'06 토질공학 중간고사

(Open Book)

1. (1) $B = 2m$

i. Bearing capacity of the bottom soil layer

$$q_b = \left(\gamma_f D_f + \gamma_1 H\right) N_{q(2)} F_{qs(2)} + \frac{1}{2}\gamma_2 N_{\gamma(2)} F_{\gamma s(2)}$$

$$N_{q(2)} = 18.40,\ \ N_{\gamma(2)} = 22.40 \ \ \left(\because \phi_2 = 30°\right)$$

$$F_{qs(2)} = 1 + \frac{L}{B}\tan\phi = 1 + \tan 30° = 1.577$$

$$F_{\gamma s(2)} = 1 - 0.4\left(\frac{L}{B}\right) = 0.6$$

$$q_b = \left(1.8 \times 2 + 0.9 \times 4\right)\left(18.4\right)\left(1.577\right) + \frac{1}{2}\left(0.7\right)\left(2\right)\left(22.4\right)\left(0.6\right) = 218.33\, t/m^2$$

ii. Bearing capacity of layered soils

$$q_l = q_b + H^2\left(1 + \frac{B}{L}\right)\left(\gamma_1 + \frac{2\gamma_f D_f}{H}\right)\left(\frac{K_s \tan\phi_1}{B}\right) - \gamma_1 H$$

$$N_{q(1)} = 37.75,\ \ N_{\gamma(2)} = 56.31 \ \ \left(\because \phi_1 = 36°\right)$$

$$\frac{q_2}{q_1} = \frac{\gamma_2 N_{\gamma(2)}}{\gamma_1 N_{\gamma(1)}} = \frac{0.7 \times 22.40}{0.9 \times 56.31} = 0.309,\ \ \phi_1 = 36° \quad \Rightarrow K_s = 4.0$$

$$q_l = 218.33 + 16\left(2\right)\left(0.9 + \frac{2 \times 1.8 \times 2}{4}\right)\left(\frac{4 \times \tan 36°}{2}\right) - \left(0.9 \times 4\right) = 340.28\, t/m^2$$

iii. Bearing capacity of the top soil layer

$$q_t = \gamma_f D_f N_{q(1)} F_{qs(1)} F_{qd(1)} + \frac{1}{2}\gamma_1 N_{\gamma(1)} F_{\gamma s(1)} F_{\gamma d(1)}$$

$$F_{qs(1)} = 1 + \tan 36° = 1.727,\ \ F_{\gamma s(1)} = 0.6$$

$$F_{qd(1)} = 1 + 2\tan 36°(1 - \sin 36°)^2 \frac{2}{2} = 1.247\,,\quad F_{\gamma d(1)} = 1$$

$$q_t = (1.8 \times 2)(37.75)(1.727)(1.247) + \frac{1}{2}(0.9)(2)(56.31)(0.6) = 323.08\, t/m^2$$

$q_t = 265.11\, t/m^2$ (Not consider depth factor)

iv. Ultimate bearing capacity & Allowable bearing capacity

$q_t < q_l$

$\therefore q_u = q_t = 323.08\, t/m^2$

$$\therefore q_a = \frac{q_u}{F.S.} = \frac{323.08}{3} = 107.69\, t/m^2$$

(2) $B = 5m$

i. Bearing capacity of the bottom soil layer

$$q_b = (1.8 \times 2 + 0.9 \times 4)(18.4)(1.577) + \frac{1}{2}(0.7)(5)(22.4)(0.6) = 232.44\, t/m^2$$

ii. Bearing capacity of layered soils

$$q_l = 232.44 + 16(2)\left(0.9 + \frac{2 \times 1.8 \times 2}{4}\right)\left(\frac{4 \times \tan 36°}{5}\right) - (0.9 \times 4) = 279.06\, t/m^2$$

iii. Bearing capacity of the top soil layer

$$F_{qd(1)} = 1 + 2\tan 36°(1 - \sin 36°)^2 \frac{2}{5} = 1.099$$

$$q_t = (1.8 \times 2)(37.75)(1.727)(1.099) + \frac{1}{2}(0.9)(5)(56.31)(0.6) = 333.95\, t/m^2$$

$q_t = 310.72\, t/m^2$ (Not consider depth factor)

iv. Ultimate bearing capacity & Allowable bearing capacity

$q_t > q_l$

$\therefore q_u = q_l = 279.06\, t/m^2$

$$\therefore q_a = \frac{q_u}{F.S.} = \frac{279.06}{3} = 93.02\ t/m^2$$

2. $q_0 \approx 93\ t/m^2$

(1) Stress & Correction factors

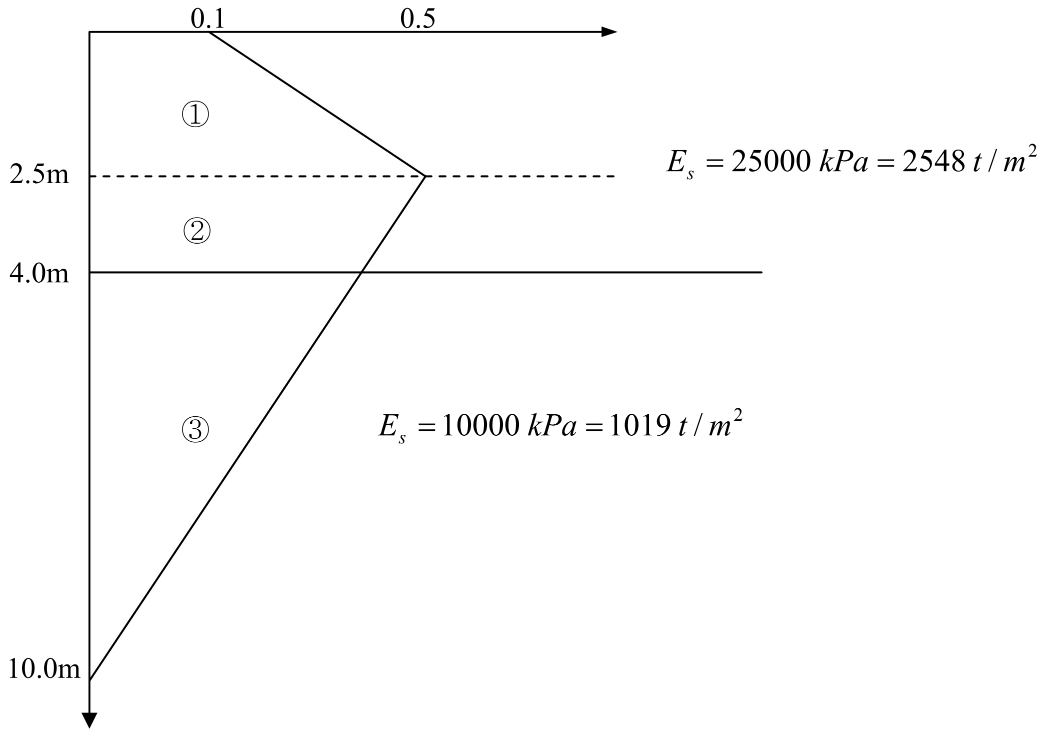
$$S_e = C_1 C_2 \left(\bar{q} - q\right) \sum \frac{I_z}{E_s} \Delta z$$

$$\bar{q} = q_0 = 93\ t/m^2, \quad q = \gamma_f D_f = 1.8 \times 2 = 3.6\ t/m^2$$

$$C_1 = 1 - 0.5 \frac{q}{\bar{q} - q} = 1 - 0.5 \frac{3.6}{93 - 3.6} = 0.98$$

$$C_2 = 1 + 0.2 \log\left(\frac{t\ yr}{0.1}\right) = 1 + 0.2 \log \frac{20}{0.1} = 1.46$$

(2) Strain influence factor



$z = 1.25m$, $I_z = \dfrac{0.1 + 0.5}{2} = 0.3$, $\quad z = 4m$, $I_z = 0.5 - 0.5\left(\dfrac{1.5}{7.5}\right) = 0.4$

$z = 3.25m$, $I_z = \dfrac{0.4 + 0.5}{2} = 0.45$, $\quad z = 7m$, $I_z = \dfrac{0.4}{2} = 0.2$

Layer	$\Delta z(m)$	$E_s(t/m^2)$	$z_{center}(m)$	I_z
①	2.5	2548	1.25	0.3
②	1.5	2548	3.25	0.45
③	6	1019	7	0.2

(3) Immediate settlement

$$S_e = C_1 C_2 (\bar{q} - q) \sum \frac{I_z}{E_s} \Delta z$$

$$\therefore S_e = (0.98)(1.46)(93 - 3.6)\left[\left(\frac{0.3}{2548}\right)(2.5) + \left(\frac{0.45}{2548}\right)(1.5) + \left(\frac{0.2}{1019}\right)(6)\right] = 0.222m = 222mm$$

3.

(1) Allowable bearing capacity

i. Bearing capacity of the bottom soil layer

$$q_b = \left(1 + 0.2\frac{B}{L}\right)5.14c_2 + \left(\gamma_f D_f + \gamma_1 H\right)$$

$$q_b = (1 + 0.2)(5.14)(70/9.81) + (1.8 \times 2 + 0.9 \times 4) = 51.21\, t/m^2$$

ii. Bearing capacity of layered soils

$$\frac{q_2}{q_1} = \frac{5.14c_2}{0.5\gamma_1 N_{\gamma(1)} B} = \frac{5.14 \times (70/9.81)}{0.5 \times 0.9 \times 56.31 \times 5} = 0.289\,,\ \ \phi_1 = 36^\circ \quad \Rightarrow K_s = 4.0$$

$$q_l = 51.21 + 16(2)\left(0.9 + \frac{2 \times 1.8 \times 2}{4}\right)\left(\frac{4 \times \tan 36^\circ}{5}\right) - (0.9 \times 4) = 97.83\, t/m^2$$

iii. Bearing capacity of the top soil layer

$$q_t = 333.95\, t/m^2\,, \quad q_t = 310.72\, t/m^2 \quad \text{(Not consider depth factor)}$$

iv. Ultimate bearing capacity & Allowable bearing capacity

$$q_t > q_l\,, \quad q_u = q_l = 97.83\, t/m^2$$

$$\therefore q_a = \frac{q_u}{F.S.} = \frac{97.83}{3} = 32.61\, t/m^2 \approx 33\, t/m^2$$

(2) Immediate settlement of sand

i. Stress & Correction factors

$$\bar{q} = q_a = 33\, t/m^2\,, \quad q = 3.6\, t/m^2$$

$$C_1 = 1 - 0.5\frac{3.6}{33 - 3.6} = 0.94\,, \quad C_2 = 1.46$$

ii. Immediate settlement

$$\therefore S_e = (0.94)(1.46)(33-3.6)\left[\left(\frac{0.3}{2548}\right)(2.5)+\left(\frac{0.35}{2548}\right)(1.5)\right] = 0.020m = 20mm$$

(3) Primary consolidation settlement of clay

i. Thickness of the clay layer & initial effective stress

$$H = 2.5B - 4 = 2.5\times 5 - 4 = 8.5m$$

$$z_{center} = 4 + 8.5/2 = 8.25m$$

$$\sigma'_{v0} = (2\times 1.8) + (0.9\times 4) + (0.6\times 4.25) = 9.75\ t/m^2$$

ii. Average stress increment

$z(m)$	$m_1 = L/B$	$n_1 = z/(B/2)$	I_c	$\Delta\sigma = q_a I_c$
4 (top)	1	1.6	0.449	14.817
8.25 (middle)	1	3.3	0.158	5.214
12.5 (bottom)	1	5	0.072	2.376

$$\Delta\sigma_{av} = \frac{1}{6}(14.817 + 4\times 5.214 + 2.376) = 6.34\ t/m^2$$

iii. Consolidation settlement

$$S_c = \frac{C_r H}{1+e_0}\log\frac{\sigma'_p}{\sigma'_0} + \frac{C_c H}{1+e_0}\log\frac{\sigma'_0+\Delta\sigma_{av}}{\sigma'_p}$$

$$\therefore S_c = \frac{0.08\times 8.5}{1+1}\log 1.2 + \frac{0.6\times 8.5}{1+1}\log\frac{9.75+6.34}{1.2\times 9.75} = 0.380m = 380mm$$

(4) Secondary compression

$$S_s = \frac{C_\alpha H}{1+e_p}\log\frac{t}{t_p}$$

$$\Delta e = C_r \log \frac{\sigma'_p}{\sigma'_0} + C_c \log \frac{\sigma'_0 + \Delta\sigma_{av}}{\sigma'_p} = 0.08 \times \log 1.2 + 0.6 \times \log 1.375 = 0.089$$

$$e_p = 1 - 0.089 = 0.911$$

$$\therefore S_s = \frac{0.05 \times 8.5}{1 + 0.911} \log \frac{20}{5} = 0.134m = 134mm$$

$$\therefore S_s = \frac{0.05 \times 8.5}{1 + 1} \log \frac{20}{5} = 0.128m = 128mm \quad (e_p \approx e_0)$$

(5) Total settlement

$$\therefore S_t = 20 + 380 + 134 = 534mm$$

$$\therefore S_t = 20 + 380 + 128 = 528mm \quad (e_p \approx e_0)$$