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Optimization of transportless technological schemes for coal seams quarrying

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Abstract. The main way to increase the competitiveness of Kuznetsk coals produced by the open method is to reduce overburden works. On the open pits of the southern Kuzbass the flat coal seam strata are developed using transportless technology during overburden works. Open-pit fields are developed in combination: the lower part to the height of 32-44 m is worked out by low-cost transportless technology (producing cost of 1 m^3 of overburden is 22-24 rubles, the upper part - by high-cost transport technology (producing cost of 1 m^3 of overburden is 35-44 rubles) using shovels EKG-10, EKG-12.5, EKG-20 excavators and quarry dump trucks with the carrying capacity of 80-180 tons. The volume increase of the rock that is transferred to the internal dump will improve the economic indicators of coal mining. In addition, due to the flat bedding, the height of the rock mass, which is processed by transport technology, is constantly increasing. At the present time, this has led to the speed decrease in the movement of the working front of the transport zone and, as a consequence, to slowing down the development of transportless. The redistribution of overburden volumes between zones in the direction of increasing the volume by transportless technology will increase the speed of movement of the transport zone (while maintaining the same complex of mining and transport equipment).

1 Introduction

In Tomusinsk and Mrassk geological and economic areas of Southern Kuzbass coal deposits are characterized by strata seams bedding in the rocks. The deposits are developed by modern large pits: "Krasnogorsky" (geological sites "Sibirginsky 8", "Sibirginsky 7", "Kiyzaksky 8", "Kiyzaksky 9"); "Mezhdurechensk" (sections "Kiyzaksky 5-7", "Sibirginsky 4-6"); "Sibirginsky" (section "Sibirginsky 1-3"), and others [1].

2 Material and Method

The overburden rocks are mudstone and siltstone with Protodyaconov hardness coefficient 5-7, as well as large-sandstones with hardness coefficient f = 8-10 [2].

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The mining of open pit field in Tomusinsk sections is made by using two technologies: transportless - to extract the lower part combining two, less often one seam; transport - to extract the upper part consisting of two or three seams (Fig. 1).

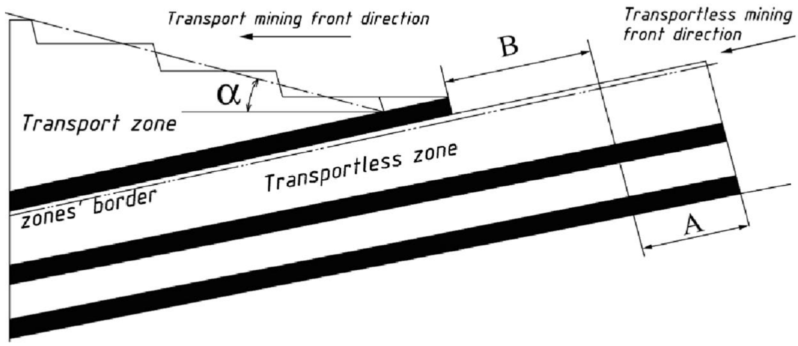

Fig. 1. The borders of the transport and the transportless zones of coal quarrying in Tomusinsk sections.

The height of cut bench on the third (top) strata seam in piling four-tier dumps depends on the piling scheme, the total height of the lower partings, bedding angle and does not depend on the width of the stope, the relation of which to the discharge radius is constant; at that cut bench height for draglines with beam length of 90-120 m is 24,7-26.9 m for dumping scheme without preparing capacity and 20.7-22.8 m for dumping with preparing capacity [3].

3 Results and Discussion

Structures of excavation schemes for the development of three flat seams strata are divided into two types, which differ in the number of stages (elements) and the work of mining equipment. The attribution criterion to the type is the ratio of the rock volume of the upper and middle ledges (taking into account rock loosing coefficient) and the capacity of the first and the second tiers [4].

Using dumping schemes with preparing capacity during the work of two excavators allows combining work of overburden and dump draglines in time [5-6]. It reduces the time of stope mining and provides the increase in the annual rate of work front movement by 12-15% and reduces the unit cost of overburden on 7-10% for all types of bedding seams in strata.

At the section "Main Field" flat seams III, IV-V and VI by mixed down-hole-continuous excavation system are developed. The power of partings of seams IV-V and VI varies from 0.2 to 14 m, with an average of 7-5 m; the power of partings of seams IV-V and III varies from 28.3 m to 49.5 m, with an average of 42-45 m. The bedding angle of the seams is from 6 to 16˚, on average 10˚.

The rock above seam III is worked by the transport technology. The bench on seams parting IV-V and III is worked by transportless technology by two draglines ESH 15.90 B. The parting of seams VI and IV-V, due to small average power is worked by transport technology in the process of mining operations on the seams. Transportation of rock and coal is made by trucks.

The task of choosing the technological scheme is solved on the basis of graph-analytical modeling of the development of transportless overburden bench with height H = 45 m along partings of seams III and IV-V. The model includes: calculation of parameters and outlining excavation schemes for values of the stope width A = 40 m; 45 m; 50 m; 55 m and 60 m; outlining planograms of organization of the drilling, stripping and mining equipment; the formula for the calculation of the basic technical indicators. Excavation schemes for A = 40 m; 50 m; 60 m, as an example, are shown in Fig. 2 a, b, c.

The upper ground of the bench “levels” as seams bedding reaches 10˚, and for the installation of heavy drilling machines SBSH-250 MN for drilling deep holes (35-45 m) there is a need for horizontal space. Blasted rock of the "cleet" is cleared from the bench by the shovel, bulldozer and placed in the internal dump. With enlarging the width of stope the volume of rock “cleet” increases and, consequently, the volume of bench rock excavated by the dragline decreases. This fact has an impact on the development of technical indicators of the transportless bench development.

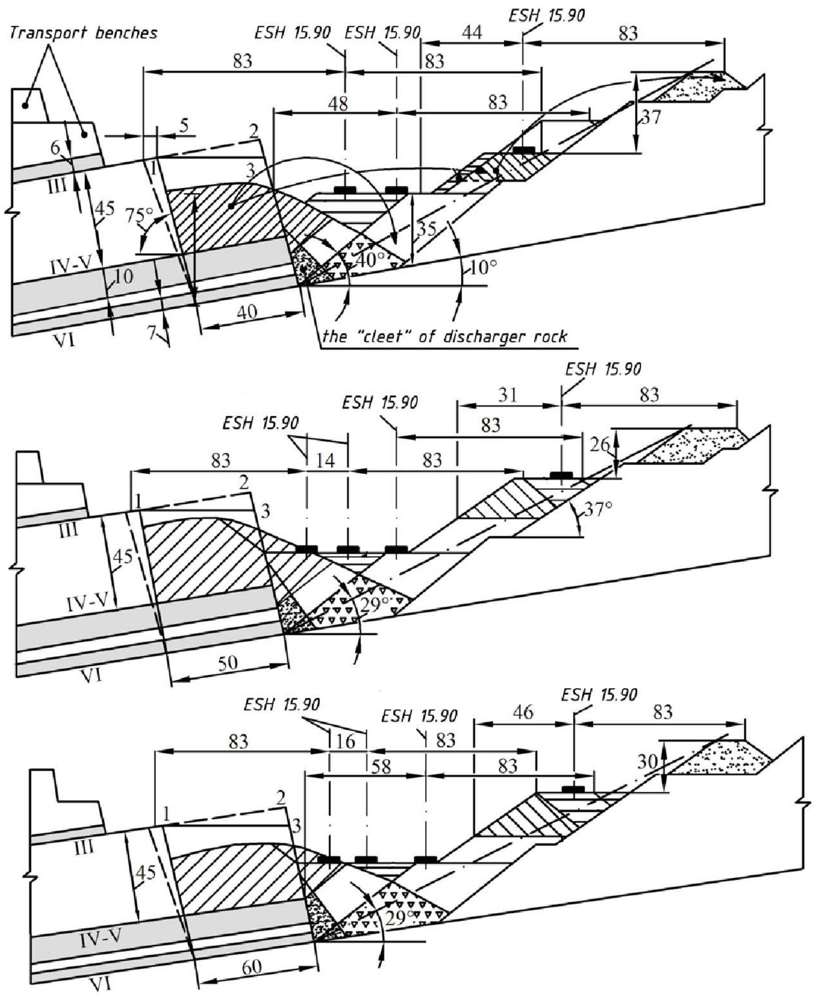

Fig. 2. The excavation schemes for the development of overburden bench with height 45 m along parting of seams IV-V and III: a, b, c – stope width 40, 50 and 60 meters, respectively.

Internal dump parameters are the following: the height of the first tier is equal to 30 m (according to the recommendations of the Siberian branch of All-Russian Research Institute of Mining Geomechanics and Survey in Prokopyevsk) with the general angle of its cut – 40° (Fig 2-b), the general slope angle of the dump – 29 ° (Fig 2-b), loosening rock coefficient in the dump – 1,4. The natural slope angle of the rock of the second layer and overlying is – 37 ° (Fig. 2-b).

When building excavation schemes the presence of the road at the base of the dump which is poured in the process of piling is taken into account [5, 6].

When dumping four-tier dumps to the listed volumes of re-excavation add the following: two rock volumes transferred to the fourth tier; the track of dragline travel when transferring rock from the third to the fourth tier.

Fig. 3 shows a graph of the dependence of explosive discharge (K_{ed}) from stope width (A).

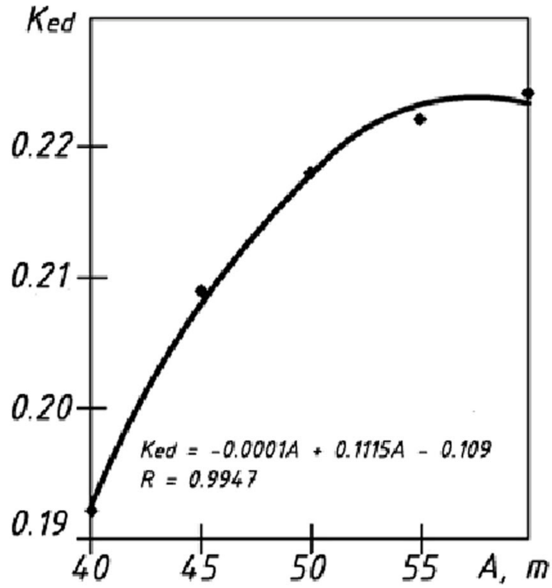

Fig. 3. The excavation schemes for the development of overburden bench with height 45 m along parting of seams IV-V and III: a - stope width 40 m; b - the same 50 m; c - the same.

Coefficient of explosive discharge increases in a parabolic dependence. When stope width is 60 m the discharge coefficient is greater than 16% relative to its value when the stope width is 40 m that improves the development of the overburden ledge. K_{ed} increasing with some slowdown is going to a value approximately equal to the width of the stope 55 m, and then stabilizes. This is due, as shown by analysis, to a decrease in the spall zone on the slope of the blasted bench because of leveling its upper platform.

To calculate the general re-excavation coefficient (K_{reg}) it was considered the work of equipment, allowing defining additional volumes of re-excavation connected with creating routes for up and down dragline movement to the working site of the second tier for dumping the third tier. K_{reg} ratio is calculated by the formula (1)

$$K_{reg} = K_{re} + \frac{n_{n(c)} \cdot V_{n.c}}{A \cdot H \cdot K_l \cdot (1 - K_{ed})}, \quad (1)$$

where: K_{re} - re-excavation coefficient; $n_{n(c)}$ – the number of up (down) tracks of dragline to dumping of the third tier: two tracks (up, down) on the left and right flanks of the stope; $V_{n.c}$ - the volume of re-excavated rock when creating or eliminating one track (220 000 m^3); A - the stope width, m; H – the height of the tier; K_l - rock loosing coefficient.

The general coefficient of re-excavation (K_{reg}) also varies according to the parabolic dependence and has a minimum in the range of 0.7 with the stope width 50-52 m. Thus, due to the amount of the total re-excavation coefficient, the stope width at the section "Sibirgin field" should be increased to 50- 52 m.

4 Conclusion

The structures of excavation schemes for the development of three flat seams strata are divided into two types, differing by the number of stages (elements) and organization of the mining equipment operation. The attribute criterion is the ratio of rock volume of the upper and middle ledges (taking into account the rock loosing coefficient) and the capacity of the first and the second tiers.

Using of dumping schemes with the preparation of capacity during the work of two excavators makes it possible to combine the operation of overburden and dump draglines in time. It reduces the time of stope mining and provides the increase in the annual rate of work front movement by 12-15% and reduces the unit cost of overburden on 7-10% for all types of bedding seams in strata.

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