Research on Deformation Characteristics of Overlying Rock Strata in Floor Roadway

ZHonghua Wang 1,2,*
1National Key Laboratory of Gas Disaster Detecting, Preventing and Emergency Controlling, Chongqing, 400037
2China Coal Technology Engineering Group Chongqing Research Institute, Chongqing, 400037
* Corresponding author’s e-mail: boaidajia2007@126.com

Abstract: In order to study the deformation characteristics of the overlying rock layer of the floor roadway, the DW-6 multi-point displacement meter is used to measure the displacement of the surrounding rock of the roadway at different depths, and it is concluded that the displacement and deformation of the surrounding rock within 15m of the upper and lower sides of the pressure relief floor rock roadway. The upper part shows the largest deformation of the surrounding rock directly above, followed by the upper and lower sides 7.5m, and the upper and lower sides the smallest 15m. The different base points of the same borehole show the characteristics of alternating wave crests and troughs from the outside to the inside. The wave crests with larger displacements are the damaged areas of surrounding rock, and the troughs with smaller displacements are the non-damaged areas of surrounding rock.

1. Mine overview

1.1. Basic situation of the mine
Shangzhuang Minefield is a part of the Wusheli mining area in Fengcheng Hexi Coalfield, located in Fengcheng City in the middle and lower reaches of Ganjiang River. The northeast is adjacent to the Bayi Mine with a coal-free area, the southwest is bounded by the F9 fault, the northwest (deep) is bounded by the F13 fault, and the southeast (deep) is bounded by the -750m coal seam floor contour. The strike length of the mine is about 5.1km, the inclination width is about 2.65km, and the area is about 13.288km². The Shangzhuang Minefield was formally explored in 1955, and the well was designed and constructed in 1958. Due to insufficient exploration, the construction was suspended in 1962. Later, it was designed by the Design and Research Institute of East China Coal Industry Capital Construction Company in 1965, with a design capacity of 210kt/a. The second well was built in April 1966 and put into production in October 1968. The approved production capacity in 1980 was 300 kt/a, and the approved production capacity in 2005 was 350 kt/a. In recent years, the annual output has stabilized at 350,000 to 400,000 tons.

1.2. Mine development and mining
The mine is a multi-level development of inclined shafts. There are five existing shafts: main shaft, auxiliary shaft, skip shaft, east air shaft, and west air shaft. The skip well is used as the main hoist, and the main inclined shaft and auxiliary inclined shaft are used as auxiliary hoists. The main inclined shaft,
auxiliary inclined shaft, and skip well take in air, and the east and west air shafts return air. The mine is designed to mine at four levels, the first, second and third levels (-110m, -230m, -450m) have been closed after mining, and the current production level is at the fourth level (-650m). The current production level has three mining areas, namely: east wing, central and west wing mining areas. The mine adopts the long-wall coal mining method, retreating, blasting coal, manual coal loading, and mechanical transportation. The working face is supported by a single hinged beam, and the roof is managed by the collapse method. At the same time, it is equipped with comprehensive mechanized coal mining surface. The tunneling face adopts the transportation method of blasting, manual loading, manual cart or small winch, and the supporting methods include anchor net, metal bracket, and bricklaying. At the same time, it is equipped with a comprehensive mechanized tunneling face.

1.3. Mine ventilation gas
The mine adopts mechanical extraction ventilation and central diagonal ventilation. The air intake shaft is the main, auxiliary shaft, skip well, the return air shaft is the east and west air shaft, and the east air shaft is the main fan of BDK-8-NO24 (motor power 2×280KW), one working and one standby; The west wind well is a BDK-6-NO17 main fan (motor power 220KW), one for work and one for standby. The total inlet air volume of the mine is 5204m³/min, and the total return air volume is 5384m³/min. The mine’s identification results in recent years are shown in Table 1.

| Year | Gas emission | Absolute amount (m³/min) | relative volume (m³/t) |
|------|--------------|--------------------------|------------------------|
| 2005 | 30.39        | 37.51                    |
| 2006 | 28.74        | 40.57                    |
| 2007 | 37.8         | 37.22                    |
| 2008 | 42.18        | 39.50                    |
| 2009 | 40.92        | 41.51                    |
| 2010 | 34.10        | 32.71                    |
| 2011 | 25.24        | 35.12                    |

2. Experimental research plan
The borehole diameter of the surrounding rock deformation survey is Φ32mm. The DW-6 multi-point displacement meter is used to measure the displacement of the surrounding rock of the roadway at different depths. The thickness of the rock pillars of the two roadways and the overlying coal seam are 15m and 19m respectively. After the drilling construction, 5 inspection holes are arranged for each inspection content, that is, 5 inspection locations, which are 15m on the lower side, 7.5m on the lower side, directly above, 7.5m on the upper side, and 15m on the upper side. The specific locations of the investigation are shown in Table 2.

| Roadway       | Inspection location (from the head of the tunneling: m) |
|---------------|--------------------------------------------------------|
| 710 Floor Lane| The first group 230  The second group 135             |
| 505 Floor Lane| The third group /                                     |

3. Deformation of surrounding rock in pressure relief floor rock roadway
After drilling the hole, use the guide rod to send the base point anchor (pawl type) to the specified depth,
install a base point (a total of 6 base points) from the inside to the outside in turn, record the readings every day after installation, and count the surrounding rock displacements at different depths the amount. The survey results of 15m surrounding rock on both sides of the roof of 505 and 710 floor roadways are shown in Tables 3 and 4 respectively.

### Table 3. Displacement and deformation of surrounding rock of 505 floor roadway

| Number of groups | Time (d) | Lower 15m | Lower 7.5m | Right above | Upper 7.5m | Upper 15m |
|------------------|----------|-----------|------------|-------------|------------|-----------|
| Head-on 260m     | 9        | 0.3       | 0.2        | 0.8         | 0.3        | 0.2       |
| (First group)    | 7        | 0.5       | 0.3        | 0.1         | 0.5        | 0.3       |
|                  | 6        | 0.3       | 0.6        | 1.1         | 0.3        | 0.5       |
|                  | 4        | 0.9       | 1.1        | 1.7         | 1.2        | 1.4       |
|                  | 3        | 0.3       | 0.4        | 0.8         | 0.9        | 0.2       |
|                  | 2        | 1         | 0.6        | 2.2         | 1.2        | 0.3       |
| Head-on 120m     | 10       | 1         | 1.2        | 0.3         | 0.3        | 0.5       |
| (Second Group)   | 8        | 0.7       | 0.5        | 1           | 0.8        | 0.7       |
|                  | 6        | 0.6       | 0.5        | 0.4         | 0.5        | 0.6       |
|                  | 5        | 1.2       | 0.7        | 1.1         | 0.9        | 1         |
|                  | 4        | 1         | 0.4        | 0.7         | 0.3        | 0.5       |
|                  | 2        | 1         | 0.9        | 1.5         | 1.2        | 0.7       |

It can be seen from Tables 3 and 4 that the displacement of the surrounding rock within 15m of the upper and lower sides of the floor tunnel basically presents the largest displacement directly above, and gradually decreases to 7.5m and 7.5~15m on both sides; different base points of the same borehole appear from the outside to the inside. It is the characteristic of the change of wave peaks and troughs,
that is, there are 2~3 places where the displacement and deformation are small, and there are 2~3 places where the displacement and deformation are large. This change law is different from the displacement of the surrounding rock of a shallow cavern and the distance from the cave wall. The monotonous change law of increasing and decreasing gradually, it is preliminarily judged that there are zonal ruptures in the surrounding rock after the excavation of the roadway. The wave crest with larger displacement is the failure area of surrounding rock, and the trough with smaller displacement is the non-wall rock. Damage zone.

4. Conclusion

The displacement and deformation of the surrounding rock within 15m of the upper and lower sides of the pressure relief floor rock roadway basically presents the characteristics that the deformation of the surrounding rock directly above is the largest, followed by the upper and lower sides of 7.5m, and the minimum of 15m.

The maximum displacement and deformation directly above the floor lane is 3.5cm. The maximum displacement and deformation within the range of 7.5m from directly above to the upper and lower sides of the floor lane is 3.0cm. The maximum displacement and deformation from 7.5m to 15m on both sides of the floor lane is 1.4cm.

Different base points of the same borehole appear from the outside to the inside as the characteristics of alternating peaks and valleys. This change law is different from the shallow-buried cavern surrounding rock displacement and the monotonous change law that gradually decreases with the increase of the distance from the cave wall. The larger wave crest is the damaged area of surrounding rock, and the wave trough with smaller displacement is the non-damaged area of surrounding rock.

Fund Project

This work was financially supported by the national key research and development program of China (2017YFC0804206), General project of Chongqing Research Institute Co., Ltd (2019YBXM31), General project of Chongqing Research Institute Co., Ltd (2020YBXM22).

References

[1] Xiao Tongqiang, Li Huamin, Yang Jianli, Jiang Shaoyong. Mechanism and control of deformation and failure of surrounding rock in chamber with super large section[J]. Journal of China Coal Society, 2014, 39(04): 631-636.

[2] Wang Dechao, Wang Qi, Li Shucai, Wang Fuqi, Ruan Guoqiang, Shao Xing, Liu Wenjiang, Wang Xin. Deformation failure mechanism and control countermeasures of surrounding rock of roadway driving along goaf in fully mechanized caving deep well[J]. Journal of Mining and Safety Engineering, 2014, 31(05):665-673.

[3] Zhang Guangchao, He Fulian. Deformation and failure mechanism and control of surrounding rock of deep mine high-stress soft rock roadway[J]. Journal of Mining and Safety Engineering, 2015, 32(04): 571-577.

[4] Li Yongbing, Zhou Yu, Wu Shunchuan, Wang Chao, Wang Yunqing. Continuous-discrete coupling analysis of deformation and failure of surrounding rock of circular roadway[J]. Chinese Journal of Rock Mechanics and Engineering, 2015, 34(09): 1849-1858.

[5] Zhang Pingsong, Xu Shiang, Guo Liquan, Wu Rongxin. Research progress and prospects of deformation and failure monitoring technology of surrounding rock in stope[J]. Coal Science and Technology, 2020, 48(03): 14-48.