Example 5.1

A load of 1500 kN is carried on a foundation 2 m square at a shallow depth in a soil mass. Determine the vertical stress at a point 5 m below the centre of the foundation (a) assuming the load is uniformly distributed over the foundation, (b) assuming the load acts as a point load at the centre of the foundation.

(a) Uniform pressure,

$$q = \frac{1500}{2^2} = 375\,\text{kN/m}^2$$

The area must be considered as four quarters to enable Fig. 5.10 to be used. In this case:

$$mz = nz = 1\,\text{m}$$

Then, for $z = 5$ m,

$$m = n = 0{\cdot}2$$

From Fig. 5.10,

$$I_r = 0{\cdot}018$$

Hence,

$$\sigma_z = 4qI_r = 4 \times 375 \times 0{\cdot}018 = 27\,\text{kN/m}^2$$

(b) From Table 5.1, $I_p = 0{\cdot}478$ since $r/z = 0$ vertically below a point load. Hence,

$$\sigma_z = \frac{Q}{z^2} I_p = \frac{1500}{5^2} \times 0{\cdot}478 = 29\,\text{kN/m}^2$$

The point load assumption should not be used if the depth to the point X (Fig. 5.5a) is less than three times the larger dimension of the foundation.

Example 5.2

A rectangular foundation 6 m × 3 m carries a uniform pressure of 300 kN/m² near the surface of a soil mass. Determine the vertical stress at a depth of 3 m below a point (A) on the centre line 1·5 m outside a long edge of the foundation, (a) using influence factors, (b) using Newmark's influence chart.

(a) Using the principle of superposition the problem is dealt with in the manner shown in Fig. 5.12. For the two rectangles (1) carrying a *positive* pressure of 300 kN/m², $m = 1{\cdot}00$ and $n = 1{\cdot}50$, therefore

$$I_r = 0{\cdot}193$$

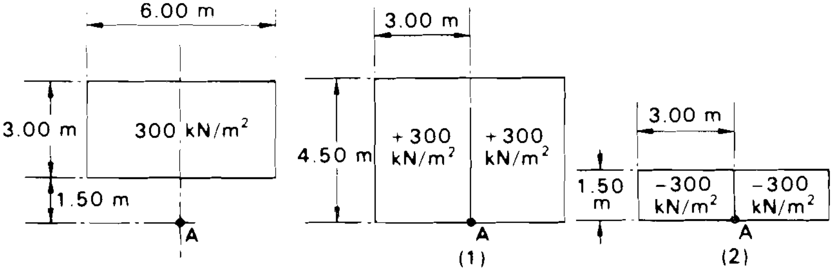

Fig. 5.12

For the two rectangles (2) carrying a *negative* pressure of $300\,kN/m^2$, $m = 1{\cdot}00$ and $n = 0{\cdot}50$, therefore

$$I_r = 0{\cdot}120$$

Hence,

$$\sigma_z = (2 \times 300 \times 0{\cdot}193) - (2 \times 300 \times 0{\cdot}120)$$
$$= 44\,kN/m^2$$

(b) Using Newmark's influence chart (Fig. 5.11) the scale line represents 3 m, fixing the scale to which the rectangular area must be drawn. The area is positioned such that the point A is at the centre of the chart. The number of influence areas covered by the rectangle is approximately 30 (i.e. $N = 30$), hence

$$\sigma_z = 0{\cdot}005 \times 30 \times 300$$
$$= 45\,kN/m^2$$

Example 5.3

A strip footing 2 m wide carries a uniform pressure of $250\,kN/m^2$ on the surface of a deposit of sand. The water table is at the surface. The saturated unit weight of the sand is $20\,kN/m^3$ and $K_0 = 0{\cdot}40$. Determine the effective vertical and horizontal stresses at a point 3 m below the centre of the footing before and after the application of the pressure.

Before loading:

$$\sigma'_z = 3\gamma' = 3 \times 10{\cdot}2 = 30{\cdot}6\,kN/m^2$$
$$\sigma'_x = K_0\sigma'_z = 0{\cdot}40 \times 30{\cdot}6 = 12{\cdot}2\,kN/m^2$$

After loading: Referring to Fig. 5.7a, for a point 3 m below the centre of the footing,

$$\alpha = 2\tan^{-1}(\tfrac{1}{3}) = 36^\circ\,52' = 0{\cdot}643 \text{ radians}$$

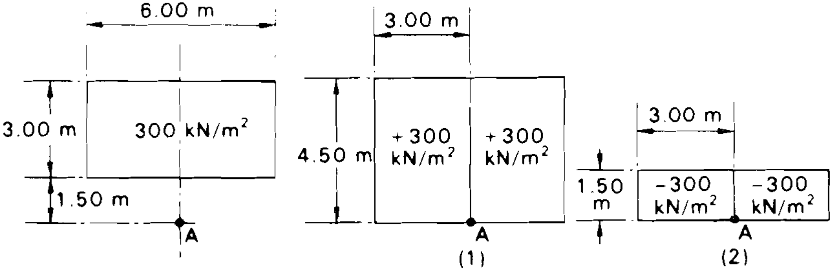

Fig. 5.12

For the two rectangles (2) carrying a *negative* pressure of 300 kN/m², $m = 1{\cdot}00$ and $n = 0{\cdot}50$, therefore

$$I_r = 0{\cdot}120$$

Hence,

$$\sigma_z = (2 \times 300 \times 0{\cdot}193) - (2 \times 300 \times 0{\cdot}120)$$
$$= 44\,\text{kN/m}^2$$

(b) Using Newmark's influence chart (Fig. 5.11) the scale line represents 3 m, fixing the scale to which the rectangular area must be drawn. The area is positioned such that the point A is at the centre of the chart. The number of influence areas covered by the rectangle is approximately 30 (i.e. $N = 30$), hence

$$\sigma_z = 0{\cdot}005 \times 30 \times 300$$
$$= 45\,\text{kN/m}^2$$