UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2018/2019

COURSE NAME	:	SOIL MECHANICS AND FOUNDATION
COURSE CODE	:	BNP 20903
PROGRAMME CODE	:	BNA/BNB/BNC
EXAMINATION DATE	:	JUNE / JULY 2019
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

Q1 (a) Terzaghi (1943) developed bearing capacity analysis based on Prandtl (1920) failure mechanism and the limit equilibrium method for a footing at a depth D_f below the ground level. Explain the assumptions made in it.

(6 marks)

(b) Soils are stable if the stress level is maintained or groundwater remains constant. However, when stresses applied in soil mass are changed, it deforms and causes settlement and consolidation in some instances. Justify the differences between immediate settlement and consolidation.

(4 marks)

(c) A square concrete footing 1.8 x 1.8 m with a 0.4 x 0.4 m square column is constructed at a depth of 2 m in a stiff clay as illustrated in **Figure Q1(c)**. It is loaded with an axial load of 900 kN and $M_x = M_y = 0$. Unconfined compressive strength (UCS) test give q_u = 120 kN/m^2. Assume the soil unit weight is 18 kN/m^3 and concrete unit weight is 24 kN/m^3.

Also given:

$$q_{act} = \frac{Q}{A} \pm M_y \pm M_x, \quad q_{ult} = 1.3cN_c + qN_q + 0.4\gamma BN_\gamma \text{ and } S.F = \frac{q_{ult}}{q_{act}}$$

(i) Determine the actual soil pressure q_{act}.

(5 marks)

(ii) Determine the ultimate bearing capacity (q_{ult}). Given bearing capacity factor are; $N_c = 5.14$, $N_q = 1$ and $N_\gamma = 0$.

(3 marks)

(iii) Determine the factor of safety.

(2 marks)

(d) A soil profile is shown in **Figure Q1(d)(i)**. Laboratory consolidation tests were conducted on a specimen collected from the middle of the clay layer. The field consolidation curve interpolated from the laboratory test results is shown in **Figure Q1(d)(ii)**. Estimate the settlement in the field caused by primary consolidation for a surcharge of 48 kN/m^2 applied at the ground surface.

Also given:

$$\sigma_o = \gamma D \quad \text{and} \quad S_c = \frac{\Delta e}{1 + e_0} H$$

(5 marks)

Q2 (a) Mega Properties Sdn. Bhd. proposed to develop a 5 storey shopping mall in Johor town. This area underlying with 10 m depth of clayey silts of very high water content. As a engineering technologist in-charge of the project, propose a suitable foundation with **TWO (2)** valid reasons. Assumption can be made to suit with the project and site conditions.

(5 marks)

(b) Describe with the aid of appropriate sketches **FOUR (4)** mechanisms of soil resisting stress for deep foundation.

(8 marks)

(c) Assess the suitability of **TWO (2)** earth dam designs by relating to the availability of suitable materials using labelled sketches.

(4 marks)

(d) A 30 m long of precast pile with 0.45 x 0.45 m in cross section fully embedded in a clayey soil layer as shown in **Figure Q2(d)**. Distinguish the contribution of end bearing and skin friction to the ultimate bearing capacity Q_{ult} of the pile. Assume c_u at pile tip is 200 kN/m^2 and given N_c is 11. **Table Q2(d)** shows the variation of α value for skin friction.

Also given:

$Q_p = N_c c_u A_p$ and $Q_s = \sum fp\Delta L$; $f = \alpha c_u$

(8 marks)

Q3 (a) Existing soil in a particular area is not always suitable to support structure constructed over them. Stabilisation work may be necessary to ensure a safe construction process. Classify **FOUR (4)** factors influencing the selection of ground improvement techniques.

(4 marks)

(b) Ground freezing is a process to strengthen and impermeabilize soils by continuously refrigerating the soil. Briefly investigate what happens when the ice thaws or unfreeze non-uniformly around a deep shaft.

(4 marks)

(c) Sketch and explain in detail on how preloading and vertical drains work to accelerate the consolidation settlement of clayey soil.

(6 marks)

(d) Dynamic compaction is a ground improvement technique for compaction and strengthening of a loose or weak soils. Differentiate the mechanisms taking place in cohesionless and cohesive soils.

(4 marks)

(e) Vacuum consolidation is an effective means for improvement of saturated soft ground. Construct a general workflow for vacuum consolidation.

(7 marks)

Q4 (a) Subsurface contamination occurs when organic and inorganic contaminants are transported by leachate or liquid waste into the unsaturated soil layer by gravity flow.

(i) With the aid of a diagram, classify **FOUR (4)** sources of contaminants.
(4 marks)

(ii) Briefly assess how subsurface contamination affects the groundwater quality.
(3 marks)

(b) Monitoring wells are used to check a subsurface contamination at the site to ensure early detection of seepage or leakage if it does occur. Illustrate how monitoring wells are installed around a waste disposal site.
(6 marks)

(c) The upstream method of raising the embankment is used most often since it is the most economical methods. Apart from the location, discuss **THREE (3)** other important factors in the design of embankment raised in stages.
(6 marks)

(d) Teguh Landfill Sdn. Bhd. plan to construct a new sanitary landfill site at Muar, Johor. You are required to propose **THREE (3)** main components to be in landfill design to prevent contamination of surrounding grounds.
(6 marks)

-END OF QUESTIONS –

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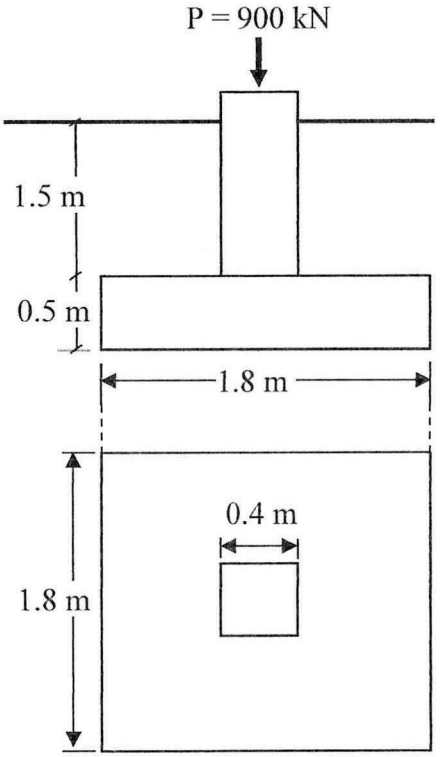

Figure Q1(c): A square footing with an axial load

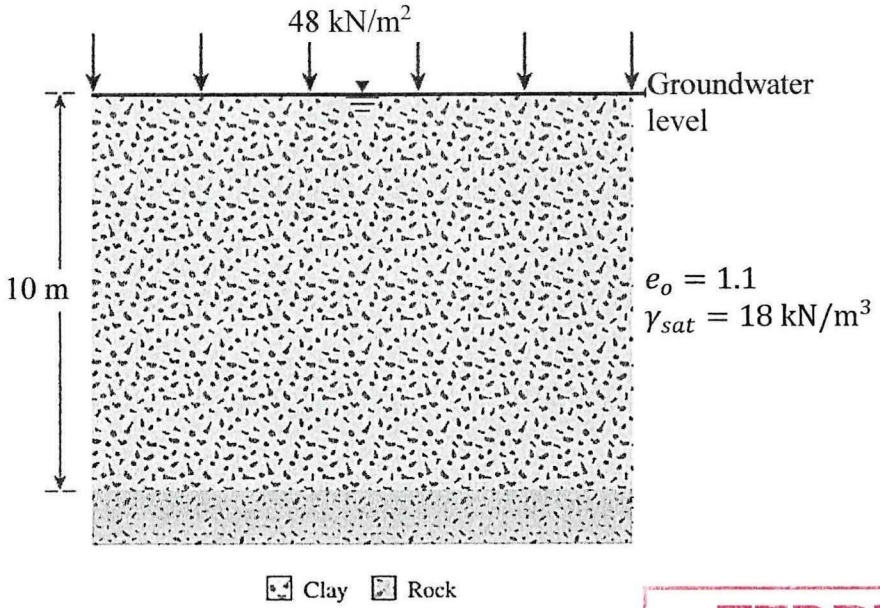

Figure Q1(d)(i): Soil profile

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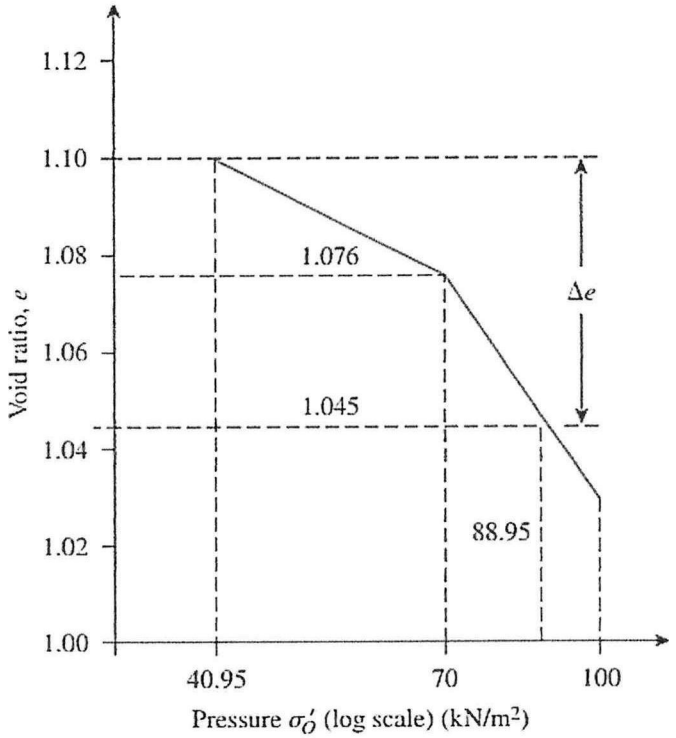

Figure Q1(d)(ii): Field consolidation curve

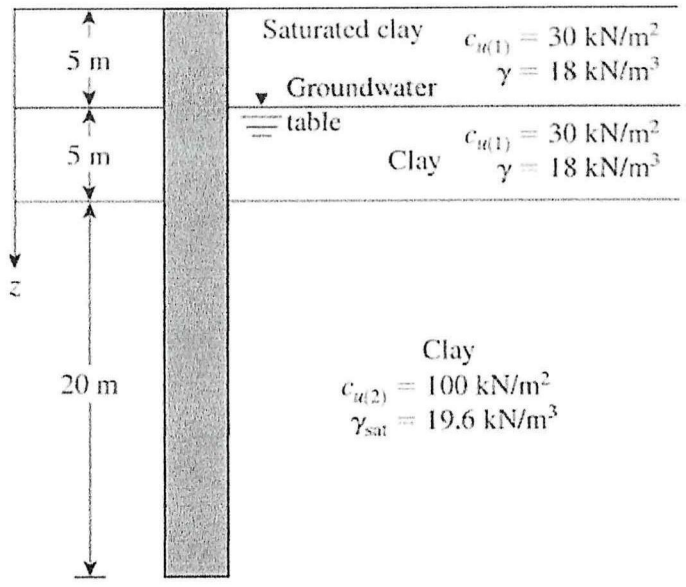

Figure Q2(d): Pile in clayey soil

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Table Q2(d): Variation of α value

$\frac{c_u}{p_a}$	α
≤ 0.1	1.00
0.2	0.92
0.3	0.82
0.4	0.74
0.6	0.62
0.8	0.54
1.0	0.48
1.2	0.42
1.4	0.40
1.6	0.38
1.8	0.36
2.0	0.35
2.4	0.34
2.8	0.34

Note: p_a = atmospheric pressure
≈ 100 kN/m^2 or 2000 lb/ft^2