

Elastic Theory

Q1.

$$\sigma_z = qI_r$$

i) **Point A**

$$m = \frac{B}{Z} = \frac{1.2}{3.5} = 0.342; \quad n = \frac{L}{Z} = \frac{2.4}{3.5} = 0.69; \quad I_{r1} = 0.0718$$

$$m = \frac{B}{Z} = \frac{0.3}{3.5} = 0.0857; \quad n = \frac{L}{Z} = \frac{2.4}{3.5} = 0.69; \quad I_{r2} = 0.0221$$

$$m = \frac{B}{Z} = \frac{1.2}{3.5} = 0.342; \quad n = \frac{L}{Z} = \frac{1.1}{3.5} = 0.31; \quad I_{r3} = 0.0425$$

$$m = \frac{B}{Z} = \frac{0.3}{3.5} = 0.0857; \quad n = \frac{L}{Z} = \frac{1.1}{3.5} = 0.31; \quad I_{r4} = 0.0085$$

$$\Delta\sigma_z = q (I_{r1} + I_{r2} + I_{r3} + I_{r4})$$

$$= 80 \times (0.0718 + 0.0221 + 0.0425 + 0.0085) = \mathbf{11.592 \text{ kN/ m}^2}$$

ii) **Point B**

$$m = \frac{B}{Z} = \frac{1.5}{3.5} = 0.429 \quad ; \quad n = \frac{L}{Z} = \frac{3.5}{3.5} = 1; \quad I_{r1} = 0.1175$$

$$\Delta\sigma_z = q \times I_{r1}$$

$$= 80 \times 0.1175 = \mathbf{9.40 \text{ kN/ m}^2}$$

ii) **Point C**

The stress in the C should be the stress caused by rectangle 5m x 1.5m minus the stress caused rectangle 1.5m x 1.5m.

For rectangle 5m x 1.5m

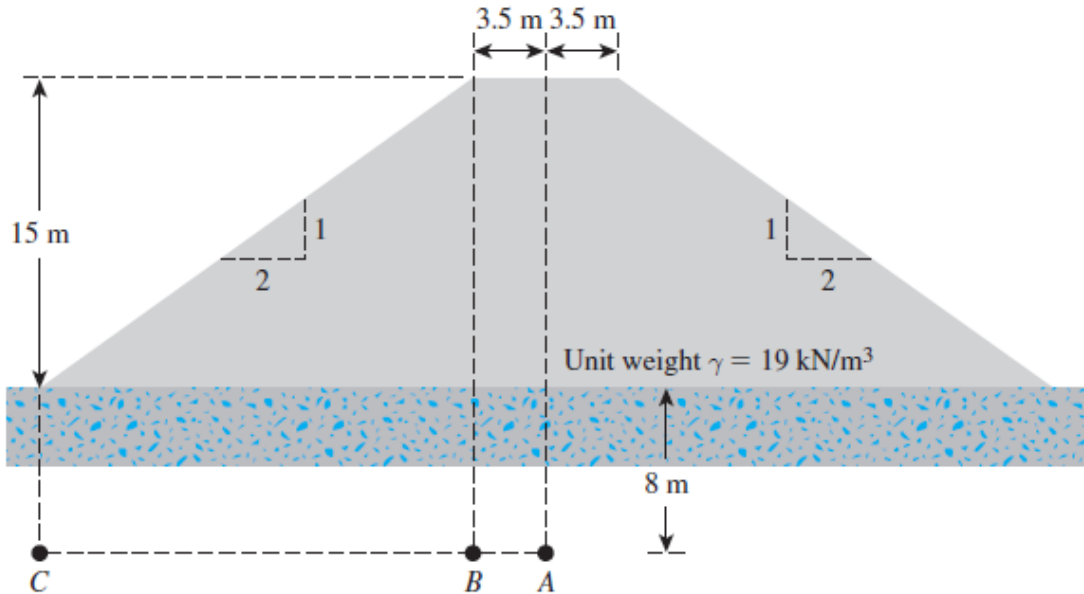
$$m = \frac{B}{Z} = \frac{1.5}{3.5} = 0.429; \quad n = \frac{L}{Z} = \frac{5}{3.5} = 1.429; \quad I_{r1} = 0.1245$$

For rectangle 1.5m x 1.5m

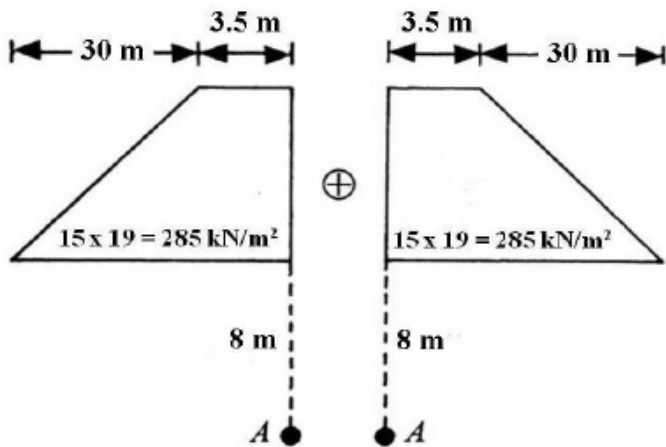
$$m = \frac{B}{Z} = \frac{1.5}{3.5} = 0.429; \quad n = \frac{L}{Z} = \frac{1.5}{3.5} = 0.429; \quad I_{r1} = 0.0788$$

$$\Delta\sigma_z = q (I_{r1} - I_{r2}) = 80 \times (0.1245 - 0.0788) = \mathbf{3.656 \text{ kN/ m}^2}$$

Q2.



At A:



For the left side:

$$\frac{B_1}{z} = \frac{3.5}{8} = 0.437$$

$$\frac{B_2}{z} = \frac{30}{8} = 3.75$$

$$I_2 = 0.46$$

For the right side:

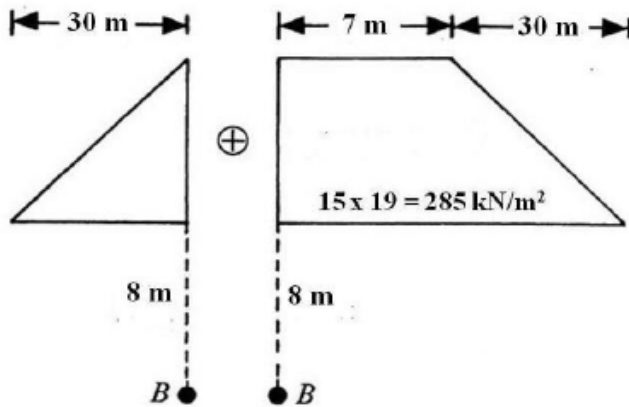
$$\frac{B_1}{z} = 0.437$$

$$\frac{B_2}{z} = 3.75$$

$$I_2 = 0.46$$

$$\Delta\sigma_z = (15)(19)(0.46 + 0.46) = 262.2 \text{ kN/m}^2$$

At B:



For the
left side:

$$\frac{B_1}{z} = \frac{0}{8} = 0$$

$$\frac{B_2}{z} = \frac{30}{8} = 3.75$$

$$I_2 = 0.41$$

For the
right side:

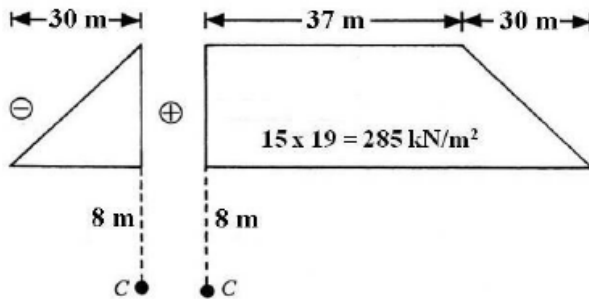
$$\frac{B_1}{z} = \frac{7}{8} = 0.875$$

$$\frac{B_2}{z} = \frac{30}{8} = 3.75$$

$$I_2 = 0.48$$

$$\Delta\sigma_z = (15)(19)(0.41 + 0.48) = 253.65 \text{ kN/m}^2$$

At C:



For the
left side:

$$\frac{B_1}{z} = 0$$

$$\frac{B_2}{z} = \frac{30}{8} = 3.75$$

$$I_2 = 0.41$$

For the
right side:

$$\frac{B_1}{z} = \frac{37}{8} = 4.625$$

$$\frac{B_2}{z} = \frac{30}{8} = 3.75$$

$$I_2 = 0.5$$

$$\Delta\sigma_z = (15)(19)(0.5 - 0.41) = 25.65 \text{ kN/m}^2$$

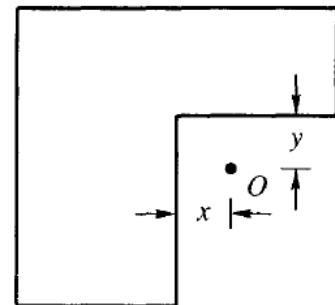
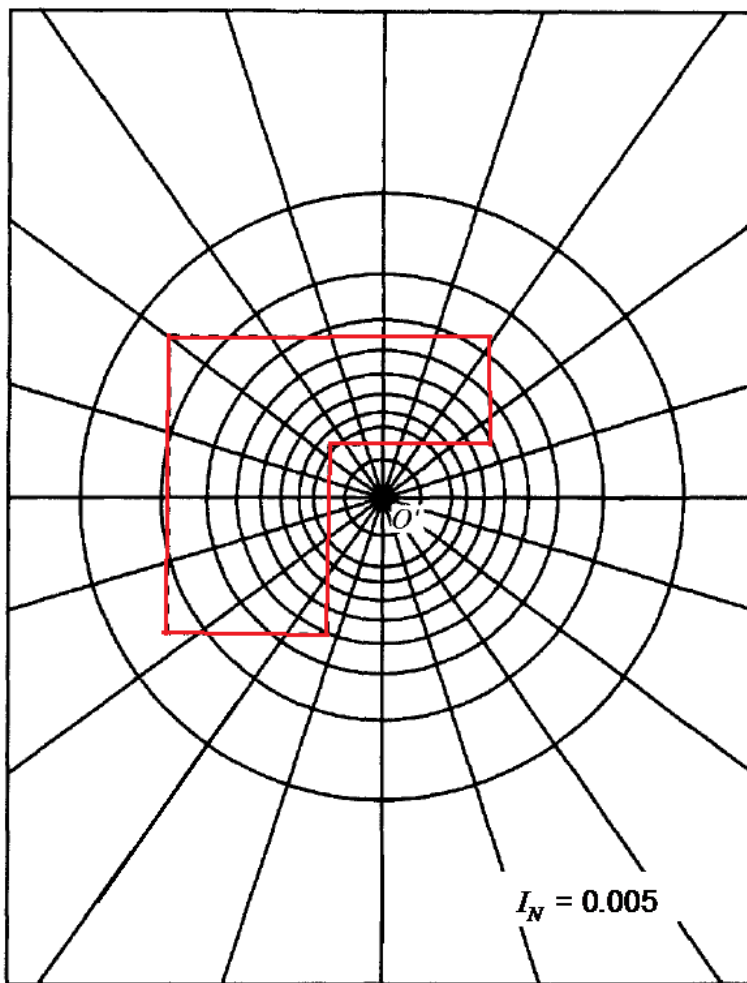
Q3. The depth at which σ_z is required is 9m. Set the depth scale on the Newmark chart equal to 9m and plot the foundation plan to this scale on tracing paper. Set point O to coincide with the center of the chart as shown in the Figure below.

Number of elements occupied by the plan, $N=62$.

Influence value of each element, $I_N=0.005$

The vertical stress increase under point O is given by:

$$\Delta\sigma_z = (I_N)(N)(q) = 0.005 \times 62 \times 300 = 93 \text{ kN} / \text{m}^2$$



9 m
Depth scale