

Examination Paper • Eksamenvraestel

SUBJECT: CHAMBER OF MINES OF SOUTH AFRICA CERT. IN ROCK MECHANICS COAL OPTION – PAPER 2	EXAMINER: Prof JN van der Merwe
SUBJECT CODE: COMRME	MODERATOR: Dr BJ Madden
EXAMINATION DATE: 11 May 2005	TOTAL MARKS: [100]
TIME: 09h00 - 12h00	PASS MARK: 60%

NUMBER OF PAGES INCLUDING COVER: 12

SPECIAL REQUIREMENTS:

1. **ANSWER ALL QUESTIONS.**
2. References other than those provided may not be used.
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 on one side of the paper only.
6. **Show all calculations on which you base your answers.**
7. In answering these questions, take full advantage wherever necessary of your practical experience as well as of the data given.
8. Graph paper is available from the invigilator.
9. A list of formulae and any other essential charts and tables are attached to the paper.

COAL OPTION

Question 1: Pillar Design (25 Marks)

The mining company you work for, owns the coal rights for Seam A (see the simplified borehole log in Figure 1.1) but not Seam B. The surface area is 2 000 ha in extent and the surface topography is flat and level.

Your company can obtain the coal rights to Seam B at an effective cost of R6 per tonne. Mining costs on Seam A will be R45 per tonne and on Seam B it will be R50 per tonne. The selling price of your coal is R55 per tonne. You have been requested to make a preliminary recommendation on one of the following two alternatives to the Board of your company:

- (a) Mine Seam A in a manner that will not jeopardize the reserves on Seam B.
- (b) Purchase the Seam B reserves and mine both seams using bord and pillar at the lowest practicable and safe safety factors.

Your company will need to invest R45 million in capital in order to mine Seam B. Analyse each of the two options stating the tonnages of coal mined and make a recommendation based on the predicted profits. Base all costs and profits on current values. Show all calculations.

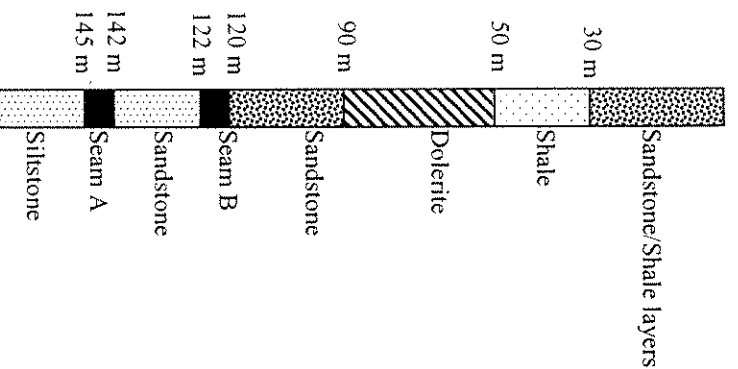


Figure 1.1

Simplified borehole log for the area described in Question 1. The sketch is not to scale.

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Question 2: Roof Support (25 Marks)**Part A**

The immediate roof in a coal mine with 6.5 m wide bords consists of laminated mudstone and sandstone for a thickness of 0.7 m, see Figure 2.1. The individual laminae are 1.2 cm thick and they are not well bonded. Overlying this is a sandstone layer of 0.6 m thick. No coal can be left in the roof. A safety factor of 1.5 is required. Use the mechanical properties of the rock types as shown in Table 2.1. The shear strength of the resin/rock contact plane has been found to be 1 200 kPa. M20 rebar is to be used in 25 mm diameter holes. Show all calculations.

- (a) Can the laminated layers be suspended from the sandstone beam? Motivate your answer. [5]
- (b) What is the maximum allowable spacing for roofbolts? [5]
- (c) Using the maximum spacing, what length of bolts will be required if resin anchors are used? [5]
- (d) What is the minimum yield strength of steel to be used in your design? [2]

Part B

With the aid of a neat sketch, describe a stress mapping technique based on visual observations that you will use to determine whether a section of a mine is subjected to problematic horizontal stress. [8]

Table 2.1 : Laboratory Scale Mechanical Properties of Selected Rock Types

Rock type	UCS (MPa)	UTS (MPa)	Shear Strength (MPa)	E (GPa)	Density (kg/m ³)
Sandstone	75	5	15	13	2 480
Shale	75	5	7	15	2 480
Siltstone	70	6	8	10	2 480
Mudstone	40	5	8	7	2 480
Dolerite	190	24	20	100	3 000
Coal	25	5	8	4	1 500

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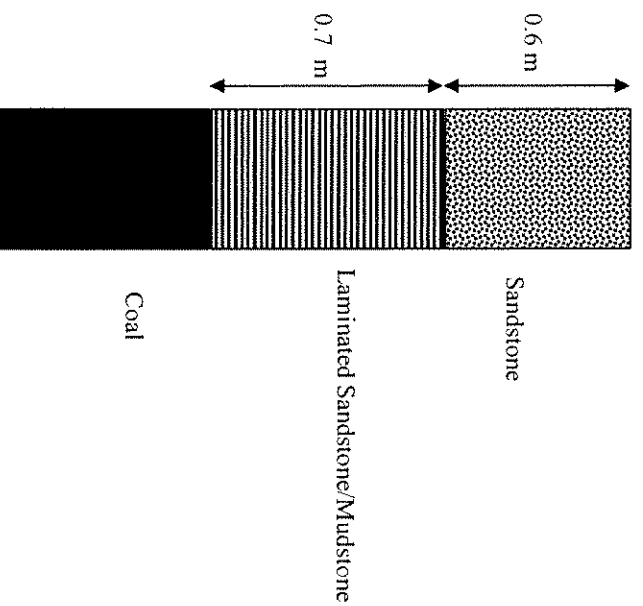


Figure 2.1

Question 3: Monitoring (20 Marks)

Routine monitoring consisting of a combination of multi-point wire extensometers and convergence meters is done on a mine where the immediate roof is a 1.0 m thick mudstone layer, overlain by a 15 m thick competent sandstone with no obvious joints. In one particular section, the extensometer anchors are installed at 1.2 m (Anchor A), 0.4 m (Anchor B) and 0.2 m (Anchor C) into the roof. A convergence meter is installed next to the extensometer, see Figure 3.1.

Over a period of 70 days, readings as shown in Table 3.1 were obtained for the various anchors. A positive number for the extensometer anchors indicates a downward displacement of the roof and a negative convergence meter reading indicates compression of the convergence meter.

- (a) Construct a graph showing the nett displacements indicated by the anchors and convergence meter as a function of time. [10]
- (b) The magnitudes of the readings indicate that something is happening – is the floor lifting, is the roof sagging, and if so, where is the roof or floor separation likely taking place and how wide are the gaps? [6]
- (c) Do you suspect imminent instability or can you conclude that the roof or floor has stabilized? Motivate your answer [4]

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Table 2.1 Displacement readings taken of anchors and convergence meter. All displacements are in millimeters.

Day	Convergence meter	Anchor A	Anchor B	Anchor C	Roadway Advance From Instrumentation Site (m)
1	0	0	0	0	2
2	1	1	2	1	2
4	2	1	1	2	2
6	-10	2	1	2	6
8	-11	4	3	1	12
11	-12	9	10	3	30
20	-12	10	9	2	90
28	-21	9	11	1	150
41	-20	11	10	2	200
52	-32	20	15	1	200
59	-48	40	34	3	200
70	-91	80	70	2	200

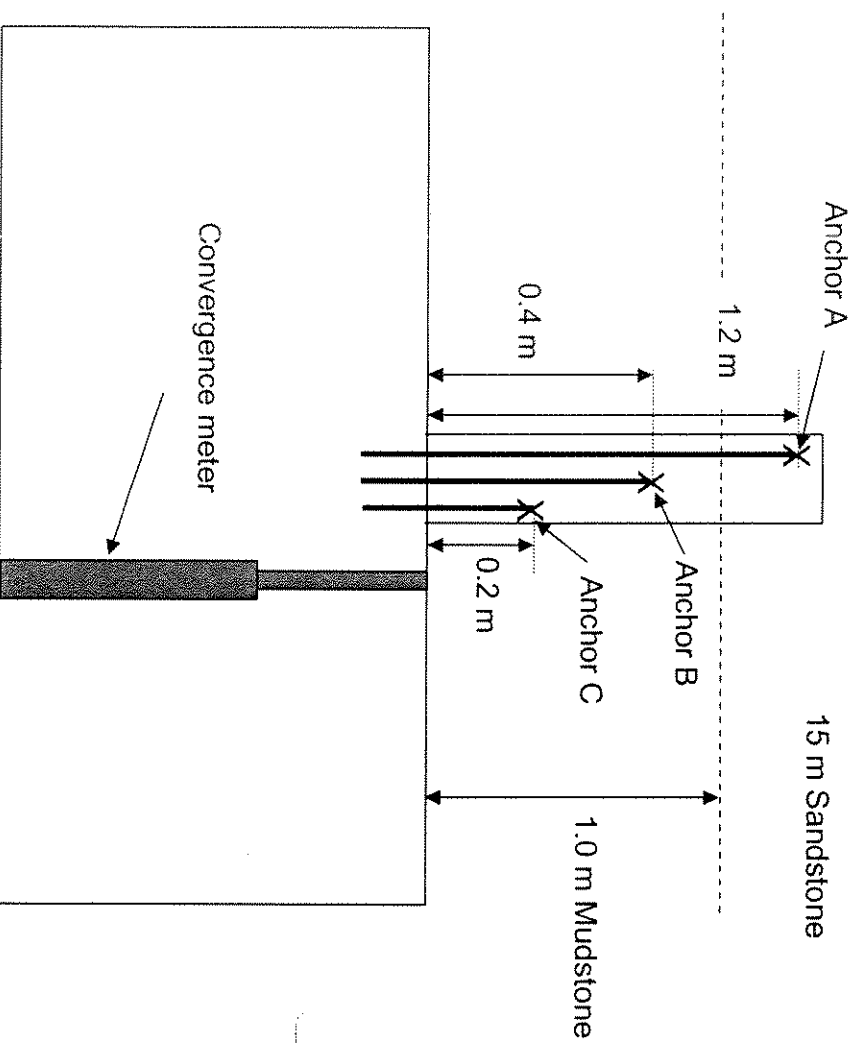


Figure 3.1

Schematic diagram indicating the instrumentation lay-out. The Figure is not to scale.

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Question 4: Subsidence (10 Marks)

Using neat annotated sketches, describe the process resulting in sub surface erosion in areas where high extraction mining had been done. Where are the potholes most likely to occur?

[10]

Question 5: General (20 Marks)

All questions must be answered by marking either the True or False column on the attached sheet. **Note that a box has to be ticked for each question, not just the correct answer.** Please make sure that your exam number is written clearly on the answer sheet, detach it and hand it in with your examination script

Note that marks will be deducted for incorrect answers and unanswered questions.

- (a) The Slake Durability Test
 - (i) is used to measure a rock sample's swelling stress when immersed in water
 - (ii) is used to evaluate floor deterioration under wet conditions
 - (iii) is used for input in the Q-system
 - (iv) is valid for continuous miners and should not be used to evaluate roof conditions in drill and blast sections
- (b) The MRRM-rating
 - (i) can only be used for large excavations, not mine tunnels
 - (ii) can be used to determine whether a longwall overburden is likely to goaf
 - (iii) is used to assess highwall stability
 - (iv) correlates well with the Q-system ratings
- (c) Swellex bolts and split sets can be classified as
 - (i) stiff, passive support
 - (ii) soft, active support
 - (iii) stiff, active support
 - (iv) soft, passive support
- (d) Surface cracks on a subsided area coincide with the position where
 - (i) half of the maximum subsidence occurs
 - (ii) maximum tilt occurs
 - (iii) maximum tensile strain occurs
 - (iv) the abutment is, i.e. directly over the edge of the panel
- (e) The stiffness of a roof support system will be increased by
 - (i) applying higher pre-tension
 - (ii) smart bolting
 - (iii) decreasing the road width
 - (iv) increasing bolt density
- (f) The South African National Institute of Rock Engineering

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- (i) functions under the auspices of the DME
 - (ii) is affiliated to the Association of Mine Managers of South Africa and the South African Colliery Managers' Association
 - (iii) functions under the auspices of the CSIR Division of Mining Technology
 - (iv) is an organization with voluntary membership
- (g) The "Effective width" for rectangular coal pillars
- (i) has the effect that the effective width of a pillar can never exceed twice the minimum width
 - (ii) is used for both the strength and the load calculations of a pillar
 - (iii) is the same as the square root of the pillar cross sectional area
 - (iv) is only used in the pillar load calculation while not affecting the pillar strength
- (h) The Coal Mine Roof Rating (CMRR)
- (i) is only valid for longwall mines in the USA
 - (ii) can be used as direct input into roof support system design
 - (ii) does not take account of water in the roof
 - (iii) is biased towards lower ratings in longwalling as opposed to bord and pillar mining
- (i) Long term pillar stability
- (i) is directly related to the safety factors of pillars using the Salamon and Munro strength formula
 - (ii) is directly related to the safety factors of pillars using the van der Merwe strength formula
 - (iii) is included in the Madden squat pillar strength formula
 - (iv) is not directly related to any strength formula
- (j) Mining under surface water courses
- (i) is only allowed at safety factors of 1.8 or greater according to the regulations of the Mine Health and Safety Act
 - (ii) is only allowed at safety factors of 2.0 or greater according to the regulations of the Mine Health and Safety Act
 - (iii) is only allowed at safety factors of 2.5 or greater according to the regulations of the Mine Health and Safety Act
 - (iv) can only be done in winter months and if surface cracks are repaired before the rain season starts

20 marks

TOTAL MARKS: [100]