Chamber of Mines of South Africa

EXAMINATION PAPER

SUBJECT: CHAMBER OF MINES CERTIFICATE IN ROCK MECHANICS:PAPER 2 **SUBJECT CODE:** COMRMC **EXAMINATION DATE: October 2017** **TIME:**	**EXAMINER:** B VAN DER KEVIE **MODERATOR:** P GREYLING **TOTAL MARKS:** [100] **PASS MARK:** 60%

NUMBER OF PAGES: 17 (including answer sheet)

SPECIAL REQUIREMENTS:

1. Answer all questions.
2. Write your **answers for Question 1 , 3.1 and 4.1 on the answer sheet provided** at the back of the question paper and submit this with your script.
3. **Only 1 (one) correct answer for all questions in Question 1.**
4. References other than those provided are not permitted.
5. Hand-held electronic calculators may be used.
6. Write your examination 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.

7. **Write in ink on the RIGHT HAND SIDE of the paper only (only the right hand pages will be marked).**
8. Show all calculations on which your answers are based.
9. Illustrate your answers by sketches of diagrams wherever possible.
10. In answering these questions, full advantage should be taken wherever necessary of your practical experience as well as of the data given.
11. Answers must be given to an accuracy that is typical of practical conditions.
12. Cell phones are **NOT** allowed in the examination room.

QUESTION 1

TICK THE MOST CORRECT ANSWER ON THE ATTACHED SHEET PROVIDED AND HAND IN WITH YOUR EXAM BOOK. ENSURE ID NUMBER IS ON THE SHEET.

Only 1 (one) most correct answer for all questions in Question 1. If more than one is ticked no marks will be given

1.1 Which **one** of the following rocks are not Igneous rocks?

a) Syenite
b) Gabbro
c) Quartzite
d) Kimberlite
e) Trachyte (1)

1.2 Which **one** of the following rocks are not sedimentary rocks?

a) Mudstone
b) Shales
c) Coal
d) Pyroxenite
e) Limestone (1)

1.3 Which **one** of the following rocks are not Metamorphic rocks?

a) Quartzite
b) Norite
c) Slate
d) Migmatite
e) Marble (1)

1.4 Which **one** of the following statements is in**correct?**

(a) Any employer may prepare and implement a code of practice on any matter affecting the health or safety of employees and other persons who may be directly affected by activities at the mine.

(b) An employer must prepare and implement a code of practice on any matter affecting the health or safety of employees and other persons who may be directly affected by activities at the mine if the Chief Inspector of Mines of Mines requires it.

(c) A code of practice required by the Chief Inspector of Mines of Mines must comply with guidelines issued by the Chief Inspector of Mines of Mines and guidelines specified by the Healt and safety committee.

(d) The employer must consult with the health and safety committee on the preparation, implementation or revision of any code of practice, only if requested by the Chief Inspector of Mines.

(e) C and D

(5)

1.5 Which **one** of the following instrument determine geological structures in the hangingwall?

a) Closure meter
b) Doorstopper
c) Geophone
d) GPR
e) Accelerometer (1)

1.6 Which **one** of the following statements is **incorrect** with regard to COP's?

(a) This Mandatory Code of Practice to Combat Rockfall Accidents is drawn up in terms of the sections 9(2) and (3) of the Mine Health & Safety Act 1996 (Act 29 of 1996).

(b) This Code of Practice may be used in an accident investigation or enquiry to ascertain compliance and also to establish whether the COP is effective and fit for purpose.

(c) All managerial instructions, recommended procedures and standards on the relevant topics must comply with the Code of Practice and must be reviewed to establish compliance. It is the responsibility of the Mine Manager that procedures and mine

standards are reviewed annually to establish compliance. The requirements drawn up in this Code of Practice represents the minimum requirements for each geotechnical area and do not preclude any person from taking or requesting further safety measures were considered necessary to make the mine a safer place.

(d) The Mine Manager will keep the Code of Practice on file. Copies will be issued to the Health & Safety Committee. Failure by the employee to prepare and implement a COP in compliance with this guideline is a breach of the MHSA.

(e) A procedure must be instigated by the appointed Rock Engineer to ensure that all employees are conversant with the relevant sections of the Codes of Practice, and these relevant sections will be translated into other languages as required, in consultation with the Health and Safety Committee. (5)

1.7 What is the ideal w:h ratio of a barrier pillar ?

a) 10
b) 5
c) 3-4
d) 20
e) 4 (1)

1.8 What is the most suitable mining method for a reef-body dipping at 25 degrees with a stoping width of 1.8m at shallow depth?

a) Conventional Scattered breast mining
b) Longwall mining
c) Board and pillar mining
d) Cut and fill mining
e) Block caving (1)

1.9 What is typical stope closure rates (mm/m face advance) for breast panel stoping in ultra deep mining depths (>3500m - B.S.)

a) 10mm

b) 0-5mm

c) 6mm

d) >30mm

e) <20mm (1)

1.10 Which **one** of the following statements is **incorrect** with regard to the mine health and safety act when a Samrass 3 form must be filled in?

ROCKBURSTS AND FALLS OF GROUND

An extensive rockburst or fall of ground causing the following damage underground

(a) At least 15 linear metres of working face has been severely damaged and choked and will require re-establishment and re-supporting, or be abandoned;

(b) At least 25m2 of working area has been severely damaged and choked rendering support units ineffectual and will have to be re-established and re-supported or be abandoned;

(c) At least 10 linear metres of gully has been restricted with rock clearly recently displaced from the hanging wall and gully sidewalls;

(d)) At least 10 linear metres continuous or 30 linear metres cumulative of access ways of tunnel or travelling way has been severely damaged and will require rehabilitation or be abandoned;

(e) At least 10 m2 of roof or 5m3 of rock has been displaced from the roof of the mining cavity or excavation. (5)

1.11 The stope width of a reef channel is 70cm of which 50cm is external waste. What would the channel value be in g/t if the cm.g/t value is 2000.

a) 150 g/t

b) 60 g/t

c) 100 g/t

d) 42,9 g/t(2) (2)

1.12 What is the standard rate recommended for testing support units for dynamic conditions in a press?

(a) 300mm/min
(b) 3m/sec
(c) 30mm/min
(d) 3mm/min
(e) 2m/sec (1)

Total: 25

Question 2

2.1 When planning a "greenfields" mining operation for an opencast mine or underground shallow mine the Rock Mass Characterization is fundamental in the mine design. You as the onsite Rock Engineer must manage this process and write the final Conceptual Mine Design report. Before this can be done you must determine the behavior of the excavations in the rock where the mine is planned. Describe how you will go about doing the rock mass characterization in a structural and chronological process. Please make use of a numbering and bullet point system when answering this question to present it chronologically. (20)

1 Collection of geotechnical data.

1.1 Site Investigation

- **Study of available geological plans and similar material**
- **Satellite imagery**
- **Aerial photograph interpretations**
- **Specific Field Mapping**
- **Targeted exploration drilling, including specific geotechnical drilling, all based on information obtained from the above investigations.**
- **Evaluation and prediction of geological influences**
    a) **Structural**
    b) **In situ and induced stress**
    c) **Groundwater**
    d) **Quality and durability of the rockmass**
    e) **Control investigations during production.**

1.2 Geotechnical logging of borehole core

1.3 Mapping of exposed rock surfaces
1.4 Laboratory rock testing

1.2 In situ Stress conditions

Tri-axial stress measurements or Doorstopper stress measurements to be obtained from adjacent mines or from SA database literature to determine k-ratio

1.3 Rock Mass classification.

Use of Q and RMR system to quantify the rockmass in terms of stability.

2.2 Name five factors that will influence the stability of an excavations in a jointed rockmass (5)

- **Strength of rock**
- **Joint frequency**
- **Joint strength**
- **Confining stress**
- **Presence of water**

Total: 25

Question 3

3.1 Name 3 types of backfill systems and for each system give 2 pros and 2 cons. Use the attached table 1 to answer the question. (15)

System	Advantages	Disadvantages	Remarks
Crushed Waste Fill	-Available waste rock on surface can be used if tipping through a pass system is appropriate -Hoisting time on shaft is reduced if waste is crushed underground -Immediate access is possible on the fill by heavy equipment	High cost of crushing underground High cost of transport Confinement provided to pillars not as good as with some other types of backfill	Sufficient waste must be available or generated
Classified cycloned tailings (CCT)	-Simple method of conveying large volumes of fill from surface directly into areas to be filled -Has good drainage characteristics	Large volumes of excess water have to be handled underground Use of only the coarser fraction, leaving the finer fraction for tailings disposal creates potential problems with the building of slimes dams More difficult to pump than full plant tailings	Sufficient backfill material must be available
Cemented Full Plant Tailings	-Simple method of conveying large volumes of fill from surface directly into areas to be filled -Maximum use of tailings product -Very good pumping characteristics	Poor drainage characteristics High moisture content requires greater quantities of binder	The binder material assists by hydrating the excess water retained by the fines
Paste Fill	-Relatively small amounts of cement (3% to 5%) produce stiff backfill (1.5 to 3.5MPa) -Reduced tailings impoundment requirements -Good support properties -Reduced spills underground -The entire tailings stream can be placed underground	Costly system which requires expensive pumps, pipes and dewatering equipment Conveying distances limited due to high pressure gradients (approximately 1km horizontally) Good quality control is necessary	Pumping difficulties can be alleviated by pumping the fill underground as a slurry and then dewatering it close to the stopes
Slurry Fill	-Very little run-off water -Can be used with full plant tailings -The total cost of this system could be less than for cemented CCT	Requires availability of a special binder Accelerator is costly and requires accurate dosing	Technically, this system is good

3.2 List five (5) high risk factors in shallow narrow reef breast mining. These factors must be typical high risk factors as being used in panel risk ratings. (5)

- Support failure
- Face shape
- Blasting practices

- Stoping width
- Poor ground conditions
- Joint orientation
- Joint condition
- Brows
- Domes
- Potholes
- Shearzones
- Change in mining direction
- Approaching geological structures

3.3 What are the possible risks of poor face shape in shallow narrow reef mining (5)

- Incomplete support lines.
- Support lines not parallel with face resulting in difficulty to install full line of temporary support with safety nets.
- Support lines not parallel with face resulting in difficulty to clean panel and thus pulling out of support.
- Poor breaking of face due to irregular face shape (poor face advance)
- Permanent support too close and/or too far from face.
- Panel choking because blasting barricade too close to face.
- Blasting out of permanent support

Total: 25

Question 4

During shaft pillar extractions and shaft pillar design numerous limiting criteria for damage to shaft steelwork and concrete lining have been quoted and researched , in terms of induced vertical stress (σ_z^i), induced vertical strain (ε_z^i) and induced tilt ($Tilt^i$) :

4.1 Complete the attached table below for the damage criteria. (6)

Type of damage	Criteria
Unspecified damage	$\sigma_z^i < 17MPa$
Unspecified damage, criterion not based on back analysis	$\varepsilon_z^i < 1x10^{-3}$ $Tilt^i < 1x10^{-3}$
Steelwork damage and increased shaft maintenance.	$\varepsilon_z^i < 0.2 \text{ to } 0.4 \text{ x} 10^{-3}$
Tensile fracture of concrete lining	$\varepsilon_z^i < -0.2 \text{ to } -0.51 \text{ x } 10^{-3}$
Compressive fracture of concrete lining	$\varepsilon_z^i < 0.7 \text{ x } 10^{-3}$

Extracting a shaft pillar in ***an operating shaft*** in deep level mining requires careful planning. Briefly describe the preparation of the shaft pillar extraction under the following headings.

4.2 Shaft sidewall preparation and support. Give estimated distances of affected area and physical conditions to be encountered. (2)

- **To prevent loose blocks of concrete falling down shaft the sidewall must be secured using diamond mesh secured with roofbolts/long anchors bolted to the rock behind the lining.**
- **The Roofbolts/long anchors will also reinforce the rock to protect it against compressive stresses induced during the stoping operation**
- **The area affected will be in the region of 10-20m above and below the reef plane.**

4.3 Alterations required to the shaft steelwork. Describe and briefly discuss 3 methods that can be used to to alter steelwork to compensate for the compression, ride and closure. (3)

- **The first method is to install telescopic guides up and down the shaft or by continuous adjustment of the guides attachments to the buntons.**
- **Second method is to attach the buntons to the sidewalls in such a manner that the buntons can be adjusted relative to the sidewall to compensate for ride and vertical closure. In this case telescopic guides is only necessary at the reef intersection. This method is cheap but requires a lot of maintenance.**

- **A third method is to suspend the shaft steelwork from a position well above the reef intersection to a position well below the reef intersection ("floating steelwork"). Once again only one set of telescopic guides is required.**

4.4 Alterations to shaft services (pipes, cables and drain holes) that may be required for the movement in the shaft.

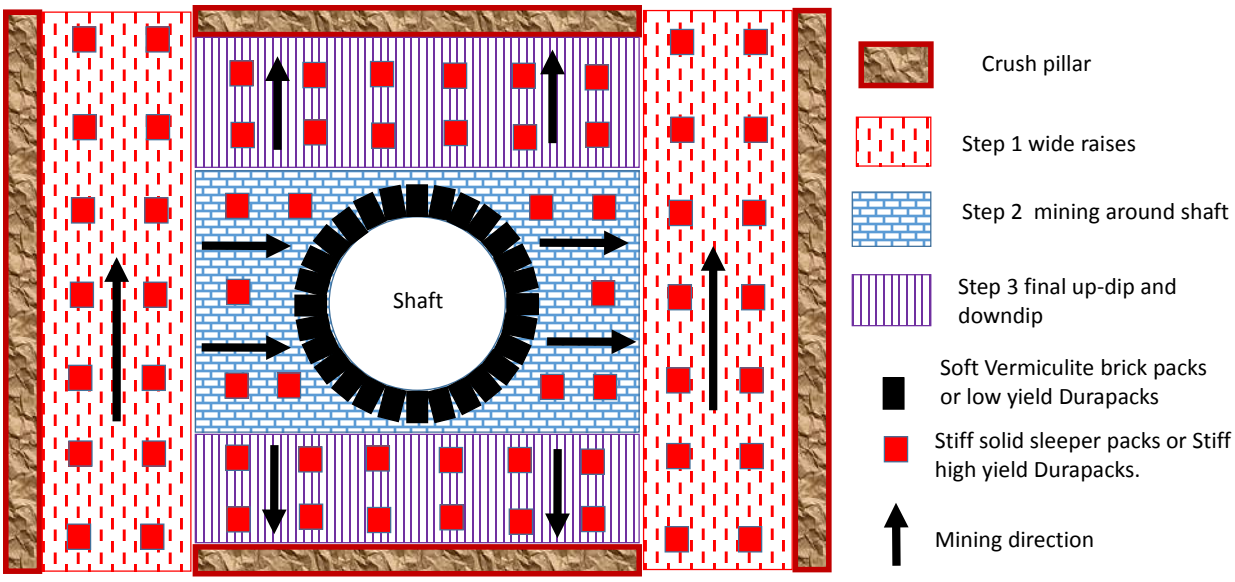
(2)

- **Telescopic pipe colums can be installed .**
- **Electric cables must have enough slack to prevent cables coming under tension.**
- **Drain holes going through the reef must be replaced by pipes in the shaft or any alternative route to be created.**

4.5 How will the inner pillar surrounding the shaft barrel be extracted (mining sequence) and what support will be required. Make use of sketches showing the final inner pillar extraction with the support and pillar requirements

(9)

- **The inner pillar around shaft must be mined first to protect the shaft barrel from deformation as far as possible.**
- **Ventilation in shaft must be sealed off by installing soft support around the barrel.**
- **Crush pillars and stiff support in remaining area but away from barrel to be installed to minimize closure as far as possible.**
- **The pillar can be mined by blasting 2 wide raises on either side of the shaft.**
- **Once completed and supported the area around the shaft can be blasted out systematically.**
- **Finally blast up-dip and downdip away from shaft to complete inner pillar mining**



4.6 Stoping of the outer pillar is done once the inner pillar is completed. What considerations must be taken into account when planning the outer pillar mining. (3)

- If seismically active features like faults and dykes are present the sequence surrounding these are very important.
- Ancillary excavations need to be protected and will dictate where overstoping will take place at the early stage.
- Unpay blocks are also factors to be considered

TOTAL 25 MARKS

Answer sheet multiple choice (Question 1)
October 2017 Paper 2

ID Number ☐☐☐☐☐☐☐☐☐☐☐☐☐

	a	b	c	d	e
1.1	☐	☐	☐	☐	☐
1.2	☐	☐	☐	☐	☐
1.3	☐	☐	☐	☐	☐
1.4	☐	☐	☐	☐	☐
1.5	☐	☐	☐	☐	☐
1.6	☐	☐	☐	☐	☐
1.7	☐	☐	☐	☐	☐
1.8	☐	☐	☐	☐	☐
1.9	☐	☐	☐	☐	☐
1.10	☐	☐	☐	☐	☐
1.11	☐	☐	☐	☐	☐
1.12	☐	☐	☐	☐	☐

ID Number

Question 3.1

Backfill System	*Pros*	*Cons*

ID Number

Question 4.1

Type of damage	Criteria
Unspecified damage	σ_z^i
Unspecified damage, criterion not based on back analysis	ε_z^i $Tilt^i$
Steelwork damage and increased shaft maintenance.	ε_z^i
Tensile fracture of concrete lining	ε_z^i
Compressive fracture of concrete lining	ε_z^i