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Application of Advanced Long Pipe Shed Construction Technology in Drift-Rock Mound Tunnel

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Abstract: Floating rock pile belongs to a special geological type, body stability of tunnel hole had a serious impact, based on the tunnel, drift rock pile in high altitude cold and arid regions of engineering characteristics were analyzed, and put forward using advanced and long pipe roof construction technology to carry on the preliminary support, introduces its construction process, to ensure the safety of the floating pile rock tunnel construction, to provide technical reference for tunnel construction problems of the same type.

Keywords: Tunnel Engineering; Boulders; Lead Long Pipe Shed

Introduction

In the process of highway tunnel construction, due to the complex geological environment of the tunnel construction area, the tunnel excavation and support process often encounter rock fracture area, loose weak surrounding rock, shallow bias and other adverse geological conditions. During excavation, it is easy to be damaged and disturbed, thus affecting the stability of surrounding rock, so different construction methods should be selected for different geological conditions in the construction of tunnel engineering [1,2]。

Due to the obvious heterogeneity and anisotropy of boulders, the construction of tunnels will be seriously affected. In view of the construction problems caused by boulder talus geology, a large number of scholars have carried out relevant research.Liu Guoqing [3] This paper introduces the application of the long pipe shed construction method in the complex geological environment, which can ensure the smooth construction. At the same time, highway tunnel construction often encounters weak surrounding rock, and the use of advanced long pipe shed support construction technology can effectively guarantee the construction quality of tunnel engineering[4-5]. Wang Kai introduces the application of the advance support technology of the long pipe shed under the unfavorable geological condition. Liu Hesong introduces the problems such as construction disjunction and pipe roof intrusion in the construction process of advanced long pipe, which will cause potential safety hazards to the tunnel. Huang Yongsheng In the introduction of its construction technology, its application scope and application are supplemented.

At the same time, the construction process of advanced long pipe shed technology is complex, including too many processes. Under complex geological conditions, if one of the steps has problems, it will affect the guidance of pipe shed, resulting in grouting can not be guaranteed, and ultimately affect the construction quality. At present, there is a lack of research on the advanced long pipe roof technology in the complex geological environment of boulder rock pile, so this paper proposes to apply the advanced long pipe roof technology in the construction of boulder rock pile tunnel, and introduces the key points of operation in its construction process to ensure the smooth progress of tunnel construction.

1. Project overview

The tunnel is located in Qinghai Province, which is a mountainous and hilly area with an elevation of 3000 m to 3500 m. The total length of the route is 8.12 km. The tunnel is a separated tunnel. Due to the influence of the terrain, the elevation difference between the two places is large, so the spiral tunnel is used now. The total angle of the tunnel is nearly 220 °, the minimum radius of the curve is 700 m, the slope is concentrated, the elevation difference of the entrance and exit is 58 m, the starting and ending pile number of the right line is K6 + 008-K8 + 562.63, the length is 2554.63 m, and the longitudinal slope is 2.3% one-way slope; The starting and ending chainage of the left line is ZK6 + 062-ZK8 + 688, with a length of 2626 m. The longitudinal slope is a one-way slope of + 2.2%, and the entrance and exit portals are end-wall portals. The underlying bedrock of the tunnel site is mainly boulder talus, and unfavorable geological structures such as fracture zone are found in the tunnel site.

The Project is located in the marginal transition zone of the Qinghai-Tibet Plateau, where the stratum distribution is complex and scattered, the geological structure is developed, and the unfavorable geology along the line is as shown in Fig. 1.

Fig. 1 Tectonically denuded alpine landform

2. Engineering characteristics of boulder heap

2.1 Formation mechanism of boulder talus

The boulder talus is located in the staggered position of the tectonic zone under different geological conditions. Due to the crustal movement, a large number of folds are formed. Under the action of extrusion and stacking, the rock strata have relatively developed joints and fissures, forming irregular square bodies. Under the action of weathering and exfoliation, they are gathered at the foot of the mountain to form talus.In addition, the formation of boulder talus is mainly due to the fragmentation and uneven weathering of argillaceous, schist, slate and other rock masses, and some of them form steep slopes with weak lithology and weak weathering resistance. During weathering, the slope surface is stepped or jagged. Due to the transportation and scouring of geological activities, the spatial distribution of boulders is random, and the talus is easy to accumulate at the slope angle. As shown in Figure 2, the boulder is prone to uneven settlement in the stratum. Its appearance is generally round and oval. When it is distributed in the stratum, it is usually inclined. When it is subjected to external force, the stress in the middle is large, the stress area on both sides is small, and the stress on both sides is greater than that in the middle. It will rotate and the pores between soil will change. The movement of water and fine sand in the pores also leads to the change of soil structure.

Due to the low strength and irregularity of boulder talus, it will bring some potential safety hazards to tunnel construction, so it is necessary to take appropriate measures to increase the intensity of support.

Fig.2 Exterior view of boulder rock pile

2.2 Influence of Boulders on Tunnel construction

The distribution of boulders is random, with obvious heterogeneity and anisotropy, which often brings potential safety hazards to tunnels. The adverse effects of its characteristics on tunnel construction are reflected in the following aspects:

(1)Insufficient anchoring force, drill sticking and hole collapse. Due to the randomness of the spatial distribution of boulders, the phenomenon of drill jamming and hole collapse often occurs when drilling, and it can not provide a good force foundation for the anchor rod, resulting in low anchorage capacity, which greatly affects the construction rate of shotcrete and anchor support;

(2)Collapse phenomenon. Because the boulder rock pile is soft and loose and deforms rapidly, large vault subsidence and clearance displacement often occur during construction, which easily leads to collapse;

(3)Water gushing and quicksand. The boulder rock pile has strong water permeability, and there are often aquifers in the soil. Under the action of dynamic water and water pressure, it affects the effect of grouting and drilling, and even leads to collapse, instability of the first support and other accidents;

(4)Dynamic load and bias problems. The boulders are very sensitive to the dynamic load, sometimes there is partial bias, and the tunnel is prone to lateral displacement and distortion.

3. Construction technology of advanced long pipe shed

The basic construction process of the advanced long pipe shed is to determine the excavation sideline of the side and front slope according to the construction design drawing, and to protect the side slope by shotcrete. Then the guide wall is applied to guide and fix the construction of the pipe shed. Set up the drilling platform and install the drilling rig to drill, and clean the inner rod, withdraw the inner rod and withdraw the pipe sleeve. Then install the pipe shed, and finally grout.

3.1 Drilling construction

φ140mm seamless steel pipe is used as the guide pipe for this drilling, with a circumferential spacing of 40cm. The drill pipe length of the hydraulic trolley is 4.3m and 5.5m.

When drilling a deep hole, the connection between the drill pipes shall be connected by the drill pipe connecting sleeve, and the material shall be the same as that of the drill pipe, and the overall strength after connection shall be ensured. See Fig. 3 for drill pipe connecting sleeve.

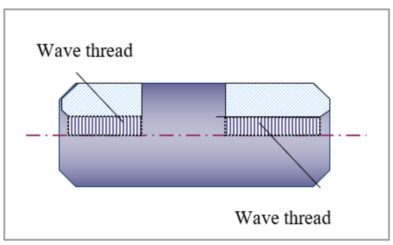

Fig. 3 Schematic Diagram of Drill Pipe Connecting Sleeve

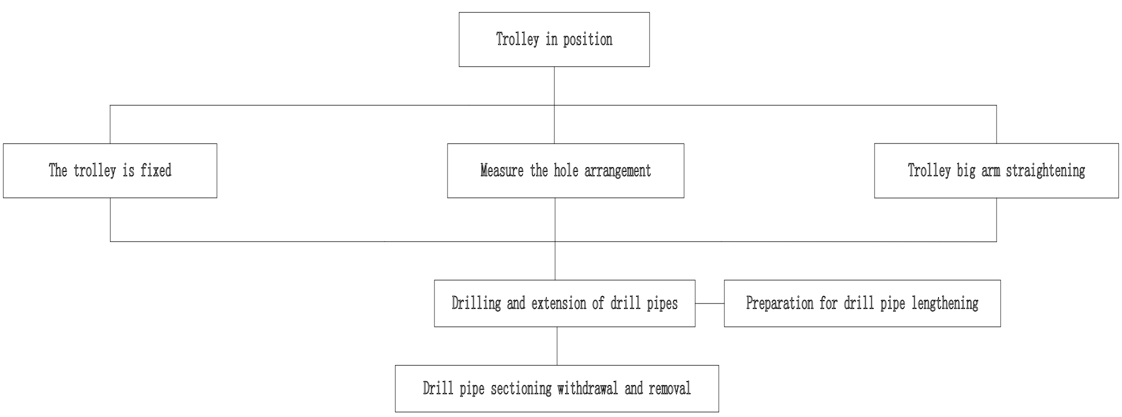

Fig. 4 Process Flow of Deep Hole Drilling

The operation of drilling deep holes has the following key points:

(1) Before drilling, it is necessary to drive the trolley to the tunnel face for positioning, and the surveyor stands on the basket of the trolley arm to determine the specific position of the drilling hole. In order to prevent vibration from affecting the accuracy of construction, the bogie arm must be pressed against the tunnel face during drilling.

(2) When the drilling machine starts to work, the speed of the drilling machine should not be too fast. When the drilling depth is about 20cm, it should be controlled at the normal speed. After the first section of drill pipe is drilled into the rock formation, stop drilling when there is about 25 cm left at the tail, and manually install the second section of drill pipe with the coupling sleeve installed into the drill rig, and connect the second section of drill rod with the tail of the first section as a whole.

(3) During the drilling process, the drill pipe may be damaged and cannot be used, so the overall structure of the drill pipe must be checked in time during the construction process to see whether there is obvious bending and damage and whether the central water hole is unblocked. When the above situation occurs, it needs to be replaced immediately.

(4) The diameter of the drilling guide hole shall be 15 ~ 20 mm larger than the outer diameter of the shed pipe, and the hole depth shall be more than 0.5m longer than the pipe length.

3.2 Process flow of pipe jacking

The combined process of large hole guide and shed pipe drilling is adopted, and the impact and thrust of the drilling machine are used to push the shed pipe with the working pipe head along the guide hole, and the shed pipe is extended section by section to the bottom of the hole. The process flow is shown in Figure 5.

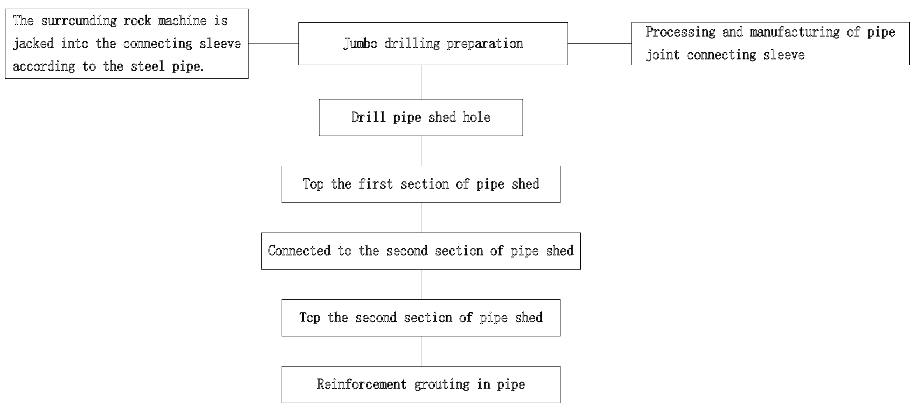

Figure 5 Process Flow of Pipe Jacking Construction

The key points of pipe jacking process and operation are as follows:

(1)Fabrication of pipe fittings: Φ108 and 6mm hot-rolled seamless steel pipes are used, with pipe sections of 3m and 6m in length. The left and right tunnels at the inlet and outlet ends of a tunnel are both 30m in length, so the pipe sections shall be lengthened. When lengthening the pipe fittings, the joints of the connected pipe sections must be staggered back and forth to make their structure stable.

Double-arm hydraulic drilling jumbo is used for the construction of the long and large pipe shed. One of the big arms is used to drill the pilot hole with a Φ120mm percussion drill, as shown in Fig. 6. The other big arm is used to Jack the Φ108mm shed pipe. A steel pipe jacking connecting sleeve (as shown in Fig. 7) corresponding to the diameter of the pipe shed must be installed on the rock drill of the pipe jacking boom, and a special steel pipe straightener (as shown in Fig. 7) must be replaced on the boom. After the pilot hole is drilled, use the pipe jacking boom for jacking operation.

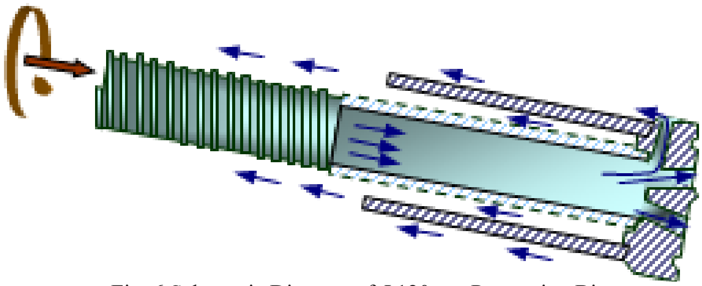

Fig. 6 Schematic Diagram of Φ120mm Percussion Bit

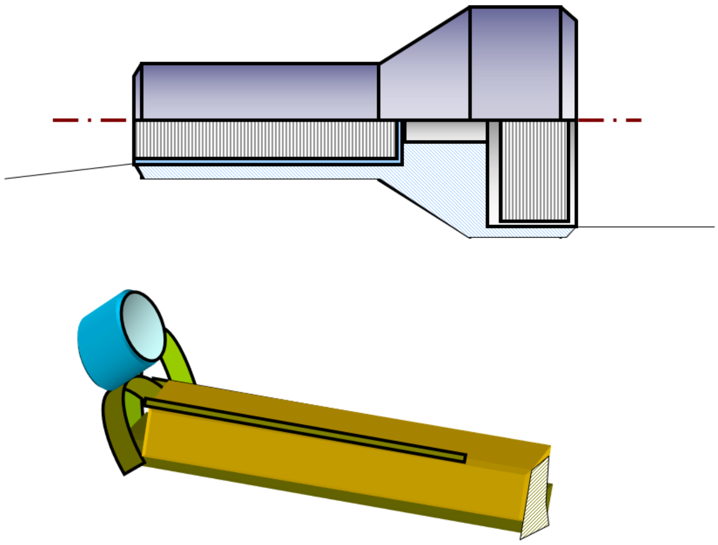

Fig. 7 Schematic Diagram of Pipe Roof Jacking Connecting Sleeve and Trolley Arm Straightener

(2) Pipe jacking operation: the other big arm of the double-arm hydraulic drilling jumbo is used to Jack the steel pipe. During operation, the steel pipe shall be pushed at a low speed. During jacking, the pressure shall be controlled at about 1.9 Mpa, and the pushing pressure shall be controlled at about 5Mpa.

(3) Connecting pipe: when the first steel pipe is about 30cm left, the big arm jacking connecting sleeve needs to be separated from the steel pipe, the rock drill is reversed, the steel pipe is connected manually, and the two steel pipes are connected into a whole at the connecting sleeve. The big arm prepares the steel pipe again, and the rock drill pushes the steel pipe in at a low speed.

(4) Grouting and consolidation: try to prevent the occurrence of grouting, and stop immediately if it occurs. At the same time, to ensure uniform grouting, a hammer can be used to knock the steel pipe. If there is a clear sound, it means that there is a vacancy and the steel pipe is not filled.

(5) Reinforcement of pipe shed: pigging shall be carried out before reinforcement, so as to strengthen the rigidity and strength of pipe shed. Reinforcing method: cement concrete is injected into the steel pipe to form the cement concrete steel pipe under common environment. In case of collapse and destruction of surrounding rock, Φ20mm reinforcement cage shall be placed in the steel pipe first, and then grout shall be injected into the steel pipe to form a concrete steel pipe.

4. Conclusion

(1) The distribution of boulders and rock piles is random. Under the action of external force, the force at different positions cannot be balanced, which often causes construction problems such as drill jamming, hole collapse, insufficient anchoring force and water gushing and quicksand.

(2) The advanced long pipe shed support plays a positive role in the construction of boulder rock accumulation tunnel project, which can effectively prevent the collapse of tunnel face excavation and form a stable composite consolidation body after grouting.

(3) The advanced long pipe shed does not require particularly large construction machinery and equipment, has good technical and economic performance and good stability, and can effectively guarantee the construction safety.

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