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Simulation of narrow coal pillar width in gob-side entry driving

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Abstract: Numerical simulation of coal pillars with different widths in goaf excavation at 1102 working face of Huacaoan Coal Mine is carried out to study the influence of different widths of coal pillars on the stability of surrounding rock in goaf excavation. Finally, the width of coal pillars is determined to be 5m, which ensures the safety of roadway excavation, improves the utilization rate of coal extraction and responds to the call of green mining.

Keywords: Gob-side entry driving; Narrow coal pillar; Numerical simulation.

1. Introduction

Coal has always been the main fuel raw material in China [1-4]. In the coming decades, China's energy consumption will continue to be dominated by coal consumption, and coal also occupies a very large share in China's energy consumption. The utilization of coal resources is directly related to the lifeblood of the country's economy [5,6]. Even though there are a lot of new energy in the world gradually appear in the public vision, but still cannot shake the position of coal resources in energy consumption.

In this paper, the stability of overlying rock surrounding rock in goaf roadway excavation at 1102 working face of Huacaotan Coal Mine is carried out. Through numerical simulation, the influence of different coal pillar widths on the stability of goaf roadway surrounding rock is studied, and different simulation schemes with coal pillar widths ranging from 3 to 10m are established.

2. Establishment of model

UDEC numerical simulation software is used to simulate the reasonable coal pillar width of goaf driving roadway in 1102 working face of Huacaotan Coal Mine. A 100m×80m model was established, and according to the depth of the working face and roadway, combined with the average bulk density of the overlying rock mass on the working face, vertical stress was applied to the upper boundary of the model, and the left and right boundary and the lower boundary were fixed. The constitutive relation adopts the Moll Coulomb constitutive relation to mesh different rock strata, divide the joints and assign parameter values.

3. Simulate different coal pillar widths

3.1. Simulation scheme

The 1102 working face of Huacaotan Coal mine has a depth of 420m and a coal seam dip Angle of 17°. According to the characteristics of goaf excavation in this working face, the stability of surrounding rock of coal pillars with different widths along goaf excavation is studied by using UDEC software. According to the geological conditions of the coal seam, the width of 3~10 m coal pillar is selected as the test object to study the stress distribution and displacement characteristics of each rock under different coal pillar widths, in order to better give the appropriate width of coal pillar and avoid the waste of resources. The simulation scheme is shown in Table 1.

Table 1. Simulation schemes of different coal pillar widths

Scheme	I	II	III	IV	V	VI	VII	VII
Width	3m	4m	5m	6m	7m	8m	9m	10m

Simulation steps: Build a model, divide joints, assign all rock parameters, apply pressure to the upper boundary of the model, fix the left and right boundaries, and then carry out excavation simulation of 1104 working face. After the simulation is stable, carry out simulation of transportation roadway of 1102 working face. Half of the thickness of coal seam is arranged along the inclination direction of coal seam to monitor the stress and displacement changes of coal pillar and surrounding rock mass.

3.2. Simulation process

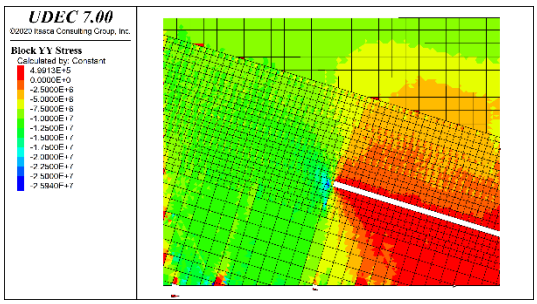
Firstly, the stress was initialized, and after it was stabilized, simulated excavation of 1104 working face was carried out. When the excavation is balanced, the stress distribution law at the side of the goaf is analyzed, as shown in Figure 1.

After the end of 1104 working face mining, the goaf roof broke continuously, resulting in collapse, subsidence and other phenomena, which destroyed the stability of the original surrounding rock and crushed the coal seam under horizontal pressure. Through the analysis of Figure 1 (a), it can be seen that after the stoping of working face 1104, the rock layer above the working face breaks and sinks due to mining activities, and the stress balance state is destroyed. After the rock layer above the working face moves and destroys, the rock layer stress sharply attenuates and transfers to the surrounding area, which significantly increases the stress of part of the rock layer at the position of working face 1102. Especially in the edge area of the goaf, there is a large stress concentration. Under the action of high stress for a long time, the coal rock mass near the goaf is damaged and plastic deformation occurs in a certain range. It can be seen from Figure 1 (b) that the vertical stress increases rapidly from 3 to 5 m from the edge of the goaf and reaches a peak value of 26

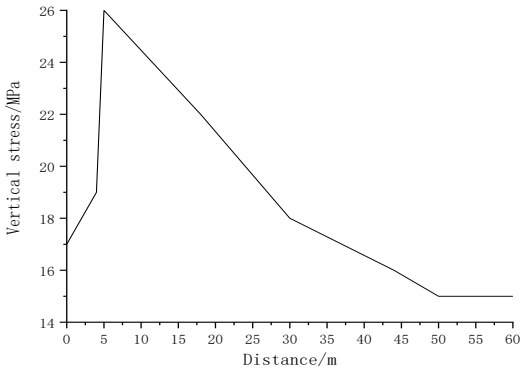
MPa at 5 m. If roadway is set in this part, it is easy to cause roof subsidence, floor heave and serious deformation of two sides of roadway. Therefore, transportation lane 1102 should be located away from the stress concentration area to prevent the roadway from being damaged by the goaf lateral stress. After reaching the maximum vertical stress, the vertical stress decreases with the increase of distance from the edge of the goaf at 5~50 meters, and gradually decreases at 50~60 meters away from the goaf until the original rock stress zone.

According to the actual situation of 1102 working face, a coal pillar width model of 3 meters, 4 meters, 5 meters, 6 meters, 7 meters, 8 meters, 9 meters, 10 meters was established to analyze the influence of different coal pillar widths on roadway stability. On the premise of not considering the roadway support, the stability of coal pillar during mining is studied by using the simulation method, and the stability of roadway is analyzed, so as to calculate the reasonable width of coal pillar.

After the stoping of 1104 working face ended and the overlying strata collapsed and stabilized, simulated excavation of the transportation roadway of 1102 working face was carried out, and measuring lines were arranged along the dip direction of coal seam at the side of the goaf, so as to analyze the stress distribution of the surrounding rock and the stability of the roadway.

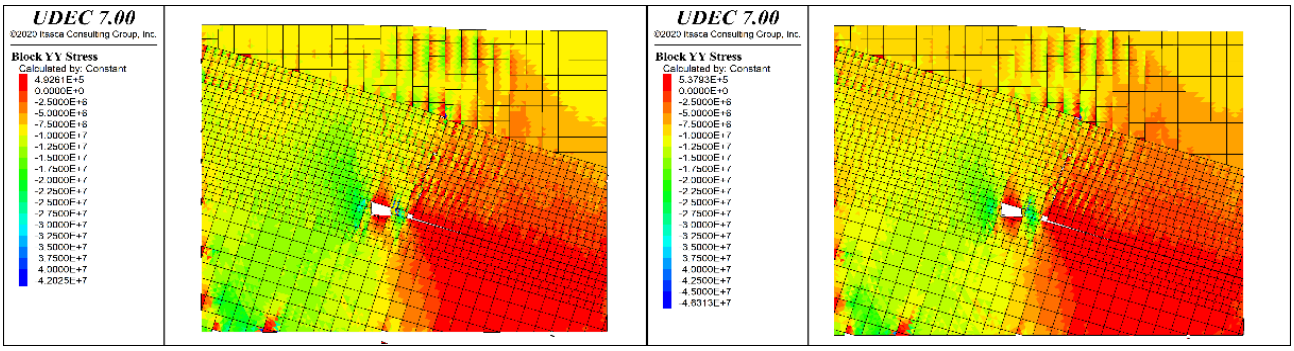


(a)Nephogram of vertical stress distribution

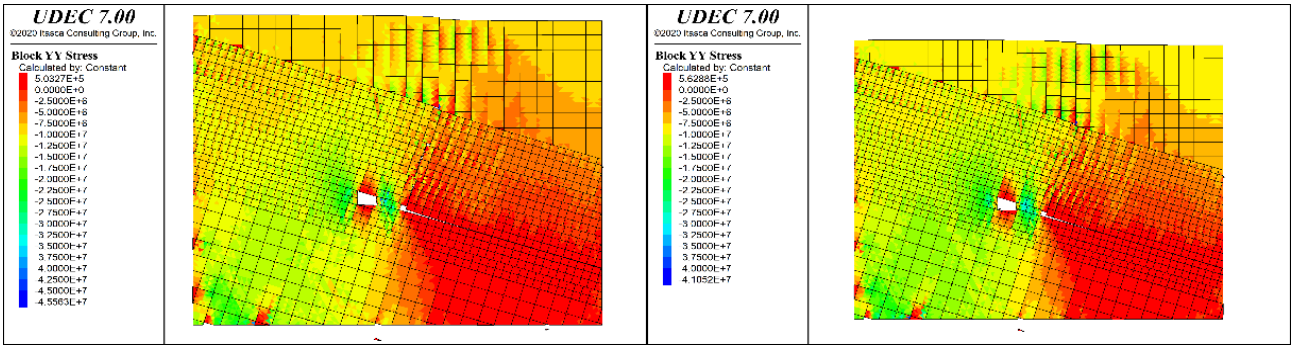


(b)Vertical stress distribution curve

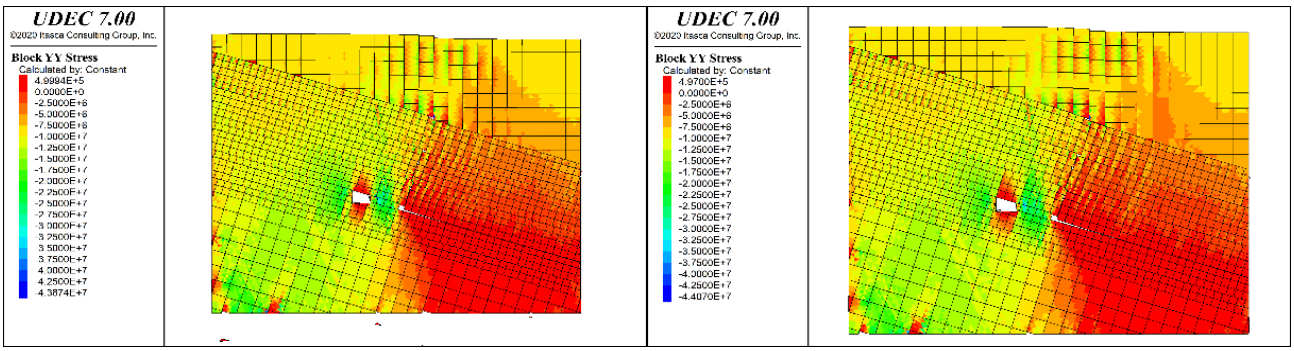
Figure 1. Vertical stress distribution in goaf



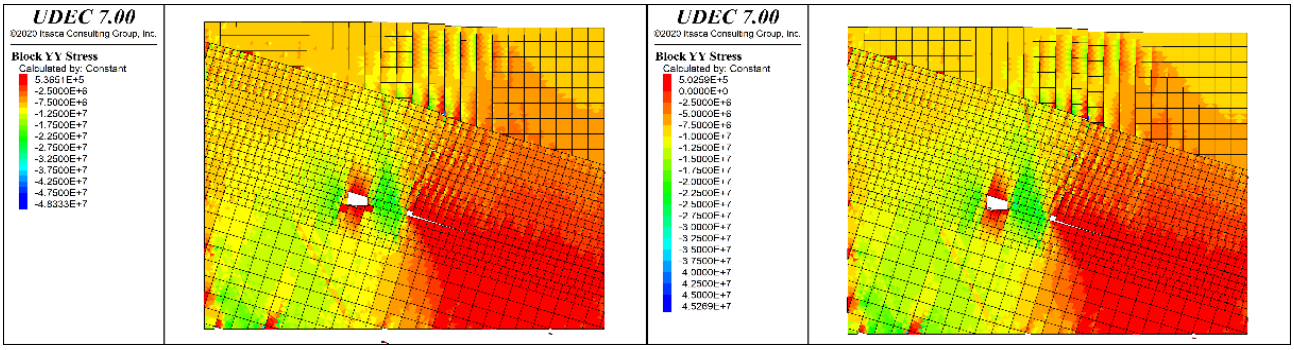
3m 4m



5m 6m

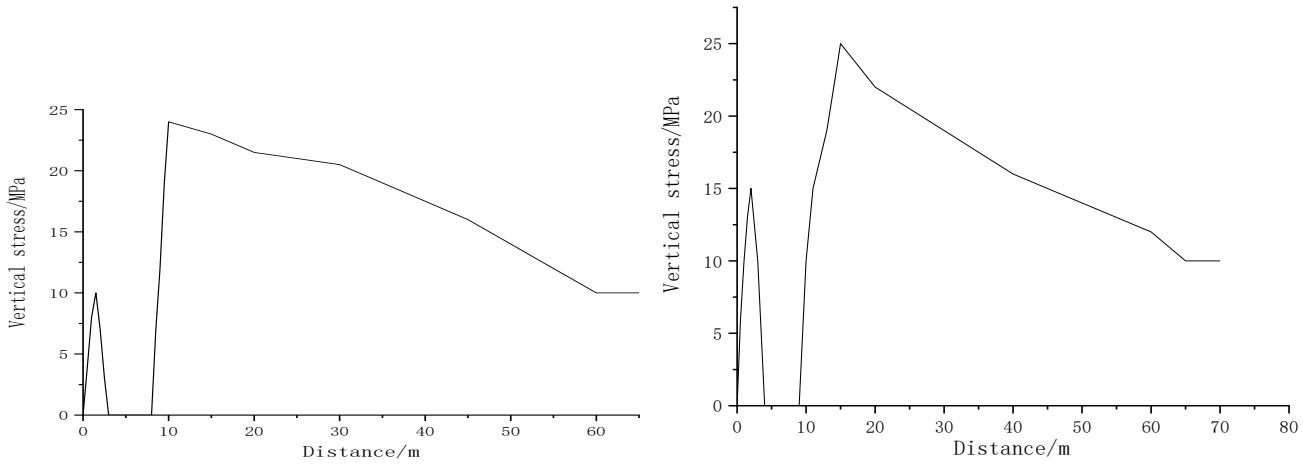


7m 8m

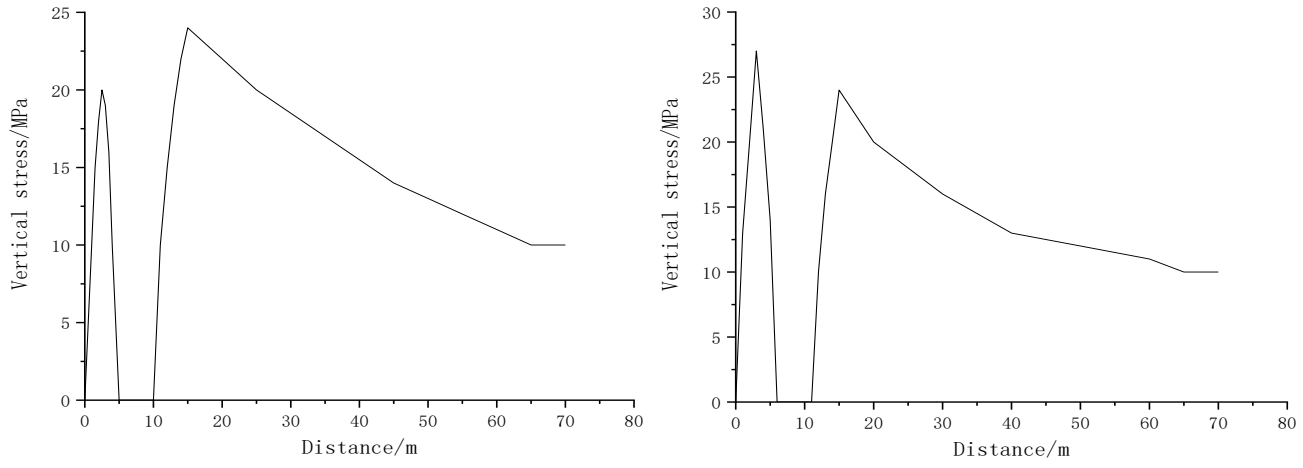


9m 10m

Figure. 2 Nephogram of vertical stress distribution



3m 4m



5m 6m

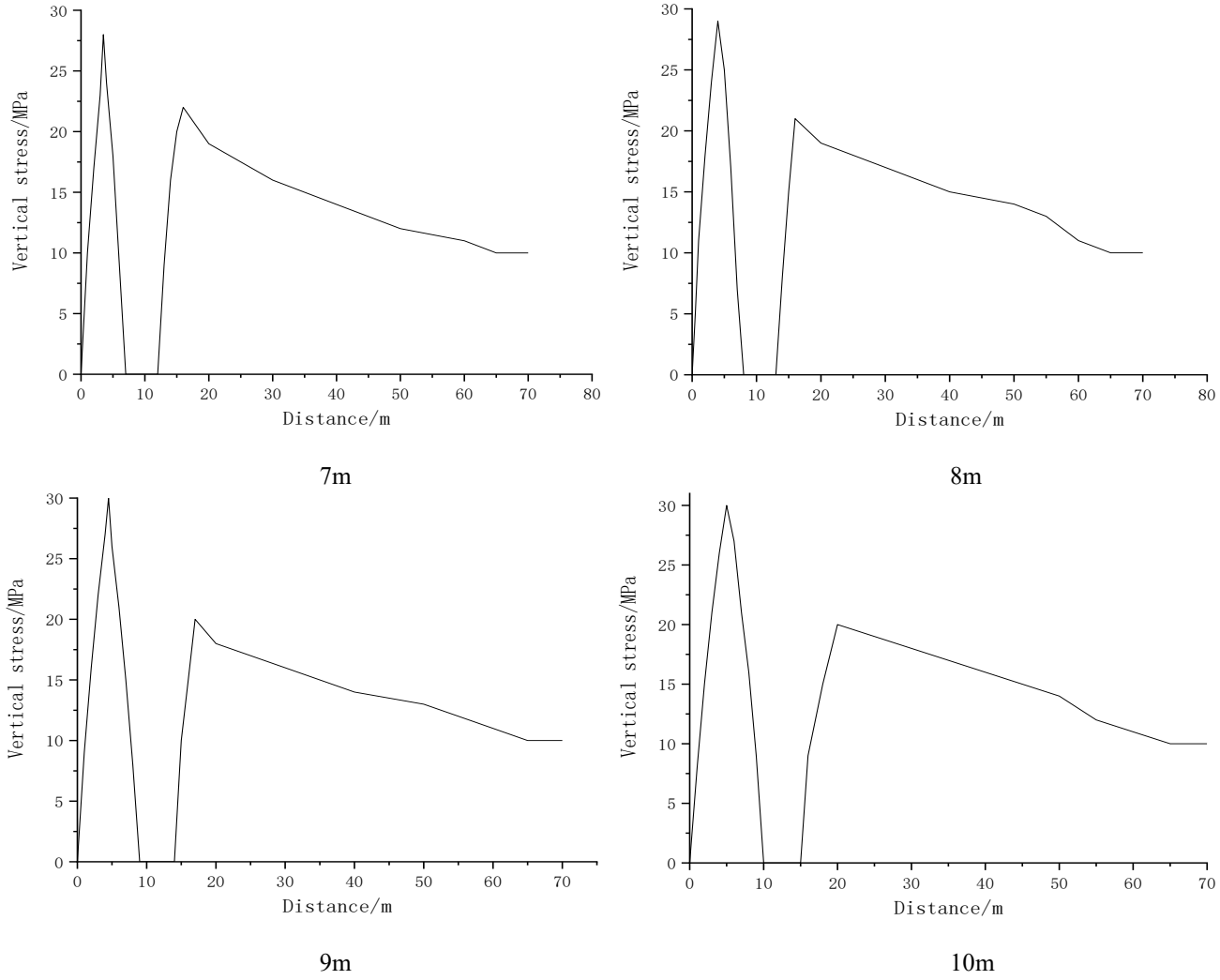


Figure.3 Stress distribution curve

According to the comprehensive analysis of Fig. 2 and Fig. 3, the stress distribution of coal pillars with different widths along the direction of coal seam during the driving of transportation roadway in 1102 working face.

When the roadway is excavated along the goaf, the peak value of the vertical stress in the coal body increases with the increase of the width of the coal pillar, and the stress concentration inside the coal body is relatively small within the width range of 3~5m coal pillar. When the width of coal seam exceeds 6 m, the phenomenon of stress concentration inside coal pillar expands more and more obviously with the increase of the width of coal pillar, and the peak value of stress becomes larger and larger, and the maximum vertical stress reaches 30.0MPa. The peak value of the side stress of solid coal first increases and then decreases with the increase of the width of the coal pillar. When the width of the coal pillar is 5m, the peak value reaches 24.5MPa. When the roadway excavation is completed, the surrounding rock pressure inside the roadway is redistributed, and its carrier is mainly coal pillar and side coal seam.

4. Conclusion

Through numerical simulation, the stability of roadway surrounding rock under different coal pillar widths is analyzed. Finally, it is determined that the coal pillar width of 5m is more in line with the actual situation. In field practice, it is found that the coal pillar with 5m width is more resource-saving and safer than the coal pillar with 20m width used in mine.

References

[1] Li Nishan. Reasearch on Performance Evaluation of YX Company based on EVA [D]. Xi 'an Shiyou University,2016.

[2] Li Nan. Research on the Comprehensive Evaluation of The Ultra Low Emission Reconstruction Project of Thermal Power Plant [D]. North China Electric Power University,2017.

[3] Zhang Jianing. Experimental Research on Physical-mechanical Properties and Productivity Evaluation of Geothermal Reservoir in Guide,Qinghai[D]. Jilin University,2018.

[4] ZHANG Bianbian. Design and Application of Control System for Pulverized Coal Heating Boiler [D]. Lanzhou University of Technology,2021.

[5] Ma Rui. Empirical Study on the Factors Influencing the Level of Accounting in Formation Disclosureof the Social Responsibility of Coal Enterprises [D]. Xi 'an University of Science and Technology,2020.

[6] ZENG Kai，JIANG Yan. Application of 3D Laser Scanning Technology in Surface Subsidence Monitoring [J]. Surveying and Mapping of Geology and Mineral Ｒesources, 2015, 31(02): 28-30.