EXAMINATION PAPER

SUBJECT:	**EXAMINER:**
CERTIFICATE IN STRATA CONTROL (COAL)	D. NEAL
SUBJECT CODE:	**MODERATOR:**
EXAMINATION DATE:	B. MADDEN
MAY 2013	**TOTAL MARKS:** [100]
TIME:	**PASS MARK:** 60%

NUMBER OF PAGES:

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.

CERTIFICATE IN STRATA CONTROL (COAL)

Question 1

1.1 Explain the parameters in the Q-rating system and their reduction factor where applicable. (8)

$$Q = \frac{RQD}{Jn} \times \frac{Jr}{Ja} \times \frac{Jw}{SRF}$$

J_n = Joint Set Number
J_r = Joint Roughness Number
J_a = Joint Alteration Number
J_w = Joint Water Reduction Factor
SRF = Stress Reduction Factor.

1.2 Calculate RQD for a 100m long borehole with 24 fractures more than 100mm apart. (2)
Stick length ave. =100/24 = 4.17m RQD = 100/100 x 100% = 100

1.3 Calculate the Q-rating using the RQD value from 1.2 above and the values in the Table below, for a planar, smooth dominant joint set plus random jointing. Some joints are tightly healed with impermeable filling while others are loose and with slight weathering. (6)

Parameters	Values
Jn	3
Jr	1
Ja	5
Jw	1
SRF	1

Q=6.67

1.4 Comment on the Q rating obtained how it could be used in a mining scenario. (4)

To assist in support selection in tunnels and shafts.

[20 MARKS]

Question 2

2. Define the following terms, give the units and explain their relevance in rock engineering design;

2.1 Shear Strength (3)
Shear strength of a material is the maximum shear stress that the material can support without yielding in shear.

Shear strength is used to determine stability across discontinuities in the rockmass.

2.2 K – ratio (3)

*The ratio of vertical stress to horizontal stress is termed the **k ratio**.*

The k-ratio indicates the direction of maximum stresses in-situ, thus aiding in the design, layout and support of underground excavation.

2.3 W:h ratio (3)

The width of a pillar divided by the mining height. It is determined using the narrowest side of the pillar.

It is an indication of the slenderness of the pillar. Pillar width to height ratios of less than 2 are considered unstable in pillar design.

2.4 Subsidence (3)

Downward movement of the overburden (soil and/or rock) lying above an underground excavation.

Subsidence can be caused by a collapse of boards or underground pillars in shallow mining environment. Pillar design in this environment must take measures to prevent the occurrence of surface subsidence.

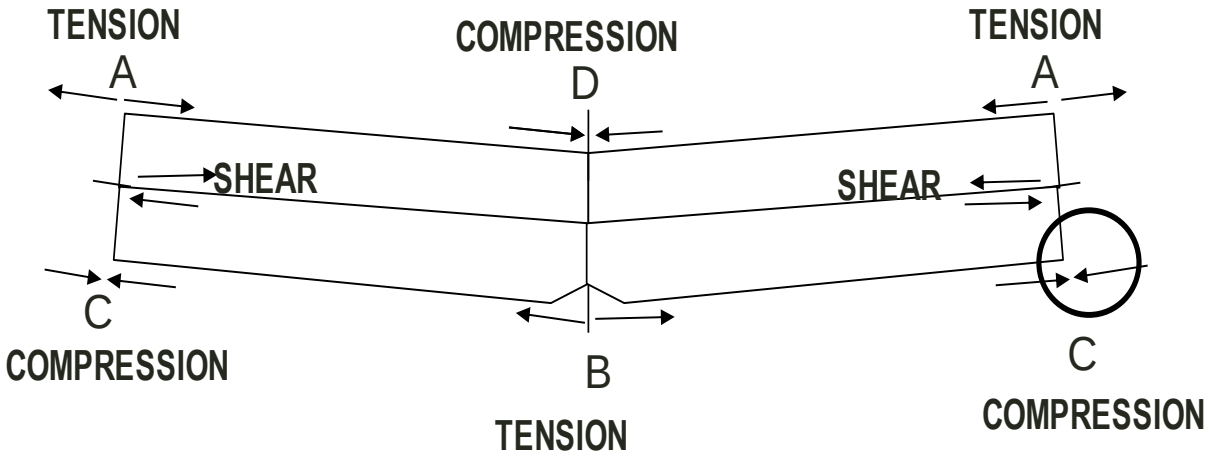
2.5 Stiffness (3)

***Stiffness** refers to the extent to which an object resists deformation in response to an applied force.*

Used in support design, a stiff support unit will deform less at an applied load when compared to a counterpart.

2.6 With the aid of diagrams describe how compressive, shear and tensile stresses are distributed in a clamped end beam. (5)

<u>Fixed Beam</u>



[20 MARKS]

Question 3

3.1 The COMRO Shallow pillar Guidelines were updated by Canbulat and Madden in 2005. What are the updated Guidelines Parameters? (6)

1. *Shallow Mining - <40m*
2. *w/h ratio of pillars >2.2*
3. *Safety factor >2.1*
4. *Areal Percentage extraction <75%*
5. *pillar width >6.5m*
6. *All parameters must be achieved*

3.2 Design the minimum pillar in a bord and pillar layout for a 3,0 m seam, depth to floor 30 m for a bord 7,2 m. What are the Safety Factors using Salamon, van der Merwe and the continuous miner adjustment? What length of pillar should be left at the portal of a highwall for this design? (14)

using w/h 2,2 = 2,2 x 3,0 (mining height) = 6,6 m OK for min. Width

But bord = 7,2 m for e% = 75% w must = 7,2 m

w/h 7,2/3 = 2,4 OK for min w/h

SF Sal = 2,88, SF Sal cm = 3,51, vdM = 2,80.

Min pillar at portal w = D/2,7 = 30/2,7 = 11,11 m

[20 MARKS]

Question 4

The formula for induced tensile stress in a competent clamped beam is:-

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

4.1 Determine the percentage increase in induced tensile stress due to an increase in bord width from 6m to 7m and then to 8m. (8)

6m=36k 7m=49k 8m=64k (2)
*6m to 7m =49-36/36 * 100 = 36.1% (2)*
*7m to 8m =64-49/49 * 100 = 30.6% (2)*
*6m to 8m =64-36/36 * 100 = 77.8% (2)*

4.2 The tensile strength of coal is 1.3MPa and the density of coal is 1550 kg/m3 calculate the minimum thickness of a competent coal beam 6m long. (6)

$$t = \frac{\gamma L^2}{2\sigma}$$ *(2)* *t = 210.5mm (4)*

4.3 If the beam consisted of sandstone why would this influence its minimum thickness? Show a calculation to justify your answer and state all assumptions.(6)

Density of sandstone 2500 kg/m3, tensile strength approximately 4 MPa (2)

$$t = \frac{\gamma L^2}{2\sigma}$$ *t = 110mm (2)*

influenced by input parameters i.e. density and tensile strength (2)

[20 MARKS]

Question 5

5.1 Name the 3 main rock types associated with coal bearing strata and give an example of each, including typical rock strength. (6)

Sedimentary – sandstone UCS 50 to 100 MPa
Metamorphic – coal UCS 10 to 45 MPa
Igneous – dolerite UCS 100 to 200 MPa

5.2 What geotechnical problems are commonly associated with dykes and give examples of how could they be managed? (8)

1. *Localised stress concentration*
2. *Increased jointing*
3. *Weakened rock types*
4. *Water and gas pressure in roof*

Increase support density and length for all.
Areal support for 2 and 3.
Bleeder holes for 4.
Monitoring holes near pillar edge for 1.

5.3 Describe with the aid of diagrams the influence of various types of discontinuity on roof , pillar side or highwall stability. (6)

[20 MARKS]

Strata Control Formulae

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

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

$$L = \frac{25HC^2}{w^2}$$

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

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

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

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

$$\eta = \frac{\gamma\ L^4}{32E\,t^2}$$

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

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

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

$$\tau = c + \sigma_n \tan\phi$$

$$V_s = \frac{4\,\pi\,r^3}{3}$$