Research on the influence of cross mining on advance support technology of overburden roadway

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Abstract. 70%~80% of the roadway is affected by mining, the most prominent problem is roadway maintenance under the influence of cross-mining. In this paper, the support of a rock backwind roadway in the east NO.4 mining area of a coal mine in huai-nan mining area is studied under the influence of mining in the lower 11-2 coal seam, The comprehensive support method of hollow grouting anchor cable anchoring and block erection is developed, and has carried on the successful application in the practice.

1. Introduction
The return air lane at the boundary of the east 4th mining area of a mine in huainan mining area, is located at the upper part of 1718(1) working face, roof collapse after face stoping, must cause the return wind lane to be difficult to maintain. It will cost a lot of manpower, material resources and financial resources to dig a tunnel again in the later period. In this paper, hollow grouting anchor cable and set up block blocks is used to reinforce the support, by adopting this scheme, It not only improves the stress state of roadway surrounding rock, but also effectively controls the deformation and failure of roadway surrounding rock. After field practice, only roof slag leakage and floor heave occurred locally in the roadway, and the roadway section could still meet the ventilation requirements. The support scheme is economical and applicable, how to support the roadway affected by cross-mining roadway is explored in a beneficial way, which has important popularization and application value.

2. Analysis of influencing factors of surrounding rock stability of trans-mining roadway

2.1. Research status
70%~80% of the roadway is affected by mining, the most prominent problem is roadway maintenance under the influence of cross-mining, mainly including mining areas up and down and section rock concentration lane, after the mining of coal seam, the supporting pressure near the working face increases and the roadway deformation is serious, mainly manifested as the large amount of the two sides of the roadway moving towards each other, the roof sinking and the floor heave. If the roadway continues to be used, the maintenance works will be large and the repair times will be many, which will seriously restrict and slow down the normal production of the mine. Roadway maintenance has become
a bottleneck restricting intensive production in coal mines[1]. Therefore, higher requirements are put forward for the stability maintenance of roadway surrounding rock affected by cross-mining.

For cross-mining roadway, the degree of deformation and failure of roadway surrounding rock varies greatly under different conditions, such as mining depth, support mode, roof and floor lithology, and normal distance of lower coal seam[2]. Due to the influence of coal seam mining, the pressure transmitted to roof decreases with the increase of normal distance, When the roadway is close to the lower coal seam, it is greatly affected by mining; when the roadway is far away from the lower coal seam, the effect of mining stress on surrounding rock deformation and failure is small; however, when the lithology of the roadway roof and floor is poor, the integrity is poor, and the fractures are developed, the roadway will still be affected by the mining in the lower coal seam despite the large distance from the coal seam method[3]. Under the influence of mining in the lower coal seam, the deformation and failure rules of surrounding rocks vary greatly under different influencing factors, needs to carry on the concrete analysis and the judgment according to the concrete geological condition.

2.2. Key influencing factors of roadway deformation and failure

The basic material that makes up the surrounding rock is rock, It is composed of various minerals or cuttings in accordance with the law under a certain geological process, lithology is some basic properties of reactive rocks, such as structure, structure, composition, type of cement, etc. Because of the difference of lithology, the surrounding rock of the cross-mining roadway has different degrees of deformation failure, which is ultimately caused by the different structure, strength, surrounding rock pressure and environment of the rock. Therefore, the surrounding rock lithology largely determines the extent and scope of the surrounding rock failure in the cross-mining roadway.

When the stress concentration exceeds the strength of the surrounding rock, the integrity and stability of the surrounding rock will be affected to different degrees, which will lead to tiny cracks in the surrounding rock. When the microfissures develop to a certain extent, the fissures are interconnected and the surrounding rocks begin to break. After the surrounding rock is broken, the broken rock is still affected by the mining on the lower working face, and the surrounding rock of the roadway continues to be destroyed and produce serious deformation. After a period of time, the surrounding rock will become unstable, thus undermining the integrity and stability of the surrounding rock of the roadway.

3. Engineering geology

The return air lane at the east fourth boundary of a mine in huainan mining area is a return air passage in the lower part of the east NO.4 mining area, affected by stoping of working face below 330m, section for straight wall semicircular arc, anchor net spraying support is adopted, section size B×H=5m×3.5m. The return air lane is located above the 17181 (1) working face, cut holes parallel to the working face, the vertical distance from the working face is about 30~40m, it is located in the curved subsidence zone formed after mining on 17181(1) working face. The working face of 17181(1) is coal seam 11-2 in N0.4 mining area, the ground elevation is +18.7~+22m, working face elevation is -706m~783m, coal thickness0~2.3m, average thickness is 1.76m, on the whole, the occurrence of 11-2 coal seam is stable.

The layout of the backwind roadway and the working face of 17181(1) at the east NO.4 boundary is shown in Fig. 1. The lithology of the rock strata is shown in Tab 1.

According to the engineering geological conditions, the main influencing factors of surrounding rock deformation and failure caused by mining in the lower working face of return air roadway include surrounding rock lithology, method distance between roadway and coal seam, position relationship between roadway and working face, support form and strength.
Tab.1 Lithology of roof and floor of coal seam 11-2

| Serial number | Lithology           | Thickness/m | Average thickness/m |
|---------------|---------------------|-------------|---------------------|
| 1             | Silty sand rock     | 8.9~17.7    | 11.9                |
| 2             | Mudstone            | 3~13.7      | 8.4                 |
| 3             | Fine sandstone      | 11.9~12.7   | 12.3                |
| 4             | Sandy mudstone      | 8.5~15.2    | 11.2                |
| 5             | Silty sand rock     | 8.6~9.2     | 8.9                 |
| 6             | Sandy mudstone      | 0.9~1.2     | 1.0                 |
| 7             | Fine sandstone      | 2.3~2.9     | 2.6                 |
| 8             | 11-2 coal           | 0.8~2.5     | 1.5                 |
| 9             | Mudstone            | 2.3~6.5     | 4.0                 |
| 10            | 11-1 coal           | 0.4~0.8     | 0.6                 |
| 11            | Mudstone            | 1.2~5.0     | 3.6                 |
| 12            | Fine sandstone      | 1.2~19.8    | 6.3                 |
| 13            | Mudstone            | 1.3~3.8     | 2.7                 |
| 14            | Carbonaceous mudstone | 0.3~0.5 | 0.4                  |
| 15            | Mudstone            | 2.1~10.8    | 6.8                 |
| 16            | Fine sandstone      | 0.9~2.4     | 1.4                 |
| 17            | Fine sandstone      | 1.7~11.4    | 6.0                 |

Fig.1 The layout of the backwind roadway and the working face of 17181(1) at the east NO.4 boundary

4. Analysis of the purpose of strengthening cross mining roadway

Considering that the backwind alley at the east NO.4 boundary is parallel to the cut of 17181(1) working face, it is difficult to withstand the influence of strong mining on the lower working face, roadway difficult to maintain, therefore, advance reinforcement is adopted, in order to avoid the original roadway in the lower working face mining process caused by strong damage, this affects pedestrians and ventilation, and return to wind alley later as return to wind function.

The return air lane is located in bending and sinking zone of 17181(1) working face, the roadway is bound to be affected by roof collapse and difficult to maintain. It will take 4 months to re-dig a roadway later, the cost of materials and labor will reach 5 million yuan, at the same time, it will affect the return wind in the lower mining area.

In conclusion, it is a new attempt to adopt a method to protect the roadway.
5. Supporting scheme and supporting parameters

5.1. Supporting scheme
Based on the actual situation, in the advance reinforcement scheme of the return air roadway at the east NO.4 boundary, the hollow grouting anchor cable with full length anchoring support and wood pile erection are adopted, the details are shown in Fig.2.

Fig.2 Schematic diagram of support scheme

5.2. Support parameter selection
(1) Surrounding rock surface spraying
The roadway surface is sprayed with concrete mortar, mortar mark C20, spray layer thickness 50~80mm.

(2) Hollow grouting and full length anchor cable support
Anchor cables are arranged along the roadway strike, with spacing of 1400 × 1200mm, three anchor cables are arranged at the top of the roadway, anchor cable installation pretension force: ≤140kN. Specification of steel strand: Φ22 × 6300mm, the anchor cable is anchored with resin and cement slurry. The part near the bottom of the hole is anchored by resin anchoring agent, anchorage length: 2000mm; rest part near the orifice shall be anchored by cement mortar. Anchor cable aperture Φ30mm, deep hole 6000mm. Second spray after anchor cable installation, the thickness of 100mm, slurry packed outer segment of anchor cable.

(3) Grouting material
Portland cement PO 32.5, water cement ratio 0.7:1.

(4) Conjoined pigsty
In the roadway according to the "well(Chinese)"-shaped block block reinforcement. The wood stack is made of 1600×160mm fresh road wood.
5.3. Economic benefits
Since the return air roadway is parallel to the cut hole of 17181(1) working face, the cut hole tunneling can be covered in the early stage, increase the strike length of 17181(1) working face by 425m compared with 17171(1) working face, the working area of multi-stope protective layer is 88,000m$^3$, more than 150,000t of coal were mined. In the later stage, through the protection of the return air lane at the east NO.4 boundary, no roadway pillar is needed, the overlying 13-1 coal seam has 680,000t of coal resources, for mine more recovery of coal resources, create huge economic benefits.

6. Conclusion
(1) The support mode of hollow grouting and full length anchoring rope combined with jointed wood stack is adopted for advanced reinforcement, engineering practice shows, this support method can significantly improve the stress environment of roadway surrounding rocks, effectively control the deformation and failure of surrounding rock, large areas of roadway collapse were avoided, it provides a guarantee for mine safety production.

(2) For the underground working face across mining, how to effectively protect the roadway 30~40m away from the overlying method has the value of popularization and application.

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