CHAMBER OF MINES OF SOUTH AFRICA

EXAMINATION FOR THE CERTIFICATE IN ROCK MECHANICS

PAPER 2

METALLIFEROUS OPTION

SUBJECT: CERT. IN ROCK MECHANICS PAPER 2 (METALLIFEROUS OPTION)	**EXAMINER:** L J GARDNER
SUBJECT CODE: COMRME	**MODERATOR:** M K C ROBERTS
EXAMINATION DATE: OCTOBER 2005	**TOTAL MARKS:** [100] **PASS MARK:** 60%

NUMBER OF PAGES: 7

SPECIAL REQUIREMENTS:

1. **Answer _ALL THE_ questions**
2. References other than those provided are not permitted. (Refer No. 10)
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.
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 which is typical of practical conditions.
10. A list of formulae and any other essential charts and tables will be issued at time of the examination.

QUESTION 1 – GEOTECHNICAL INVESTIGATIONS

The mine on which you are employed has recently discovered a new reserve, which it intends to exploit. Although the intrusive pipe-like orebody is massive, 800 metres in diameter and extends from 300 to 1800 metres below surface, the surrounding host rock is stratified and steeply dipping, with extremely variable geotechnical properties.

Although there is presently no physical access to the orebody, both the orebody and the surrounding area have been extensively drilled.

The intention is to sink a vertical shaft from surface alongside the orebody, create the necessary infrastructure and utilise mechanised mining methods to extract the orebody.

As the mine's rock engineering practitioner, you are requested to define the geotechnical environment. This will be used as input by the project team, to determine optimal location, orientation, extraction and support methodologies.

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

a) Geology-related investigations (6)

b) Geotechnical investigations (8)

c) Rock property testing (6)

20 MARKS

QUESTION 2 – SUPPORT DESIGN

The manager of a small, shallow chrome mine has approached you to assist with a design for in-stope support, as they have recently had several serious fall of ground incidents. The mine exploits a 1.2 metre thick chromitite seam using traditional narrow-reef stoping techniques – 24 metre long breast panels are advanced 1.0 metre / day using hand drilling, and cleaned by scrapers. Apart from inter-panel grid pillars, permanent support in the panels consists of 200 millimetre diameter mine poles spaced at 2.5 metre centres on both dip and strike. Temporary mechanical props are used in the face area for protection during the drilling shift.

An analysis of the mine's fall of ground database has revealed the following facts:

- There is a definite bi-modal distribution of falls, with small thin falls occurring in the face area and larger thicker falls / collapses occurring well back from the face (15 metres plus).
- The maximum thickness of the face area falls is 0.8 metres, the average block size is 1.75 square metres, and they are roughly square in shape.
- The maximum thickness of back area falls is in the order of 3.0 metres, the average block size is 8 square metres, and they are generally rectangular in shape, with the long axis orientated on dip.

The database information is backed up by an interview with the mine's geologist, who explains that the face area falls are generally joint-bound block breaking off along reef-parallel chromitite stringers located between 0.75 and 0.8 metres above the reef horizon. The larger back area falls are normally caused by unravelling of the hanging wall mass, particularly along prominent geological features.

As several of the face area falls have been associated with the installation and removal of temporary support units, mine management would like to eliminate the use of temporary support and replace it with systematic roofbolting.

Given that the average density of the hanging wall rock mass is 3.0 tons / cubic metre, you are required to:

2.1 Design a suitable roofbolting-based support system for the face area, based on tendons with a 5 ton load-bearing ability. Specify and motivate:

- Required support resistance
- Recommended dip and strike spacing of tendons
- Recommended length and installation angles of tendons (7)

2.2 Based on a combination of cost, effectiveness, robustness and user-friendliness, which type of tendon / bonding system would you recommend for this application and why? (3)

2.3 Design a suitable elongate support system for the back area, based on elongates with a (derated) 450 kN load-bearing ability. Specify and motivate:

- Required support resistance
- Recommended dip and strike spacing of elongates
- Maximum distance from face for installing elongates (7)

2.4 Can the support resistance generated by the tendons be included in the calculation for the back area support? Motivate your answer (3)

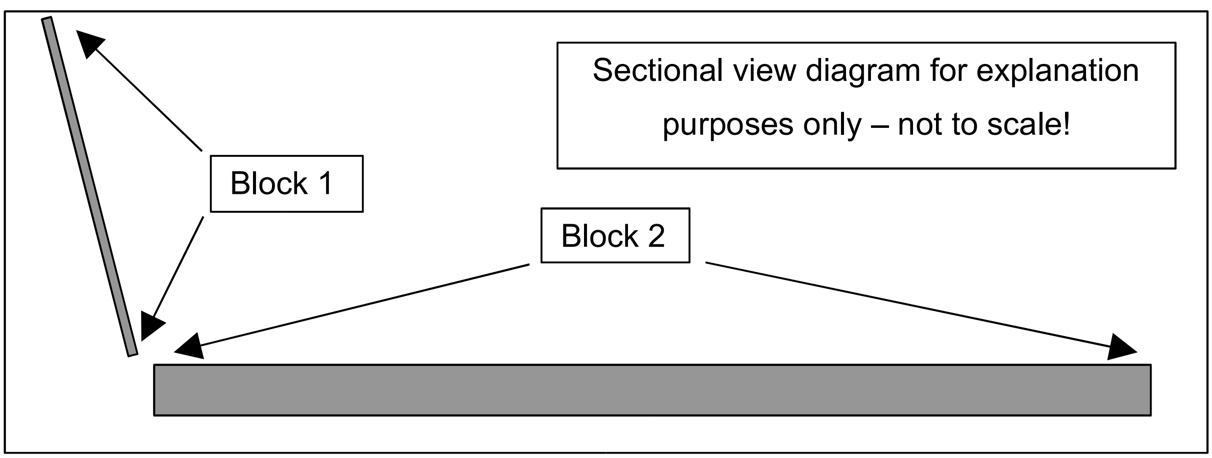
20 MARKS

QUESTION 3 – MINING LAYOUTS

The geology department on your mine has recently finalised exploration of new reserves located adjacent the current mine workings. The reserves are located from 600 to 1000 metres below surface, with a strike extent of approximately 5 kilometres. Both the hanging wall and footwall strata are strong (200 MPa +) and competent, while the reef horizon is somewhat weaker (150 MPa).

Two separate potential mining blocks have been identified, as shown in the diagram below, namely:

- Block 1 - A steeply dipping (65 degrees+) block, extending over some 400 metres vertically, with a channel width of approximately 1.2 metres.
- Block 2 - A flat dipping (0 – 5 degrees) block, extending over some 2.5 kilometres, with a channel width of approximately 8.0 metres. This block is located below block 1.



3.1 Using diagrams and short notes, explain which different mining methods / strategies you would propose to extract the two different blocks of ground (20)

20 MARKS

QUESTION 4 – NUMERICAL MODELLING

3-Dimensional elastic modelling (MINSIM / MSCalc) is one of the tools commonly used by rock engineering practitioners.

4.1 Name and explain 3 important assumptions of this form of modelling (6)

4.2 You are employed as the rock engineering practitioner on a mine that extracts a shallow-dipping narrow-reef tabular orebody, using scattered mining layouts at 2000 m below surface. The mine intends to extract a large pillar that overlies both a critical footwall drive and a crosscut that will be used to access the pillar being mined.

Explain which variables / outputs you will use to assess the following aspects, and the relevant criteria for each on which you will base your recommendations:

a) The potential for the pillar to generate seismic activity (3)
b) The long-term stability of the footwall drive (2)
c) The crosscut's ability to provide continued access to the stoping horizon during the mining process (3)

4.3 When conducting such modelling, explain how the following changes in the model setup affect the stress levels within the on-reef pillar:

a) Decreasing the Young's Modulus from 75 GPa to 50 GPa
b) Increasing the Poisson's ratio from 0.2 to 0.25
c) Increasing the vertical cover load from 30 MPa to 40 MPa (6)

20 MARKS

QUESTION 5 – REGIONAL SUPPORT

Regional support when mining tabular orebodies at depth pillars 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? (3)

5.2 Using a table, list the application, advantages and disadvantages of each of the different systems when used in isolation (15)

5.3 What benefits can be gained by combining one or more of these systems? (2)

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