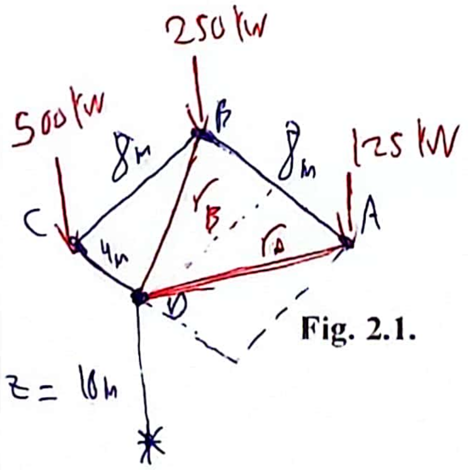
Birzeit University
Soil Mechanics, ENCE 331
Homework Assignment 2
(Due to 23 Jan 2024, 10:00 p.m.)

Student Name: Youhanna MuSleh **Inst.: Eng. Saheem Murshid**

Student ID: 1211224 **T.A.: Eng. Tamer AL-Shyoukhi**

Submission Date: 1/22/2024

1. Point loads of magnitude 125, 250, and 500 kN act at A, B, and C, respectively. Determine the increase in vertical stress at a depth 10 m under point D, see **Fig. 2.1.**



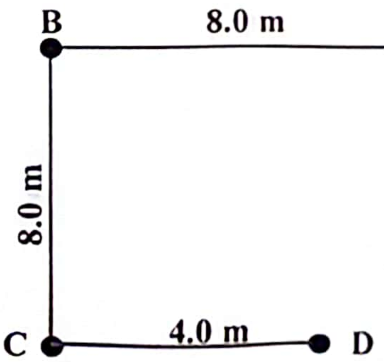


Fig. 2.1.

for C :

$\frac{r_C}{z} = \frac{4}{10} = 0.4$

$\Rightarrow I_1 = 0.3294$ from Table of the point Load

$\Delta\sigma_C = \frac{500}{10^2} * 0.3294 = 1.647 \ kN/m^2$

$r_B = \sqrt{8^2+4^2} = 8.94 \ m = r_A$

$\frac{r_B}{z} = \frac{8.94}{10} = 0.894 = \frac{r_A}{z}$

Interpolation :-

$\frac{0.90 - 0.85}{0.894 - 0.85} = \frac{0.1083 - 0.1226}{x - 0.1226}$

[from the Table]

$-0.0143 = 1.136x - 0.1393$

$x = 0.11 \Rightarrow I_1 = 0.11$

$\Rightarrow \underset{\text{for B}}{\Delta\sigma_z} = \frac{250}{(10)^2} * 0.11 = 0.275 \ kN/m^2$

$\Rightarrow \underset{\text{for A}}{\Delta\sigma_z} = \frac{125}{(10)^2} * 0.11 = 0.137 \ kN/m^2$

Total increase in the vertical Stress :-

$\Delta\sigma_{total} = \Delta\sigma_A + \Delta\sigma_B + \Delta\sigma_C$

$= 0.137 + 0.275 + 1.647$

$\Delta\sigma_{total} = 2.0595 \ kN/m^2$

2. Determine the increase of stresses at point A due to two line-loads as shown in **Fig. 2.2.**

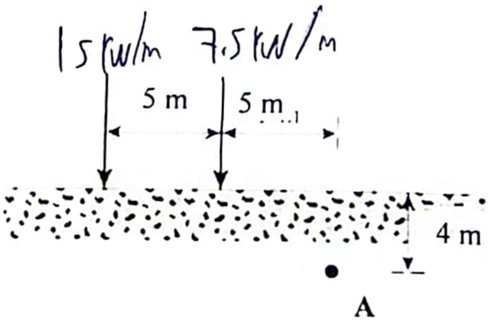


Fig. 2.2.

for 7.5 kN/m :- $x = 5m$

$\Rightarrow \frac{x}{z} = \frac{5}{4} = 1.25$

Interpolation :- [from the Table]

$\frac{1.3 - 1.2}{1.25 - 1.2} = \frac{0.088 - 0.107}{X - 0.107}$

$-0.019 = 2X - 0.214$

$X = 0.0975$

$\frac{\Delta\sigma}{(q/z)} = 0.0975 \Rightarrow \frac{\Delta\sigma}{(7.5/4)} = 0.0975$

$\Delta\sigma_{z_1} = 0.183 \ kN/m^2$

for 15 kN/m :- $x = 10m$

$\Rightarrow \frac{x}{z} = \frac{10}{4} = 2.5$

Interpolation:-

$\frac{2.6 - 2.4}{2.5 - 2.4} = \frac{0.011 - 0.014}{X - 0.014}$

$X = 0.0125$

$\frac{\Delta\sigma}{(q/z)} = 0.0125$

$\frac{\Delta\sigma}{(15/4)} = 0.0125$

$\Delta\sigma_{z_2} = 0.0468 \ \frac{kN}{m^2}$

$$\boxed{\begin{aligned}\Delta\sigma_{total} &= \Delta\sigma_{z_1} + \Delta\sigma_{z_2} \\ &= 0.183 + 0.0468 \\ \Delta\sigma_{total} &= 0.2298 \ \frac{kN}{m^2}\end{aligned}}$$

3. For the **Fig. 2.3**, given $B = 4\ m, q = 100\ kN/m^2, z = 1\ m, and\ x = 1\ m$. Find $\Delta\sigma_z$ at point A.

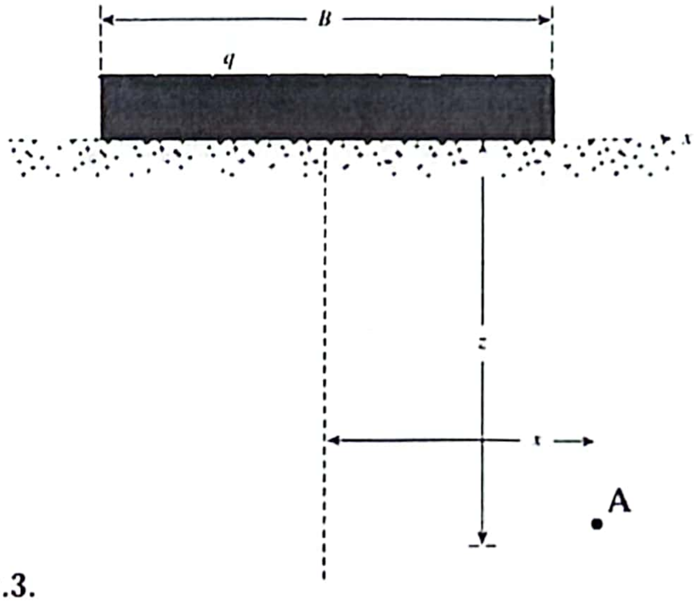


Fig. 2.3.

$\frac{2z}{B} = \frac{2(1)}{4} = 0.5$ / $\frac{2x}{B} = \frac{2(1)}{4} = 0.5$

From Table [Vertical strip load Table]

$\frac{\Delta\sigma}{q} = 0.902 \Rightarrow \frac{\Delta\sigma}{100} = 0.902 \Rightarrow \Delta\sigma_z = 90.2\ kN/m^2$

4. A flexible rectangular area is subjected to a uniform distributed load of $q = 330\ kN/m^2$. Determine the increase in vertical stress; $\Delta\sigma_z$, at a depth of $z = 6\ m$ under points A, B, and C, see **Fig. 2.4.**

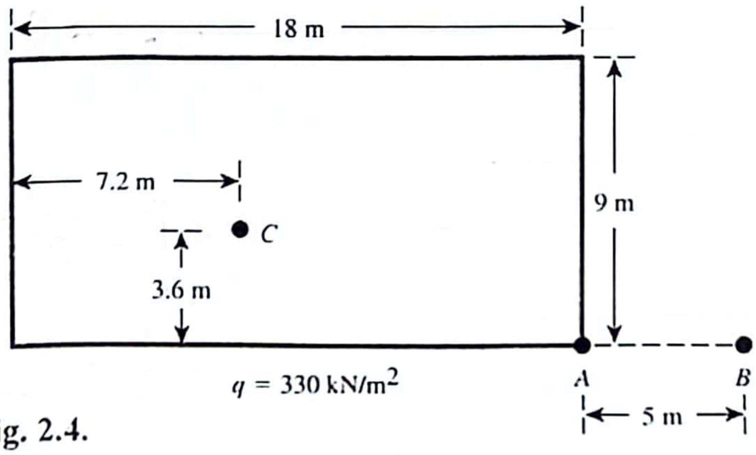
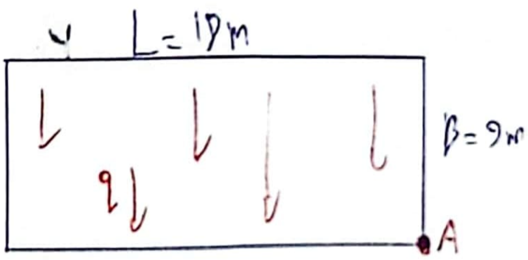


Fig. 2.4.

for A:-



$$m = \frac{B}{z} = \frac{9}{6} = 1.5 \ / \ n = \frac{L}{z} = \frac{18}{6} = 3$$

Interpolation:-
[from Table
Rectangular Area]

$$\frac{1.6-1.4}{1.5-1.4} = \frac{0.2309-0.2250}{x-0.2250}$$

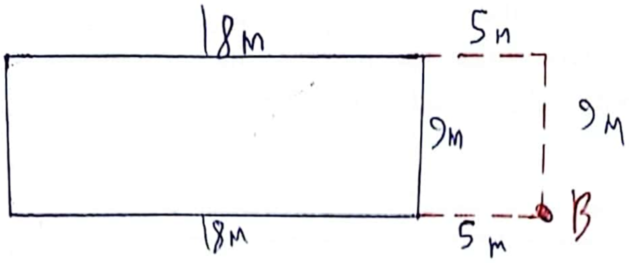
$$5.9\times10^{-3} = 2x - 0.45$$

$$x = 0.2280 = I_3$$

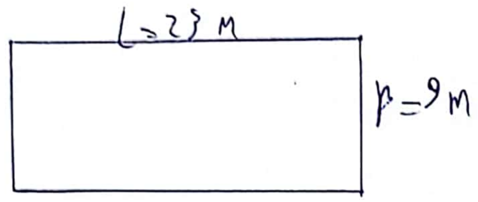
$$\Delta\sigma = qI_3 = 330(0.2280)$$

$$\Delta\sigma_{zA} = 75.24\ kN/m^2$$

for B:



Part ①



$$m = \frac{B}{z} = \frac{9}{6} = 1.5$$

$$n = \frac{L}{z} = \frac{23}{6} = 3.83$$

Interpolation:-

$$\frac{1.6-1.4}{1.5-1.4} = \frac{0.2309-0.2250}{x-0.2250} \Rightarrow x = 0.2280$$

$$\frac{1.6-1.4}{1.5-1.4} = \frac{0.2320-0.2260}{x-0.2260} \Rightarrow x = 0.2290$$

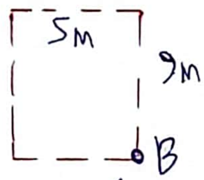
Interpolation:-

$$\frac{4-3}{3.83-3} = \frac{0.2290-0.2280}{x-0.2280} \Rightarrow x = 0.2288$$

$$\Delta\sigma = 330(I_3)$$

$$\Delta\sigma_{B1} = 330(0.2288) = 75.504 \text{ kN/m}^2$$

Part ②



$m = \frac{B}{z} = 1.5$ / $n = \frac{5}{6} = 0.833$

Interpolation:-

$$\frac{1.6-1.4}{1.5-1.4} = \frac{0.1774-0.1739}{x-0.1739}$$

$$x = 0.17565$$

$$\frac{1.6-1.4}{1.5-1.4} = \frac{0.1874-0.1836}{x-0.1836}$$

$$x = 0.1855$$

Interpolation:-

$$\frac{0.9-0.8}{0.833-0.8} = \frac{0.1855-0.17565}{x-0.17565}$$

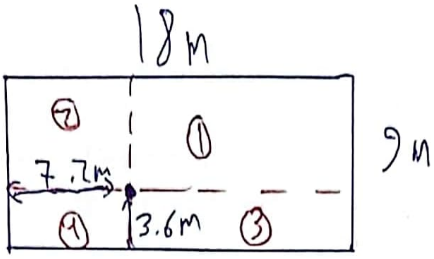
$$x = 0.1789$$

$$\Delta\sigma_{B_2} = 330(0.1789) = 59.037 \text{ kN/m}^2$$

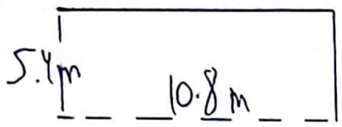
$$\Delta_B = \Delta\sigma_{B_1} - \Delta\sigma_{B_2}$$

$$= 75.504 - 59.037 = 16.467 \text{ kN/m}^2$$

for C :-



1



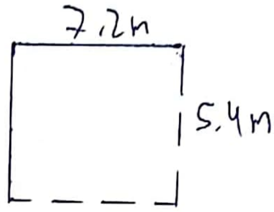
$m = \frac{5.4}{6} = 0.9 \; / \; n = \frac{10.8}{6} = 1.8$

from Table

$\Rightarrow \; I_3 = 0.1899$

$\Delta\sigma = 330(0.1899) = 62.667 \; kN/m^2$

2

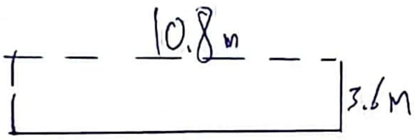


$m = \frac{5.4}{6} = 0.9 \; / \; n = \frac{7.2}{6} = 1.2$

$\Rightarrow \; I_3 = 0.1777$

$\Delta\sigma = 330(0.1777) = 58.641 \; \frac{kN}{m^2}$

3

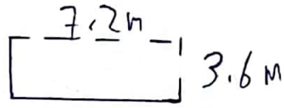


$m = \frac{3.6}{6} = 0.6 \; / \; n = \frac{10.8}{6} = 1.8$

$\Rightarrow \; I = 0.1521$

$\Delta\sigma = 330(0.1521) = 50.193 \; \frac{kN}{m^2}$

4



$m = \frac{3.6}{6} = 0.6 \; / \; n = \frac{7.2}{6} = 1.2$

$\Rightarrow \; I = 0.1431$

$\Delta\sigma = 330(0.1431) = 47.223$

Total stress in C : $\Delta\sigma_c = \Delta\sigma_1 + \Delta\sigma_2 + \Delta\sigma_3 + \Delta\sigma_4$

$= 62.667 + 58.641 + 50.193 + 47.223$

$\Delta\sigma_c = 218.724 \; kN/m^2$

5. **Fig. 2.5** shows the schematic of a circular water storage facility resting on the ground surface. The radius of the storage tank, R = 2.5 m, and the maximum height of water, h_w = 4 m. Determine the vertical stress increase, $\Delta\sigma_z$, at points 0, 2, 4, 8, and 10 m below the ground surface along the centerline of the tank.

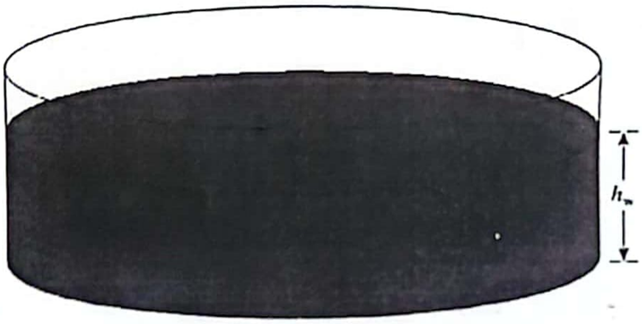


Fig. 2.5.

$h_w = 4m$  $R = 2.5\ m$

$\Delta\sigma (A' + B')$ $\quad q = h_w \gamma_w = 4(10) = 40\ kN/m^2$

\# for $z = 0$

$\Rightarrow \frac{z}{R} = 0 \ / \ \frac{r}{R} = 0 \Rightarrow A' = 1.0$ {From Table}

$B' = 0$ Uniformly dist. Loaded cir. Area.

$\Delta\sigma = 40(1+0) = 40\ kN/m^2$

\# for $z = 2m$

$\Rightarrow \frac{z}{R} = \frac{2}{2.5} = 0.8 \ / \ \frac{r}{R} = 0 \Rightarrow A' = 0.37531$

$B' = 0.38091$

$\Delta\sigma = 40(0.37531 + 0.38071) = 30.2492\ kN/m^2$

* for $z = 4m$

$\Rightarrow \frac{z}{R} = \frac{4}{2.5} = 1.6 \;/\; \frac{r}{R} = 0 \Rightarrow A': \frac{2-1.5}{1.6-1.5} = \frac{0.10557 - 0.16795}{x - 0.16795}$

$A' = 0.155474$

$\therefore \Delta\sigma = 40(A' + B')$

$\Delta\sigma = 15.843 \ kN/m^2$

$B': \frac{2-1.5}{1.6-1.5} = \frac{0.17889 - 0.25602}{x - 0.25602}$

$B' = 0.240594$

* for $z = 8m \Rightarrow \frac{z}{R} = \frac{8}{2.5} = 3.2 \;/\; \frac{r}{R} = 0$

$A': \frac{4-3}{3.2-3} = \frac{0.02986 - 0.05132}{x - 0.05132}$, $B': \frac{4-3}{3.2-3} = \frac{0.05707 - 0.09487}{x - 0.09487}$

$A' = 0.047028$ $\quad B' = 0.08731$

$\Rightarrow \Delta\sigma = 40(A' + B')$

$\Delta\sigma = 5.373 \ kN/m^2$

* for $z = 10m$

$\Rightarrow \frac{z}{R} = \frac{10}{2.5} = 4 \;/\; \frac{r}{R} = 0 \Rightarrow A' = 0.02986$

$B' = 0.05707$

$\Delta\sigma = 40(A' + B')$

$\Delta\sigma = 3.4772 \ kN/m^2$

6. Referring to **Fig. 2.6.** For the linearly increasing vertical loading on an infinite strip of width 5 m, determine the vertical stress increase, $\Delta\sigma_z$, at A.

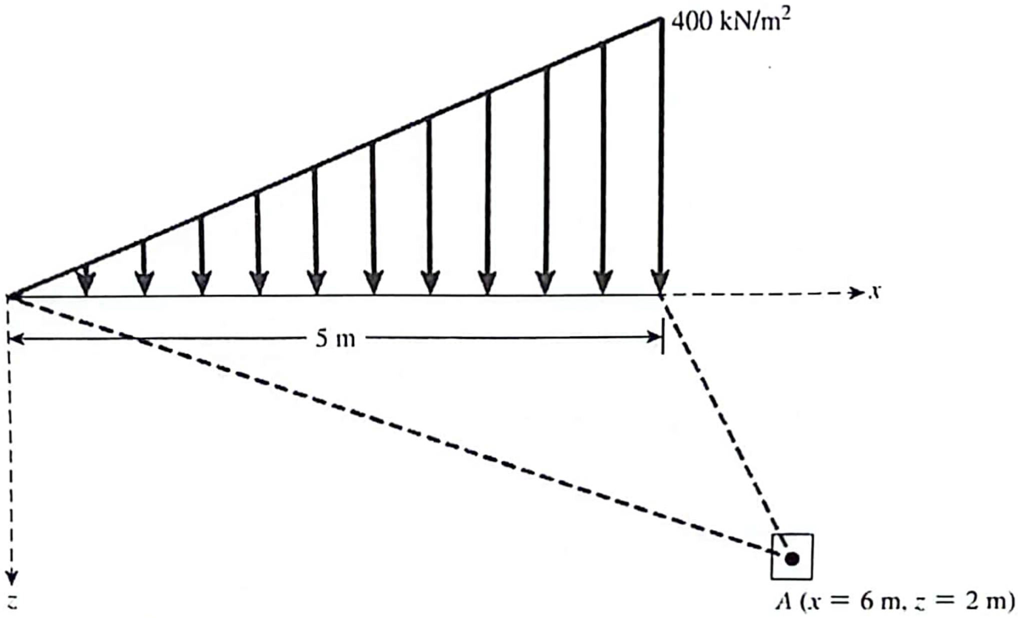


Fig. 2.6.

$\frac{2x}{B} = \frac{2(6)}{5} = 2.4$ / $\frac{2z}{B} = \frac{2(2)}{5} = 0.8$

Interpolation:-

$\frac{1-0.5}{0.8-0.5} = \frac{0.3524-0.4220}{x-0.4220}$

$x = 0.3802$

$\frac{1-0.5}{0.8-0.5} = \frac{0.0622-0.0152}{x-0.0152}$

$x = 0.04337$

Interpolation:-

$\frac{3-2}{2.4-2} = \frac{0.04337-0.3802}{x-0.3802}$

$x = 0.2455$

$\therefore \frac{\Delta\sigma_z}{q} = 0.2455$

$\Delta\sigma_z = 0.2455(400) = 98.2 \frac{kN}{m^2}$