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CALCULATION OF PARAMETERS OF THE PROTECTION MEANS FOR ROADWAY DISTRICTS IN WHICH CEMENT-MINERAL MIXTURES ARE USED

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Abstract. The method for calculating parameters of the cast and packed protective-insulating walls was improved. The method is distinguished by the combined accounting of physical and technical properties of cement-mineral mixture used in the construction of the wall and the intensity of stress changes in the hardening concrete depending on the mining, geological and technological conditions of the roadway functioning. The following factors are taken into account when calculating the change in loads on the protection means of the roadway district over time: weighted average compressive strength of the rock layers in the roadway roof and floor; category of cavability of the coal seam roof; step of the first and subsequent roof falls; rate of longwall face advancing.

To substantiate the correspondence of the mixture physical and technical properties (the intensity of concrete hardening over time) to the change in loads on the protection means of roadway, the values of the limit strength of concrete for uniaxial compression, obtained according to standard tests in laboratory conditions, are used. In order to take into account mine conditions for the construction and functioning of the protective-insulating walls, dimensionless coefficients of influence of the following factors were introduced into the method for calculating their parameters: the wall structure; irregularities of relief of the underworked and overworked rocks pressing on the wall; chemical aggressiveness of mine water, which is used to dissolve the mixture.

For the purpose of further controlling condition of supports and protection means in the belt roadway No. 166 of the production enterprise Lisova Mine of the state enterprise Lvivvugillya and adjusting parameters of the protective-insulating wall, a method of mine experimental research is proposed. The method provides for complex studies of the mining condition at all stages of mining operations - during roadway driving, in zone of influence of the longwall bearing pressure, as well as in zones of intense and constant displacements behind the longwall. The displacement of the roadway contour and the change of loads on the means of its protection depending on the location of the longwall face and the speed of its advance are subject to measurement. The criterion for assessing condition of the protective-insulating wall is its relative vertical deformation over time.

The results of the calculation of rational parameters of the protection means in the belt roadway No. 166 (width of the berm and packed wall) with the specified physical and technical properties of the cement-mineral mixture are presented. Based on them, scientific and technical recommendations were developed for support setting and protection of this roadway.

Keywords: reuse of roadway districts, protection means of roadway, cement-mineral mixtures, cast and packed protective-insulating walls, intensity of the protection means loading

1. Introduction

The current technologies of coal mining in underground conditions assume the use of a panel system for coal seam mining. Mine roadways bordering on a coal seam prepared for mining operations are called the roadway districts. In order to increase productivity of the mines, the belt roadway district should be saved for reuse as the air working of the next panel. This reduces the total length of the roadway districts and contributes to reducing the costs of their drivage and supporting and speeding up the development of new panels. In addition, the saving of the belt roadway after it has been passed allows the use of direct-flow ventilation schemes. This reduces the limitation for the rate of coal seam mining by the gas factor.

The main difficulty for maintaining the necessary cross-section of the roadway districts and their safe operation when mining two adjacent panels is the following. After the coal seam has been extracted, a cavity is formed in the wall of the roadway district. In order to prevent the roadway roof fall, protection means are built along it to replace the extracted coal seam. There are different types of means for the roadway protection - various structures made of wood (rows of breaker props, stacked walls, chocks, clustered chocks, etc.) or concrete walls. The used roadway protection means should solve the following tasks: to take on the load from the weight of the roof rocks of the seam after its extraction; to facilitate to the "trimming" of undermined rock massif outside the formed arch with keeping it balanced; to prevent asymmetry of load on the roadway supports; to minimize subsidence and, therefore, destruction of the stable arch; to reduce intensity of crack formation in the roadway roof at the border with the mined-out space of the longwall; to contribute to the stable condition of the berm part of the roadway contour; to minimize swelling of the roadway floor; to prevent leakage of a fresh air stream into the mined-out space of the longwall.

These tasks are effectively managed by concrete protective walls [1–3]. Cast (CW) and packed (PW) walls have become the most widespread among such roadway protection means due to their strength properties and effectiveness of their construction. Construction of CW assumes placing of empty packs between the rows of breaker props followed by their filling with a quick-hardening cement-mineral mixture dissolved with water. While building of PW, packs with dry mixture are laid out between the rows of breaker props and, then, water is added to the mixture through a needle injector. That is, both technologies use quick-hardening mixtures in a liquid state, which, during a certain period of concrete hardening, are not able to take on the load from the massif of undermined rocks.

Therefore, when calculating the CW and PW parameters, on the one hand, it is important to take into account the intensity of concrete hardening, and, on the other hand, the rate of increase of loads on the roadway protection means. That is, the correspondence of the strength of concrete hardening to the expected load over time.

The purpose of the research is to improve the method for calculating parameters of the cast and packed protective-insulating walls by determining changes of load on them over time with taking into account the strength of the host rocks and the speed of the longwall face advancing in order to substantiate the compliance of the mixture parameters with geological and technological conditions of the coal seam mining.

To this end, it is necessary to solve the following problems:

- to substantiate the necessity and the way to establish the correspondence of the limit strength of concrete for uniaxial compression during its hardening to compressive stress in the cast and packed protective-insulating walls;
- to substantiate the method for calculating the compressive stress in the cast and packed protective-insulating walls depending on geological and technological conditions of the roadway support;
- to substantiate the method for calculating the limit strength of concrete for uniaxial compression during its hardening with taking into account mine conditions of operation of the cast and packed protective-insulating walls.

Rate of the load growth depends on the category of cavability of the coal seam roof according to the DonVUGI classification [4] (Table 1) and the speed of the longwall face advancing. The faster is the longwall face advance and the weaker is the roof of the coal seam, the faster the roadway protection means is loaded. In the case of a delay in gaining strength by concrete relative to the increased loads on it, cracks occur and spread in the concrete, which leads to the loss of the load-bearing capacity of the protection means of the roadway.

Therefore, an important criterion for calculating parameters of the cast or packed walls is the correspondence of the rate of gaining strength by concrete to the mining and geological conditions of the roadway location and the technological parameters of the coal seam mining. This research is devoted to the solution of this problem.

Table 1 – Excerpt from the DonVUGI rock classification

Category	Characteristics of roof rocks	Values of geomechanical criteria	Approximate lithological composition for fore-casting adjoining rock categories
Cavability of the roof rock massif, A			
A1	easily-caving	β=0.04; K_v=15%	An even-strength massif of alternating layers of shale, coal, sandstone, and separating limestone (f_{av}<4) of small thickness without pronounced secondary sediments *a / m > 5*.
A2	medium-caving	β =0.025; K_v=15–30%	Heterogeneous massif of alternating layers of shale, sandstone and limestone (4<f_{av}<6) with pronounced secondary sediments and a small cavity step *a/m < 5*.
A3	poorly-caving	β =0.015; K_v=30–50%	Fairly homogeneous massif of strong shale, sandstone, limestone or a massif with "bridge rocks" (6<f_{av}<10). Clearly expressed secondary sediments with a large step of cavity.
Stability of the direct floor, F			
F1	unstable	σ_{ind}<10	Shales of "curly" texture with slickensides *(f<2).*
F2	low stability	10< σ_{ind}<25	Shales, less often sandstones with "curly" tex-ture *(2<f<4).*
F3	stable	σ_{ind}>25	Homogeneous massif of shales or sandstones *(f>4).*

Conventional designations adopted in the classification: β – convergence of rocks per 1 m of width of the face area in fractions of the seam thickness; K_v – coefficient of variation of convergence; a – thickness of caving rocks, m; m – thickness of the extracted coal seam, m; f – rock strength coefficient according to M.M. Proto-diakonov and its average value f_{av}; σ_{ind} – resistance of the upper layer of the floor to indentation, MPa.

2. Methods

Research methods consist in studying the mining, geological and technological conditions of development of the Sokalsky coal seam n_7^b with the roadway No. 166 of the PE Lisova Mine of the SE Lvivvugillya and taking them into account to calcu-late the parameters for the protective-insulating wall.

The Sokalsky coal seam n_7^b is of a simple one-pack structure, relatively strong in terms of thickness. Coal is black, humus, clarine-durene with fusain smears, semi-glossy, cracked, friable, step fracture. Thickness of the coal seam is m = 1.35–2.08 m

(1.53 m), coefficient of the coal strength is f = 1.5, angle of the coal seam dip is $\alpha = 6^0$.

The direct roof of the coal seam is argillite. The argillite is dark gray, dense, horizontally layered, with fragments of brown silicified concretions, with veinlets of calcite along the bedding, with remains of carbonized flora, with slickensides. The argillite thickness is m = 1.90–6.40 m (4.15 m), strength coefficient is f = 3. On the contact with the coal seam, a "false" roof with a thickness of m = 0.10–0.61 m can be seen, which will fall during stoping operations following coal extraction by a cutter-loader.

The main roof of the seam is siltstone with thin layers of argillite. Siltstone is dark gray, micaceous, with inclusions of brown silicified concretions, with veinlets of calcite along the bedding. The layer thickness is m = 3.70–7.05 m (5.37 m), strength coefficient is f = 5–6.

The immediate floor of the coal seam is represented by quartz sandstone, gray, strong, medium-grained, the upper part is of the lumpy structure of the "curly" type with fragments of carbonized flora, vertically cracked. The thickness of the sandstone layer is m = 2.10–10.0 m (6.05 m), strength factor is f = 8.

The analysis of mining and geological conditions shows that, according to the classification of DonVUGI, the Sokalsky coal seam n_7^b belongs to seams of medium thickness, main roof is medium caving A2, direct floor is F3 (see Table 1).

Stoping operations in the longwall No. 166 are partially carried out in a zone of the Sokalsky coal seam n_7^b erosion and of increased rock fracturing (ZIRF), where the roof rocks are saturated with water from chalk deposits. In the dangerous zone, the cracking of the coal seam roof is 12–17 cracks/r.m, it is prone to spontaneous fall.

Natural gas-bearing capacity of the coal seam is 5 m^3 per ton of daily ash-free matter. A potential source of methane release is the coal seam n_6, which is located at a depth of ~19.0 m along the normal to the rocks bedding from the floor of the coal seam n_7^b.

Depth of the development is 265 m, length of the longwall is 270 m, average speed of the longwall face advancing is 2 m/day, ripping of the floor of the roadway district relative to the bottom of the coal seam does not exceed 0.45 m.

3. Results and discussion

Calculation of parameters for the protective-insulating wall.

While calculating parameters for the protective-insulating wall, it is important to correctly estimate the expected loads on it. Load intensity depends mainly on the structure and strength of the roof rocks. The combined influence of these factors is taken into account by the coefficient of change in the roof rock strength k_f (rad) at a height of up to 20 m above the seam [5]. This height is affected by the influence of underworking while mining coal seams of small and medium thickness.

$$k_f = arctg\frac{f_i^2 h_i + f_m^2 h_m + f_a^2 h_a}{0{,}5 f_i h_i^2 + f_m h_m (h_i + 0{,}5 h_m) + f_a h_a (h_i + h_m + 0{,}5 h_a)}, \quad (1)$$

where, f_i, f_m are the rock strength coefficients for the immediate and main roofs, respectively, according to M.M. Protodiakonov; h_i, h_m are thickness of the rocks in the immediate and main roofs, respectively, m; f_a is the strength coefficient of the rocks in the layer with the thickness of $h_a = 20 - (h_i + h_m)$.

According to the mining and geological forecast, the calculation by formula (1) shows that the coefficient of change in the strength of the roof rocks at a height of 20 m is equal to $k_f = 0.42$ rad.

The plan of protection means location in the roadway district is shown in fig. 1. The expected load on the protective-insulating walls is determined, according to the roadway supporting passport, by formula [6]

$$P_p = 44\gamma\left(b + b_{ber} + b_{wall}\right) \cdot m^{0.5} k_f \, exp\left(0.0025H / f_{im}\right), \qquad (2)$$

where P_p is the calculated load per running meter of protective wall, *kN/m*; γ is volumetric weight of the roof rocks within the thickness of 20 m, kN/m^3; b is width of the roadway, m; b_{ber} is width of the berm, m; b_{wall} is width of the protective-insulating wall, m; H is depth of mining, m; m is thickness of the extracted coal seam, m; f_{im} is the average strength coefficient of the direct and main roofs within the thickness of 20 m

$$f_{im} = \left(f_i h_i + f_m h_m + f_a h_a\right)/20. \qquad (3)$$

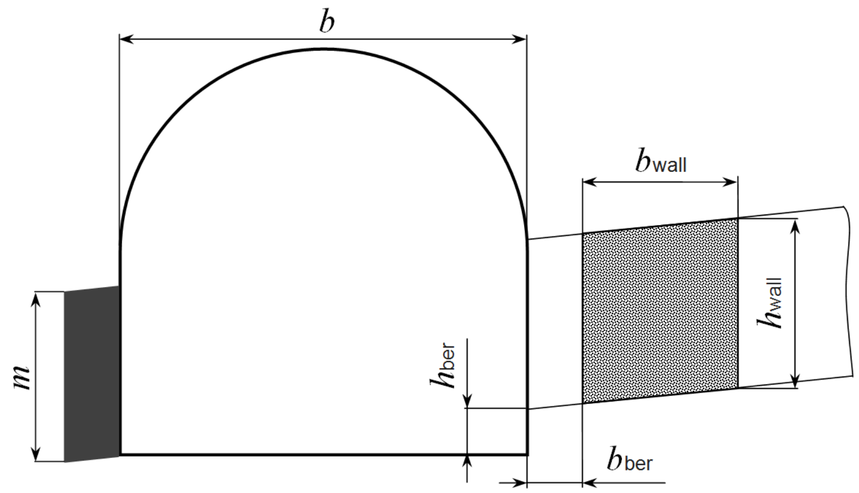

Figure 1 – Plan of protection means location in roadway district

For the conditions of mining the Sokalsky coal seam n_7^b with longwall No. 166 with taking into account the margin of strength of the protective-insulating wall $f_{im} = 4.54$.

According to the guidance document [7], with a medium-caving roof (category A2), the width of the concrete wall is $b_{wall} = 1.0$ *m*, where $m = 1.5$ m.

When $m = 1.5$ m, the expected load per running meter of the wall with a width of $b_{wall} = 1.5$ m is determined by formula (2)

$$P_p = 44 \cdot 26 \cdot (4.18 + 0.45 + 1.5) \cdot 2^{0.5} \cdot 0.42 \exp(0.0025 \cdot 265/4.54) = 4850\,\text{kN/m}.$$

Thus, the calculated maximum compressive stress in the protective-insulating wall is

$$\sigma_{comp\,calc} = P_p / b_{wall} = 3.2\ \text{MPa}. \quad (4)$$

The calculated maximum loads on the concrete wall will be reached at the moment before the roof fall, that is, at maximum values of the length of the cantilever of suspended rocks. Therefore, the higher is the category of roof caving (table 2) [8], the more the maximum loads on the wall will be achieved. On the other hand, the rate of load growth, on the contrary, is greater with weak roof rocks, that is, with a lower category of its cavability.

Table 2 – Excerpt from the classification of rock cavability of DonVUGI

Category of roof cavability	Step of first roof fall	Step of subsequent roof falls
A1	$S_f \leq 10$ m	is not manifested
A2	$S_f = 25$ m	$S_s \leq 15$ m
A3	25 m< $S_f \leq 50$ m	15 m< $S_s \leq 30$ m

Roof of the coal seam n_7^b refers to the category A2. Therefore, at an average speed of stope advancing of 2.0 m/day, before the maximum load is reached (first roof fall), the mixture hardening time will be about 12.5 days. Further roof falls will occur every 5.0–7.5 days. According to the nomogram obtained from experimental data [9], with the roof of category A2 and speed of stope advancing of 2.0 m/day, the load on the wall will be 10 MPa after 5 days, and 15 MPa after 12.5 days.

In order to construct protection means in the belt roadway No. 166, it is planned to use the mixture GiSiV-Sh. According to the mixture technical characteristics (Table 3), and in compliance with the standard tests, concrete strength R_{comp} is not less than 19.3 MPa after 3 days and 26.0 MPa after 7 days. Thus, the intensity of concrete hardening over time exceeds the intensity of growth of loads on the wall, therefore, physical and technical characteristics of the GiSiV-Sh mixture correspond, with a margin, to the conditions of the Sokalsky coal seam n_7^b mining with longwall No. 166 at the PE Lisova Mine of the SE Lvivvugillya.

To improve the accuracy of calculations, dimensionless coefficients of concrete walls weakening k_{str} under the influence of their structure, irregularities in the relief of the underworked and overworked rocks k_{rel}, and the influence of the aggressiveness of mine water, which is used to dilute the mixture, should be taken into account [9]. Evaluation criterion: with an increase of the coefficients, the bearing capacity of the wall increases.

During the construction of the cast wall, the liquid cement-mineral mixture is poured into large containers - approximately 1.0 m in length and width and a height equal to the coal seam thickness. Due to this, the wall has a monolithic structure, which helps to increase its bearing capacity. Therefore, when calculating the CW parameters, the coefficient of the structure is k_{str} = 1.0. The packed wall consists of packs of small sizes filled with a mixture, weighing 20 kg, which have an irregular geometric shape. Therefore, in the case of calculating the PW parameters, the coefficient of the structure is k_{str}= 0.7.

Table 3 – Physical and technical characteristics of the GiSiV-Sh dry mixture and mortar on its base

Physical and technical parameter	Value
Bulk density, kg/m^3	1300–1400
Moisture %, by mass, not more than	0.5
Coarseness of the filler, mm, not more than	5.0
Working life, min., not less than	30
Spreadability, cm, not less than	11.0
Flowability, cm, not less than	8.0
Limit of compressive strength after hardening under normal conditions, MPa, not less, age:	
1 day	14.3
3 days	19.3
7 days	26.0
14 days	29.8
28 days	32.0
Limit of bending tensile strength after hardening under normal conditions, MPa, not less, age:	
1 day	2.0
3 days	3.4
28 days	5.0
Strength of adhesion to the concrete base at the age of 28 days, MPa, not less than, after setting:	
– in air-dry conditions	1.5
– at soaking in water	1.5
– at alternating freezing and thawing, 50 cycles	1.2
Waterproof for 24 hours. at the age of 28 days, MPa, for layer with a thickness of 10 mm, not less than	0.4

After extraction of the coal seam, its roof and floor rocks have an uneven relief. These irregularities concentrate stress in some points of the protective wall, which leads to formation of cracks in it. At the same time, in case of the CW use, mainly vertical cracks appear in the concrete, which grow to the entire height of the protective means and cause its destruction. Therefore, for CW, k_{rel} = 0.7. In case of the PW use, only the top and bottom layers of the packs are destroyed under the influence of irregularities of relief; these layers make the load balanced along the area of the other layers of the packs. This helps to increase bearing capacity of the PW, therefore, when calculating its parameters, k_{rel} = 1.0.

Depending on mineral composition of mine waters, which are used for dissolving the cement-mineral mixture, the compressive strength of concrete in CW and PW decreases, on average, by 10%, therefore, k_{vod} = 0.9.

It was decided to use a packed wall to protect belt roadway No. 166. Therefore, taking into account mining conditions for the PW operation, its compressive strength for uniaxial compression $R_{\text{comp m}}$ after 7 days of the wall hardening will be

$$R_{comp\ m} = R_{comp} \cdot k_{str} \cdot k_{rel} \cdot k_w = 26 \cdot 0.7 \cdot 1.0 \cdot 0.9 = 16.4 \text{ MPa}, \quad (5)$$

where R_{comp} is the uniaxial compressive strength of concrete in laboratory conditions according to standard tests.

Therefore, it follows from the comparison (4) and (5) that $R_{\text{comp m}} > \sigma_{\text{comp calc}}$, i.e., with taking into account the coefficients of the concrete walls weakening, technical characteristics of the GiSiV-Sh mixture also meet the conditions of the coal seam n_7^b mining with the longwall No. 166.

Stability of the roadway floor is affected by the strength of the layer, thickness of which is equal to the width of the roadway. According to the geological survey, for the conditions of the belt roadway No. 166 location, the weighted average compressive strength of the considered layer of the floor rocks is 80 MPa. According to the classification of DonVUGI (see table 1), the immediate floor is classified as stable (F3). In these conditions, the minimum distance of the wall from the rough contour of the entry is

$$b_{ber} = 0.6 \cdot h_{ber} = 0.6 \cdot 0.45 = 0{,}27 \text{ m}, \quad (6)$$

where b_{ber} is the calculated minimum width of the berm, m; h_{ber} is the berm height (bottom ripping), m.

When choosing the final width of the berm, it should be taken into account that the smaller is its size, the smaller load on the frame support should be expected.

The scientific novelty of the research consists in substantiation of the ratios for assessing the correspondence of the limit strength of concrete for uniaxial compression during its hardening to compressive stress in the cast and packed protective-insulating walls depending on geological and technological conditions of the roadway support, and differs from other researches by taking into account the coefficients of the wall structure, unevenness of the relief of underworked and overworked rocks and the influence of the aggressiveness of mine water, which is used to dissolve the mixture.

Based on the calculations, scientific and technical recommendations were developed regarding the protection parameters of the belt roadway No. 166 for its reuse during the development of the adjacent panel.

Methodology of further experimental studies.

In the future, in the process of the panel mining, the state of supports and protective-insulating wall in the belt roadway No. 166 at the RE Lisova Mine of the SE Lvivvugillya will be monitored. This will make it possible to establish patterns of the wall loading and deformation depending on its parameters and the speed of the longwall face advancing.

The methodology of experimental research is as follows.

In order to obtain information about the state of supports of the roadway and the rocks surrounding it, it is necessary to undertake a set of measures to control those parameters, which determine stability of the roadway. These parameters include the convergence of the roof-floor and the walls of the roadway, load on supports, stress state, degree of cracking and degree of rock massif separation, etc.

For different mining, geological and technical conditions of the coal seam mining and passports for supports of the roadways, an own plan of measuring stations layout is made with an indication of survey stakes and the complex of equipment, which the station includes. Each monitoring station is assigned an individual identification code. When signs of significant and dangerous changes are detected during the process of monitoring, it is necessary to strengthen the control over this area.

Stress-strain state of the protection means of the roadway district and the degree of deformation of its supporting is measured with taking into account location of the longwall face at the stages of its mining and its further operation.

The change of compressive stresses in the protection means of the roadway during the longwall face advancing is measured by special hydraulic devices consisting of metal containers filled with oil and equipped with a high-pressure hose with a pressure gauge [10]. These devices are installed in the protective wall at different distances from the roadway contour. This makes it possible to study the patterns of load distribution across the width of the wall.

The stress-strain state of the protection means of roadway is assessed by criterion of its relative vertical deformation under the pressure of the underworked roof at various stages of concrete hardening. For this purpose, benchmarks are set on the top and bottom borders of the packed wall, the distance between which is used for calculating relative vertical deformation of the wall. With the help of notches on the frame supporting, roof-floor convergence of the roadway is measured with reference to the location of the longwall face.

All of the listed measurements are carried out from the moment the roadway district drivage starts until its transition to the mode of permanent deformation along the line of the stope. Therefore, the studies cover all stages of the roadway deformation - before the influence of stoping operations begins, in zone of bearing pressure ahead of the longwall, as well as in zones of intense and permanent displacements in front of the longwall.

4. Conclusions

1. The method of calculating parameters for cast and packed protective- insulating walls is improved. The following factors are taken into account when calculating the change in loads on the protection means of the roadway district over time: weighted average compressive strength of the rock layers in the roadway roof and floor; category of cavability of the coal seam roof; step of the first and subsequent roof falls; rate of longwall face advancing.

2. When calculating parameters for cast or packed walls, it is proposed to use correspondence of the rate of gaining strength by concrete to the mining and geological

conditions of the roadway location and the technological parameters of the coal seam mining as a criterion for evaluating their effectiveness.

3. In order to substantiate the correspondence of intensity of concrete hardening over time to the change in loads on the roadway protection means, the values of the limit strength of concrete for uniaxial compression and dimensionless coefficients of influence of the following factors are used: the wall structure; irregularities of relief of the underworked and overworked rocks pressing on the wall; chemical aggressiveness of mine water, which is used to dissolve the mixture.

4. The method of mine experimental studies of the condition of supports and protection means of the roadway district is proposed for adjusting parameters of protective-insulating walls. The displacement of the roadway contour and the change of loads on the means of its protection depending on the location of the longwall face and the speed of its advance are subject to measurement. The criterion for assessing condition of the protective-insulating wall is its relative vertical deformation over time.

5. Rational parameters of protection means for the belt roadway No. 166 of the PE Lisova Mine of the SE Lvivvugillya (width of the berm and packed wall) were calculated with the specified physical and technical properties of the cement-mineral mixture. Based on them, scientific and technical recommendations were developed for support setting and protection of this roadway.

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РОЗРАХУНОК ПАРАМЕТРІВ ЗАСОБІВ ОХОРОНИ ДІЛЬНИЧНИХ ВИРОБОК, У СКЛАДІ ЯКИХ ВИКОРИСТОВУЮТЬСЯ ЦЕМЕНТНО-МІНЕРАЛЬНІ СУМІШІ

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Анотація. Вдосконалена методика розрахунку параметрів литих і пакетованих охоронно-ізолюючих смуг. Методика відрізняється одночасним врахуванням фізико-технічних властивостей цементно-мінеральної суміші, що використовується при спорудженні смуги, та інтенсивності зміни напружень в твердіючому бетоні в залежності від гірничо-геологічних та технологічних умов функціонування виробки. При розрахунку зміни навантажень на засіб охорони дільничної виробки в часі, враховуються наступні чинники: середньозважена міцність на стиск породних шарів покрівлі і підошви виробки; категорія обвалюваності покрівлі вугільного пласта; шаг первинного та подальших обвалень покрівлі; швидкість посування вибою лави.

Для обґрунтування відповідності фізико-технічних властивостей суміші (інтенсивності твердіння бетону в часі) зміні навантажень на засіб охорони виробки, використовуються значення межі міцності бетону на одноосьовий стиск, отримані за стандартними випробуваннями в лабораторних умовах. З метою врахування шахтних умов спорудження і функціонування охоронно-ізолюючих смуг, в методику розрахунку їх параметрів введені безрозмірні коефіцієнти впливу наступних факторів: структури смуги; нерівностей рельєфу підроблених і надроблених порід, що тиснуть на смугу; хімічної агресивності шахтної води, яка використовується для розчину суміші.

Для здійснення подальшого контролю стану кріплення і засобу охорони конвеєрної виробки № 166 ВП «Шахта Лісова» ДП «Львіввугілля» та коригування параметрів охоронно-ізолюючої смуги запропонована методика шахтних експериментальних досліджень. Методика передбачає комплексні дослідження стану виробки на всіх етапах ведення гірничих робіт – під час проведення виробки, в зоні впливу опорного тиску лави, а також в зонах інтенсивних і сталих зміщень за лавою. Вимірюванню підлягають зміщення контуру виробки та зміна навантажень на засіб її охорони в залежності від положення вибою лави і швидкості його посування. Критерієм оцінки стану охоронно-ізолюючої смуги є її відносна вертикальна деформація в часі.

Представлено результати розрахунку раціональних параметрів засобу охорони конвеєрної виробки № 166 (ширини берми і пакетованої смуги) при заданих фізико-технічних властивостях цементно-мінеральної суміші. На їх основі розроблено науково-технічні рекомендації з кріплення і охорони цієї виробки.

Ключові слова: повторне використання дільничних виробок, засоби охорони виробок, цементно-мінеральні суміші, параметри литих і пакетованих охоронно-ізолюючих смуг, інтенсивність навантаження засобів охорони.