Chapter 11 Review

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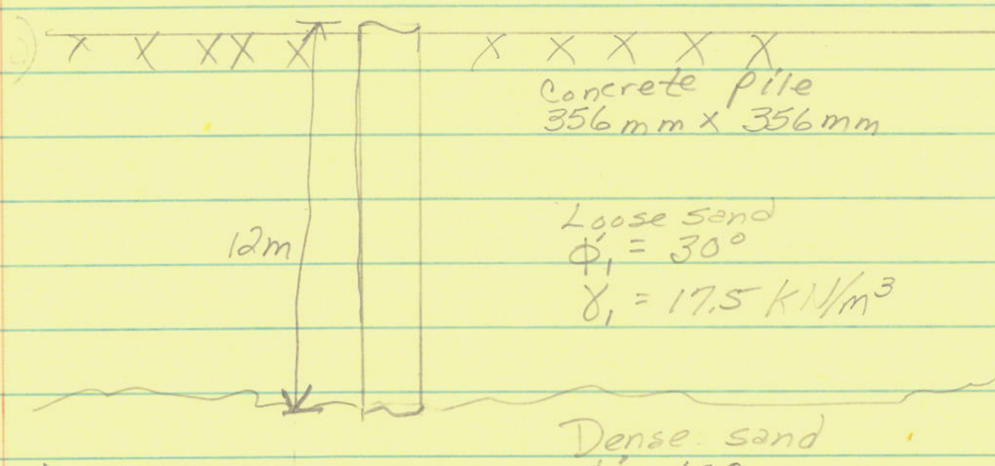
Chapter 11

#11.2 Refer to pile below & estimate the side resistance Q_s (frictional resistance) by:

a) Using Eqn 11.40 thru 11.42 $K = 1.3$ & $\delta' = 0.8\phi'$

b) Coyle & Castello's method Eq 11.44.



a)

[11.40] $L' \approx 15D \therefore L' = 15(.356m)$

$L' = 5.34m$

[11.41] $f = K\sigma'_o \tan\delta'$ = (for $z = 0$ to $z = 5.34$)

@ $z = 5.34$ $f = (1.3)(17.5 \times 5.34)\tan(0.8 \times 30°) = 54.1\,kN/m^2$

[11.43] $Q_s = f_{avg}\, p L' + f_{z=5.34}\, p(L - L')$ p = perimeter of pile

$Q_s = \left(\frac{0 + 54.1}{2}\right)(4 \times 0.356)(5.34) + (54.1)(4 \times 0.356)(12 - 5.34)$

$Q_s = 205.69 + 513.08 =$ **718.77 KN**

[11.44] b) $Q_s = K\bar{\sigma}'_o \tan(0.8\phi')\, p L$

$= (1.3)(105)\tan(0.8 \times 30)(4 \times 0.356)(12)$

$\bar{\sigma}'_o$ = effective overburden

$\bar{\sigma}'_o = (17.5 \times 12) \div 2 = 105\,kN/m^2$

$Q_s = 279.6$ kN

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#11.7 A concrete pile 50 ft long having a cross section of 15" x 15" is fully embedded in a saturated clay layer; $\gamma_{sat} = 121\ \#/ft^3$, $\phi = \emptyset$ & $c_u = 1600\ \#/ft^2$

Determine the allowable load that the pile can carry, FS=3. Use the α method to estimate the skin friction & Veric's method for point load calculations

P_a = pressure of atmosphere

Q_s [11.53] $f = \alpha c_u$

$f = (0.54)(1600\ \#/ft^2)$

$f = 864\ \#/ft^2$

$\frac{c_u}{P_a} = \frac{1600}{2000} = 0.8$

Tbl 11.10 for $\frac{c_u}{P_a} = 0.8$

$\alpha = 0.54$

[11.55] $Q_s = \Sigma f p \Delta L$

$Q_s = (864\ \#/ft^2)(4 \times 1.25')(50')$

$Q_s = 216{,}000\#$ or $\boxed{216\ k}$

p = perimeter of pile

$\frac{15''}{12''/ft} = 1.25\ ft$

Q_P [11.33] $I_{rr} = I_R$ [11.35] $I_r = 347\left(\frac{c_u}{P_a}\right) - 33 \leq 300$

$I_r = 347(0.8) - 33 = 244.6$

[11.32] $N_c^* = 4/3(\ln I_{rr} + 1) + \frac{\pi}{2} + 1$

$N_c^* = 4/3(\ln(244.6) + 1) + \pi/2 + 1 = 11.24$

[11.31] $Q_P = A_P\, c_u N_c^* = (1.25' \times 1.25')(1600\ \#/ft^2)(11.24)$

$Q_P = 28100\#$ or $\boxed{28.1\ kip}$

$Q_{ALL} = \frac{Q_P + Q_s}{FS} = \frac{28.1k + 216k}{3} = \frac{244.1\ k}{3} = \boxed{81.4\ k}$

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#11.15 A 30m long concrete pile is 305mm x 305mm & fully embedded in sand. If $n_h = 9200\ kN/m^2$, the moment @ gnd level, $M_g = \emptyset$, the allowable displacement of pile head = 12mm; $E_p = 21 \times 10^6\ kN/m^2$ & $F_{Y(PILE)} = 21{,}000\ kN/m^2$ calculate allowable lateral load Q_g by Brom's method. Assume the pile is flexible & free headed, Soil $\gamma = 16\ kN/m^3$, Soil $\phi' = 30°$ & Yield stress of pile $F_y = 21\ MN/m^2$ or $21{,}000\ kN/m^2$.

[Tbl 11.3a] $S = 3.097 \times 10^{-3}\ m^3$

Check for bending failure $M_y = F_Y S = (21{,}000)(3.097 \times 10^{-3})$ [11.101]

$M_y = 83.37\ kN \cdot m$

$\dfrac{M_y}{D^4 \gamma K_p} = \dfrac{83.37}{(0.305)^4(16)(3)} = 200.7$ $\quad K_p = \tan^2\left(45 + \frac{\phi'}{2}\right)$ [11.99]

$K_p = \tan^2\left(45 + \frac{30}{2}\right) = 3$

$\dfrac{e}{D} = \emptyset$ from figure 11.32 $\dfrac{Q_{u(g)}}{K_p \gamma D^3} = 75$

$Q_{u(g)} = 75(3)(16)(0.305)^3$

$\boxed{Q_{u(g)} = 102\ kN}$

[11.102] $\eta = \left(\dfrac{n_h}{E_p I_p}\right)^{1/5}$ $\quad I_p = \dfrac{d^4}{12} = \dfrac{(.305)^4}{12}$

$I_p = 7.21 \times 10^{-4}$

$\eta = \left(\dfrac{9200\ kN/m^2}{(21 \times 10^6\ kN/m^2)(7.21 \times 10^{-4})}\right)^{1/5}$

$\eta = 0.905\ m^{-1}$

$\eta L = 0.905\ m^{-1} \times 30\ m = 27.1$; $\dfrac{e}{L} = \emptyset$

Tbl 11.33a $\dfrac{x_{z=0}\ E_p I_p^{3/5}\ n_h^{2/5}}{Q_g L} = 0.75$

next ↷

11.15 cont

$$Q_g = \frac{\gamma_{z=0}\left[E_p I_p\right]^{3/5} n_h^{3/5}}{0.75 L}$$

$$Q_g = \frac{(0.012)\left[(21\times10^6)(7.21\times10^{-4})\right]^{3/5}(9200)^{3/5}}{0.75(30)}$$

$$\boxed{Q_g = 41.05\ kN}$$

11.23

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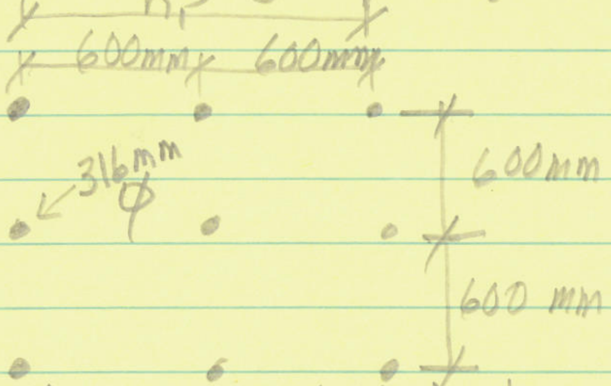
The plan of a group pile is shown below. Assume that the piles are embedded in a saturated homogenous clay having a $c_u = 86\,kN/m^2$. Given diameter D = 316 mm, center-to-center spacing = 600 mm, pile length = 20 m. Find the allowable load carrying capacity of the pile group, FS = 3.



assume $p_o = 100\ kN/m$

$A_p = \frac{\pi(316)^2}{4} = 0.0784\,m^2$

$n_1 = 3$

$n_2 = 3$

p = perimeter of pile $.316\pi$

Piles acting individually

[11.121] $\Sigma Q_u = n_1 n_2 \left[9 A_p c_u + \Sigma \alpha p c_u \Delta L\right]$

$\frac{c_u}{p_o} = \frac{86\,kN/m^2}{100\,kN/m^2} = 0.86$ Tbl 11.10 $\alpha \approx 0.50$

$\Sigma Q_u = (3)(3)\left[9(0.0784)(86) + (0.5)(.316\pi)(86)(20)\right]$

$\Sigma Q_u = 8230.0\ KN$

$Q_{all} = \frac{Q_u}{FS} = \frac{8230}{3} = \boxed{2743\ kN}$

Piles Acting as a group

[11.122] $\Sigma Q_u = L_g B_g c_u N_c^* + \Sigma 2(L_g + B_g) c_u \Delta L$

$L_g = B_g = (n-1)d + 2\left(\frac{D}{2}\right) = (3-1).6m + 2\left(\frac{.316}{2}\right) = 1.52$

(Fig 11.37)

11.23 Cont.

$$\frac{L}{B_g} = \frac{20\,m}{1.52\,m} = 13.2$$

From Fig 11.41 $N_c^* = 9$

$$\Sigma Q_u = (1.52)(1.52)(86)(9) + 2(1.52 + 1.52)(86)(20)$$

$$Q_u = 1788 + 10{,}457 = 12{,}245\ kN$$

$$Q_{ALL} = \frac{Q_u}{FS} = \frac{12{,}245}{3} = \boxed{4{,}082\ kN}$$

Take the smaller $\boxed{Q_{ALL} = 2{,}743\ kN}$