

# Evaluation of a Tunnel Underpass Building Scheme in Yunnan Province

Xiwen Yang<sup>1</sup>, Tiefeng Zhou<sup>1</sup>, Xiangyang Cui<sup>3\*</sup>, Hongyan Guo<sup>2</sup> and Ke Li<sup>2</sup>

<sup>1</sup>Shidian Baoshi Expressway Investment and Development Co., Ltd, Baoshan, 678000, China

<sup>2</sup>China Merchants Chongqing Communications Technology Research & Design Institute Co., Ltd, Chongqing, 400000, China

<sup>3</sup>Chongqing Jiaotong University, Chongqing, 400000, China

**Abstract.** Side-crossing residential buildings in tunnel construction may lead to building subsidence, structural damage by tension and affect the use of buildings. Aiming at the structural damage caused by the side-crossing structure of Re Shuitang Tunnel NO.1, by simulating the influence of tunnel construction on the building, it is concluded that the surrounding rock above the tunnel will be deformed when the tunnel crosses the building. The maximum horizontal displacement is 0.64 mm and the maximum vertical displacement is 4.43 mm. According to the analysis results, the surrounding rock above the tunnel should be strengthened in time, and attention should be paid to the impact of blasting on residential buildings, so as to ensure the safety of buildings and provide reference for future construction.

## 1 Introduction

Tunnel passing through residential buildings may lead to settlement of residential buildings in the construction process. In serious cases, cracks appear in buildings, which will affect the stability of the structure and lead to collapse risk. Therefore, it is of great significance to analyze the impact of tunnel excavation on the structural stability of built residential buildings, to ensure that the impact on the buildings is within the safe range, and to ensure the 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: Dong Yunpeng and others used MIDAS-GTS numerical simulation software to study the seven-storey frame structure office building above a tunnel. It was concluded that the soil under the office building should be reinforced first, and the location of the office building should be excavated away from it to ensure the minimum impact on the building. [4]. Zhong Yujian and other subway lines 2 are wearing a building on the side of the building. The finite element model is used to study the stress and deformation of high-rise buildings. It is concluded that the subway construction process will lead to a 16% increase in surface settlement. Increased force by 50% [5]

This paper relies on the Re Shuitang Tunnel NO.1 as an engineering example. The numerical simulation method is used to analyze the deformation of the surrounding rock during the tunnel crossing the residential building. The safety of the building is demonstrated by the deformation of the surrounding rock above the tunnel, so as to propose targeted treatment.

These measures provide research guarantee for construction safety and normal operation of expressway. [6-8].

## 2 General situation of Engineering

The Re Shuitang Tunnel NO.1 starts from the right hole K8+110~K8515, the length is 405m, the buried depth is 90.49m; the left hole ZK8+112~ZK8+510, the length is 398m, the short tunnel, the buried depth is 81.80m. The tunnel has a clear distance of 22~25m and the cross section is a separate tunnel. The elevation of the tunnel area is 1802~1897m, and the relative height difference is 95m. It is a low-neutral landform with dissolution and erosion. The terrain is steep. The entrance section of the tunnel has rural cement roads leading to convenient transportation. The surface of the import section is farmland; the exit section only has rural dirt roads. The surface is mountainous. Vegetation in the import and export section is not developed.

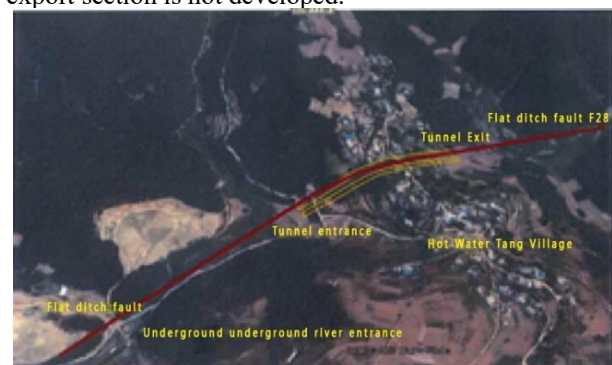


Figure 1 Topography of the Re Shuitang Tunnel NO.1

\*Corresponding author's e-mail: 1559039300@qq.com

## 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 mainly composed of argillaceous siltstone and marl in the upper part of the Baoshan Formation of the Cambrian system. It belongs to the dissolution and erosion low-mountain landform. The tunnel mountain is a dome mountain. The mountain top is flat and round, and the slope of the entrance section is gentle. The natural slope is 25~31°; the exit section is slow, the natural slope is 25~31°, and the terrain is undulating.

## 2.2 Hydrogeology

The project area is located 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

The paper uses the Midas GTS to numerically simulate it. As shown in Fig. 2, in the simulation process, the surrounding rock adopts the Mohr-Coulomb constitutive model, the support adopts the elastic constitutive model, and the second lining adopts the plane strain model. The surrounding rock and support parameters are shown in Table 1.

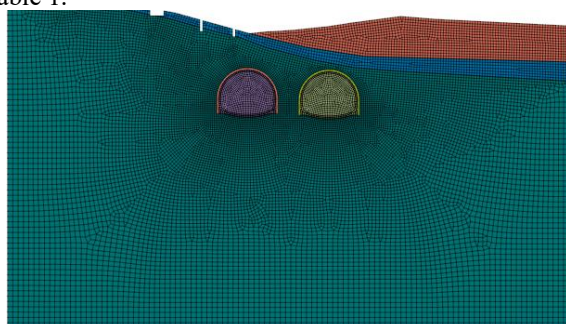


Figure 2. Calculation model diagram

Table 1 Mechanical parameters of surrounding rock and support

Rock and soil	Natural density (g/cm <sup>3</sup> )	Bearing capacity of foundation (kPa)	Friction angle $\varphi$ (°)	Cohesion (MPa)
Silty clay	20	250	20.3	0.36
Muddy siltstone	23.5	280	35	
Stucco	25.5	500	55	

### 3.2 Analysis of results

After the completion of the tunnel structure, the displacement distribution of the surrounding rock is shown in Figure 3. The excavation of the rock mass leads to a decrease in the binding force between the soils. The soil above the tunnel has a certain slope, which causes the horizontal displacement of the soil to increase. The left tunnel structure produces horizontal deformation in the tunnel under the action of surrounding rock reaction force. The right tunnel is excavated by the left tunnel. The left tunnel waist and arch are subject to large horizontal displacement. The maximum displacement is 0.64mm.

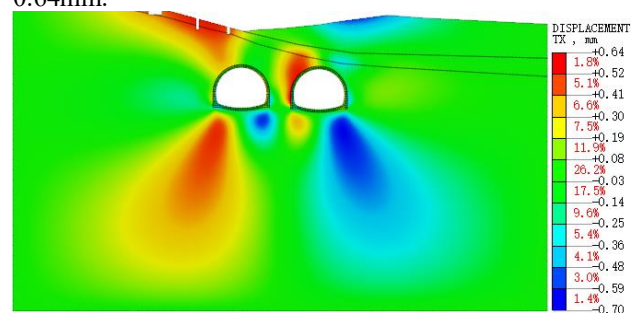


Figure 3 Horizontal displacement distribution of surrounding rock

After the tunnel structure is completed, the vertical displacement of the surrounding rock is shown in Figure 4. Due to the excavation of the tunnel structure, the surrounding rock has increased the disturbance to the surrounding rock, causing vertical deformation of the surrounding rock with a maximum displacement of 4.43 mm.

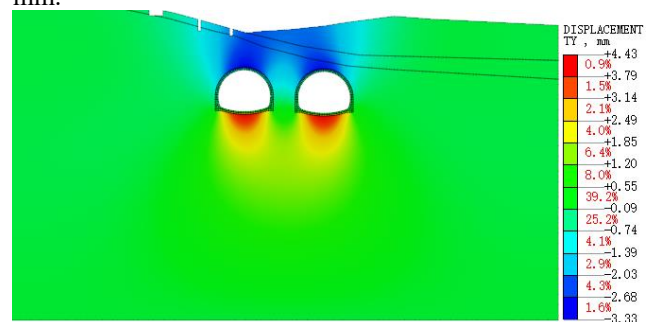


Figure 4 Vertical displacement distribution of surrounding rock

In summary, it can be concluded that due to the disturbance of the soil during tunnel excavation, in the construction stage, the second lining should be applied in time after the surrounding rock is stabilized to prevent

excessive deformation of the surrounding rock and ensure the safety of the tunnel construction.

#### 4 Conclusion

Through the comprehensive analysis of the Re Shuitang Tunnel NO.1, the influence of the construction of the two-lane tunnel on the soil above the tunnel is studied. Through the numerical simulation of the excavation section, the following conclusions are drawn.

(1) During the construction of tunnel blasting excavation, the amount of explosives should be strictly controlled, and the possibility of damage to the top of the building caused by blasting vibration should be considered.

(2) The tunnel is a short tunnel. Due to the fracture of the rock mass and the requirements of the construction period, the distance between the two working faces should be strictly controlled to avoid the superposition effect of the two-hole stress release ring.

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