Minerals Council South Africa

EXAMINATION PAPER

SUBJECT: MINERALS COUNCIL OF SOUTH AFRICA CERTIFICATE IN STRATA CONTROL – METALLIFEROUS **SUBJECT CODE**: COMCSCM **DATE**: 08 OCTOBER 2024 **TIME:** 14H30 TO 17H30	**EXAMINER**: MW WIGGINS **MODERATOR**: Y RAJPAL **TOTAL MARKS**: [100] **PASS MARK:** (60%)

NUMBER OF PAGES: 6

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

SPECIAL REQUIREMENTS:

1. **Answer All the Questions**. Answer the questions **legibly** in English.
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 the 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 using sketches or diagrams wherever possible.
7. **Final answers** must be given to an accuracy typical of practical conditions, however, be careful not to use too few decimal places during your calculations, as rounding errors may result in incorrect answers.

NB: Ensure that the correct unit of measure (SI unit) is 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 the 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 are **NOT** allowed in the examination room.

QUESTION 1

DEFINITIONS, BASIC CALCULATIONS AND GENERAL THEORY

1.1. Define in brief the following:

a. Critical bond length (2)
b. Primary Support (Development) (2)
c. MHSA (2)
d. Pillar (2)
e. Seismically active mine (2)

1.2. Choose the correct answer by choosing a, b, c or d. Multiple answers will be marked negatively.

1.2.1. The SI unit for k-ratio is (1)
   a. 0.5
   b. kN/m²
   c. MPa
   d. None

1.2.2. Density of material is depicted by (1)
   a. m/s
   b. Kg/m³
   c. t/m²
   d. J

1.2.3. The SI unit of Force is depicted by: (1)
   a. Pa
   b. N
   c. K
   d. W

1.2.4. The DMRE acronym is defined as (1)
   a. Department of Minerals and Resourceful Extraction
   b. Department of Mineral Resources and Energy
   c. Deposits of Mine Resources and Equality
   d. Deportation of Mining Resources and Energy

1.2.5. Buckling can be defined as: (1)
   a. Failure characterized by sudden loss of strength
   b. Breaking of fragments along a tunnel wall under high load due to structure deflection
   c. To fall inwardly or cave in
   d. Alteration of shape and/or volume of rocks

1.3. Basic calculations:

As part of the rock engineering department, there are times when you will need to measure falls of ground. During a recent seismic event, a fall of ground occurred, resulting in failure of the hangingwall of the stope. It affected a total of 4m in length, 2.3m in width along the panel face with a fall out of 75cm. The hangingwall of the panel consists out of quartzite with a density of 2.75t/m³ and a stoping width of 2.2m.

Part of the failure identified was the fact that the crew was installing their 0.9m long tendon support at 45° to the hangingwall plane at 1.0m dip spacing.

Based on this information, please answer the following questions:

1.3.1. What was the total fall of ground area affecting the panel? (1)
1.3.2. What was the weight of the rocks dislodged in this area? (2)
1.3.3. What is the true height of the bedding supported by the poorly installed tendons? Would it have been sufficient to carry the fall out? (2)

Total [20]

QUESTION 2

MINING AND LEGAL RESPONSIBILITIES

2.1. Re-establishment of panels

Considering a narrow reef environment, due to falls of ground and various other failures i.e., local rock burst, you will need to provide guidance on how to re-establish the panel.

2.1.1. By means of an annotated sketch, please provide a potential design for re-developing on reef in high stress conditions. (6)

2.1.2. Briefly describe which factors could have an influence and why. (2)

2.2. The DMRE provides a guideline for the compilation of the guideline for the compilation of a mandatory Code of Practice to Combat Rock fall and Rock burst accidents in tabular metalliferous mines. Based on this information please answer the following questions:

2.2.1. What are the strategies for Special Areas on the mine? (4)

2.2.2. Not all mines are stand-alone and at times there might be a neighbouring mine that could influence your mining. What measures are described in the COP with regards to the impact of mining activities on neighbouring mines? (4)

2.2.3. What are the two types of Special Areas described in the COP? (2)

Total [18]

QUESTION 3

EXCAVATION STABILITY

When working in an underground metalliferous mine, you will note changes in the ground conditions that are related to stress, depth, and the host rock interaction. Rock Engineering could adjust support design to cater for these changes. One of the methods applied is evaluating the Rockwall Condition Factor.

3.1. Please define the following equation parameters: (2)

$$RCF = \frac{3\sigma_1 - \sigma_3}{F.\sigma_c}$$

3.2. With reference to the below diagram and graph, answer the following questions:

a. Which are the three empirical limits of RCF relating to ground conditions? (3)

b. Tabulate in short what would the (a) primary and (b) secondary typical support requirements be for average ground conditions in terms of: (6)

B1. Static stress conditions
B2. Stress changes anticipated
B3. Seismic activity anticipated

3.2.1. Show the empirical design rule for determining the (a) length and (b) spacing of tendons in development ends. (1)

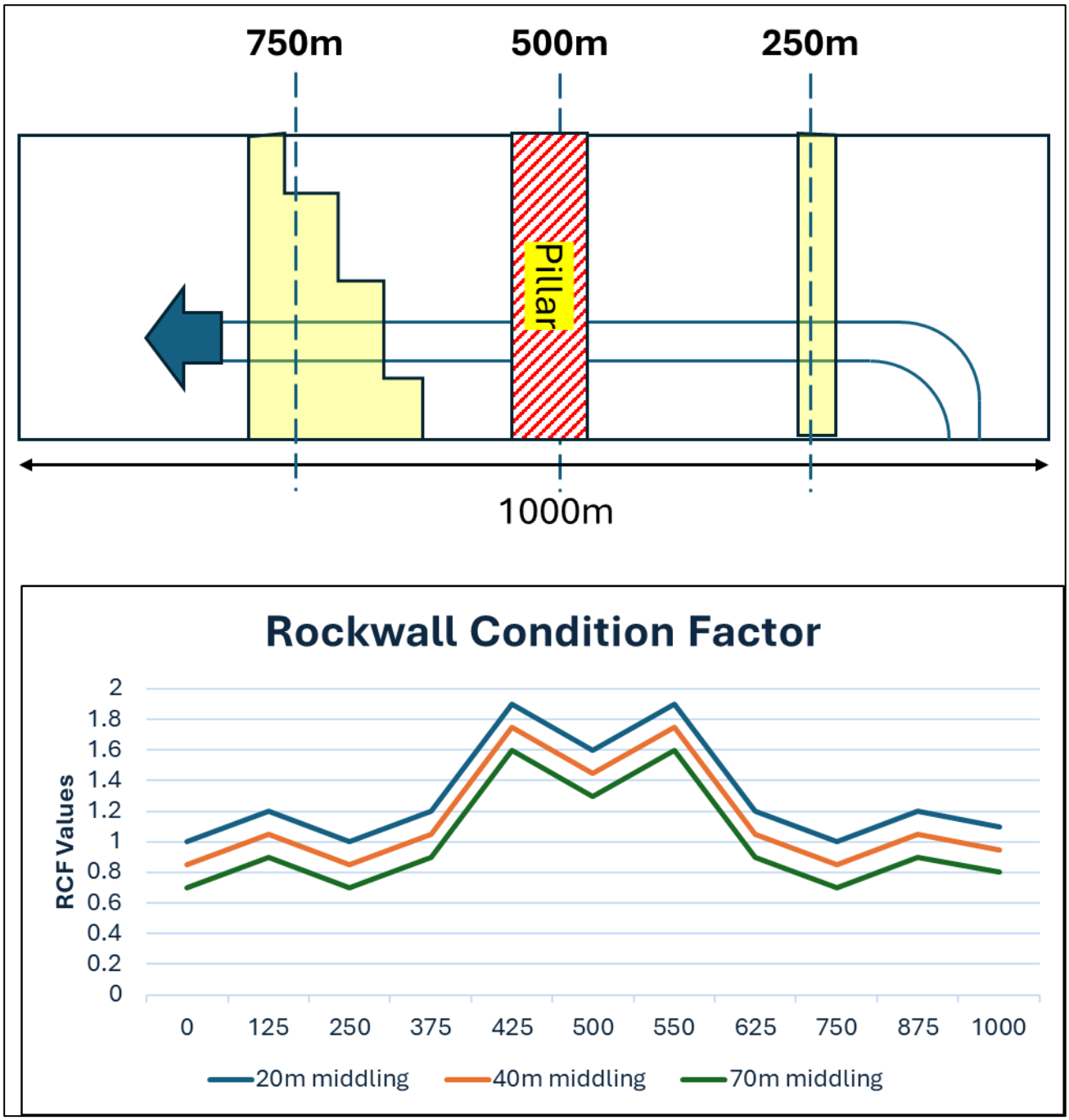

Diagram to be used as reference for Question 3.2

Total [12]

QUESTION 4

SUPPORT DESIGN

4.1. Briefly state which factors do you need to consider when a support system is to be designed? (3)
4.2. Backfill has been utilized in several deeper level mines. Name 4 backfill types in the industry. (2)
4.3. Pillars are blocks of ground left in situ for various reasons.
4.3.1. Briefly describe 4 types of pillars (8)
4.3.2. Provide an annotated sketch of the stress:strain behaviour of hard rock pillars at different width to height ratios. (2)
4.4. Show the difference between static and dynamic support roles in terms of support design for rock burst conditions, by means of:
4.4.1. the support resistance formulae required with correct SI Units (4)
4.4.2. and an annotated sketch. (6)

Total [25]

QUESTION 5

PILLARS AND SUPPORT CALCULATIONS

Metalliferous mines are driven by the extraction of the orebody and the role of the Rock Engineering Department is to ensure that this is done in a safe manner. The following mine requires the input of the Rock Engineering Department to ensure that their bord and pillar operations are done safely.

Using the approach adopted by Hedley and Grant, applying the assumption of TAT (Tributary Area Loading) and the following input parameters:

a. *Mining Height of 1.8m*
b. *DRMS (Mean Design Rock Mass Strength) of 25.02 MPa*
c. *Depth of 850m*
d. *Bord and pillar mining method with bord widths of 5m*
e. *Overburden density of 3000kg/m³*
f. *Average parting distance between cohesionless / slickenside plane above orebody of 2.5m*
g. *Required factor of safety of 1.2 as per Mine's Code of Practice*

5.1. Calculate the strength of the 4m wide square on-reef pillar and the average pillar stress (APS) of the system. (10)
5.2. Calculate the FOS (Factor of Safety) of the above pillar (6)
5.3. During the planning session, the Mining Manager suggests the use of pre-stressed elongates yielding at 200kN spaced at 1.8m apart on dip and strike. Prove or disprove this suggestion with calculations and motivation. (9)

Total [25]

TOTAL [100]

FORMULAE SHEET

$$e = \frac{A_T - A_P}{A_T}$$

$$PS = k.\frac{w^{0.46}}{h^{0.66}}$$

$$PS = k.\frac{w^{0.5}}{h^{0.75}}$$

$$APS = \frac{\rho g h}{1 - e}$$

$$e = \frac{(b + w)^2 - w^2}{(b + w)^2}$$

$$F_s = \frac{\sigma_s}{APS}$$

$$Q = \frac{RQD}{J_n} \cdot \frac{J_r}{J_a} \cdot \frac{J_w}{SRF}$$

$$\tau = \sigma_n \tan\left(\theta_b + JRC \log_{10}\left(\frac{JCS}{\sigma_n}\right)\right)$$

$$\sigma_{\theta\theta} = \frac{1}{2}q(1 + k)\left(1 + \frac{R^2}{r^2}\right) + \frac{1}{2}q(1 - k)\left(1 + \frac{3R^4}{r^4}\right)\cos 2\theta$$

$$E = \frac{\sigma}{\varepsilon}$$

$$v = \frac{\varepsilon_r}{\varepsilon_a}$$