Simulation Test Study on Similar Materials of Fully Mechanized Mining Face Overlying Strata

Huang Xuchao[1, 2, a, *]

[1]Gas Research Branch, China Coal Technology Engineering Group Chongqing Research Institute, Chongqing 400037, China

[2]State Key Laboratory of the Gas Disaster Detecting Preventing and Emergency Controlling, Chongqing 400037, China

[a] 38409031@qq.com

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Abstract: Influenced by multiple factors such as coal seam dip angle and geological structure, the overburden structure of large dip angle coal seam mining is a complex, dynamic and nonlinear space problem. In this paper, the large-scale overlying strata structure of the large inclined coal seam stope is taken as the research object. Through the similar material simulation method, the law of overburden migration is studied. It is concluded that there is a large and small period of pressure on the working face, and the top plate is pressed for the first time. It is not the most intense; with the advancement of the working surface, the bedrock layer first appears to be separated from the layer, and then falls again. There is no linear relationship between the height of the fallen layer and the height of the separation layer and the advancement distance of the working surface, but a step-like ascending curve. The results obtained can be used as the basis for field measurement research and data method analysis design research.

1. Introduction

For the study of the movement and failure law of the overlying strata after mining, especially for the rock mechanics problems involving elastoplasticity, crushing, slumping and various physical and mechanical processes, in the study with qualitative as the main target, similar materials are used to simulate[1].It is often more effective. Similar simulation experiments were proposed by the former Soviet Union Kuznetsov in the 1930s and applied in the mine measurement and coal research institute. It is also widely used in Germany, Poland, Japan, Australia, and the United States. Up to now, it has become an important research method in foreign mining industry [2-3]. In the study of coal mining problems using similar material simulation experiments, Chinese scholars have also achieved certain results [4~6].

2. Similar model design and production

2.1 Similar model design and production

The test is based on the fully mechanized mining face of B8 coal seam in Xiaogou Mine of Nanshan Coal Mine. According to the mine data and field investigation, the working face is 950 m long, with a tendency of 114-136 m long and a cutting length of 114 m. Coal seam thickness: generally between 2.23m and 4.79m, with an average thickness of 4.2m and a coefficient of variation of 45%. The coal seam is characterized by a coal seam of 320° in the working face, a tendency of 69°, and a dip angle of 38° to 42° in the working face, and the coal seam structure is also relatively stable.

This similar material simulation test uses a test bench size of 5 m × 2 m × 0.4 m and an effective height of 1.8 m. According to the actual mining of Nanshan Coal Mine, combined with the similar simulation test bench size and related data, the similarity constants in the test were comprehensively set.

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2.2 Similar material production

Arrangement of observation points

A 50 cm boundary is set, and 20 dial gauge points are arranged on the surface of the model. The distance between the measuring points is 20-40 cm, and the surface displacement is observed. A displacement of 35.8 cm of argillaceous siltstone at the bottom, 83.2 cm of coarse sandstone at the bottom, 111.7 cm of argillaceous siltstone at the bottom, and 141.6 cm of argillaceous siltstone at the bottom. The measuring line and the measuring line are arranged with 24 displacement measuring points respectively, and the measuring point spacing is 20 cm. The measuring lines are numbered from bottom to top, respectively, measuring line A, measuring line B, measuring line C, measuring line D, and measuring points from left to right. The right numbers are A0, A1, A2, A3, ..., A20, B0, B1, B2, B3, ..., B20, C0, C1, C2, C3, ..., C20, D0, D1, D2, D3, ..., D20. The dial gauge, line and measuring point arrangement are shown in Fig.1.

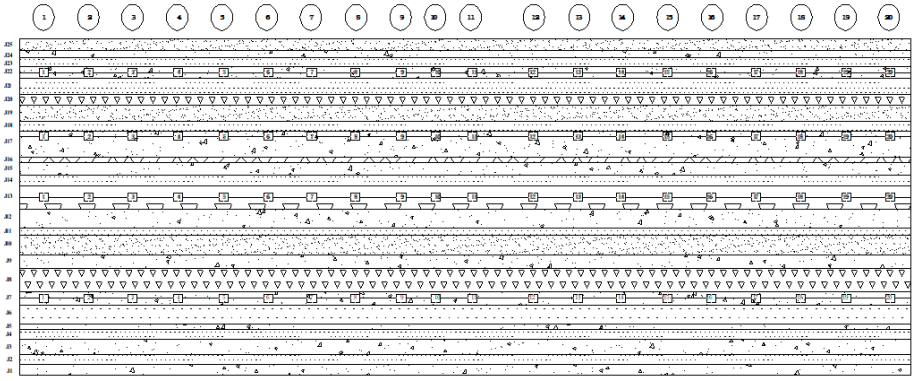


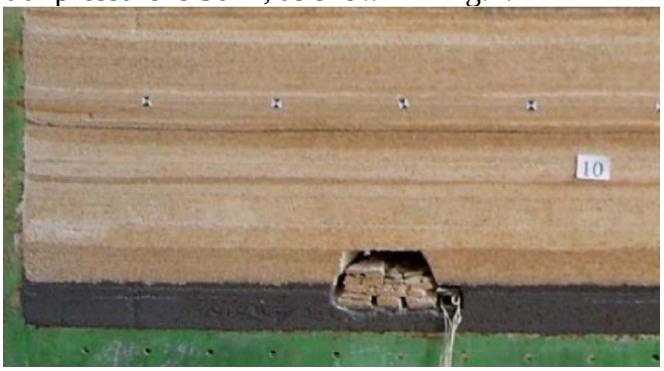
Fig.1 Dial indicator, line and measuring point layout

According to the experimental design, a 5m similar simulation model was paved, and the model was excavated according to the experimental scheme. As the mining progressed gradually, the roof gradually collapsed, and the measuring points on the model gradually shifted.

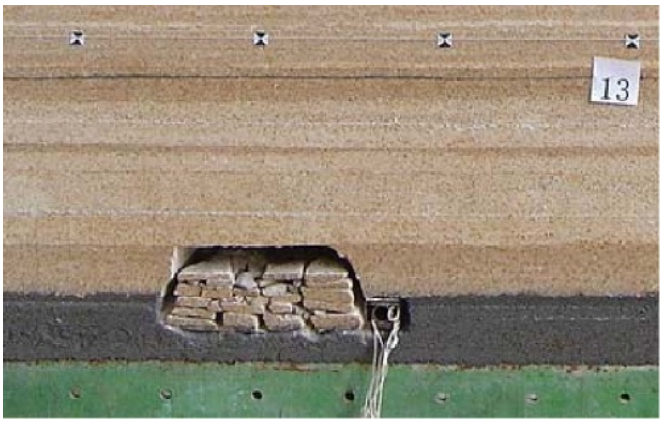
3. Test results and analysis

3.1 Bedrock movement and pressure law

(1) When the working surface is advanced to 50 m (corresponding model is 20 cm, for the sake of easy understanding, the following data are all converted into prototype data), the reading on the strain gauge changes drastically, indicating that the load on the bracket increases sharply, and the slump height is 13.75 m. The height of the separation layer is 16.25 m, and the top plate is pressed for the first time. The initial pressure is 50 m, as shown in Fig.2.



(a) The first pressure



(b) The first periodic pressure

(c) The second periodic pressure

Fig.2 Cycle pressure situation

(2) When the working surface is advanced to 65 m, the reading on the strain gauge changes sharply again, indicating that the load on the bracket is increased again, and the old top is again pressed. This is the first cycle of the old top, and the pressure step is 15 m. The drop height is still 13.75 m, and the echelon development height is 18.75 m. When the working surface is advanced to 80 m, the working face pressure rises sharply, the working face is pressed, the pressure step is 15 m, and the roof slump height is still 13.75. m, the height of the separation layer is 22.5 m, as the working surface continues to advance, the old roof continues to press for a period of 15 to 30 m.

3.2 Mining surface pressure law

The experiment uses the strain gauge to record the deformation on the simulated bracket, and then converts it into a load. For the sake of easy understanding, the experimental ore pressure data is all converted into the prototype value according to the hydraulic bracket selected on the working surface, then: the total average load of the bracket: 4882 kN / frame; load during the load of the bracket: 5997~ 7125 kN / frame, average load during the support pressure: 6658 kN / frame.

The working face has a large and small period of pressure, and the initial pressure of the top plate is not the most severe.

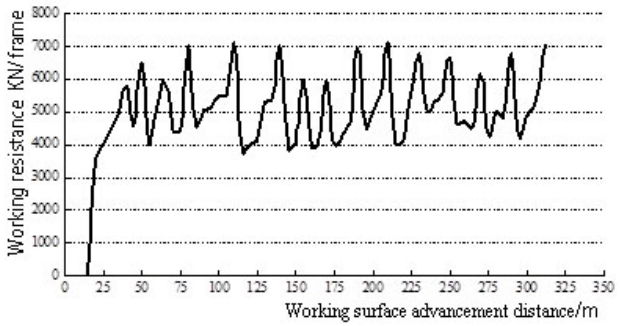


Fig.3 Simulated working surface top plate pressure and working surface propulsion diagram

4. Conclusion

(1) The simulation results of similar materials show that the initial pressure of the working face is about 50 m, and the first time of the old top is pressed when the working surface is advanced to 65 m. The pressing step is 15 m and the slump height is 13.75 m. The development height of the separation layer is 18.75 m; when the working surface is advanced to 80 m, the second period of the old roof is pressed, and the height of the separation layer is 22.5 m; as the working surface continues to advance, the old top continues to press. The step size ranges from 15 to 30 m. The working face has a large and small period of pressure, and the initial pressure of the top plate is not the most severe.

(2) The law of bedrock movement: With the advancement of the working face, the bedrock layer first appears to be separated from the layer and then collapsed. There is no linear relationship between the height of the fallen layer and the height of the separation layer and the advancement distance of the working surface, but a step-like ascending curve; When the working surface is pushed past the measuring point by about 75 m, the measuring point in the middle part of the bedrock located 70m away from the roof of the coal seam begins to sink obviously. The sinking at this stage has the characteristics of “slowing down and large amplitude”.

Acknowledgments

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