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Study of Soft Rock Roadway Support Technique

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Abstract

Soft rock prevalent in coal-bearing strata in China, a lot of soft rock is buried deep in the larger role of high stress by the formation, and maintenance of the roadway is very difficult to dig. Therefore, the soft rock tunnel in the control theory and practice of in-depth study on the maintenance of soft rock and coal mine production safety have important theoretical and practical engineering value. Based on the characteristics of soft rock roadway analysis, and theory and method of supporting the research, choose the right type of support and supporting means, surrounding rock deformation control, reduce destruction of surrounding rock strata behavior, to take reasonable supporting effective technical control of roadway deformation and maintain the stability of surrounding rock. On the roadway approach to the design support for soft rock tunnel problems, combined with the practical application of steel mesh and anchor design support system anchorage system and deep surrounding rock formation deep control system, calculation of parameters of rational support And the corresponding recommendations and measures, and achieved good results.

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Keywords: Soft rock; roadway; anchor; cable; Support Technology

1. The definition of soft rock

Soft rock geology is less than the uniaxial compressive strength of 25MPa loose, broken, weak, weathered, expansion of a class of rock in general. These rocks are mostly mudstone, shale, siltstone and shale rocks lower strength rock, a natural geological formation of the complex media. Therefore the concept of soft rock is often used, that works under force, can have a significant plastic deformation of the rock mass. This definition reveals the relative nature of real soft rock, which depends on the relationship between the work force and rock mass strength. When the power of certain works, the different rock mass, the strength level higher than the engineering force may shows the mechanical properties of hard rock, the intensity level lower than the engineering force may appear to the mechanical properties of soft rock; and on the same rock, in the more Works under low power, it performs the

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deformation characteristics of hard rock; in the role of higher engineering force, it may show the deformation of soft rock [1].

2. The characteristics of soft rock

Soft rock's most distinctive feature has a severe strata behavior, roadway maintenance difficulties, mainly from the surrounding rock stability in the short time to pressure quickly, large amount of rock deformation, speed, long duration, surroundings to pressure, Floor uplift obviously, water swelling, deformation increased, can be summed up in 4 words: loose, Scattered, soft, weak.

3. The support principles of soft rock roadway

Supporting principles: the early supporting theory design support parameters follow the ground structural engineering principles, rock is the object of support, support is only the artificial to build support structure. However, modern rock mechanics revealed a residual strength of rock burst, break loose rock still has a very high carrying capacity, surrounding rock is not only a source of the support pressure , but also is carrier to maintain the balance of the original rock stress , and is the main Bearing structure. The supporting role is to maintain and improve the residual strength of loose rock and full play the carrying capacity of wall rock. [3] Thus, in the soft rock roadway, we should follow the principle of the following aspects:

(1) the principle of maintaining and preserving the residual strength of rock.
(2) principles of increasing the residual strength of rock .
(3) the principle of giving full play to carrying capacity of the wall rock.

4. Supporting examples

A maximum thickness of coal mine 4103 mining faces up to 4.3m (roadway height of 2.8m), about 1.7m thickness of the upper mudstone, coal and mudstone formed for the soft layer of roof up to 3.9m thickness of about the same time, coupled with expanded roadway to 4.2 m, this 2.2m long ordinary bolt hard to the soft composite layer of 3.9m thickness around reinforced play an effective role in the roof, so you must use a longer cable for reinforcement. According to this the characteristics of the soft layer composite roof, the use of prestressed anchor and bolt joint reinforcement, that is, on the basis of the Anchoring ordinary bolt the appropriate section to install cable along of the roof to reinforce.

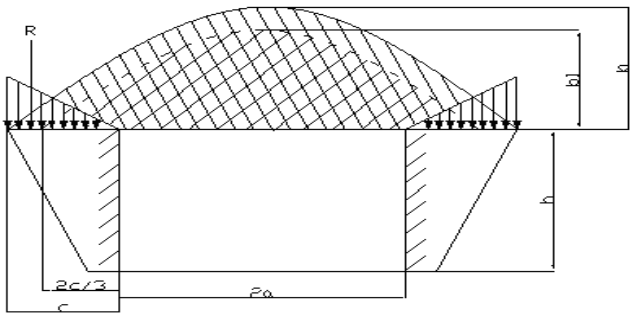

Fig.1 Schematic diagram of roadway damage

4.1. Analysis of cross-vaulted roof fall

As the thickness of the top coal and mudstone large arched shape of its collapse, according to Platts-free pressure arch theory, shown in Figure 1, it is determined by the scope of the destruction of two sides roadway. When the width ratio of 3.8/1.2 = 1.36, K_c = 3.0, taking γ = 25kN/m^3. When both sides of the coal is both entities, K_c = 1; wall of one-way compressive strength σ_m = 18.85MPa; seam angle of internal friction, φ = 50 °; tunnel height, h = 2.8m; depth, H = 727.4 m.

In accordance with the destruction of arch theory can help determine the extent of damage to the two roadway

$$C = \left(\frac{K_c \gamma H K}{100\sigma_m} - 1\right) h \times \tan\left(45° - \frac{\varphi}{2}\right) \quad (1)$$

Formula: K_c—the extrusion stress coefficient around roadway;
γ —the average weight density of rock tunnel;
K—mining influence factors;
σ_m—to wall one-way compressive strength, MPa;
h —tunnel height, m;
H—depth, m;
φ—Internal friction angle,(°). [4]

The above parameters into the above equation, have C = 1.93m.

4.2. Ordinary Anchorage coefficient

1) The length of the wall anchor

Shown in Fig.1, the reinforcement of the two wall, you can take in the damage range of 2 / 3, that is, The point of location, as the length of two wall support the lower limit, and all damage to the upper limit of the range as a support. Therefore, the effective range of bolt in the length of the two wall l1= 1.29 ~ 1.93m, averaging l1 = 1.61, taking into account the length of the exposed parts of 0.2m, the actual length of wall anchor l '= 2.0m.

2) The length of roof bolt

The point of support along the arch formed by high-end b1 as the lower limit of roof bolting, the full range of arch height in roof support conditions as a loose upper limit of support, so the effective anchorage length of the roof bolt l

$$l_{top} = b_1 \sim b = \frac{a + \frac{2}{3}c}{f} \sim \frac{a + c}{f} = 1.69 \sim 2.07\text{m} \quad (2)$$

Averaging and to consider the length of the exposed end of 0.2m, while the actual length of the roof bolt to take l_{top}= 2.1m.

3) Inter-row spacing of roof bolt

The number of roof bolts should be able to meet the following two conditions: a can withstand heavy rock arch; b bar shear strength to meet the physical requirements.

The need to balance re-arches rock bolt spacing calculated

$$S_1 = \sqrt{\frac{R_T}{k\gamma b}} \tag{3}$$

Formula: R_T—the actual bolt anchoring force, take 40kN / root;

k —safety factor, from 3;

γ —Gravity density of coal, taking 13.5kN/m^3;

The above parameters into the above equation, have S_1 = 0.691m.

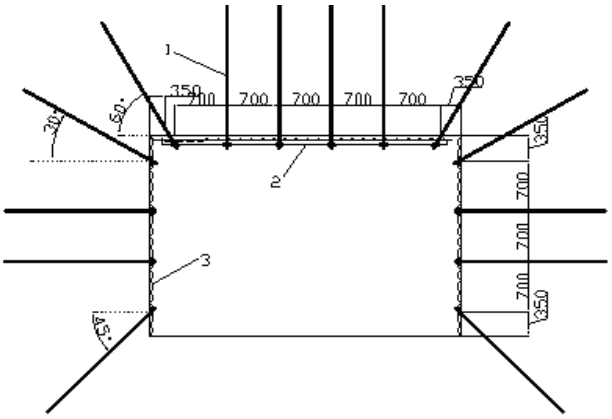

Fig.2 Anchorage sectional drawing

In summary, the 4103 gateway bolting wire forms and parameters are Fig.2 as follows.

Roof: steel bolt + net + ladder, anchor length of 2.1m, the steel rod as Φ20mm, 3 Volumes Resin Cartridge, full length Anchorage, bolt row spacing between 0.7m × 0.7m.

Two wall: Bolt + net, bolt length is 2.0m, with Φ18mm steel rod as the anchor, two Φ25mm× 350mm Resin Cartridge, inter-row spacing is 700mm × 700mm. In order to control the deformation of floor. The angle between wall anchor the next corner and horizontal is 45 °.

4.3. Anchor reinforcement parameters

1) Cable length, distance

Taking into account the changes in coal thickness, in order to ensure the top hard rock anchor in a certain length, is to ensure the anchoring force, the effective length of the selected cable is 5m, the exposed part is 0.5m, the total length of 5.5m. Arranged two rows cable along roadway section, and use the 3.8m-length channel or I-steel together, cable to cable spacing of 2m, along 75 ° into the roof, as shown in Fig.3. The maximum thickness of the coal bed by taking deep into the 0.75m in upper hard rock. [5]

2) Cable row spacing

Most important task is that cable is to ensure "in arch" stability. The spacer bolt hit a row of 3 rows of cable, that cable row spacing 2.8m, the anchoring force of each cable is

$R_T = (89 \times 2.8 + 13.5 \times 2.06 \times 4.2 \times 0.7) / 2 = 165.7$kN / root

the anchoring force of need to anchor each cable is not less than 165.7kN, the actual anchoring force take 170kN.

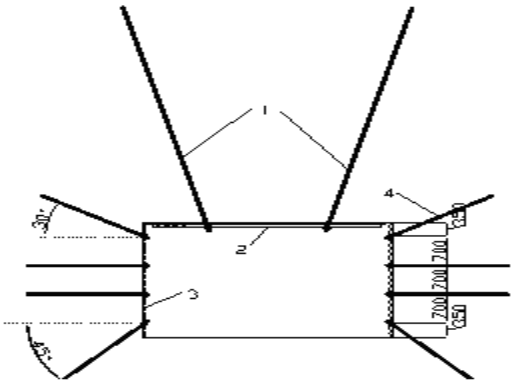

Fig.3 Anchor reinforcement cross-section diagram

In summary, the selection of destructive as 260.7kN, low-relaxation Φ15.24mm strand cable, the total length of 5.5m,each anchor diameter selection 4-volume Φ25mm, length 350mm to resin Cartridge Anchor head, cable spacing of 2.0m, every 3 rows of ordinary bolt hit a row of cable, and its layout is Fig.4 as follows.

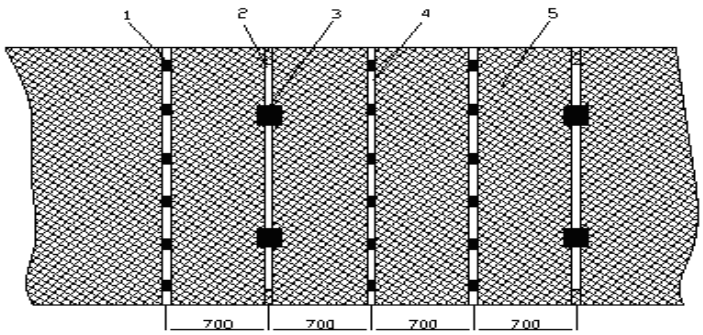

Fig.4 Roof Anchor floor plan

5. Conclusions and recommendations

By actual observations it is Confirmed that support method for the control of the surrounding rock deformation achieved good results, there was no Rib, roof caving and other more obvious strata behaviors. The supporting role is to:

(1) Upper roof anchor can be fixed into a strong pressure on carrying capacity of the upper arch, known as the "outer arch. "

(2) "outside the arch, " not only to maintain its own stability, but also to become the next bit from the conventional anchor net balance of the formation of arch support that "the arch " on which to maintain stability.

(3) Through the appropriate row spacing, cable will make "outside arch" along the roadway to overlapped, remain "outside arch, " within the rock mass stability.

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