

The Application and Discussion of Three-arm Rock Drilling Platform in Highway Tunnel Excavation

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Abstract: The traditional tunnel drilling and blasting excavation is carried out manually. With the diversification of construction means, mechanizing the tunnel with three-arm rock drilling trolley can effectively improve the working efficiency and make the construction progress faster. This paper discusses the contents of the three-arm drilling trolley in the excavation of the highway tunnel, and discusses its construction mode, mechanical equipment and construction organization to provide reference suggestions for realizing the rapid and efficient construction scheme.

1. Introduction

With the vigorous development of the construction cause in our country, more and more tunnel excavations appear in the construction process, the use of traditional manual methods can no longer meet the needs, and at the same time will have a negative impact on environmental protection, energy saving, and construction period. This paper will explore the specific contents according to the safety, quality and duration of the project, aiming at reducing the old dynamic intensity of manual excavation, improving the working environment and exerting the working efficiency of machinery and equipment, which is in line with the concept of green construction development in the new era.

2. Outline of Three-Arm Drilling Rig

The conventional hand-held pneumatic rock drill has certain advantages under the construction conditions of small section, short tunnel and poor surrounding rock geology, while the trolley has the advantages of high mechanization, low noise and less pollution under the condition of large section and long tunnel. At the same time, there are some advantages in cost control, which can effectively improve the progress of construction and reduce the difficulty of work. In particular, the three-arm drilling rig with all-directional parallel function can be accurately located, over-underdigging control to reach the 11-15 level, so that its blasting effect is higher than manual excavation, can strictly control the excavation quality, greatly reduce the amount of shotcrete[1]. The operator can operate on a fixed control platform, but the operating platform is equipped with a safe roof, which can protect the operator from falling rock. The safety factor is higher than that of the drill hole. At the same time, the use of power conversion power will reduce the generation of dust, air pollution is not large, of course, will also have a certain noise, compared with the air drill, the noise is low, if the operator wears anti-noise earplugs, can greatly reduce the harm to the human body.

2.1. Characteristics of Working Methods

From the way of measuring, drilling and charging, perfecting the components of three-arm drilling trolley, it is more convenient, quick and effective to improve the working efficiency than the common manual drilling.

Based on manual drilling machine drilling rod positioning direction is not accurate, over-underdigging control up to 20-25 cm, its exposure effect is lower than the trolley excavation, will

increase the difficulty of control.

Artificial air drill excavation, control personnel close to the face of the palm, only a few meters away. However, the excavation of wind drill is easy to be affected by the vibration rock wool, which results in the rock falling in the arch of the tunnel. Most of the workers are injured because of the distance relation, which threatens the life[2]. At the same time, artificial air drill is the use of high-pressure wind as the driving force, the number of air drill large, air pollution around will also cause harm. With the excavation of the tunnel, the air condition will gradually become worse, and the high decibel noise produced by the air drill will pose a great threat to the health and safety of the construction workers.

The use of three-arm rock-drilling trolley can effectively reduce the impact of the above content, operators can operate on the operating table, a distance of more than ten meters from the face of the palm, and the operation platform with a safety shed roof to ensure the safety of the operator, to prevent the impact of rock fall, the safety is obviously higher than the above content. The cost of excavation is about equal to that of manual excavation, but the excavation time is more economical and the efficiency is about 20% higher than that of manual excavation, which can greatly save cost and improve engineering efficiency.

3. Project Fact Sheet

The project is a double-line tunnel in the highway section, the left line inlet mileage of the project is ZK77+495, the exit mileage is ZK80+635, the left line tunnel length is 3140m, the right line entrance mileage is K77+455, the exit mileage is K80+573, and the right line tunnel length is 3118m. According to the left and right line separation arrangement, the route spacing is 24.695 m~30 m~25.516 m, and the inlet and outlet are all single pressed open portal.

3.1. Construction Method

According to the principle of the new Austrian method, the excavation of the whole section of the second grade surrounding rock is realized, and the whole section excavation of the fire surrounding rock is adopted after the excavation of the third grade surrounding rock step method, both the three-arm drilling rig and the wet jet manipulator are used to carry out the full section drilling and blasting excavation, so as to achieve the purpose of rapid construction[3].

3.2. Construction Organization

Adopting the three-level management mode of the project department, the work area and the shelf team, the construction control is carried out, and the supporting construction is coordinated and managed by the work area, and the shelf team is responsible for the concrete implementation. After using the inclined well to enter the main hole, the construction of two working ports is formed.

The excavation equipment of three-arm drilling rig should be determined according to transportation conditions, circulation time, project schedule and other factors. From this we can determine the three-arm drilling trolley drilling and blasting operation, drilling 6, blasting 9, tunneling 4, auxiliary production staff electrician 1, equipment maintenance 2, accessories buyer 1, a total of 23.

According to the geological conditions, the drilling depth is 4m, the circulation advance is 3.5-4m, the circulation practice is 720min, after deducting the impression of equipment maintenance and repair and construction delay, the average monthly work effect of two drilling rigs is 25 days, the average circulation advance is 3.6m, the monthly average progress is 180m, the maximum is 210m.

4. Three-arm Drilling Rig Construction

4.1. Positioning of the Trolley

According to the tunnel section size, after positioning, the distance between the trolleys can be kept about 2.5m, and the distance between the outer side walls is about 2.4m.

4.2. Measuring Lay-Out

The center line and the position of the surrounding hole are drawn with the blue in the middle of the drill rig, the excavation section of the previous cycle is measured again, and the over-under-digging situation is treated according to the mark of the site[4].

4.3. Car Drill Hole

The drilling hole is set according to the blasting design, the aperture is about 45mm, the construction of the way of digging the hole, and then the surrounding eye is set, and the hole cutting in the hole is carried out to improve the cutting effect and the blasting vibration reduction.

4.4. Blasting Parameters

Using the wedge-shaped way to cut out, weaken the blasting, using the surrounding smooth blasting mode, the electric detonator and the blasting mode of the detonator. Remember to use low explosive speed, low explosive force, high explosive force, drilling good explosive, to avoid the superposition of low wave, reduce vibration (see figure 1).



Figure 1 Three-arm rig

4.5. Charge Blasting

After clearing the hole, use the trolley to hang the basket charge, check the connection of the high-second detonator, connect the electric lightning line, ensure that the control personnel and equipment are evacuated to the safe area, carry out the blasting, and have a special person responsible for the safety alert work.

4.6. Ballast Out

2 loaders for ballast loading, dump truck transport, excavator to assist in cleaning the face of the palm.

4.7. Optimal Blasting Design

Carry on the inspection according to each blasting effect, analyze the reason, revise the blasting parameters according to the blasting effect and local geological conditions, and guide the construction work on the spot.

5. Technical Requirements for Excavation

The full section excavation space is large and the working procedure is less, so it is necessary to cross the operation arrangement according to different working procedures, which can shorten the cycle time, reduce the amount of excavation section, and reduce the vibration through blasting. According to the design requirements of drilling and blasting, control the hole spacing, depth and angle, according to the relevant design content to carry out the supervision and inspection of the hole, re-drill the contents that do not conform to the hole, qualified to charge the setting. According to the requirements of the face of the geological description, drillers can respond to the current

drilling problems.

6. Rules for the Use of Three-Arm Drilling Rigs

Work sign into the pump, air compressor inspection, at the same time to check the relevant lines, joints and other content to determine whether there is oil leakage, leakage, air leakage phenomenon. Handle all parts of the operation lever, control device, instrument content in the work sign. For the purpose of operation, use the lift platform to carry on the reverse control, moderately retract the price, put the guide rod to the level, ensure that the car maintains the initial position, and retract the leg to complete the driving function. Before driving, check the surrounding area to ensure that the front and back no one, after the five obstacles, the operation of the indicator light, do not affect the follow-up work because of misoperation. During driving, it is necessary to maintain a smooth state to avoid accidents caused by emergency handling, especially in the process of up and down the slope, because of the car body field, the steering needs to ensure the front and micro-end of the large motion swing, so as to maintain the balance of the arm end. When the hydraulic oil is at 30-75°C, it can run normally. If it exceeds 75°C, it is necessary to stop immediately (see figure 2).



Figure 2 Three-arm rig

Before drilling, the surrounding dangerous stone should be removed in time, and the dust in the compression pipe should be discharged before connecting the water pipe. Connect the insulator cable to the power supply, the operator should open his legs to complete the drilling and lifting operation. Before drilling and lifting platform operation, ensure the stability of the body, do not arbitrarily move the body and cause damage to the arm and guide rod. If it is necessary to work the arm displacement, it is necessary to first return the guide rod to make the vertex leave the working face to ensure that the arm rod does not collide with each other, resulting in the winding of the hose. Lift table is, be sure to use gestures or signals to alert the operator, always check the lower arm of the guide rod position.

7. Treatment of Conventional Problems

7.1. How to Ensure Continuous Operation

Each process should be arranged in good order, specific responsibilities to people, coordination of the process construction process, the deployment of equipment and staff, reduce the number of working procedures. be equipped with sufficient labor force to speed up the construction process. Set up a three-arm rock-drilling trolley repair class, to carry out routine daily repair and maintenance work, but also to give the trolley to carry out monthly maintenance, form a standard maintenance system to complete the follow-up construction and operation work. For the three-arm drilling rig often damaged accessories to do a good job of equipment, do a good job of model matching work, to avoid delays (see figure 3).



Figure 3 Three-arm rig

7.2. How to Improve Surface Blasting and Overdigging

Surface blasting and over-under-digging are the technical indexes of tunnel blasting excavation. In order to meet this effect, the operator can follow the class to guide the operation and do the work of hole layout, drilling and charge. At the same time, the three-arm drilling rig technical training work to enhance the novice control ability, improve the level of drilling and blasting construction. Evaluate and analyze the effect of cyclic blasting, find out the deficiency and correct it in time. According to the exposed rock joints, the fractures are analyzed, the lithologic characteristics are observed, and the blasting parameters are modified. Complete the monitoring content according to the blasting vibration speed, adjust the management content of the explosive charge quantity from the single section. Accurate lofting, ensure measuring accuracy and standard gun hole position, set drill hole, command by special personnel. Carry out the mechanism of fixing the hole by special personnel, and carry out the quality examination of the fixed hole by the special person in the follow-up.

8. Conclusion

Compared with the traditional manual excavation, the advanced scheme of the three-arm rock-drilling trolley has significant advantages. In the course of the construction of the three-arm rock-drilling technology of the highway tunnel, it is necessary to synthesize the key points and systematically supervise it in order to construct a complete construction safety system.

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