Chamber of Mines of South Africa

**EXAMINATION PAPER**

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| SUBJECT:<br>CERTIFICATE IN ROCK MECHANICS<br>PAPER 3.1 : HARD ROCK TABULAR<br><br>**SUBJECT CODE:**<br>COMRMC<br><br>**EXAMINATION DATE: 16 May 2013**<br><br>**TIME:** 14:30 – 17:30 | **EXAMINER:**<br>L J GARDNER<br><br>**MODERATOR:**<br>JJ THOMPSON<br><br>TOTAL MARKS: [100]<br><br>PASS MARK: 60% |

NUMBER OF PAGES: 10

SPECIAL REQUIREMENTS:

1. Answer any ***FIVE of the SIX*** questions. Only the first **FIVE** questions answered will be marked.
2. References other than those provided are not permitted.
3. Hand-held electronic calculators may be used.
4. Put 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.**

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

## QUESTION 1 – GEOTECHNICAL INVESTIGATION

The mine on which you are employed is planning to extend its current operations, which presently stop at 1200 metres below surface, by means of a sub-level decline system. As part of this project, a large chamber must be blasted to accommodate an underground refrigeration plant. When complete, the chamber will measure 100 m long x 12 m wide x 12 m high. The area in which the chamber will be located is presently accessed by a 3 m x 3 m development crosscut. As the mine's rock engineering practitioner, you are requested to define the geotechnical environment as input into further design of the chamber.

1.1 **By means of short notes and sketches**, **describe** how you would go about this task, including:

a) Geology-related investigations (4)

b) Geotechnical investigations (7)

c) Rock property testing (4)

1.2 As part of the rock property testing, you must submit samples for testing. **List** five aspects that you must pay attention to in the selection of samples (you may assume that the samples come from drilled borehole core) (5)

**[20]**

## QUESTION 2 – MINING LAYOUTS

As part of the design team planning a new intermediate depth shaft for a new mine, you are required to conduct an early shaft pillar extraction in order to minimise the complications associated with a conventional shaft pillar. The shaft is intended to be 10m in diameter, concrete-lined and fully equipped to hoist personnel, material and rock. The shaft's final depth will be 2000m, but it will intersect the tabular orebody (1.5m channel width, $10^{o}$ dip) at 1500m.

2.1 Using diagrams and short notes, explain how you would propose to go about this task. Your notes should include:

a) Location of the reef cut in relation to other levels and infrastructure (5)

b) Dimensions, extraction sequence and support strategy for the inner cut (5)

c) General sequence for mining the outer section of the pillar area (5)

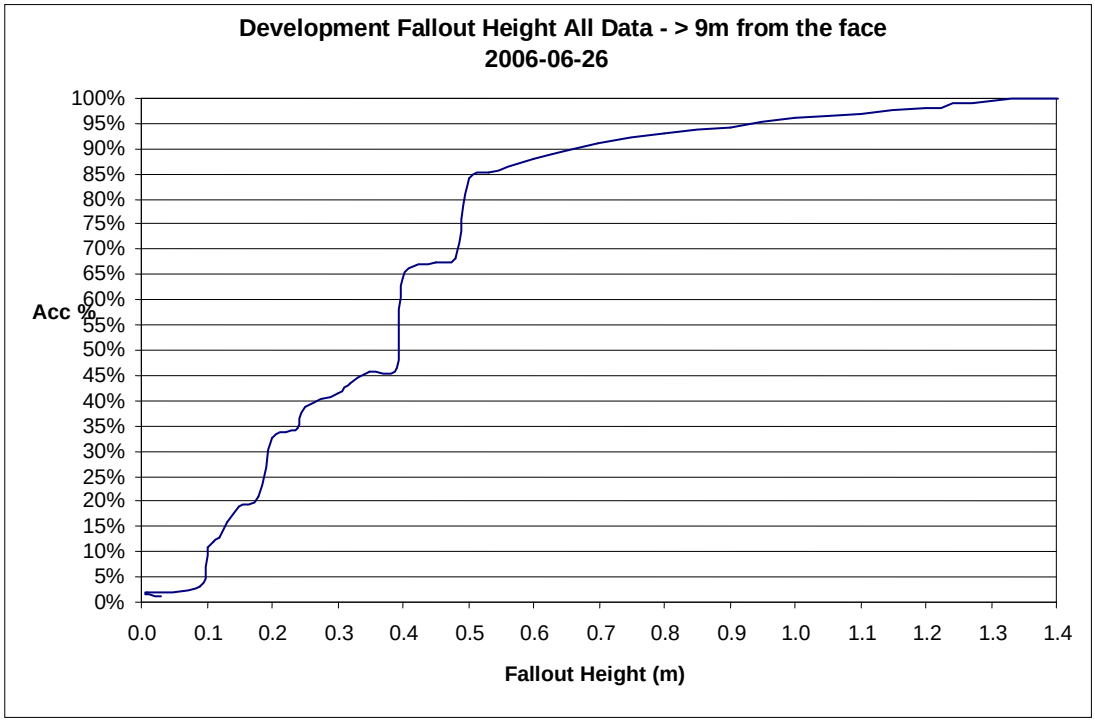
d) Location and design criteria for satellite pillars (5)

**[20]**

## QUESTION 3 – SUPPORT DESIGN

You have been contracted by the manager of a **small, shallow mine with a low profit margin** to design a suitable tendon support system for their development ends. The following information has been provided:

- The mine manager wishes to have an active support system on the face, as there have recently been a number of Fall of Ground accidents.
- The rock in which development takes place is moderately to heavily jointed (joint spacing 0.75m – 1.2m), and most falls are bounded by joints.
- The average adjusted rock mass rating in present development ends is 45, using the Laubscher MRMR system.
- The average development end size is 3. 0 m wide x 3.5 m high.
- Development takes place via conventional means using jackhammers and air legs
- A search of development end Falls of Ground from the mine's FOG database (+/- 500 FOGs), provided the information shown on the graph below.




3.1. Based on empirical evidence rules of thumb, **what length** of tendon would you recommend and **why**? (2)

3.2. Based on the information provided by the FOG database, **what fall out height** needs to be catered for, and **what support resistance** does the support system need to generate if the average rock density is 4.05 t / $m^3$ (2)

3.3. Barton recommends tendon lengths based on the formula:

$$L = \frac{2 + (0.15 \times B)}{ESR}$$

For an excavation support ratio of 2, **what length** of tendon would be required according to this formula? (2)

3.4. In light of the above calculations, **compile** a tendon support system for the mine, **specifying**:

- Type of unit to be installed (2)
- Length of unit (3)
- Spacing of tendons (2)

- Minimum angle of installation (2)
- Necessary quality control measures (2)

3.5 **Give an indication** of what the system will cost in terms of R / $m^2$. In all cases your answers must be properly motivated (1)

3.6 **What additional** on-the-face support measures / systems can the mine manager call on to ensure worker safety, should ground conditions deteriorate further? (2)

**[20]**

## QUESTION 4 – ROCKPASS REHABILITATION

As the rock engineering practitioner on a deep-level gold mine, you are notified that one set of the shaft's main rockpasses have holed into one another as a result of excessive scaling and deterioration.

4.1 **Name** four factors that possibly contributed to this occurrence, and **describe** how each factor could contribute to the deterioration of the rockpass surfaces? (8)

4.2 **With the aid** of sketches**, describe** three possible methods for rehabilitating the rockpasses and **comment** on the suitability of each method for ensuring long-term stability in view of the circumstances listed above (9)

4.3 To prevent similar occurrences in the future, **list** three practical warning signs that would provide an indication of ore pass deterioration (3)

**[20]**

## QUESTION 5 – REGIONAL SUPPORT

When mining tabular orebodies at depth, regional support is generally provided by one or more of the following:

- Strike-orientated regional pillars
- Dip-orientated regional pillars
- Backfill

5.1 Briefly describe the functions of such regional support systems? (6)

5.2 Using a table, list the application, advantages and disadvantages of each of the different systems when used in isolation (10)

5.3 What benefits can be gained by combining two of these systems? (4)

**[20]**

## QUESTION 6 – REGIONAL SUPPORT

Pillars are traditionally classified as crush, yield or rigid pillars, based on their behaviour under load.

6.1 Using the attached graph paper, **sketch** the typical load / deformation curves of these three pillar types. Make sure that you **show and name** important points on each of the curves. Plot all the curves on the same set of axes so that the differences are clearly evident. (6)

6.2 **By means of a table, compare** the following aspects of the three different pillar types:

- Typical width: height ratio
- Typical values for peak strengths (give relevant rock type)
- Typical values for residual strengths (give relevant rock type)
- Typical mining application or depth range (14)

**[20]**

**TOTAL MARKS: 100**