

Study of Appropriate Underground Mine Design by Using Room and Pillar Method in El Corazón Gold Mine, Ecuador

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1. Introduction

Ecuador has experienced significant growth in the mining sector due to its rich mineral resources. This development poses challenges for underground mining, requiring technical approaches to ensure safe and sustainable operations. In this research, El Corazón underground gold mine was selected as a case study due to its social, economic, and geological relevance. The analysis focused on evaluation of the room and pillar mining method to ensure the stability of the disseminated deposit (Figure 1). Field investigations, laboratory tests, and numerical simulations using RS2 software were carried out for preparation of a mine planning guideline for similar deposits, contributing to the strengthening of Ecuador's mining sector.

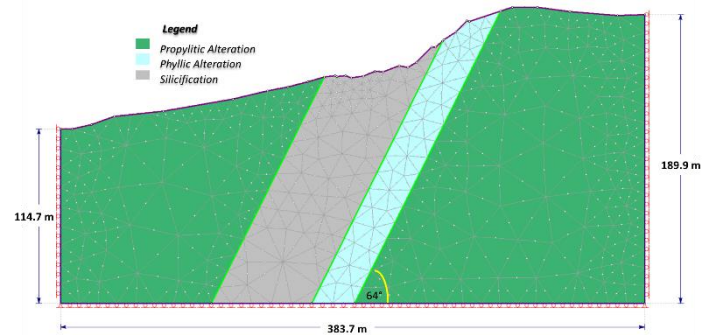


Figure 1. Numerical Model for the Analysis.

2. Research Methodology

Geomechanical, geological, and topographic data were collected through strategic rock sampling at El Corazón. Geological strength index (GSI), Uniaxial compressive strength (UCS), Brazilian tensile strength (BTS), Young's modulus and so on were obtained from the several kinds of mechanical tests. These results were shown in Table 1.

Table 1. Geomechanical Properties of the Rocks from El Corazón Gold Mine.

Geological Strength Index (GSI)	Alteration Type	Dry Density (kg/m ³)	UCS (dry) (MPa)	Tensile Strength (MPa)	Young's Modulus "E" (MPa)	Poisson's Ratio "ν"
65	Phyllic Alteration	2,563	32.73	5.55	1.13	0.18
73	Propylitic Alteration	2,570	53.84	11.11	2.19	0.19
70	Silicification	2,627	86.96	7.44	7.23	0.21

Numerical models and were made in RS2 for an elastic finite element analysis (FEM) by using the obtained values (Table 1), and the generalized Hoek-Brown criterion was applied for the evaluation of rock mass stabilities. Different configurations of the room and pillar method were assumed for the appropriate mine design, especially assessing their stability. Additionally, backfill was applied on the improvement of stability after exaction of the veins.

3. Results and Discussions

Figures 2-4 show the examples of the analytical results. The simulations and analysis led to key conclusions from these results:

- The crown pillar demonstrated optimal stability between 15 and 30 meters; thinner areas showed critical zones.
- Three-meter pillars were the most stable in phyllic zones, although taller pillars require additional support (Figure 2).
- Increasing pillar width improves strength, particularly for 10 m, 15 m, and 20 m pillars.
- Chambers are wider than 12 meters in phyllic zones reduce stability; limiting their width is recommended.
- Alternating chamber configurations significantly improve overall system stability by minimizing stress concentrations in critical areas (Figure 3).
- Cement and polymer backfill provide greater long-term stability, while hydraulic and crushed rock backfills are viable alternatives depending on operational needs.

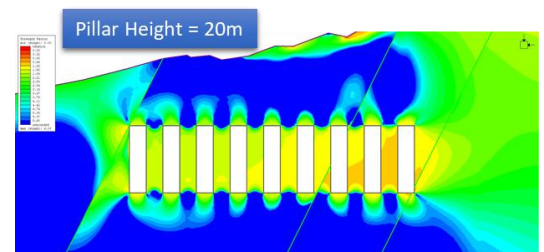


Figure 2. Distribution of the Strength Factor with a 20-meter Pillar Height.

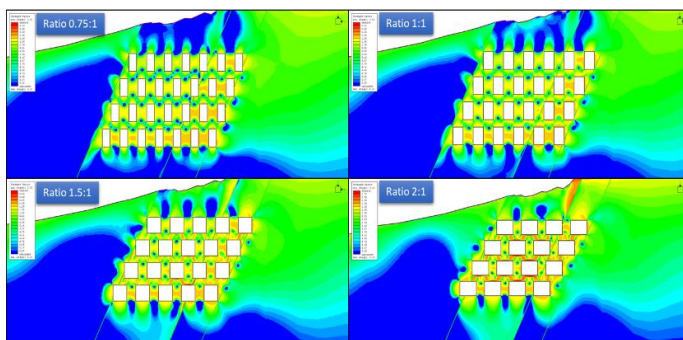


Figure 3. The effect of Alternating Opening Configurations at Multiple Depth Levels: Distribution of the Strength Factor.

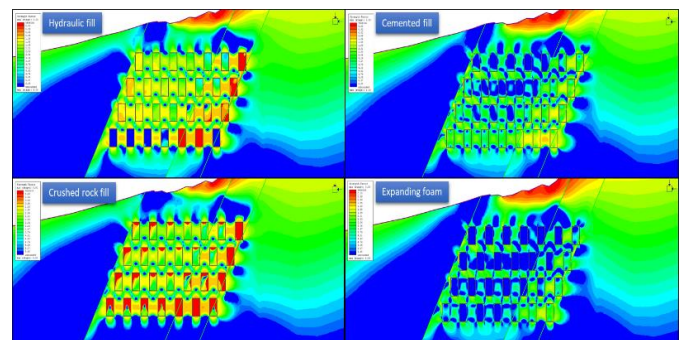


Figure 4. Effect of Backfill on the Room and Pillar Method: Distribution of the Strength Factor.