UTHM
Universiti Tun Hussein Onn Malaysia

# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## SEMESTER I
## SESSION 2018/2019

| | | |
|---|---|---|
| COURSE NAME | : | GEOTECHNICS II |
| COURSE CODE | : | BFC 34402 |
| PROGRAMME CODE | : | BFF |
| EXAMINATION DATE | : | DECEMBER 2018/ JANUARY 2019 |
| DURATION | : | 2 HOURS AND 30 MINUTES |
| INSTRUCTION | : | 1. ANSWER **ALL** QUESTIONS IN PART A<br>2. ANSWER ANY **TWO (2)** QUESTIONS IN **PART B** |



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

**PART A**

Q1 (a) The term landslide by common usage typically includes slope failures by fall or topple, flow and lateral spreading, and slide or slip.

(i) Describe the main similarities between these different modes of slope failure.
(4 marks)

(ii) Briefly explain the importance of distiguishing flow failures and slip failures.
(6 marks)

(b) Stability of a cut slope is determined by calculating its safety factor against sliding.

(i) Define the term safety factor that is normally used in determining stability of slope.
(4 marks)

(ii) Briefly explain the required soil parameters that are necessary to determine the resisting forces and also the common methods to obtain those parameters for design.
(6 marks)

(c) Potential slip circle of slope can be broadly divided into toe failure and base failure.

(i) Sketch the toe failure and base failure of slope.
(4 marks)

(ii) Predict the dangerous level of toe failure as compared to base failure and justify the prediction.
(4 marks)

(d) An extensive slope of a sandy soil is inclined at an angle of 17°; a hard impermeable layer lies 4 m below and parallel to the slope surface. The properties of the sand are:

$c' = 0$ kN/m$^2$; $\phi' = 32°$; $\gamma = 18$kN/m$^3$ ; $\gamma_{sat} = 20$kN/m$^3$

Determine the factor of safety against movement for the following cases:

(i) Negligible water in the slope
(4 marks)

(ii) Waterlogged slope, with parallel seepage
(4 marks)

(iii) Groundwater level parallel to surface at a depth of 2m, with parallel seepage.
(4 marks)

PART B

**Q2** (a) (i) Velocity of water, V through soil and seepage velocity of water, Vs are related to the permeability of water. Briefly describe the factor that effect the Velocity of water, V and seepage velocity of water, Vs respectively.

(4 marks)

(ii) In most cases, the sheetpile wall is constructed underneath the earth dam with the aim to increase the flow path of water from upstream to downstream.

Briefly describe its necessity and the impact of constructed sheetpile towards the stability of earth dam.

(6 marks)

(b) (i) Briefly explain the main function of flow net analysis.

(2 marks)

(ii) Flow net comprises of equipotential lines and flow lines that intersect each other at right angles.

Describe the function of flow lines and equipotential lines that are used in flow net analysis.

(4 marks)

(c) A dam shown in **Figure Q2** retains 10 m of water. Given that the soil underneath the dam is clay with the following properties:

$k_x = k_y = 3 \times 10^{-3}$ cm/s; specific gravity, S.G. = 2.67; void ratio, e = 0.85

Assume that the soil underneath earth dam is homogeneous and isotropic.

(i) Determine the number of equipotential lines and flow lines

(2 marks)

(ii) Calculate the flow rate under the dam in $m^3$/day/meter run

(2 marks)

(iii) Calculate the pore water pressure at points A, B and C.

(6 marks)

(iv) Determine maximum hydraulic gradient.

(2 marks)

(v) Determine the safety of factor against piping failure.

(2 marks)

**Q3** (a) (i) Describe the lateral earth pressure at rest, active and passive conditions.

(6 marks)

(ii) Briefly explain the differences between 'active Rankine state' and 'passive Rankine state'.

(4 marks)

(b) Retaining wall is a structure constructed to retain the soil. List any **THREE (3)** types of retaining wall.

(3 marks)

(c) The 11m high retaining wall is as shown in **Figure Q3(i)**.

Determine Rankine active force per unit length of the wall together with the location of the resultant force

(4 marks)

(d) A retaining wall as shown in **Figure Q3 (ii)** was designed to withstand a backfill soil of 8 m and the height of soil layer in front of wall is 2 m. The slope is reported to be dry and has a uniformly distributed load of 20kN/m$^2$ on backfill surface. The backfill material is categorized as coarse grained soil and its properties are determined as: unit weight of 20kN/m$^3$ and friction angle $\phi = 38°$. Coefficient of Bottom wall friction($\mu$) is 0.55. Ultimate Bearing capacity is 730kN/m$^2$ and the unit weight of concrete is 24kN/m$^3$.

Determine the followings by using Rankine's earth pressure theory:

(i) Soil active pressure on the wall and location of the resultant active pressure.

(4 marks)

(ii) Soil passive pressure on the wall and location of the resultant passive pressure.

(4 marks)

(iii) Soil active pressure on the wall and location of the resultant active pressure if the water table is found at 2 m below the ground surface.

(4 marks)

(iv) Comment the effect of water table on the resultant active pressure on the wall.

(1 mark)

**Q4** (a) (i) In general, the soil settlement caused by loads is divided into **THREE (3)** broad stages. Explain each stage with the aid of sketches/ diagrams.

(9 marks)

(ii) Discuss any **THREE (3)** factors that may affect the rate of consolidation for a stratum of clay soil.

(6 marks)

(b) **Table Q4** shows the results of laboratory consolidation test. The time and dial gauge readings obtained from an increase of pressure on the specimen from 25 $kN/m^2$ to 50 $kN/m^2$. Using the square root of time method, determine coefficient of consolidation, $C_v$. The average height of the specimen during consolidation was 2.25 cm, and it was drained at the top and bottom.

(15 marks)

**- END OF QUESTIONS-**

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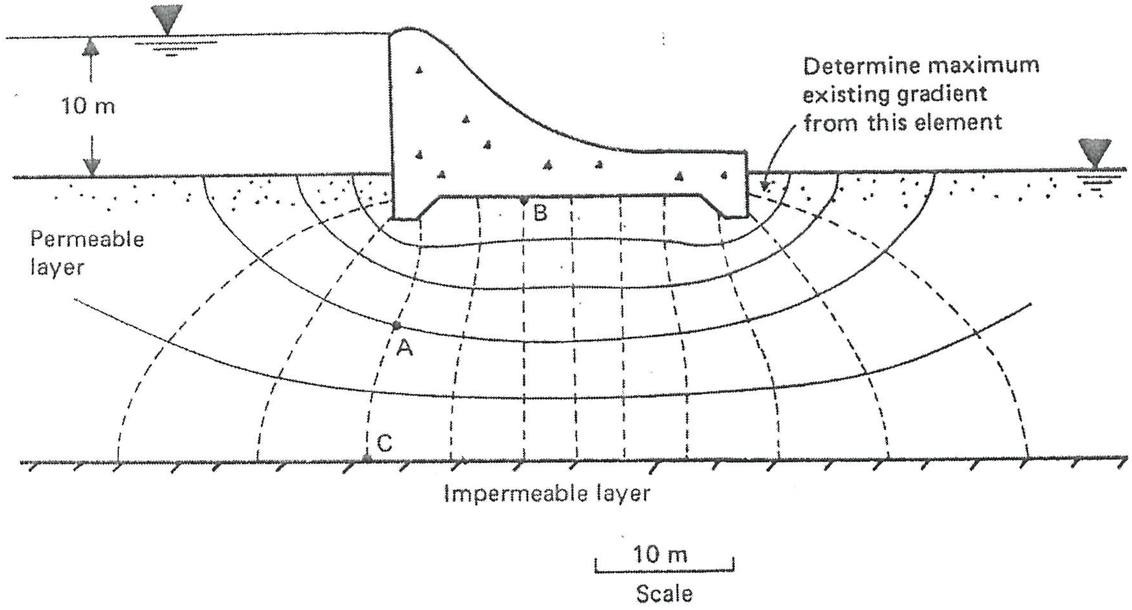


**FIGURE Q2:** Flow net underneath earth retaining wall

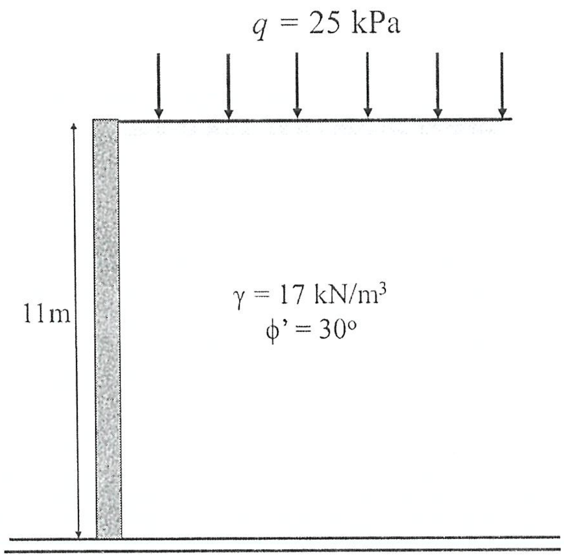


**FIGURE Q3(i):** Retaining wall

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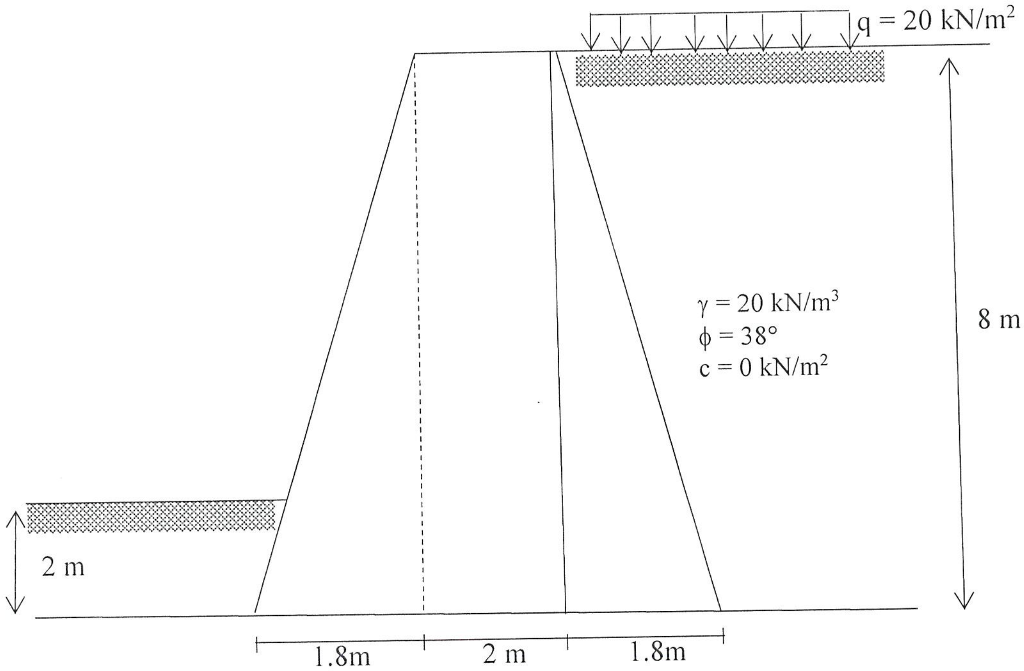


**FIGURE Q3(ii):** A retaining wall

**Table Q4:** Results of laboratory consolidation test

| Time (min) | Dial gauge (cm x $10^4$) | Time (min) | Dial gauge (cm x $10^4$) |
|---|---|---|---|
| 0.0 | 1988 | 16.0 | 2286 |
| 0.1 | 2041 | 30.0 | 2369 |
| 0.3 | 2051 | 60.0 | 2462 |
| 0.5 | 2064 | 120.0 | 2540 |
| 1.0 | 2083 | 240.0 | 2604 |
| 2.0 | 2112 | 480.0 | 2642 |
| 4.0 | 2149 | 960.0 | 2667 |
| 8.0 | 2210 | 1440.0 | 2682 |

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**Flow in Soil**

$q = k \frac{HN_f}{N_d}$ *isotropic soil*

$q = \sqrt{k_x k_z} \frac{H N_f}{N_d}$ *Anisotropic soil*

$i_{max} = \frac{\Delta h}{L}$ ,

Head loss of each potential drop, $\Delta h = \frac{\Delta H}{N_d}$

$$i_{cr} = \frac{G_s - 1}{1 + e_o}$$

**Stress in Soil**

*Conventional retaining walls*

*Rankine active and passive pressure*

$P_a = \frac{1}{2} K_a \gamma_1 H^2$ $\qquad$ $P_a = \frac{1}{2} K_a \gamma_1 H^2 + q K_a H$

$P_v = P_a \sin \alpha°$ $\qquad$ $P_h = P_a \cos \alpha°$

$P_p = \frac{1}{2} K_p \gamma_2 D^2 + 2c_2' \sqrt{K_p} D$

$K_a = \tan^2 (45° - \frac{1}{2}\phi_1')$ $\qquad$ $K_p = \tan^2 (45° + \frac{1}{2}\phi_2')$

*Factor of safety against overturning*

$$FS = \frac{\Sigma W_i X_i}{\Sigma P_{a_i} z_{a_i}} = \frac{\Sigma (A_i \times \gamma_i) X_i}{\Sigma P_{a_i} z_{a_i}}$$

$$FS = \frac{\gamma_{n+i} A_{n+i} x_{n+i} + \text{K} + \gamma_n A_n x_n}{P_a \cos \alpha (H'/3)}$$

*Factor of safety against sliding*

$$FS = \frac{\Sigma V \tan (\frac{2}{3}\phi_2') + \frac{2}{3} B c_2' + P_p}{P_a \cos \alpha}$$

$$z_o = \frac{2c_u}{\gamma}$$

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**Consolidation and Settlement**

$$OCR = \frac{\sigma'_c}{\sigma'_o}$$

$$S_p = H\frac{\Delta e}{1+e_o}$$

$$S_p = \frac{C_c H}{1+e_o}\log\left(\frac{\sigma'_o + \Delta\sigma'}{\sigma'_o}\right)$$

$$S_p = \frac{C_r H}{1+e_o}\log\left(\frac{\sigma'_o + \Delta\sigma'}{\sigma'_o}\right)$$

$$S_p = \frac{C_r H}{1+e_o}\log\left(\frac{\sigma'_c}{\sigma'_o}\right) + \frac{C_c H}{1+e_o}\log\left(\frac{\sigma'_o + \Delta\sigma'}{\sigma'_c}\right)$$

$$T_v = \frac{c_v t}{H_{dr}^2}$$

$$c_v = \frac{0.848 H^2{}_{dr}}{t_{90}}$$

$$m_v = \frac{a_v}{1+e_{av}} = \frac{(\Delta e / \Delta\sigma')}{1+e_{av}}$$

$$T_v = \frac{\pi}{4}U^2{}_{avg} \qquad T_v = \frac{c_v t}{d^2} \qquad T_v = -\,0.933\log(1 - U_{avg}) - 0.085$$

$$U_z = 1 - \frac{u_e}{u_i} \qquad U_z = \frac{\Delta\sigma - u_e}{\Delta\sigma}$$

**Slope Stability**

$$FS = \frac{c_n l_n + \sum_{n=1}^{n=p}(W_n cos\alpha_n - r_u sec\alpha_n)tan\phi_n'}{\sum_{n=1}^{n=p} W_n sin\alpha_n}$$

$$FS = \frac{\sum_{n=1}^{n=p}(c'R\theta + W_n cos\alpha_n tan\phi')}{\sum_{n=1}^{n=p} W_n sin\alpha_n} \qquad FS = \frac{\sum C_u R^2\theta}{\sum W_d}, \theta \text{ in radian}$$