Research on the Construction and Living Quarters Slope Stability Induced by Excavating the First and Secondary Platforms

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Abstract. Research on slope excavation and control measures has important implications for engineering safety. Based on a living station slope of A Tunnel project of Yunnan Province. On the basis of geological survey results and indoor geotechnical mechanics experiment, the 3D geological model was established by three-dimensional finite difference method FLAC3D. The slope stability and deformation law are analyzed through excavating the first and secondary platforms. The analysis results provides a reference for slope optimization design and scientific construction.

1. Introduction
With the implementation of the national One Belt And One Road strategy. A large number of transportation, water conservancy, hydropower, construction and other infrastructure are accelerating construction [1-2]. Yunnan, as a radiation center facing South Asia and Southeast Asia, is accelerating the construction of five major infrastructure networks. Along with a lot of infrastructure construction, inevitably produces a lot of engineering slope. The stability of these massive engineering slopes seriously restricts economic and social development, affecting people's life and property and security [3-4]. The research on excavation plan and control measures of engineering slope is of great significance to national economic development and people's life and property safety [5]. Based on the survey of A tunnel project construction in Yunnan and living quarters slope as the background, the numerical simulation method analyzes the causes of slope excavation surrounding rock displacement and stress evolution rule, the stability of the slope is discussed under the supporting measures, research results of the project provides reference to optimize the design of the excavation and supporting scheme.

2. Engineering situation
A Tunnel project construction and living quarters Located in Xundian County, Kunming City, belong to the monsoonal climate of low latitude subtropical plateau in northern latitude. The water system is
the Jinsha River. The geological structure is complex, the formation is more, the zone is affected by crustal movement and natural weathering, faults and folds, ground breaking, mountain peaks, ravines crossbar, relatively high difference is bigger. Surface water and groundwater are abundant, the Lului River has clear water all year round. Tunnel entrance and bridge area belong to tectonic erosion of zhongshan deep valley landform area, the terrain is steep on both sides of the slope, and the slope of the entrance is about 40 to 60 degrees, vegetation is relatively sparse.

The area near the exit of the tunnel is steep hill, gully, narrow, there is no gentle terrain within 1500m near the entrance of the cave. Tunnel construction and life station are selected near the entrance to the right side in the range of 20m ~ 170m. The slope is excavated and the retaining wall is constructed, the method of filling out 6.06 mu is used for tunnel construction and life resident construction. The topography of this area is relative to the whole slope is more gentle, the slope is about 40 degrees, the site is close to the hole, It is convenient for construction personnel to enter the hole construction and convenient for the transportation of materials and materials needed in various holes.

Construction and living location is on the right side of A tunnel project YK87 + 710 ,and it is on the left side of the construction main road BDK1+190-BDK1+360. The site has living area, rebar processing area, machinery parking area and transformer, air compressor, it is divided into three layers, one of which is the first and the secondary platform belongs to the excavation side slope, the tertiary platform belongs to half - dug and half - filled slope. At the same time, the tertiary platform is supported by 8m high slurry block stone retaining wall. Site covers an area of 11. 64 mu.

3. The establishment of the model and parameter selection

3.1. The establishment of the model

Numerical simulation model of the whole station is established, the length of model is 70m (The width of the slope), and height is 81m. In order to optimize the grid at the same time also can meet the requirements of accuracy, the excavation and filling and the surrounding parts of the unit is encrypted distribution. The total units of model is 66430, the total nodes of model is 70929. Simulation model is shown in figure 1, and retaining structure is shown in figure 2, lateral brace layout is shown in figure 3. In left and right boundary of the model, X direction displacement is fixed, in the front and back boundary of the model, Y direction displacement is fixed, and at the bottom of the model, displacement is fixed. Take the vehicle load and the combination of the surrounding building load as the initial conditions. Mohr-Coulomb strength criterion is adopted [5-7].
3.2. Geotechnical mechanics parameters

Geotechnical mechanics parameters were determined according to “Geological survey report on the construction and residential slope of A Tunnel project”. Table 1 shows geotechnical mechanics parameters of numerical simulation.

| Geotechnical name             | Density (g/cm³) | Cohesion (kpa) | Internal friction angle(°) | Poisson's ratio | Deformation modulus (MPa) |
|------------------------------|-----------------|----------------|----------------------------|-----------------|----------------------------|
| Fill                         | 1.80            | 15             | 24                         | 0.33            | 0.012                      |
| clay                         | 1.80            | 18             | 25                         | 0.33            | 0.028                      |
| Crushed clay                 | 1.90            | 24             | 20                         | 0.30            | 0.016                      |
| Strong weathered sandstone   | 2.10            | 34             | 25                         | 0.28            | 3.0                        |
| Medium weathered limestone   | 2.50            | 41             | 40                         | 0.24            | 6.0                        |
| Weakly weathered limestone   | 2.40            | 50             | 45                         | 0.25            | 11                         |
| Middle weathered sandstone   | 2.20            | 35             | 42                         | 0.20            | 2.8                        |

4. Calculation results and analysis

![FLAC3D 3.00](image)

Figure 2. The displacement of X direction

According to the calculation results, after excavating and uninstalled the platform, Due to the destruction of the original stress field balance state, the stress field of the slope has been redistributed. The rock body must seek a new equilibrium state. In the process, it causes deformation of the rock mass. Figure 2 and Figure 3 are respectively the displacement distribution law after the excavation of the first and secondary platform. The calculation results show that after the formation of the first secondary platform. The maximum horizontal displacement of the slope is 3.69cm, which appears on the secondary platform. The local horizontal displacement of the slope surface and the secondary
platform is 2cm. Horizontal displacement occurs on the lower slope of the secondary platform. The maximum displacement is 3cm. Once the platform has been excavated and completed, due to excavation unloading, the platform surface has a certain uplift, the maximum uplift of the secondary platform was 11.04cm, and the maximum uplift of the primary platform is 3cm. So after the platform has been excavated. The upper part of the platform should be compacted, increasing the compactness of the platform soil and the bearing capacity of the foundation.

Figure 3. The displacement of Z direction

Figure 4. The maximum principal stress

The main index of slope stability is the magnitude and state of the stress in the slope. Figure 4 and Figure 5 are the maximum principal stress and the minimum principal stress distribution map of the
slope surrounding rock after the excavation of a secondary platform. The results can be found, the contour map of the main compressive stress is stratified. As the depth increases, the main compressive stress increases gradually, which caused by the increasing weight of the overlying strata. Under the excavation and unloading of the first and secondary platform. The maximum principal stress and minimum principal stress of the lower strata of the secondary platform decreased. On the top of the platform, the tensile stress appears in the slope area. It is easy to destabilize the rock mass under the action of tensile stress. The maximum tensile stress appears on the top level of the platform, and the maximum tensile stress is 1.099Mpa. The compressive stress concentration appears in the local area of the slope foot, and the maximum pressure should be 3.53mpa. The position of tensile stress concentration should be easy to appear on the slope and foot, which should increase the bolt depth properly. Reduce the distance between anchor bars. And increase the concrete spray layer thickness to ensure the stability of the slope.

Figure 5. The minimum principal stress

5. Conclusion
On the basis of analysis of field research and engineering geological general situation, 3D finite difference model is established by FLAC3D. Through analysis to stress field, displacement field and supporting structure stability, results show that the living station slope of a tunnel project instability does not occur, and the slope stability is well. Which has a certain guiding significance to the slope design and production safety.

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