Minerals Council South Africa

EXAMINATION PAPER

SUBJECT: CERTIFICATE IN STRATA CONTROL (COAL) **SUBJECT CODE:** COMSCC **DATE:** 10 MAY 2022 **TIME:** 14h30 – 17h30	**EXAMINER:** C. SELAI **MODERATOR:** R. MALOGWA **TOTAL MARKS:** [100] **PASS MARK:** (60%)

NUMBER OF PAGES: 9 (including this one)

THIS IS NOT AN OPENBOOK EXAMINATION – ONLY REFERENCES PROVIDED ARE ALLOWED

SPECIAL REQUIREMENTS:

1. **Answer All the Questions**. Answer the questions **legibly** in English.
2. Write your **ID 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.

3. Show all calculations **and check calculations on which the answers are based.**
4. Hand-held electronic calculators may be used for calculations. **Reference notes may not be programmed into calculators.**
5. Write **legibly** in ink on the **right-hand page** only – **left hand pages will not be marked**.
6. Illustrate your answers by means of sketches or diagrams wherever possible.
7. **Final answers** must be given to an accuracy which is typical of practical conditions, however, be careful not to use too few decimal places during your calculations, as rounding errors may result in incorrect answers.

NB: Ensure that the correct unit of measure (SI unit) is recorded as marks will be deducted from answers if the incorrect unit is used even if the calculated value is correct.

8. In answering the questions, full advantage should be taken of your practical experience as well as data given.
9. Please note that you are not allowed to contact your examiner or moderator regarding this examination.
10. Cell phones AND OTHER SMART DEVICES are **NOT** allowed in the examination room.

QUESTION 1– PILLAR STABILITY

A 4m thick coal seam which outcrops on a mountainside will be extracted using a bord and pillar mining method. The cover depth ranges from 0m to 250m below surface.

1.1. Comment on the stability at the depth of 35m below surface, if the mining height = 3m and bord width = 6m and make any necessary recommendations (*show all the necessary calculations using the Salamon and Munro strength formula*) (15)

1.2. Due to the variation in depth to the floor, the mine manager has requested that the adjustment in pillar geometry be done such that the panel width remains the same. If the effective pillar width required to achieve a safety factor of 2.0 is 7.6m, what is the pillar length at the depth of 55m, mining height = 3m.

1.3. Comment on the usage of continuous miner adjustment at the depth greater than 175m below surface and pillar width less than 5m. (2)

1.4. List at least 4 ways in which the floor dip affect pillar stability (5)

[25 MARKS]

QUESTION 2 ROCKMASS CLASSIFICATION AND CHARACTERIZATION

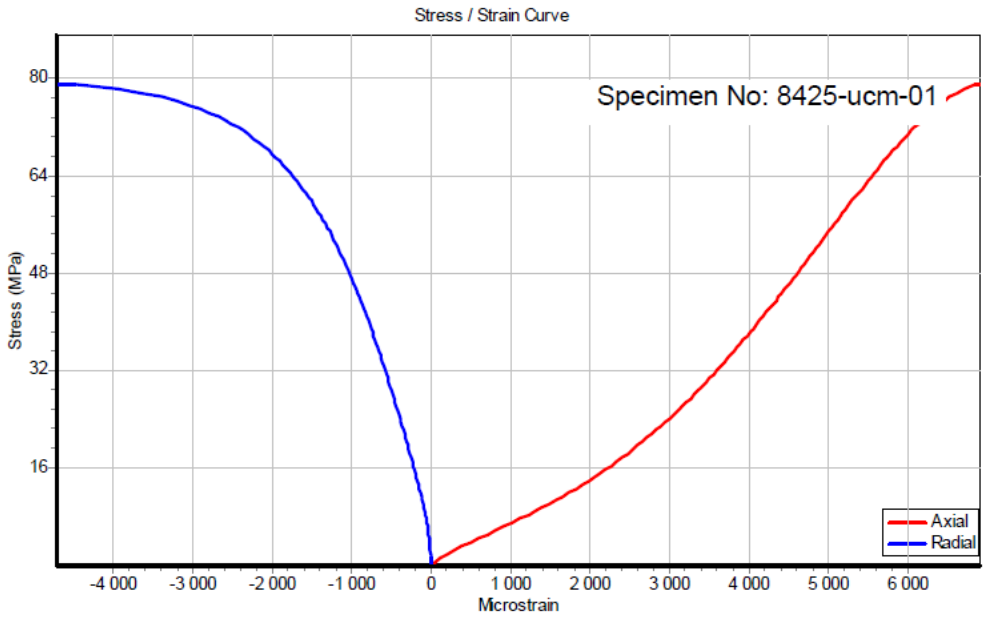
2.1. Diamond drill holes have been recovered as part of the new mining project for the coal strip mine boxcut rock mass characterization, with an average depth of 35m. You have conducted a geotechnical logging and recorded a total of 400 joints in the recovered core. Two distinct sets of joint sets were recorded dipping at roughly 20° and 80°, respectively. One of these sets is rough and undulating whilst the other is smooth, planar and slickensided. Traces of micaceous filling, varying in thickness from 0mm-3mm, are visible on the joint planes and no signs of water. You have also noted an approximately 2m thick weathered dolerite dyke striking through the core.

2.1.1. Q-system is one of the systems of quantifying the quality of the rockmass and is divided into six (6) components as indicated in the formula below. Explain the meaning of the parameters used to determine the Q-value (6)

$$Q = \frac{RQD}{J_n} x \frac{J_r}{J_a} x \frac{J_w}{SRF}$$

2.1.2. Calculate the rockmass quality based on the Q-system, using the tables provided in Appendix 1 and motivate reasons for each value chosen. (14)

2.2. A standard uniaxial compressive strength test was conducted on a sandstone specimen with strain gauges for determining the elastic modulus properties. The following stress-strain profiles were recorded during the laboratory testing. Answer the questions that follow:



2.2.1. What is the peak strength of the sample? (1)

2.2.2. What is the peak axial strain at failure (1)

2.2.3. What is the peak lateral strain at failure? (1)

2.2.4. Determine the modulus of elasticity of the sample (2)

[25 marks]

QUESTION 3 STRESSES AND SUPPORT

3.1. Show that the presence of a joint on the roof increases the induced tensile horizontal stress in the roof six-fold (3)

3.2. Explain the principle of resin chemical reaction as used for roof support taking into consideration the resin components and impacts of spinning and holding time on the quality of support installation. (6)

3.3. With the saying that *"Mining does not create stresses; it merely redistributes the existing ones"* in mind, describe and demonstrate (through diagrams) how the stresses are redistributed around the common coal mine roadway corners and clearly show the magnitude of stresses for the following K-ratios.

3.3.1. K-ratio = 1 (3)

3.3.2. K-ratio >1 (3)

3.3.3. K-ratio <1 (3)

3.4. What do we call the phenomenon resulting from the stress redistribution and concentration on the corners of the roadways? (1)

3.5. Describe the mode of formation of the phenomenon mentioned in 3.4, taking into consideration the stress distribution. (6)

[25 MARKS]

QUESTION 4 OPENCAST

As a Strata Control Officer on a coal strip mine, your Rock Engineering Practitioner have requested you to research with an intention to purchase some software to analyse the stability of the various slopes, including joint related instability as well as slope deformations.

4.1. List the appropriate software types for the various failure modes (5)

4.2. What input parameters are required for analysis in each program type (10)

4.3. How will you establish the input parameters listed above (5)

4.4. List at least five (5) conditions to be observed for safe working conditions in a coal strip mine where old underground pillars are being mined out (5)

[25 MARKS]

TOTAL MARKS [100]

APPENDIX A: Q-System rating tables

1. Rock Quality Designation	RQD
A Very Poor	0 – 25
B Poor	25 – 50
C Fair	50 – 75
D Good	75 – 90
E Excellent	90 – 100
Note: (i) Where RQD is reported or measured as ≤ 10 (including 0), a nominal value of 10 is used to evaluate Q. (ii) RQD interval of 5, i.e., 100, 95, 90, etc., are sufficiently accurate.	

2. Joint Set Number	J_n
A Massive, no or few joints	0.5 – 1
B One joint set	2
C One joint set plus random joints	3
D Two joint set	4
E Two joint set plus random joints	6
F Three joint set	9
G Three joint set plus random joints	12
H Four or more joint sets, heavily jointed	15
J Crushed rock, earthlike	20
Note: (i) For intersections, use ($3.0 \times J_n$). (ii) For portals, use ($2.0 \times J_n$).	

3. Joint Roughness Number	J_r
(a) Rock-wall contact, and (b) Rock wall contact before 10 cm shear	
A Discontinuous joints	4
B Rough or irregular, undulating	3
C Smooth, undulating	2
D Slickensided, undulating	1.5
E Rough or irregular, planar	1.5
F Smooth, planar	1.0
G Slickensided, planar	0.5
Note: (i) Descriptions refer to small and intermediate scale features, in that order.	
(c) No rock-wall contact when sheared	
H Zone containing clay minerals thick enough to prevent rock-wall contact	1.0
J Sandy, gravelly or crushed zone thick enough to prevent rock-wall contact	1.0
Note: (ii) Add 1.0 if the mean spacing of the relevant joint set ≥ 3 m. (iii) J_r = 0.5 can be used for planar slickensided joints having lineations, provided the lineations are oriented for minimum strength.	

4. Joint Alteration Number		φ_r approx.	J_a
(a) Rock-wall contact (no mineral fillings, only coatings)			
A	Tight healed, hard, non-softening, impermeable filling, i.e., quartz or epidote	–	0.75
B	Unaltered joint walls, surface staining only	25 – 35°	1.0
C	Slightly altered joint walls. Non-softening mineral coating, sandy particles, clay-free disintegrated rock, etc.	25 – 30°	2.0
D	Silty- or sandy-clay coatings, small clay fraction (non-softening)	20 – 25°	3.0
E	Softening or low friction mineral coatings, i.e., kaolinite or mica. Also chlorite, talc, gypsum, graphite, etc., and small quantities of swelling clays	8 – 16°	4.0
(b) Rock wall contact before 10 cm shear (thin mineral fillings)			
F	Sandy particles, clay-free disintegrated rock, etc.	25 – 30°	4.0
G	Strongly over-consolidated non-softening clay mineral fillings (continuous, but < 5 mm thickness)	16 – 24°	6.0
H	Medium or low over-consolidated softening clay mineral fillings (continuous, but < 5 mm thickness)	12 – 16°	8.0
J	Swelling-clay fillings, i.e., montmorillonite (continuous, but < 5 mm thickness). Value of J_a depends on percent of swelling clay size particles, and access towater, etc.	6 – 12°	8 – 12
(c) No rock-wall contact when sheared (thick mineral fillings)			
K, L, M	Zones or bands of disintegrated or crushed rock and clay (see G, H, J for description of clay condition)	6 – 24°	6, 8, or 8 – 12
N	Zones or bands of silty- or sandy-clay, small clay fraction (non-softening)	–	5
O, P, R	Thick, continuous zones or bands of clay (see G, H, J for clay condition description)	6 – 24°	10, 13, or 13 – 20

5. Joint Water Reduction Factor		Water pressure	J_w
A	Dry excavation or minor inflow, i.e., < 5 l/min locally	< 1 (kg/cm^2)	1.0
B	Medium inflow or pressure, occasional outwash of joint fillings	1 – 2.5	0.66
C	Large inflow or high pressure in competent rock with unfilled joints	2.5 – 10	0.5
D	Large inflow or high pressure, considerable outwash of joint fillings	2.5 – 10	0.33
E	Exceptionally high inflow or water pressure at blasting, decaying with time	> 10	0.2 – 0.1
F	Exceptionally high inflow or water pressure continuing without noticeable decay	>10 (kg/cm^2)	0.1 – 0.05

Note: (i) Factors C to F are crude estimates. Increase J_w if drainage measures are installed.
(ii) Special problems caused by ice formation are not considered

	STRESS REDUCTION FACTOR	
A	No shear, faults, dyke or weakness zone	1
B	One shear, fault, dyke or weakness zone	2.5
C	One shear, fault, dyke or weakness zone with blocky ground conditions	4
D	Curved joints or dome structure approaching a pothole, reef roll or OPL's	7.5
E	Curved joints or dome structure approaching a pothole, reef roll, OPL's with blocky ground conditions	8
F	Many faults, dyke and weakness zones.	9
G	Wide shear zone	10

APPENDIX B: Strata Control (Coal) Formula sheet

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

$$e\% = 1 - \frac{w_1 w_2}{C_1 C_2}$$

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

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

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

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

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

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

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

$$\sigma_{nj} = \frac{\gamma L^2}{2t}$$

$$\sigma_j = \frac{3\gamma L^2}{t}$$

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

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

$$Q = \frac{RQD}{J_n} x \frac{J_r}{J_a} x \frac{J_w}{SRF}$$

$$RQD = 115 - 3.3 x J_v$$

$$RQD = \frac{\sum lenght\ of\ core\ pieces > 10cm}{total\ lenght\ of\ core}\ x\ 100$$