114CE02

國立臺北科技大學 114 學年度碩士班招生考試

系所組別：3120 土木工程系土木與防災碩士班乙組

第一節　土壤力學　試題

注意事項：

1. 本試題共 5 題，每題 20 分，共 100 分。
2. 不必抄題，作答時請將試題題號及答案依照順序寫在答案卷上。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

1. Fundamental Properties of Soil (20 points)

A soil sample has a bulk unit weight (γ) of 18.5 kN/m^3 and a water content (w) of 12%. The specific gravity of the soil solids (G_s) is 2.65.

(1) Calculate the void ratio (e) of the soil. (10 points)

(2) Determine the degree of saturation (S_r). (10 points)

Use the equations:

$$\gamma = \frac{(1+w)G_s\gamma_w}{1+e}, \quad S_r = \frac{wG_s}{e}$$

where γ_w is the unit weight of water.

2. Permeability of a Multilayered Soil (20 points)

A foundation is underlain by three soil layers with the following properties:

- **Layer 1:** $k_1 = 3.0 \times 10^{-5}$ m/s, $H_1 = 2$ m
- **Layer 2:** $k_2 = 1.5 \times 10^{-5}$ m/s, $H_2 = 3$ m
- **Layer 3:** $k_3 = 2.0 \times 10^{-5}$ m/s, $H_3 = 1$ m

(1) Calculate the equivalent hydraulic conductivity (k_{eq}) for **vertical** flow through the multilayered soil system. (10 points)

$$k_{eq} = \frac{H_1 + H_2 + H_3}{\frac{H_1}{k_1} + \frac{H_2}{k_2} + \frac{H_3}{k_3}}$$

(2) Calculate the equivalent hydraulic conductivity (k_{eq}) for **horizontal** flow through the multilayered soil system. (10 points)

3. Stress Beneath a Circular Foundation (20 points)

A circular foundation with a radius of 3 m applies a uniform load of 200 kPa. The depth of interest is 5 m below the center of the foundation.

(1) Calculate the stress due to the self-weight of the soil, where γ is 18 kN/m^3. (10 points)

(2) Determine the stress increase due to the load: (10 points)

$$\Delta\sigma_z = q\left[1 - \frac{1}{\left(\left(\frac{R}{z}\right)^2 + 1\right)^{3/2}}\right]$$

where:

- q is the uniform load applied at the surface,
- R is the radius of the circular foundation,
- z is the depth below the foundation.

4. Consolidation Settlement and Time Analysis (20 points)

A clay layer is 3 m thick, with an initial void ratio (e_0) of 0.8, a compression index (C_c) of 0.25, and a coefficient of consolidation (C_v) of 2.5×10^{-7} m^2/s. The effective stress increases from 50 kPa to 150 kPa. Assume two-way drainage for the clay layer.

(1) Calculate the expected settlement (ΔH). (10 points)

$$\Delta H = H\frac{C_c}{1+e_0}\log\frac{\sigma_2}{\sigma_1}$$

注意：背面尚有試題

(2) Determine the time required to achieve 50% consolidation (t_{50}). (10 points)

$$t_{50} = \frac{T_{50} H_d^2}{C_v}$$

where $T_{50} = 0.197$ (dimensionless time factor for 50% consolidation). Note that you must determine the appropriate drainage path length (H_d) based on two-way drainage conditions.

5. Shear Strength and Failure Plane Analysis (20 points)

A soil sample is tested under triaxial conditions, where the maximum principal stress (σ_1') is 400 kPa and the minimum principal stress (σ_3') is 100 kPa. The soil's internal friction angle (ϕ') is 30°.

(1) Determine the effective cohesion (c') using the Mohr-Coulomb failure criterion. (10 points)

(2) Calculate the angle between the failure plane and the maximum principal stress plane (θ). (10 points)