※ 注意：請於試卷內之「非選擇題作答區」依序作答，並應註明作答之大題及小題題號。

(1) (25%) An isotropically consolidated undrained (CU) triaxial test was conducted on a saturated clay specimen. During the consolidation stage, a confining pressure of 400 kPa was applied. During the shearing stage, the axial load was increased under undrained condition. At failure, the deviator stress was 320 kPa while the excess water pressure was 240 kPa.

(i) (8%) Draw the total stress and effective stress Mohr circles under failure condition. Clearly label all the axes and the Mohr circles (e.g. major and minor principal stresses).

(ii) (5%) Determine the effective stress friction angle. Draw the Mohr-Coulomb failure envelop on your plot from (i).

(iii) (6%) Determine the shear stress and orientation (direction) of the failure plane.

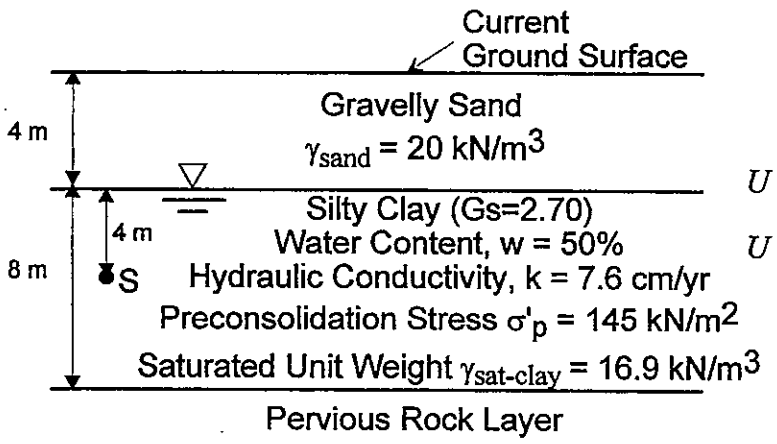
(iv) (6%) For this CU test, if the saturated clay specimen was subjected to a confining pressure of 560 kPa (instead of 400 kPa), what would be the deviator stress and excess water pressure at failure?

(2) (25%) A site profile is indicated in Figure 1. A soil sample was obtained from location S. A consolidation test reveals that the compression index C_c and recompression index C_r are 0.4 and 0.05, respectively. The coefficient of consolidation C_v is 2.5 m^2/yr.

(i) (12%) Evaluate the field void ratio and overconsolidation OCR of the silty clay layer. Give two possible causes of overconsolidation.

(ii) (7%) A fill with thickness of 3.5 meter and unit weight of 18 kN/m^3 is to be placed on top of the current ground surface. Evaluate the settlement due to primary consolidation of the silty clay layer. Also, estimate the percentage of consolidation that has completed 2 years after placement of the fill.

(iii) (6%) List three assumptions of Terzaghi's consolidation theory.



$$U=0-60\%:\quad T_V=\frac{\pi}{4}\left(\frac{U\%}{100}\right)^2$$

$$U>60\%:\quad T_V=1.781-0.933\log(100-U\%)$$

Figure 1. Site Profile for Question 2.

(3) (25%) A certain site is underlain by saturated clay. A proposed building for this site will have a 600 kN column load (including the weight of foundation) to be supported on 2 m surface square footing in preliminary design. For verifying the design, a plate loading test was performed using a square plate of size 30 cm. Figure 2 displays the pressure-settlement curve, from which the ultimate capacity of the plate was 250 kN/m^2. Answer the following questions:

(i) (15%) Considering the factor of safety of 2 against vertical bearing capacity and the allowable settlement of 2.5 cm for design requirements, draw the interactive chart of the allowable bearing capacity vs. the size of square footing.

(ii) (10%) Evaluate if the designed footing size satisfies the design requirements and explain the reason. If no, determine the minimum footing size to meet the requirements.

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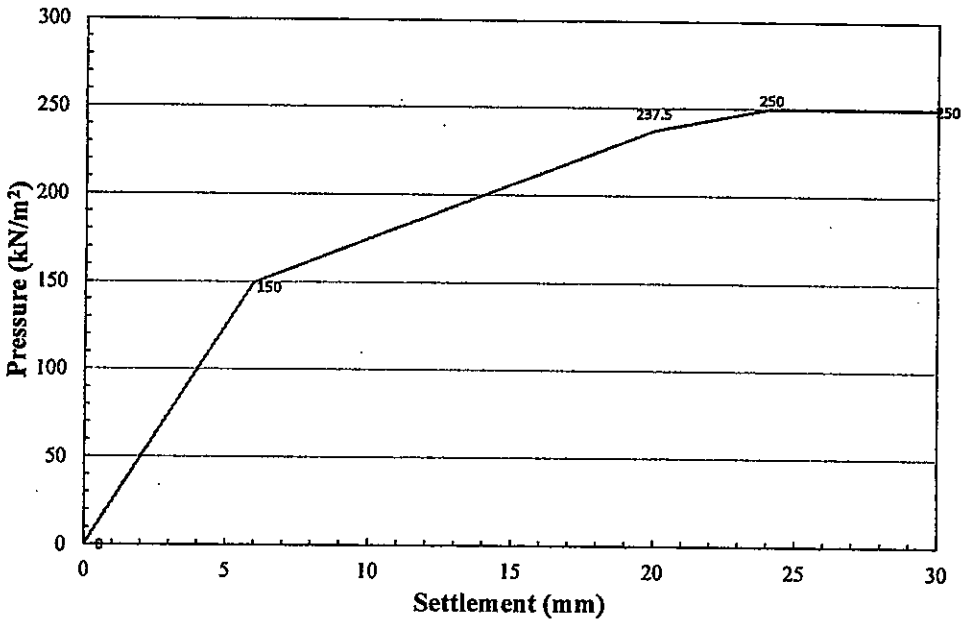

Figure 2. Load-settlement curve of the plate loading test for Question 3.

(4) (25%) Figure 3 shows a concrete pile of diameter of 1m and length 20 m embedded in clay overlain by a fill of thickness of 5 m. In the figure, γ is the unit weight of fill, γ_{sat} the saturated unit weight of clay, ϕ' the friction angle of clay and δ' the friction angle of the soil-pile interface. Answer the following questions:

(i) (10%) Estimate the total downward drag force on the pile if the pile is a friction pile.

(ii) (10%) Estimate the total downward drag force on the pile if the pile is an end-bearing pile.

(iii) (5%) Explain how the negative friction occurs and list the possible conditions that a negative friction force exists.

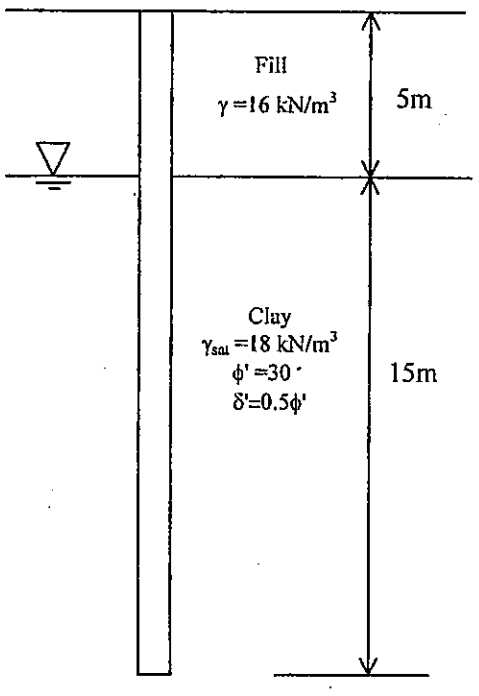

Figure 3. Soil profile for Question 4.

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