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An Innovative Solution to Reduce a time of Developing of the Mine Excavation's Technological Parts.

1. Problem status

In coal mines of Ukraine per 1 km of mine excavations that are being constructed, it is necessary to prepare up to 7 mines' connections (fig.1). This requires the construction of the same number of technological parts. They are no long, but need from 1 up to 3 months to be created or 10% of general developing period [1]. At the same time processes and operations for technological parts developing are the most labor intensive. This step makes it difficult to move intramine transport, reduces safety and increases the cost of constructed roadway. As the result the cost of 1 t of mined mineral is also increases.

Therefore, the reducing in time and complexity of this stage is an actual problem.

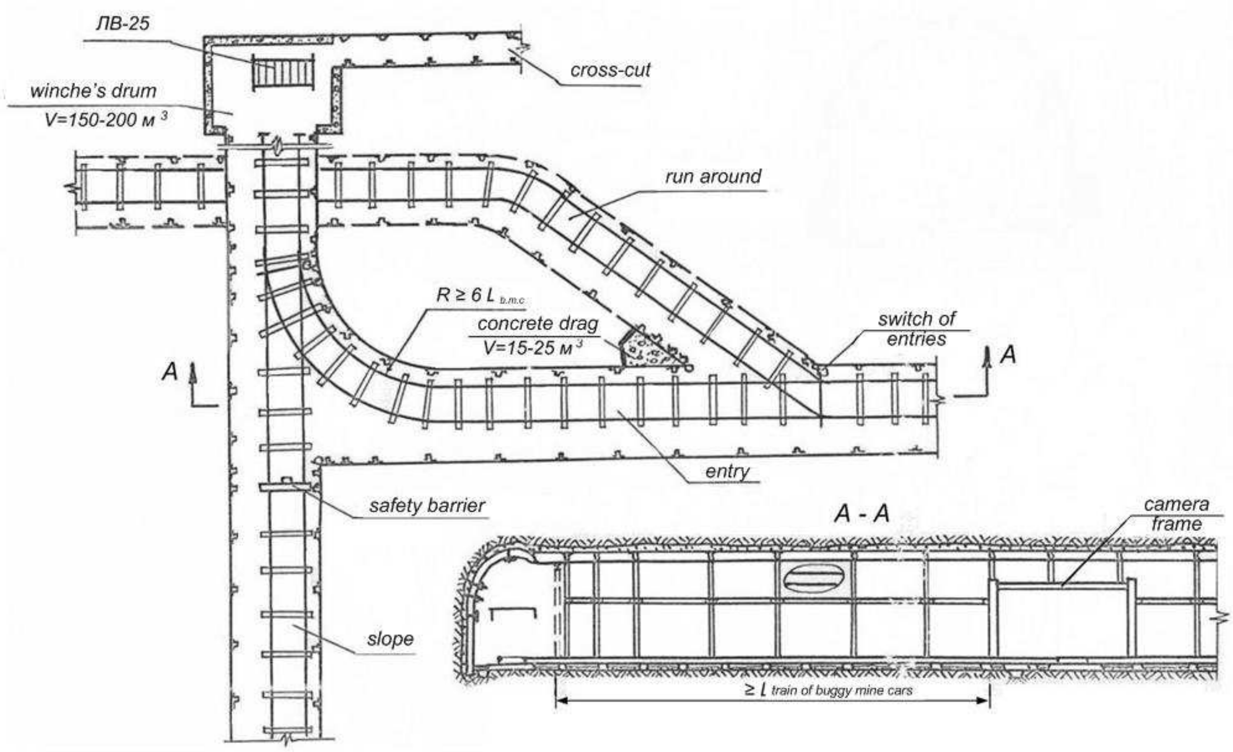

Fig. 1. Example of mine excavations' connections

2. Stages of the excavations' construction

Construction excavation – complex of works from the beginning of its equipment up to the start of exploitation - consists of 4 stages [2]. The scope and duration of each stage are depends on the geological conditions, an applied technique and technology that determines the velocity of the mine building as a whole. Duration of an excavation construction, in shifts, is defined as:

$$t_c = t_p + t_{t.p.} + t_m + t_d + tt_f, \quad (1)$$

where

t_p - duration of a preparing stage;
$t_{t.p.}$ - duration of a technological part's construction;
t_m - duration of an equipment mountain;

t_d - duration of the heading;
t_f - duration of the final processes.

Preparatory work is a supply of communications (electrical cables, pipes of water, compressed air, cable connection), laying stretching on to and arrows, a fan of local ventilation, weighed, ventilation pipes, appliance water or shale barriers, equipment, underground transport, and, if necessary, a water separator.

Dismantling of equipment, repair, or replacement of individual elements of the lining, the whitewashed, complete the installation of permanent equipment of construction excavation and relate to the final stage.

Duration of a technological part's construction, in shifts, can be determined as

$$t_{t.p.} = \frac{L_{t.p.}}{V_{t.p.}} + t_{\mathrm{m}}, \qquad (2)$$

where

$L_{t.p.}$ - length of a technological part, m;

$V_{t.p.}$ - velocity of it's developing, m/shift.

Duration of other stages, in shifts, can be determined using formula (3).

$$t_{\mathrm{s}} = \sum_{i=1}^{n} \frac{W_i}{K_{\mathrm{up}} \cdot H_{p_i} \cdot n_i}, \qquad (3)$$

where

W_i - a scope of corresponding process;

K_{up} - coefficient of over-fulfillment of production quotas;

H_{p_i} - a production quota for i-th process;

n_i – the number of workers are needed for i-th process, pers/shift.

A specific of the technological part construction is a big part of manual work. All operations in this stage are operated in three phases:

Phase I: drilling of boreholes with hand electric drill (punches); reduced length of holes (1.2 - 1.5 m), blasting in several stages, combination (manual and mechanical) cleaning of the rock mass (to the buggy mine cars are placed on connected entry or run around); installation of chamber frame (Fig. 2) ; construction of a timbering with a shortened step.

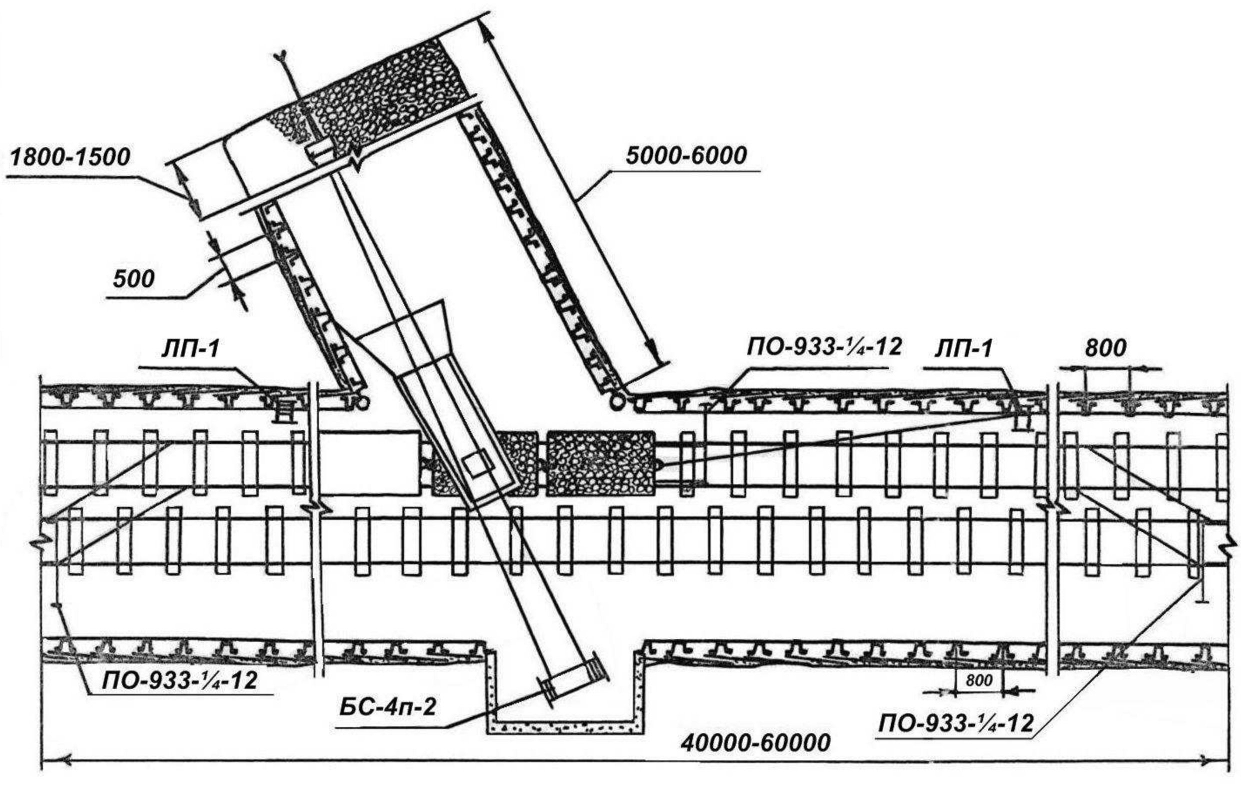

Fig. 2. A layout of equipment for a technological part developing. Phase I

An excavation's crosses squares are differ along the length of the arrival. Working's span at this point reaches 5 - 9 m.

To reduce the load on the supports the concrete drag is built in nodes of the connections. For this case the rock is removed, a temporary roof support is installed and a formwork is put. A capacity of a concrete mass is ranged form 15 m^3 up to 40 m^3. Excavation is carried out at a length of 5 - 6 m.

Phase II:

a) if a shearer technology or drilling and blasting with the use of muck cars on wheels is applied to the technological part construction - drilling holes by the use of drilling machines or hand electric drill (punches); the normal length of holes; blasting in one step; mechanical harvesting of rock; the construction of the timbering with a normal step; organization of the vent pipes; if necessary, lagging the track. The rock mass is recommended to load into trucks with small-size breeds - loading machines or use scrapering loading (Fig. 3). Excavation is carried out of a length of 10 - 15 m.

b) by the use of drilling and blasting technology of horizontal workings with an application of muck cars on tracks the excavation is spend more on 25 - 30 m. After this the total length of the technological part is 30 - 35 m. For slopes with the direction “up-to-down” the total length is 20 - 25 m; with the direction “down-to-up” it ranged from 35 m to 40 m.

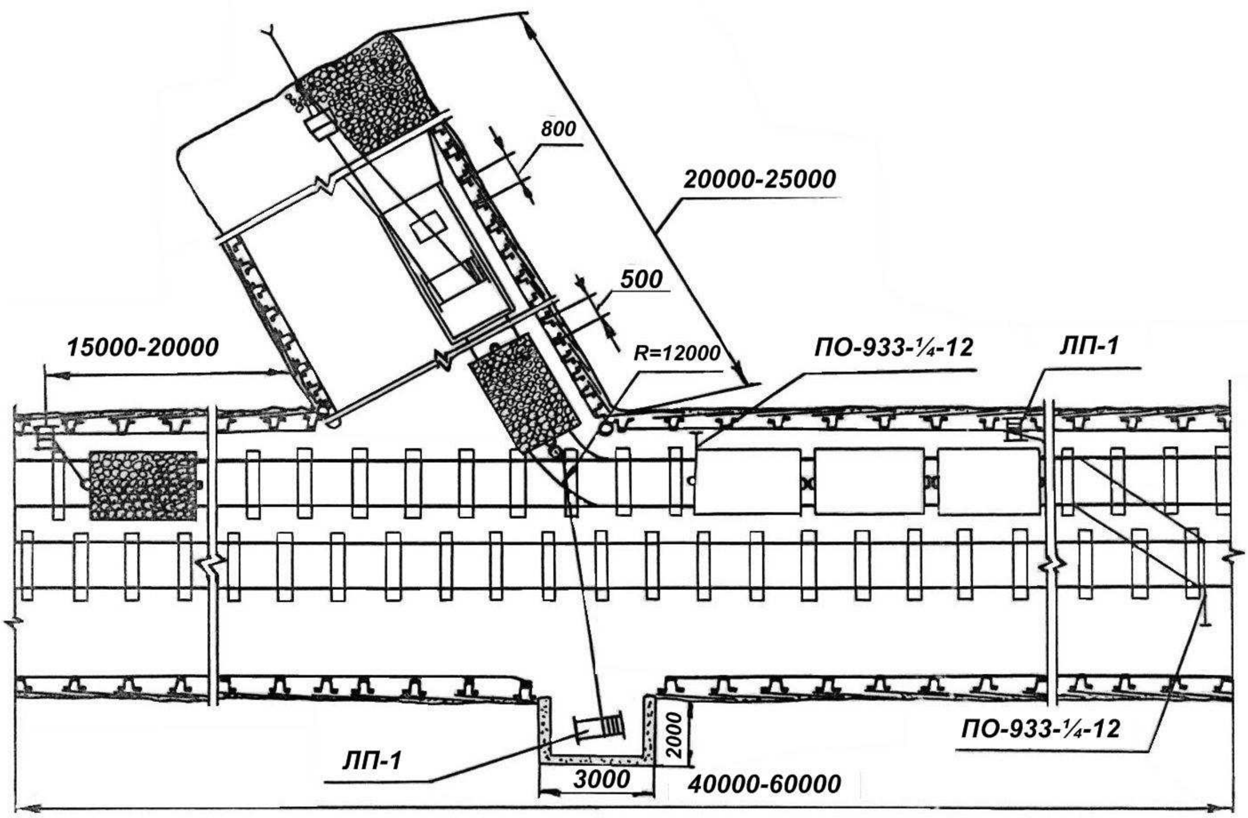

Fig. 3. A layout of equipment for a technological part developing. Phase II

Phase III: Dismantling of equipment used in the technological part’s construction process, installation of equipment for the next processes. Machinery delivers on special platforms and into the buggy mine cars. Unloading is performed by means of hoists (manual winches), which are attached to the upper elements of the timbering. Under it and the adjacent frames in the course of the work the scaffolds are set. Machine components come according to the wiring diagram, after unloading their place is in technological part.

Duration of works for construction of a single node with one-sided connection is 20 – 40 shifts. Complexity – 100-300 pers/shift.

The duration of the construction process (including facilities receiving area, winches cameras, etc.) accounted from 100 to 300 shifts. In bilateral connections these values are doubled.

After performing of all stages the excavation is ready for operation.

3. An innovative solution

To reduce a time of the construction in [3] the curve-terrace form of the excavation’s face is proposed. Part of the rock mass, adjacent to an excavation, is made as a terrace. It interfaces with the cylindrical surface of the certain radius. This surface is perpendicular to the longitudinal axis of an excavation. The lower part of the face is a vertical.

For laboratory experiments to determine the effectiveness of the proposed form a model is made (fig.4). It created from equivalent materials (cement-sand mortar, cement brand - 600, cement-sand ratio C:S=1:3) in compliance with the geometric and physical (energy) similarity on a scale of 1:10.

The model is created in a cube, the lateral edges of which are the size of metal sheets 650 x 650 x 650 mm, connected by a 4 bolts on each side. In the cube is placed a metal matrix which simulates the curve-terraced face form. Thereafter, the space of matrix between the walls of the cube and the cement-sand mortar is filled.

Initial data for the passport of drilling-blasting works passport (actual value):

Rock strength - 23.8 MPa.
Sectional area - 12.5 m^2.
Width - 4676 mm.
Height - 3576 mm.
Radius of sphere - 2333 mm.
Bench Height - 576 mm.
Shoulder width - 2700 mm.
Diameter of holes is 8 mm.

Fig. 4. A model of an excavation face with a curve-terrace form

Use the proposed form involves the next order of blasting: at first charges in the terrace part are blasted, and then – near the ground. After this, the rows of holes in series are blasted from the bottom to up.

A rock shaft is formed by blasting of terrace part will be stable, if

$$V_{ter.} \geq V_{cur.} + V_{vert.}. \quad (4)$$

To satisfy the safety requests a height of vertically-curved part should be at least 1800 mm. Rational length of a stope - 1 m. The minimum distance from the holes to the contour of excavation is 150 mm, line of the least rock strength – not less then 300 mm, the diameter of the hole - 42 mm, the minimum height of the terrace ledge is taken to be 500 mm.

4. An industrial implementation

On the base of the theoretical researches and results of laboratory experiments a Directive [4] and Instruction [5] on perfection of explosive works at carrying out of mountain developments and creation of the excavations' connections on mines of IC "Donetskugol" and "Selidovugol" are developed. Proposed technical decision is approbated during the developing of the connection between south gallery N3 of the coal seam l_2^1 with the slope N2 of the coal seams $l_1 - l_2^1$ on mine "Rossiya" of IC "Selidovugol".

5. Future directions

Future directions are an implementation of the explosive technology with the rational parameters together with the use of curve-terrace form of the excavation face during a construction of the mines' technological parts and to estimate technical and economic effect.

LITERATURE

1. *Koshelev K.V., Ignatovich N.V., Poltabets V.I.* Podderganie gornih virabotok. – K.: Tehnika, 1991. – 176 p.

2. *Shkumatov A.N.* Sovercshenstvovanie tehnologii razdelki soprjageniy gornih virabotok // Organizatsionno-tehnicheskie problemi shahtnogo stroitelstva. – Kemerovo: Kuzbass. Politechn.in-t, 1992. – P. 32-37.

3. A. s. 1528075 CCCP E21 B 9/00. Sposob prohodki gornih virabotok / *A.G. Gudz, A.N. Shkumatov* and other. (USSR) – Zajvl. 21.12.1987; Zaregistr. v Gos. reestre izobr. 8.09.1989.

4. *Shkumatov A.N.* Rulovodstvo po sovershenstvovaniyu vzrivnih rabot pri provedenii gornih virabotok i razdelke soprjageniy na shahtah PO Donetskugol. – Donetsk, 2000. – 44 p.

5. *Shkumatov A.N., Cherkasov I.A.* Instructsia po sovershenstvovaniyu vzrivnih rabot pri stroitelstve soprjageniy gorizontalnih i naklonnih virabotok na shahte "Rossiya" GP "Selidovugol". – Donetsk: DonNTU-Selidovugol, 2008. – 41 p.