

Minerals Council South Africa



EXAMINATION PAPER

SUBJECT: CHAMBER OF MINES OF SOUTH AFRICA – CERTIFICATE IN STRATA CONTROL – METALLIFEROUS SUBJECT CODE: COMCSCM EXAMINATION DATE: 9 OCTOBER 2018 TIME: 14:30 – 17:30	EXAMINER: JC. VAN ZYL MODERATOR: P. COUTO TOTAL MARKS: [100] PASS MARK: (60%)
NUMBER OF PAGES: 6	
THIS IS NOT AN OPENBOOK EXAMINATION – ONLY REFERENCES PROVIDED ARE ALLOWED SPECIAL REQUIREMENTS: All candidates must complete Questions 1 to 4. Answer the questions <u>legibly</u> in English. Complete only one of the following questions (5, 6 or 7) in relation to your specific field of study. Question 5: Narrow Tabular Hard Rock Question 6: Open Pit Question 7: Massive Mining - 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. - Show all calculations and check calculations on which the answers are based. - Hand-held electronic calculators may be used for calculations. Reference notes may not be programmed into calculators. - Write legibly in ink on the right-hand page only – left hand pages will not be marked. - Illustrate your answers by means of sketches or diagrams wherever possible. Final answers must be given to an accuracy which is typical of practical conditions. However, be careful not to use too few decimal places (minimum 2) during your calculations, as rounding errors may result in incorrect answers. NB: Ensure that the correct unit of measure (SI units) is recorded as marks will be deducted from answers if the incorrect unit is used (even if the calculated value is correct). - In answering the questions, full advantage should be taken of your practical experience as well as data given. - Please note that you are not allowed to contact your examiner or moderator regarding this examination. - Cell phones are NOT allowed in the examination room.	

1 QUESTION 1 – GENERAL: (11 MARKS)

1.1 Define, annotate and explain the following terms: **(11)**

- a) Stress
- b) Primitive stress (virgin stress)
- c) Induced stress
- d) Excess Shear Stress
- e) Energy Release Rate (ERR)

2 QUESTION 2 – MINING LAYOUTS: (24 MARKS)

You are employed on a deep level gold mine that has been in operation for more than 30 years. The ore reserve has nearly been depleted, and there is consideration to shut down the operation. Long term planning has just been completed and several stabilizing pillars has been identified for partial extraction which can increase the life of mine by another 5 years. The areas identified will be classified as “Special areas”.

Your mine's Code of Practice for Support and control of rock-falls, requires that “Special Areas” are to be declared in any situation where it is considered that there is an increased possibility of rock-falls, rock bursts, or other hazardous conditions. It is expected that stress, ERR, stress induced fracturing and seismicity will increase.

List or describe what layout considerations you will apply while extracting this “Special Areas”. **(24)**

3 QUESTION 2 – BACKFILL: (20 MARKS)

3.1 Backfill is an important mining strategy to alleviate rock stress problems in the deep level mines.

Explain the effects or uses of backfill as

- (a) local support and
- (b) Regional support. **(8)**

3.2 List the five types of backfill that are used in the mining industry. **(5)**

3.3 What other benefits does backfill have besides its superior supporting capabilities? **(7)**

4 QUESTION 4 – SUPPORT: (25 MARKS)

You are working on a shallow chrome mine, the Manager has requested that you optimise the tendon support design.

Given the current support design:

- Spacing: 1.0m dip, 1.0m on strike
 - Bord width 10.0m
 - Tendon: Resin bolt 22mm diameter 2.0m long
 - 450 MPa Tensile strength
 - Anchored with 2.5MPa resin
 - Pyroxenite hanging wall
 - FoH of 0.9m
- a. Calculate the critical bond length? **(5)**
- b. Calculate the support resistance required and the support spacing to maintain a FOS of 1.5 **(7)**
- c. Draw the hangingwall support pattern for a 10.0m wide bord indicating the difference between the old and new support layout. **(5)**
- d. Sketch and describe the mechanism / installation process of resin grouted bolts. **(8)**

5 QUESTION 5 – PILLARS: (20 MARKS)

- 5.1 Explain the fundamental assumption of the tributary area theory and illustrate your understanding by means of a sketch? **(4)**
- 5.2 You are working on a shallow chrome mine extracting the LG6 and LG6a reef package. A new mining block has been opened where the bulk of the production will be delivered from over the following 5 years.

The mining depth is 400.0m below surface and the stoping width has increased to 4.0m. The UCS of the pillar material is 95MPa and the K factor was established to be 60% of the UCS using Laubscher's design rock mass strength (DRMS). A system of regular pillars 11.0m wide x 11.0m long and 8.0m wide bords are planned with an extraction ratio of 66%. The pillar width to height ratio is 2.75 and FOS is 1.8

The Mine Manager has highlighted two areas of concern regarding the layout as follow:

- Due to the length of the pillars, bord width and the requirement that the face must advance past the holing position, mechanical means of ventilation (fans) will be required in all bords.
- The increase of the waste middling (2.4m thick) between the LG6 and LG6a reefs have a major impact on yields and grade, resulting in mining the full package uneconomical.

The Rock Engineer has requested you to come up with a solution as the LoM depended on extracting this block of ground. He has provided you the following guidelines:

- Pillar center-to-center spacing's must be planned 15.0m. The bord widths must remain at 8.0m wide. This will solve the ventilation constraints and maintain the current production profile.
- The LG6a and waste middling must be undercut to eliminate the dilution. The footwall will be over break by 0.6m to ensure the stoping is cut at 1.8m high to accommodate the trackless equipment.

5.2.1 Determine the extraction ratio, width to height ratio and safety factor for the pillar layout according to the guidelines provided by the Rock Engineer. **(13)**

5.2.2 Provide the Manager with feedback by commenting on the proposed layout pillar safety factor, width to height ratio of the pillars and the extraction ratio. **(3)**

6 QUESTION 6 – OPEN PIT: (20 MARKS)

6.1 On your operation you have a weak zone within your pit. Heavy rains fall within the area and the zone starts to fail.

6.1.1 Describe and annotate the four failure modes. **(8)**

6.1.2 Explain how you as a practitioner will monitor this area in future. **(8)**

6.1.3 What safety precautions will you implement to ensure safety of the mining personnel in the pit within close proximity of this weak zone. **(4)**

7 QUESTION 7 – MASSIVE MINING: (20 MARKS)

7.1 Draw points in massive mining environments are critical to the LoM. Explain, describe and annotate what as a Strata Control Officer what you would see underground in these environments to ensure that the stability is maintained considering the following points. **(20)**

- Support types
- Support purpose
- Support layouts
- Operational stability
- Rehabilitation method

Formulas:

$$\text{Total Energy} = \frac{1}{2} m v^2 + mgh$$

$$s_x = \frac{2(1-\nu)q}{G} \sqrt{l^2 - x^2}$$

$$l_c = \frac{s_m G}{2(1-\nu)q}$$

$$\sigma_s = 7.2 \frac{R_0^{0.5933}}{V^{0.06667}} \left\{ \frac{0.5933}{\varepsilon} \left[\left(\frac{R}{R_0} \right)^\varepsilon - 1 \right] + 1 \right\} MPa$$

$$e = 1 - \frac{w_1 w_2}{C_1 C_2}$$

$$ERR = \frac{\Delta U_m}{\Delta A} = \frac{\pi(1-\nu)lq^2}{2G}$$

$$v_p = \sqrt{\frac{\lambda + 2G}{\rho}} \quad v_s = \sqrt{\frac{G}{\rho}}$$

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

$$RQD = \frac{\sum \text{length of core pieces} > 10\text{cm}}{\text{total length of core}} \times 100$$

$$\frac{h}{s} = \frac{1}{\sqrt{\frac{g h}{s} - G}}$$

$$Q = RQD/J_n \times J_r/J_a \times J_w/SRF$$

$$G = \frac{E}{2(1+\nu)}$$

$$\tau = \sigma n \tan(\phi + JRC 10 \log \tan(\frac{JCS}{\sigma n}))$$

$$APS = q_d/(1-e)$$

$$\varepsilon = \Delta l / L$$

$$E = \sigma/\varepsilon$$

$$\nu = \varepsilon_r / \varepsilon_a$$

$$Ps = K w^{0.46} / h^{0.66}$$

$$Ps = K w^{0.5} / h^{0.75}$$

$$F_y = \sigma_y \cdot A \quad SR = \rho \cdot g \cdot h$$

$$L = \frac{F_y}{\pi \cdot D \cdot \sigma_b} \quad \text{Tendon spacing} = \frac{\text{Tendon yield strength}}{(FOS) \cdot (SR)}$$