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Analysis and Research on Slope Stability of Qipanling Dump

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Abstract

This article is to study the slope stability of the Qipanling dump site, using numerical simulation methods for calculation and analysis. The analysis results show that the soil layers of the taken profile are in a stable state, comply with the safety level requirements in the specification, and have the function of safe rotation. Combining the calculation results with the geological conditions, relevant supplementary suggestions are put forward for the slope stability during the construction process of the dumping site, so as to improve the safety reserve.

Keywords

Dump, slope; Stability; Strength reduction method.

1. Introduction

The operation process of open-pit mines is carried out under the combined action of many complicated factors, such as grade distribution, ore body shape, production technology and so on. However, the author believes that the stability of the dump slope is one of the most important factors affecting the normal operation of open-pit mines. In the production of open-pit mines, whether the slope of the dump has sufficient stability determines whether the mine can operate reasonably [1-2]. After the excavation yard slope experiences people's mining activities, and natural phenomena such as wind, rain, and snow, it is likely to induce slope slippage accidents. How to prevent disasters such as landslides and mudslides has now become an important research topic [3-4]. At present, experts and scholars have conducted research in this area. Taking the Baima Iron Mine II dumping site as the background, Cun Yinhua used the limit equilibrium method to study the dumping site slope stability [5]. Taking the dump of Pingshuo East Open-pit Mine as the background, Wang Yantao used the limit equilibrium method to study the unstable position of the slope and its safety factor [6]. This article will take the Qipanling dump site as the background and use the strength reduction method to study the slope stability of the Qipanling dump site.

2. Project Overview

2.1. Geological Condition

The open-pit iron mine is located in the central part of Liaoning Province, 70 kilometers from Anshan City in the southwest and 40 kilometers from Liaoyang City in the northwest. It is under the jurisdiction of Gongchangling District of Liaoyang City.

As shown in Figure 1, It is located in the northwest of Qianshan, the southwest branch of Changbai Mountain. Except for the large alluvial plains in the northwest, most of them belong to low mountains and hills, which belong to the topography of the late middle age. The peak height is generally 260~500m above sea level, the highest peak is 565m above sea level, the lowest riverbed elevation is 220m, and the relative height is 345m. The slopes of the mountains are small, mostly 10-20°, with strong denudation, and most of the valleys are U-shaped.

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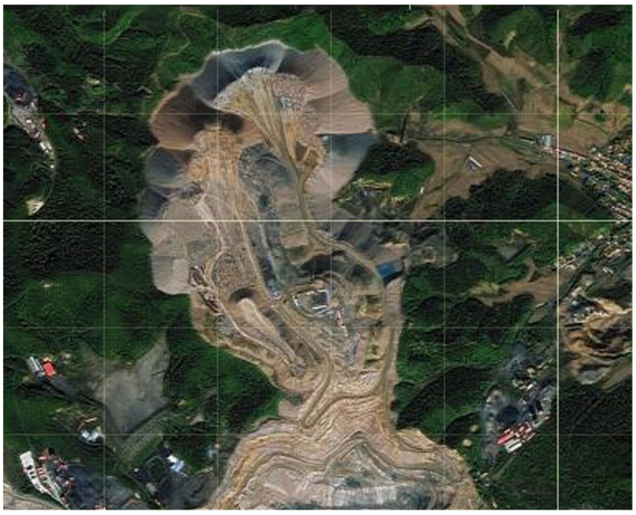

Figure 1. Topographic map of Qipanling dump

2.2. Geographical Structure

The dumps in Gongchangling are affected by regional structure, and fold structures and fault structures are developed. Qipanling, 320 and Dayanggou dumping sites are located outside the structural development area of the mining area.

1. Fold structure.

The dumping site is located in the southwest wing of the Gongchangling anticline in the regional secondary structural unit, and a gently sloping compound syncline is developed. The wave-like fold structure is formed by the fourth syncline and three anticlines.

2. Fault structure.

Dalizi Transverse Fault (F1): This fault is located at the boundary between the second mining area and the southern circle 100~140m southeast of the southeast end of Line 28. It is the largest transverse fault in the mining area. To the northeast and southeast, the inclination angle is 65°~90°, and the horizontal cutting distance is greater than 100 meters. The lithology of the two plates is relatively large and it is difficult to compare.

3. Slope Stability Analysis

3.1. Theoretical Basis

The basic idea of intensity reduction was first proposed by the British scientist Zienkiewicz, and it has not been well developed in the past due to technical limitations and other reasons. With the application and development of computer technology, the application of the strength reduction method has become more and more extensive, and has gradually become a new trend in calculating the safety factor of slopes.

The advantage of this method is that it can calculate the slope of complex terrain and geology. The constitutive relationship of rock and soil and the influence of deformation on stress are considered; the process of slope can be simulated; therefore, defects caused by artificial assumptions are avoided, and the shape and position of the sliding surface are not required to be assumed.

In view of the superiority of the strength reduction basis, this slope stability analysis adopts the strength reduction method. The safety factor obtained by this method is basically the same as that obtained by the limit equilibrium method. The safety factor of slope stability in the strength reduction method is defined as the ratio of the actual shear strength of the slope rock and soil to the strength after reduction when it is on the verge of failure. See formula for specific reduction formula (1), (2).

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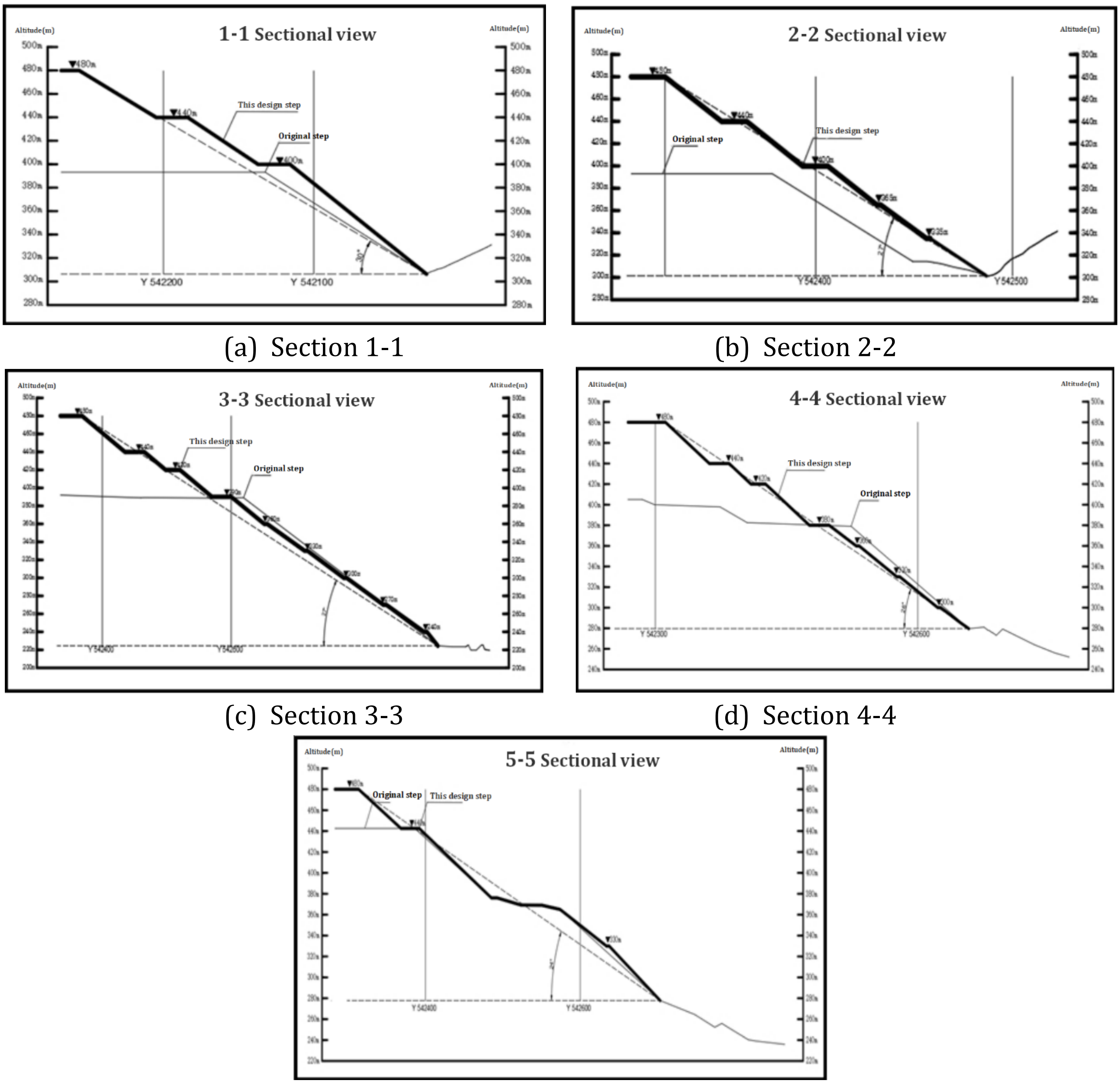
$$c' = \frac{c}{F_{trial}}. \tag{1}$$

$$\varphi' = \tan^{-1}\left(\frac{\tan\varphi}{F_{trial}}\right). \tag{2}$$

c' represents cohesion after reduction; c is cohesion; φ' represents reduced internal friction angle; φ is internal friction angle; F_{trial} is the mean value of reduction factor.

3.2. Sectional Division

According to the dumping plan provided by the mining profession, five representative sections were selected for the slope of the Qipanling dump, The numbers are 1-1, 2-2, 3-3, 4-4, 5-5. As shown in Figure 2.



(a) Section 1-1 (b) Section 2-2

(c) Section 3-3 (d) Section 4-4

(e) Section 5-5

Figure 1. Slope profile

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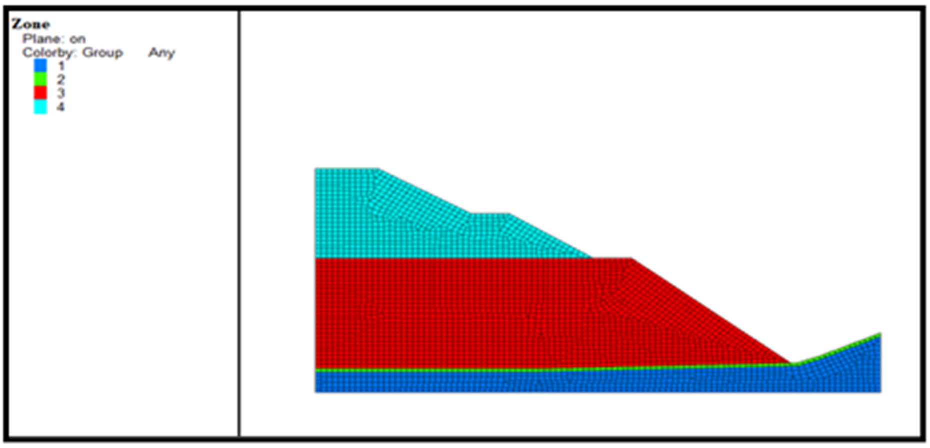
3.3. Slope Stability Analysis

The Qipanling dumping site of Gongchangling Open-pit Iron Mine, the first stage dumping platform elevation is 240m, the final dumping site elevation is 480m, the stacking height is not more than 240m; the step slope angle is 33.7°, and the final slope angle not more than 30°.

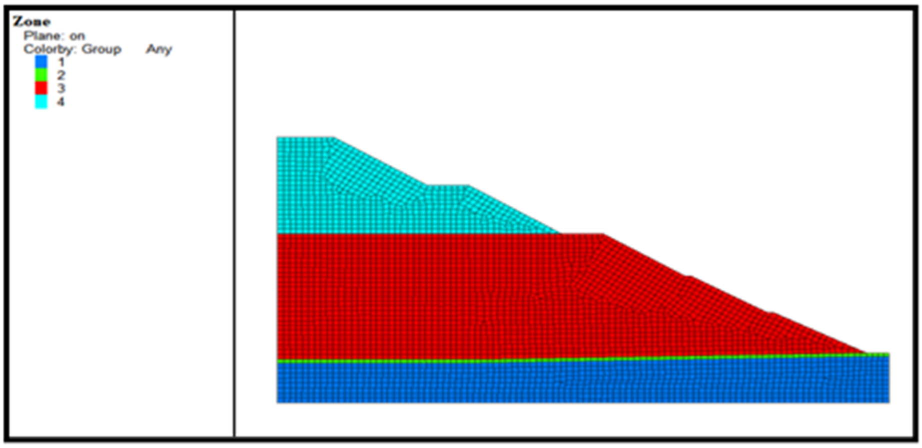
The numerical calculation of the profile adopts the Mohr-Coulomb constitutive model, the mesh is mainly hexahedron, and tetrahedron is supplementary. The section calculation model, the number of nodes, the number of grids, and the safety factor are shown in Table. 1. Analyze and calculate the model according to the slope stratum distribution, initialize the deformation variables, and form the original in-situ stress field. On the basis of the stress field, input the corresponding stratum physical characteristic parameters and boundary conditions. The slope calculation model is shown in Figure 3. The calculation results are as follows:

Table 1. Parameters of slope calculation model of dump

Profile	Calculation model (m)	Number of nodes	Number of grids	Safety factor
1-1	400×40×200	34045	29720	1.33
2-2	400×40×220	38984	34220	1.38
3-3	600×40×290	67958	60100	1.35
4-4	560×40×260	60808	53750	1.45
5-5	660×40×270	66737	58890	1.40



(a) Section 1-1



(b) Section 2-2

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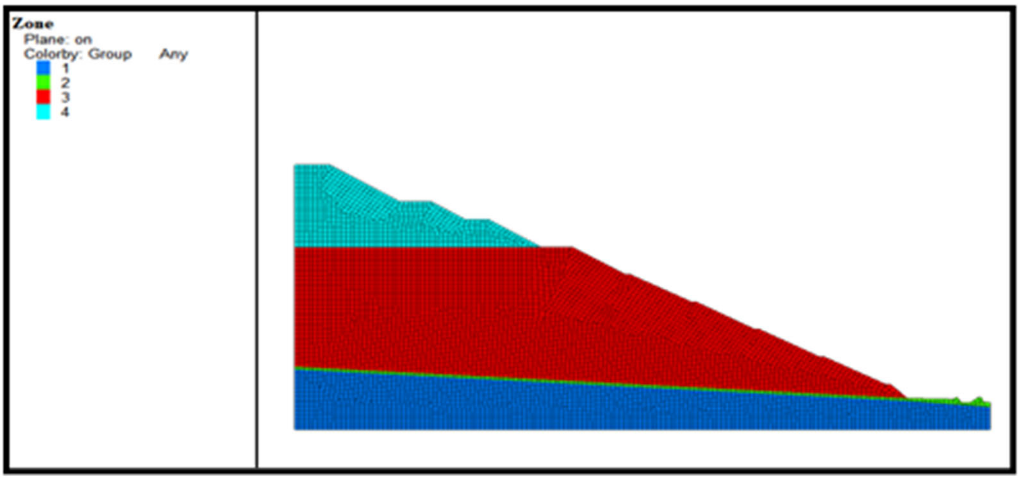
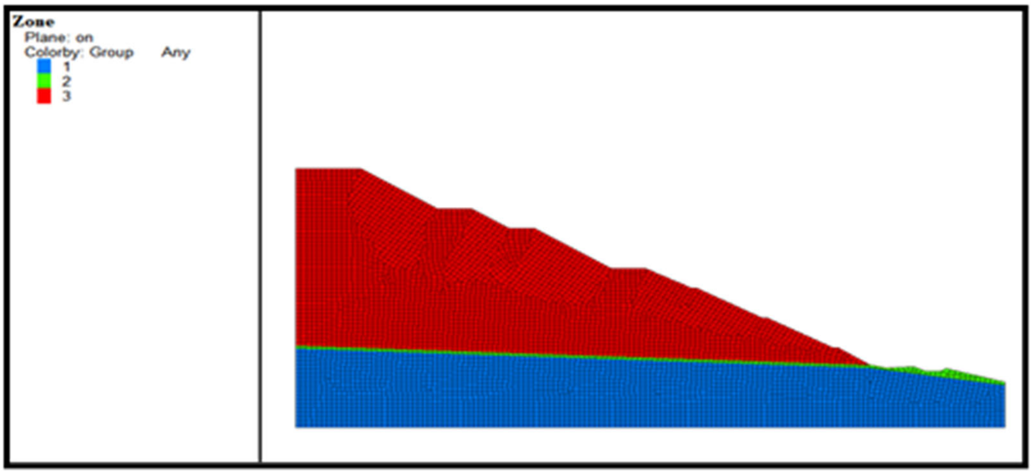
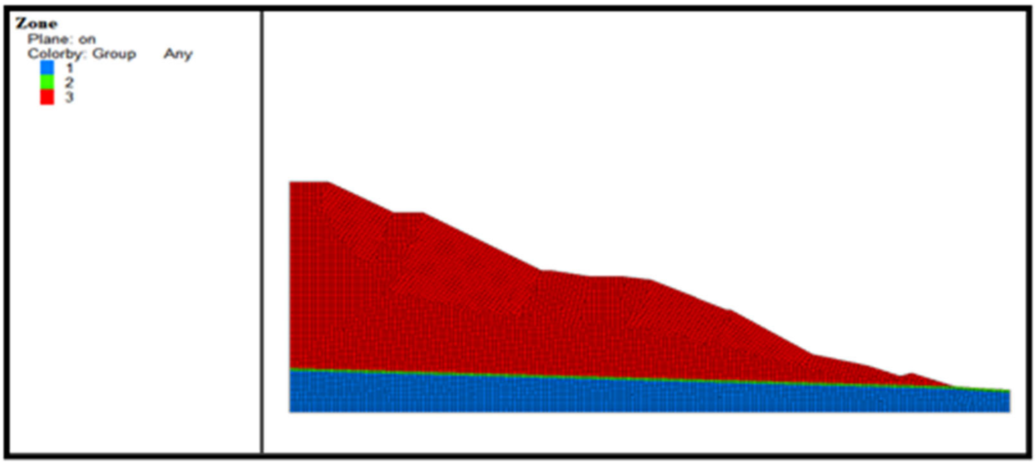


(c) Section 3-3



(d) Section 4-4



(e) Section 5-5

Figure 3. Slop calculation model

Within the scope of stability calculation, the profile surface is mainly composed of strongly weathered mixed rocks, and there are a few fully weathered mixed rocks, gravel soils and Quaternary artificial fills; the majority of the interior is slightly weathered and moderately weathered mixed rocks.

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4. Conclusions and Suggestions

Conclusions: The Qipanling dumping site section 1-1, 2-2, 3-3, 4-4, 5-5, empirically calculated, the safety factors are 1.33, 1.38, 1.35, 1.45, 1.40, respectively. From the results of stability analysis and calculation , The slope of the dump is in a stable state.

Suggestions:

A. The impact of blasting vibration during stope production on the slope stability of Qipanling dumping ground should be paid attention to, timely observation and monitoring should be carried out, and effective measures should be taken to maintain the slope of the rock yard.

B. With the implementation of the slope project of the Qipanling dump, new changes in the engineering geological conditions of the slope will occur at any time. The slope stability analysis should be carried out in real time, and the slope of the rock yard should be effectively protected according to the analysis results to ensure the side slope.

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