Research on Special Support Technology of Gob-side Entry Retaining with Filling the Non-roadway Side in the Thin Coal Seam

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1. Introduction

The retention of coal columns will cause a large loss of coal resources, and the technology along the empty lanes has eliminated the protection of coal columns along the section, to a large extent, improve the recovery rate of resources [1-4]. Since the roadway along the goaf has to withstand the influence of secondary mining, the key to its success is the secondary support method and means [5-8]. China's technology along the empty lane developed in the 1950s, the main means of roadside support are stone stacking, wood-intensive pillars, and so on, and limited to the application of thin coal seams. By the 1970s, concrete blocks and dense pillars were used and applied to medium-thick coal seams. However, these lane side support has the disadvantages of insufficient support resistance, non-matchable performance, low degree of mechanization, labor intensity and poor air-sealing performance, which limit the use of the lane along the empty lane. The laneless filling technology is more used in thin coal seam mining because of its simple operation and low labor intensity.

In this paper, the application of the technology of filling along empty lanes without lanes is studied in a mining area of a mine 2 and coal seams.

2. Mine overview

The main coal seams of the mine are 2 coal and 2 lower coal. The 2 coal roof is a composite roof, the direct roof is gray massive siltstone with a thickness of 1.5m, the main roof is fine sandstone with a thickness of 10.2m, and the direct bottom is gray black siltstone with carbonaceous matter; the 2 lower...
coal pseudo roof is black soft carbonaceous mudstone with a thickness of 0.1M and unstable distribution. The direct roof is gray black siltstone with a thickness of 2.4m, the main roof is gray black medium fine sandstone with a thickness of 5.8m, and the direct bottom is gray black siltstone with a thickness of 4.6m.

The mining area is a single-winged mining area, divided into four sections. 2 coal and 2 lower Coal seam Top floor slate conditions are better, the top plate is a composite top plate, the direct top is gray block powder sandstone, the direct bottom is gray-black powder sandstone, containing carbon; the top floor is stable and stable, and the work surface is easy to maintain. In addition, hydrogeological aspects, the main water-filled factors, although 2 coal seam top sandstone aquifer, adjacent mining area west wing empty area, the surface has river currents, but because of the middle of the mud rock, sandstone and other water layers, therefore, has no impact on mining. The gas content of coal seam is low, there is no tendency of spontaneous combustion, and coal dust is not explosive.

As can be seen from the above analysis, the mining area section is small, such as according to the normal situation of the jumping arrangement will exist to the following problems [9-10]:

(1) Affected by adjacent mining, excavation time is limited, the working surface is difficult to achieve normal replacement.

(2) Small coal columns need to be retained and the excavation workload is large. In order to facilitate the maintenance of the back-mining laneway, the normal recovery needs to leave small coal columns to protect the roadway, which is also the traditional method of retaining coal columns. But this will greatly increase the amount of digging, but also reduce the recovery rate of coal.

(3) Affected by water accumulation in the upper mining area, the construction conditions are complex.

In view of the above characteristics, the mining area mining by way of no lane side filling along the empty lane.

3. along the empty roadway special support methods

3.1. One support in the alley

(1) Support form

One support of the laneway is supported by an anchor net. Select the appropriate anchor support parameters according to the actual geological conditions. According to the "Coal Lane Anchor Support Design Code" of Yantai Mining Bureau, the top anchor rod is made of high-strength left-hand threaded steel body with a high strength of 22, and the full-length anchoring of the resin dosage is chosen; The length of the anchor rod is taken 2000mm and the spacing is 700mm × 700m.

(2) Numerical calculation analysis

In order to further study the deformation law along the empty roadway and provide the basis for the design of its support scheme, a numerical simulation analysis of the support is carried out, and the results are shown in Figures 1 to 2.

From the numerical simulation results can be seen, after the roof support and the support of the alley gang, the amount of the top plate sink decreases, the amount of deformation of the alley gang is also reduced, fully explains that the anchor bar support, is to meet the requirements of a support.
3.2. Secondary support in the alley
The secondary support method depends on the specific geological characteristics of the coal seam. Since the coal seam in the mining area is thin coal seam, and the top floor slate strength of the coal seam is large, easy to support, therefore, can be used without lane side filling along the empty lane way, specifically: the front work surface to make up the anchor rope to strengthen the support, while the monolith pillar with the cross articulated top beam, and hanging metal mesh way to control the flow of zircon into the roadway and promote its natural formation "roadside zircon pallets" support.

3.2.1. Anchor support parameter design
(1) Anchor length
The anchor rope should be anchored in a stable rock formation deep in the top plate. According to the comprehensive column chart of the work surface formation, the direct top is thick sandstone and fine 1.2m sandstone, which are more developed in layer theology, and the upper layer is a 0.2m thick coal line. The old top is sandstone, black and gray-black coal-clamping line, the layer is more developed.8.6m. According to the comprehensive layer level assignment condition and the ability to drill holes, determine the depth of the anchor rope 8.0m hole, anchor length: L. 8.3m.

(2) The spacing between the anchor ropes
Since L hole /S≥2, S≤L hole /2 = 4.0m, then according to the roadway section size, the spacing between S = 2.1m; According to the bolt support, take row spacing S = 4.0m.

(3) Anchoring agent selection
The anchoring agent selects the resin coil, according to the mine bureau "coal Roadway Bolt Support technical Code" provisions: the resin cement anchoring length is not less than 1.5m, according to the mine commonly used resin coil selection, S2370, Z2360 and Z2335 each one, the anchoring length is:

\[ L = \frac{11.5^2 \pi (700 + 600 + 350)}{\pi (14^2 - 7.62^2)} = 1582\text{mm} > 1500\text{mm} \]

The results meet the requirements.

(4) The anchoring force of the anchor rope
According to the Mine And Mines Bureau's "Coal Lane Anchor Support Technical Specification", Anchorage Force Design Value Should Be Greater Than 200KN. Design anchor anchoring force to take 210kN.

3.2.2. Single pillar support parameters
Single with metal articulated top beam (shun lane arrangement) to strengthen the roof support, down the alley to play three rows, one beam two columns, column distance. One of the first row, the second row playing in the upper gang, respectively, from the middle line of the laneway, the third row hit in the middle line of the laneway below the side. Single pillar wear shoes, to ensure that the initial support of the single body is not less than 90600m1.7m1.2m0.2m KN, and to meet the mountain strong. A cushioned shed between the top plate and the top beam, not less than two pieces per beam.

3.2.3. Steel frame shed support
In the local surrounding rock broken section using beams, the upper and lower helpers are, column legs, shed distance of 2.8m2.6m2.2m1.0m, and according to the timely adjustment of the situation, the column legs and horizontal surface of 75 degrees inclination to the alley tilt. If the top plate inclination changes significantly, the length of the legs can be adjusted between 2.2, 2.4 and 2.6m specifications as needed, but the net height in the lane should not be less than 2.0m.

3.2.4. Point Pillar Support
In the roadway section with complete roof, point pillar support is adopted. The wooden point pillar is supported in the first row of mono on the upper side. The selection of \( \varphi \geq 180\text{mm} \) high quality Korean pine (or I-beam steel), the spacing is medium to medium 500mm.

3.2.5. Metal mesh
In order to prevent the mining area zircon into the alley, in the first row of single-body empty area side, hanging 1.2 x long metal long latitude network guard, mesh between the joints, and with 142.2m0.1m lead wire every double wire twisting solid. 0.2m. The concrete support form of the roadway along the goaf is shown in Figure 3.
4. Support effect
Take a working face in the mining area as an example, carry out daily mine pressure observations along the goaf roadway to determine the deformation amount and deformation speed of the roadway roof and two sides. The specific test results are shown in Figures 4-8. [9, 10]

Figure 3 Supporting form of roadway along goaf

Figure 4 Deformation of the two sides

Figure 5 Deformation speed of the two sides
It can be seen from the figure that the closer the roadway is to the coal wall, the greater the deformation, and the deformation will gradually decrease to a certain fixed value with the gradual advancement of the working face. The deformation of the two sides of the roadway gradually increases when the distance from the coal wall is about 0~145m, and becomes stable when it exceeds 145m, and the deformation speed of the two sides gradually decreases to zero after this stage; the maximum amount of the bottom heave of the roadway is 600mm, The distance from the coal wall exceeds about 120m and stabilizes at a normal value. The deformation of the roof and floor of the roadway shows a gradual increase before the distance of 120m from the coal wall, and basically remains unchanged after this distance, and the amount of roof subsidence tends to be stable after the distance from the coal wall exceeds 130m. The support effect is good.

In addition, by testing the air leakage and gas content of the tunnel, the mine is a low gas mine, with an absolute gas emission of 3.34m³/min and a relative gas emission of 2.33m³/t. According to the appraisal in 2010, the 2# coal mined is Class III and is not easy to ignite spontaneously, and the coal dust is not explosive. Through the detection of the air leakage rate of the reserved lane at the working face every ten days, the actual measurement of the air leakage rate and the length of the reserved lane shows that the air leakage rate per square meter area in the reserved lane is less than 0.02m³/min. Therefore, spraying is not required to prevent air leakage measure.

5. Conclusion
This dissertation studies the specific application of the technology of retaining lanes along the goaf without filling, and the following conclusions can be drawn:
(1) Under the condition of high strength of the roof and floor of the thin coal seam, a good support effect can be achieved by retaining the roadway along the goaf through special support methods such as single props with hinged roof beams and supplementary anchor cables;
(2) It can be promoted and used under similar geological conditions.

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