# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## SEMESTER II
## SESSION 2013/2014

| | | |
|---|---|---|
| COURSE NAME | : | GEOTECHNICS II |
| COURSE CODE | : | BFC 34402 |
| PROGRAMME | : | 2 BFF |
| EXAMINATION DATE | : | JUNE 2014 |
| DURATION | : | 2 HOURS |
| INSTRUCTION | : | ANSWER **FOUR (4)** QUESTIONS ONLY |

THIS QUESTION PAPER CONSISTS OF **TEN (10)** PAGES

**Q1** (a) Briefly describe the piping phenomenon under the dam and give **ONE (1)** solution to avoid failures of hydraulic structures due to piping effects.

(5 marks)

(b) A soil stratum with permeability, k = 5 X $10^{-7}$ cm/sec overlies an impermeable stratum as shown in Figure **Q1(b)**. The impermeable stratum lies at a depth of 18 m below the ground surface. A sheet pile wall penetrates 8 m into the permeable soil stratum. Water stands to a height of 9 m on upstream side and 1.5 m on downstream side, above the surface of soil stratum.

i) Determine the quantity of seepage.

(5 marks)

ii) Calculate the seepage pressure head (m) at a point P which is located 8 m below surface of soil stratum and 4 m away from the sheet pile wall on its upstream side.

(7 marks)

iii) Determine the pore water pressure (kPa) at point P.

(3 marks)

iv) Determine the maximum exit gradient when the length ($\Delta l$) of the last element as shown in Figure **Q1(b)** is equal to 3.1 m.

(5 marks)

**Q2** (a) Define the total stress and effective stress concept with the aid of sketches to show the related relationship.

(5 marks)

(b) A total load of 900 kN is uniformly distributed over a rectangular footing of size 3 x 2 m. The plan of a flexible area of pad foundation is shown in Figure **Q2(b)**.

Calculate the following questions using Figure **Q2**. Given $\sigma_z = qI_z$.

i) The vertical stress increment at C' and D' located at depth 2.5 m below the footing.

(10 marks)

ii) If another footing of size 3 x 1 m with a total load of 450 kN is constructed adjoining the previous footing, what is the additional stress at the point C at the same depth due to the construction of the second footing?

(5 marks)

iii) The total vertical stress at depth 2.5 m below point C after the construction of the second footing if the unit weight of soil underneath the foundation is 18 $kN/m^3$.

(5 marks)

**Q3** (a) In general, structures built on soil especially soft soil are subject to settlement. It is important to identify the causes of settlement and predicting the settlement. List **FOUR (4)** possible causes of settlement.

(4 marks)

(b) The data in Table **1** were taken during an oedometer test on saturated clay (drained in both sides) when the applied pressure was increased from 100 kPa to 550 kPa.

Given:
Specific gravity, $G_s$ = 2.73, Final moisture content = 35.9%, and Thickness of the specimen after 1440 min = 11.20 mm.

i) Determine the coefficient of consolidation using Taylor method.

(15 marks)

ii) Determine the value of coefficient of permeability.

(6 marks)

**Q4** (a) Define the terms "pore pressure ratio" and "mobilised angle of friction" and explain their significance in the study of soil slope stability.

(7 marks)

(b) Taylor's Stability numbers for a 1 horizontal to 1 vertical slope are given in Table **2**. A canal 3 m deep, with side slopes of 1 in 1 is excavated in a soil having the following properties;

Cohesion, c = 12 $kN/m^2$
Angle of friction, ø' = 16°
Porosity, n = 40%

Specific gravity, $G_s = 2.70$

Using Taylor's stability numbers provided;

i) Determine the factor of safety when the canal is flowing full and assuming the friction to be fully mobilised.

(8 marks)

ii) Determine the factor of safety on friction, when the canal is suddenly emptied and the factor of safety on friction is considered to be twice that of cohesion.

(10 marks)

**Q5** (a) The consolidation process of a fully saturated clayey soil can best be explained by a model known as piston-spring analogy. Briefly, explains the process by using the piston spring analogy with the aid of sketches.

(5 marks)

(b) A soil profile is shown in Figure **Q5(b)**. The uniformly distributed load $\Delta\sigma$ is applied at the ground surface resulted in additional stress at top clay layer.

Given:
Pre-consolidation stress, $\sigma_c$ for the clay layer = 125 kN/m$^2$.
$C_s = 0.06$.

i) Calculate and draw the distribution with depth of the total vertical stress, effective vertical stress and the pore water pressure.

(10 marks)

ii) Determine the settlement of the clay layer caused by primary consolidation.

(10 marks)

**- END OF QUESTION -**

**FINAL EXAMINATION**

SEMESTER/SESSION: SEM II/2013/2014 PROGRAMME : 2 BFF
COURSE NAME : GEOTECHNICS II COURSE CODE: BFC 34402

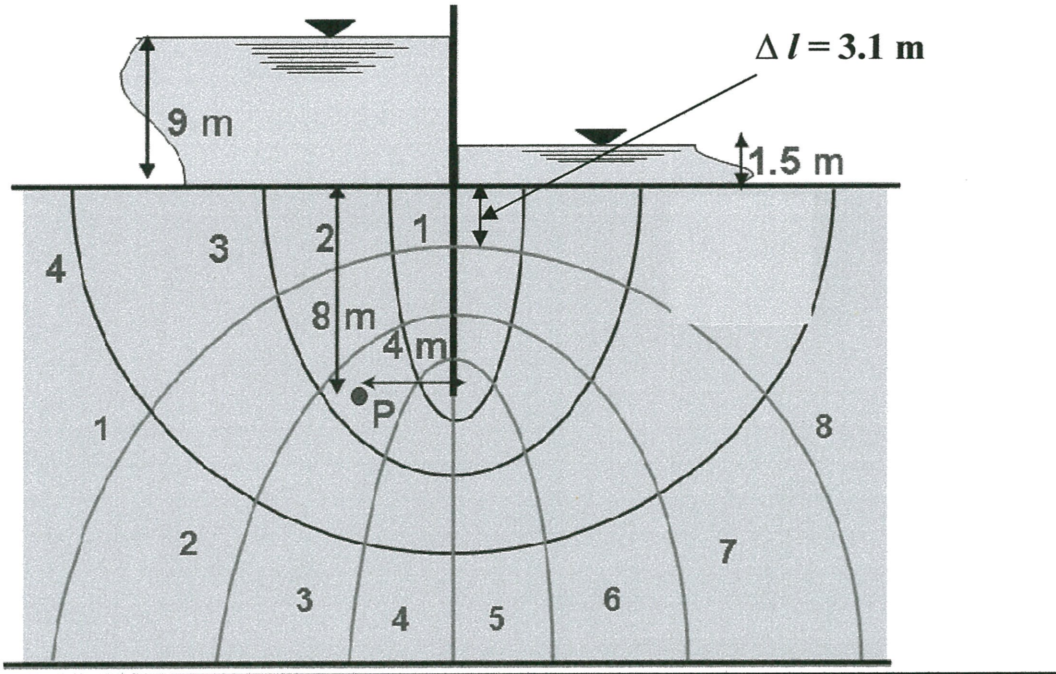


**FIGURE Q1(b)**

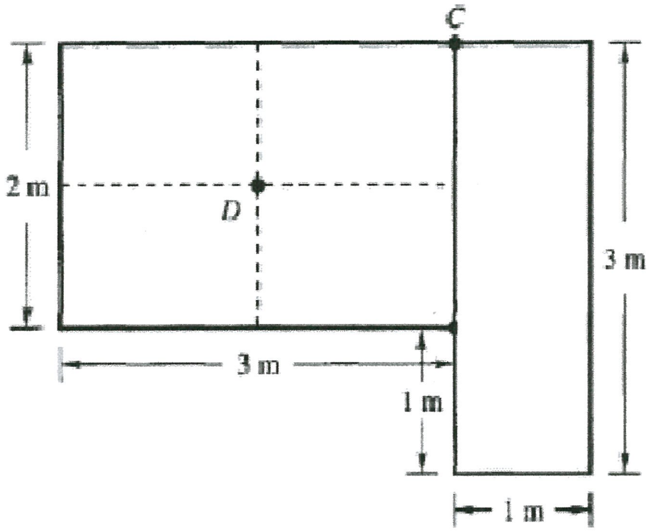


**FIGURE Q2(c)**

**FINAL EXAMINATION**

SEMESTER/SESSION: SEM II/2013/2014 PROGRAMME : 2 BFF
COURSE NAME : GEOTECHNICS II COURSE CODE: BFC 34402

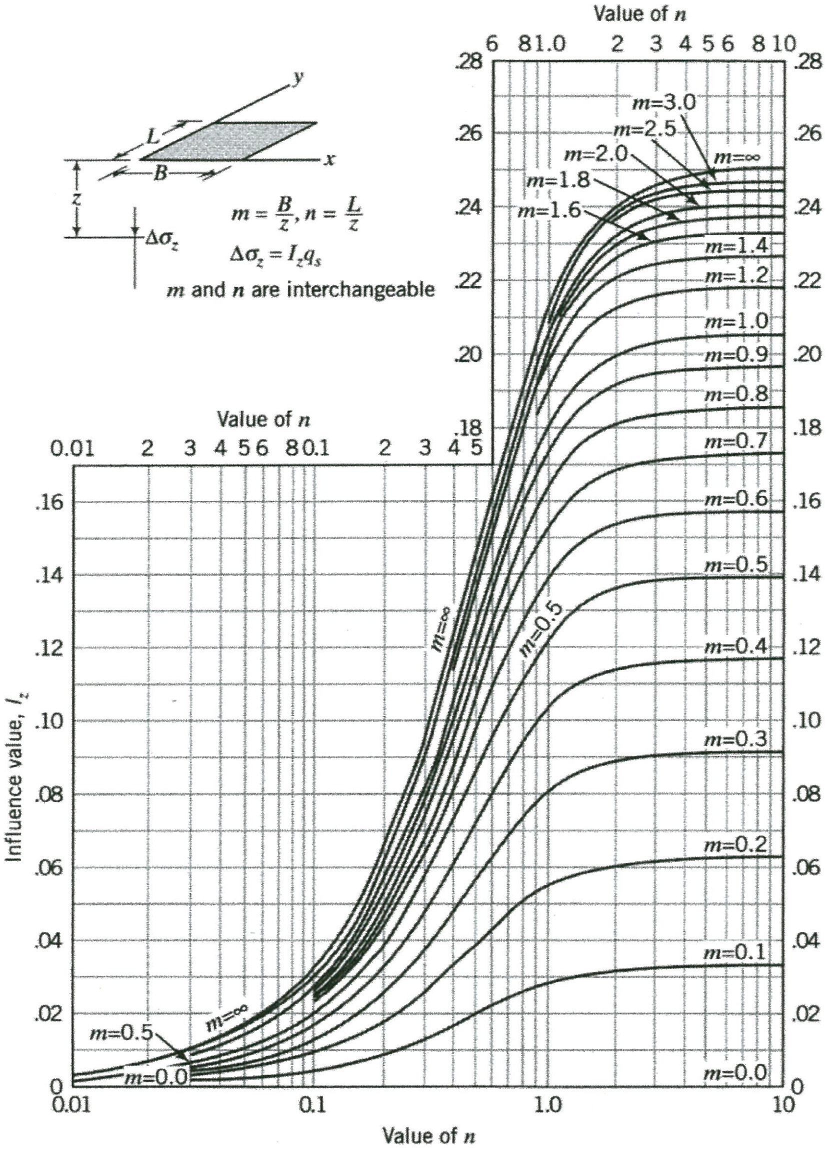


**FIGURE Q2**: The variation of $I_z$ with m and n

**FINAL EXAMINATION**

SEMESTER/SESSION: SEM II/2013/2014 PROGRAMME : 2 BFF
COURSE NAME : GEOTECHNICS II COURSE CODE: BFC 34402

**TABLE 1**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Time (min) | 0 | 0.25 | 0.5 | 1 | 2.25 | 4 | 9 | 16 |
| Gauge (mm) | 5.00 | 4.67 | 4.62 | 4.53 | 4.41 | 4.28 | 4.01 | 3.75 |
| Time (min) | 36 | 49 | 64 | 81 | 100 | 200 | 400 | 1440 |
| Gauge (mm) | 3.28 | 3.15 | 3.06 | 3.00 | 2.96 | 2.84 | 2.76 | 2.61 |

**TABLE 2**

| | | | | | |
|---|---|---|---|---|---|
| Angle of friction, ø' (°) | 0 | 5 | 10 | 15 | 20 |
| Stability Number, m | 0.181 | 0.136 | 0.108 | 0.083 | 0.062 |

**FINAL EXAMINATION**

SEMESTER/SESSION: SEM II/2013/2014 PROGRAMME : 2 BFF
COURSE NAME : GEOTECHNICS II COURSE CODE: BFC 34402

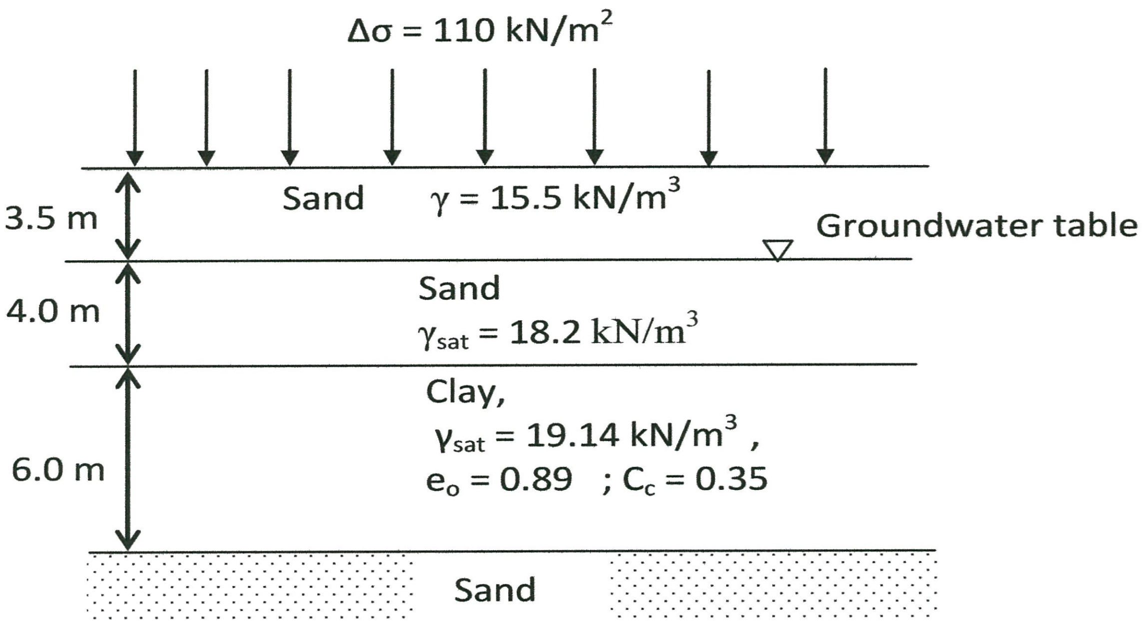


**FIGURE Q5(b)**

**FINAL EXAMINATION**

SEMESTER/SESSION: SEM II/2013/2014 PROGRAMME : 2 BFF
COURSE NAME : GEOTECHNICS II COURSE CODE: BFC 34402

## FORMULAE

### LATERAL EARTH PRESSURE

$$k_o = 1 - \sin\phi'$$

$$k_o = 0.95 - \sin\phi'$$

$$k_{o(overconsolidated)} = k_{o(normally\ consolidated)}\sqrt{OCR}$$

$$P_o = qk_oH + \frac{1}{2}\gamma H^2 k_o$$

$$P_a = \frac{1}{2}\gamma H^2 k_a - 2c'H\sqrt{k_a}$$

$$z_c = \frac{2c'}{\gamma\sqrt{k_a}}$$

$$P_a = \frac{1}{2}\left(H - \frac{2c'}{\gamma\sqrt{k_a}}\right)\left(\gamma H^2 k_a - 2c'H\sqrt{k_a}\right)$$

$$k_a = \tan^2\left(45^\circ - \frac{\phi}{2}\right) = \frac{1-\sin\phi}{1+\sin\phi}$$

$$k_a = \cos\alpha\frac{\cos\alpha - \sqrt{\cos^2\alpha - \cos^2\phi'}}{\cos\alpha + \sqrt{\cos^2\alpha - \cos^2\phi'}}$$

$$k_a = \frac{\sin^2(\beta+\phi')}{\sin^2\beta\sin(\beta-\delta')\left[1+\sqrt{\frac{\sin(\phi'+\delta')\sin(\phi'-\alpha)}{\sin(\beta-\delta')\sin(\alpha+\beta)}}\right]^2}$$

$$k_p = \tan^2\left(45^\circ + \frac{\phi}{2}\right) = \frac{1+\sin\phi}{1-\sin\phi} = \frac{1}{k_a}$$

$$k_p = \cos\alpha\frac{\cos\alpha + \sqrt{\cos^2\alpha - \cos^2\phi'}}{\cos\alpha - \sqrt{\cos^2\alpha - \cos^2\phi'}}$$

$$k_p = \frac{\sin^2(\beta-\phi')}{\sin^2\beta\sin(\beta+\delta')\left[1-\sqrt{\frac{\sin(\phi'+\delta')\sin(\phi'+\alpha)}{\sin(\beta+\delta')\sin(\alpha+\beta)}}\right]^2}$$

**FINAL EXAMINATION**

SEMESTER/SESSION: SEM II/2013/2014 PROGRAMME : 2 BFF
COURSE NAME : GEOTECHNICS II COURSE CODE: BFC 34402

**FORMULAE**

**CONSOLIDATION**

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

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

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

$$e_f = wG_s$$

$$e_o = e_f + \Delta e$$

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

$$m_v = \frac{1}{1+e_o}\times\frac{e_o-e_f}{\sigma_f-\sigma_o}$$

$$k = c_v m_v \gamma_w$$

$$T_v = \frac{c_v t}{H_c^2}$$

For U%: 0% to 60%;

$$T_v = \frac{\pi}{4}\left(\frac{U\%}{100}\right)^2$$

For U% > 60%;

$$T_v = 1.781 - 0.931\log(100-U\%)$$