Study on Stability Analysis and Monitoring Technology of Deep Concave Open-Pit Mine Slope

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Abstract. In this paper, using the FLAC3D software to establish the numerical model of the rock slope in the south of Washan stope and to compare and verify with the monitoring result, reference is made to the original engineering and hydrogeological data of Washan stope. The results show that the stability of the South slope is mainly affected by the dominant structural plane, and the potential slip surface and the dominant structure surface are the same. During the recovery period of -120m platform residual mine, the disturbance stress is increasing but the overall amplitude is small and the slope is relatively stable.

1. Introduction

The stability of Stope slope is the basic guarantee of stope production, especially in the deep concave open pit, the stability of slope is especially important, and once the slope of stope is unstable, it poses serious threat to the personnel equipment of stope, and can induce many kinds of geologic disasters [1]. In the process of artificially stripping high slope work, many discontinuous surfaces which were originally deposited below the surface are exposed gradually, thus forming or enlarging the temporary surface, the supporting force of the slope is reduced, and the stability of the slope is very common and serious damage due to the effect of weathering and softening of the newly-detached slope [2]. Therefore, the study of slope stability plays an important role in the stability of the mining area.

2. High rock slope monitoring technology

2.1 Displacement monitoring technology

The main contents of deformation monitoring are surface deformation and internal deformation of slope. Surface deformation monitoring includes displacement monitoring and rock mass tilt monitoring [3]. Deformation observation in the slope, that is, drilling in the rock and other technical means to measure the deformation inside the rock mass. In the monitoring of open-pit metal mines in China, the travel process of landslides can be comprehensively studied by using GIS technology. In the past, the methods of monitoring surface deformation are reviewed, such as macroscopic observation, simple observation and station observation.

2.2 Ground stress monitoring technology

Stress monitoring is mainly to measure the stress and surface stress in different parts of slope rock, and to distinguish the tensile region and pressure zone [4]. These physical quantities can reflect the deformation strength and can be combined with other monitoring data to analyze and predict the deformation dynamics. In China's mine slope, the monitoring technology of ground stress is mainly based on various kinds of stress gauges, in addition, the method of using the sensor to monitor the stress change of the rock mass. The disturbance stress monitoring system is used in the stress monitoring of the rock mass of the south slope of Washan stope.

2.3 Acoustic emission monitoring technology

The acoustic emission technique commonly used in slope monitoring category can be called micro-seismic monitoring technology. This technique mainly utilizes the principle of the Caesar effect. When the target rock mass is in a landslide, it begins with the formation of the micro-fissure in the rock body [5]. At present, the acoustic emission tester and the ground sound detector are applied to the monitoring of rock slope deformation and the safety monitoring of surrounding rock reinforcement, which provides the basis for predicting rock damage.

3. Project summary and modeling

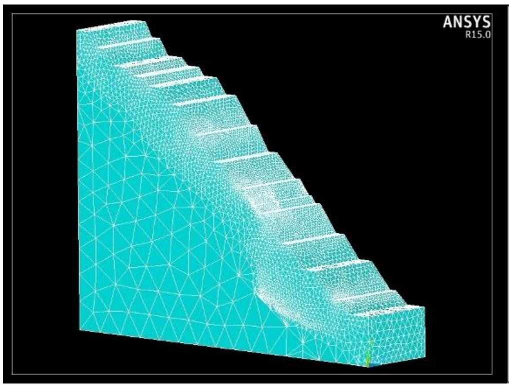
3.1Project summary

Washan stope is located in Xiangshan town of MaAnShan city, AnHui province, it is an old mine with a history of more than 60 years (see Figure 1).The upper stratum of the stope in south side consist of tufa and diorite, the lower part in near the -90m step, is the residual ore on the edge of the iron ore deposit, which basically exposed the surface and extends to the upper part of the -160m step, with a depth of about 20m. The lower stratum of the ore body is mainly composed of diorite porphyrite or diorite porphyrite and tuff.

Figure 1. Washan deep concave type iron ore stope

3.2 Slope modeling

According to the actual geological characteristics, the production of the structure plane and combined with the array range of the monitoring system, the area to which the south upper benefit structure exposed is the center of the surface, and the regional side slopes that extend each 25m are modeled. The model mainly consists of three groups of rock groups, namely, block crystallite tuff, diorite porphyrite and breccia magnetite ore. The partition of the slope is shown in FIG. 2 and 3, and its corresponding physical and mechanical parameters are shown in table 1.



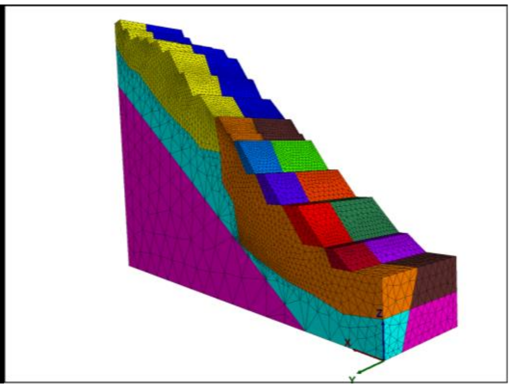


Figure 2. Use ANSYS to divide the grid Figure 3. The rock grid that import to FLAC

Table 1. Mechanical parameters of rock mass in the south side slope

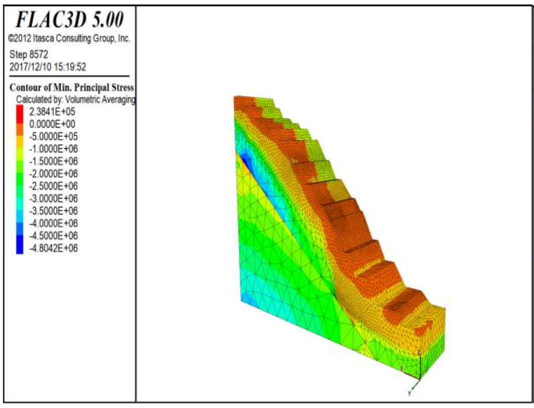
Designation	Density （kg/m3）	Poisson ratio	Bbulk modulus （GPa）	Shear modulus （GPa）	Cohesive force （MPa）	Inner friction angl （°）
blockcrystal tuff	2.21	0.20	35.66	26.74	50	25
diorite porphyrite	2.54	0.27	41.77	22.69	300	30
Breccia magnetite	3.28	0.23	9.17	6.04	160	30
Structural plane	2.47	0.15	0.15	0.15	100	25

4. Stability analysis before and after recovery of residual ore

4.1 Stability analysis of residual ore before recovery

The parameters of the different rock groups are assigned and the stress field caused by the weight is established. Before the excavation disturbance, the tensile stress mainly concentrates on the upper part of the south Slope, and the closer the intersection line between the superior structural plane and the surface step, the greater the value, the local area can reach the 0.238MPa level (FIG.4). This shows that the overall stability of the rock mass in the south slope is better under the action of gravity.

Under the influence of deadweight, the displacement field between the upper rock mass and the lower rock mass in the superior structural plane shows a more obvious boundary. The horizontal displacement of the rock mass at the top of the -30m to the -60m step is larger than that of the other parts of the slope, which indicates that the potential sliding surface of the slope under Deadweight is the plane of the dominant structural plane. Close to the structure surface of the position, the maximum number of horizontal displacement is 2.4mm (FIG.5). Under the action of gravity, the slope is relatively stable and the risk of instability is small.



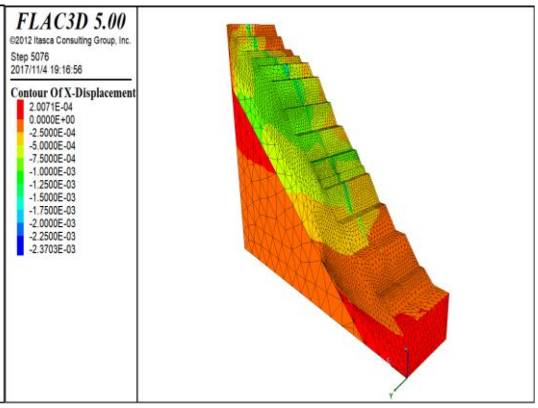
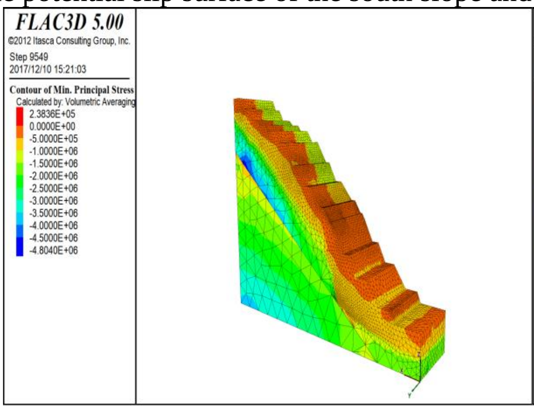


Figure 4. pre-disturbance maximum principal stress Figure 5. horizontal displacement

4.2 Stability analysis of residual ore recovery process

The recovery of the south-help residual ore and the corresponding stripping work are carried out from the -90m steps down by step. After the exploitation of each step, the horizontal displacement of the slope caused by the disturbance is mainly in the vicinity of the mining area, and the displacement field of the slope is formed as shown by the relatively small horizontal displacement due to the mining activity. The maximum principal stress cloud (FIG.6) After the disturbance is not changed much compared to the prior mining.

The displacement at the surface of the -30m step and dominant structural surface reaches its peak, about 2.47mm and perpendicular to 4.16mm (FIG.7). Moreover, the horizontal displacement of the rock mass above and below the structural plane is quite different, which shows that the risk of instability is much higher than the other parts of the slope in the process of disturbance, which shows that the potential slip surface of the south slope and the surface of the dominant structure are the same.



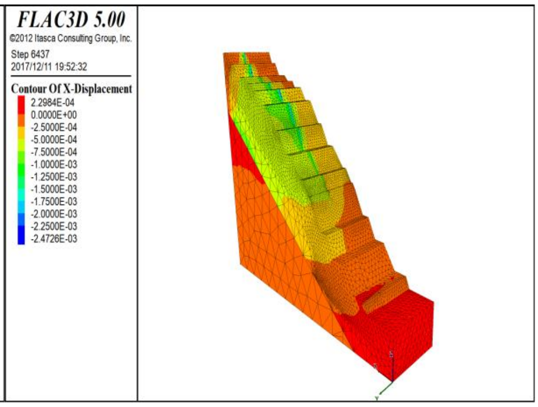


Figure 6. Maximum principal stress after disturbance Figure 7. Horizontal displacement field

5. Conclusion

After excavation disturbance deformation, the deformation of the south slope of Washan stope is mainly occurred between -60m steps to -15m steps, in the spatial region of the center of the dominant structure, and the horizontal displacement value of this region is greater than the other slope. The stability of the south side slope is mainly influenced by the dominant structure plane, and the potential slip surface and the dominant structure plane are basically the same. During the recovery of the residual ore in the -120m mining platform, the disturbance stress keeps increasing but the overall amplitude is small and the slope is relatively stable.

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