EXAMPLE No. 15A

Failure of Pile to Attain Required Penetration

Pile in Example 14A (revised design using 14" piles) penetrates only 7.5 feet vs. 9.0 feet (minimum) required. No change in pile pull or lean values. (Refer to Section 7-3.04A.)

1. Find new value for L_2

New $D/H = 7.5/12 = 0.625$

From Figure 7-17, "Q" = 1.11 (for normal soil)

New $L_2 = H + (Q)(Y_2) = 12 + (1.11)(5.83) = 18.47'$

2. Calculate $f_{bp(2)}$ using new L_2

$$F_2 = \frac{3EI\Delta}{(12L_2)^3} = \frac{3(1.6 \times 10^6)(1086)(4)}{(12 \times 18.47)^3} = 3326 \text{ lbs.}$$

$$f_{bp(2)} = \frac{F_2(12L_2)}{S} = \frac{(3326)(12 \times 18.47)}{269} = 2740 \text{ psi}$$

3. Check bent type

New L_u = 2.0 + new Y_2 = 2.0 + (1.11)(5.83) = 8.47'

$L_u/d = \frac{8.47 \times 12}{14} = 7.27 < 8.0$ Still type I bent

4. Evaluate system adequacy

$f_{be(1)}$ and f_c are unchanged.

$L_u = L_2 = 18.47'$ (longitudinal direction governs)

$L_u/d = \frac{18.47}{12.4} = 17.87$ ← no change

$$F_c = \frac{480000}{(17.87)^2} = 1503 \text{ psi}$$

Solve combined stress expression –

$$\frac{f_{bp(2)} + 2f_{be(1)}}{3F_b} + \frac{2f_c}{3F_c} \not> 1.0$$

Values from 14A calcs.

$$\frac{2740 + 2(625)}{3(1800)} + \frac{2(273)}{3(1503)} = 0.74 + 0.12 = 0.86 \text{ OK}$$

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EXAMPLE 15B

Assume critical pile in Example 14B pile bent has the following as-driven values:

	Planned	Actual
D	12' (min.)	10'
Δ	6" (max.)	6"
e_1	4" (max.)	8" at 60° angle (relative brg.) with Δ

Check Pile Capacity (See Section 7-3.04)

1. Check adequacy of pile penetration

$D/H = 10/16 = 0.625, \quad 0.75 > 0.625 > 0.45$ Find "Q"

From Figure 7-17, "Q" = 1.11 (for normal soil)

2. Find new values for Y_2 and L_2

New $Y_2 = Q \times Y_2 = (1.11)(6.25) = 6.94'$

New $L_2 = H + \text{new } Y_2 = 16.0 + 6.94 = 22.94'$

3. Check bent type

$L_u = 6.0 + \text{new } Y_2 = 12.94'$

$L_u/d = \dfrac{(12.94)(12)}{15} = 10.35$ Still Type II bent

4. Calculate stress due to pile pull

$$F_2 = \frac{3EI\Delta}{(12L_2)^3} = \frac{3(1.6 \times 10^6)(2485)(6)}{(12 \times 22.94)^3} = 3431 \text{ lbs.}$$

$$f_{bp(2)} = \frac{F_2(12L_2)}{S} = \frac{(3431)(12 \times 22.94)}{331} = 2853 \text{ psi}$$

Note that it is not necessary to calculate the initial bending stress for this pile because Δ is unchanged. (The longer L_1 length will give a corresponding lower value for $f_{bp(1)}$).

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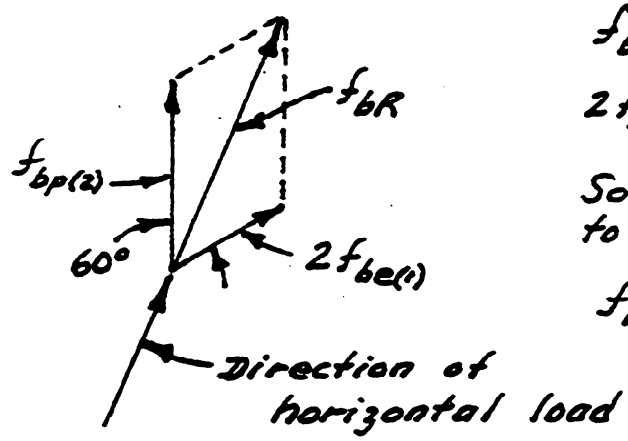
Example 15B Continued

5. Calculate stress due to pile lean

$$f_{be(1)} = \frac{P_v(e_1)}{S} = \frac{(36000)(8)}{331} = 870 \text{ psi}$$

6. Calculate stress resultant - See Section 7-3.04B(1)



$f_{bp(2)} = 2853$ psi

$2f_{be(1)} = 1740$ psi

Solve stress vector triangles to find the resultant stress

$f_{bR} = 4016$ psi

7. Calculate stress due to design H

$H = 720$ lbs

New $L_u = 12.94'$ (see step 3)

$$f_{bH} = \frac{H(12L_u)}{S} = \frac{(720)(12 \times 12.94)}{331} = 338 \text{ psi}$$

8. Calculate horizontal displacement

$$x = \frac{H(12L_u)^3}{3EI} = \frac{(720)(12 \times 12.94)^3}{3(1.6 \times 10^6)(2485)} = 0.23'' = e_2$$

9. Calculate stress due to e_2

$$f_{be(2)} = \frac{P_v(e_2)}{S} = \frac{(36000)(0.23)}{331} = 25 \text{ psi}$$

Example 15B Continued

10. **Determine allowable compressive stress**

(Note: actual f_c is unchanged at 203 psi)

L_u = new L_2 = 22.94 (long. direction governs)

$$L_u/d = \frac{22.94 \times 12}{13.3} = 20.7$$

← unchanged value

$$F_c = \frac{480000}{(20.7)^2} = 1120 \text{ psi}$$

11. **Solve combined stress equation**

$$\frac{f_{bR} + 2(f_{bH} + f_{be(2)})}{3F_b} + \frac{2f_c}{3F_c} \not> 1.0$$

$$\frac{4016 + 2(338 + 25)}{3(1800)} + \frac{2(203)}{3(1120)}$$

$$0.88 + 0.12 = 1.0 \quad \underline{OK}$$