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Research Article

Treatment Design and Construction Strategy for Tunnel Mud and Water Inrush Disaster

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Abstract: With the rapid development of the transportation industry in China, the number and scale of tunnel construction are increasing. Tunneling through fault zones and other complex geological environments is becoming more and more common. In the construction of highway tunnels, due to the special geographical environment and complex geological conditions, mud and water inrush often occur in the tunnel. Water inrush disasters pose a major risk to the construction of highway tunnels and affect the normal construction of highway tunnels. This paper combines the engineering background of the tunnel mud and water inrush accidents, carries out evaluation on the accident treatment measures and the treatment efficiency, and summarizes the main concerns in the construction process and the technical guidelines for dealing with the tunnel mud and water inrush.

Key words: Tunnel; Mud and water inrush; Disaster treatment; Construction strategy

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1 Preface

With the rapid development of traffic construction in China, the number of tunnel projects is increasing, which not only brings huge engineering advantages, but also causes many engineering problems. Among them, tunnel mud and water inrush is one of the common engineering problems. The inrush of mud and water during the construction of highway tunnels will adversely affect the safety of the project itself and the surrounding ecosystem.

2 Disaster form of tunnel mud and water inrush

2.1 Mud and water inrush in caves

After the mud and water inrush occurred in the tunnel, the disaster area should be investigated in time, and the cause of the mud and water inrush should be analyzed according to the local geological conditions. The bedrock in the tunnel area is mainly composed of mixed rocks (gneisses, gneiss, quartzite, etc.) formed by local metamorphism. However, due to weathering, the rock mass near the cave is shattered, and due to geological tectonic movement, the shattered rock mass gradually enters surrounding rocks, resulting in local intrusion of rock veins, greatly complicating the entire tunnel area and nearby geological bodies. The area around the tunnel is affected by two regional faults. One of these two regional faults is the north-south striking fault[1]. Under the influence of two faults, the rock mass was squeezed and shattered. After a long period of natural weathering, some shattered rocks were peeled off into fine mineral particles, which mixed with the atmospheric sediments stored in the cracks to form mud.

2.2 Funnel

The tunnel is affected by the interactions of two faults. The surrounding rocks in this area are shattered and the overall stability is poor. When mud and water rush in, the surrounding rocks above

the cavity continuously supply the cavity under the actions of negative pressure and dead load. When the rock and soil shatter, the upper layer of soil collapses, eventually forming a funnel.

2.3 Dislocation cracking

When the surrounding rocks fracture, the upper surrounding rocks are sent into the cavity, forming a funnel. The soil around the rot pit has a large free surface, and the soil tends to become a free surface. Meanwhile, under the influence of the inrush of water and mud, the groundwater level suddenly drops, and the shattered rock and soil clumps redistribute the stress, leading to ground subsidence. The joint movement leads to the appearance of tension-type staggered cracks on the mountain[2].

2.4 Faulting of slab ends

Under the influence of the water and mud sprayed out of the tunnel, the rapid decrease of groundwater and the redistribution of stress in the rock and soil lead to partial cracks in the national highway. According to the field investigation, the overall stability of the rock and soil layer at the southern end of the east-west fault is relatively good, and is not affected by the drop in groundwater level. Therefore, the subsidence in this area is relatively small and there are few cracks on the national highway. However, the overall stability of the rock and soil layers at the northern end is relatively poor, and is greatly affected by the drop in groundwater level, and there are many cracks in the area[3].

3 Treatment design for mud and water inrush in tunnel

Considering the large area of karst development revealed by advanced geological drilling, the pre-grouting reinforcement should be comprehensively considered based on the scale of karst development, the relative position with the tunnel, filling characteristics, and groundwater level etc. The angle and number of grouting pipes should be determined according to the development of karst. The characteristics are determined according to actual needs. In other words, a comprehensive treatment construction plan called "mainly blocking, limited discharge, combining both blocking and discharge" was adopted.

4 Construction strategies for tunnel mud and water inrush

In order to prevent mud overflow in highway tunnels, follow the precautionary principle of "mainly blocking, limited discharge, combining both blocking and discharge", and adopt effective and feasible preventive measures. It should be adopted and implemented correctly to achieve the ultimate goal of "reliable waterproofing and worry-free drainage". The specific measures are as follows.

4.1 Mud jet treatment

The sludge discharge of highway tunnels should be controlled first, and pay attention to the prevention of the drainage treatment and blockage of the sludge, and prevent the sludge from entering the tunnel and affecting the tunnel construction. Effective waterproof and drainage measures should be taken to prevent mud gushing. More and more construction projects in China have affected China's ecological environment. Increase the requirements for project structures to avoid further damage to nature. In case of mud flooding, the groundwater system should be kept as unobstructed as possible. If the mud flow is too large and the surrounding trees are lush, drainage equipment must be used to drain the stagnant water. However, this weakened the bearing capacity of the surrounding rocks, resulting in project collapse, subsidence, and ground deformation, etc., which changed the overall structure and the construction of the tunnel, and at the same time affected the surrounding environment and dried the surrounding water. Therefore, if the amount of mud discharged is too large, anti-leakage measures must be taken first, and then discharge appropriately. The cement slurry is partially submerged by cement or other materials, and then the bedrock is reinforced to prevent the gap from expanding. The leakage will prevent the future tunnel from causing secondary threats, and the leakage will have a negative impact on the tunnel project and the ecological environment [4].

4.2 Water supply and drainage treatment

Drainage pipes and buried pipes are used throughout the drainage process. Drainage pipes (horizontal, longitudinal, circumferential) are used to infiltrate the central drainage channel from behind the initial support, and the buried pipe directly leads the water sprayed from the tunnel. First of all, semi-spring drain

pipes should be used to support the ground for dense circumferential drainage, and several drain pipes should be arranged side by side. If the leakage point is obvious, the gap must be appropriately shortened. Especially when there are many drainage holes, the vertical gap should be further tightened, and the circular drainage pipes and the horizontal drainage pipes should be directly connected and introduced into the central drainage pipe. It is worth noting that the installation and recovery of horizontal drainage pipes, vertical drainage pipes and circular drainage pipes should be strengthened when pouring concrete to prevent cement slurry from penetrating into the pipes and causing poor drainage. Install drainage pipes in areas with a large amount of water and mud, and use buried pipes for water drainage. In order to prevent the water pressure in the karst cave from getting too high, steel pipes are buried in the concrete backfill structure of the karst cave. This is the main pipeline that relieves the water pressure from the cave to the exterior.

4.3 Post-treatment mud cracking and water leakage

After clogging the tunnel with mud and spraying water, due to various reasons, the best clogging effects may not be achieved. Placing mud can better deal with pouring water, reduce potential safety risks and damage to the surrounding ecological environment. In response to this situation, sprinkle concrete on the leaking parts for grouting, and take effective measures to ensure the infiltration of muddy water meets the standard, so as to ensure that the quality and control effect can reach the ideal state.

4.4 Emergency measures for public mud and water inrush

First of all, when a mud and water inrush occurs, the construction personnel should immediately report the problem to the supervisor, and do not panic or take wrong measures. Secondly, construction personnel must mobilize staff immediately after receiving the report to get a hold of the situation around the tunnel, determine an emergency plan for dealing with debris and floods, and set up an emergency team to deal with mudslides and floods. If the geological disaster is more serious, you should seek help from government departments. After the emergency team arrives at the scene, they must check the situation at the scene, the severity of the disaster, personnel statistics and property losses, and pre-assess the damage caused by mud and water to the safety of the tunnel project. Please follow the on-site instructions to ensure effective handling in emergency response. Anyone injured or killed at the incident site should immediately contact the local hospital and rescue personnel to establish a temporary clinic at the incident site and prepare appropriate medical equipment, such as various medical supplies, medicines, equipment and other first aid supplies. Finally, if rescuers do not arrive at the scene, the emergency team will prevent the situation from worsening, prohibit personnel from entering, ensure the safety of construction personnel, reduce obstacles, and avoid mud and water inrush for rescue work to be carried out. Must be pre-processed.

5 Conclusion

The inrush of mud and water in the tunnel is one of the inevitable geological disasters and project water gushing in the construction of highway tunnels. When dealing with disasters, targeted measures were proposed to deal with the mud and water inrush according to the nature and geological conditions of the tunnel, thus ensuring the safety of the tunnel and normal construction.

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