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Research on Supporting Safety of Gob Roadway in Coal Lane of Three Soft Strata

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Abstract

In this paper, through monitoring, analysis, simulation, test and other research means, in view of the three soft strata coal lane in the goaf roadway different support technology, select the best support scheme and support materials, forming a suitable for Xiao tun coal mine "three soft" formation coal lane along the goaf roadway effective roadway support technology; At the same time, it can also be used for guidance during similar roadway tunneling. Through the industrial experiment of an engineering example, the design of full-anchor grouting support is applied to an engineering example, and the field monitoring results are analyzed. The results show that the support design is safe and feasible.

Keywords

Three soft strata; Digging a lane along the gob; Roadway support technology.

1. Introduction

It is an effective measure to improve the recovery rate of resources and economic benefits to leave small coal pillars along the roadway [1]. Determine and lane in supporting design is influenced by geological conditions and the supporting effect, the mine roadway with soft surrounding rock roadway deformation, big, poor stability, mining influence etc., low bearing capacity of surrounding rock, the supporting is difficult [2], the roadway support body anchoring force quick recession, roadway frequent repair, undercover and expansion repair large quantities, supporting the cost is high, leading to coal seam roadway surrounding rock is hard to control, roof breakage [3], severely restricts the safe and efficient mining face, brings great hidden trouble for mine safety in production, need to support security research and supporting technology innovation.

2. Project overview

The roadway length is 830m. The main functions of the roadway are ventilation, transportation and stoping. The buried depth of the transportation roadway is 380m and the width of the small coal pillar is 6m. The roof and direct floor of the coal seam are respectively 2.2m argillaceous siltstone and 1.26m mudstone. The old bottom is 2.4m argillaceous siltstone, and the lithology of the roof and floor is relatively soft, which expands and softs when exposed to water. The surrounding rock of this mine is mostly mudstone and silty mudstone, with a total clay content of more than 50%. The surrounding rock is weathered and expanded when exposed to water or water absorption and floor heave. The coal seam is distributed with soft stratification with a thickness of 0-1.5m, which is a typical "three soft" stratum.

3. Supporting design of three soft coal seams along gob roadway

3.1 Roadway support scheme

The roof bolt is 22mm in diameter and 2400mm in length. Each row has 6 roots and the spacing between rows is 800×800mm.Help of composite grouting anchor rod before body segment Ø 22 mm

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in diameter, the backend diameter 25 mm; Length is 3400 mm; Install aperture Ø 32, built-in hole sealing hole sealing way. Roof resin anchor cable diameter 21.6mm, length 8000mm; Adopt "2-1-2" three-pattern layout. Roof bolt tray for grouting anchor cable 100×100×10mm;Side bolt tray 150×150×10mm;Roof net reinforced spot welding net;10# wire mesh shall be used on the side; Top net 4900 x 850 mm; Help net 3200 x 850 mm;W220/375 steel belt; Length is 4500 mm; At the same time two aided with steel beam and diamond mesh.

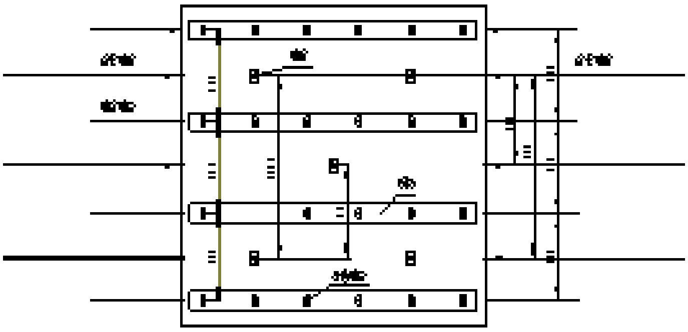

Figure 3-1. Layout plan

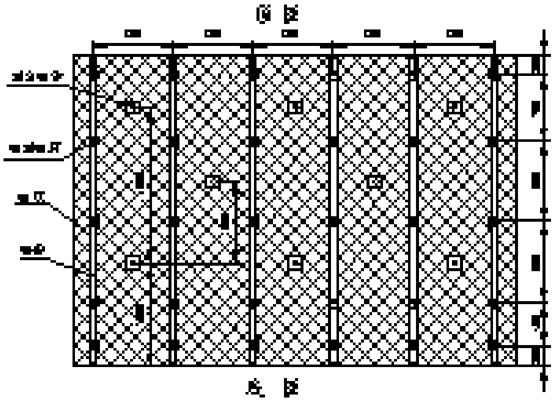

Figure 3-2. Support drawing of roadway side

3.2 Grouting anchor rod construction

A total of 48 rows of combined grouting bolts were constructed in the test section. In the first 25 rows or so, each row has 10 grouting anchor bolt, and the lower anchor Angle of the anchor bolt is 15-25°; Eight grouting bolts in each row of the rear 25 rows. The original 2.2m common bolt is used to tie the bolt at the local bottom of the first 25 rows. The rear 25 rows of grouting combination bolts are 8 in each row and 6 in each local row. The original 2.2m ordinary bolts are used for the bottom bolt. The first 25 rows, basically according to the test plan two side bolt layout construction; The last 25 rows belong to equal spacing combined grouting anchor construction.

4. Support effect test

4.1 Comparative analysis before and after strengthening support

Figure 4-1. The grouting support is neat along the empty side

4.1.1. Comparison of deformation conditions of the two sides

The net pocket appears along the goaf side of the original branch protector, and the drift moves from the middle to the bottom. The grouting support along the goaf is neat, and there is basically no net in the early grouting section, with a small amount of internal displacement. The side net appears in the original supporting solid coal part; The net of solid coal side of grouting support is basically absent.

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Water seepage is common from the middle to the lower part of the primary branch protector along the hollow side. The middle to the bottom of the grouting support is dry, without water seepage. This phenomenon already exists in front and back of the roadway in the test section, which indicates that the grouting cementing material has improved the anchoring performance of the bolt. The current heading head is more than 100m away from the test section, and the ore pressure has appeared.

Figure 4-2. Grouting support roadway roof

Figure 4-3. Grouting support floor

4.1.2. Comparison of roof deformation

The steel belt at the top of the original support roadway has been greatly bent, and there are large pockets and bolts moving out locally. The roof of the grouting support is neat with only small bending.

4.1.3. Contrast of floor heave

The roadway height in the test section is 3.0-3.3m. The height of the original supporting roadway is 3.0m.Due to floor heave, the height of part of the goaf roadway is only 2.0m at 100m from the vehicle yard, and the floor of the original supporting roadway is generally wet and soft. There is a lot of soft muddy water on the floor of the original supporting roadway. The bottom plate of grouting support is dry and hard.

Figure 4-4. Test section integrity roof

Figure 4-5. The test section is smoothed along the hollow

4.2 Effects of dynamic pressure in the test section

Under the influence of dynamic pressure, the height and width of the roadway in the test section were lower than that in the non-test section, and the roadway space was open. The roof of the test section is of good integrity, and the deformation of the shoulder nest is smaller than that of the non-test section. The surrounding rocks of the two sides of the test section are flat and the broken area of the net is much smaller than that of the non-test section. In the test section, the floor heave along the roadway was large in the middle and small near the two sides. The overall floor heave was not found in the test section.

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4.3 Test section multi-point displacement meter data detection and analysis

4.3.1. Monitoring results of deep surrounding rock deformation

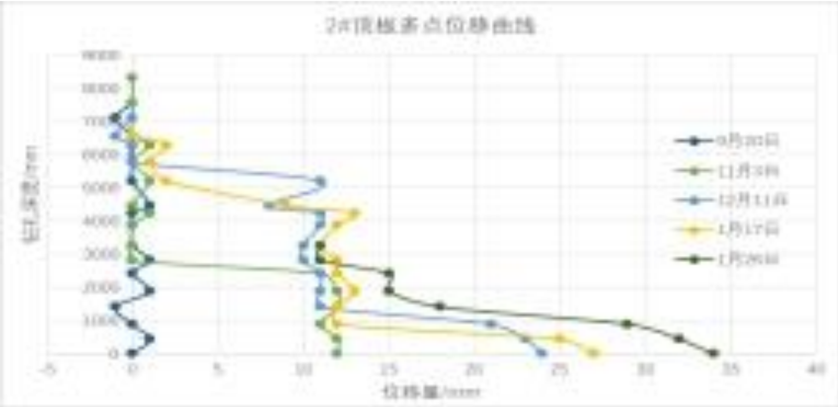

Figure 4-6. Multi-point displacement curveof 1# roof

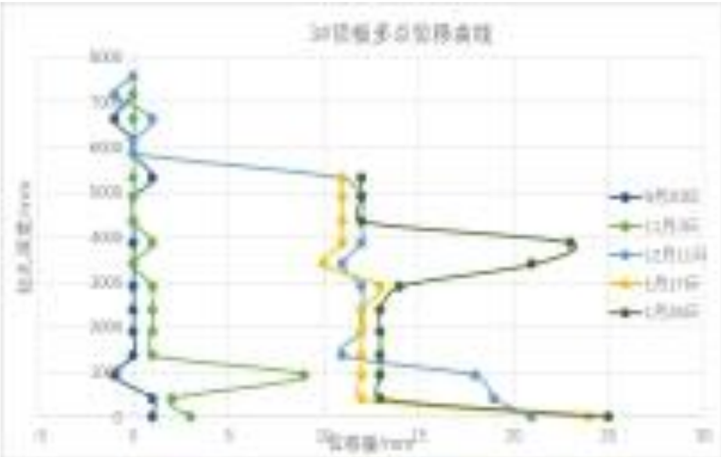

Figure 4-7. Multi-point displacement curveof 2# roof

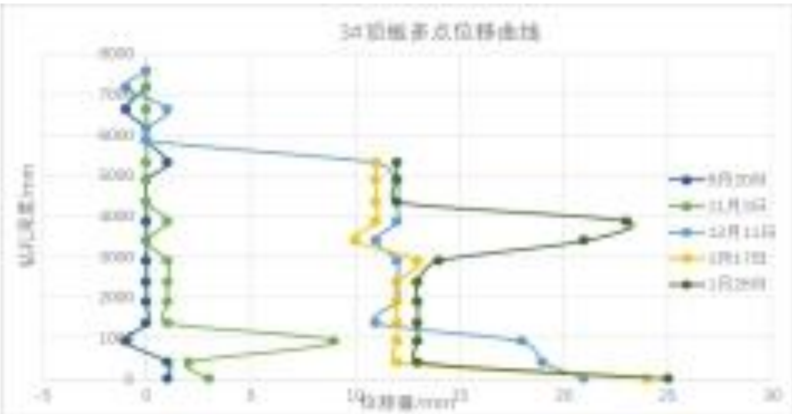

Figure 4-8. Multi-point displacement curveof 3# roof

The observed section 2# of the multi-point displacements meter is located in the middle of the test section, while the observed sections 1# and 3# are located at the front and back 20m of the test section respectively. The observation holes in the no.1 and No.2 solid coal sides of the observation sections were damaged in the later stage, and only part of the data were available. The coal body along the goaf has low strength and hole collapse phenomenon. The observed sections 1# and 3# cannot be detected due to borehole deformation and failure.

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(1) By comparing the multi-point displacement curves of the top plate of the observed sections 1#, 2# and 3#, the deformation of the top plate is similar: the borehole depth is 1.0m and the deformation is large, up to 10-15mm;The depth of borehole is 3.0m-4.0m, and there is a separation zone of about 10mm. The observation section 1 and 3 are very obvious. The observation section 2 has relatively small amount of two layers, only 4mm, due to the factor of two-side reinforcement. There is a separation zone of about 12mm at the depth of 5.5-6.0m.

(2) Compared with observation sections 1# and 3#, the roof displacement of test section 2# of the main roadway is within the action range of bolt within 1.0m, and the bolt support effect is good; The dissociation occurred only at 5.5-6.0m and the amount of dissociation was relatively small. According to the multi-point displacement curve, the failure of the roof and the integrity of the roof strata can be improved by increasing the strength and stiffness of the two sides.

(3) Time sequence of roof rock failure: In the first stage, the anchor rod plays its role in about 30 days. Firstly, displacement failure occurs in the rock layer near the anchorage scope of the anchor rod; in the second stage, the stratum is separated at 5.5-6.0m in about 60 days, and the anchor cable plays its role; in the third stage, the stratum is separated outside the anchorage area of the anchor rod, and the displacement of the roof increases.

The multi-point displacemet curves of the solid coal side on the observation surfaces 1#, 2# and 3# are shown in figure 4-9, 4-10 and 4-11.

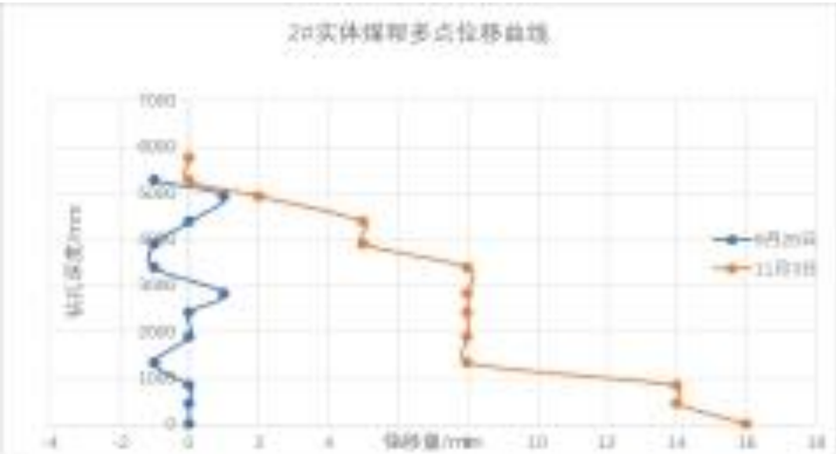

Figure 4-9. Multi-point displacement curveof 1# solid plate

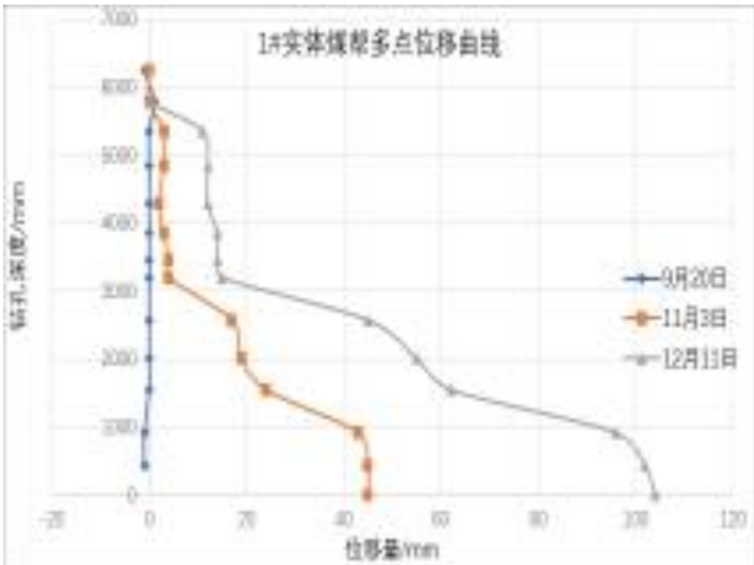

Figure 4-10. Multi-point displacement curveof 2# solid plate

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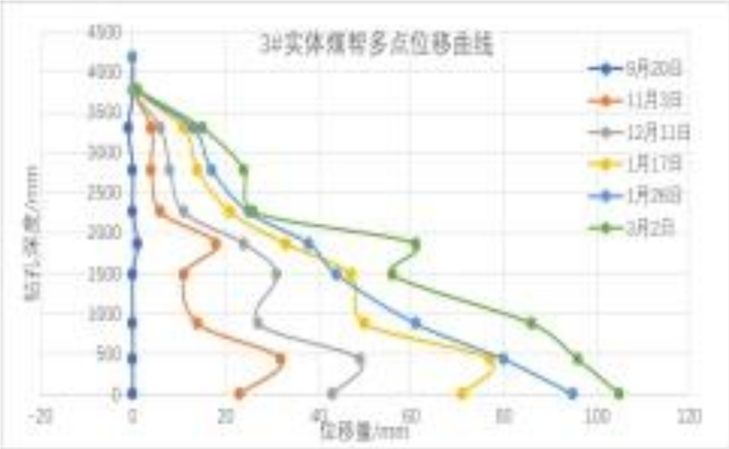

Figure 4-11. Multi-point displacement curveof 3# solid plate

(1) Observed multi-point displacement curve of section 3# solid coal side, the displacement of 4 months reaches 100mm, and the whole displacement of surrounding rock is within the range of 4.0m.The goaf roadway is located in the low stress zone, but due to the dynamic pressure of stoping in the previous working face, the coal body is relatively broken, rigid and weak. The goaf roadway was arranged in the surrounding rock with poor lithology, and the solid coal side deformation was large, up to 100mm.

(2) According to the observation data of 1#, 2# and 3# in the first two months, the deformation of the test section is small, and the deformation of the non-test section is not uniform. In other words, the deformation of the section with good surrounding rock is small, while that with bad surrounding rock is large. In other words, the deformation of the two sides is greatly affected by the nature of surrounding rock, and improving the integrity of surrounding rock through grouting can significantly reduce the deformation of solid coal side surrounding rock.

(3) From the analysis of test section 2, the combined bolt length is 3.3m, and the grouting section is 1.0m-3.3m, and the surrounding rock is basically not deformed, indicating that the bolt has a significant anchoring effect, plays a role of integral rock beam, and can reduce the failure of deep coal and rock mass.

5. Conclusion

(1) Grouting reinforcement has achieved remarkable effect along the goaf and the roadway deformation along the goaf is not affected by mining pressure, and the deformation of the roadway along the goaf is within the control range. The deformation of the roadway along the goaf and the floor is basically not deformed, and the deformation of the roof and floor is about 20cm, with remarkable effect.

(2) Grouting support to control the deformation and damage of small coal pillars and block the goaf water. Grouting support not only improves the anchoring force and reduces the damage of goaf roadway, but also fills some large cracks, preventing goaf water from flowing into goaf roadway.

(3) The most economical and effective way to control the bottom drum is to tie down the bolt. The construction quality of the tie down bolt is directly related to the control of the dropout quantity. Therefore, strict requirements should be applied to the tie down bolt construction to ensure the quality.

(4) Grouting in this mine can improve the anchoring performance of the anchorage material, which is suitable for early grouting and early reinforcement, and reinforcement support in later stage according to the deformation situation. The results of the field observation and industrial test of the support scheme along the goaf roadway show that the support scheme has a good supporting effect. It can ensure the stability of roadway surrounding rock roof and guarantee the whole excavation replacement, and has achieved remarkable technical, economic and social benefits.

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