Minerals Council South Africa

EXAMINATION PAPER

SUBJECT: CHAMBER OF MINES CERTIFICATE IN ROCK MECHANICS: PAPER 3.4 **SUBJECT CODE:** COMRMC3.4 **EXAMINATION DATE:** 05 NOVEMBER 2020 **TIME:** 14h30 – 17h30 (3 hours)	**EXAMINER:** Anton Gregory **MODERATOR:** Peter Terbrugge **TOTAL MARKS:** [100] **PASS MARK:** 60%

NUMBER OF PAGES: 5

SPECIAL REQUIREMENTS

1. Answer **all five** questions;
2. References other than those provided are not permitted;
3. Hand-held scientific calculators may be used, but programmable electronic calculators are not permitted;
4. Put your **Identity number** on the outside cover of each book used and on any graph paper, sketch or other loose sheets handed in;
   NB: Your name must not appear on any answer book or loose sheets;
5. **Write in ink on the right hand side of the paper only (only the right hand pages will be marked). Request as many answer books as needed;**
6. Show all calculations on which your answers are based;
7. Illustrate your answers by sketches and/or diagrams wherever possible;
8. In answering these questions, full advantage should be taken wherever possible of your practical experience as well as of the given data; and
9. Answers must be given to an accuracy that is typical of practical conditions.
10. No cell phones will be allowed in the examination room

Question 1

Identify the factors included in a geotechnical model. Discuss their individual influence on the stability of the rock slopes, as well as the measures that can be applied to increase the stability of the pit slope. [50 /2 = 25 marks]

Question 2

Define and discuss the following (use sketches and diagrams where possible/applicable):

[20 marks]

a. As Low as Reasonably Practicable (ALARP) [4]

b. In terms of numerical modelling, define and discuss the following:

   i. Ubiquitous joint model [3]

   ii. Strain softening model [3]

   iii. Boundary conditions [5]

c. Back Analysis [5]

Question 3

Discuss the following numerical analysis methods with their applicability to the open pit environment:

- Continuum modelling
- Discontinuum modelling
- Hybrid/Coupled modelling

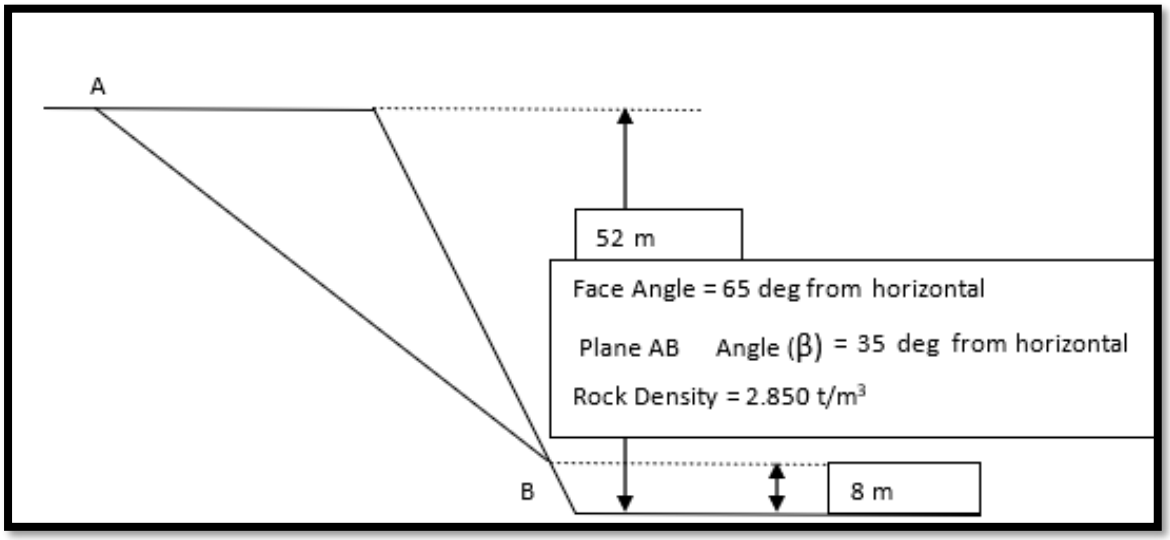
In your answer comment the following:

- Fundamentals of each method
- Critical input parameters
- Advantages
- Limitations
- Examples of commercially available codes for each of the methods.

[20 marks]

Question 4

Figure 1 illustrates the geometry of a potential planar slope failure which contains a talc filled fault (AB). The slope is regarded to be dry.



You have requested that ten shear strength tests be performed on the plane. Dr Jen from Pick n' Lab performed the test and the table below summarise the results.

	n	Mean	Std Deviation	Coefficient of Variation
Cohesion (MPa)	10	0.0153	0.0031	20%
Friction (deg)	10	16.8	1.48	8%

Note: the distributions of the random variables can be regarded as truncated normal with the cohesion ranging from the mean by +33% and -34.4% and the friction angle by +15.3% and -16.8%.

The General Manager of the mine is pressurising you for an answer as production has been suspended until such time as you have completed your stability assessment.

Using the formulas provided calculate:

a. The factor of safety at the average values for cohesion and friction.

b. The probability of failure of the slope using Harr's point estimate method with the distributions provided.

List any other assumptions you have to make, comment on the results obtained and make a recommendation to the General Manager.

Formulae

Factor of Safety

$$F = (cA + (W\cos\beta)\tan\Phi) / W\sin\beta$$

Point Estimate Method Formulation.

$P_F = \sum F / (1 - \text{std dev } F)$ where F is derived for the values of the distributions of c and Φ.

$$\sigma^2_F = \underline{F^2} - (\underline{F})^2$$

[20 marks]

Question 5

The slopes at your mine are excavated using Drill & Blast techniques. However, the blasting results in damage to the final walls due to excessive blast energy propagating back into the rock mass.

Discuss how you would go about improving these results, with particular attention to:

a) Explain the mechanisms by which blast damage is caused in the unexcavated rock mass **[4]**

b) Explain the controlled blasting techniques that you would apply to limit the current damage, and how you would calculate the necessary blasting parameters, such as burden and spacing, charge mass, and minimum distance to the mining limit for production blasting. **[10]**

c) Describe how you would both qualitatively and quantitatively monitor the blast damage in your mine, and how this information can be used to continuously improve your limit blasting programme. **[6]**

(20 marks)

Total: 100 marks