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Authors	Min Yong, Wei Shen Zhu, Da Jun Yu, Li Ge Wang
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Study on the Stability of Underground Constructions with Different Locations in Alpine and Gorge Region

Min Yong[a], Weishen Zhu[b], Dajun Yu[c], Lige Wang[d]

Geotechnical and Structural Engineering Research Center, Shandong University, Jinan, People's Republic of China. 250061

[a]16656563@qq.com, [b]zhuw@sdu.edu.cn, [c]djyu2002@126.com, [d]barcelonawlg@163.com

Keywords: Mountain Slope Angle; Underground Construction; Numerical Analysis; Initial Stress; Joint-Rock Mass; Different Location

Abstract. The reasonable selection of a location for underground structures has a great influence on the stability of surrounding rock masses, especially when the construction is built in the alpine and gorge regions. In general, the higher and steeper the mountains are, the more significant the effect is. In this paper, numerical analysis was carried out to study the stress distribution characters in the mountain with different slope angles of 30 °, 45 ° and 60 °. The results show that, the initial vertical component of stress field can not be directly determined by the buried depth when the slope angle is greater than 30 °. Meanwhile, numerical results indicate that is unfavorable for the structural stability when the underground caverns are constructed in the stress concentration areas of mountains with high slope angle. Moreover, some conclusions and recommendations were proposed for the design of underground constructions.

Introduction

Dozens of hydropower stations, as well as many other underground structures, will be built in western China in coming years, which are mostly constructed in the alpine and gorge region. So the initial stress distribution characteristics that have important influce on the stability of underground structures are greatly affected by the terrain and the slope angle of mountains in these areas. However, this problem has rarely been systematically studied. Currently, in the underground structures, the direct height h from the mountain surface to the top of the main building is taken as the basis parameter of initial stress calculation according to the conventional practice. The vertical initial stress is as $\sigma_y = \gamma h$. However, the steeper the slope is, then the larger the dispersion will be. In this paper, the initial stress characteristic of different slope angles were studied first, then its influence on the stability of surrounding rock were discussed with different positions of underground structures.

Influences of Different Mountain Slopes on the Distribution of Vertical Initial Stress

At underground engineering design stage, some on-site stress measurements are usually done to get basic data for judging the initial stress field, but the number of measurement points is very limited. Moreover, these measured values usually have considerable dispersion. Therefore, the simulation of this stress field will lead to possible errors. In this section, the calculations have been done under the gravity stress field with different mountain slope angles. A two-dimensional model of plane strain condition was taken for calculation. The parameters of rock mechanics see Table 1. The mountain calculation domain see Figure 1.

The defination of parameter N is as follows,

$$N = \sigma_y / \sigma_y' \quad . \tag{1}$$

$$\sigma_y' = \gamma h \quad . \tag{2}$$