8. STRESS DISTRIBUTION IN THE SOIL

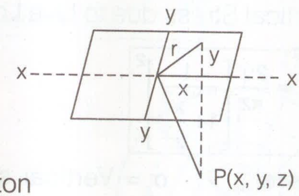
Stress in the soil may be caused by:

1. Self weight of soil
2. Applied load on soil

BOUSSINESQ'S THEORY

Vertical stress at point 'P'. (σ_z)

(i) $$\sigma_z = \frac{3Q}{2\pi z^2}\left[\frac{1}{1+\frac{r^2}{z^2}}\right]^{5/2}$$



where, Q = Point load in newton

(ii) $$\sigma_z = k_B \cdot \frac{Q}{z^2}$$

where, $k_B = \frac{3}{2\pi}\left[\frac{1}{1+\frac{r^2}{z^2}}\right]^{5/2}$ $\quad$ $k_B|_{max} = \frac{3}{2\pi} = 0.4775$

(iii) 'σ_z' below the point load at depth z, $\sigma_z = 0.4775.\frac{Q}{z^2}$

WESTERGAARD'S THEORY

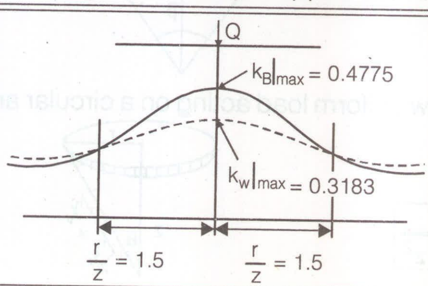
(i) $$\sigma_z = \frac{Q}{\pi z^2}\left[\frac{1}{1+\frac{2r^2}{z^2}}\right]^{3/2}$$

(ii) $$\sigma_z = k_w.\frac{Q}{z^2}$$

(iii) $k_w|_{max} = 0.3183$

NOTE: Boussinesq's theory is applicable for Isotropic soil where as westergaards theory is applicable for non-Isotropic soil.

Remember



if $\frac{r}{z} < 1.5 \Rightarrow k_B > k_w$

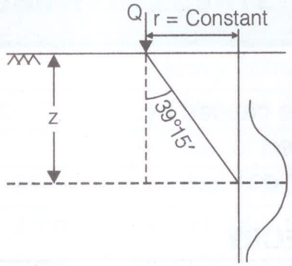
if $\frac{r}{z} > 1.5 \Rightarrow k_w > k_B$

if $\frac{r}{z} = 1.5 \Rightarrow k_w = k_B$

BOUSSINESQ'S RESULT

$\sigma_z|_{max} = 0.0888\frac{Q}{r^2}$

$\sigma_z|_{max} = 0.1332\frac{Q^2}{z^2}$



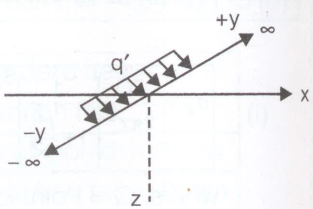
$\sigma_z|_{maximum} = 0.0888\frac{Q}{r^2}$

$\sigma_z|_{maximum} = 0.1332\frac{Q}{z^2}$

WESTERGAARD'S RESULTS

(i) Vertical Stress due to Live Loads

$$\sigma_z = \frac{2q'}{\pi z}\left[\frac{1}{1+\frac{x^2}{z^2}}\right]^2$$



where, σ_z = Vertical stress of any point having coordinate (x, z)

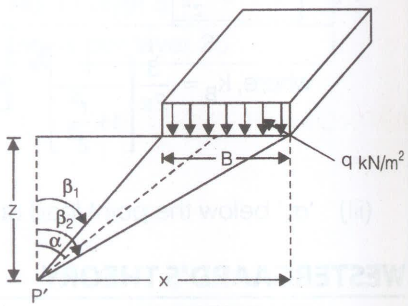
Load intensity = q'/m

at x = 0 → $\sigma_z = \frac{2q'}{\pi z}$

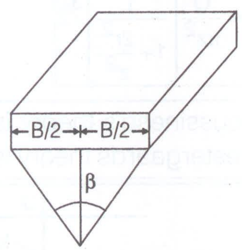
(ii) Vertical Stress due to Strip Loading

$$\sigma_z = \frac{2q}{\pi}\left(\frac{x}{B}\alpha - \frac{\sin 2\beta}{2}\right)$$

where, σ_z = Vertical stress at point 'p'



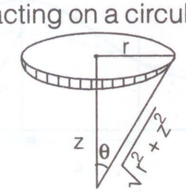
(iii) $\sigma_z = \frac{q}{\pi}[\beta + \sin\beta]$



(iv) Vertical stress below uniform load acting on a circular area.

$\sigma_z = q(1-\cos^3\theta)$

where, $\cos\theta = \frac{z}{\sqrt{r^2+z^2}}$



NEWMARK'S CHART METHOD

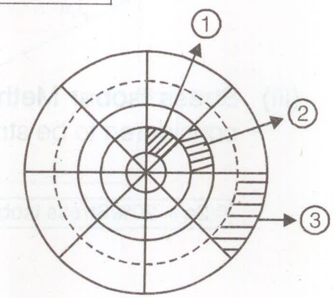
This method is applicable to semi-infinite, homogeneous, isotropic and elastic soil mass. It is not applicable for layered structure. The greatest advantage of this method is that it can be applied for uniformly distributed area of irregular shape. Newmark's chart is made of concentric circles and radial lines. Normally there are 10 concentric circles and 20 radial lines.

no. of concentric circle = 10 | no. of radial lines = 20

Influence of area (1) = Influence of area (2) = Influence of area (3)

$$\text{Influence of each area} = \frac{1}{\text{Total no of sectoral area}} = 0.005$$

$\sigma_z = 0.005qN_A$



where, N_A = Total number of sectorial area of Newmark's chart.

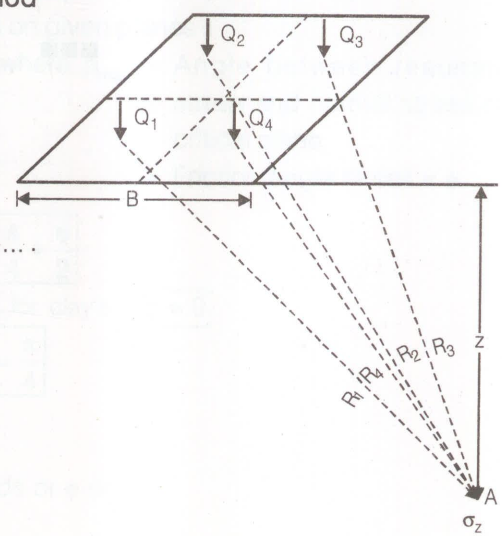
APPROXIMATE METHOD

(i) Equivalent Load Method

$\sigma_z = \sigma_{z_1} + \sigma_{z_2} + \sigma_{z_3} + ...$

where, $\sigma_{z_1} = k_{B_1}\frac{Q_1}{z^2}$

$\sigma_2 = k_{B_2}\cdot\frac{Q_2^2}{z^2}$....



(ii) Trapezoidal Method

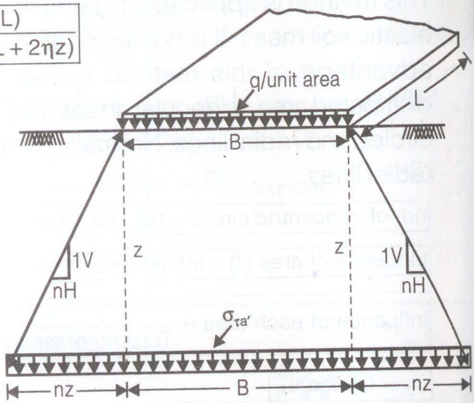
$$\sigma_z \text{ at depth } 'z' = \frac{q(B \times L)}{(B + 2\eta z)(L + 2\eta z)}$$

For 1H : 1V

$$\sigma_z = \frac{q(B \times L)}{(B + 2z)(L + 2z)}$$

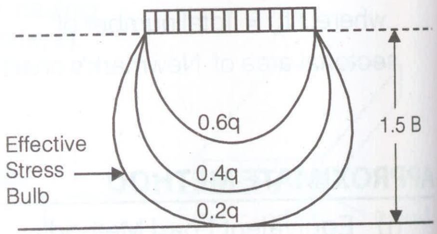
For 2H : 1V

$$\sigma_z = \frac{q(B \times L)}{(B + 4z)(L + 4z)}$$



(iii) Stress Isobar Method : Area bounded by 0.2q stress isobar is considered to be stressed by vertical stress on loading.

0.2q = 20% Stress Isobar



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