UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	GEOTECHNICAL ENGINEERING
COURSE CODE	:	DAC 22103
PROGRAMME CODE	:	DAA
EXAMINATION DATE	:	JULY / AUGUST 2023
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER **ALL** QUESTIONS FROM SECTION A AND **TWO (2)** QUESTIONS FROM SECTION B. 2.THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK.** 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA **CLOSED BOOK**

THIS QUESTION PAPER CONSISTS OF **TWELVE (12)** PAGES

SECTION A (60 MARKS)

Q1 (a) A saturated soil has a dry unit of 16.19kN/m^3. Its moisture content is 25%. Calculate the saturated unit weight.

(2 marks)

(b) The moist unit weight and degree of saturation of a soil are given in **Table Q1(b).**

Table Q1(b)

Sample	γ (kN/m^3)	S (%)
A	16.72	49
B	18.00	76

Determine for sample A and B:

(i) Void ratio

(4 marks)

(ii) Specific gravity

(1 marks)

(iii) Percentage of air void

(3 marks)

Q2 (a) List **three (3)** general factors that affect the design and size of foundations.

(3 marks)

(b) A circular water tank will be built on the surface of the ground in redevelopment project located at Bandar Saujana, Johor. The load of the water tank together with the raft foundation under it has a load of 500 kN/m^2 as shown in **Figure Q2(b)** The radius of the circular tank and base is 4.2 m.

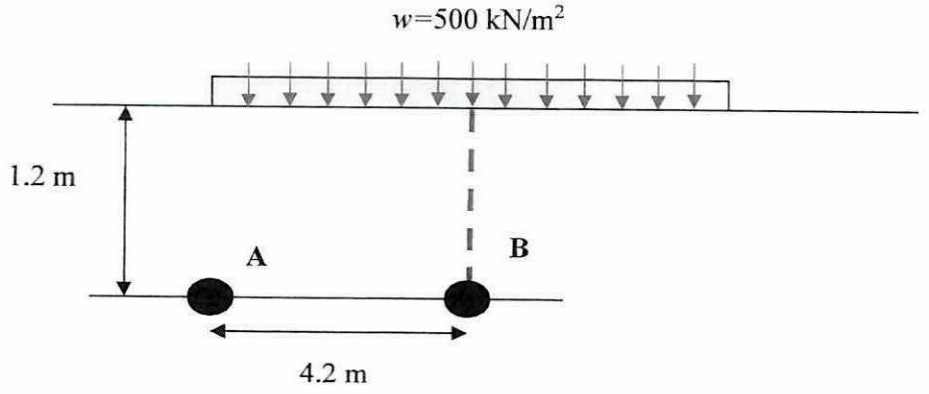

Figure Q2(b)

Evaluate the vertical stress increase at the position of the two old pipes marked with circles at A and B. Use **Table Q2(b)** to find the related parameter.

(7 marks)

Q3 (a) State **two (2)** factors that influence the flow rate of water in soil.

(2 marks)

(b) A permeability test is conducted for sand type of soil. The following data obtained:

Length of specimen	= 25 mm
Diameter of specimen	= 64 mm
Head difference	= 456 mm
Water collected in 2 min	= 0.51 cm^3
Void ratio of the soil specimen	= 0.44

(i) Name the type of the permeability test.

(1 mark)

(ii) Calculate the hydraulic conductivity, k, for this test (cm/min).

(3 marks)

(iii) Determine the discharge velocity, v (cm/min).

(2 marks)

(iv) Calculate the actual velocity, V_{actual} (cm/min).

(2 marks)

Q4 (a) Describe the condition of normally consolidated clay and over consolidated clay.

(2 marks)

(b) The time for 50% consolidation of a 20 mm thick and 75 mm diameter sample taken from a 10 m clay layer thick in the laboratory is 15 min.

(i) If the clay layer in field has the same drainage condition as the laboratory sample which is drainage at the upper and lower boundaries, calculate the time taken by 10 m clay layer to achieve 50% consolidation.

(4 marks)

(ii) If the drainage existed on only one boundary, calculate the time taken by 10 m clay layer to achieve 90% consolidation.

(4 marks)

Q5 (a) List **three (3)** laboratory testing to obtain the shear strength parameter of soil.

(3 marks)

(b) Describe the unconfined compression test with an aid of a diagram.

(6 marks)

(c) The readings given in **Table Q5(c)** were taken during shear box tests on samples of sand compacted to the same density. The shear surface measured 60 mm x 60 mm.

Table Q5(c)

No	Normal Load (N)	Shear Load at Failure (N)
1.	110	61
2.	230	128
3.	350	198

(i) Find normal stress and shear stress at failure in kN/m^2.

(6 marks)

(ii) Determine the apparent cohesion and angle of friction for the soil.

(5 marks)

If the Safety Factor (FS) is 3, calculate:

(i) Ultimate bearing capacity (q_{ult})

(6 marks)

(ii) Allowable bearing capacity (q_{all})

(2 marks)

(iii) Allowable gross load (Q_{all})

(2 marks)

Q7 (a) Describe the method to conduct the pile load test with an aid of a diagram.

(4 marks)

(b) A 12 m long concrete pile with the diameter of 0.32 m is fully driven at a site as in **Figure Q7(b).** Calculate the design capacity of the pile with a safety factor of 2. The value of N*q for pile in sand as shown in **Figure Q7.**

Note: Sketching of the Pv diagram is needed.

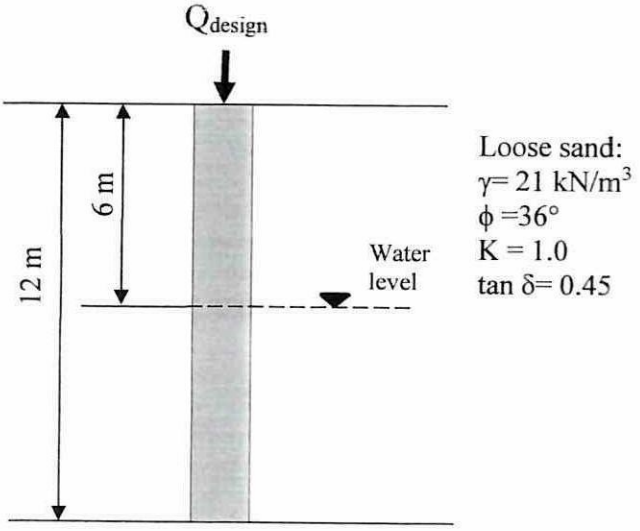

Figure Q7(b)

(10 marks)

(c) A concrete pile with a diameter of 0.45 m was driven into 12 m layered clay soil. The detail of the clay layers is as below:

Depth 0 to 3 m	:	$\gamma = 18.5$ kN/m^3 and $q_u = 120$ kN/m^2
Depth 3 m to 7 m	:	$\gamma = 20.5$ kN/m^3 and $q_u = 140$ kN/m^2
Depth 7 m to 12 m	:	$\gamma = 21.0$ kN/m^3 and $q_u = 160$ kN/m^2

Refer **Figure Q7(c)** for the value of α. The ground water level can be neglected.

Calculate the ultimate pile load, $Q_{ultimate}$

(6 marks)

Q8 (a) List **four (4)** steps to analyze the stability of retaining wall.

(4 marks)

(b) The 8-m high retaining wall is shown in **Figure Q8(b)**

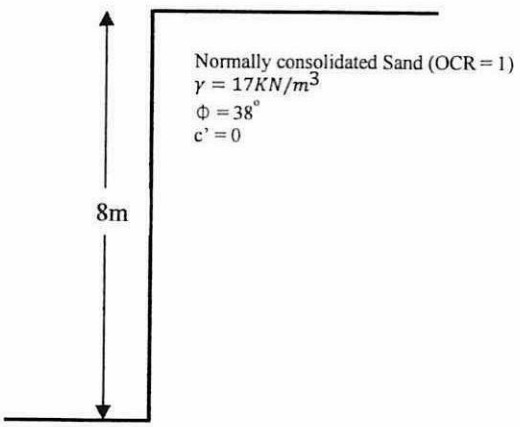

Figure Q8(b)

Calculate:

(i) Rankine active force per unit length of the wall and the location of the resultant using pressure distribution diagram.

(4 marks)

(ii) Rankine passive force per unit length of the wall and the location of the resultant using pressure distribution diagram.

(4 marks)

(c) The retaining wall shown in **Figure Q8(c)** is made from concrete with unit weight of 24 kN/m^3. The angle of the backfill material is 13^0. The retaining wall is to support a deposit of granular soil that has the following properties.

$\gamma = 18kN/m^3$
$\acute{\Phi} = 30°$
c = 0
Coefficient of base friction, $\mu = 0.55$
Foundation soil's ultimate bearing capacity = 622 kN/m^2.

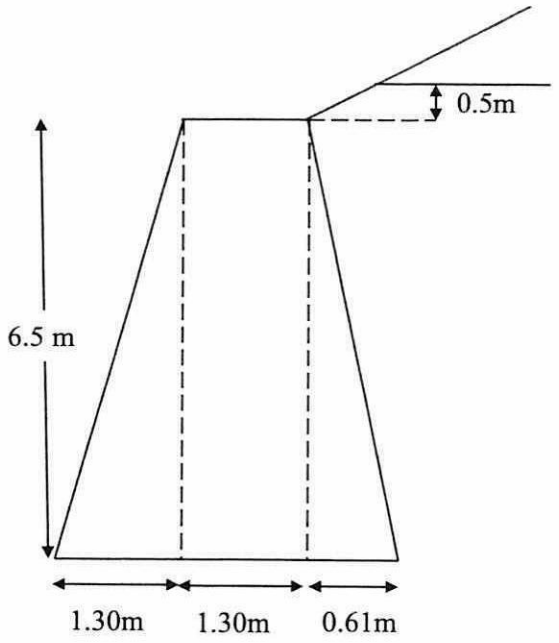

Figure Q8(c)

(i) Determine P_a, $P_{a(h)}$, and $P_{a(v)}$ (6 marks)

(ii) Determine overturning moment, M_0. (2 marks)

- END OF QUESTIONS –

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Table Q2(b): Influence coefficient for points under uniformly loaded circular area.

(Spangler and Handy, 1973)

	r/a									
z/a	*0*	*0.25*	*0.50*	*1.0*	*1.5*	*2.0*	*2.5*	*3.0*	*3.5*	*4.0*
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*
0.25	0.986	0.983	0.964	0.460	0.015	0.002	0.000	0.000	0.000	0.000
0.50	0.911	0.895	0.840	0.418	0.060	0.010	0.003	0.000	0.000	0.000
0.75	0.784	0.762	0.691	0.374	0.105	0.025	0.010	0.002	0.000	0.000
1.00	0.646	0.625	0.560	0.335	0.125	0.043	0.016	0.007	0.003	0.000
1.25	0.524	0.508	0.455	0.295	0.135	0.057	0.023	0.010	0.005	0.001
1.50	0.424	0.413	0.374	0.256	0.137	0.064	0.029	0.013	0.007	0.002
1.75	0.346	0.336	0.309	0.223	0.135	0.071	0.037	0.018	0.009	0.004
2.00	0.284	0.277	0.258	0.194	0.127	0.073	0.041	0.022	0.012	0.006
2.5	0.200	0.196	0.186	0.150	0.109	0.073	0.044	0.028	0.017	0.011
3.0	0.146	0.143	0.137	0.117	0.091	0.066	0.045	0.031	0.022	0.015
4.0	0.087	0.086	0.083	0.076	0.061	0.052	0.041	0.031	0.024	0.018
5.0	0.057	0.057	0.056	0.052	0.045	0.039	0.033	0.027	0.022	0.018
7.0	0.030	0.030	0.029	0.028	0.026	0.024	0.021	0.019	0.016	0.015
10.00	0.015	0.015	0.014	0.014	0.013	0.013	0.013	0.012	0.012	0.011

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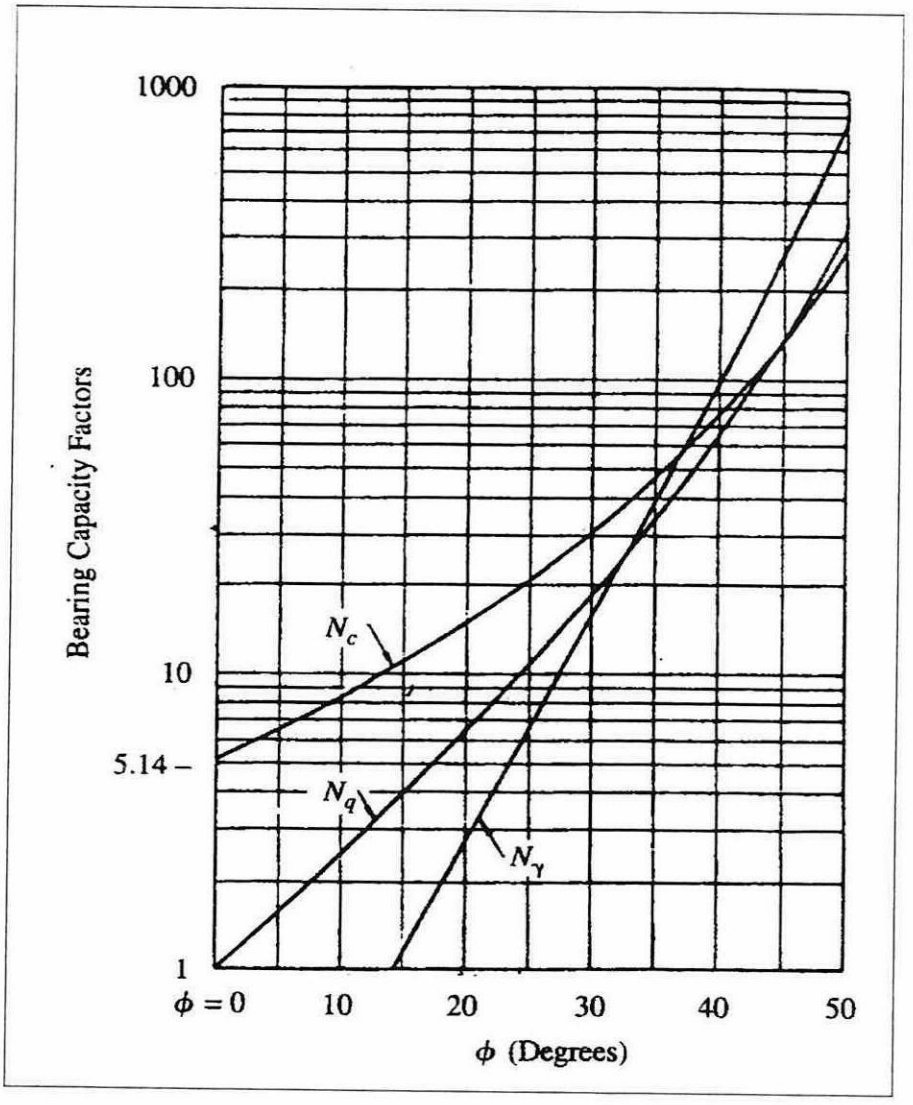

Figure Q6: Chart of Terzaghi's bearing capacit factors and angle of internal friction, ∅

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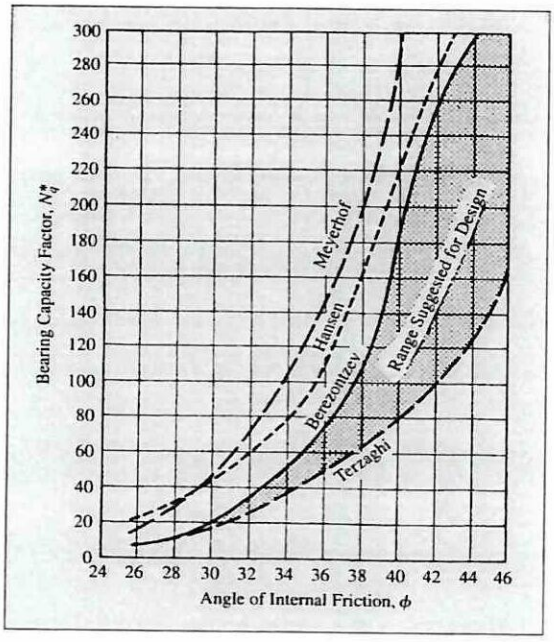

Figure Q7

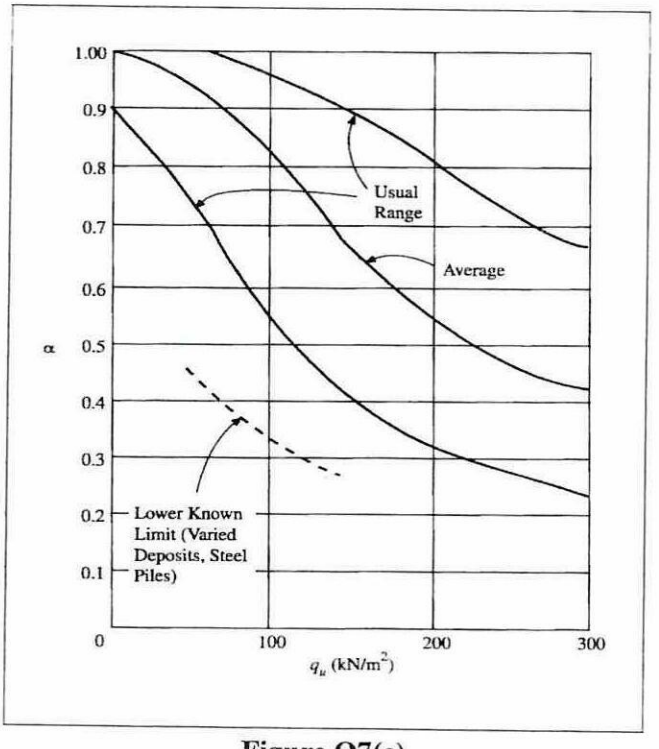

Figure Q7(c)

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FORMULA:

$\rho = [(Gs + Se)\,\gamma_w] / (1 + e)$

$Av = e(1+S) / (1 + e)$

$$cos\beta\ x\left(\frac{cos\beta - \sqrt{(\cos^2\beta - \cos^2\emptyset)}}{cos\beta + \sqrt{(\cos^2\beta - \cos^2\emptyset)}}\right)$$

$\sigma' = K_a\,\sigma_a' = K_a\gamma z \qquad \sigma' = K_p\,\sigma_p' = K_p\gamma z$

v = ki. v= volume/time/area

k = (QL)/ Aht

$V_{actual} = (v(1+e)) /e$

$T_{90} = C_v t_{90} / H^2 dr$

$T5_0 = C_v t_{50} / H^2 dr$

$C_v = T_v H^2/t$

$P = Iw$

$$\sigma' = \frac{N}{A} \qquad s = \frac{R}{A}$$

$q_{ult} = 1.2\ c'N'c + \gamma_1'\ Df\,N'q + 0.4\gamma_2'BN'\gamma$ *(square)*

$$c' = \frac{2}{3}c$$

$$\phi' = \tan^{-1}\left(\frac{2}{3}\tan\phi\right)$$

$q_{ult} = 1.2\ cNc + \gamma_1\ Df\,Nq + 0.6\gamma_2 BN\gamma$ *(circular)*

$$q_{all} = \frac{q_{ult}}{FS}$$

$$c = \frac{q_u}{2}$$

$Q_{all} = q_{all}$ x A

Area of circle = πr^2