Example 1

A column supporting 165 ton of load has10'×10' footing, 3 ft thick, and is located 5' below ground surface. Underlaying sand has γ = 120-130 pcf. Concrete has γ_{con} = 150 pcf. Cone penetration test results near the footing are given. Find footing settlement after 10 years.

Depth ft	γ pcf	CP Resistance, $q_c$tsf	Depth below footing base	$E_s = 2.5q_c$ tsf
5	120	30	0	75
7.5	120	31	2.5	77.5
10	120	30	5	75
12.5	120	40	7.5	100
15	130	41	10	103
20	130	60	15	150
25	130	63	20	158
30	130	68	25	170
35	130	72	30	180

Solution

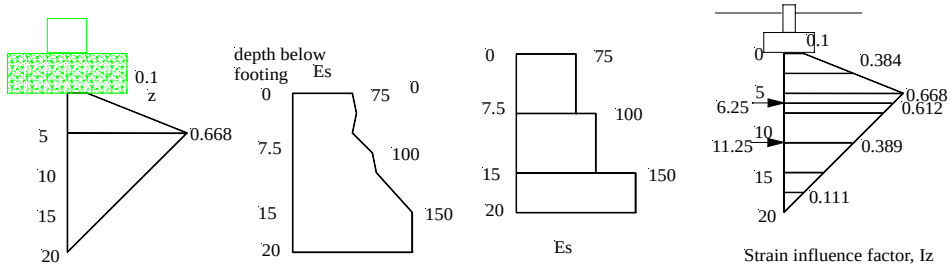
q' = 120×5/2000 = 0.3 tsf

q_o = 165/10×10 + 150×3/2000+120×2/2000 = 1.995 tsf

Location of maximum I_z = 10/2 = 5' below footing

σ_z' = (5+5)×120/2000 = 0.6 tsf

$$I_{z\text{-max}} = 0.5 + 0.1\left(\frac{1.995 - 0.3}{0.6}\right)^{0.5} = 0.668$$



Divide soil into several layers (Δz) using I_z and E_s discontinuities.

Δz, ft	I_z	E_s, tsf	$\frac{I_z \times \Delta z}{E_s}$
5	0.384	75	0.0256
2.5	0.612	75	0.0204
7.5	0.389	100	0.0292
5	0.11	150	0.0037
		$\sum_{0}^{z_2} \frac{I_z}{E_s} \cdot \Delta z$	0.0789

$$C_1 = 1 - 0.5\left(\frac{0.3}{(1.995 - 0.3)}\right) = 0.912$$

$$C_2 = 1 + 0.2\log(10 \times 10) = 1.4$$

$$S_1 = 0.912 \times 1.4 \times (1.995 - 0.3) \times 0.0789 = 0.17\text{ft}$$