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Evaluation of a tunnel in Yunnan using CRD construction method

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Abstract. According to the surrounding rock conditions of Re Shuitang Tunnel NO.2, it is analyzed whether the CRD method is suitable for such surrounding rock conditions. By comparing and analyzing the distribution of plastic zone of surrounding rock during construction and the displacement deformation of tunnel monitoring point, the tunnel is constructed. The plastic zone of the middle arch and the arch is obviously changed, and should be reinforced. The settlement of the right vault and the side wall is larger than the left side, which is about 19.8% and 21.9%. According to the analysis results, the vault should be reinforced in advance during tunnel construction to prevent collapse and ensure construction safety, and provide reference for future construction.

1 Introduction

The tunnel excavation is constructed by the CRD method. Under the condition of poor stability of the surrounding rock, whether the construction safety can be ensured, the construction progress is ensured, and the danger of collapse is prevented. Therefore, it is important to use the CRD method to meet the stability requirements during tunnel excavation in the condition of poor surrounding rock conditions, and to ensure the safety of construction [1-3].

Domestic and foreign scholars have used the theoretical analysis and numerical simulation to do the following research on the tunnel construction using the CRD method: Wang Chunhe et al. analyzed the surrounding rock deformation during the excavation using the up-and-down step method and the CRD method, and obtained the CRD method for controlling deformation and plasticity. The area changes better [4]. Yao Hongwei et al. studied the shallow excavation section of Hangzhou Zizhi Tunnel and optimized the excavation process, temporary support structure type and excavation step of CRD [5].

This paper relies on the Re Shuitang Tunnel NO.2 as an engineering example. The numerical simulation method is used to analyze the deformation of the surrounding rock structure when the tunnel is excavated by the CRD method. By comparing the change of plastic zone and displacement deformation of surrounding rock structure, the corresponding treatment measures are put forward to provide research guarantee for construction safety and normal operation of highways. [6-9].

2 General situation of Engineering

The starting point of the Re Shuitang Tunnel NO.2 is K9+115~K9+710, the length is 595m, the depth is 103.75m, the left hole is ZK9+175~ZK9+705, the length is 530m, the short tunnel is buried, the depth is 98.97m. The tunnel has a clear distance of 25~26.5m and the cross section is a separate tunnel. The elevation of the tunnel area is 1774~1880m, and the relative height difference is 106m. It belongs to the dissolution and erosion low mountain landscape. The terrain is steep, the tunnel entrance has no road access, the traffic is inconvenient, the import and export limit forest land, and the vegetation is relatively developed.

Figure 1 Topography of Re Shuitang Tunnel NO.2

2.1 Engineering geological conditions.

According to the regional geological data of Yunnan Province, the area where the route is located is the compound part of the front arc of the mountain-shaped structure in Yunnan Province and the middle part of the Eastern Branch of the Qinghai-Tibet-Yunnan-Burma evil-shaped structure system. The geological structure in

*Corresponding author's e-mail: 1559039300@qq.com the area is complex. The structural geology takes the radial structure as the backbone structure, and the zonal structure is active for a long time. Radial structure is a prominent structural system in the region. It belongs to a part of the meridional structural system of Sichuan and Yunnan. It is mainly composed of compressive and torsional faults of the radial structural system, a small number of co-directional folds and Cenozoic basins. The bottom of the tunnel entrance trough passes through the regional fault-leveling fault, and the fault plane tends to the northeast, and the dip angle is steep. A crushing belt having a width of about 50 m and an extruded lens body composed of gray loyalty are formed along the fracture. Affected by the fault, the K9+120~K9+210 and ZK9+170~K9+270 sections of the tunnel entrance section are extremely broken, and the excavation is prone to large collapse. According to the "Yunnan Province Activity Fracture Map", the fault is not an active fault.

The upper part of the tunnel crossing area is dominated by limestone in the upper part of the Baoshan Formation of the Cambrian system. It is a dissolution and erosion low mountain landscape. The tunnel mountain is a dome mountain. The top of the mountain is smooth and round, and the slope of the entrance section is steep. The natural slope is 25~45. °; the exit section is slow, the natural slope is 20~30°, and the terrain is undulating.

2.2 Hydrogeology

The project area is located in the Nujiang River system, in the Shidian River Basin. The Shidian River originates from the Nangao Mountain Area of the Shidian Basin. It flows through the basin from the south to the north, and flows into the Nujiang River from the sharp corner of Wang Street to the southwest. The basin channel is artificial. Renovation and straightening, the longitudinal slope is small, the flow in the rainy season is large, and the dry season is cut off.

3 Numerical simulation analysis

3.1 Parameter selection

This paper uses FLAC3D to numerically simulate the surrounding rock stability during the excavation process using CRD. The surrounding rock adopts the Mohr-Coulomb constitutive model. The initial model adopts the shell model, and the second lining adopts the line model. The numerical simulation is shown in Figure 2.

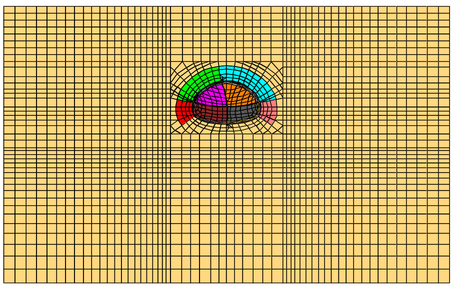

Figure 2. Calculation model diagram

The surrounding rock and support parameters are shown in Table 1.

Table 1. Mechanical parameters of surrounding rock and support

Rock and soil	Density (g/cm3)	Bearing capacity of foundation （kPa）	friction φ （°）	Cohesion (MPa)
Hard plastic clay	19	220	13.4	0.04

3.2 Analysis of results

During the construction of the tunnel structure, the plastic zone distribution of the surrounding rock is shown in Figure 3. It can be seen that with the excavation of the left guide hole, the distribution of the plastic zone mainly occurs at the arch shoulder and the arch foot, and the plastic zone at the arch is small; with the excavation of the right guide pit, the force is redistributed and excavated. Due to the disturbance of the soil part, the plastic zone on the right side changes more than the left side.

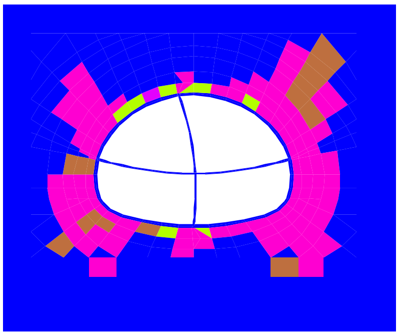

Figure 3. Distribution of plastic zone of surrounding rock

3.3 Monitoring point displacement

During the tunnel excavation process, five monitoring points are set in the tunnel vault, the left and right arch waist, and the left and right arches. The displacement changes of the monitoring points are shown in Figure 4 and Figure 5.

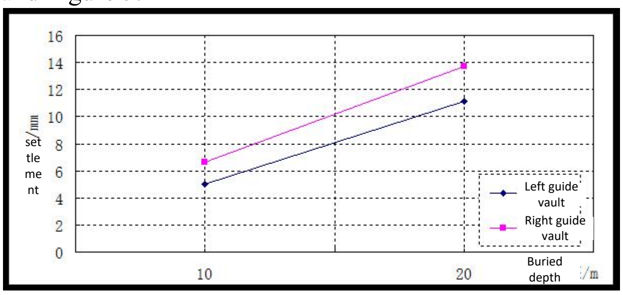

Figure 4. Vertical displacement of surrounding rock excavated by CRD method

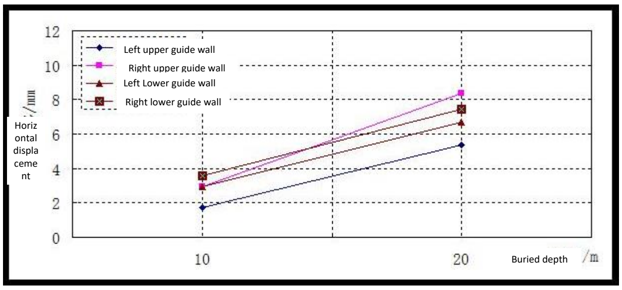

Figure 5. Horizontal displacement of surrounding rock by CRD method

When the tunnel is excavated by CRD method, the left arch is excavated due to soil excavation. The maximum settlement at the vault is 11.6 mm, and the maximum displacement of the left side wall is 6.4 mm. Under the disturbance, the settlement of the right dome is 13.9, which is 19.8%, and the maximum displacement of the right side wall is 7.8mm, which is 21.9%.

4 Conclusion

Through the comprehensive analysis of the No. 2 tunnel in the hot water pond, the plastic zone change and displacement effect of the surrounding rock during tunnel excavation are studied. Through the numerical simulation of the excavation section, the following conclusions are drawn.

(1) The tunnel should strengthen the foundation of the cave door and the reinforcement design of the top slope of the cave.

(2) The rock mass of the tunnel is relatively broken. When the tunnel is constructed, it should be short-stroke, multi-cycle, blasting, strengthening initial support, and timely lining to prevent collapse of the roof.

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