2025 ARMA Student Competition

INTRODUCTION

Thank you for participating in the ARMA Student Design Competition, organized by ARMA Student Chapters and sponsored by ITASCA. For this challenge, teams are asked to assess the impact of extracting the crown pillar of an open pit mine following the completion of underground mining. This is a gold mine and therefore there is considerable value in being able to extract the crown pillar, if it can be done safely.

The underground orebody is 15 m thick, 750 m long striking North-South, and extends 280 m below the floor of the open pit. The open pit begins at ground surface (assumed to be flat) and extends 250 m deep with 80° benches that are 15 m high and 15 m wide for an overall open pit slope angle of 40°. The underground mine stopes have been planned to be 15 m wide and 50 m high.

Open pit mining will utilize large-scale production blasting while underground mining will utilize an underhand cut-and-fill method. A 30 m thick crown pillar is planned. Given the lower strength of GTU-West, each level is to be mined in two sections (lower and upper). Each level is extracted starting at the lowest level, progressing upwards, using an underhand cut-and-fill approach. The lower stope section will be mined, then backfilled before the upper section is extracted. Then the next stope will be mined similarly. The crown pillar has been designated with upper and lower sections (each 15 m high) so that different extraction strategies may be evaluated.

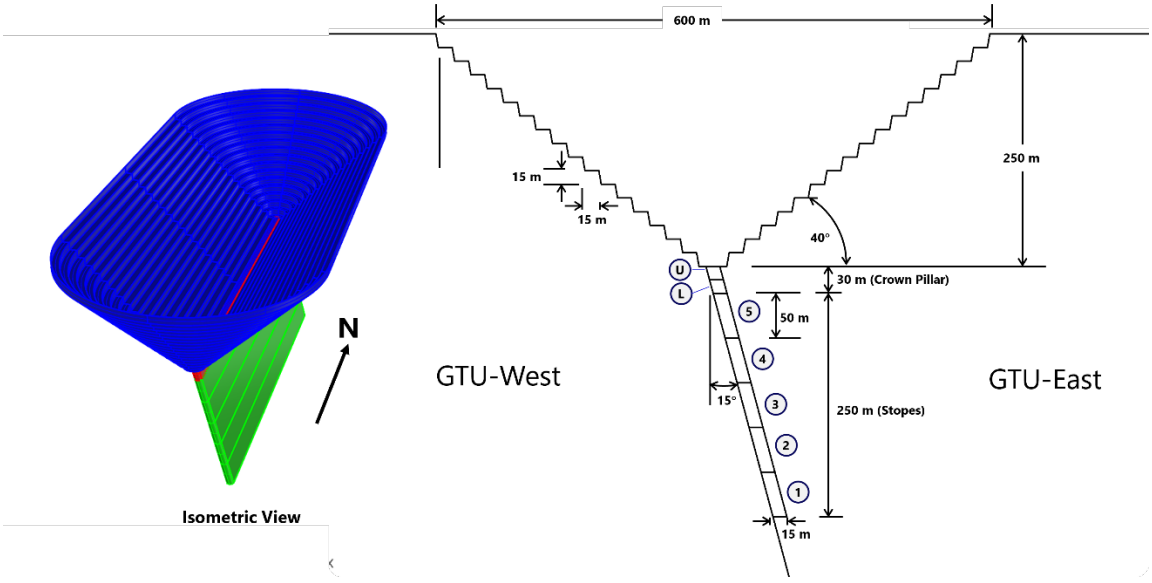

Figure 1. The mine layout.

OBJECTIVES AND SCOPE

As part of this gold mine's prefeasibility study, you are to perform an initial factor-of-safety assessment of the open pit to evaluate its stability (1) after surface mining (prior to underground mining), (2) if the currently planned crown pillar's thickness is sufficient to isolate the surface and underground mining operations, and (3) can the crown pillar be recovered entirely or in part while maintaining the design criteria.

MATERIAL PROPERTIES

Rock Mass

The mine site consists of two major lithologies or geotechnical units (GTU-West and GTU-East, in the footwall and hangingwall. respectively). The following Hoek-Brown rock mass properties have been assessed based on limited borehole data.

Table 1. Rock mass mechanical properties.

Property	Units	GTU-West (FW)	GTU-East (HW)
GSI	---	38	45
m_i	---	8	10
σ_{UCS} (intact)	MPa	50	70
Density	Kg/m^3	2,700	2,700
Young's Modulus	GPa	70	70
Poisson's Ratio	---	0.2	0.2
Dilation	°	0	0

Water

Ignore effective stress (i.e., water table pore pressures) at this stage.

Blast Damage

Ignore the effects of large-scale blast damage (i.e., D = 0) at this stage.

Stresses

With no in-situ stress measurements currently available, assume that mine stresses are lithostatic in nature. Based on the Word Stress Map there are nearby indications of a stress *k*-ratio of 1.5.

Backfill

The mine stopes are planned to be tightly backfilled. The backfill will be modeled as Mohr-Coulomb material using the mechanical properties in Table 2. Note that the Mohr-Coulomb constitutive model in FLAC2D is perfectly plastic (i.e., no strain softening).

Table 2. Paste backfill properties.

Property	Units	Value
Density	kg/m^3	1,900
Young's Modulus	MPa	120
Poisson's Ratio		0.35
Friction Angle	°	30
Cohesion	kPa	115
UCS	kPa	398.4

DESIGN CRITERION

The overall open pit factor of safety must be ≥ 1.2 at all stages of mining.

NUMERICAL MODELING

You are free to use any analysis tool you prefer. All the information needed to run a 2D numerical model has been provided.

For your convenience, ITASCA will be providing a free, fully functional web license for FLAC2D to each participating team for the duration of this competition. A model template (data file) will be provided with everything you need to model this mine. You may, of course, edit the data file to expand or modify the model. A webinar will be held to provide an overview of working with FLAC2D and the data file template.

REPORT

The submitted report should address the following topics:

- Problem definition.
- Sketch representing the geological/geotechnical model.
- Overall approach, including assumptions.
- Numerical modeling approach. Comment on the use of a 2D model versus 3D.
- Include and discuss numerical modeling results:
    - Plots of FOS contours and calculated FOS
    - State of stress in the crown pillar over the course of mining
    - Plasticity indicators (material yielding/failure)
    - History displacements
- How sensitive is the mine design to stress k-ratio?
- Discuss the importance of tight mine backfill. What would you expect if the mining operation couldn't achieve tight backfill conditions.
- What are your strategy and recommendations for the crown pillar?
- What are the key risks to the proposed design?
- How might these risks be mitigated?

Ideally, the report should be less than 8 pages, but there is no formal limit. Report technical writing and organization quality and presentation will be considered when evaluating each team.

If you have any questions about the ARMA Student Design Contest, please contact the ARMA student branch organizers. If you have any questions using FLAC2D or the web license, please email David DeGagné, Senior Engineer (Technical Marketing) with ITASCA Minneapolis at ddegagne@oneitasca.com.