Minerals Council South Africa

EXAMINATION PAPER

SUBJECT: CERTIFICATE IN ROCK MECHANICS PAPER 3.1 : HARD ROCK TABULAR **SUBJECT CODE:** COMRMC **EXAMINATION DATE:** 13 MAY 2021 **TIME**: 14:30 – 17:30 (3 HOURS)	**EXAMINER:** KB LE BRON **MODERATOR:** S VAN BUUREN **TOTAL MARKS:** [100] **PASS MARK:** (60%)

NUMBER OF PAGES: 4

THIS IS NOT AN OPENBOOK EXAMINATION – ONLY REFERENCES PROVIDED ARE ALLOWED

SPECIAL REQUIREMENTS:

1. Answer **ALL** the questions **legibly** in English and **in the suggested table format**.
2. Write your **ID Number** on the outside cover of each book used and on any graph paper or other loose sheets handed in.

NB: Your name **must not** appear on any answer book or loose sheets.

3. Show all calculations **and check calculations on which the answers are based.**
4. Hand-held electronic calculators may be used for calculations. Reference notes may not be programmed into calculators.
5. Write **legibly** in ink on the **right hand page** only – **left hand pages will not be marked**.
6. Illustrate your answers by means of sketches or diagrams wherever possible.
7. **Final answers** must be given to an accuracy which is typical of practical conditions.

NB: Ensure that the correct unit of measure (SI unit) are recorded as marks will be deducted from answers if the incorrect unit is used even if the calculated value is correct.

8. In answering the questions, full advantage should be taken of your practical experience as well as data given.
9. Please note that you are not allowed to contact your examiner or moderator regarding this examination.
10. Cell phones and other smart devices e.g. smart-watches are **NOT** allowed in the examination room.

QUESTION 1.

1.1 Only write down True or False for each of the following statements:

A. Graben are produced from parallel reverse faults. The faults typically dip away from the centre of the graben from both sides.
B. The dip of a surface measured in a plane oblique to strike is called the true dip.
C. The effective stress s' is related to total stress, s and pore pressure by:

$$s' = s + u$$

D. Principal stresses are maximum and minimum value of normal stresses on a plane (when rotated through an angle) on which there is shear stress.
E. The volumetric strain is the unit change in volume, with *SI* unit m^3.
F. Hydraulic fills are any kind of backfill carried by water through pipelines. Solid particles are sluiced through the water quickly without having the chance to settle until they reach the dumping point.
G. Paste fill is made from full mill tailings, with an effective grain size of approximately 5µm, that are combined with an additive / binder and water.
H. The maximum value for mining induced vertical strain criterion in a shaft barrel to ensure the steelwork is not compromised, is 0.0004.
I. The hanging wall of the VCR is mainly Elsburg Quartzite, lava or WAF.
J. In a deep mine, the peak particle velocities (PPV) are lower in the rock mass than at the tunnel surface.

(10)

1.2 The concept of Ground Reaction Curves (GRC):

A. Explain your understanding of the Ground Reaction Curve? (2)
B. What is the purpose of developing a GRC? (2)
C. Explain the 2D vs 3D approach in developing a GRC for an advancing tunnel. (2)

D. Ground reaction curves may be developed for a deep mine tunnel using numerical modelling. Explain the process you would follow. (4)

(10)

1.3 Assume that a concrete plug has to be installed in a 5 m x 5 m water tunnel to control the flow of water from a flooded section of a mine. Applying the effective stress concept, explain how you would evaluate whether the water tunnel may result in surface instability (assume the tunnel is 10 m below surface located within a weathered Sandstone with a density of 2200 kg/m^3). Assume a water head of 50 m (upstream dam).

(3)

1.4 When designing a resin bolt system:

1.4.1 Which test type do you consider essential to ensure that the correct strength is achieved when installing a resin bolt? (1)

1.4.2 What is the main output from this test? (1)

1.4.3 What is the practical implication of this test (from a cost optimization perspective)? (1)

1.4.4 Name one factor that you would review as part of your ergonomics assessment when designing a support system in a conventional stope? (1)

1.5 If you are appointed as a rock engineer:

1.5.1 How often would you carry out vertical shaft barrel inspections? (1)

1.5.2 What laboratory testing would you consider critical for a bord and pillar design? (2)

[30]

QUESTION 2.

2.1 A platinum mine is planning to advance underneath a surface stream, and you have been requested to assess the geotechnical risk associated with the planned mining and to advise the management on the way forward.

Assume the following:

- Depth of the Merensky ore body below the ground elevation is 45 m
- Current bord dimensions are 10 m on dip and 10 m on strike
- Current pillar dimensions are 10 m x 10 m
- Weathered zone extends to 40 m below surface
- Dip of ore body is less than 10 degrees
- Site location in the Western Bushveld

2.1.1 Name two platinum-bearing ore bodies in the Western Bushveld. (2)

2.1.2 Draw a simple process flow diagram illustrating the steps you will follow to determine the way forward in order to advise management. (6)

2.1.3 List the hazards associated with the planned mining. (4)

2.1.4 Make appropriate recommendations w.r.t. the way forward. Motivate each recommendation (note that a recommendation must be logically motivated and concluded based on sound engineering principles). (8)

2.2 You have been requested to design an underground bord and pillar layout for a new gold mine, located in the West Rand next to an old worked-out flooded underground mine. Access is through a decline from surface. The weathered zone extends to 20 m. Mining is planned from a depth of 10 m below surface to a depth of 500 m below surface. Surface infra-structure consist of office buildings, roads, overland conveyor and a plant.

2.2.1 Classify the following hazards as either Low Risk, Medium Risk or High Risk, for when the underground development phase (through drilling and blasting) commence.

Hazards:

i. In rush of water
ii. Subsidence
iii. Rockburst
iv. Sinkhole formation
v. Rock falls

(5)

2.2.2 Match the treatment option with the hazard.

Treatment:

A. Crown pillar design
B. Barrier pillar design
C. Bord and pillar layout design
D. Cone bolts
E. Shotcrete

(5)

[30]

QUESTION 3.

3.1 Match the tests from column A to what you believe is the most suitable practical application in column B.

Number	*A*	*B*
3.1.1	Tri-axial Compression	Stope hanging wall
3.1.2	Shear box	Pillar with low angled joints
3.1.3	Tensile strength pull-test	Pillar Core
3.1.4	UCS for anisotropic behaviour	Chromitite Stringer
3.1.5	Brazilian Tensile Strength	Open joint

(5)

3.2 Match the geological references in column A to what you believe is the most suitable in column B.

Number	*A*	*B*
3.2.1	MG1	Back-break hazard
3.2.2	RCF	Rock fall hazard
3.2.3	Bastard Reef	ESS
3.2.4	Low angled joint	Chrome Seam
3.2.5	Fault	Tunnel stability

(5)

3.3 Match the activities in column A to what you believe is the most suitable in column B.

Number	*A*	*B*
3.3.1	Manual barring	Cable anchor
3.3.2	Time delays	Blast hole burden
3.3.3	Pre-stressing	Blast damaged rock walls
3.3.4	Face drilling	Hazard identification
3.3.5	Demarcation of geological features	Reduced energy release

(5)

3.4 Match the mining classification in column A to what you believe is the most suitable in column B.

Number	*A*	*B*
3.4.1	Long hole face parallel drilling	Follow-behind tunnel
3.4.2	Sequential Grid mining	Rockbursts
3.4.3	Remnant extraction	Highly faulted reef
3.4.4	Scattered mining	Advanced development
3.4.5	Longwall mining	Pre-conditioning

(5)

[20]

QUESTION 4.

4.1 Define the following: -

4.1.1 RQD

4.1.2 Shear Modulus

4.1.3 Plane Strain

4.1.4 Strain Softening

4.1.5 Mohr envelope

4.1.6 Tilt test

4.1.7 Powder factor

4.1.8 Support resistance

4.1.9 Horst

4.1.10 JRC

(10)

4.2 Explain the following:

4.2.1 For plane strain conditions, how would you simulate roller boundaries in FLAC? (1)

4.2.2 For plane strain conditions, how far should your boundaries be away from a tunnel being modelled in UDEC? (1)

4.2.3 What does roller boundaries represent? (1)

4.2.4 Draw a schematic for typical boundary conditions for plane strain conditions of a 5 m x 5 m tunnel at a depth of 50 m below surface? (4)

4.2.5 Which software package is able to explicitly simulate fracture initiation and propagation? (1)

4.2.6 What type of boundary conditions would you use when modelling dynamic loading in UDEC, to avoid wave reflection at the boundaries? (1)

4.2.7 Which software package is able to model saturation of weathered soil material? (1)

(10)

[20]