ANALYSIS OF MULTIPLE SEAM STABILITY

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ABSTRACT

The analysis of influence of multiple coal seam mining on stress and strain condition of the rock massif was made with use of a finite element method. Researches were conducted for conditions of mining of three coal seams in the Alardinskaya mine in the Kuznetsk coal basin. The scientific novelty of researches consists in establishment of distribution of stress at consecutive multiple coal seam mining. As a result of the executed researches recommendations on ensuring safe multiple coal seam mining are made.

Keywords: underground mining, multiple seams, longwall, coal pillar, stress and strain state, numerical simulation, goaf, rock bump.


1. INTRODUCTION

The main method of underground mining of coal seams is longwall mining. Use of the modern reliable high-performance equipment in longwall provides high efficiency of mining of flat coal seams [1-4]. Increase in depth of mining operations in mines leads to growth of gas emission on the longwall panels. Increase in productivity of longwall also leads to gas emission growth. The problem of effective gas management is relevant for the majority of the Russian mines [5-16]. The problem of safe mining of gas-bearing seams is still not solved and
the frequency of accidents in mines remains very high [17]. The large number of papers is devoted to safety problems at underground coal seam mining [17-27]. The complexity of geological conditions of underground coal mining leads to high power expenses [28-37] and high cost of products of coal mines [38-44]. As a perspective solution of a problem of forecasting and management of gas the method of the system analysis can be recommended [45-47]. One more problem of underground coal mining is mining of the multiple seam. At multiple seam mining there is their interaction: regional parts of the massif and a pillar form zones of the increased stress, and the goafs form unloading zones. Besides, at multiple coal seam mining there is an active liberation of gas in the goaf of the mining seam that does its mining more dangerous. Multiple seam mining is in detail already considered in the following scientific articles [48-50]. In this paper the case of multiple seam mining prone to rock bump, in the conditions of the Alardinskaya mine of the Kuznetsk coal basin is considered. The relevance of work is caused by very difficult geological conditions of multiple coal seam in the Alardinskaya mine and frequent emergence of the accidents connected with explosions of methane in the goaf and rock bumps.

2. METHODS

For the analysis of change of the stress and strain condition of the massif the finite element method was used. Numerical analysis was conducted with use of the developed model (Figure 1). In figure 1 the model of multiple coal seam mining is shown: Thickness of the 1 seam is 1.5-2.0 m, thickness of the 3-3a seam is 3-3 4.0-7.0 m, thickness of the 6 seam is 6.3-7.9 m. Interbed thickness of 1 seam and 3-3a seam is 50-60 m. Interbed thickness 3-3a seam and 6 seam is 28-35 m. Seams inclination is 10-15 degrees. Seams are gas-bearing, prone to rock bump, prone to self-ignition. Mining of seams (3-3a and 6) is carried out with division of seam into two layers. Length of longwall panels is 850-2100 m, width of longwall panels is 200-220 m.

Figure 1 3D model of rock massif for numerical analysis

When performing researches consecutive mining of seams since the top 1 seam was modelled. Such order of mining of seams was applied in the mine to an exception of rock bump at the subsequent mining of 3-3 seam and 6 seam.
3. RESULTS AND DISCUSSION

At the first stage of carrying out researches assessment of the geostatic field of stress (figure 2) was executed. From figure 2 it is visible that the hilly surface leads to various level of vertical stress at the level with an identical geodetic mark.

![Figure 2 Fields of vertical stress in rock massif](image)

At the following stage of researches the analysis of influence of mining of the top layer was made. As mining of the first seam was carried out without leaving of coal pillars the goafs of longwall panels (LP 1-45, LP 1-46, LP 1-47, LP 1-48) represented one big goaf. Formation big goaf led to unloading of undermined and overmined rock massif provided conditions for safe mining of the seams prone to rock bump (figure 3). In regional parts of the massif zones of concentration of stress are observed. Apparently from figure 3 the zone of unloading covers underlying 3-3a seam under goaf of 1 seam.

![Figure 3 Fields of vertical stress after 1 seam mining](image)

In figure 4 distribution of stress after mining of all three seam is shown. Mining of 1 seam was carried out without leaving of coal pillar. At mining of seams 3-3 and 6 between longwall panels were left coal pillar. From figure 4 it is possible to see that leaving of pillar between longwall panels leads to formation around pillar of zones of the increased stress. Still the high
concentration of stress is observed in regional parts of the massif where there is an imposing of zones of the increased stress from regional parts of all three seams.

![Figure 4 Fields of vertical stress after multiple seam mining](image)

The executed researches showed that at arrangement of seams at distance of less than 60 m interaction of multiple seam is observed. Mining of 1 seam without leaving of coal pillars provides safe conditions for 3-3a seam mining. Mining of 3-3a seam creates conditions for safe mining of 6 seam. However, leaving of coal pillars between longwall panels leads to formation of zones of the increased stress constituting the increased danger at mining of seams prone to rock bump.

It should be noted that a mining attempt at first of 3-3a seam (without 1 seam mining) made in the mine led to rock bump. Thus, at mining of the seams prone to rock bump, it is necessary to fulfill the safest seams (with smallest thickness of a seam).

4. CONCLUSIONS
As a result of executed the numerical analysis distribution of stress at consecutive multiple coal seam mining in the conditions of the Alardinskaya mine was received. The executed researches showed importance of the choice of the sequence of mining of multiple seam and confirmed need of priority mining of 1 seam without leaving of coal pillars. Also importance of accounting of zones of the increased stress formed around coal pillars was established, at multiple seam mining prone to rock bump.

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REFERENCES
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