



Chamber of Mines of South Africa

EXAMINATION PAPER

SUBJECT: CHAMBER OF MINES CERTIFICATE IN ROCK MECHANICS: PAPER 2 SUBJECT CODE: COMRMC EXAMINATION DATE: 11 May 2016 TIME: 14:30 – 17:30	EXAMINER: B VAN DER KEVIE MODERATOR: P GREYLING TOTAL MARKS: [100] PASS MARK: 60%
---	--

NUMBER OF PAGES: 9 (including answer sheet)

SPECIAL REQUIREMENTS:

1. Answer all questions.
2. Write your **answers for Question 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 CORRECT ANSWER ON THE ATTACHED SHEET PROVIDED AND HAND IN WITH YOUR EXAM BOOK. ENSURE ID NUMBER IS ON THE SHEET.

Only 1 (one) 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 statements is **correct**?

- a) Foliation is a structure (or texture) due to the parallel disposition in layers (or lines) of one or more conspicuous mineral. The most common rock exhibiting foliation is shale.
- b) Erosion channels are methamorphic-filled channels or stream that are cut into pre-existing layers of rock during deposition
- c) A fold is a bend in a surface or layer of rock, and can occur only in igneous rock formations.
- d) An unconformity represents a period in geological history during which new strata were deposited in layers. The strata already formed before this deposition may be uplifted or tilted by earth movements. (4)

1.2 Which **one** of the following statements is **incorrect**?

- a) The Witwatersrand basin's precise age is difficult to determine since rocks were deposited by sedimentation approximately 2700 million years ago. Before the age of fossils.
- b) The Bushveld complex was formed by various igneous activity like a basic volcanic phase, sill phase, acidic volcanic phase, plutonic phase and acid plutonic phase.
- c) The Vaal reef, "C" reef, Ventersdorp Contact Reef (VCR) and Elsburg reefs are all part of the Klerksdorp Goldfields.

- d) The West-Wits or Carletonville Goldfields comprises of the Basal Reef, Kimberly Reef, Carbon Leader Reef, Middelvlei Reef and Ventersdorp Contact Reef (VCR)(4)

1.3 Which **one** of the following statements is **correct**?

- a) There also appears to be some correlation between the size of a fault (expressed in terms of its throw, though probably also including its areal extent) and the maximum size seismic event that can be generated by the fault. Van der Heever (1983) showed empirically that in the Carletonville goldfield the likely maximum sized event on a fault with a throw of 15 m has a magnitude of 3, and on fault with a throw of 280 m a magnitude of 5. He expressed this relationship by $M_{\max} \approx 1.8 \log_{10} D + 1.6$ (where D is throw in m)
- b) A seismic event is a sudden elastic deformation within a given volume of rock whereby a source radiates detectable seismic waves. The amplitude and frequency of the radiated waves depend, in general, on the size of the source, and on the magnitude and the rate at which the stress in the rock is relaxed during the fracturing process.
- c) On the analysis of seismicity in time, the slope of the ΣV_2 (Cumulative Apparent Volume) reflect changes in the strain rate
- d) When a seismic event is plotted on the plan, the point where it originated is referred to as the hypocenter

(4)

1.4 Which **one** of the following statements is **incorrect**?

- a) The simple yet insightful concept of Energy Release Rate ('ERR', expressed in MJ/m²), introduced in the 1960s by workers including Cook et al (1966) and Salamon (1984), remains to this day the most accessible measure of severity of conditions in deep mining situations. The average level of ERR pertaining at a given set of mining faces appropriately takes into account the effects of depth, mining span, stoping width, rock mass modulus, presence of backfill or pillars, and influences of neighbouring mining. It is related to the extent of volumetric

convergence taking place, or being permitted to take place, in the back areas of a given stope.

- b) If a weak plane in the rock mass is subjected to a sufficiently high level of shear stress, slip (ride) on the plane will occur. The extent to which this is possible, and the severity of any resulting seismic event, are governed by the cohesion properties of the plane. Two states have to be considered: the static (pre-slip) shear strength, and the dynamic strength once slip has been fully mobilised
- c) Comminuted or milled waste backfill (CMW) is prepared from underground waste rock using a dedicated crushing and milling plant sited underground. A well-graded material is produced with a maximum size of approximately 5 mm and a fines content of which only 10 – 15 % passes the 38 micron mesh size. The material has optimum and placement porosities of 15 % and 36 % respectively, and can be pumped to stopes at a relative density of 2.1 (Gürtunca et al 1989).
- d) Classified or de-slimed tailings backfill (CCT) is produced by the cycloning of run-of mine tailings to reduce from 50 % to 10 % the particle size fraction passing 0.038 mm mesh size. This material, which has optimum and placement porosities of 40 % and 52 % respectively, is usually gravity fed to the underground filling sites at a slurry relative density of between 1.65 and 1.75 (Gürtunca et al 1989).

(4)

1.5 Which **one** of the following statements is **incorrect**?

- a) Boundary Element ((BE) models are efficient numerical models for the solution of arbitrarily shaped tabular voids (stopes, planes of weakness, cracks) in an inelastic material are popularly based on the so-called displacement discontinuity method which exploits known BE kernels to formulate
- b) The finite element method provides a general framework for the analysis of the mechanical behaviour of arbitrarily shaped bodies containing arbitrary inhomogenities, and can be adapted to solve problems involving large geometrical strains and nonlinear material behaviour.
- c) Finite difference methods represent some of the earliest attempts to generate numerical solutions to solid mechanics problems described by analytically intractable systems of differential equations. In this form of analysis the problem region is covered by a number of regularly spaced points (nodes) and the derivative terms in the describing equations are approximated by suitable

difference formulae which depend on the values of the key variables at the nodes surrounding the node of interest.

- d) Distinct element models were pioneered mainly by Cundall (1971). The modelling paradigm provides a framework for tracking the motion of distinct polygonal or polyhedral blocks as a function of time. The blocks interact through their common interfaces and may themselves be deformed elastically or can undergo plastic deformations. In principle, the models are fully dynamic and can undergo arbitrary large strain deformations (4)

[20]

QUESTION 2 (MINE DESIGN)

- 2.1 Describe and explain 2 (two) methods of drilling? (4)

- 2.2 With regard to the following 3 numerical modeling techniques. Describe and explain the principles of these modeling techniques and secondly for which typical Rock Engineering applications they are used.

- a) Finite Element method
- b) Boundary element
- c) Distinct Element Method (6)

- 2.3 Describe and explain a process of geotechnical hazard and risk evaluation on a typical shallow mine in the Bushveld. (10)

[20]

QUESTION 3 (MINE SUPPORT AND DESIGN)

- 3.1 Mechanical full column grouted long anchors are extensively used in mines. Describe and discuss these long anchors under the following headings.

- a) Describe installation procedure and sequence of events. Under each phase of the installation procedure mention the salient points to look out

for to ensure a proper installation.

(8)

b) Give technical specifications of typical long anchors used on your mine

(2)

3.2 Describe and give the procedure for the Brazilian indirect tensile strength test. Also comment on the thickness/diameter ratio, loading rate, specimen diameter and the formula used to calculate the tensile strength.

(7)

3.3 Name 3 types of Borehole Extensometers

(3)

[20]

QUESTION 4

You are the Shaft Rock Engineer on a Bushveld Platinum mine. Recently the FOG's in the stopes increased significantly over the past few months to unacceptable high levels. The Mine Manager requested you to investigate, report and recommend systems to reverse this trend because the current systems are not effective.

The mine is mining a scattered mining layout at a depth ranging from 60m to 400m B.S at a stoping width of 1m. The elastic pillar system is pillars on the ASG (4mx4m) with no sidings and numerous potholes used as regional natural pillars.

Comment on the following:

a) Safety Management System that can be used and the requirements of such a system if implemented

(7)

b) Fall of Ground data collection or database requirements from Rock Engineering perspective

(4)

c) Recommendations, implementation plan and action to be taken to reverse or improve the number of FOG's

(9)

[20]

QUESTION 5

- 5.1 It is sometimes possible to avoid leaving a shaft pillar in vertical shafts. The Rock Engineer must always be on the look-out for such an opportunity, which can save the company considerable expenses and/or inconvenience at some time in the future.

List and briefly describe 4 possible arrangements to avoid a shaft pillar. Make use of a sketch where possible.

(8)

- 5.2 Give 3 possible **practical** reasons why holes are on excessive burden.

(3)

- 5.3 Give 3 reasons why holes are firing out of sequence.

(3)

- 5.4 See attached table 1 and complete the blank spaces with regard to common gasses found in mines

(12)

[20]

TOTAL MARKS: 100

		Answer sheet multiple choice (Question 1) May 2016 Paper 3.2					
		ID Number					
		a	b	c	d	e	
	1.1						
	1.2						
	1.3						
	1.4						
	1.5						

Exam number or ID number: _____					
Table 1 (Question 5.4)					
Gas	Chemical formula	Sources of gas	Dangers	Senses	
	CO ₂	Blasting, Fuels, Fires		Colourless and odorless	
Carbon Monoxide	CO		Poisoness		
	NOx	Explosives and Diesel Equipment		Can smell	
Hydrogen			Highly Explosive	Nil	
Ammonia	NH ₃	Blasting, excessive liming of settlers, refrigerants			
	CH ₄	Decay of vegetable and organic material		Nil	