the excavation front support. The task is solved by numerical models using the finite element software Phase2. Enlargement of the basic model in Figure 6, [7].

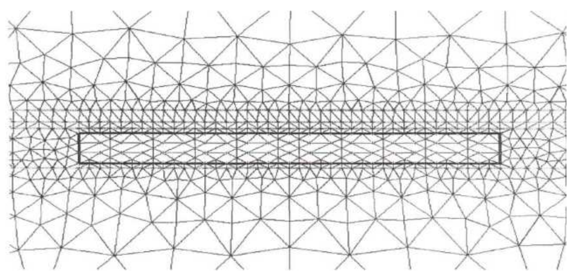


Figure 6 Enlargement of excavation

During the study, the basic model is transformed into a dozen separate models and in all the simulated excavation in nine phases. Modeled coal seam thickness of 3 meters. During the excavation is planned leaving the floor panel thickness 0.3 meters. The thickness of the roof slab of coal was variable, and thus the height of excavation.

Step progress of excavation is 1 meter, and the maximum range without roof slab front of support is 2 meters. Active timbering segment length is 2 meters. Have been modeled to the disintegration of the coal is performed in a single pass machines for digging.

All models are made up of about 2500 triangular elements with three nodes per element. Given that the model is a slice of rock mass that continues on all four sides of the model contour conditions are resolved so that all nodes in the contour model set infinite elements.

SIMULATION OF THE MINING PROCESS

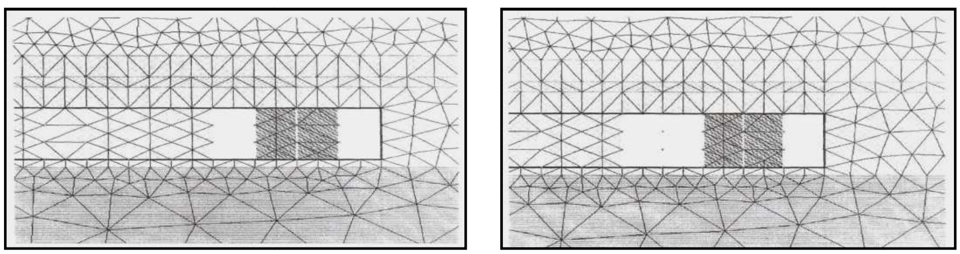
As can be seen in Figure 7 simulate the excavation layers at a distance of 20 meters, ie. 20 segments per 1 meter. Since the program allows up to 9 phase to simulate the excavation of the length of excavation was used by successive models.

In the first stage processed the model with the initial condition without any engineering activities to be able to monitor changes in certain parameters. The next phase was carried out disintegration of four segments and assembling a supporting web of support with the active length of 2 meters, Figure 7.

Then, phase 2 was carried out in the disintegration of the segments has a front roof supports wherein the created without roof suport maximum span of 2 meters. The next phase of the simulated movement of support for one meter, which is outside the range of support without roof suport reduced to 1 meter, a range of support behind increased by 1 meter. This procedure is repeated cyclically until he simulated excavation of all 20 segments, and 20 meters.

Simulated the excavation of three thick roof slab (0.3, 0.5, 0.8 m). Followed by the stress state and distribution of safety margin in the roof panel, front roof supports, with simultaneous assessment the level of destruction roof layers behind the support.

The existence of a fault in a layer of the sampler that in some places there is no floor plate of 0.8 meters of coal (in the previous excavation), or it is significantly thinner or thicker. Therefore, we have analyzed a model without roof panels above the hanging wall of coal sandstone.



a) b)

Figure 7. Simulation of excavation, phase 1 and 2

DETERMINATION OF THE THICKNESS OF COAL ROOF PANELS WHICH PROVIDES STABILITY OF THE EXCAVATION FRONT SUPPORT

Based on engineering experience and preliminary studies of model is first modeled plate of coal under the roof sandstone thickness of 0.3 meters. After a number of steps to fracture the excavation roof panel behind the roof supports progressive failure occurs and demolishing rock mass over excavation (consolidated old work). Soon after coming to fracture and roof panels in front of support and gradually.

A graphical representation of condition described is shown in figure 8 The picture shows the date isolines level of security with markers of broken elements. Markers in the form of points show that the marked element broken due to the load on the hood, a marker in the shape of crosses that the fracture was caused by shear [1].

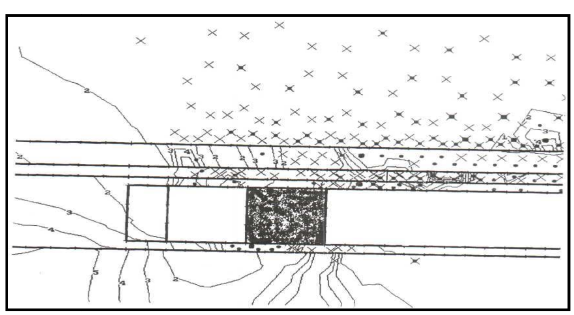


Figure. 8 Graphic condition stability of the roof panel 0.3 m

The next phase of research, created a basic model with a roof plate 0.5 m thick coal. Finished the complete simulation of excavation as in the previous case, the successive models. In this case, in front of the roof plate of support does not show the necessary stability.

In the next phase of the study, modeled coal plate 0.8 meter thick. And this time he performed a complete simulation of excavation in successive models.

In this case, after complete excavation of 20 meters and a progressive fracture rock mass plate of coal in front of support showed satisfactory stability at the maximum range of 2 meters. In Figure 9 shows the isolines of safety.

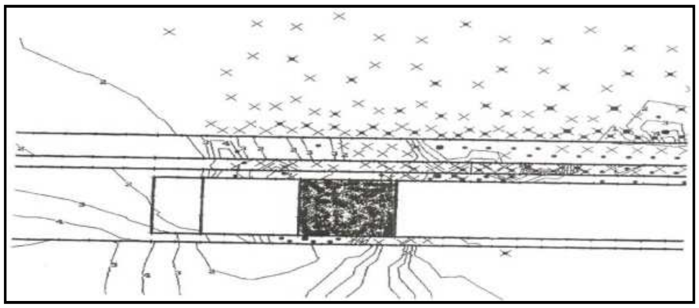


Figure. 8 Graphic condition

CONCLUSION

Using different methodology for calculating the specific conditions of the test sites is obtained by a very wide range of values required capacity mechanized hydraulic roof supports in concrete terms. If we adopt this as a criterion, then the nearest value of the required capacity of MHP obtained using the finite element method. Numerical methods can be used successfully in predicting the distribution of stress and deformation around a broad forehead especially in difficult conditions.

One thing is certain, that must work to improve the input data for numerical methods which in turn can only be achieved by testing the results of calculations and measurements "in-situ.

As a general observation to analyze the conditions of coal "Lubnica" that thinner roof plate (0.3 and 0.5 m) crashes before the panel backward from excavation of the roof layer. What is the difference in thicknesses greater that the delay in the demolition higher. Considering the fact that only a slab of 0.8 meters securing satisfactory stability of the excavation front support.

The analysis of the results presented suggest that it will fracture the roof plate come after six steps of one meter or as a range exceed six meters. Fracture will occur immediately after the first support. Together with the roof plate of coal will result in the demolition of the sandstone roof panel.

Sandstone interlayers significantly less strength than coal does to the two plates behave as two independent structural element. It is very important, when forced demolitions while demolition and top panels of coal.

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