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Determination of reasonable stop-mining line position of 7311 working face

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Abstract: *Aiming at the problem of determining the location of reasonable stop-mining line in 7311 working face of Baodian Coal Mine, the numerical model of different stoping face lengths was established by using FLAC3D numerical simulation method, and the roof stress evolution of working face with different stoping face lengths was compared and analyzed, so as to determine the location of reasonable stoping line by inversion.*

Keywords: *stop-mining line, FLAC3D, stress evolution*

1. Introduction

Generally, the stop line position of fully mechanized top-coal caving mining is determined in the design according to the size of the upper (lower) coal pillar. Practice has proved that this kind of stop mining line is not designed according to the roof weighting condition.The stability of the roof in the closing and removing space has great influence.

Through the similar simulation test in the laboratory, Cao[1] studied the roof stability of the closing and withdrawing space of fully mechanized top-coal caving face. The results show that when the working face is in the period of periodic weighting, it will bring unsafe hidden danger to the support withdrawal. When the working face is located after periodic weighting, the closing and support removal at this time is very beneficial to the roof management.In order to analyze the influence of the advance abutment pressure on the downhill of the working face in Chen[2],he distribution law of the advance abutment pressure in Yong 'an Coal Mine of Jincheng was analyzed by theoretical calculation and numerical simulation, and the peak position of the advance abutment pressure was determined. Through laboratory similar simulation test, Sun[3] studied the roof stability of the closing and withdrawing space of fully mechanized top-coal caving face. The results show that when the working face is in the period of periodic weighting, it will bring unsafe hidden danger to the support withdrawal. When the working face is located after periodic weighting, the closing and support removal at this time is very beneficial to the roof management. Based on the principle of composite beam, the upper load of key stratum in the process of underground mining is calculated, and the stress and strain of key stratum are calculated, Jing[4] reveals the stress distribution law of key stratum fracture in the lower coal seam, and thus puts forward the criterion of roadway stability, which provides a basis for determining the reasonable position of stop mining line in mining face. Through numerical simulation research, Zhang[5] believes that when the stop mining line is outside the periodic weighting, the stress of the support is small and uniform, the roof subsidence is small, and the degree of coal wall spalling is light.

With the increasing complexity of mining geological conditions, the traditional method has defects in determining the reasonable position of fully mechanized mining stop line, which will bring negative impact on mine safety production and economic benefits. Therefore, this paper uses numerical simulation method and FLAC3D to study the reasonable stop mining line position, in order to provide guidance for the safe mining of 7311 working face in Baodian Coal Mine.

2. Engineering overview

2.1. Workface Overview

The 7311 working face is located in the north of the east wing of the seventh mining area of Baodian coal mine, and the area above and affected by the collapse is mainly agricultural land. The ground elevation is from +43.27 to +44.21m, with an average elevation of +43.58m.

2.2. Coal seam and top and bottom plate conditions

The coal seam mined in working face 7311 is Shanxi Group 3 upper coal, black, mainly bright coal, followed by dark coal, semi-bright coal, with strip structure, laminated structure. 3 upper coal thickness is 5.12~5.77m, average thickness is 5.37m, f=2.9. The spacing between 3 upper coal and 3 lower coal is 1.2~5.77m, average spacing is 3.11m.

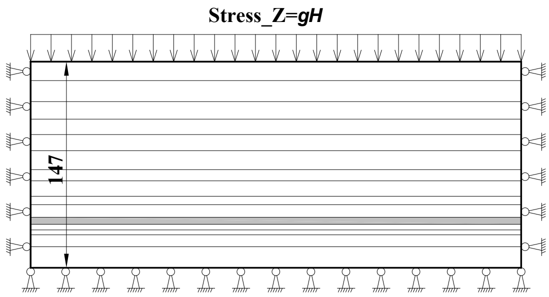
The direct top of 7311 working face is muddy siltstone, thickness 0.6~1.3m, average thickness 1.2m, gray-black, aluminous, dense block, the rock is broken, lamination is not developed, joints are developed, hardness f=4. The basic top is siltstone interbedded, thickness 10.37~23m, average thickness 17.08m, gray to light gray, local sandstone stripes, the composition is mainly quartz, feldspar, followed by a small amount of dark feldspar. The composition is mainly quartz, followed by feldspar, with a few dark minerals and mud-silica cementation, and the bottom contains a large number of plant debris fossils and high mud content, hardness f=4-5.

3. Umerical simulation

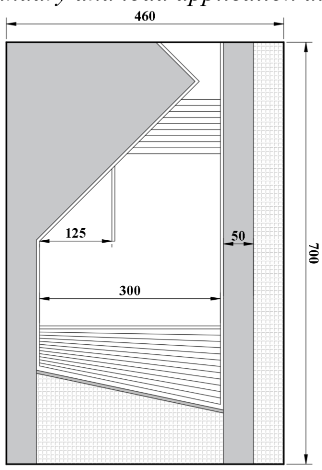
The reasonableness of the location of the stopping line depends on two aspects, one is the risk to the impact pressure caused by the degree of stress concentration due to the shortening of the working face length, and the other is whether the state in which the roof movement is conducive to the safety of the withdrawal face.

3.1. Model building

In order to compare the difference of roof stress at different terminal surface lengths, 10 numerical models of 55m terminal surface, 65m terminal surface, 75m terminal surface, 85m terminal surface, 95m terminal surface, 105m terminal surface, 115m terminal surface, 125m terminal surface and 135m terminal surface length were established for comparison and analysis, and the specific model establishment and simulation results are analyzed as follows.



(a) Boundary and load application diagram



(b) Schematic diagram of the location relationship

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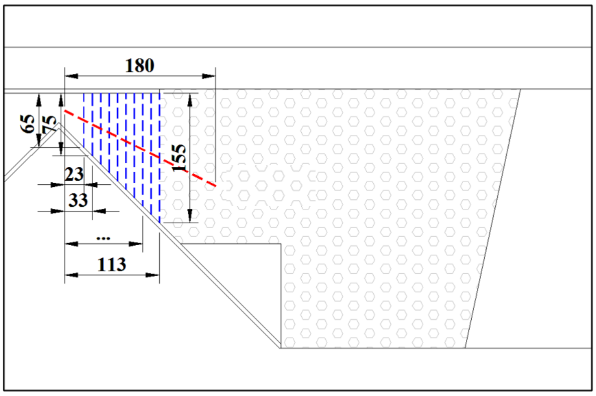
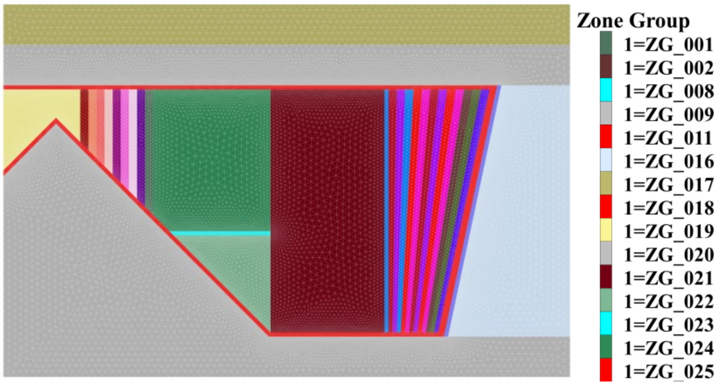


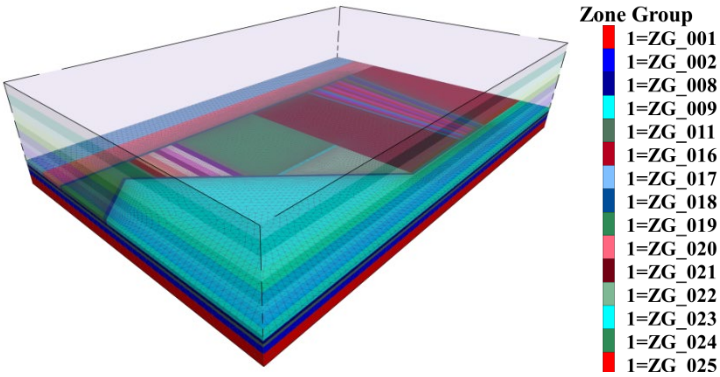
(c) Schematic diagram of model arrangement

Figure 1: Numerical simulation design diagram

According to the purpose of the study, the model was established based on the comprehensive bar chart of 7311 working face, and the design model is shown in Figure 1, and the numerical model was established using FLAC3D simulation software as shown in Figure 2.



(a) Numerical model plan



(b) Numerical model perspective view

Figure 2: Numerical model diagram

In order to simulate the actual rock size as much as possible, the model size was set to 700m*460m*147m (length*width*height), and the Moore-Coulomb model was used, with a total of 570392 units and 100569 nodes. For the simulation calculation, the bottom boundary of the numerical model is fixed, the front and rear boundaries are fixed with normal displacement, and the top boundary is free, and a fixed uniform load of 10.46 MPa is applied to the top of the model according to the height of the overlying rock layer.

3.2. Analysis of simulation results

This section must be in one column. The simulation obtained the cloud diagram of roof stress evolution at different terminal surface lengths as shown in Figure 3. As can be seen from the figure, the roof stress rises sharply in front of the coal wall, forming a high stress concentration, and then gradually

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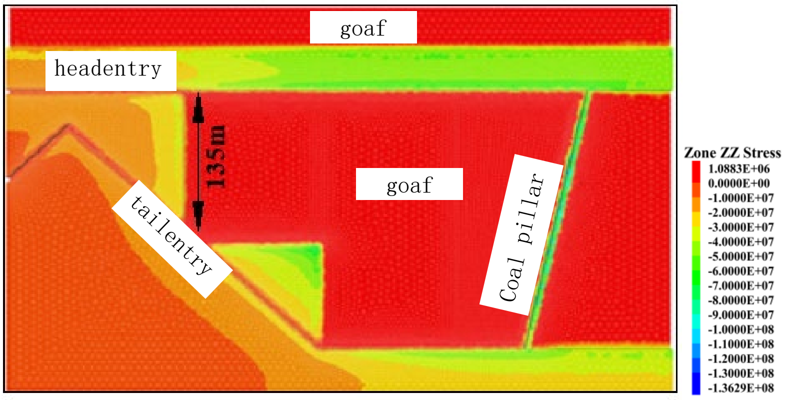
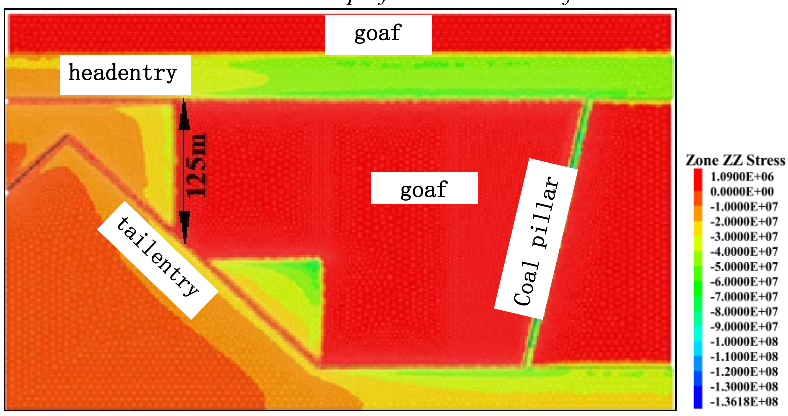
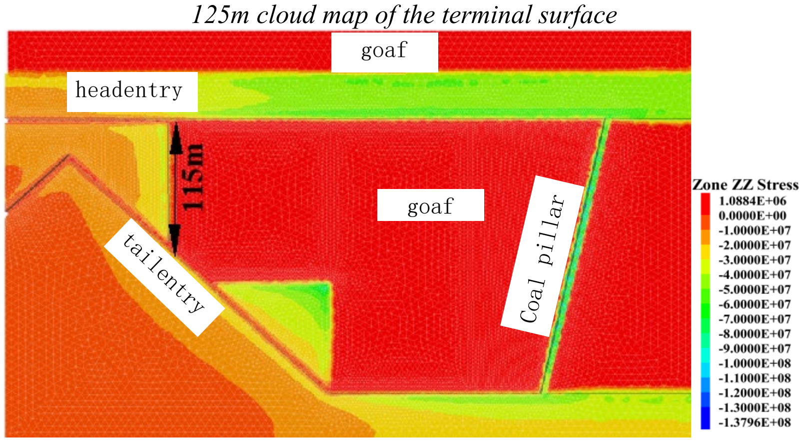
decreases as it moves away from the working face, finally showing the state of the original rock stress. As the working face continues to advance, the working face length gradually decreases, and the peak overhead support pressure shows a gradually increasing trend. It can be seen that the reduction of working face length will cause the further concentration of over-supporting pressure on the working face, which will significantly affect the safety production on site.



135m cloud map of the terminal surface



125m cloud map of the terminal surface



115m cloud map of the terminal surface

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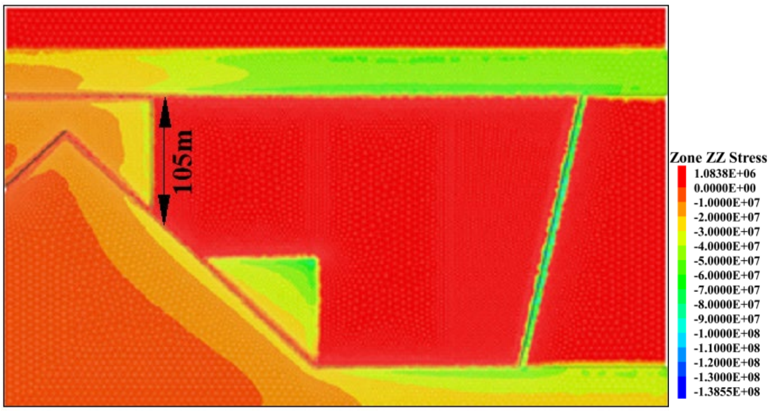
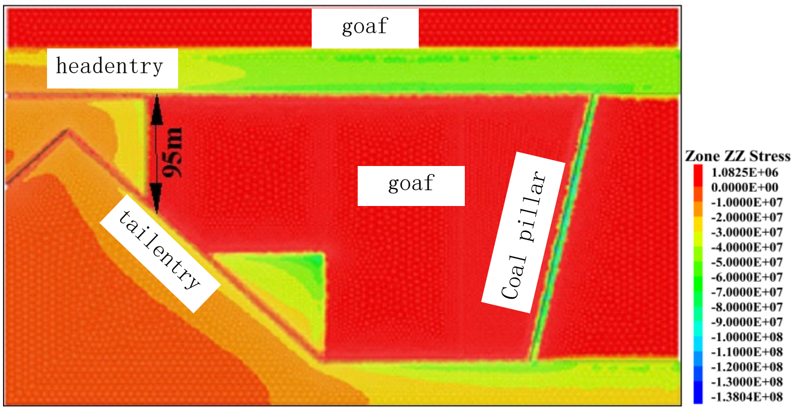
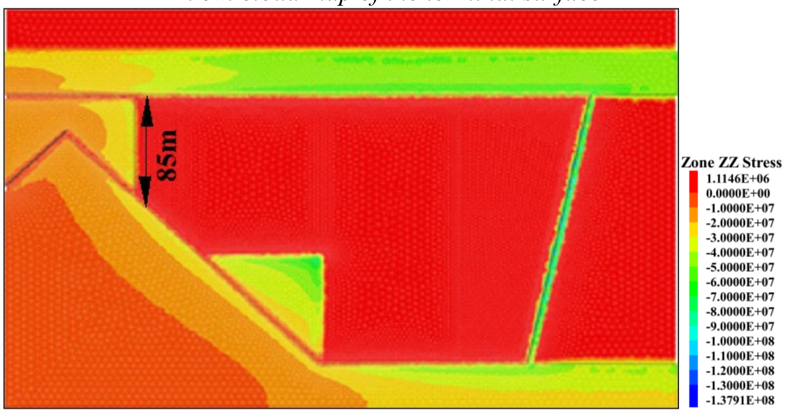


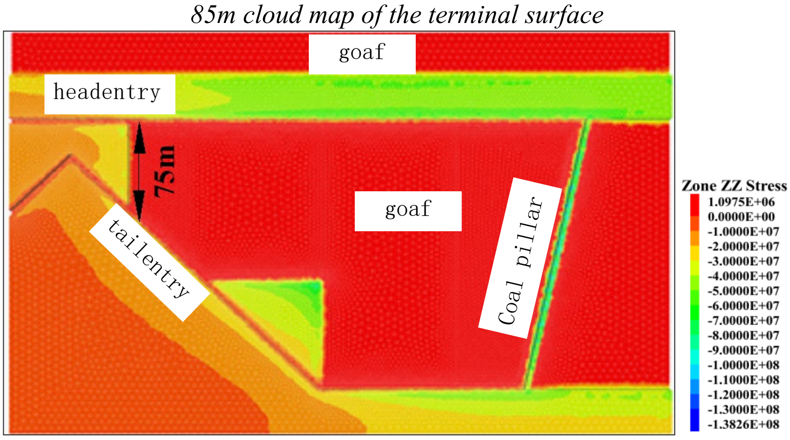
105m cloud map of the terminal surface



95m cloud map of the terminal surface



85m cloud map of the terminal surface



75m cloud map of the terminal surface

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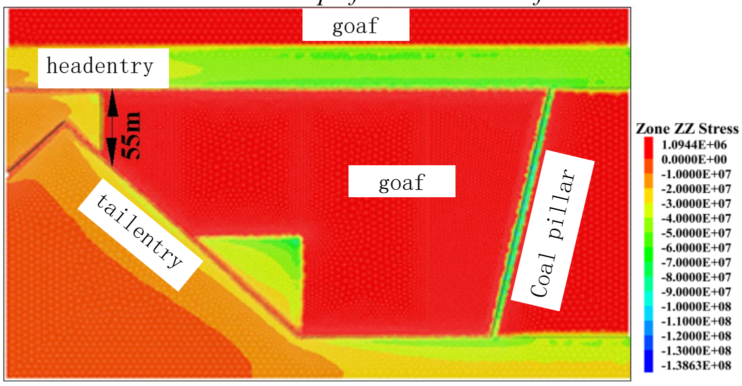
65m cloud map of the terminal surface



55m cloud map of the terminal surface

Figure 3: Cloud Map of Long Stress Evolution in Different Stopping Mining Faces

Table 1: Long peak stress at different terminal surface

terminal surface length/m	55	65	75	85	95	105	115	125	135	145
Peak stress /MPa	44.4	42.6	40.0	36.0	35.3	34.8	34.2	33.8	33.6	33.5

The evolution of peak stress for different face lengths is shown in Figure 3. The peak overrun support pressure for 55m terminal surface, 65m terminal surface, 75m terminal surface, 85m terminal surface, 95m terminal surface, 105m terminal surface, 115m terminal surface, 125m terminal surface, 135m terminal surface and 145m terminal surface lengths are 44.4MPa, 42.6MPa, 40.0MPa, 36.0MPa, 35.3MPa, 34.8MPa, 34.2MPa, 33.8MPa, 33.6MPa and 33.5MPa, respectively. Statistical analysis shows that the peak overrun support pressure is larger when the terminal surface length is less than 85m, and it changes significantly with the location of the stopping line, as shown in Table 1. Compared with 55m terminal surface, 65m terminal surface and 75m terminal surface, the peak pressure at 85m terminal surface length is reduced by 18.9%, 15.5% and 10.0% respectively, which is a significant reduction. When the terminal surface is longer than 85m, the peak pressure basically tends to stabilize, and when the terminal surface length is longer than 85m, the further increase of the terminal surface length has little effect on the roof stress. In view of this, it is determined that the length of the terminal surface should be greater than 85 m. Considering the influence of periodic pressure, in addition to the length of the terminal surface is greater than 85 m, the specific location should be pushed past the fracture position of the old top rock beam of periodic pressure by 2~3 m.

4. Conclusion

In this chapter, in view of the determination of the reasonable terminal line position in 7311 working face, FLAC3D numerical simulation method is used to establish ten numerical models with different terminal face lengths, and the evolution law of roof stress is compared and analyzed. It is found that when the terminal face length is less than 85m, the roof stress concentration degree is high and the peak stress changes obviously with the change of terminal face length. When the terminal face length is more than 85m, the change of terminal face length has basically no influence on the roof stress. The peak stress fluctuates in a small range, and it is finally determined that the length of the on-site terminal face is more than 85m. At the same time, the terminal line should push through the periodic weighting position for 2~3m.

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