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Distribution of ground stress on Puhe Coal Mine

Guo Zhibiao *, Jiang Yulin, Pang Jiewen, Liu Jiawei

State Key Laboratory of Geomechanics and Deep Underground Engineering, Beijing 100083, China
School of Mechanics and Civil Engineering, China University of Mining & Technology, Beijing 100083, China

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ABSTRACT

Puhe Coal Mine is a typical Tertiary coal in Shenbei mining area. With an increase in mining depth, tectonic stress field becomes more complex, leading to increased deformation and failure of the soft rock roadway. Stress becomes an important factor of mine safety and stability. This paper analyzes the distribution of the regional tectonic field, and determines the distribution of situ stress measurement through measuring the ground stress field in the main mining area level of Puhe Coal Mine using stress relief method. The acquired in situ stress data at different locations and depths provide a reference for the rational arrangement of the stop and mine roadway supporting design, which are of great significance for the efficient safety production of the mine.

1. Introduction

Stress, often referred to as the original rock stress, is the ground state of stress inherent in the body that was first put forward by Heim, a Swiss geologist. The main causes of stress are gravity and tectonic movement, especially in the horizontal direction where the tectonic movement has the greatest impact on the formation of stress [1–3]. For many hundreds of thousands years ago, the Earth experienced numerous large and small tectonic movement. Tectonic movement of the stress field has also been affected by multiple stacking, traction and transformation. Besides, stress field is influenced by other factors, which results into the complexity and diversity the state of stress. Because of that, it is rather difficult to get the size and direction of the stress by mathematical calculations or model analysis method. Thus, field stress measurement is the most effective way to understand the state of stress in a particular region [4,5].

Puhe Coal Mine is located in the eastern Shenbei coalfield Puhe town, Shenbei, Shenyang. It has over 40 years of mining history, and is the third oldest coalfield department which locates between the Kaiyuan–Damintun fault and Qingyuan–Fushun fault with complex geology and coal seam law. Within coalfield, the strata are Sinian, Jurassic, Paleogene and Quaternary from old to new.

The surrounding rock is the Tertiary soft rock with low engineering rock strength, strong expansion, fissures, and easy production of large nonlinear deformation, which result in serious roof sinking, uplift of bottom plate, asymmetrically large deformation convergence and great difficulties for the production [6–10]. In Puhe Coal Mine, in order to know stress distribution of Puhe Coal Mine and current tectonic situation and evolution of the mining areas, the stress measurement is carried out for the purpose of providing a scientific basis for reasonable support of the deep roadway and safe mining design of the seam.

2. Measuring stress

2.1. Geological conditions

Puhe coalfield is flat, and terrain is slightly high in the east, with the ground elevation +81 m. The terrain in the east is somewhat low, with the ground elevation +60 m. In a word, Puhe coalfield is a flat alluvial–diluvial plain for quaternary. The F1 fault is the dividing line for the east and southeast of Puhe coalfield, adjacent to Qingshui Coal Mine. F8 fault is the dividing line for the south of Puhe coalfield, adjacent to Daqiao Coal. F30 and F47 faults are the dividing lines of the west of Puhe coalfield, adjacent to Xinchengzi coalfield, whereas F7 and F36 faults are the dividing lines for the north of Puhe coalfield, adjacent to Yanghe coalfield. Fold structures develop widely, most of them distribute in the middle and south of coalfield, comprising a series of arc-shaped bent folds. From west to east, the fold structures are as follows: anticline and syncline of Magujiazi, syncline of Xinchengzi, anticline of Daqiao, syncline of Wanghuaguchengzi, anticline of Puhe plunging (anticline of Wanghua plunging) and syncline of Haodianzi. 14 large and medium-sized faults identified in the coalfield were clas-

* Corresponding author. Tel.: +86 13910283906.
E-mail address: guozhibiaobj@126.com (Z. Guo).

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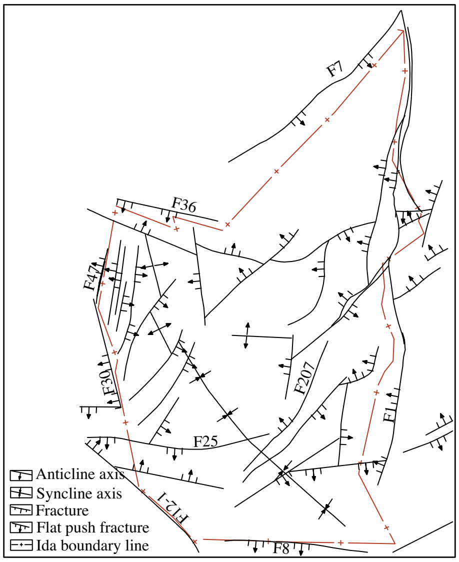


Fig. 1. Distribution of main structure in mining area.

sified as normal faults. Based on two things, faults can be divided into two strikes, namely north-east strike where the backbone is a fault rupture and east-west strike where the trending faults are well developed as the backbone structures associated fractures. It is a sheet-shear extrusion fault. The dip of fault generally ranges from 45° to 60° or less than 65°. From shallow to deep in the vertical point of view, the dip gradually slows down until the gap becomes a small pinch. From the large gap between the middle planes, reduction of the smaller steep angle to both sides slows down. The distribution of the main structure is shown in Fig. 1.

Based on a comprehensive analysis of its formation sequence, Shenyang coalfield structure can be divided into three phases, i.e., mainly fold structure in the first phase and fault structure in the second and third phases. Shenbei coalfield is a completely broom knob construct. Therefore, this constitutes the basis structural frame of internal part of coalfield. The axial structure of these folds shows the northern end of close convergence, the central curved bend and the southern tip of loose cast echelon distribution. The tectonic of area should belong to the complex intersection of Tianshan–Yinshan zonal structure and the new Cathaysian structure; it is more complex in structure. Therefore, it is necessary to use field measurement of the stress field to determine the characteristics of tectonic stress field in the Puhe Coal Mine.

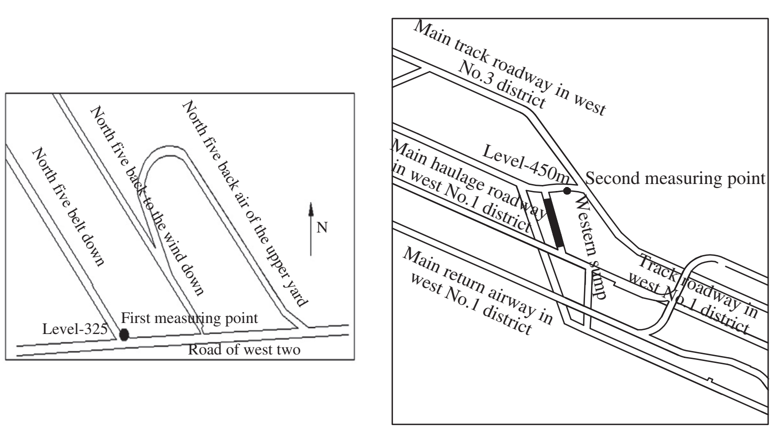
2.2. Test method and apparatus

Due to the complex conditions underground in coal mine and limited operating space, the stress relief method is easy to operate. This is the most common method to realize the stress perturbations and carry out measurement, that is, using a horizontal and directional instrument sends CSIRO cells into drilling to make sure it reach the installation location in the right direction. And then pushing the installation of pole is to make sure the mucus agent inflow into the crack between the stressometer and the wall of small hole. After a period of solidification, it becomes firm. That is to say, the stress relief can be carried out. The principal stress error determined in lab is 3%, and the direction error is ranging from 2° to 4°.

This research uses KX-81 hollow inclusion triaxial strain gauge which is developed by the Academy of Geological Sciences [11–15]. The main part of gauge, made by epoxy resin, is a hollow cylinder whose wall thickness is 3 mm and outer and inner diameters are respective 36 and 30 mm. Three groups of resistance strain rosette are buried in the intermediate part of hollow cylinder along the same circumference equidistant. Each group of resistance strain rosette is composed of four strain gauges with an interval of 45° each. It has already become the widely used measuring transducer in the world because it has the following advantages: easy and quick installation, high reliability, high rate of accuracy and better water resistance.

2.3. Measuring points

In principle, for any survey area, several stress stations should be arranged in order to implement multi-dimensional measurement of stress, so that stress field characteristics can be fully researched and analyzed. Taking into account the actual situations of coal production and the acclimation of stress relief method, mainly using the advantage of Puhe coal mining area of the existing roadway and the chamber is to arrange the measuring point at the floor of mainly mining coal seam, and try to avoid mining additional stress field influencing on stress measuring points. The measuring points are arranged as far as possible from the working face of mining, boring head and intersection. But, the arrangement of measuring points tries to avoid the fault fracture zone, and measuring points should be arranged in a complete, homogeneous and stable rock to ensure the strain gauge to be undisturbed and the accuracy of measurement results. Fig. 2 shows the concrete



(a) 1 # (b) 2 #

Fig. 2. Layout of 1# and 2# measuring points.