Assessment of Rigid Overlying Strata Failure in Face Mining

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Abstract: The method of overlying strata failure assessment of extracted seams is based upon the simultaneous assessment of surface subsidence and seismic activity, considering the spatial-temporal progress of mining, depending on the character of the rock mass. The rigid overlying strata failure assessment results in finding whether a failure of the firm overlying rocks occurred or whether a strutting arch was formed over the mined-out area. The practical importance of the overlying strata failure assessment consists in determining the size of the mined-out area at which the complete failure of the rigid overlying strata occurred and in the assessment of the current stress condition of the overlying strata failure. The assessment method is applicable in deep mine workings where thick coal seams are being mined by means of the method of longwall mining with controlled caving. The results of this method are used to amend contemporary known methods of rock-burst protection, namely (regarding the use of surface measurements for the evaluation) in overlying strata areas.

Keywords: strutting arch • surface subsidence • extent of complete failure • rigid overlying strata breakthrough • subsidence trough

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1. Introduction

Stress always increases around a mined-out area, resulting in compression of the working face surroundings that reveals itself by a certain measurable surface subsidence. Determination of the surface subsidence value in relation to the extent and thickness of the mined-out workings is important to recognize the conditions under which a deformation of the rigid overlying strata may occur. In many cases a strutting arch is formed over the mined-out area and no complete failure of the entire thickness of the relatively consistent rigid overlying strata takes place. Formation of a strutting arch results in an enormous rock surcharge concentration and anomalous geo-mechanical phenomena. However, in cases when a complete failure of the consistent rigid overlying strata takes place, the extent of the complete failure must not be further extended by subsequent mining. During the complete deformation of the rigid overlying strata, failure does not occur in the entire space over the gob (the area from which coal has been removed). A part of firm overlying layers (known as overhangs) over the gob remains unbroken. Overhangs of the unfaulted firm layers which are tailed into the non-
undermined overlying strata take a part in a considerable surcharge of the affected area. That is why in this area a high stress concentration occurs.

It is possible to calculate the dimensions of the mined-out area at the time of the complete failure by the back assessment of mine surveying and seismic observations in the given locality. The reverse assessment also provides an overview of the overlying strata failure of formerly extracted seams, which is of a substantial importance for correct interpretation of the current overlying strata failure assessment of the currently extracted seam.

It has previously been shown [1] that natural coal has an ability to store and rapidly release elastic strain energy. This appears to be a fundamental condition for the occurrence of rock-bursts in deep underground coal mines. In Upper Silesia, where a number of existing mines work below a critical depth, several indices have been proposed and their numerical values found experimentally in order to classify the potential liability of coal seams to create rock-burst hazards. When complete predictions of the rock-burst hazard for a specific location in a mine are to be made, data on in-situ stress concentrations must also be collected. Since direct stress measurements in coal are hard to recommend as a routine procedure in mines, a number of indirect methods are currently being practiced, with drilling yield and seismic wave velocity methods giving the most reliable results.

It is also shown [2] that the extended set of parameters describing the focal mechanism of seismic events implies a clear connection with the geological and tectonic conditions of mining operations and the resultant seismic hazard.

2. Locality description

The Karviná Mine is situated in the Czech part of the Upper-Silesian Coal Basin and is the largest deep mining complex in the Czech Republic. In this paper the overlying strata failure assessment results of the formerly extracted seams No. 38 and No. 39 and the currently extracted seam No. 40 of the Karvina Mine, Lazy plant, are presented.

Mine working in this area is performed by the method of longwall mining with controlled caving. Working the faces throughout the 9th block is carried out as home mining. The mean daily amount of the coal extraction is approx. 4 m. The opening and closing times of working the individual faces are presented in Figure 1.

In the area of the 9th block of the Karvina Mine, Lazy plant, the extracted part of seam No. 38 is located at an average depth of 625 m, seam No. 39 at a depth of 640 m and seam No. 40 at an average depth of 708 m. The mentioned seams belong to anticline layers of the Karvina group of strata. The layers of the 9th block generally dip 6 - 7˚ to the north-northeast. Two significant tectonic faults go through the assessed area. The geologic information is provided by the boreholes No. 85/XXI and D40-86 situated in the immediate vicinity of mining, Figure 1.

The first seam being assessed (No. 38) is located approx. 115 m under seam No. 37 extracted previously. The extracted thickness of seam No. 38 ranged between 4.55-5.65 m. The interlayer between seams No. 37 and No. 38 is mostly composed of sandstone. The sandstone layers with the largest thickness are situated in the immediate floor of seam No. 37, where two sandstone layers with the thickness of approx. 8 m are located. In the direct overlying strata of seam No. 38 there is a sandstone layer with the thickness of approx. 7 m.

Seam No. 39 is situated approx. 15 m under seam No. 38. The extracted thickness of seam No. 39 ranged between 4.10-5.80 m. The interlayer between seams No. 37 and No. 38 is mostly composed of sandstone; the sandstone layers with the largest thickness are situated in the immediate floor of seam No. 37, where two sandstone layers with the thickness of approx. 8 m are located. In the direct overlying strata of seam No. 38 there is a sandstone layer with the thickness of approx. 7 m.

Seam No. 39 is situated approx. 15 m under seam No. 38. The extracted thickness of seam No. 39 ranged between 4.10-5.80 m. The interlayer between seams No. 38 and No. 39 is mostly composed of sandstone; the largest thickness of a sandstone layer is 2.8 m.

Currently the mining is performed in seam No. 40 with an average thickness of 4 m. The interlayer between seams No. 40 and No. 39 has a mean thickness of 60 m and is mostly composed of sandstone. The character of the

Figure 1. Overview of extraction in seams No. 38, 39 and 40 in the area of the 9th block of the Karviná Mine, Lazy plant.