



CHAMBER OF MINES OF SOUTH AFRICA

EXAMINATION PAPER

SUBJECT: CERTIFICATE IN STRATA CONTROL (COAL) SUBJECT CODE:COMSCC EXAMINATION DATE: 10 OCTOBER 2017 TIME: 14:30 – 17:30	EXAMINER: Marc Henderson MODERATOR: Sandor Petho TOTAL MARKS: [100] PASS MARK: 60%
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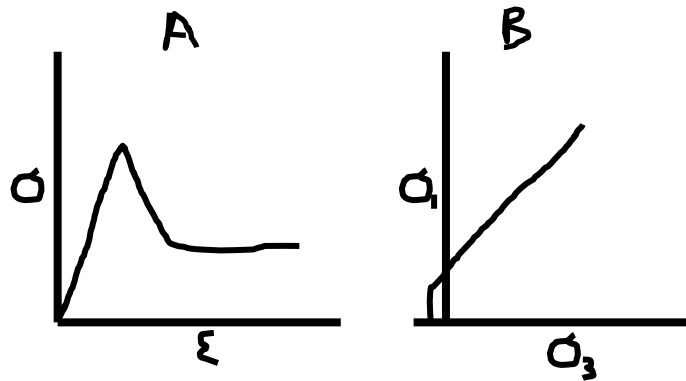
NUMBER OF PAGES: 12(Including formula sheets)

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. 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.
 10. Cell phones are **NOT** allowed in the examination room

QUESTION 1

- Explain what you understand by the terms 'brittle' and 'ductile'. (4)
- Explain the difference between a uniaxial compressive test and a tri-axial compressive test. (4)
- Explain what is represented by diagrams A and B below. (4)



- Complete this expression: Shear strength = Cohesion + (3)
- Your immediate roof is described by the Geologist as having a high clay mineral content. What hazards would you associate with this? (2)
- What is the effect of allowing an area to stand unsupported for an extended period of time? (2)
- At a CM section, you are asked to increase the cutting depth of a 7m wide bord from 7m to 15m. What effects may this change have? (3)
- A main development section is blasting through a heavily jointed burnt coal area near a dyke. What must be considered if ribside support is to be done using split-sets? (2)
- Describe the process for determining CMRR. (6)

[30]

QUESTION 2

Using the pillar strength formula $S = 7.2w^{0.46}/h^{0.66}$

Your colliery employs a bord and pillar mining layout at 30m below surface with a mining height of 4m. The minimum w:h ratio applied is 3, the minimum safety factor is 1.6, and the bord width is 6m. Assume square pillars. Show all calculations.

- 1) What size pillars are required to meet the mines own criterion? (5)
- 2) As part of their surface protection strategy, the Rock Engineer determined that the mining height should be reduced to 2.5m. Following this, you have been requested to re-determine the required pillar size, and then compare the change in extraction percentage of the total volume of coal that would be achieved at a 4m height to that at a 2.5m height? (15)
- 3) Using a stress / strain diagram, illustrate differences between a pillar with a width to height of 2 and a pillar with a width to height of 7. (5)

[25]

QUESTION 3

a) Estimate the support capacity of the following (3):

1. Rockprop,
2. Split-set, and
3. 20mm resin bolt.

b) Calculate the length required for a 23mm resin capsule to fill a 27mm diameter hole, of length 2.4m, with a 20mm resin bolt installed? (10)

c) How much longer will the above capsule need to be if provision is made for a 5cm over-drill?

(7)

d) Name 3 ways in which a resin bolt can contribute towards roof stability. (3)

e) What risk is associated with exceeding the recommended spin time on a spin/hold resin system? (2)

[25]

QUESTION 4

The immediate roof at your mine comprises of multiple 0.4m thick layers of rock material. After conducting lab tests, you determine the Brazilian tensile strength to be 5MPa.

- a) Assuming that the layers act independently, use the beam formula below to calculate the safety factor of the bottom layer for a 5m bord width and a rock density of 0.025MN/m³.

$$\sigma = \frac{\gamma L^2}{2t} \quad (5)$$

- b) Explain why the above calculated safety factor is or is not a good basis for motivating that the area does not require systematic support. (6)
- c) Draw a section of a clamped beam showing where you would expect the shear stress to be at its maximum. (3)
- d) Assume the tensile strength of your beam to be equal to zero. Explain, with use of a simple sketch, how it is possible for such a beam to remain stable? (3)
- e) Give a rough estimate of the maximum stress occurring near the edges of the roof of a roadway at a depth of a 100m, and a k ratio of 2? (3)

[20]

TOTAL MARKS: 100

Strata Control Formulae

Candidates may find some of the following equations useful, although other equations may also be used.

Pillars

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

$$\sigma = 4.5 \frac{w^{0,46}}{h^{0,66}}$$

$$\sigma = 4,3 \left(0,64 + 0,36 \frac{w}{h} \right)$$

$$\sigma = 3.5 \frac{w}{h}$$

$$\sigma = k \frac{R_0^b}{V^a} \left\{ \frac{b}{\varepsilon} \left[\left(\frac{R}{R_0} \right)^\varepsilon - 1 \right] + 1 \right\}$$

$$\sigma = \frac{.0786}{V^{0.0067}} \{ R^{2.5} + 181.6 \}$$

$$w_e = \frac{4A}{C}$$

$$SF_{cm}=SF\!\left(1+\frac{0.6}{w}\right)^{2.46}\qquad SF_{cm}=SF\!\left(1+\frac{0.6}{w}\right)^3$$

$$SF^{'}=SF\!\left(\frac{w-\Delta w}{w}\right)^{2.46}\qquad SF^{'}=SF\!\left(\frac{w-\Delta w}{w}\right)^3$$

$$SF^{''}=\!\left(\frac{h}{h+\Delta h}\right)^{0.66}\qquad SF^{''}=\!\left(\frac{h}{h+\Delta h}\right)$$

$$Load=\frac{[.025(H-T)+.03T]C_1C_2}{w_1w_2}$$

$$e\% = 100 \left[\frac{h_m}{h_s} \left(1 - \frac{w^2}{C^2} \right) \right] \frac{W}{W+P}$$

$$E_{cp}=\frac{0,562w_e}{h}-2,293$$

$$R=m\!\left[\frac{h}{T}\right]^x$$

$$d\;=\;w-\big[0,00714S_{\min}HhC^2\big]^{0,333}$$

$$S_{\min}=0.4$$

$$T=\left[\frac{d}{mh^x}\right]^{\frac{1}{1-x}}$$

Region	m	x
Vaal Basin, Klip River and South Rand	1,3888	0,804
Witbank No.2 and No.4 Seams	0,1799	0,7549
Witbank No.5 Seam	0,105	-0,3061

Roof Support

$$\sigma_t=\frac{qB^2}{2t^2}$$

$$q=\rho gt_m$$

$$t_m=\sqrt{\frac{qL^2}{2\sigma_t}}$$

$$Ab_s=\frac{Fm}{\left[\frac{0,75qLF}{t_mTan\phi}+q\right]}$$

$$Ab_c=\frac{Fm}{q}$$

$$l_a=\frac{Fm}{\pi d_h\tau}$$

$$\sigma_{\imath}=\frac{fq_c s^2}{2t^2}$$

$$s=1.414t_{\min}\sqrt{\frac{\sigma_{tm}}{fq_c}}$$

$$q_c=q_l+\frac{q_uE_l-q_lE_u}{E_l+E_u}$$

$$l_a=\frac{\rho g s^2 t_w}{\tau_c \pi d_h}+.05$$

$$\eta=\frac{SF\rho g t}{P_d}$$

$$\sigma_{ts}=\frac{4W_b}{\pi d_b^2}$$

$$l_c=\frac{l_a\left(d_h^2-d_b^2\right)}{\left(d_h\right)^2}$$

$$t_{sb}=\frac{fk\rho g B^2}{2\sigma_{tm}}$$

$$\tau_b=\frac{3k\rho g B}{4}$$

$$\sigma_t = \left(\frac{\gamma_s t_s + \gamma_u t_u}{2 * t_s^2}\right)b^2$$

$$n_l = \frac{t_s}{tc} \qquad t = \frac{n_l L^2 \gamma SF}{2 \sigma_t}$$

$$l_b = t_{wl} (1 + ((\gamma S b^2)/(\pi d \tau)))$$

$$\tau_t = \frac{3(\gamma_s t_s + \gamma_u t_u) \mathfrak{b}}{4 t_s}$$

$$F_T = F_b \rho g k t_{sb} s^2$$

$$l_a = \frac{F_T}{\pi d_h \tau_c}$$

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

$$\sigma_s = \frac{4F_T}{\pi d_s^2}$$

$$z = \frac{4(2bh^2\cot\emptyset + hb^2)}{(k-1)\pi d^2}$$

$$\beta = \arctan \left(\frac{L/2}{\eta} \right) - \arctan \left(\frac{\eta}{L/2} \right)$$

$$R=\frac{L/2}{Cos\beta}$$

$$d\theta=\frac{\pi}{2}-\arctan\left(\frac{R-\eta-h_l}{L/2-d}\right)$$

$$S=t_ld\theta$$

$$\sigma_r=\frac{\tau_l S_b}{d_b}$$

$$\varepsilon_r=\frac{\sigma_r}{E_r}$$

$$S_r=\varepsilon_r(d_h-d_b)+R_s$$

$$SSF=\frac{S}{S_r}$$

Subsidence

$$S_{m,he}=0,39h\left(\frac{W}{H}\right)^{0,32}$$

$$S_{m,pf}=0.1h_e$$

$$h_e=he$$

$$S_x=\frac{S_{\max}}{2}\left[\tanh\left(\frac{7x}{W}-1,645\right)+1\right]$$

$$L_c=2T\sqrt{k+\frac{\beta}{D}}+2(H-D)\tan\theta$$

$$\beta=\frac{c-b\gamma d}{\gamma_m\tan\phi}-\frac{kl}{2}$$

$$\beta=\frac{1.53}{\gamma_m}-0.8$$

$$\gamma_m=\gamma_s\frac{D-T}{D}+\gamma_d\frac{T}{D}$$

$$\gamma_m=0.025\frac{D-T}{D}+0.03\frac{T}{D}$$

$$T_m=21.6S_m+7$$

$$\varepsilon_{m+}=4.2S_m+1.7$$

$$\varepsilon_{m-}=-9.1S_m-2.8$$

Other

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

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