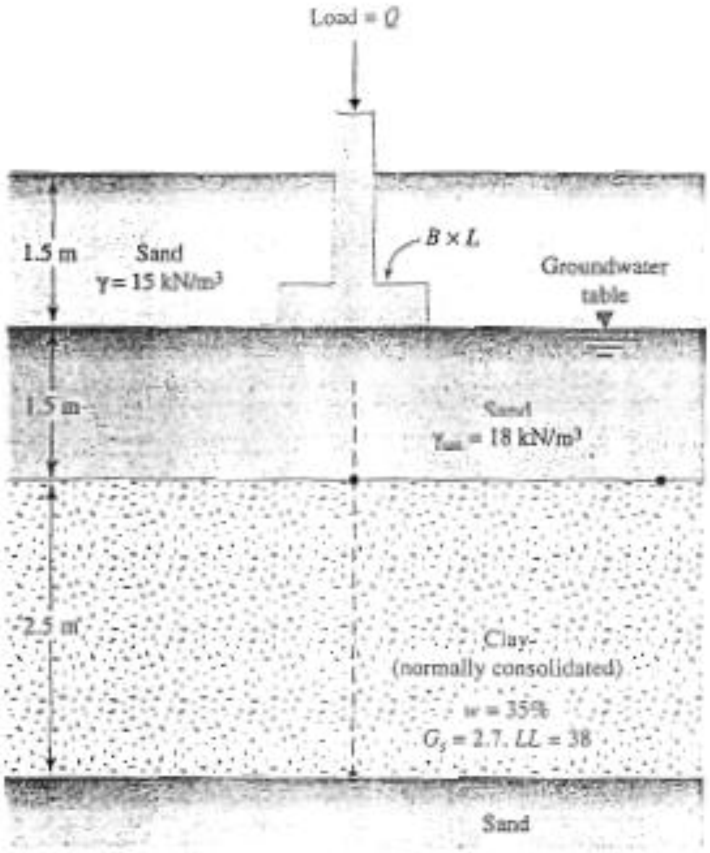
Problem:

Refer to the figure below given that B=1.5m, L=2.5m, and Q=120KN. Calculate the Primary consolidation settlement of the foundation.

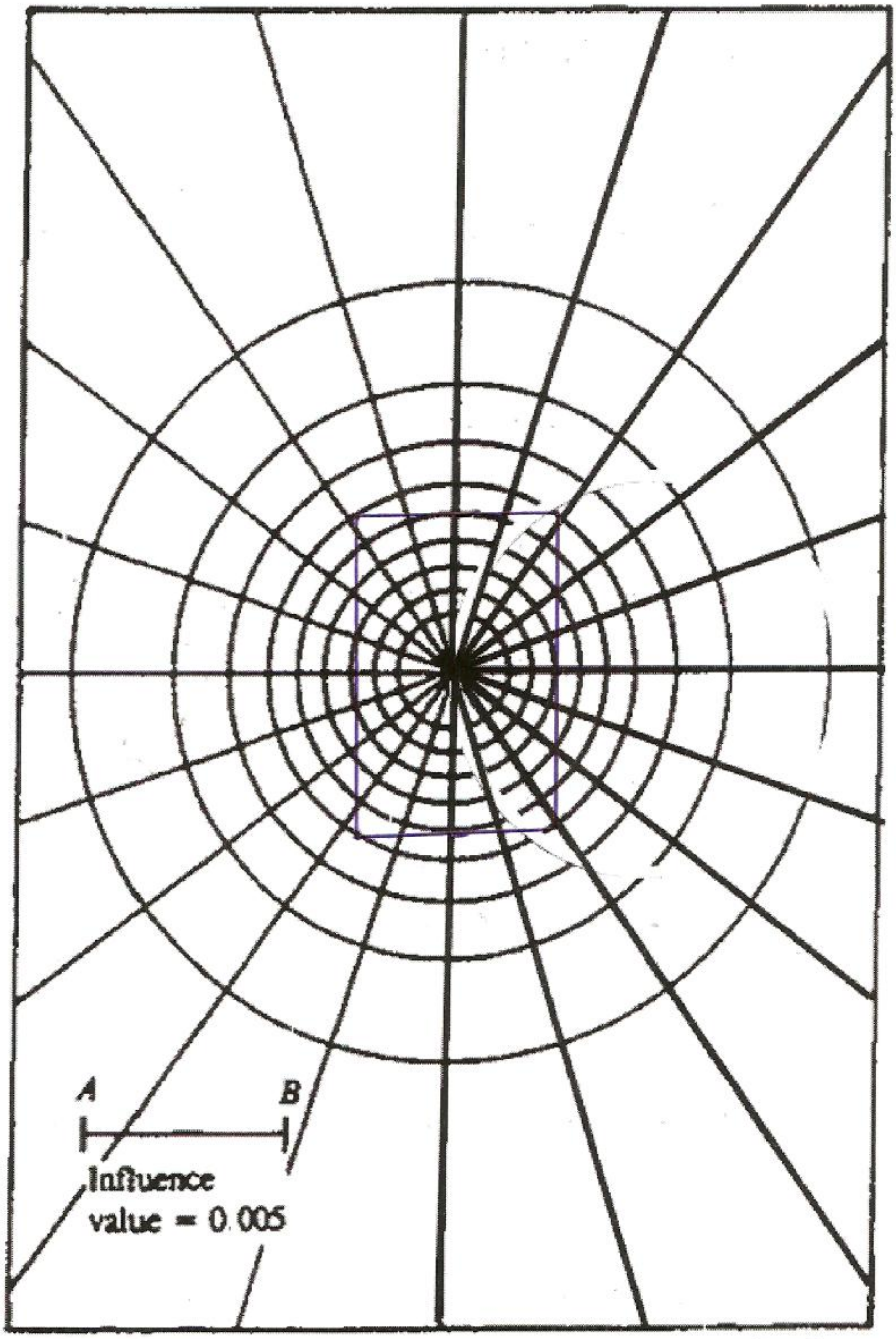


$$\gamma_{sat(clay)} = \frac{G_s\gamma_w + wG_s\gamma_w}{1 + wG_s} = 18.4\ KN/m^3$$

$$\gamma_{sat(clay)} = \frac{(G_s + e)\gamma_w}{1+e} \Longrightarrow e = 1.44$$

$$C_c = 0.009(LL-10) = 0.252$$

$$\sigma'_0 = 1.5 \times 15 + 1.5 \times (18 - 9.81) + 1.25 \times (18.4 - 9.81) = 45.5225 KN/m^2$$



M ≈ 76

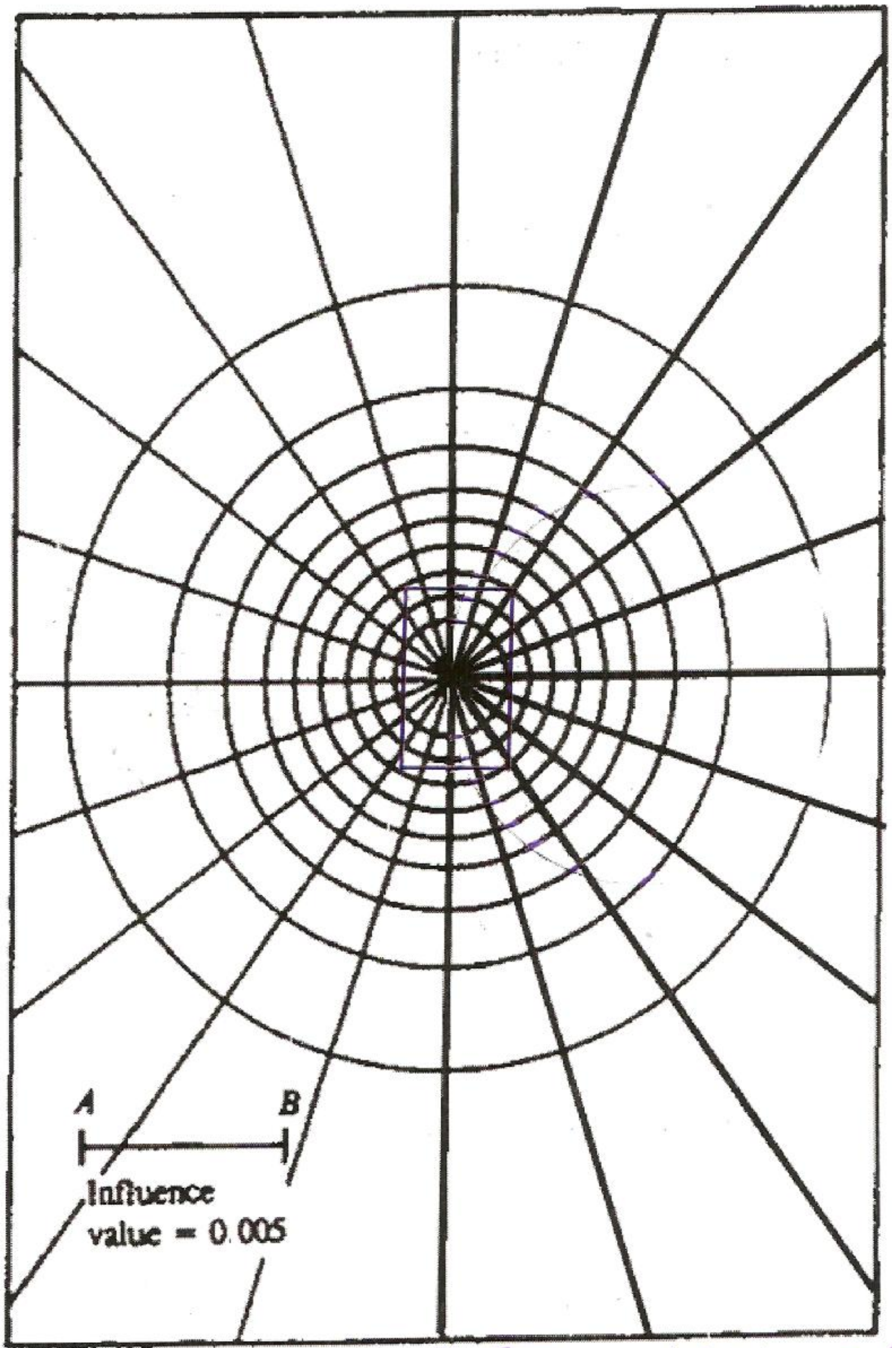
at $Z = 1.5m$, $|AB| = 2.6 cm$

$$Scale = \frac{|AB| \times 100}{Z\ (cm)} = \frac{2.6 \times 100}{150} = 1.73 cm$$

$\Rightarrow$ $1m = 1.73 cm$

at $B = 1.5m \Rightarrow$ on sketch $B = 1.5 \times 1.73 = 2.6 cm$

at $L = 2.5m \Rightarrow$ on sketch $L = 2.5 \times 1.73 = 4.3 cm$



$M \simeq 32$

at $Z = 2.75$, $|AB| = 2.6$ cm

$\Rightarrow$ $Scale = \frac{|AB| \times 100}{Z\ (cm)} = \frac{2.6 \times 100}{275} = 0.945$

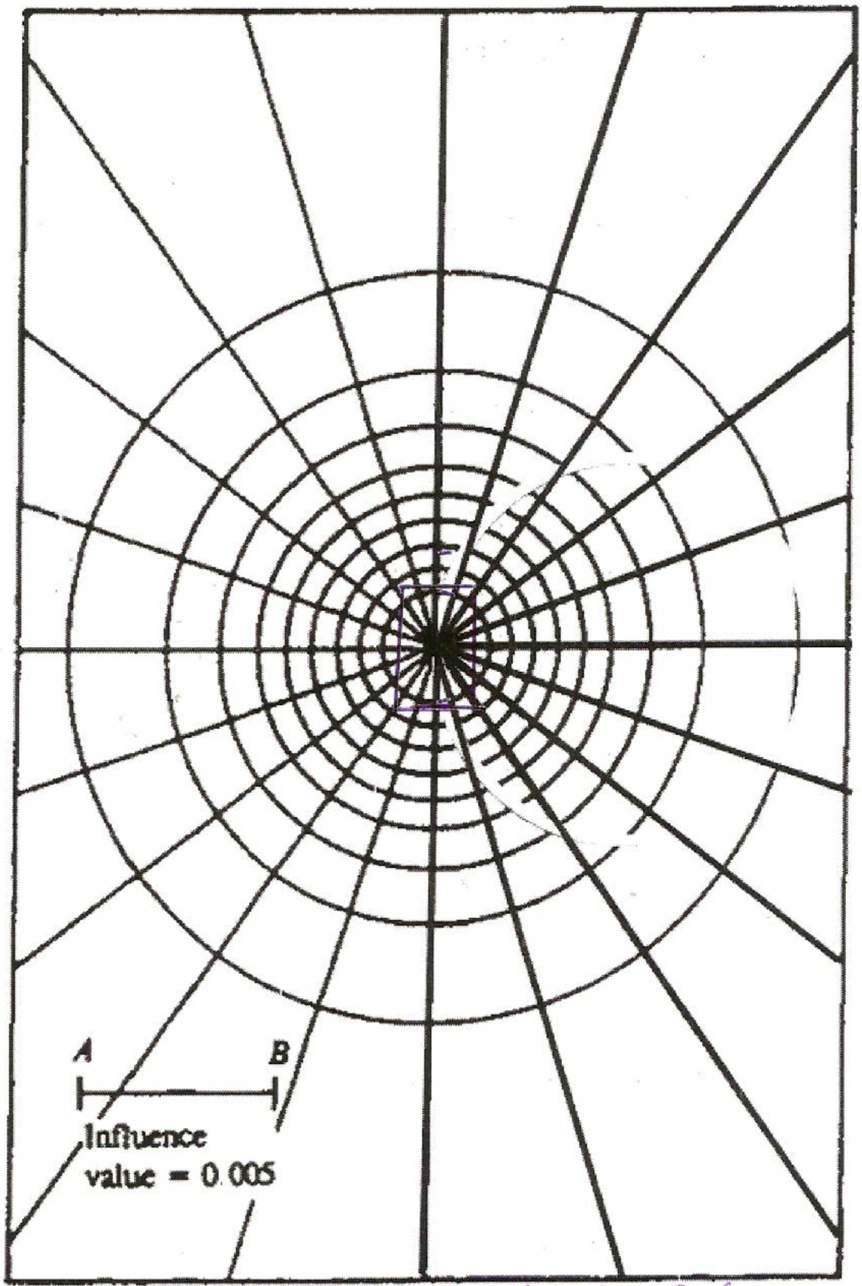
$\Rightarrow$ 1m = 0.945 cm

For B = 1.5m $\Rightarrow$ on sketch B = 1.5 × 0.945

$\Rightarrow$ B = 1.42 cm

For L = 2.5m $\Rightarrow$ on sketch L = 2.5 × 0.945

L = 2.36 cm



M ≃ 18

at $Z = 4m$, $|AB| = 2.6cm$

$$\text{Scale} = \frac{|AB| \times 100}{Z\,(cm)} = \frac{2.6 \times 100}{400} = 0.65$$

$\Rightarrow 1m = 0.65cm$

at $B = 1.5m \Rightarrow$ on sketch $B = 0.975cm$

at $L = 2.5m \Rightarrow$ on sketch $L = 1.625cm$

Z (m)	M	IV	$q = \frac{Q}{A}$ (KN/m²)	$\Delta\sigma = IV \times M \times q$ (KN/m²)
1.5	76	0.005	32	$\Delta\sigma_t = 12.6$
2.75	32	0.005	32	$\Delta\sigma_m = 5.12$
4	18	0.005	32	$\Delta\sigma_b = 2.88$

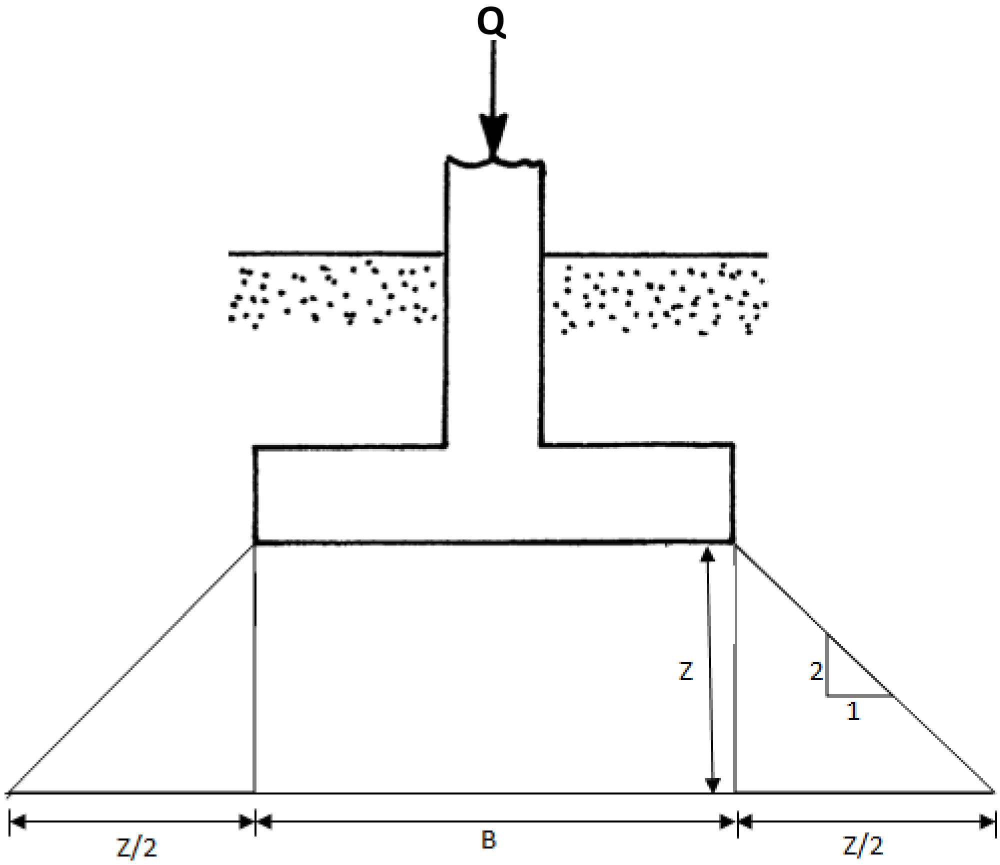
$$\Delta\sigma_{avg} = \frac{\Delta\sigma_t + 4\Delta\sigma_m + \Delta\sigma_b}{6}$$

$$\Delta\sigma_{avg} = \frac{12.6 + 4 \times 5.12 + 2.88}{6} = 5.993KN/m^2$$

$$S_c = \frac{C_c H}{1 + e_o} \log\left(\frac{\sigma'_o + \Delta\sigma'}{\sigma'_o}\right)$$

$$S_c = \frac{0.252 \times 2.5}{1 + 1.446} log\left(\frac{45.5525 + 5.993}{45.5525}\right) = 0.0138m = 1.38cm$$

Alternative solution using Approximation method:



$$\Delta\sigma' = \frac{Q}{(B+Z)\times(L+Z)} = \frac{q\times B\times L}{(B+Z)\times(L+Z)}$$

At Z=1.5m $\Delta\sigma'_t = \frac{120}{(1.5+1.5)\times(2.5+1.5)} = 11.42KN/m^2$

At Z=2.75m $\Delta\sigma'_m = \frac{120}{(1.5+2.75)\times(2.5+2.75)} = 5.37KN/m^2$

At Z=4m $\Delta\sigma'_b = \frac{120}{(1.5+4)\times(2.5+4)} = 3.35KN/m^2$

$$\Delta\sigma'_{avg} = \frac{\Delta\sigma'_t + 4\Delta\sigma'_m + \Delta\sigma'_b}{6}$$

$$\Delta\sigma_{avg} = \frac{11.42 + 4\times 5.37 + 3.35}{6} = 6.04KN/m^2$$

$$S_c = \frac{C_c H}{1+e_o}\log\left(\frac{\sigma'_o + \Delta\sigma'}{\sigma'_o}\right)$$

$$S_c = \frac{0.252 \times 2.5}{1 + 1.446} log\left(\frac{45.5525 + 6.04}{45.5525}\right) = 0.0139m = 1.39cm$$