

Foundations Ch 5 problems 1a, 1b(assume poisson ratio= 0 and 0.3), 2, 4-7

- 5.1 A flexible circular area is subjected to a uniformly distributed load of 150 kN/m^2 . The diameter of the loaded area is 2 m. Determine the stress increase in a soil mass at a point located 3 m below the center of the loaded area.
- by using Eq. (5.3)
 - by using Eq. (5.28). Use $\mu_s = 0$

GIVEN $q_0 := 150 \frac{\text{kN}}{\text{m}^2}$ $B := 2 \text{ m}$ $z := 3 \text{ m}$

FIND 1. Stress Increase in a soil mass at a point located 3 m below

METHOD 1. Using Boussinesq Eq 5.3
2. Using Westergaard Eq 5.28 $\mu_s := 0$

SOLUTION 1. $\Delta\sigma := q_0 \cdot \left[1 - \frac{1}{\left[1 + \left(\frac{B}{2z} \right)^2 \right]^{\frac{3}{2}}} \right] = 21.928$ 2. $\eta := \sqrt{\frac{(1 - 2\mu_s)}{(2 - 2\mu_s)}} = 0.707$ EQ 5.25

$$\Delta\sigma := q_0 \cdot \left[1 - \frac{\eta}{\left[\eta^2 + \left(\frac{B}{2z} \right)^2 \right]^{\frac{1}{2}}} \right] = 14.32$$

- 5.2 Refer to Figure 5.4, which shows a flexible rectangular area. Given: $B_1 = 4 \text{ ft}$, $B_2 = 6 \text{ ft}$, $L_1 = 8 \text{ ft}$, and $L_2 = 10 \text{ ft}$. If the area is subjected to a uniform load of 3000 lb/ft^2 , determine the stress increase at a depth of 10 ft located immediately below point O.

GIVEN $w := 3000 \frac{\text{lb}}{\text{ft}^2}$ $z := 10 \text{ m}$ $B_1 := 4 \text{ ft}$ $B_2 := 6 \text{ ft}$
 $L_1 := 8 \text{ ft}$ $L_2 := 10 \text{ ft}$

FIND 1. Stress Increase at 10 ft below point O

METHOD 1. Use Eq 5.7 and 5.8 for m and n
2. Use Eq 5.6 for each rectangle to determine the influence factor I
3. Use Eq 5.5 and 5.9 to determine stress

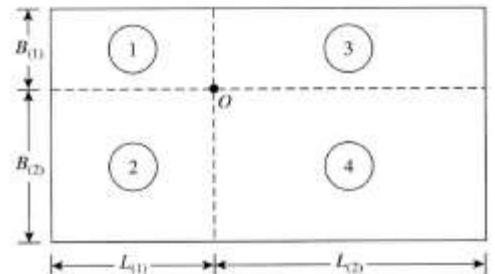


Figure 5.4 Stress below any point of a loaded flexible rectangular area

SOLUTION For rectangle 1: $\frac{B}{z} := 0.4$ $\frac{L}{z} := 0.8$

$$I_1 := \frac{1}{4\pi} \cdot \left[\left(\frac{2m \cdot n \cdot \sqrt{m^2 + n^2 + 1}}{m^2 + n^2 + m^2 \cdot n^2 + 1} \right) \cdot \left(\frac{(m^2 + n^2 + 2)}{(m^2 + n^2 + 1)} \right) + \operatorname{atan} \left(\frac{2m \cdot n \cdot \sqrt{m^2 + n^2 + 1}}{m^2 + n^2 - m^2 \cdot n^2 + 1} \right) \right] = 0.093$$
 EQ 5.6

For rectangle 2: $\frac{B}{z} := 0.6$ $\frac{L}{z} := 0.8$

$$I_2 := \frac{1}{4\pi} \cdot \left[\left(\frac{2m \cdot n \cdot \sqrt{m^2 + n^2 + 1}}{m^2 + n^2 + m^2 \cdot n^2 + 1} \right) \cdot \left(\frac{(m^2 + n^2 + 2)}{(m^2 + n^2 + 1)} \right) + \operatorname{atan} \left(\frac{2m \cdot n \cdot \sqrt{m^2 + n^2 + 1}}{m^2 + n^2 - m^2 \cdot n^2 + 1} \right) \right] = 0.125$$

For rectangle 3: $\frac{B}{z} := 0.4$ $\frac{L}{z} := 1$

$$I_3 := \frac{1}{4\pi} \cdot \left[\left(\frac{2m \cdot n \cdot \sqrt{m^2 + n^2 + 1}}{m^2 + n^2 + m^2 \cdot n^2 + 1} \right) \cdot \left(\frac{(m^2 + n^2 + 2)}{(m^2 + n^2 + 1)} \right) + \operatorname{atan} \left(\frac{2m \cdot n \cdot \sqrt{m^2 + n^2 + 1}}{m^2 + n^2 - m^2 \cdot n^2 + 1} \right) \right] = 0.101$$

For rectangle 2: $\underline{\underline{B}} := 6$ $\underline{\underline{L}} := 10$ $\underline{\underline{m}} := \frac{B}{z} = 0.6$ $\underline{\underline{n}} := \frac{L}{z} = 1$

$$I_4 := \frac{1}{4 \cdot \pi} \cdot \left[\left(\frac{2m \cdot n \cdot \sqrt{m^2 + n^2 + 1}}{m^2 + n^2 + m^2 \cdot n^2 + 1} \right) \cdot \left(\frac{(m^2 + n^2 + 2)}{(m^2 + n^2 + 1)} \right) + \operatorname{atan} \left(\frac{2m \cdot n \cdot \sqrt{m^2 + n^2 + 1}}{m^2 + n^2 - m^2 \cdot n^2 + 1} \right) \right] = 0.136$$

$$\underline{\underline{\Delta \sigma}} := w \cdot (I_1 + I_2 + I_3 + I_4) = 1.366 \times 10^3 \frac{\text{lb}}{\text{ft}^2} \quad \text{EQ 5.9}$$

5.4 Using Eq. (5.10), determine the stress increase ($\Delta \sigma$) at $z = 10$ ft below the center of the area described in Problem 5.2.

GIVEN $\underline{\underline{w}} := 3000 \frac{\text{lb}}{\text{ft}^2}$ $\underline{\underline{z}} := 10 \text{ m}$ $\underline{\underline{B1}} := 4 \text{ ft}$ $\underline{\underline{B2}} := 6 \text{ ft}$ $\underline{\underline{B}} := B1 + B2 = 10 \text{ ft}$
 $\underline{\underline{L1}} := 8 \text{ ft}$ $\underline{\underline{L2}} := 10 \text{ ft}$ $\underline{\underline{L}} := L1 + L2 = 18 \text{ ft}$

FIND 1. Stress Increase at 10 ft below point O using Eq 5.10

METHOD 1. Use Eq 5.12 and 5.13 for m and n
 2. Use Eq 5.11 to determine the influence factor I_c
 3. Use Eq 5.10 to determine stress

SOLUTION $\underline{\underline{m}} := \frac{L}{B} = 1.8$ EQ 5.12 $\underline{\underline{n}} := \frac{z}{\left(\frac{B}{2}\right)} = 2$ EQ 5.13

$$I_c := \frac{2}{\pi} \left[\operatorname{asin} \left[\frac{m}{\left(\sqrt{m^2 + n^2}\right) \cdot \left(\sqrt{1 + n^2}\right)} \right] + \left[\frac{(m \cdot n)}{\sqrt{1 + m^2 + n^2}} \right] \frac{(1 + m^2 + 2 \cdot n^2)}{(1 + n^2) \cdot (m^2 + n^2)} \right] = 0.463 \quad \text{EQ 5.11}$$

$$\underline{\underline{\Delta \sigma}} := w \cdot I_c = 1.39 \times 10^3 \frac{\text{lb}}{\text{ft}^2} \quad \text{EQ 5.10}$$

5.5 Refer to Figure P5.5. Using the procedure outlined in Section 5.5, determine the average stress increase in the clay layer below the center of the foundation due to the net foundation load of 900 kN.

GIVEN $\underline{\underline{w}} := 3000 \frac{\text{lb}}{\text{ft}^2}$ $\underline{\underline{d}} := 10 \text{ m}$ $\underline{\underline{B1}} := 4 \text{ ft}$ $\underline{\underline{B2}} := 6 \text{ ft}$
 $\underline{\underline{L1}} := 8 \text{ ft}$ $\underline{\underline{L2}} := 10 \text{ ft}$

FIND 1. Average stress increase in the clay layer due to the q_n foundation

METHOD 1. Using

SOLUTION

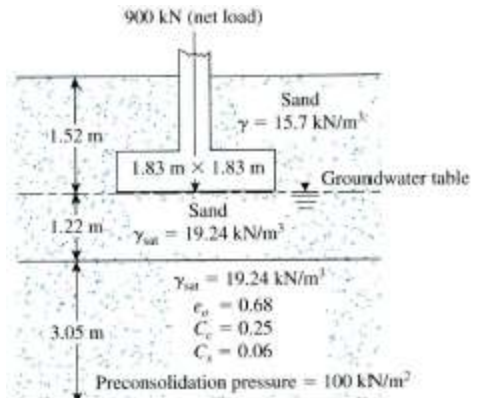


Figure P5.5

5.6 Solve Problem 5.5 using the 2:1 method [Eqs. (5.14) and (5.84)].

GIVEN $w := 3000 \frac{\text{lb}}{\text{ft}^2}$ $d := 10 \text{ m}$ $B1 := 4 \text{ ft}$ $B2 := 6 \text{ ft}$
 $L1 := 8 \text{ ft}$ $L2 := 10 \text{ ft}$

FIND 1. Average stress increase in the clay layer due to the q_n foundation

METHOD 1. Solve using 2:1 method Eq. 5.14 and 5.84

SOLUTION

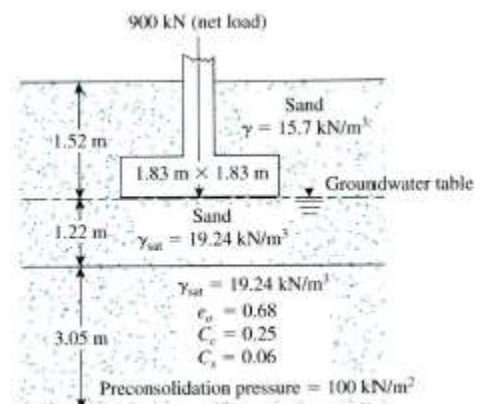


Figure P5.5

5.7 Figure P5.7 shows an embankment load on a silty clay soil layer. Determine the stress increase at points A, B, and C, which are located at a depth of 5 m below the ground surface.

GIVEN $w := 3000 \frac{\text{lb}}{\text{ft}^2}$ $d := 10 \text{ m}$ $B1 := 4 \text{ ft}$ $B2 := 6 \text{ ft}$
 $L1 := 8 \text{ ft}$ $L2 := 10 \text{ ft}$

FIND 1. Stress increase at A, B and C

METHOD 1. Solve using 2:1 method Eq. 5.14 and 5.84

SOLUTION

