Influence of Speed Mineral Extraction on the Nature of Displacement Underworked Rock Mass

Murat Mustafin
National University of the mineral resource "University of mines" (Russia)
mustafin_m@mail.ru

Abstract— Shows a model of the environment in which the stress-strain state of the rocks in coal extraction is estimated taking into account the speed. Algorithm for computing is implemented in the software package. With specific examples demonstrate the difference between the displacement of rocks at different speeds coal extraction. Presented preliminary recommendations for the correction of existing rules.

I. INTRODUCTION

Current state of underground mining of coal seams in Russia is characterized by the transition to an intensive mode of production, which are usually handled one excavation, but its parameters are significantly different from those who were 10-20 years ago. Thus, the width of mine workings increased by 1.5-2.0 times and amounted to 250-300 m, and their length is 2 km and more. Thus, daily recess coal was 20,000,000 Kg., Which results in an overall excavation speed of 300 m / month.

II. METHODS

Under these conditions, changes significantly the nature of deformation and displacement of the rock mass. At high speeds, mineral extraction destruction roofing comes with a large dynamic effect due to the increased span of collapse. Accident at Kuzbass mines are proof of this. It can be argued that in most cases the growth rate of the coal seam excavation leads to more pronounced discrete nature of the process of collapse. In general, for certain geological and mining conditions there is a critical or optimal speed mountain mining production. When her movement speed is low and significantly less than the rate of destruction of man-made rock mass. In another, when each step conditional moves are totally (taking into account the rheological factors) implemented the process of destruction of rocks, then we can talk about the absence of the effect of speed on the final deformation in the array and on the earth's surface. It should be noted that such speeds were mainly to the 90s of the last century and in view of the above noted a slight influence on the process of deformation of rock mass - this factor was not given much attention (connected with this small number of publications on the subject). With the prevalence of the speed of excavation on the rate of destruction, there is a reduction in the overall duration of the process of displacement and, consequently, the value of strain on the earth's surface. With regard to the stress in the areas near the excavation (reference pressure), then at high speeds in a layered array of a relatively strong rocks (> 30 MPa) in the roof rock is destroyed larger production units. Accordingly, they "take" on the big load and create increased pressure on contour generation - the effect of the console.

When considering the temporal process play an important role creep rocks. Simulation of creep of rocks can be performed using the method of variable parameters of elasticity and deformation patterns of species identified as a result of field studies (observations). In this case, the creep curves should be obtained on the basis of inverse calculation using the general laws for different types of creep stress state of rocks.

Geomechanical services mining enterprise must take into account the course and consequences of these processes for the improvement of techniques for observation of displacement of the rock mass, including the earth's surface, and form the basis of prediction and prevention of negative phenomena.

We show some results developed modeling approach, embodied in the software package (PC) "NEDRA" [1].

Solution of the problem is divided into two: one - a simulation of the proper motions of excavation, and the second - modeling of deformation of rock mass based on the time factor.

The first question is technical and can be solved by including in the model the flexible elements (PC "NEDRA" implements the finite element method - FEM). Movement excavation modeled assignment elements within the area of the coal seam and subsequently removed, the values of the elastic modulus of 3 or more orders of magnitude lower than before the recess. The velocity is determined by the ratio of the size of the stage of excavation to the time in which it occurs. To one of the most important advantages of this method include the fact that the control convergence roofing with the ground in mines is carried out automatically and therefore complied with the correct solution of the problem on this factor. Accounting for the time factor in the simulation of deformation of rocks associated with the speed of development and should be attributed only to the area of influence of mining.

Below are examples of modeling including taking into account the temporal process of deformation and fracture undermined rocks and advance rates stope.

Consistently one model considered static and temporal problems (Fig. 1).

Structural model, its dimensions and elastic parameters are shown in Fig. 1 as well. Rock strength were the following: the clutch sediment 2 MPa; mudstone (mudstone) 3-5 MPa; Coal 2 MPa. Tensile rupture strength taken from the instantaneous strength values with a reduction ratio of 1.5 to 2.0. We used the finite element model, with approximately 20,000 members.

For a visual comparison shows the following solutions to the problem of the destruction of species: elastic-plastic (Fig. 1b), viscoelastoplastic static (without taking into account the rate of coal extraction, Fig. 1c) and viscoelastoplastic considering the dynamics of coal extraction (at a speed of 1 m / day , Fig. 1, g and 10 m / day, Fig. 1, e).
Fig. 1. The simulation results of static and temporary tasks (a – model; b - elastic model; c – elastoplastic; d - time, speed of 1 m/day, the movement from left to right, e - time, speed 10 m/day).
As can be seen from the simulation results, the picture of destruction in statics are symmetrical, but taking into account the dynamics of coal mining, they acquire asymmetry.

When uproplasticheskom decision (registration zones inelastic behavior of rocks) are confined to the destruction of the contour generation, and in the middle of them originated from the tensile stress, and the edges - from shearing forces.

Viscoelastoplastic static solution of the problem (see. Fig. 1, c) can be considered for excavation formed for the cross section perpendicular to the direction of its mining. The process of displacement of rocks about 1 month. From an examination of solutions shows that significantly increased the destruction zone is also increased, and vertical displacement of the earth surface by 25%.

When taking into account the rate of coal extraction (see. Fig. 1d), you can see the growth (increase) in the zone of destruction (working out from left to right). Picture of destruction is clearly different from the above, while it is asymmetric. In a further embodiment demonstrates the behavior of the rock mass at a rate of coal extraction of 10 m / day. It should be noted that such rates are already the norm for many mines.

Deformations of the Earth's surface at high speeds excavation of coal characterized in that the sedimentation $\eta_2$ (Fig. 2), respectively, and tilts ($\iota_2$) smaller in comparison with the case of the slow speed ($\eta_1$, $\iota_1$). It might be hypothesized that the increase in the rate of coal extraction is equivalent to a decrease in a removable coal seam thickness. However, in this and in other cases, the angular characteristics of the process of shifting the earth's surface remain unchanged ($\psi_3$, $\delta_0$).

Reported findings are based on field observations of the Earth's surface displacements, made in Kuzbass. The observations carried out at speeds of coal extraction of 10 m / day and above indicate that subsidence Earth's surface receives less to 15% of the calculated values to be determined by regulations [2], which are defined for coal extraction speeds up to 150 m / month. Is much smaller and most dangerous for ground displacement rate structures - the slope of the earth's surface $\iota$ (see. Fig. 2).

III. CONCLUSIONS

These examples relate to the case of modeling the impact of the lack of tectonics. When using the described technique involves keeping its original assignment conditions on the boundaries of the model, which in turn requires consideration of the block structure of the region under study and to determine their interaction. However, the results obtained allow one hand to adjust the regulatory parameters of the deformation process, and earn some money displacement of the rock mass, and on the other to improve methods of control rock pressure and displacements the earth's surface.

REFERENCES
