



EXAMINATION PAPER

SUBJECT: CHAMBER OF MINES OF SOUTH AFRICA – CERTIFICATE IN STRATA CONTROL – METALLIFEROUS SUBJECT CODE: COMCSC EXAMINATION DATE: TIME: 14:30 – 17:30	EXAMINER: Y Jooste MODERATOR: DA Arnold TOTAL MARKS: [100] PASS MARK: (60%)
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NUMBER OF PAGES:

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

SPECIAL REQUIREMENTS:

1. Answer all the questions. Answer the question **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 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, 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) 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 are **NOT** allowed in the examination room.

QUESTION 1

Use table supplied at the end of the exam paper and hand it in with your answer sheet

- 1.1 Overstoping is an effective method of protecting off-reef excavations from the effects of large mining induced stress changes.
- a. True
 - b. False
- 1.2 APS stands for:
- a. Apparent pillar stress
 - b. Average pack stress
 - c. Ambient pillar stress
 - d. Average pillar stress
- 1.3 What is the surface area of a mine pole with radius 105mm and length 2.2m?
- a. 1.40m^2
 - b. 1.52m^2
 - c. 0.89m^2
 - d. 1.98m^2
- 1.4 The virgin vertical stress at a depth of 3200 m below surface where the k-ratio is 0.5 and the rock density is 2750 Kg/m^3 is:
- a. 43.16 MPa
 - b. 86.32 kN
 - c. 86.32 MPa
 - d. 42.12 kN
- 1.5 Stope closure continues to take place even if there is no further face advance.
- a. True
 - b. False

1.6 This type of rock is formed from a body of magma that cools down and solidifies.

- a. Sedimentary rock
- b. Igneous rock
- c. Metamorphic rock

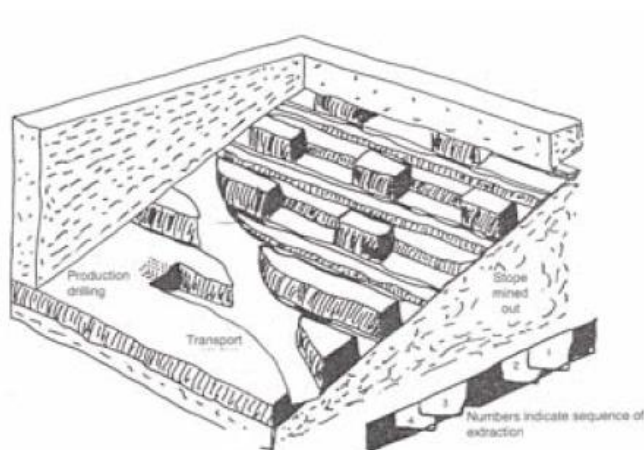
1.7 Packs should be built perpendicular to the reef dip.

- a. True
- b. False

1.8 Under-burdened blast holes means that holes are drilled too far apart from each other.

- a. True
- b. False

1.9 Name the mining method in the figure below:



- a. Bord and pillar mining
- b. Sub level stoping
- c. Cut and fill mining
- d. Step room and pillar mining

1.10 Buckling potential decreases if elongate length to diameter ratio is more than 10.

- a. True
- b. False

QUESTION 2 – Definitions

Define the following terms and where applicable give units:

- 2.1 Virgin stress
- 2.2 APS
- 2.3 Bedding planes
- 2.4 Joints
- 2.5 Ride

[10]

QUESTION 3 – Force and Stress

- 3.1 Calculate the load in kN at which a 20mm diameter rock bolts will fail, assuming that the tensile strength of steel is 450Mpa. (3)
- 3.2 Consider a point at a crosscut position that is 2000m below surface, 100m below the reef plane and 100m ahead of a longwall stope. Assume a k-ratio of 0.5.
 - 3.1.1 Calculate the vertical and horizontal primitive stress at this point. (4)
 - 3.1.2 Assume that the stoping induced stress increases this value by a factor of 1.5. Calculate the field stress in which the crosscut is situated. (2)
 - 3.1.3 Calculate the total stress in the sidewall of the crosscut assuming a stress concentration factor of 2. (1)

[10]

QUESTION 3 – Pillars

- 3.1 Draw the stress-strain behaviour graphs of the following hard rock pillar types:
 - Non-yield
 - Yield
 - Crush

Indicate the typical operating points of these pillar types. (9)

3.2 What is the fundamental assumption of the tributary area theory? (2)

3.3 A system of regular pillars are planned for mining at a depth of 700m below surface in a rock density of 2800 kg/m^3 . The stoping width will be 3.1m, and 8m wide bords and 6m wide square pillars are planned. The in situ cube strength of the host rock was determined to be 145 MPa. Determine the safety factor of the system. (9)

[20]

QUESTION 4 – SUPPORT

4.1 The table below lists a number of support types. State which support type is active and which is passive at the time of initial installation. Also classify them in terms of what conditions they best operate in? Use the answer sheet at the end of the paper and hand it in with your exam paper.

Support unit	Active/Passive	Dynamic/static conditions
End-anchor bolts		
Grouted Ripple bar		
Pre-stressed mat pack		
Rapid yielding hydraulic prop		
Crush Pillar		
Shotcrete		
Mesh and lace		
Rock prop		
Cemented backfill		
Timber Sets		

(10)

4.2 Some important rock and support related issues need to be considered before a support system is designed by a rock engineer. List 5 geotechnical factors you

would consider important when designing a support system for a mining excavation. (5)

- 4.3 What geotechnical aspects would you as a rock engineer consider in order to ensure that energy release rates on your deep level mine are controlled?

(5)

[20]

QUESTION 5 – SEISMICITY

- 5.1 Name the two types of body waves commonly detected and used in mine seismicity monitoring, and state their typical propagation velocities?

(2)

- 5.2 Define the difference between a seismic event and a rock burst? (4)

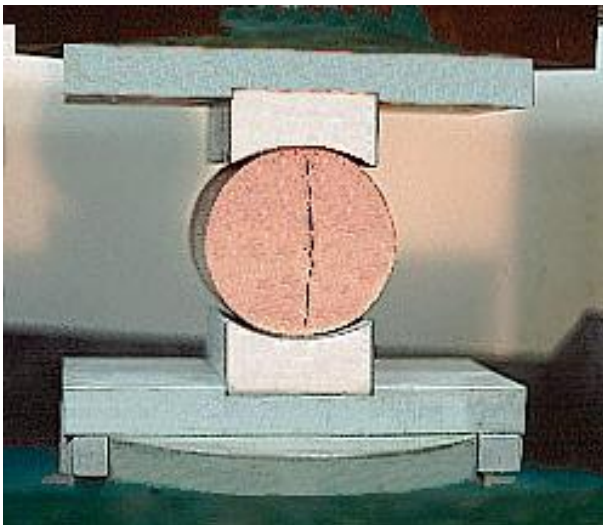
- 5.3 What 4 parameters can be obtained instantly from a seismic monitoring system when a seismic event occurs? (4)

[10]

QUESTION 6 – MONITORING

- 6.1 Name the testing method illustrated in the figure below and briefly describe how it is done.

(3)



6.2 Why do we need to do rock engineering monitoring ? (4)

6.3 A standard uni-axial compression test was carried out on a specimen of kimberlite. The initial dimensions were 47.2mm in diameter and 96,4mm in length. The load-deformation record showed that the specimen deformed in a perfectly elastic manner and that it had been compressed to a length of 96.21mm when failure occurred at a load of 213 kN. The lateral strain at this stage was 0.00058. Calculate:

6.3.1 The stress at failure

6.3.2 The axial strain at failure

6.3.3 The lateral deformation at failure

6.4.4 The Poisson's ratio

6.4.5 The modulus of elasticity, E (Young's modulus)

6.4.6 The shear modulus, G

(13)

[20]

TOTAL MARKS: [100]

ANSWER SHEET

Mark the correct answer only

QUESTION 1

Question	Select correct answer			
1.1	a	b	c	d
1.2	a	b	c	d
1.3	a	b	c	d
1.4	a	b	c	d
1.5	a	b	c	d
1.6	a	b	c	d
1.7	a	b	c	d
1.8	a	b	c	d
1.9	a	b	c	d
1.10	a	b	c	d

QUESTION 4.1

Support unit	Active	Passive	Dynamic	static
End-anchor bolts				
Grouted Ripple bar				
Pre-stressed mat pack				
Rapid yielding hydraulic prop				
Crush Pillar				
Shotcrete				
Mesh and lace				
Rock prop				
Cemented backfill				
Timber Sets				

FORMULE SHEET

1. Total Energy = $\frac{1}{2} m v^2 + mgh$
2. $s_z = \frac{2(1-\nu)q}{G} \sqrt{l^2 - x^2}$
3. $l_c = \frac{s_m G}{2(1-\nu)q}$
4. $\sigma_s = 7.2 \frac{R_0^{0.5933}}{V^{0.0667}} \left\{ \frac{0.5933}{\varepsilon} \left[\left(\frac{R}{R_0} \right)^\varepsilon - 1 \right] + 1 \right\} MPa$
5. $e = 1 - \frac{w_1 w_2}{C_1 C_2}$
6. $ERR = \frac{\Delta U_m}{\Delta A} = \frac{\pi(1-\nu)lq^2}{2G}$
7. $\nu_p = \sqrt{\frac{\lambda + 2G}{\rho}} \quad \nu_s = \sqrt{\frac{G}{\rho}}$
8. $RCF = \frac{3\sigma_1 - \sigma_3}{F\sigma_c}$
9. $RQD = \frac{\Sigma \text{length of core pieces} > 10cm}{\text{total length of core}} \times 100$
10. $\frac{h}{s} = \frac{1}{\sqrt{\frac{8h}{s} - 6}}$
11. $Q = RQD/Jn \times Jr/Ja \times Jw/SRF$
12. $G = \frac{E}{2(1+\nu)}$
13. $\tau = \sigma n \tan(\emptyset + JRC \log \tan(\frac{JCS}{\sigma n}))$
14. $APS = q\sqrt{1-e}$
15. $\varepsilon = \Delta l / L$
16. $E = \sigma/\varepsilon$
17. $\nu = \varepsilon_r / \varepsilon_a$
18. $Ps = K w^{0.46} / h^{0.66}$
19. $Ps = K w^{0.5} / h^{0.75}$