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# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## (ONLINE)
## SEMESTER II
## SESSION 2020/2021

| | | |
|---|---|---|
| COURSE NAME | : | ENGINEERING GEOLOGY |
| COURSE CODE | : | BFC21303 |
| PROGRAMME CODE | : | BFF |
| EXAMINATION DATE | : | JULY 2021 |
| DURATION | : | 3 HOURS |
| INSTRUCTIONS | : | ANSWER **ALL** QUESTIONS |

THIS QUESTION PAPER CONSISTS OF **NINE (9)** PAGES

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**Q1** (a) Using your own words, distinguish between 'Geology' and 'Engineering Geology'.
(4 marks)

(b) Write a description of each internal layers of the earth based on physical properties.
(8 marks)

(c) Convergent boundaries are one of the plate boundaries type. Name and illustrate **TWO (2)** of the convergent boundaries type.
(4 marks)

(d) Describe **TWO (2)** properties of minerals that you could use to identify an unknown mineral.
(5 marks)

(e) In your opinions, explain at least **TWO (2)** reasons why civil engineers need to study about minerals.
(4 marks)

**Q2** (a) Igneous rock is the most abundant rock in the world and is also known as primary rock.

(i) Differentiate between an intrusive igneous rock and extrusive igneous rock.
(3 marks)

(ii) Among various types of rock, igneous rocks are very competent for civil engineering construction. Discuss the effect of minerals and the structure of rock that contribute to the strength of the rock.
(5 marks)

(b) Explain how climate, rock types, topography, and time influence the types of soil produced by weathering.
(10 marks)

(c) Explain briefly differences between joint and fault. Use diagrams to support your answer.
(3 marks)

(d) A road will be constructed in a hilly area. The contractor decides to cut the rock slope at CH 18000 and CH 20000 as shown in **Figure Q2(d).** Discuss the effect of cutting slopes during construction and on the safety of road user after the road is open to the public.
(4 marks)

**Q3** (a) A core sample of granite was drilled at 1.5 m length at Muar. Based on the rock core sample as shown in **Figure Q3(a)**, determine the Total Core Recovery (TCR), Solid Core Recovery (SCR) and Rock Quality Designation (RQD).

(6 marks)

(b) Describe rock parameters that obtained from the following testing:

(i) Seismic Velocity test
(ii) Brazilian test
(iii) Slake durability test
(iv) Schidmt hammer test
(v) Triaxial Compression Test
(vi) Point load test

(6 marks)

(c) **Table Q3(c)** presentssamples information for point load test. Based on the data:

(i) Calculate the Unconfined Compression Strength for sample A and B.

(8 marks)

(ii) Classify the strength of sample A and B based on Bieniawaski 1975 classification as given in **Table Q3c(ii)**.

(2 marks)

(iii) As an engineer, define the reason of strength classification of sample A and B.

(3 marks)

**Q4** A road cutting 60 m deep is driven through a sequence of granite rock. The rock slope face cutting in the direction of 160° and dip angle 70°. The rock slope has been mapped and analysed. The discontinuity sets, slope geometry and rock parameters are presented in **Table Q4**.

(a) Analyse the entire rock slope failure modes using equatorial equal-area net in **Figure Q4(a)(i)** with the criterion are given in **Table Q4(a)(i)**.

(6 marks)

(b) Calculate factor of safety for **all** potential modes of failures by using a formula in **Figure Q4(b)(i)** and **Figure Q4(b)(ii)** when the tension crack is completely filled with water.

(14 marks)

(c) Recommend a new rock slope dip angle to avoid potential any rock slope failure modes and predict the consequences of the recommendation.

(5 marks)

**- END OF QUESTIONS –**

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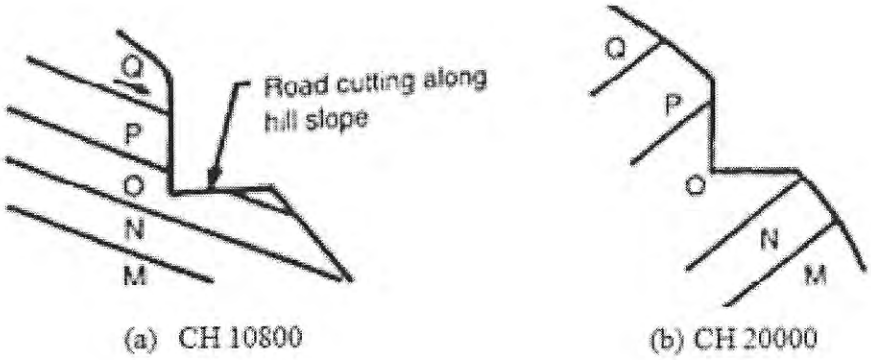


**Figure Q2(d):** Road construction on rock slope

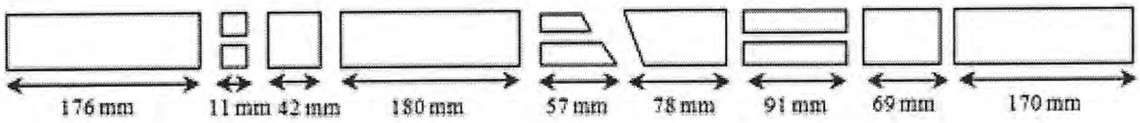


**Figure Q3(a):** Rock core of boring exploration

**Table Q3(c):** Information of samples for point load test

| Parameter | SAMPLE A | SAMPLE B |
|---|---|---|
| Location | Uphill side | Bank upstream |
| Upper width (mm) | 47 | 45 |
| Lower width (mm) | 55 | 60 |
| Diameter (mm) | 56 | 41 |
| Load (kN) | 10.5 | 1.75 |

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**Table Q3(c)(ii)**: Bieniawski 1975 Classification

| No. | Parameters |
|---|---|
| 1) | UCS > 200 MPa, very high strength |
| 2) | UCS 100 – 200 MPa, high strength |
| 3) | UCS 50 – 100 MPa, medium strength |
| 4) | UCS 25 – 50 MPa, low strength |
| 5) | UCS <25 MPa, very low strength |

**Table Q4:** Discontinuity set, slope geometry and rock parameters

| Parameters | Values |
|---|---|
| Joint set 1 | 145°/42° |
| Joint set 2 | 240°/60° |
| Joint set 3 | 340°/40° |
| Slope face dip direction | 160° |
| Slope face angle (slope angle) | 70° |
| Upper slope face dip direction | 160° |
| Upper slope face angle | 0° |
| Height of slope / wedge | 60 m |
| Unit weight of the rock | 25 kN/m$^3$ |
| Depth of tension crack | 2.5 m |
| Unit weight of water | 9.81 kN/m$^3$ |
| The cohesion of all discontinuities | 80 kPa |
| Friction angle for all discontinuities | 30° |
| Inclined angle of anchor ($\Omega$) = ($\psi_T$) | 20° |
| Bars for Y25 | 10 ton = 100 kN |

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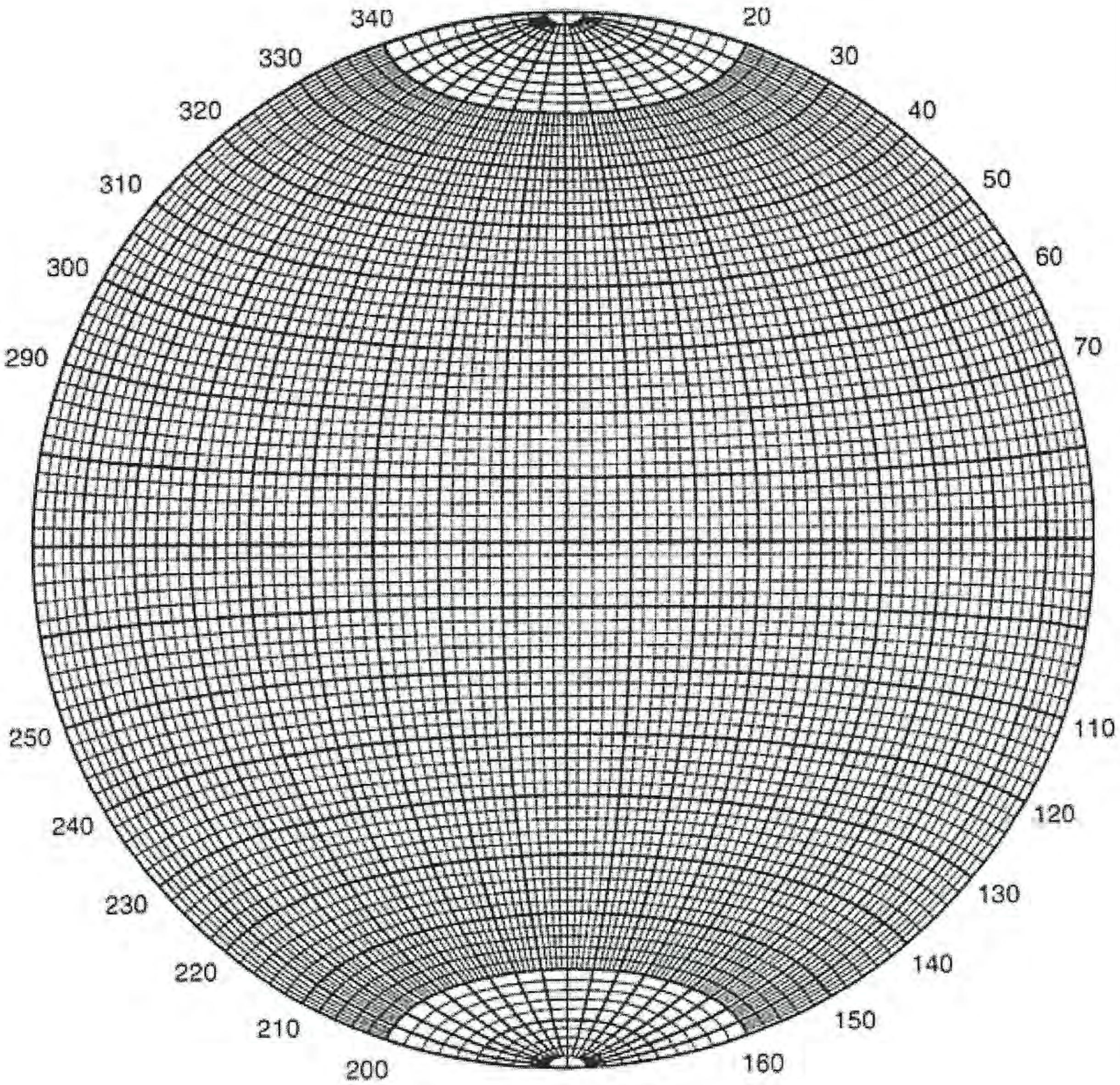


**Figure Q4(a)(i):** Equatorial equal-area stereo-net marked in 2° intervals

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**Table Q4(a)(i):** Rock slope criterion

| **Modes of failure** | **Criteria are met** |
|---|---|
| Circular | i. Very weak material, highly jointed or fractured or weak soil<br>ii. Homogenous soil |
| Planar | i. The dip direction of the joint must be laid within ± $20^0$ from the slope dip direction.<br>ii. $\psi_f > \psi_p > \phi$ (slope angle> plane angle > friction angle)<br>iii. Release surfaces must be present to define the lateral boundaries of the slide. |
| Wedge | i. $\psi_f > \psi_i > \phi$ (slope angle > the intersection angle of 2 joints > friction angle) |
| Toppling | i. The dip direction of the joint must be laid between ±10° in the opposite direction of the slope dip direction.<br>ii. $(90^0 - \psi_f) + \phi \leq \psi_t$ |

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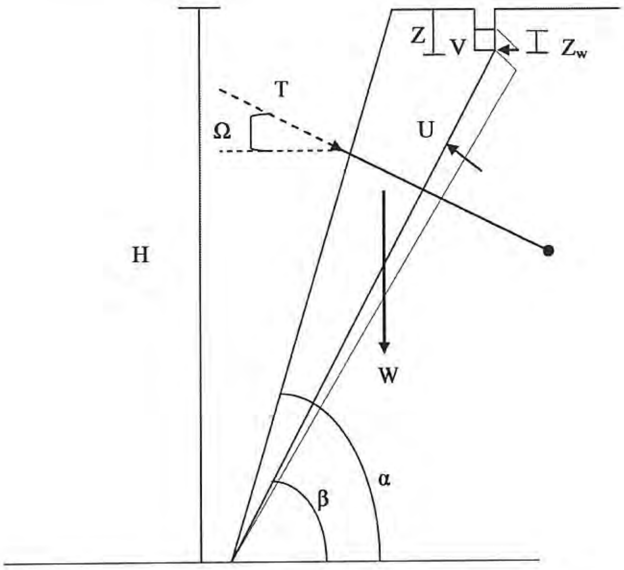


**Given:**

$$\textbf{FOS} = \frac{cA + (W\cos\beta - U - V\sin\beta + T\sin(\Omega+\beta))\tan\phi}{W\sin\beta + V\cos\beta - T\cos(\Omega+\beta)}$$

A= failure plane area
c = cohesion
W = weight of failure block
β =failure plane angle
H = height of plane
T = tension of anchor
$\gamma_r$= unit weight of rock
ϕ = friction angle
U = vertical water pressure
V = horizontal water pressure
α = slope angle
Z = tensional cracks
Ω = inclined angle of anchor
$\gamma_w$= unit weight of water

$A = (H-Z).\text{cosec}\,\beta$

$$W = \tfrac{1}{2}\gamma_r H^2\left[\left(1-\left(\tfrac{Z}{H}\right)^2\right)\cot\beta - \cot\alpha\right]$$

$$U = \tfrac{1}{2}\gamma_w . Z_w . (H-Z).\text{cosec}\,\beta$$

$$V = \tfrac{1}{2}\gamma_w . Z_w^2$$

$$\text{cosec}\beta = \frac{1}{\sin\beta} \quad \sec\beta = \frac{1}{\cos\beta} \quad \cot\beta = \frac{1}{\tan\beta}$$

**Figure Q4(b)(i) :** Planar failure

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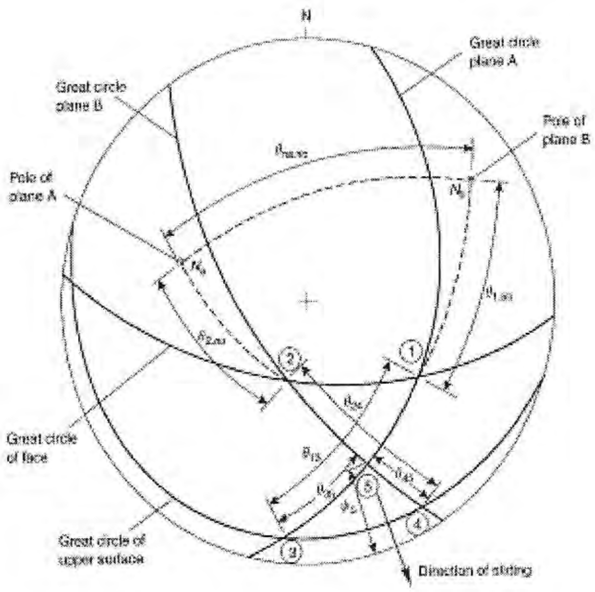


**Given:**

$$Fos = \frac{3}{\gamma H_t}(C_a.X + C_b.Y) + (A - \frac{\gamma_w}{2\gamma}.X)Tan\phi_a + (B - \frac{\gamma_w}{2\gamma}.Y)Tan\phi_b$$

$C_a$ = Cohesion
$H_t$ = height of wedge
$\psi_b$ = dip angle for plane b
$\gamma$ = unit weight of rock
$\phi_b$ = Friction angle
$\psi_a$ = dip angle for plane a
$\psi_5$ = dip angle for wedge intersection
$\gamma_w$ = unit weight of water

X, Y, A, B is factor which depend upon the geometry of wedge

$$X = \frac{Sin\theta_{24}}{Sin\theta_{45}Cos\theta_{2.na}} \quad Y = \frac{Sin\theta_{13}}{Sin\theta_{35}Cos\theta_{1.nb}} \quad A = \frac{Cos\psi_a - Cos\psi_b Cos\theta_{na.nb}}{Sin\psi_5 . Sin^2\theta_{na.nb}}$$

$$B = \frac{Cos\psi_b - Cos\psi_a Cos\theta_{na.nb}}{Sin\psi_5 . Sin^2\theta_{na.nb}}$$

**Figure Q4(b)(ii) :** Wedge failure