UNISA university of south africa

EXAMINATION PAPER

SUBJECT:	**EXAMINER:**
CERTIFICATE IN ROCK MECHANICS PAPER 3.2 : COAL OPTION	G MAKUSHA
SUBJECT CODE:	**MODERATOR:**
COMRMC	B MADDEN
EXAMINATION DATE:	**TOTAL MARKS:** [100]
22 May 2009	**PASS MARK:** 60%
TIME: 9:00 – 12:00	

NUMBER OF PAGES: 13

SPECIAL REQUIREMENTS:

1. **Answer *ALL FOUR* questions**
2. References other than those provided are not permitted.
3. Hand-held electronic calculators may be used.
4. 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.

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.

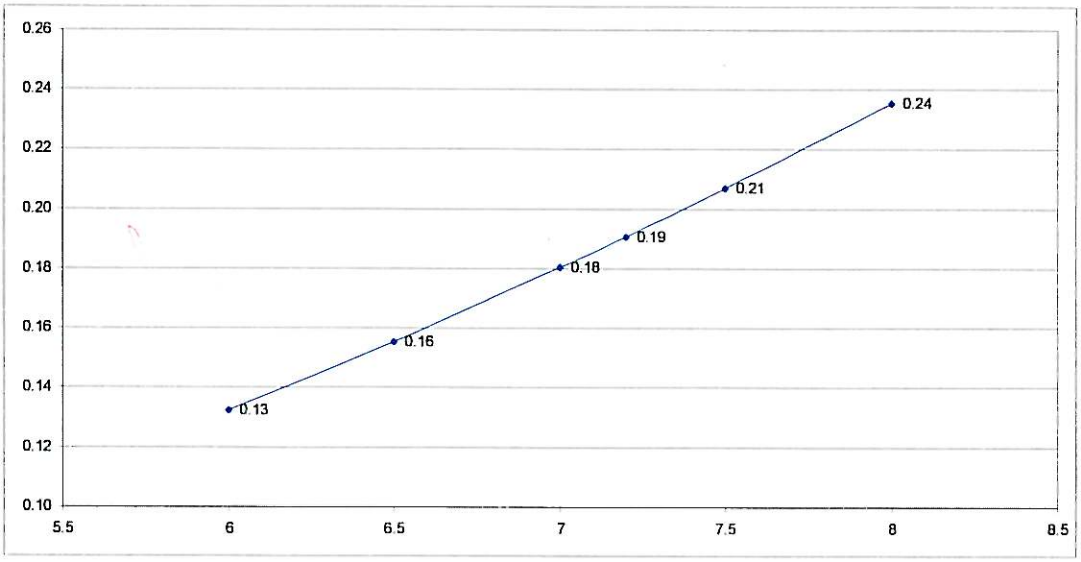
Question 1: (Total 25 Marks)

a.

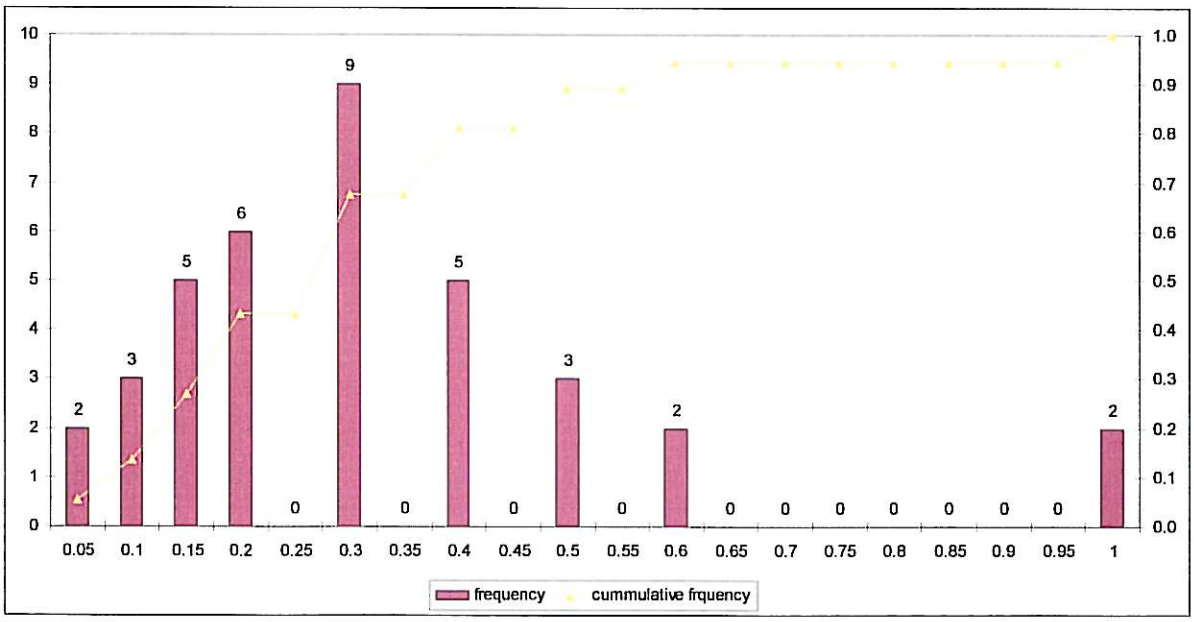
Answer a:

1.1

F	p	g	b	tens. Stress	t
1.5	0.0025	9.81	**6**	5	**0.13**
1.5	0.0025	9.81	**6.5**	5	**0.16**
1.5	0.0025	9.81	**7**	5	**0.18**
1.5	0.0025	9.81	**7.2**	5	**0.19**
1.5	0.0025	9.81	**7.5**	5	**0.21**
1.5	0.0025	9.81	**8**	5	**0.24**



1.2 b.



Coal Option

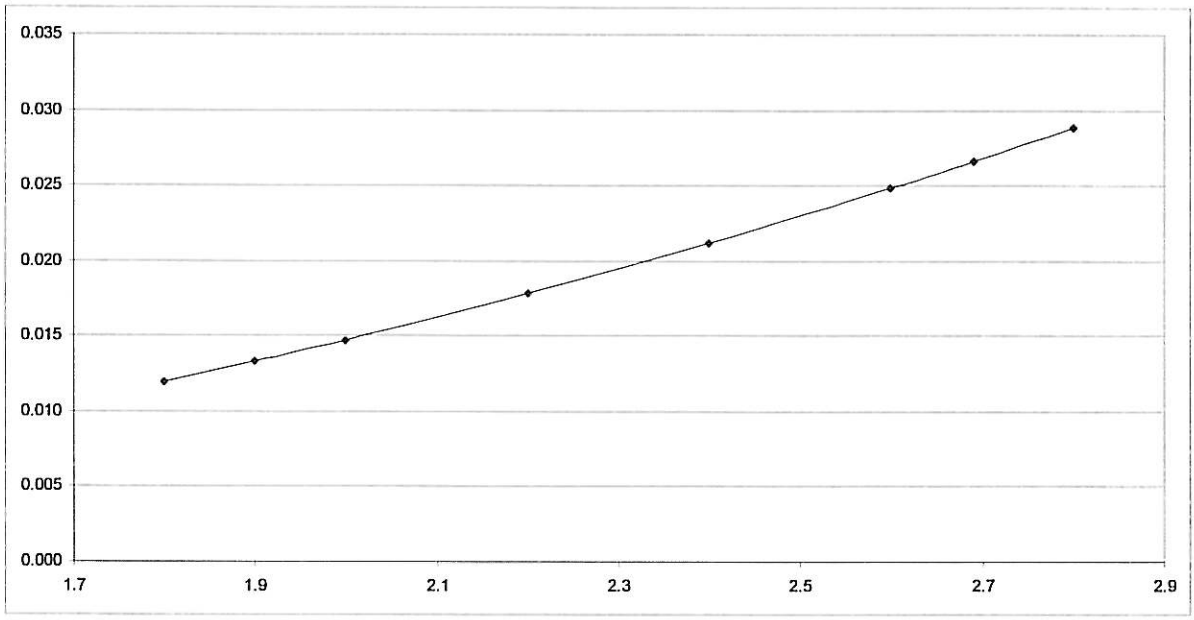
At 7.2m bord, theory predict stability at 0.19m but practice reveal thicker beams have failed. Theoretical beam assumes continuous rock with no discontinuities but in reality rock is traversed by several weaknesses that affect its strength.

1.3 c.

b	**s**	**t**	**D**	**F**	**Volume**	**weight**	weight/bolt	Required Bond length
7.2	2	0.6	2.5	1.2	10.368	254.3	84.8	0.26
7.2	2	0.7	2.5	1.2	12.096	296.7	98.9	0.31
7.2	2	0.8	2.5	1.2	13.824	339.0	113.0	0.35
7.2	2	0.9	2.5	1.2	15.552	381.4	127.1	0.40
7.2	2	0.6	2.5	1.2	10.368	254.3	84.8	0.26
7.2	2	0.7	2.5	1.5	15.12	370.8	123.6	0.39
7.2	2	0.8	2.5	1.5	17.28	423.8	141.3	0.44
7.2	2	0.9	2.5	1.5	19.44	476.8	158.9	0.50

1.4 d.

F	p	b	tens. Stress	Thickness(m)
1.5	0.0025	1.8	5	0.012
1.5	0.0025	1.9	5	0.013
1.5	0.0025	2	5	0.015
1.5	0.0025	2.2	5	0.018
1.5	0.0025	2.4	5	0.021
1.5	0.0025	2.6	5	0.025
1.5	**0.0025**	**2.69**	**5**	**0.027**
1.5	0.0025	2.8	5	0.029



Coal Option

Largest span between bolts will be along diagonal, was calculated to be 2.69m, self supporting layer at that span will be 0.027m and potential mass of fall (5Kg) out although capable of inflicting injury will unlikely cause human fatality.

To calculate fall out thickness use the same formula in 1.1 but substituting Bord width B in the equation with support spacing.

Question 2 (Total 20 marks)

Remember to fill in you examination number on the sheet.

Marks will be deducted for incorrect answers.

a. The "tributary area theory" for determining the load on the pillars

i) assumes that the whole weight of overburden is shared equally by the pillars if the panel size is less than the area of a circle drawn with a radius 0.75 to 1.0times the depth below surface Answer (*False)*

ii) assumes that each individual pillar supports the weight of overburden immediately above it (True)

iii) can be applied equally in designing non uniform sized pillars for chain road development (*False,)*

iv) does not apply at shallow depths less than 40m (False)

b. The squat pillar formula

i) takes into account the increase in pillar load as the pillar width to height ratio increases (False)

ii) takes into account the decrease in the strength of a pillar as its width to height ratio increases (False)

iii) can be applied for a bord and pillar layout with 12m x 6m wide pillars if the mining height is 2.0m. (False)

iv) the term 'V' in the formula refers to the volume of rock in the overburden to be carried by that pillar. (False)

c. For Surface subsidence in high extraction panels

i) the total magnitude of surface subsidence is significantly less than the original mining height (true) False

ii) the total subsidence is reached quickly within 24 hours of goaf occurring. (False)

iii) the maximum vertical subsidence increases with increasing mining height and depth and decreases with increasing panel width. (False)

iv) The angle of break(caving angle) is used to derive the horizontal distance for protection of pillars in the formula, D/2.7. (False)

d. Fixed head full column resin roof bolts with dual speed resin can be classified as

i) stiff, passive support (False) True

ii) soft, active support (False)

iii) stiff, active support (True) False

iv) soft passive support (False)

e. Horizontal stress in coal mines

i) is caused **only** by the posion's ratio effect *False*

ii) has a magnitude at shallow depths that can never exceed the vertical component of stress caused by the weight of overlying rock False

iii) Is the cause of excessive pillar scaling False

iv) Direction could be estimated by roof mapping where the outline of damage manifests parallel to the direction of horizontal stress. False

f. Roof guttering occurs

i) The most likely mode of failure is tensile failure of weak highly laminated roof rockmass False

ii) favourably at the corners, at the skin of the rock , where the difference between the stress perpendicular and parallel to skin are greatest and shear stress reach maximum levels. True

iii) Solely as a result of high horizontal stress False

iv) The position of occurrence in a roadway could be an indication of the orientation of principal stresses in the vertical plane. True

g. The stiffness of a loading system on pillars will be decreased by

i) pillar splitting if the panel width is greater than the mining depth False

ii) presence of dykes True

iii) reducing the road widths False

iv) increasing the panel widths True

2.8. The post failure modulus of a coal pillar

Coal Option

i) is the same for all pillars in the same geographical area irrespective of pillar shape False

ii) is the negative of the pre-failure modulus False

iii) can never be positive False

iv) is a function of the ratio of the pillar prior to failure (supposed to read ratio of pillar width to height)

2.9)The strength of a coal pillar

i) decreases with decreasing size of pillar (true)

ii) increases as the width to height ratio increases (True)

iii) increases as the depth of coal seam increases False

iv) increases as the density of coal increases False

2.10)The amount of roof sag

i) increases with increase in modulus of elasticity of roof material False

ii) increases in proportion to the 2nd power of the bord with all else being the same False

iii) reduces with increase in thickness of roof beam all else being the same True

iv) increases with increase in unit weight of roof material True

$$\eta = \frac{\gamma B^4}{32Et^2}$$

Question 3 (30 marks)

Answer:

3.1 An access and installation hole (100-150mm diameter) drilled at and angle between 15 and 45 degrees to test location about 10m or more from the excavation.

An accurate deformation measuring device or strain cell is installed (glued) to the end of a cored pilot hole.

The cell is then over cored and the strain response of the cell monitored as the stresses on the core are relieved whist the drilling is in progress.

The recovered core containing the stress cell is then reloaded in to a biaxial pressure cell to check the strain response for a known stress change and to determine the in-situ elastic properties of the rock core.

Answer:

3.2 A number of anchors in a single hole, drilled to the required depth above the roof say 4.0m

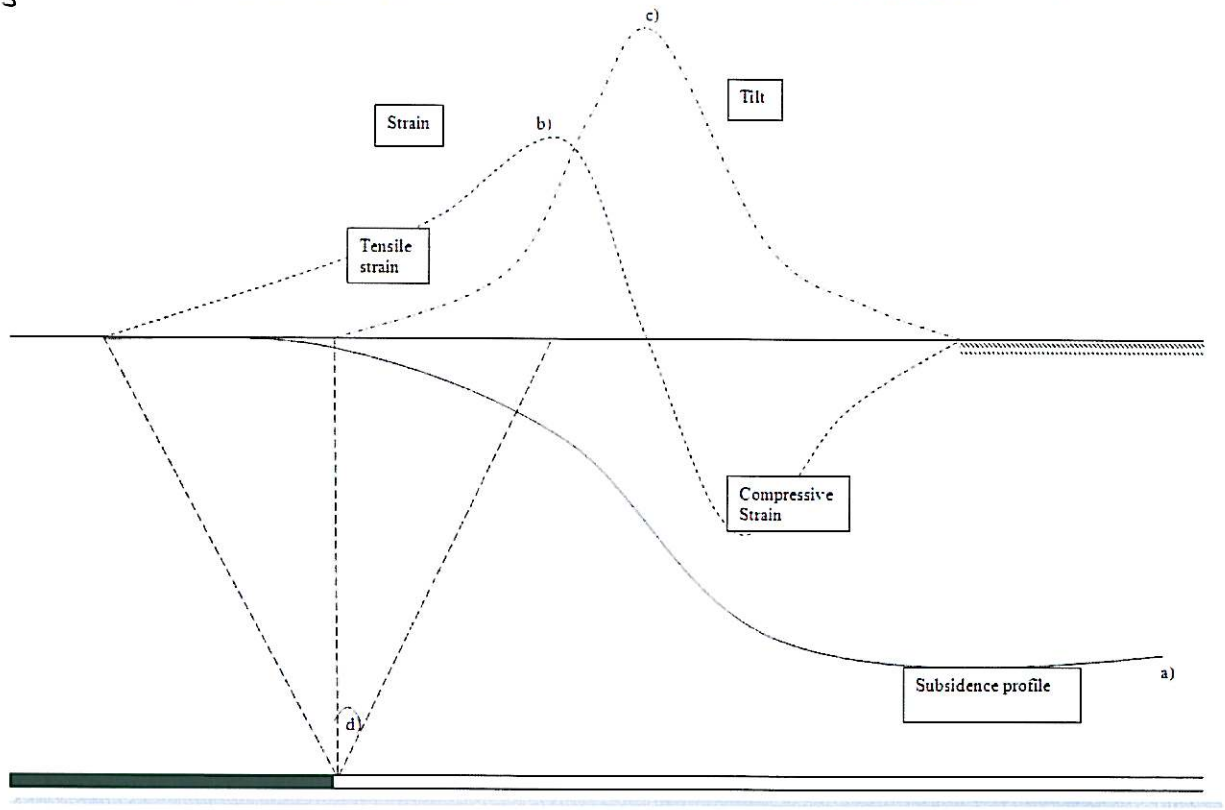
Each equipped with a thin rod or cable used to measure distances between end points to determine relative displacement.

Sonic probe extensometers use circular magnetic anchors fitted at various positions in a borehole.

The distance between anchors is a function of the desired accuracy.

The probe passed through the anchors to the back of the hole determines the distance between anchors electronically to within fractions of a millimetre. (diagram)

3.3 FIGURE 1 HAND THIS IN WITH YOU SCRRIPT EXAM: NUMBER.....



3. e) Assume acceptable FOS 2

Use Salamon formula to back calculate mining width (5.0m)

Probability of failure, Pillar width to height ratio 5/4

3. f) Shallow mining, FOS alone not good enough, weak roof and floor, sinkhole formation potential and shallow mining guidelines.

ANSWER QUESTION 4 (TOTAL 25 MARKS)

Initial centre 20 m.

Pillar width 13,3 m.

Initial percentage extraction 55.8 % areal.

Coal in pillars 44,2 %.

One pillar – total recoverable tons = $(13,3)^2$ x 1,6 x 3,5 x 0,71 = 703 tons (Coal density 1.5 acceptable)

Available Top Coal 0,558 x 400 x 3,5 x 1,6 x 0,45 = 562 tons.

Recovery rate Top Coal say 90 %, available coal = 506 tons.

Recovery rate stooping say 70 % (60 – 80 acceptable) = 492 tons.

Recovery better with Top Coaling.

Top Coal cheaper and safety but Safety Factor reduces to 1,28 (min 1,40 acceptable).

Width to height ratio 1,9, pillar unlikely to yield and could fail violently

Exposure of shale roof

It would be therefore better to stoop

Leaving a metre or more of coal in the roof may be considered

CERTIFICATE IN ROCK MECHANICS: PAPER 3.2 25 May 2009

Coal Option

Answer sheet question 2:

Exam number: _____

	QUESTION	TRUE	FALSE
2.1			
1			F
2		T	
3			F
4			F
2.2			
1			F
2			F
3			F
4			F
2.3			
1			F
2			F
3		T	
4			F
2.4			
1		T	
2			F
3			F
4			F
2.5			
1			F
2			F
3			F
4			F
2.6			
1			F
2		T	
3			F
4			
2.7			
1			F
2		T	
3			F
4		T	
2.8			
1			F
2			F
3			F
4		T	F(Bonus)
2.9			
1		T	
2		T	
3			F
4			F
2.10			
1			F
2			F
3		T	
4		T	

$e = 1 - \frac{w^2}{c^2} =$

ANSWER Q5a)

4 *Initial centre 20 m.* 2✓+2

1 *Pillar width 13,3 m.* 1✓

2 *Initial percentage extraction 55.8 % areal.* 2✓

1 *Coal in pillars 44,2 %.* 1

3 *One pillar – total recoverable tons = $(13,3)^2$ x 1,6 x 3,5 x 0,71 = 703 tons* (2+2) 3

3 *Available Top Coal 0,558 x 400 x 3,5 x 1,6 x 0,45 = 562 tons.* 2+2 3

1 *Recovery rate Top Coal say 90 %, available coal = 506 tons.* 1

1 *Recovery rate stooping say 70 % (60 – 80 acceptable) = 492 tons.* 1

1 *Recovery better with Top Coaling.* 1

3 *Top Coal cheaper and safety but Safety Factor reduces to 1,28 (min 1,40 acceptable).* 3

2 *Width to height ratio 1,9 , pillar unlikely to yield and could fail violently.* 2

1 *Shale roof exposed.* 1

1 *Therefore better to stoop.* 1

1 *1,0 m or more coal left in roof may prove a viable alternative.* 1

✓25