Iranian Journal of Engineering Geology
Winter 2021, Vol.13, No.4

Stability analysis and determination of support system in 2741 level of angouran underground mine

S. Chehreghani*[1], H. Azad Sola[2], H. Chakeri[3], A. Nozari[4]

Abstract

The stability of underground mining spaces and the analysis of stresses and deformations created after explotiation have a particular importance in underground mine designe. Anguran lead - zinc mine is located 125 kilometers southwest of Zanjan city and according to the plan, at least 12,000 tons of ore will be extracted from underground section of it. The ore in this mine consists of three rock types, including sulfur ore, carbonate, as well as a mixture of sulfur and carbonate ores. Sulfur ore mass has the highest rock mechanical strength and carbonate ore has the lowest. This research investigate the stopes stability of 2741 level in underground Angoran mine in order to obtain appropriate dimensions of stopes and to provide the necessary support using Finite Element Method. For this purpose, in both sulfur and oxidized ore zones, different dimensions and supports of the stopes are determined by comparing the displacements around the stopes with the critical and permissible strain values calculated from the Sakurai relations. The results of the analyzes based on the input data indicate the appropriate stability condition in the sulfur ore. The impact of pillar in sulfur ore was investigated for two widths of 5 and 10 m, and the results showed that in both cases, the stopes were stable without support system. But due to discontinuities in the roof and parts that are mixed with sulfur and oxidized, a support system is needed. In oxidized and mixed ores, the support system should be used because of the poor properties of the rock the dimensions of the pillar.

***Key words**: Underground mine of angouran, Finite Element Method (FEM), stability analysis, support system, sakura criterion.*

[1]* . Department of Mining Engineering, Faculty of Engineering, Urmia University
Corresponding Author: s.chehreghani@urmia.ac.ir.
[2] . School of Mining Engineering, College of Engineering, Sahand University of Technology.
[3] . Mining Engineering Department, College of Engineering, Sahand University of Technology
[4] . School of Mining Engineering, College of Engineering, University of Tehran

Extended Abstract:

1. Introduction

The stability analysis of underground openings is one of the most important subjects in rock mechanics. By development in modeling methods for continuous & discontinuous environments and existence and applications of high performance computers, evaluation of complicated underground apaces is practicable, so nowadays the numerical and empirical methods, both are more widely used all over the world. Angouran lead - zinc mine is located 125 kilometers southwest of Zanjan city and according to the plan, at least 12,000 tons of ore will be extracted from underground section of it. This research investigate the stopes stability of 2741 level in underground Angoran mine in order to obtain appropriate dimensions of stopes and to provide the necessary support using Finite Element Method. For this purpose, in both sulfur and oxidized ore zones, different dimensions and supports of the stopes are determined by comparing the displacements around the stopes with the critical and permissible strain values calculated from the Sakurai relations. In order to calculate the stress and deformation around openings, Phase2 which is a two-dimensional elastoplastic finite elements code was used and the stability analysis was done separately for Sulphide and oxide zones.

2. Materials and methods

The first step of a numerical modelling is appropriate method and code selection with regards to environment of tunnel. results of investigations show that, if the ratio of joints distance and tunnel diamater was between 0.01-0.25, it can be assumed that the rock mass is discontinuous and out of this ranges its continuous. Consideration of geotechnical condition of Angouran mine show that the environment of its can be supposed continuous, so for modelling of this project, the FEM based code, Phase2 was applied to evaluate induced stresses and maximum deformations for stopes with different pillar width in oxide and sulphide zones. The ore in this mine consists of three rock types, including sulfur ore, carbonate ore, as well as a mixture of sulfur and carbonate ores. Sulfur ore mass has the highest rock mechanical strength and carbonate ore has the lowest. There are no laboratory tests performed on the rock mass, however, some field observations and geological mappings have been conducted. So RocLab have been used that represent reliable estimates of rock mass properties (table 1). The model geometry has 122 meter height and 156 meter width and the Excavation section is D shaped by dimantions of 5m × 3.2m. Since the actual ground surface is modelled in Phase2, gravitational field stress is choosen for this analysis. For removing the boundary effects, the distance of excavations and model boundaries assumed 5 times more than width of stopes. Mesh type of model is graded 6 noded triangles and gradiation factor is 0.1 for having a finer mesh around the excavations.

Table 1. estimates of angouran underground mine rock mass properties

Input data						Output data			
Geotechnical Type	**D**	**mi**	**Density (gr/cm³)**	**UCS (Mpa)**	**GSI**	**Tensile St (Mpa)**	**Em (MPa)**	**φ (Deg)**	C (Mpa)
Marble	0.8	9	2.68	55	52	0.074	4992.67	40.3	**0.426**
Breccia carbonate	0.8	18	2.9	30	37	0.005	1554.93	33.77	**0.254**
Sulphide rock mass	0.8	18	3.43	40	55	0.035	5060	45.32	**0.46**
Oxide rock mass	0.8	10	2.81	5	17	0.0002	200.74	9.6	**0.045**
Mix(sulphide-oxide)	0.8	10	2.64	15	20	0.001	413.23	15.5	**0.083**
Schist	0.8	10	2.5	75	50	0.075	5196	42.6	**0.469**

3. Conclusion

The stopes stability of 2741 level in underground Angoran Mine was investigated in order to obtain appropriate dimensions of stopes and to provide the necessary support using FEM. For this purpose, in both sulfur and oxidized ore zones, different dimensions and supports of the stopes are determined by comparing the displacements around the stopes with the critical and permissible strain values calculated from the Sakurai relations. The effect of pillar in sulfur ore was investigated for two widths of 5 and 10 m, and the results showed that in both cases, the stopes were stable without any support system. But due to discontinuities in the roof and some faces that are mixed with sulfur and oxidized, a support system is needed. In oxidized and mixed ores, the support system should be used because of the poor properties of the ore rock and the dimensions of the pillars. the displacements around stopes without support in oxide zones are largerer than Sakurai's critical displacement, and its not depend on pillar width, so support system for this zones is necessary. The recommended support systems are steel beam IPE 160 and wooden lagging. In sulphide zone, stability of stopes depends on pillars width, in 5 m width, plastic zones around stopes are extended and displacments of them are larger than Sakurai's critical displacement,so excavation is unstable. But in 10 and 15 m width, stopes can excavate without any support system.