Numerical Study on Reasonable Entry Layout of Lower Seam in Multi-seam Mining

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Abstract: According to the geological conditions of 6# coal seam and 8# coal seam in Xieqiao Coal Mine, reasonable entry layout of lower seam in multi-seam mining has been studied by FLAC3D numerical simulation. Three ways of entry layout including alternate internal entry layout, alternate exterior entry layout and overlapping entry layout has been put forward for discussing on reasonable entry layout. Then stress distribution and displacement characteristics of surrounding rock have been analyzed in the three ways of entry layout by numerical simulation, leading to the conclusion that alternate internal entry layout pattern, which make the entry located in stress reduce zone and avoid the influence of abutment pressure of upper coal seam mining to a certain extent, is a better choice for multi-seam mining. The research results herein can offer beneficial reference for entry layout with similar geological conditions in multi-seam mining

Keywords: multi-seam; entry; entry layout;numerical simulation

1. Introduction

In the course of gently inclined multi-seams mining, it is very necessary to take into account not only the influence of the below coal seam mining on the upper coal seam, but also the impact and damage of the upper coal mining on the lower coal seam[1-2]. When the upper coal seam has been mined, the stress distribution in the overlying rocks of the lower coal mining will be more complex [3]. Along with the improve of the mechanized degree of mining and the increase of mining depth, mining-induced influence between multiple coal seams are worsening gradually, which result in not only increasing difficulty of entry maintenance, but restriction to the product capacity and raising security risks of mining. In this paper, as the engineering background of working faces of 6# seam and 8# seam in Xieqiao Coal Mine, the selection of entries' reasonable location under the mining of gently inclined multi-seams was systematically studied by employing FLAC3D numerical simulation. This provides an important theoretical reference and practical guide for reasonable entry layout of seam 6# and 8# in Xieqiao Coal Mine. Meanwhile, it is also beneficial for entry layout of multi-seams mining with similar geological condition.

2. The Geological Conditions of the Working Face

In Xieqiao Coal Mine, face13118, with a strike of 1551*m* and an inclination of 209.7*m* , is the first working face of 8# coal seam The coal seam at an average angle about 12.1° is stable and simply structured , and ranges from1.19m ～ 5.87*m* in thickness with an average of 3.25m .Face 13116 of 6# coal seam, with a strike of 1350*m* and an inclination of 240.1*m*, is under the face 13118, and at a depth of 610*m* buried. 6# coal seam is also simply structured and stable, and the upward distance from 8# coal seam ranges between 16.1*m*～57.5*m* with an average of 32.8*m*. The coal seam is at an average angle of 11.3° and with an average thickness of 2.8*m*. The relative position of face 13118 and face 13116 is shown in Figs.1.

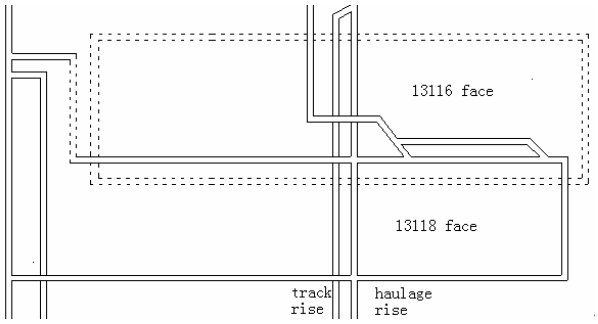


Fig.1 Production system of 13118 face and 13116 face

3. To determine mechanics parameters of rock mass

In recent years, remarkable advances have been made in in-situ test technology of mechanics parameters of rock mass, but which is not perfect. What's more, the cost of in-situ test technology is very high, so it cannot completely instead of test in lab at the present time. For there many differences of rock block and rock mass in many respects, especially in intercalated weak layer, fault and

Supported by Higher specialized research fund project for the doctoral program (200803610001),the Key Project of Science and Technology of Anhui Educational committee(KJ2010 A081) and Project of Huainan City(2009A05015).

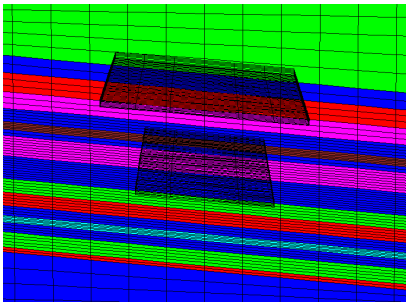
crack, mechanics parameters of rock test in lab is greatly different from its actual values of rock mass. If mechanics parameters of rock test in lab is directly used to simulation calculation, it will make an unbelievable result. In order to make calculation result nearer the truth, revising the parameters of rock test in lab is one of the key steps for numerical simulation. In the study, Elastic modules of rock mass was revised to 1/10 elastic modules of rock tested in lab. Mechanics parameters of rock numerical calculation by Mohr-Coulomb criterion needs are finally determined shown as table 1.

Table.1 Mechanics parameters of rock mass

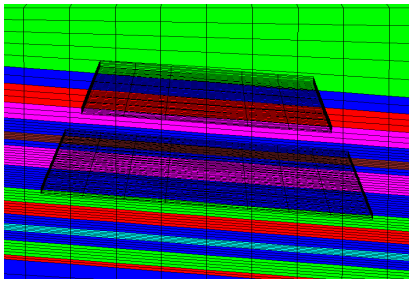
Lithology		Density (kg/m^3)	Bulk Modulus (GPa)	Shearing Modulus (GPa)	Cohesion (MPa)	Angle of internal friction (°)	Uniaxial compression strength (MPa)
Roof of 8# Coalseam	Fine sandstone	2870	21.006	13.522	3.2	42	1.29
	Mudstone	2464	5.12	4.73	1.2	30	0.605
	Siltstone	2560	10.833	8.125	2.75	38	1.84
	Sandy mudstone	2530	6.076	3.47	2.45	40	2.01
	Mudstone	2488	9.97	7.35	1.2	32	0.58
Coal seam	8#coal seam	1380	4.907	2.008	1.25	32	0.15
Between 6# coal seam and 8# coal seam	Mudstone	2461	5.12	4.73	1.2	30	0.605
	Sandy mudstone	2530	6.076	3.47	2.45	40	2.01
	Fine sandstone	2870	21.006	13.522	3.2	42	1.29
	Sandy mudstone	2510	6.076	3.47	2.16	36	0.75
	Sandstone	2587	12.22	10.785	2.06	40	1.13
	Mudstone	2461	9.97	7.35	1.2	30	0.605
Coal seam	6#Coal seam	1380	4.907	2.008	1.25	32	0.15
Floor of 6# coal seam	Mudstone	2460	5.12	4.73	1.2	32	0.58
	Fine sandstone	2870	21.006	13.522	3.75	38	1.84
	Sandstone	2580	12.22	10.785	2.5	42	3.6
	Sandy Mudstone	2530	5.968	6.01	2.45	40	2.01

4. Scheme of numerical simulation

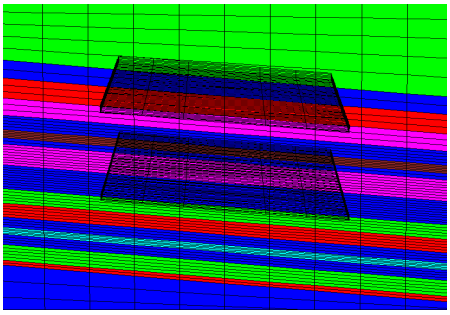
In order to reduce the mining-inducing influence of the face of the upper coal seam on the face of lower coal seam and realize safety and high efficient mining, reasonably entry layout and mining sequence need to be solved firstly. In this paper, three schemes [4] of numerical simulation for entry layout (namely alternate internal entry layout patter, alternate exterior entry layout pattern and overlapping entry layout pattern) are discussed to study on reasonable entry layout. As shown in Fig. 2, in the way of alternate internal entry layout, entries of lower coal seam are laid inside of the face of upper coal seam. Inversely, entries of lower coal seam are laid outside of the face of upper coal seam, namely under district coal pillar, in the way of alternate exterior entry layout. Overlapping entry layout is just what the name implies: the entries in the face of upper coal seam and the face of lower coal seam are vertically overlapped, and the two faces are with the same length.



(a) Alternate internal entry layout



(b) Alternate exterior entry layout

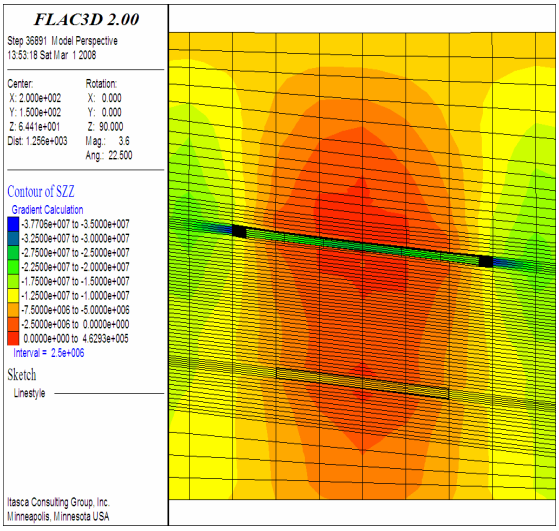


(c) Overlapping layout

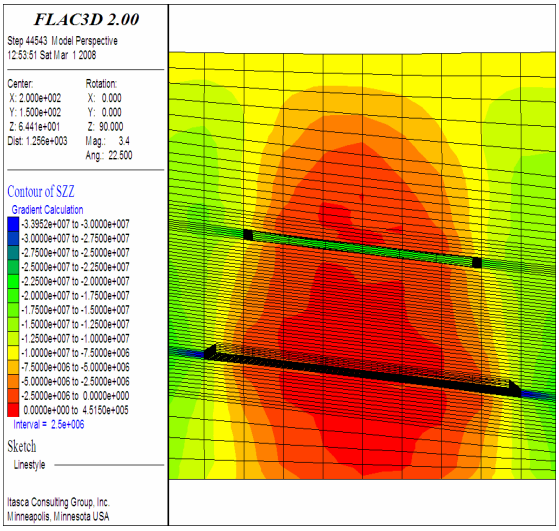
Fig.2 schemes of numerical simulation for entry layout

5. Analysis of the results

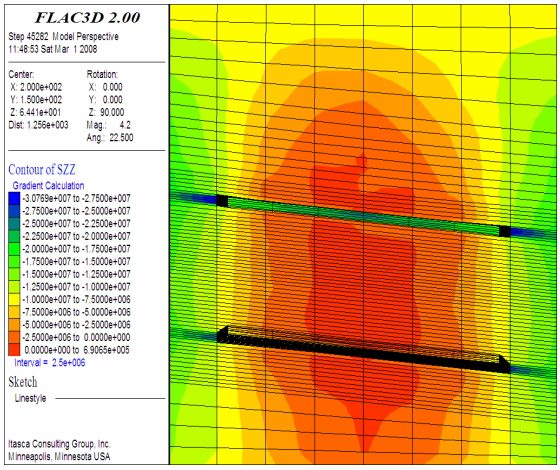
5.1. Characteristics of stress distribution in the different ways of entry layout



(a) Alternate internal entry layout

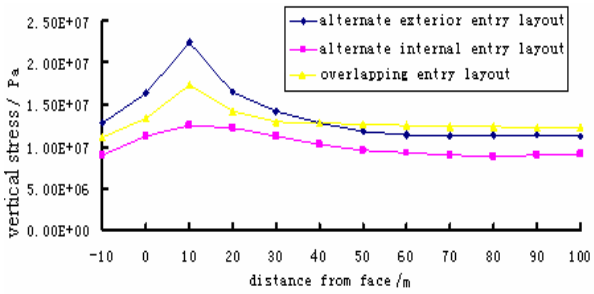


(b).Alternate exterior entry layout

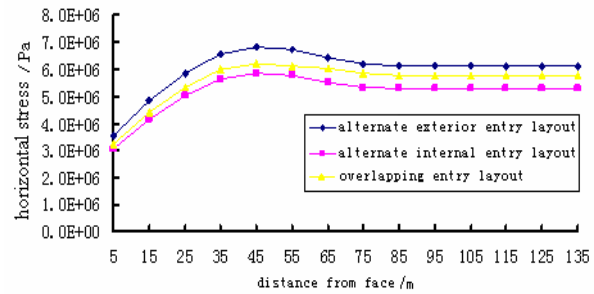


(c) Overlapping entry layout

Fig.3 Vertical stress distribution in the different ways of entry layout



(a) Vertical stress distribution



(b) Horizontal stress distribution

Fig.4 curve of stress in the different ways of entry layout

Alternate internal entry layout: As shown in Fig. 3(a) and Fig.4, vertical stress and horizontal stress of surrounding rock of entries are both lower. As the working face of advance, the variation scope of stress in entries is smaller, and stress concentration is not apparently.

Alternate exterior entry layout: As shown in Fig. 3(b) and Fig.4, vertical and horizontal stress in roof and floor of the entry are both greater. By analysis on abutment pressure of the above face, it is not difficult to find the

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cause of the higher stress. The abutment pressure at the bottom side of the above face was transferred to the bottom of district coal pillar, so a high stress zone was formed. The entries of the lower coal seam (6#) are just laid in the high stress zone.

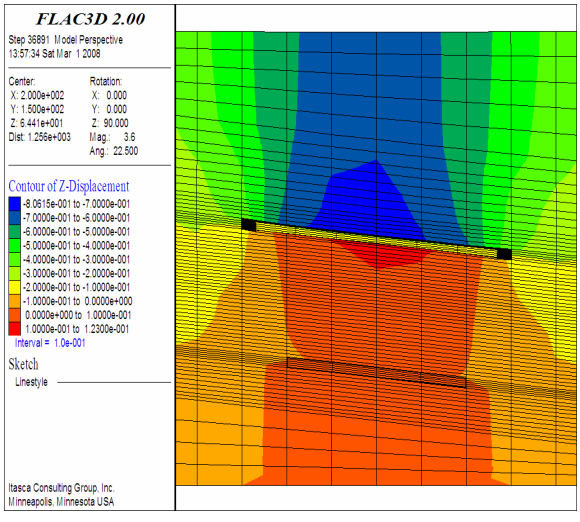
Overlapping entry layout: As shown in Fig. 3(c) and Fig.4, the entries of the upper face and lower face are all in high stress zone.

5.2. Characteristics of deformation in the different ways of entry layout

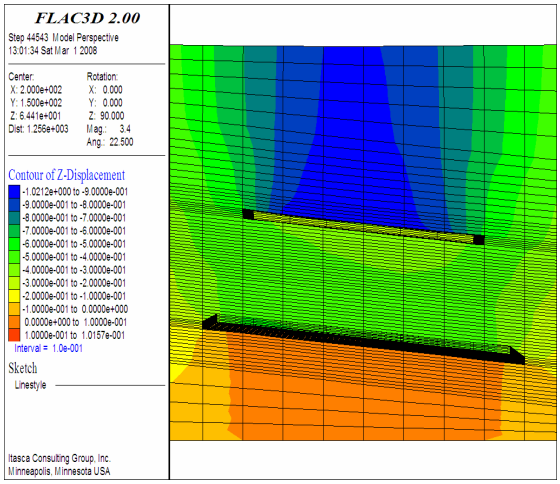
Alternate internal entry layout: Vertical displacement of measure points in roof and floor of entries is very small when they are far away from the working face. As the working face advances, vertical displacement of roof and floor and two sides of entries increases gradually, but increase rate of which is less. 10~15*m* in front of the face, the displacement of entries reaches maximum, only 7.8*cm* shown in Fig. 5(a) and Fig. 6. All this have corroborated that entries of lower coal seam is laid beneath the goaf of upper coal seam, where lower stress zone is.

Alternate exterior entry layout: As shown in Fig. 5(b) and Fig. 6, roof convergence and two sides convergence increase with the working face advancing. As the working face advances to 30~40*m*, vertical and horizontal displacement of entries increases dramatically and that result in serious deformation and failure of the entries.

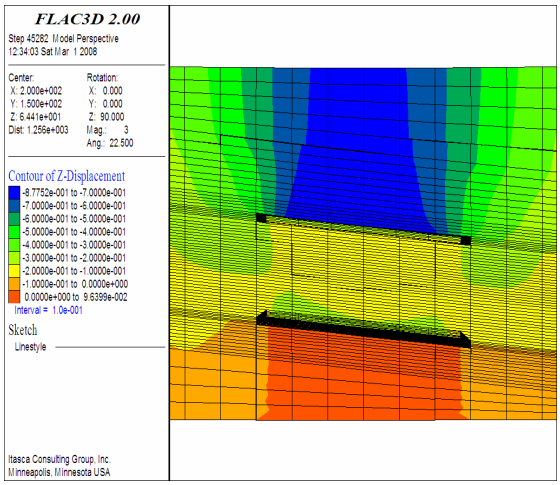
Overlapping entry layout: As shown in Fig. 5(c) and Fig. 6, deformation law of entries in the way of overlapping entry layout is basically consistent to its law in the way of alternate exterior entry layout. With the working face advancing, roof convergence and two sides convergence gradually increases. After measurement points 50~60*m* far away from face, vertical and horizontal displacement of entries increases observably.



(a) alternate internal entry layout

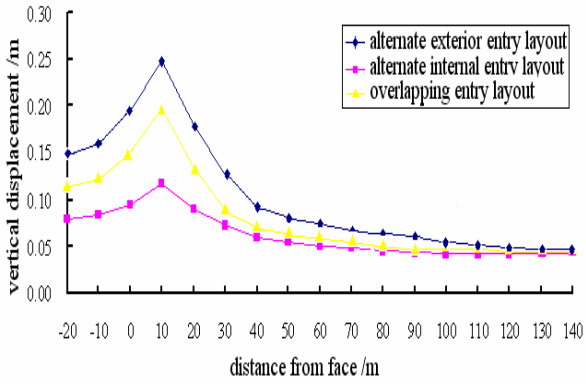


(b) alternate exterior entry layout

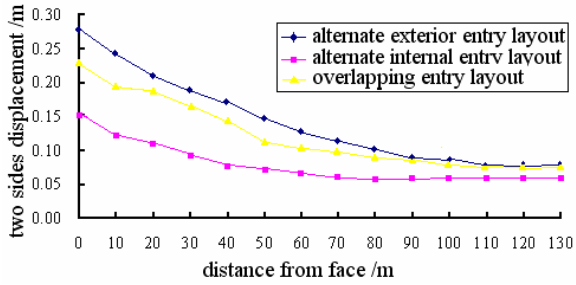


(c)Overlapping entry layout

Fig.5 Displacement distribution in the different ways of entry layout



(a)Vertical displacement distribution



(b)Horizontal displacement distribution

Fig.6 Curve of deformation in the different ways of entry layout

6. Conclusions

Known from the analysis of numerical simulation result, as for multi-seams mining, in the way of alternate internal entry layout, entries of lower coal seam is located in the stress reduced zone and entries is easy to maintain. If the way of alternate exterior entry layout or overlapping entry layout is adopted, entries of lower coal seam will be located in the stress concentration zone where abutment pressure of upper working face transfer downward. Then the entries pressure will be apparently presented and the deformation of entries will be greater. Up to now, the mining practice of face13118 and face 13116 in Xieqiao Coal Mine and field measurement have given a consistent result to numerical simulation.

References

[1] Li Quansheng, Zhang Zhongwen, Nan Peizhu. Mining impact pattern of multi-coal seam. Journal of China Coal Society, 2006, 31(4):425～428.

[2] Liu Hongyuan, Tang Chun'an, Rui Yongqing. Numerical simulation of strata failure process with multi-coal strata mined. Chinese Journal of Rock Mechanics and Engineering, 2001, 20(2):190～196

[3] XIA Xiaohong, SUI Wanghua,YANG Weifeng. Model test and numerical simulation of overburden failure process in multi-coal seam mining. Journal of Engineering Geology.2008, 16(4):529～531

[4] ZHAO Qifeng. Study on the Stress Field and Movement Laws of Overlying Strata in Gently Inclined Multi Coal Seams Mining.Huainan: Anhui University of Science and Technology.2007, 6.

978-1-935068-25-9