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Numerical simulation research on influence to fault based on thick coal seam mining

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Abstract: In order to find out the influence to fault based on fully-mechanized sublevel caving of thick coal seam, the software UDEC was used to establish the numerical model. The measuring points were arrangeed on the coal seam roof every 100m to monitor the relative displacement of upper wall and footwall under the condition of different working face mining. The result shows that all faults were influenced by mining activities, the top and bottom of formative fault space are small and the middle was large. The space of fault close to the working face was large. By the influence of two working face repeating mining, the space of fault close to the working face was compacted, and the space of fault which is far from working face have the trend of development. The fault space provides the space to storage water and become to hidden danger of water disaster.

Introduction

The surrounding rock was regard as homogeneous mass in large underground excavation (the mining engineering), the research of this rock movement deformation law was relatively mature [1-2]. But, the research achievements based on homogeneous mass was no longer applicable when fault around the excavation area. The special strata movement rule appeared near to the fault, and the fault "activation" was involved [3]. Fault "activation" was produced by fault under the condition of mining, the characteristic of no permeability or low permeability in the original state was changed, and the conductivity was enhanced to be a water inrush channel [4]. According to statistics, 38.7% of water inrush that the value more than 600 m^3/h in China were induced by water transmitting fault, among them, the percentage of water inrush induced by fault "activation" was 20% [5]. It is hard to predict this type of water inrush, and this type of water inrush is a major threat in the process of mine construction and production.

From 2007 to 2011, there were two water inrush in Laohutai coal mine, the accident working face were located in footwall of fault, and near to the fault. In order to find out the mechanism of water inrush, the influence to upper wall and footwall of fault and the characteristic of fault space under the condition of working face mining need to be analysis.

The profile of mine and working face

The condition of coal mine and geology

Laohutai coal mine was exploited in 1907, and with one hundred years history of mining. The mine developed with inclined and vertical shaft, there are 7 air-inlet shaft and 4 air-outlet shaft. The first coal seam was mined, and the thickness of first coal seam is 0.6~110.5m, the average thickness is 55~75m. The changing rule of the first coal seam is that thickness of coal seam in western is thicker than in eastern.

The profile of working face

The working face 68002 is located in footwall of fault F18, southern flank of the syncline axis. The width of working face is 120m, and the length is 470m.

The working face 73003 is located in the central of coal field, the length is 650m. The width of eastern is 80m and the width of western is 100m.

The numerical simulation of influence to fault of thick coal seam mining

The numerical simulation model

The section 6250 was selected to be the main section of model, and the gray area was model range. According to the research purpose, the gray area was simplified slightly. The numerical simulation model was established on the basis of figure 1. The length of model is 2000m and the height is 759.77m. The strata of the model were hierarchical processed and shown in figure 2.

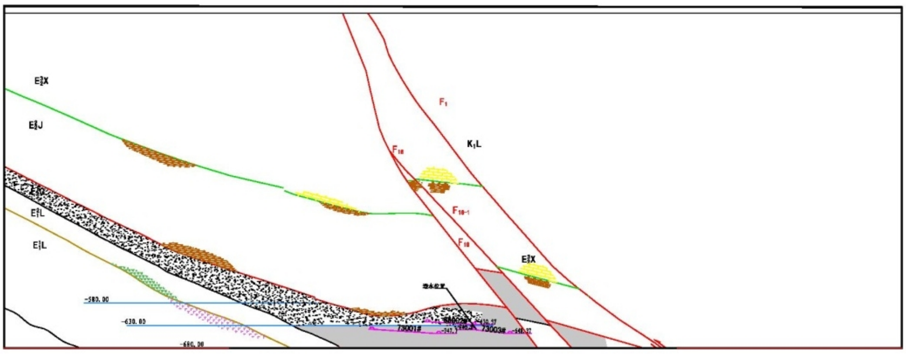

Fig.1 The reference figure of numerical simulation model in the profile 6250

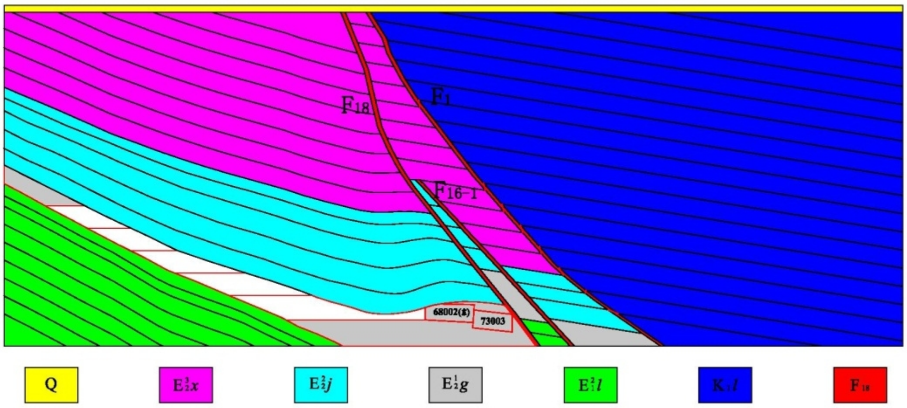

Fig.2 The classification figure of numerical simulation model in the profile 6250

The model was established by software UDEC, and the mesh unit was divided by irregular triangle. In order to analysis the deformation of overlying rock, yield and failure state, on the basis of the physical and mechanical properties of each rock strata, thickness and the different load condition, the density of unit division was different. The mesh division of model was shown in figure 3. Mohr - coulomb model was selected to be constitutive relation of model block, and the coulomb model of surface contact was selected to be constitutive relation of joint.

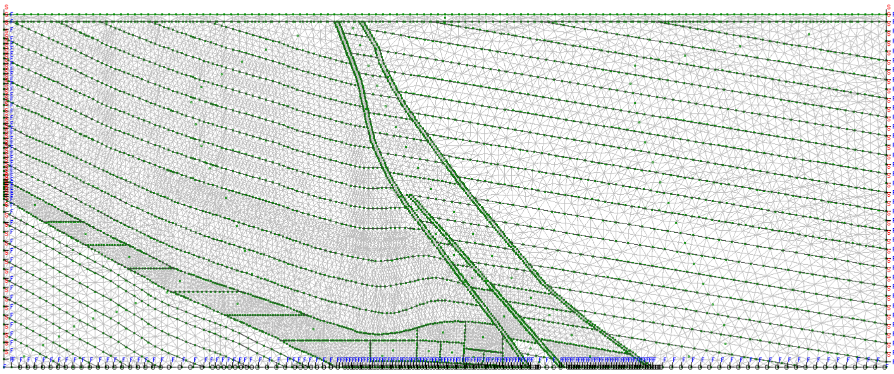

Fig3 The numerical simulation model figure in the profile 6250

The parameters of physic and mechanics and boundary condition

According to the data of rock mechanics properties test and the parameters adopted by the previous simulation experience, the parameters were determined (table 1).

Table1 The coal, rock physical and mechanical parameters of numerical simulation model

Lithology	Gravity density (kg/m^3)	Elasticity modulus (MPa)	Compressive strength (MPa)	Tensile Strength (MPa)	Poisson's ratio	Cohesive force (MPa)	Internal friction angle (°)
Green shale	2453	14920	26.3	+	0.21	4.0	50
Oil shale	2189	1170	5.5	1.01	0.24	1.1	44
Coal seam	1220	3350	17.3	2.98	0.28	3.4	42
Muddy limestone	2712	44768	40.1	4.60	0.22	6.8	54
Glutenite	2552	17885	23.0	1.52	0.18	3.0	57
Fault	2189	1170	5.5	1.01	0.24	1.1	44
Unconsolidated stratum	2189	1170	5.5	1.01	0.24	1.1	44

According to the actual situation, the boundary constraint of model was determined as follows:

(1) The bottom boundary of model was simplified as the displacement boundary, and can be moved in the x direction. The direction of y was fixed and v=0;

(2) The top boundary of model was the free boundary;

(3) The left and right boundary of model were simplified as the displacement boundary, and can be moved in the y direction, the direction of x was fixed, u=0.

When the model was mined from top to bottom, the white area in the figure 2 was mined by 5 steps, then the working face 68002 and 73003 were mined in turn.

The displacement of upper wall, footwall of fault and characteristic of fault space

The measuring points were arranged on both side of the fault to monitoring the displacement of the upper wall and footwall. The measuring points were arranged every 100m from coal seam to the top of fault. When the fault extension was limited, the spaces of measuring points were adjusted appropriately. The measuring points of upper wall and footwall of fault were located in the same horizontal plane. The measuring points arrangement were shown as figure 4.

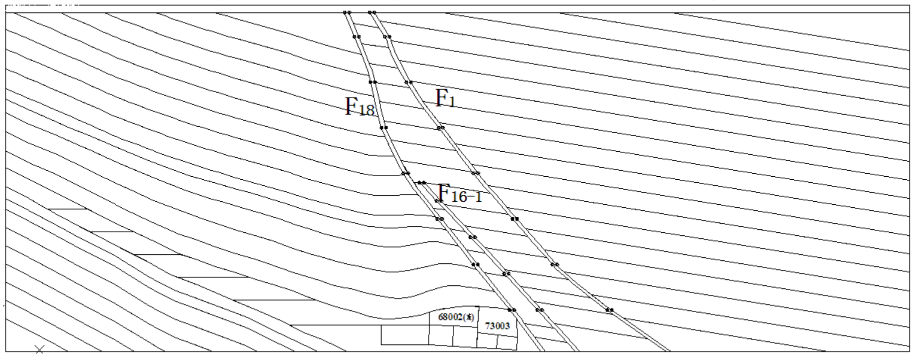

Fig.4 The arrangement figure of measuring points in the profile 6250

According to the analysis results of the numerical simulation, the relative displacements of fault F18, F16-1 and F1 upper wall and footwall were shown in the figure 5. After the working face 68002 mining, the relative displacements of fault F18 upper wall and footwall were larger than fault F16-1 and F1, the maximum value is 0.85m (400m from coal seam roof). The second was the relative displacement of F1 upper wall and footwall, the maximum value is 0.09m (600m from coal seam roof). The relative displacement of fault F16-1 was minimum, the maximum value is 0.04m (160m from coal seam roof). The fault F18, F16-1 and F1 upper wall and footwall were moved in the different extent. Because of fault F1 upper wall is cretaceous glutenite aquifer, the space between upper wall and footwall was recharged by aquifer, and to be a good storage space.

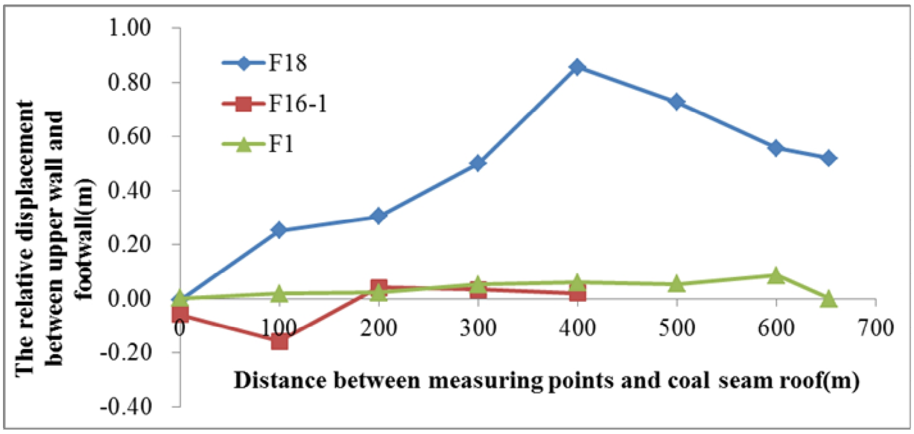

Fig.5 Relative displacement of each fault upper wall and footwall after the working face 68002 mining

According to the analysis results of the numerical simulation, the relative displacements of fault F18, F16-1 and F1 upper wall and footwall were shown in the figure 6. After the working face 73003 mining, the relative displacements of fault F18 upper wall and footwall were larger than fault F16-1 and F1, the maximum value is 0.84m (400m from coal seam roof). The second was the relative displacement of F1 upper wall and footwall, the maximum value is 0.13m (200m from coal seam roof). The relative displacement of fault F16-1 was minimum, the maximum value is 0.03m (240m from coal seam roof).

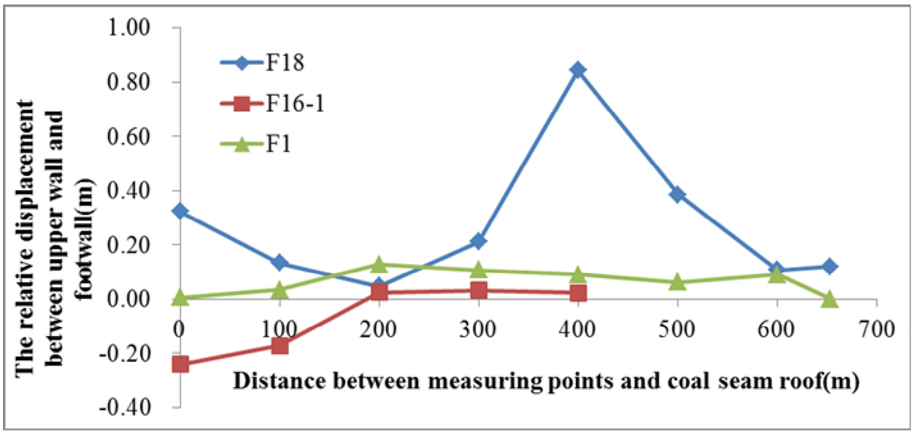

Fig.6 Relative displacement of each fault upper wall and footwall after the working face 73003 mining

Conclusions

(1)The influence to fault based on fully-mechanized sublevel caving of thick coal seam, the fault spaces of each fault was appeared in different extent. The top and bottom of space were small and the middle was large;

(2)Fault space of F18 that closest to the working face was the largest, the second was F1 that farthest from working face. The large fault is most affected by the excavation.

(3)Under the condition of coal seam repeating mining, the fault space of F18 that closest to the working face is become smaller, and the fault space of F1 that farthest from working face is become larger.

Acknowledgements

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