Parameter optimization of double side wall method for soft surrounding rock tunnel

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Abstract. When the Xiaojiazhai tunnel is constructed by the double-wall method, different curvature radii have different effects on controlling the stability of the surrounding rock and speeding up the construction progress. By numerically simulating the tunnel excavation under different radius of curvature, it is concluded that R is adopted respectively. The deformation displacement of surrounding rock is $\approx 11.6\text{m} \angle 520$ and $R=5.76\text{m} \angle 1060$. The maximum horizontal displacement and vertical displacement are smaller when $R=5.76\text{m} \angle 1060$ is selected. According to the analysis results, when $R=5.76\text{m} \angle 1060$ is selected, the deformation of surrounding rock can be controlled to ensure the safety of construction and provide reference for future construction.

1 Introduction

Due to multiple excavation during double-side wall construction, the surrounding rock has been disturbed many times, which has aggravated the deformation of surrounding rock. The optimization of supporting parameters during construction is of great significance for controlling the deformation of surrounding rock. Therefore, optimizing the double-side wall support parameters is of great significance for speeding up the construction schedule and ensuring construction safety [1-3].

Domestic and foreign scholars have used the theory and numerical simulation to do the following research on the influence of tunnel excavation on the buildings above the tunnel: Deng Wei used numerical simulation to analyze the dynamic construction process of Baise Dakang Tunnel in Guangxi, and obtained the deformation and stress law of surrounding rock in different construction steps [4]. Luo Yong analyzed the construction method and main technical measures when the double-side wall method was used to break the biased surrounding rock in the Qinling Mountains. [5].

Based on the Xiaojiazhai tunnel as an engineering example, this paper analyzes the parameters of different

curvature radius when using double-side wall method by numerical simulation method. By comparing the two different supporting parameters, it is concluded that $R=5.76\text{m} \angle 106$ is adopted. It can reduce the deformation of surrounding rock and provide research support for construction safety and control of surrounding rock deformation [6-9].

2 General situation of Engineering

The starting distance of the Xiaojiazhai tunnel is K28+228~K29+435, the length is 1207m, the depth is 110.76m, the left hole is ZK28+220~ZK29+455, the length is 1235m, the short tunnel is buried at 104.5m. The tunnel has a clear distance of 21~28m and the cross section is a separate tunnel. The elevation of the tunnel area is 1569~1695m, and the relative height difference is 126m. It belongs to the dissolution and erosion low mountain landscape. The terrain is steep. The tunnel entrance has rural cement road access, convenient transportation, only the country road in the exit section, the traffic is inconvenient, the vegetation is less. development.

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Figure 1 Topography of Xiaojiazhai Tunnel

2.1 Engineering geological conditions.

According to the regional geological data of Yunnan Province, the area where the line is located is located in the composite part of the Yunnan-type mountain front structure and the middle branch of the eastern branch of the Qinghai-Tibet-Burma-type structure system. The geological structure is complex in the area, and the tectonic geological structure is the backbone structure. The long-term activity of the zonal structure, the meridional structure is a prominent structural system in the area, which belongs to the meridional tectonic system of the Sichuan-Yunnan system, mainly consisting of the compressive, torsional fracture and small amount of the same direction of the meridional tectonic system.

The stratum of the tunnel crossing area is dominated by the Silurian system of the Silurian system, the Shangrenheqiao Formation (S2r) and the Devonian system (D1) limestone. It belongs to the dissolution and erosion low-mountain landform. From the structure, the tunnel mountain is a single oblique mountain; The shape is regarded as a dome mountain, and the sides of the hole are flat slopes, which is favorable for the drainage of the hole and the stability of the slope, and the mountain shape is full and full. The slope of the entrance section is

gentle, the natural slope is $15^{\circ}\sim 25^{\circ}$; the exit section is steep, the natural slope is $25^{\circ}\sim 45^{\circ}$, 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 basin and flows through the basin from the south to the north.

3 Numerical simulation analysis

3.1 Parameter selection

In this thesis, the Midas GTS is used to numerically simulate the two different curvature radius conditions of the double sidewall method, as shown in Figure 2. which are $R=11.6\text{m} \angle 52^{\circ}$, (2) $R=5.76\text{m} \angle 106^{\circ}$, and the surrounding rock is adopted. The Mohr-Coulomb constitutive model uses an elastic constitutive model for the support and a plane strain model for the second lining.

a) $R=11.6\text{m} \angle 52^{\circ}$

b) $R=5.76\text{m} \angle 106^{\circ}$

Figure 2. Curvature radius 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)
Silty clay	18.5	240	12	0.03

3.2 Parameter selection

The whole process of construction is carried out under the condition that the surrounding rock depth is 20m. The excavation and support sequence are: 1 step excavation and support on the left guide pit → 2 left guide pit under the step excavation and support, left guide Pit initial support closure → 3 right guide pit on the step excavation and support → 4 right guide pit under the step excavation and support, the right guide pit initial support closure → 5 middle guide pit on the step excavation and support → 6 The lower step of the guiding pit is excavated and supported, and the whole ring is initially supported and closed → 7 Demolition temporary support.

3.3 Analysis of results

During the tunnel excavation process, the vertical displacement of the surrounding rock is simulated as shown by different curvature radii. When the radius R=11.6m, the maximum settlement of the vault is 13.4mm, and the maximum settlement of the vault is 15.7mm when R=5.76mm, mainly the excavation of the right guide hole and the excavation of the middle guide hole, re-disturbing the surrounding rock and accelerating the vault settlement. Although the latter has larger sedimentation than the former, the left and right cave vault settlements are smaller than the former, so the latter scheme is optimal.

Figure 3. Vertical displacement

During the tunnel excavation process, the horizontal displacement of the surrounding rock is as shown in the different radius of curvature. When the radius R=11.6m, the maximum horizontal displacement of the side wall is

7.8mm, and when the radius R=5.76m, the maximum horizontal displacement is 6.9mm. The latter's horizontal displacement is smaller than the former.

Figure 4. Surrounding rock horizontal displacement

In summary, when using the double-wall method, R=5.76m ∠106 should be selected, which can better control the deformation.

4 Conclusion

Through the comprehensive analysis of Xiaojiazhai tunnel, the influence of different radius of curvature on surrounding rock excavation is studied. Through the

numerical simulation of the excavation section, the following conclusions are drawn:

- (1) The Xiaojiazhai tunnel should use the curvature form of R=5.76m ∠ 1060 to prevent excessive deformation of surrounding rock and strengthen monitoring and measurement.
- (2) The tunnel entrance and exit sections are shallowly buried, and the support design is strengthened to prevent construction problems such as roof collapse.

(3) When the water volume in the tunnel is large, it is recommended to use advanced pre-grouting to strengthen and strengthen the drainage measures inside the cave.

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