Bearing capacity of pile group

Figure 1 shows a group pile in saturated clay. Using the figure, one can estimate the ultimate load-bearing capacity of group piles in the following manner:

Step 1: Determine $\sum Q_u = n_1 n_2 (Q_b + Q_s)$

$$Q_b = A_b 9 C_u, and\ Q_s = \sum \alpha C_u P(\Delta L)$$

Where Cu is the undrained cohesion at the pile tip or end

$\sum Q_u = n_1 n_2 [9 A_b C_u + \sum \alpha C_u P(\Delta L)]$ ....(1)

Step 2: Determine the ultimate capacity by assuming that the piles in the group act as a block with dimensions $L_g * B_g * L$. The skin resistance of the block is:

$$\sum p_g \alpha C_u \Delta L = \sum 2(L_g + B_g) \alpha C_u \Delta L$$

Calculate the end bearing capacity:

$A_b q_b = (L_g B_g) C_u N_C^*$, thus the bearing capacity of pile group:-

$\sum Q_u = L_g B_g C_u N_C^* + \sum 2(L_g + B_g) C_u \Delta L$ ....(2)

Obtain N_C^* from Fig.2

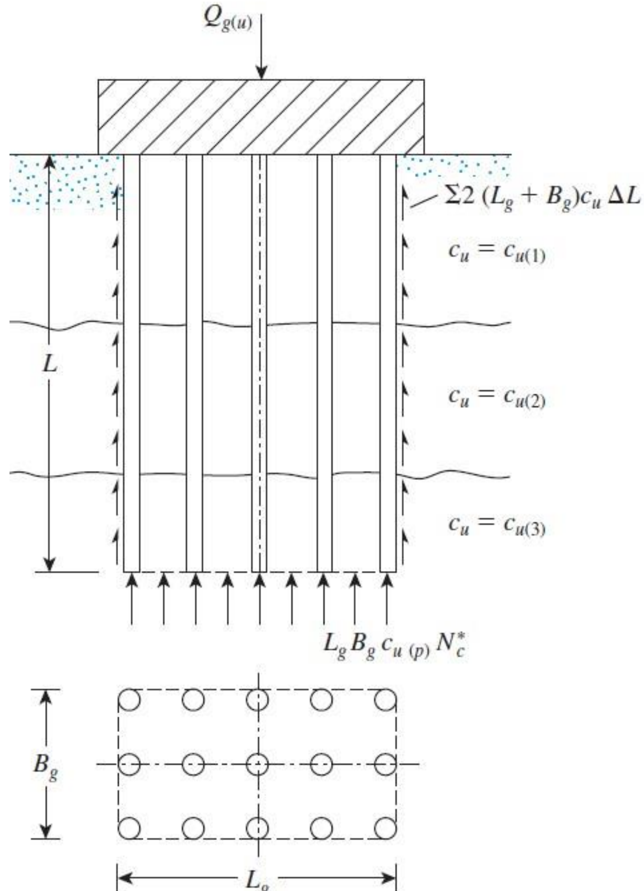

Fig.1: Ultimate capacity of group piles in clay

Step3: Compare the values obtained from Eqs. (1) and (2). The *lower* of the two values is Qg(u) .

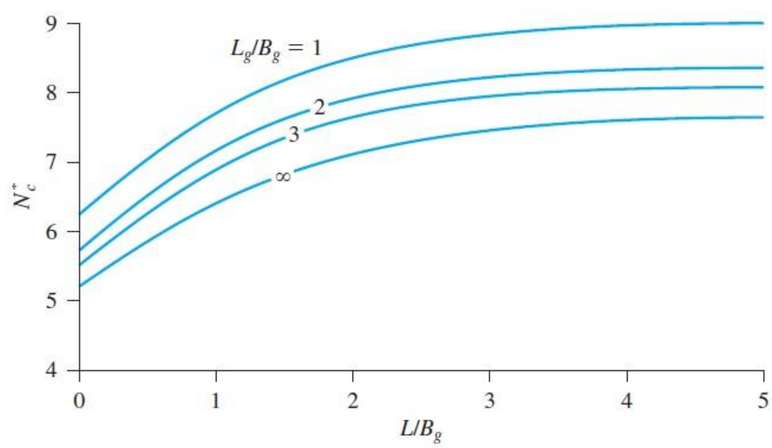

Fig.2 : Variation of Nc* with Lg/Bg and L/Bg

The section of a 3 × 4 group pile in a layered saturated clay is shown in Figure 11.42. The piles are square in cross section (356 mm × 356 mm). The center-to-center spacing, *d*, of the piles is 889 mm. Determine the allowable load-bearing capacity of the pile group. Use FS = 4. Note that the groundwater table coincides with the ground surface.

Solution

From Eq. (11.120),

$$\Sigma Q_u = n_1 n_2 [9A_p c_{u(p)} + \alpha_1 p c_{u(1)} L_1 + \alpha_2 p c_{u(2)} L_2]$$

From Figure 11.42, $c_{u(1)} = 50.3\ \text{kN/m}^2$ and $c_{u(2)} = 85.1\ \text{kN/m}^2$.

For the top layer with $c_{u(1)} = 50.3\ \text{kN/m}^2$,

$$\frac{c_{u(1)}}{p_a} = \frac{50.3}{100} = 0.503$$

From Table 11.10, $\alpha_1 \approx 0.68$. Similarly,

$$\frac{c_{u(2)}}{p_a} = \frac{85.1}{100} \approx 0.85$$

$$\alpha_2 = 0.51$$

$$\Sigma Q_u = (3)(4)\begin{bmatrix}(9)(0.356)^2(85.1) + (0.68)(4 \times 0.356)(50.3)(4.57) \\ + (0.51)(4 \times 0.356)(85.1)(13.72)\end{bmatrix}$$

$$= 14011\ \text{kN}$$

For piles acting as a group.

$$L_g = (3)(0.889) + 0.356 = 3.023\ \text{m}$$

$$B_g = (2)(0.889) + 0.356 = 2.134\ \text{m}$$

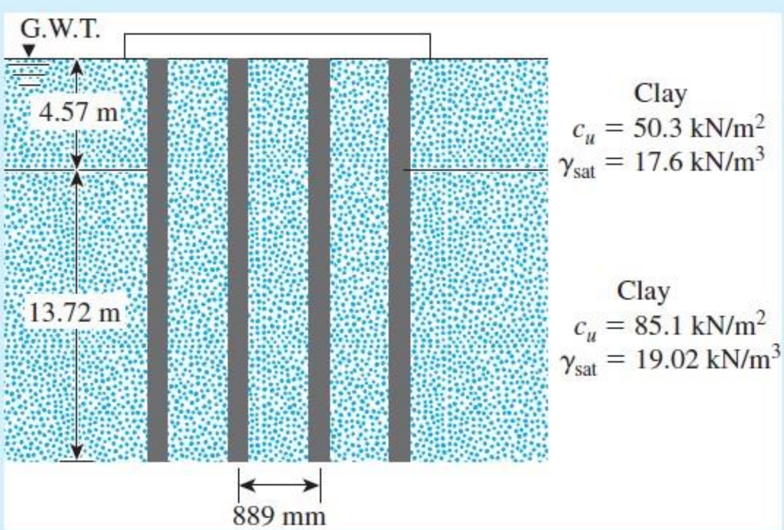

Figure 11.42 Group pile of layered saturated clay

$$\frac{L_g}{B_g} = \frac{3.023}{2.134} = 1.42$$

$$\frac{L}{B_g} = \frac{18.29}{2.134} = 8.57$$

Obtain from Fig.2 $N_c^* = 8.75$ and Eq.2

$$\Sigma Q_u = L_g B_g c_{u(p)} N_c^* + \Sigma 2(L_g + B_g) c_u \Delta L$$

$$= (3.023)(2.134)(85.1)(8.75) + (2)(3.023 + 2.134)[(50.3)(4.57) + (85.1)(13.72)]$$

$$= 19217 \text{ kN}$$

Hence, $\Sigma Q_u = 14{,}011$ kN.

$$\Sigma Q_{all} = \frac{14{,}011}{FS} = \frac{14{,}011}{4} \approx \mathbf{3503\ kN}$$

Problem1:

The plan of a group pile is shown in Fig. 3. Assume that the piles are embedded in a saturated homogeneous clay having a *Cu*= 86 KN/m2 Given: diameter of piles (*D*= 316 mm), center-to-center spacing of piles d = 600 mm, and length of piles L= 20 m. Find the allowable load-carrying capacity of the pile group. Use F=3.

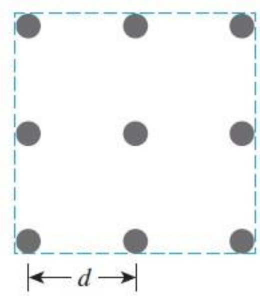

Fig.3

Problem2:

Redo Problem 1 with the following: center-to-center spacing of piles $= 762mm, L = 13.7m, D = 305m,$

$C_u = 41.2\frac{KN}{m2},\ \gamma_{sat} = \frac{19.24KN}{m3},\ F = 3$

Problem3:

The section of a (4 * 4) group pile in a layered saturated clay is shown in Fig.4. The piles are square in cross section (356 mm * 356 mm). The center-to-center spacing (*d*) of the piles is 1 m. Determine the allowable load-bearing capacity of the pile group. Use F= 3.

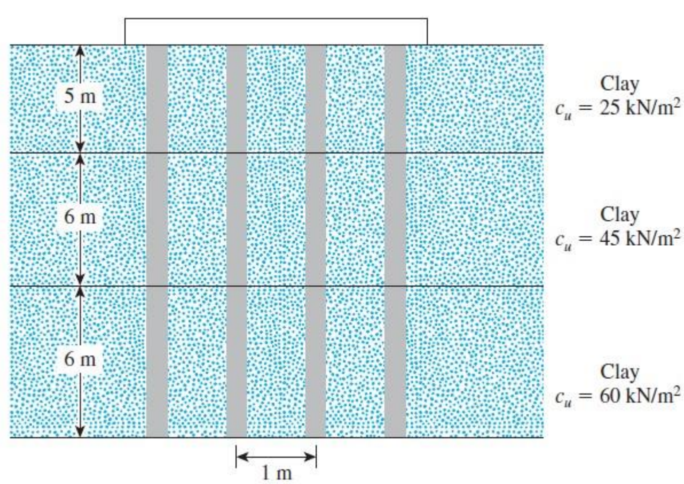

Fig.4