Journal of Geology & Geosciences
ISSN: 2381-8719
Wu et al., J Geol Geosci 2014, 3:3
DOI: 10.4172/2329-6755.1000156

Research Article Open Access

Analysis of the Engineering Geology and Deformation Control in Highway Tunnel

Wu K*[1], Zhang K[2], Zheng-yin L[2] and Wang CJ[2]

[1]*Geotechnical and Structural Engineering Research Institute, Shandong University, Jinan, Shandong 250061, China*
[2]*Shandong Provincial Communications Planning and Design Institute, Jinan, Shandong 250031, China*

Abstract

The tunnel engineering geology and deformation control is one key of the basis for the tunnel engineering construction and operation management and safety technology security. However, it is becoming one of the bottleneck problems for underground tunnel construction project information to be solved accurately and fast to assess the stability of surrounding rock because of the special environment in the tunnel construction and acquiring the deformation information of surrounding rock. Relying on the geology analysis and the surrounding rock deformation control of research work on the ZIJING mountain tunnel in DAGUANGNAN highway in HUBEI province of Chinese, it is investigated to combine the geological information with field monitoring organically which is in order to determine the possible geological damage during tunnel construction. Then, based on the monitoring data processing and analysis, the deformation control standard of the tunnel geological disaster area is putted forward. Those research works are providing important reference basis for similar projects.

Keywords: Tunnel; Stability; Geology; Monitoring measurement; Deformation control

Introduction

Tunnel engineering is a very complicated system which has always been known as "concealed work" and "grey system". Especially for the tunnel in geological disaster prone areas, the geology and deformation control are more complicated and important. And timely grasping the tunnel geology and surrounding rock deformation information is very important in construction process. In recent years, many researchers have been studied about the tunnel surrounding rock deformation measurement, which usually are the use of surrounding rock deformation of the surrounding or vault subsidence observation to monitor the safety of the tunnel construction. LIU Xuezeng was based on several field monitoring data of the highway tunnels to discuss the characteristics of different surrounding rocks by statistical analyzing a large number of surrounding rock deformation [1]. HU Da was discussing the change regulation of the surrounding rock deformation with the excavating depth in highway tunnel [2]. SU Yonghua was obtained the general form of the function of tunnel surrounding rock stability based on the surrounding rock deformation criterion in tunnels [3]. And some researchers have found a lot of similar work [4-6]. However, those research works are very few considering the combination the geology with surrounding rock deformation. In the paper, according to the surrounding rock deformation monitoring and control of research work on the ZIJING mountain tunnel in DAGUANGNAN highway in HUBEI province of Chinese, it is investigated to combine the geological information with field monitoring organically which is in order to determine the possible geological damage during tunnel construction. Then, based on the monitoring data processing and analysis, the deformation control standard of the tunnel geological disaster area is putted forward.

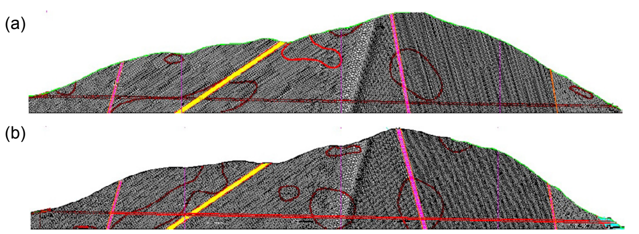

Figure 1: (a) Tunnel geology left line. **(b)** Tunnel geology right line.

The ZIJING Mountain tunnel is the separated tunnel which the biggest buried is 360.5 m and total length is 2298 m. The area of tunnel is the hilly topography tectonic erosion-corrosion and the surrounding rock are mainly limestone, which causes the karst developing, mostly Karst depression, cave, karren, solution groove, sinkholes and so on. The geological condition is very complex and the construction safety risk is very big.

Engineering Geology Analysis

The tunnel area tectonic is as one part fold bundle of the Yangze para platform and Taizimiao platform, which is located at the plunging crown of Damu mountain anticlinorium. The tunnel is crossing the secondary folds Xu Lizhong~Guojiachong syncline south which axial is NEE and hub to NEE plunging. The two wings of the silurian-devonian sandstone and shale, the core part is the carbonate rocks of two fold and three fold. The exposed strata of tunnel from import to export are T_1d^2, T_1d^1, $P_1m + P_1q$, C_2h, S_3m and so on. Influenced by tectonic action, the secondary structures are well-developed, small and medium-sized wrinkling is well-developed in rock. And one secondary anticline structure is developing at ZK221+520 in the tunnel which causes the development of fracture.

The Figures 1 and 2 are tunnel geological analysis and Tunnel geological remote sensing. Based on remote sensing interpretation, geological survey and geophysical exploration results, it can be founded that: (1) the fault named RF2 (Guojiachong) is developing in the syncline core, to about NE60°, about 2.3 meters wide and the

***Corresponding author:** Wu K, Geotechnical and Structural Engineering Research Institute, Shandong University, Jinan, Shandong 250061, China, Tel: 86 531 8836 4701; E-mail: wk4223@163.com

Received March 06, 2014; **Accepted** April 25, 2014; **Published** April 29, 2014

Citation: Wu K, Zhang K, Zheng-yin L, Wang CJ (2014) Analysis of the Engineering Geology and Deformation Control in Highway Tunnel. J Geol Geosci 3: 156. doi: 10.4172/2329-6755.1000156

Citation: Wu K, Zhang K, Zheng-yin L, Wang CJ (2014) Analysis of the Engineering Geology and Deformation Control in Highway Tunnel. J Geol Geosci 3: 156. doi: 10.4172/2329-6755.1000156

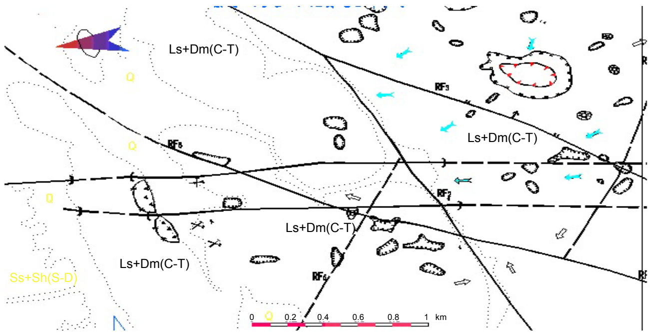

Figure 2: Tunnel geological remote sensing.

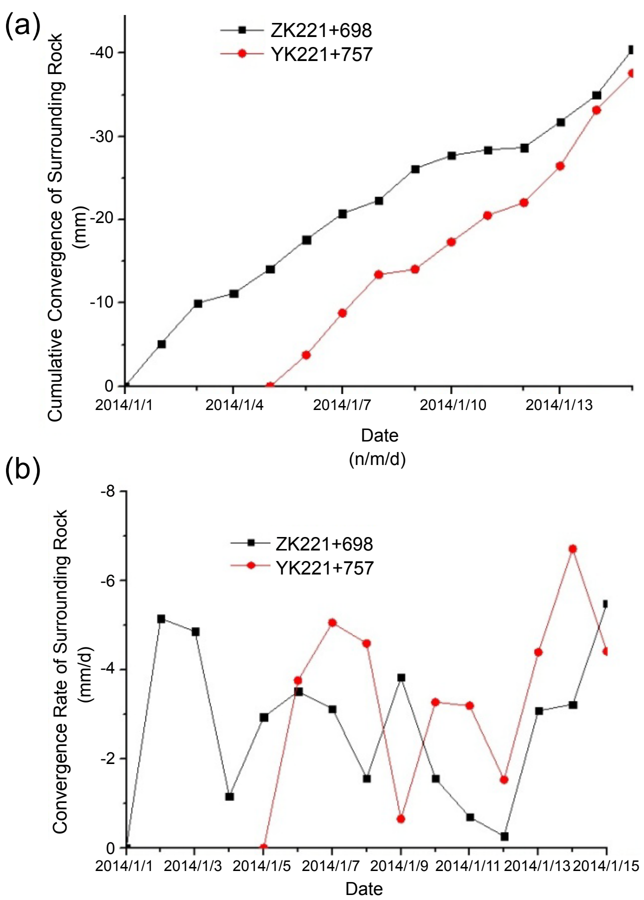

Figure 3: Curves of horizontal convergence of surrounding rocks at the left line ZK221+698 or the right line YK221+757.
(a): Curve of cumulative convergence
(b): Curve of convergence rates

fracture length is more than 6800 m. It is the compression fault and the regional rich water fault. The fault is as the water delivery or water-collecting gallery of groundwater in tunnel area which controls the overall flow of the tunnel groundwater. According to the remote sensing interpretation, the fault is located in the left line ZK220+215 or the right line near YK220+235. (2) And another fault F1 is located in the left line ZK220+630 or the right line near YK220+610, which rock is broken and karst is developing, towards NNE, N, around 70°~80° angle. (3) At the left line ZK221+700 or the right line YK221+760, one fault F2 is developing which is a compressive shear fault, strike 125°~210°, tended to the southeast, angle of 75°~85°. The bandwidth of fault is about 3.5 meters and the fracture length is more than 3600m. (4) At the left line ZK222+375 or the right line YK222+350, it has the next fault named F3, fault to SEE, S, angle 70°~80°. (5) In addition, according to the remote sensing interpretation, the tunnel has two groups of "X" type fault to NE and NW-RF1 and RF5, RF6 and RF4, which control the development and distribution of karst.

Based on the above analysis, it can be obtained that the fault F2 is easy to form groundrivers or other geological damages with tunnel sections which is because that the fault of engineering mechanical properties is poor and at the top of the fault in mountain is able to form ditch constantly to the tunnel water gushing through fault.

Deformation Control Analysis

According to the geology analysis, the monitoring measurement of surrounding rock is carried out, emphasis on the sections around at the left line ZK221+700 or the right line YK221+760. Figures 3 and 4 are the curves of horizontal convergence and sedimentation of surrounding rocks at the left line ZK221+698 or the right line YK221+757 from January 1st to 15th in 2014.

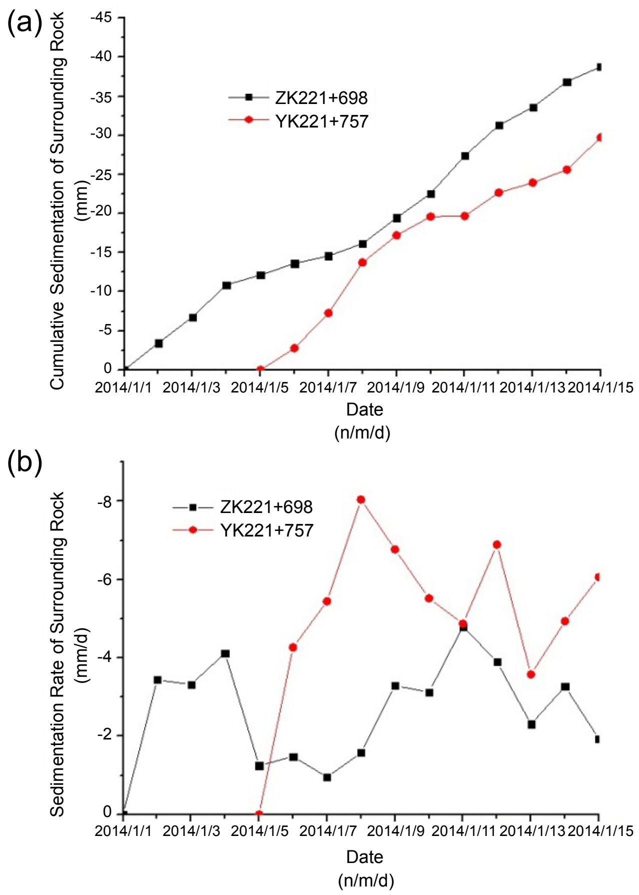

Figure 4: Curves of sedimentation of surrounding rocks at the left line ZK221+698 or the right line YK221+757.
(a): Curve of cumulative sedimentation
(b): Curve of sedimentation rates

It can be observed that: (1) the cumulative horizontal convergence of surrounding rocks at the left line ZK221+698 or the right line YK221+757 are becoming increasing as the straight line with the date. And, the maximal values are 40.46 mm and 37.58 mm respectively. However, the curves of convergence rate are not stability and the magnitudes of vibration are big. Those mean that the surrounding rocks are not stability and need to strengthen the supports. (2) The sedimentation of surrounding rocks at the left line ZK221+698 or the right line YK221+757 are increasing quickly as the straight line with the date. And, the maximal values are 38.79 mm and 29.73 mm respectively. At the same time, the curves of convergence rate are not stability and the magnitudes of vibration are big. Therefore, the horizontal convergence and sedimentation of surrounding rocks at the left line ZK221+698 or the right line YK221+757 are obviously changing and unstability, which would easily cause the collapse during the tunnel construction if the support was not strengthened. The results of field monitoring measurement are similar with those of geology analysis.

Conclusions

Based on the geology analysis and surrounding rock deformation control of research work, it is investigated to combine the geological information with field monitoring organically which is in order to determine the possible geological damage during tunnel construction. The results are following:

- The engineering geology is very important for tunnel construction. Through the geology analysis, the possible geologic damage is founded, which will provide early warnings for builder.
- The monitoring measurement is one important method for deformation control of surrounding rocks. Based on analyzing the curves of horizontal convergence and sedimentation of surrounding rocks at different sections, the deformation rule of surrounding rock could be mastered and early warning the damages.

Therefore, it is the most effective method of combining the geology analysis and deformation control for the possible damages during tunnel construction.

Acknowledgement

This work was financially supported by the National Natural Science Foundation of China (51308323), Shandong Province Natural Science Foundation (ZR2011DQ008) and Transportation technology projects of Shandong Province (2011-26).

References

1. Xuezeng L, Jingwei S, Xiaoxing W (2009) Statistical analysis on time effects and evaluation index of deformation stability to NATM surrounding rock deformation. China Civil Engineering Journal 42: 115-120.
2. Da H, Jie L, Qingguang Y, Yingxiang W (2010) The surrounding rock deformation law and the regression analysis of highway tunnel. Highway Engineering 35: 5-8.
3. Yonghua S, Zhengdong L, Wenguo W (2010) Failure probability analysis with SVM for tunnel surrounding rock mass deformation. Chinese Journal of Applied Mechanics 27: 804-808.
4. Bucher CG (1990) A fast and efficient response surface approach for structural reliability problems. Structural Safety 7: 57-66.
5. Rajashekhar MR, Ellingwood BR (1993) A new look at the response surface approach for reliability analysis. Structural Safety 15: 205-220.
6. Xiaohong L, Hongtu W, Jianqing J, Chunhe Y, Guozhong H, et al, (2005) Ultimate displacement discrimination of stability and reliability analysis of surrounding rocks of tunnel and underground engineering. Rock and Soil Mechanics 26: 850-854.