Study on the Outburst Scheme of a Shallow Buried Bias Tunnel in Yunnan

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Abstract. Improper construction of the tunnel entrance is likely to cause collapse and affect construction safety and damage the ecological environment. Aiming at the poor stability of the surrounding rock at the exit position of Xiaoguanhuan tunnel, on the basis of investigating the geology and driving scheme near the tunnel, the asymmetric distribution of axial force of cross-section structure under shallow eccentric pressure is obtained through numerical simulation, and the maximum axial force is applied at the left arch waist and right arch foot. According to the analysis results, the surrounding rock should be reinforced in time, and the import section should be dealt with in the design stage to ensure construction safety and efficiency, and provide reference for future construction.

1. Introduction

The explosive growth of expressways has led to more and more tunnels passing through the mountains and mountains. The entrances or exits of tunnels are often located in the anticlines or skews of the mountains, making the construction of the tunnels likely to cause a risk of collapse. Therefore, it is important to analyze the excavation method at the hole to stabilize the surrounding rock and smoothly enter the hole to ensure construction safety [1-3].

Domestic and foreign scholars have used the theory and numerical simulation to do the following research on tunnel tunneling: Yan Tao et al. used the principle of limit equilibrium for the left and right tunnel tunnel gates to obtain the bias rate and displacement of the surrounding rock. And the stress is larger than in the case of no slope [4]. Song Qing will use numerical simulation method to analyze a shallow buried tunnel, and obtain the stress and deformation characteristics of the supporting structure at the hole, and propose corresponding treatment measures [5].

Based on the Xiaoguanhuan Tunnel as an engineering example, this paper analyzes the geological environment of the site and analyzes the stress characteristics of the tunnel structure during the construction process by numerical simulation method, so as to propose targeted treatment measures for construction safety and normal highway [6-9].
2. General situation of Engineering
Xiaoguanshi tunnel starts and ends mileage ZK1+830~ZK4+005, length is 2175m, K1+805~K3+990, length is 2185m, long tunnel. The maximum buried depth of the tunnel is 136.52m and the right hole is 134.87m. The tunnel clearance is 15~17m, and the section form is a separate tunnel. As shown in Figure 1, the elevation of the tunnel area is 1935~2093m, and the relative height difference is 158m. It is a low-mountain landform with a structurally denuded terrain. The terrain is steep and the tunnel has a rural entrance. The dirt road leads to the inconvenient transportation; the entrance section is lush vegetation, and many pines and other forests, while the mouth section is mountainous, and the vegetation is less developed.

![Figure 1 Topography of Xiaoguanshi Tunnel NO.3](image)

2.1 Engineering geological conditions.
According to the geological data, the area where the line is located in the composite part of the frontal arc of the Yunnan-type mountain structure and the middle section of the eastern branch of the Qinghai-Tibet-Burma-type structure system. The geological structure in the area is complex, and the tunnel crossing area is dominated by Devonian limestone. The upper part of the Upper Cambrian Formation of the Cambrian is dominated by limestone, which is a low-middle mountainous landform of dissolution and erosion. The tunnel mountain is a dome mountain. The top of the mountain is smooth and round, the slope of the entrance section is gentle, and the natural slope is 15~30°. Steep, natural slope 25~45°, large terrain fluctuations.

The tunnel area belongs to the low-latitude mountain monsoon climate dominated by the mid-subtropical zone. The rainfall is abundant, the dry and wet seasons are distinct, and the climate is mild and humid. The average annual rainfall is 944.5mm. The abundant rainfall in the survey area is the main source of groundwater recharge, and due to seasonal changes, the groundwater also has obvious dynamic changes with the seasons. The annual average temperature is 17.6 °C. The annual average maximum temperature is 32 °C, and the annual average minimum temperature is -3.2 °C. The vertical zoning of the climate is obvious, and the areas at different altitudes are very different. The valley area is quite hot, with no frost all year round; alpine areas are colder, and there is often a brief snow in late winter and early spring. In general, regional climatic conditions have less adverse effects on tunnel construction and operation.

2.2 Hydrogeology
The project area is located in the Nujiang River system, in which the K3+200 is located in the Shidian River Basin. The Donghe River is the upper reaches of the Baltic River, a tributary of the Nujiang River. It flows from the north to the south through the Baoshan Basin. The Shidian River originates from the Nangao Mountain Area of the basin. The north flows through the basin, and flows from the sharp corner of Wang Street to the southwest into the Nujiang River. The basin is manually refurbished and
straightened, the longitudinal slope is small, the flow in the rainy season is large, and the dry season is cut off.

2.3 Analysis of the design of the hole section

The exit section of the exit section of the tunnel is steep, with a natural slope of 25°-45°. The exposed rock is limestone, the rock is weathered, the bedrock is bare, the joints are relatively developed, and the rock mass is relatively intact. The slope of the slope of the exit section of the tunnel is steep, and the natural slope of the slope is stable. The projection analysis of the natural slope of the slope on the slope of the exit section of the tunnel is shown in Figure 3. The existing natural slope is stable, and the slope is steeped by the slope of the natural slope (1: 0.50), where the occurrence C and the joint J1 are combined. The J2 composite structure is unfavorable to the stability of the slope, and may form a mold slip. It is necessary to pay attention to the fact that the exit section is the J1 top slope, which needs to be emphasized. Therefore, when using s: 0.50 for grading, it is recommended to use the anchor cable frame.

![Figure 2. The red slope projection of the natural slope of the slope on the exit section of the tunnel](image)

3. Numerical simulation analysis

3.1 Parameter selection

In this thesis, the model is simulated by flac3d. In the simulation process, the surrounding rock adopts the Mohr-Coulomb constitutive model, and the support adopts the elastic constitutive model. The initial branch adopts the shell unit, and the second lining adopts the solid element as shown in Figure 3. As shown, the top of the numerical simulation model is a free boundary, a fixed constraint is applied to the bottom, and a displacement constraint is applied around.

![Figure 3. Calculation model diagram](image)

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

| Table 1. Mechanical parameters of surrounding rock and support |
|---------------------------------------------------------------|
| Surrounding rock level | Gravit $\gamma$ (kN/m$^3$) | Modulus of deformation $E$ (GPa) | Poisson's ration $\mu$ | Friction $\phi$ (°) | Cohesion $c$ (MPa) |
|------------------------|-----------------------------|-----------------------------|------------------------|------------------|-------------------|
| V                      | 20                          | 1.3                         | 0.35                   | 22               | 0.12              |
3.2 Analysis of results

According to the actual engineering geological conditions, the construction simulation is carried out at the entrance of the hole. For the construction method of the CRD method, the axial force variation of the surrounding rock during the construction process is shown in Figure 4. During the construction process by CRD, with the excavation of the left and right guide pits, there is obvious bias phenomenon at the hole, and the axial force of the left arch waist and the right arch of the tunnel structure is larger. After the tunnel is completely excavated, the axial force of the tunnel biasing portion is greatly affected.

![Figure 4. Axial force distribution diagram](image)

In summary, it can be concluded that the biasing part of the tunnel is affected by the thickness of the soil during tunnel excavation. The tunnel structure is mainly affected by the tension and the force is obvious. In the construction stage, the surrounding rock reinforcement treatment of the tunnel entrance section should be strengthened early and designed. Ensure the structural bearing capacity of the biasing section to ensure the safety of tunnel construction.

4. Conclusion

Through the comprehensive analysis of the Xiaoguanshi tunnel, the optimization of the construction scheme of the double-lane shallow-buried bias tunnel is studied. Through the numerical simulation of the excavation section, the following conclusions are drawn:

(1) The construction of the tunnel section of Xiaoguanshi tunnel uses the CRD method to reduce the slope of the tunnel entrance, avoiding the damage to the ecological environment at the entrance, speeding up the construction schedule, reducing the disturbance to the surrounding rock and ensuring the construction safety.

(2) The construction of the hole should control the deformation of the surrounding rock, and the rock mass of the tunnel should be broken. The tunnel should be short-stroke, multi-cycle, weak blasting, strengthen the initial support, and timely lining to prevent the collapse of the landslide and affect the stability of the slope. The design of the top slope and the cave door foundation should be strengthened in advance to avoid landslides due to poor stability of the surrounding rock at the entrance.

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