

International Master's Programs in the Graduate School of Engineering, 2025

Screening Examination Questions • Answer Sheet

Subject	Soil Mechanics
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Score

【 Q1 】 Solve the following questions (50 points)

(1) There are two uniform soil layer deposits as shown in Figure 1.

(a) Initially, the ground-water table elevation was at the same elevation of ground surface and the soil is saturated. Derive formula of saturated unit weight γ_{sat} by using γ_w , G_s and e .

(b) The ground-water table elevation was decreased to H_1 m due to heavy water pump up. The soil above the ground-water table was unsaturated and the degree of saturation S_r became 50.0%. Assuming that e was 0.80 which was constant in spite of water table change, G_s was 2.60, γ_w was 10.0 kN/m^3 .

Calculate the soil wet unit weight γ_t , the soil water content w and soil dry unit weight γ_d above the ground-water table.

(c) Derive formula of the vertical effective stress σ_v' at element A after water table change by using γ_t , γ_{sat} , γ_w , H_1 and H_2 .

(d) When γ_t of Soil1 layer is 16.7 kN/m^3 , γ_{sat} of Soil2 layer is 20.0 kN/m^3 , H_1 and H_2 are 5m, respectively, calculate the σ_v' value.

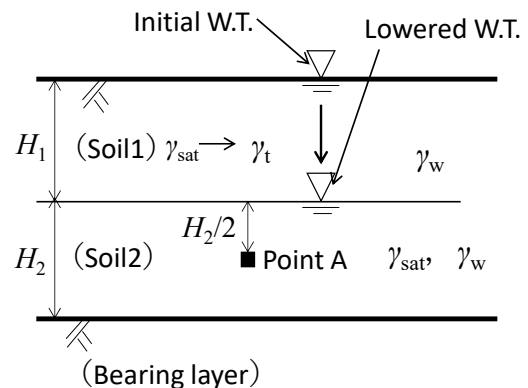


Figure 1

(a) $\gamma_{sat} = \frac{G_s + e}{1 + e} \gamma_w$ _____

(b) $\gamma_t = 16.7$ _____ kN/m^3 $w = 15.4$ _____ % $\gamma_d = 14.5$ _____ kN/m^3

(c) $\sigma_v' = \gamma_t H_1 + (\gamma_{sat} - \gamma_w) \frac{H_2}{2}$ _____ (d) $\sigma_v' = 108.5$ _____ kN/m^2

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(2) A vertical frictionless wall with 10 m height was constructed in a horizontal ground as shown in Figure 2. The vertical distance from the horizontal ground surface is defined as z . The backfill soil behind wall was at active earth pressure condition. The ground-water table elevation was at the middle elevation of the vertical wall. By using parameters in Figure 2, determine the Rankine's lateral earth pressure coefficient K_a value. Then, calculate the effective vertical stress σ_v' at $z = 5$ m and the lateral effective stress σ_h' at $z = 5$ m. In addition, determine the depth z_0 at which the horizontal effective stress applied to the wall is zero. Further, if the lateral effective stress at the tension zone ($z = 0$ to z_0 m) is taken as zero, calculate the resultant active thrust P_a and resultant lateral thrust P applied to the wall due to soil and pore water. Note that coefficient of active earth pressure K_a can only be applied to the effective stresses, and $\sqrt{1/3}$ should be calculated using 0.57.

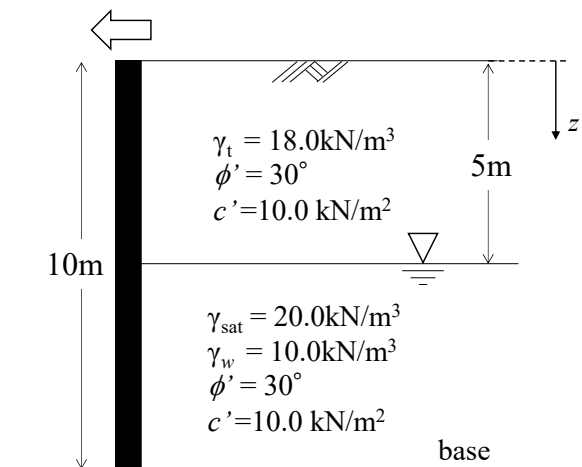


Figure 2

K_a	Effective vertical stress σ_v' at $z=5$ m (kN/m ²)	Lateral effective stress σ_h' at $z=5$ m (kN/m ²)
1/3	90	18.6
Tension zone depth z_0 (m)	Resultant active thrust P_a (kN/m)	Resultant lateral thrust P (kN/m)
1.95	163.1	288.1