Large-diameter Long-hole Full-length Cumulative Cutting Blasting Control Technology under the Condition of Adjacent to Filling Body

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Abstract. For the pillar stope adjacent to the filling body, in order to reduce the damage of blasting to the filling body as much as possible, the large-diameter long-hole full-length cumulative cutting blasting control technology is used for the side hole. The special PVC cumulative pre-cutting pipe is used for the side hole, the strip charge and the air column are distributed at intervals, and the accurate positioning device of blasting cutting line is used in the process of lowering. Compared with the previous side hole blasting control technology based on loose blasting and smooth blasting, this technology controls the damage caused by the impact energy entering the filling body through the heterogeneous interface, so as to realize the concentrated release of blasting energy in the target direction and directional rock breaking.

1. Introduction

The large-diameter long-hole sublevel open stoping with filling method has a series of irreplaceable advantages, such as large production capacity, high degree of safety, good economic indicators, etc., which is widely used in thick and large ore body mining at home and abroad. It is mainly divided into two steps: bord and pillar mining. Step one is to mine the bord stope and the open adopts cemented filling with tailings; step two is to mine the pillar stope and the open adopts cemented filling with waste rock or tailings. In the mining of pillars adjacent to filling body, there are many problems such as unreasonable blasting charge structure, collapse of unstable tailings filling body and serious ore loss and dilution, which are common technical problems in the later stage of filling mining [1].

Because the pillar stope is surrounded by low strength fillings on both sides, when the side holes adopt large-diameter long-hole blasting, the fillings are often damaged by impact or even collapse due to the large blasting scale, resulting in ore loss and dilution.

In order to reduce the damage to the filling body caused by the shock wave generated by the blasting operation in the pillar stope, the heterogeneous interface loose blasting control technology is generally used for the side hole, which mainly includes the use of air interval charging, reasonable determination of the side hole distance, and the control of maximum section charge. Under the unconstrained condition, although the heterogeneous interface loose blasting control technology [2-5] is adopted, the blasting
energy still diffuses in all directions, forming the ring crushing area and fracture area around. When the stress wave propagating outwards enters the heterogeneous interface between the rock and the tailing cemented filling with large difference in wave impedance, reflection and transmission occur at the heterogeneous interface, and a considerable part of blasting energy enters the filling and causes damage. Therefore, the traditional heterogeneous interface loose blasting control technology still has some technical defects.

In order to solve the above technical problems, this paper innovatively proposes a large-diameter long-hole full-length cumulative cutting blasting control technology under the condition of adjacent to filling body, which limits the diffusion path and direction of the blasting energy through a special device, controls the destructive effect of the impact energy entering the tailing cemented filling through a heterogeneous interface, and realizes the concentrated release of the blasting energy in the target direction and directional rock breaking.

2. Complete technical solutions
The large-diameter long-hole sublevel open stoping with filling method is suitable for the stable ore body with a sharp inclination with medium thickness or thicker. The stage height is generally 40-60m, and the two-step mining method of first mining bord and then mining pillar is adopted. When the stope is finished, cemented filling is used, and the pillar stope is adjacent to both sides of the filling body of the bord. In the mining of pillar stope, a downward, vertical, large-diameter long-hole connects the upper drilling chamber and the lower mine-production chamber; the middle hole is cut by VCR method; the side hole is cut by large-diameter long-hole full-length cumulative cutting blasting control technology, so as to fully ensure the stability of the surrounding filling body.

2.1. Overview of the large-diameter long-hole full-length cumulative cutting blasting control technology under the condition of adjacent to filling body
For the pillar stope adjacent to the filling body, in order to ensure the stability of the filling body and the effective control of the boundary of the stope during blasting, the side holes near the heterogeneous interface between filling body and ore rock adopt the large-diameter long-hole full-length cumulative cutting blasting control technology. Based on the blasting directional fracture technology, through the shaped charge and the shaped air column (Emulsified strip charge and air columns are distributed at intervals in a special cumulative cutting device), the directional cumulative cutting in the full length direction of the large-diameter long-hole is innovatively realized. Compared with the previous heterogeneous interface blasting control technology based on loose blasting and smooth blasting, this technology makes the blasting energy concentrate on the predetermined cutting surface, so that the impact energy is more on the rock breaking, and it reduces the damage caused by the shock wave entering the filling body as much as possible.

2.2. Parameters of side hole mesh
The hole diameter is Φ 165mm, and the hole depth is 35-55m. The distance a between side holes is 2-2.5m, the distance b between side hole and filling body boundary (bord stope boundary in step one) is 1m-1.5m, and the distance w between side hole and blasting hole boundary of middle cutting area is 2.5m-2.8m. The specific values of the parameters of side hole mesh are selected according to the mechanical properties of ore rock and filling body. The layout of side holes is shown in Figure 1.
2.3. Charge structure

The side hole adopts the air interval full-length shaped charging structure, and it adjusts the charging structure parameters by changing the ratio of charging length to air column length according to the change of filling body mass and mining site boundary conditions. In the hole, a special cumulative cutting device with emulsified strip charge and air columns distributed at intervals is used. Generally, it is an air column with an interval of 0.8-1.2m for a charge (0.5m-0.6m). See Figure 2 for charge structure.
2.4. The large-diameter long-hole full-length cumulative device

In this paper, a special large large-diameter long-hole full-length cumulative pre-cutting pipe is used. The length of a single section is generally 8-10m. The emulsified strip charge and air column are distributed at intervals.

The pre-cutting pipe is ordinary PVC pipe with a thickness of 4-6mm, outer diameter of 150mm and inner diameter of 140mm. The length of the strip charge is 0.5-0.6m and the diameter is 130mm. We need to pre-cut both sides of the pipe wall before charging. The length of the cutting seam is 100mm, the width of the cutting seam is 5-8mm, and the interval is 20mm. Generally, there is reservation of 20cm at both ends of the pipe wall without cutting. The positioning holes shall be reserved at both ends of the cutting pipe to ensure that the radial direction of the cutting seam is consistent with the line direction of the side holes.

Surrounded by the cumulative pre-cutting pipe, the action time of explosive gas is extended, and the ore crushing effect is enhanced. At the same time, the explosive impact energy flow is released concentratedly along the direction of the cutting seam, which is conducive to the formation and expansion of the rock fracture in the pre-set direction of the blasting hole.

The full-length cumulative device is shown in Figure 3.

2.5. Cutting line positioning of full-length cumulative device

In order to realize the directional cumulative cutting blasting along the direction of pre-control, during the lowering process of the shaped charge device, it should be ensured that the cutting seams correspond one to one, that is, the pre-cutting seams of each side hole should be on the same cutting surface as the blasting design line. For this purpose, a directional drum is made, and a coil positioning groove with a spacing of 150 mm is distributed along the direction of the drum. The directional rope is wound in the same direction with the positioning groove, and a positioning hook is installed at the lower end of the directional rope, which is used to hook the positioning hole at one end of the shaped charge device during the lowering process.

In the process of lowering cutting charge, the directional drum is placed in the tripod groove of the orifice, and the axis direction of the drum is consistent with the cutting line. The lowering process should be uniformly slow to avoid the rotation of the charge device. When the charge reaches the preset position of the blasting hole, the hook can be released only after confirming that the axis of the drum is consistent with the cutting line direction of the side hole.

The cutting line positioning in the process of lowering is shown in Figure 4.
3. Conclusion
This paper mainly focuses on the large-diameter long-hole in the downward direction. Through a special cumulative cutting device with the strip charge and the air column distributed at intervals, combined with the accurate positioning means of blasting cutting lines in the process of lowering, the large-diameter long-hole full-length cumulative cutting blasting control technology under the condition of adjacent to filling body is innovatively proposed.

(1) The side hole adopts the uncoupled charging structure with the strip charge and air column distributed at intervals. The ratio of charging length to air column length can be adjusted according to the mass of the filling body and the boundary conditions of the mining site.

(2) The strip charge shall be placed in a special cumulative pre-cutting pipe. The original PVC pipe is used as the pre-cutting pipe, and the two sides of the pipe wall are pre-cut, so as to realize the concentrated release of blasting energy in the target direction and effective rock breaking, and greatly reduce the blasting damage of the side hole to the filling body.

(3) In order to ensure that the pre-cutting seam of the side hole cumulative pipe and the blasting design line are on the same cutting surface, the design adopts devices such as tripod groove, directional drum, coil positioning groove, directional rope, positioning hook, positioning hole, etc.

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