UNISA university of south africa

EXAMINATION PAPER

SUBJECT:	**EXAMINER:**
CERTIFICATE IN STRATA CONTROL (COAL)	D. NEAL
SUBJECT CODE:	**MODERATOR:**
EXAMINATION DATE:	B. MADDEN
18 OCTOBER 2011	**TOTAL MARKS:** [100]
TIME: 14h30 – 17h30	**PASS MARK:** 60%

NUMBER OF PAGES: 4

SPECIAL REQUIREMENTS:

1. **Answer ***ALL FIVE*** 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 (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

The Puma Colliery practices shortwall mining at a depth of 95m below surface. If the goaf angle is 15 degrees, calculate the following:

1.1. The average pillar stress on a 12m wide gateroad pillar, when a goaf is developed on both sides of it? (6)
1.2. The width of the ridge over the gateroad pillar between subsided panels on surface? (4)
1.3. If the pillar is 2km long what is the safety factor of the pillar when the mining height is 4m and the bord is 7m. Both before mining the shortwall and after the goaf is formed on both sides? (10)

[20 MARKS]

1.1 Consider a 1m slice

Pillar stress = 0.025 x depth x tributary area/pillar area

= 0.025 x 95 x (12+95tan15)/12

= 7.413 MPa

1.2 Ridge = 12 + 2x(95xtan15) = 86.91m

1.3 w_e=4A/P = 4 x 2000/(24 + 4000) = 23.86m

pillar strength = 7.2 x $w_e^{0.46}/h^{0.66}$ = 12.407 MPa

on development

pillar load = 0.025 x H x C/w = 0.025x95x19/12 = 3.760 MPa

SF = Strength/Load = 12.407/3.760 = 3.299

After goaf

SF = 12.407/7.413 = 1.674

QUESTION 2

Auger mining will be done from a highwall at a depth of 25 m to the bottom of the seam. The diameter of the auger is 1.8 m. The seam height is 4.0 m and therefore 2 rows of auger holes will be drilled above one another.

The spacing between the holes will be 0.3 m and 5 sets of auger holes will be drilled before leaving a pillar of 5.0 m. It is planned to auger holes 200m long.

2.1 Calculate the safety factor of the pillar. (6)
2.2 Calculate the percentage extraction of the seam. (4)

2.3 If only 1 row of auger holes are drilled, what is the safety factor and percentage extraction of the seam. (8)

2.4 What factors must be considered when choosing an auger mining site. (2)

[20 MARKS]

2.1 assume pillar carries full tributary load

H = 2x1.8 + 0.3 = 3.9m

h = 25m

system length (C) = 5 + 5x1.8 + 4x0.3 = 15.2m

w = 5m

Load = 0.025xHxC/w = 0.025 x 25 x 15.2/5 = 1.90 MPa

w_e=4A/P = 4x200x5/(10+400) = 9.76m

pillar strength = 7.2 x $w_e^{0.46}/h^{0.66}$ = 8.36 MPa

SF = Strength/Load = 8.36/1.9 = 4.40

Alternative using w (conservative)

Strength =$7.2x5^{0.46}/3.9^{0.66}$ = 6.15 MPa

SF = 6.15/1.9 = 3.24

2.2 2d approach based on area

Extraction = n x $\pi D^2/4$ = 10 x 1.8^2 x $\pi/4$ = 25.45 m^2

Coal System = C x h = 60.8m^2

% Extraction = Extraction/System x 100% = 41.86%

2.3 h = 1.8m

Strength = $7.2x8.36^{0.46}/1.8^{0.66}$ = 13.932 MPa

SF = 13.932/1.9 = 7.33

Alternative using w (conservative)

Strength =$7.2x5^{0.46}/1.8^{0.66}$ = 10.242 MPa

SF = 10.242/1.9 = 5.39

% Extraction = {(5 x $1.8^2\pi/4$)/60.8} x 100% = 20.93%

2.4

Highwall stability

Use of augered area after mining

Egress and access

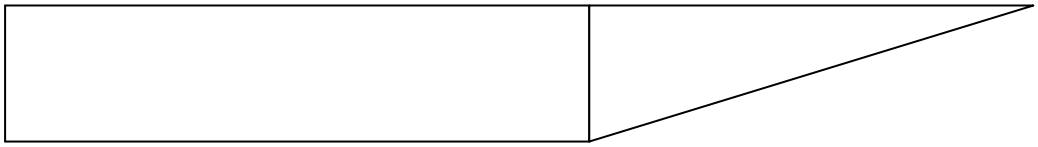
QUESTION 3

A box cut 45m wide, 100m long and 23m deep is developed with an additional access ramp excavation at 10 degrees.

3.1 What is the total length of the excavation? (2)
3.2 If the density of the material is 2500 kg/m^3 what is the mass of the material moved? (4)
3.3 What is the volume of broken material if the swell factor is 1.4? (4)
3.4 What is the base area required if the broken material was dumped in a conical heap with an angle of repose of 45 degrees? (10)

[20 MARKS]

3.1



Length = 100 + 23/tan 10 = 100 + 130.44 = 230.44 m

3.2

Ramp Volume = ½ base x height x width = 0.5 x 130.44 x 23 x 45 = 67502.4 m^3

Box volume = base x height x width = 100 x 23 x 45 = 103500 m^3

Total volume = 171002.4 m^3

Mass = RD x Volume = 2.5 x 171002.4 = 427506 tons

3.3

Bulked Volume = volume x swell factor = 171002.4 x 1.4 = 239403.36m^3

3.4

Volume = 1/3 h x D^2/4 x π or 1/3 h x r^2 x π

But at 45˚ r = h , so

Volume = h^3 x π/3 , therefore

h^3 = 3/ π x Volume

h= $\sqrt[3]{}$(3/ π x Volume)

h = 60.89 m and h = r

Area = π r^2 = 11650.1 m^2

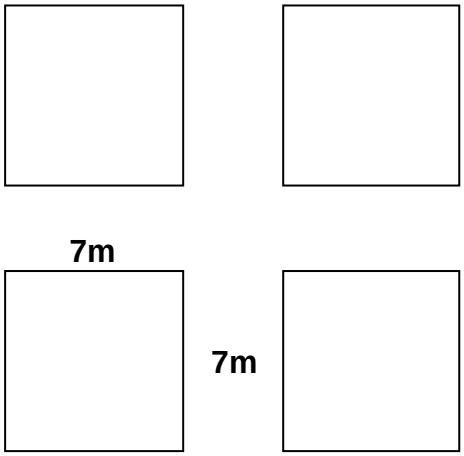
QUESTION 4

Somewhere Mine wants to rapidly develop to the end of its reserve which is 80m to the base of a 3,5m thick coal seam. Mining is carried out using a 3,5m wide continuous miner, doing double pass mining. Initial development is to create square pillars to be split and quartered to a final CM safety factor of 1.6 on retreat.

4.1 Calculate the pillar width of the final square pillars. (15)
4.2 Calculate the CM adjusted safety factor of the primary development pillars. (5)

[20 MARKS]

4.1



H = 80m h = 3.5m b = 7m SF (cm) = 1.6

Iterate

TRY 1, C = 17 m, w = 10 m

$$FS = 288\frac{w^{2.46}}{Hh^{0.66}(w+b)^2}$$ **= 1.57**

w_0 = 0.3m

$$\eta = \eta_o\,(1+\frac{2\Delta w_0}{w})^{2,46}$$

CM adjusted SF = 1.81

TRY 1, C = 16 m, w = 9 m

$$FS = 288\frac{w^{2.46}}{Hh^{0.66}(w+b)^2}$$ **= 1.37**

w_0 = 0.3m

$$\eta = \eta_o \left(1 + \frac{2\Delta w_0}{w}\right)^{2,46}$$

CM adjusted SF = 1.61

Pillar Width = 9m Centres = 16m

4.2

H = 80m, h = 3.5m, w = 9 + 9 +7 = 25m, C = w + 7 = 32m

SF = 4.23

CM adjusted = 4.48

NB. The primary development is squat, w/h ratio > 5, but for equivalent comparison Salamon SF used throughout.

QUESTION 5

With the aid of sketches describe and compare how various geological discontinuities influence the stability of underground bord and pillar mining areas. (20)

[20 MARKS]

Water
Persistence
Roughness
Spacing
Direction
Dip
Infill/Healing
Position relative to pillars

Strata Control Formulae

$$S = 7{,}2\frac{w^{0,46}}{h^{0,66}}$$

$$S = 3.5\left(\frac{w}{h}\right)(MPa)$$

$$L = \frac{25\,H\,C^2}{w^2}$$

$$\eta = \eta_o\,(1+\frac{2\Delta w_0}{w})^{2,46}$$

$$n = SF\ \frac{pgt}{Pf}$$

$$Lb = \frac{d_c^2\ \ Lc}{D^2 - d^2}$$

$$\tau = \frac{Pf}{\pi.D.Lb}$$

$$\eta = \frac{\gamma\,L^4}{23\,E\,t^2}$$

$$\sigma = \frac{\gamma\,L^2}{2\,t}$$

$$FS = 288\frac{w^{2.46}}{Hh^{0.66}(w+b)^2}$$

$$\sigma_s = 7.2\frac{R_0^{0.5933}}{V^{0.0667}}\{\frac{0.5933}{\varepsilon}[(\frac{R}{R_o})^{\varepsilon} - 1] + 1\}$$