Schmertmann's Method

This method is used to calculate the value of settlement of sand soils.

$$S_e = C_1 C_2 (\overline{q} - q) \sum_0^{z_2} \frac{I_z}{E_s} \Delta z$$

I_z = strain influence factor

C_1 = a correction factor for the depth of foundation embedment = $1 - 0.5 \, [q/(\overline{q} - q)]$

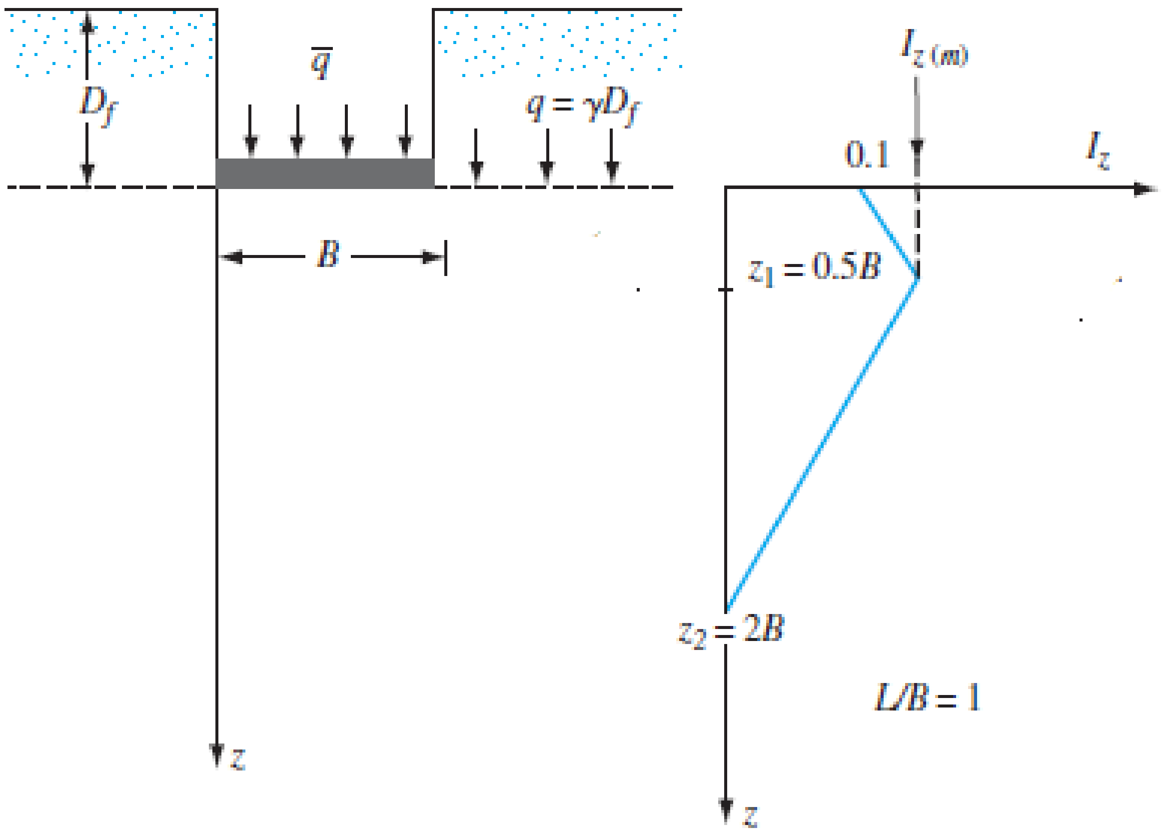
C_2 = a correction factor to account for creep in soil
= $1 + 0.2 \log$ (time in years/0.1)

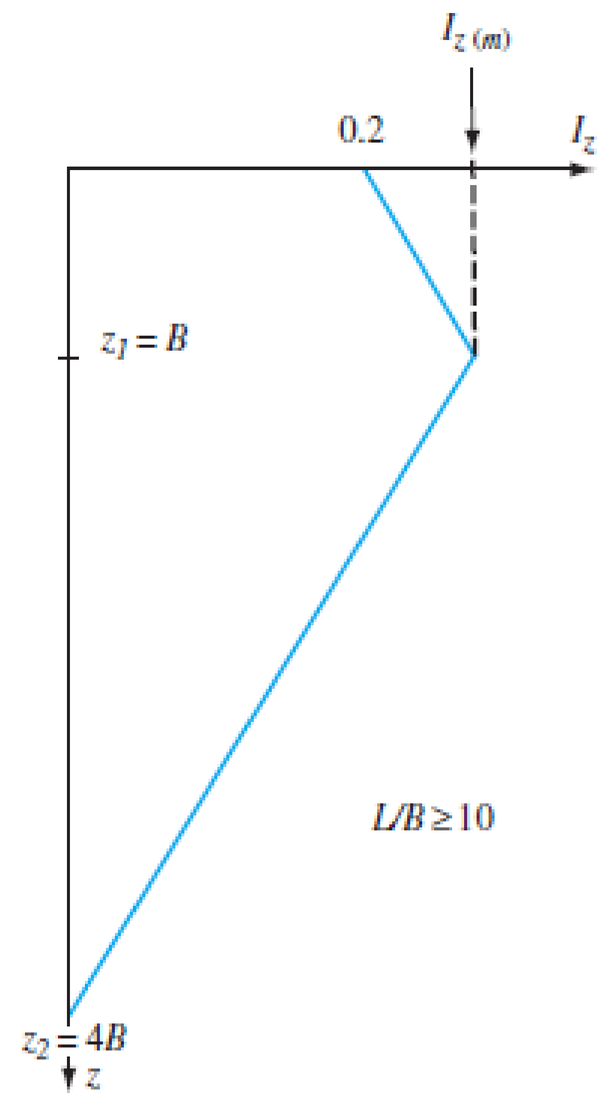
$\overline{q}$ = stress at the level of the foundation

$q = \gamma D_f$ = effective stress at the base of the foundation

E_s = modulus of elasticity of soil

Schmertmann's Method

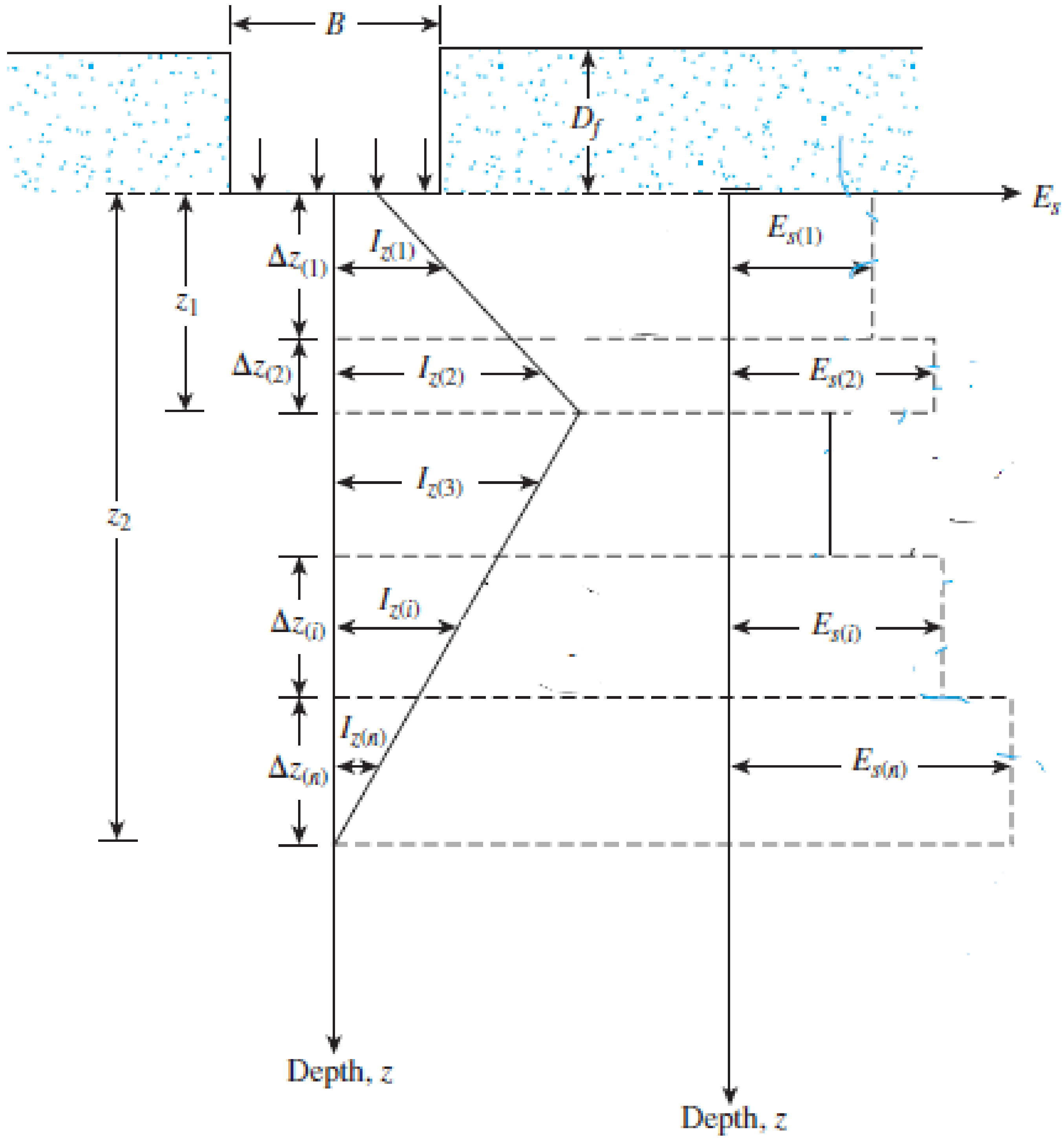




$$I_{z(m)} = 0.5 + 0.1\sqrt{\frac{\overline{q} - q}{q'_{z(1)}}}$$

where

$q'_{z(1)}$ = effective stress at a depth of z_1 before construction of the foundation



B
D_f
E_s
Δz(1)
Δz(2)
Δz(i)
Δz(n)
z1
z2
I_z(1)
I_z(2)
I_z(3)
I_z(i)
I_z(n)
E_s(1)
E_s(2)
E_s(i)
E_s(n)
Depth, z
Depth, z

Layer no.	Δz	E_s	I_z at the middle of the layer	$\frac{I_z}{E_s}\Delta z$
1	$\Delta z_{(1)}$	$E_{s(1)}$	$I_{z(1)}$	$\frac{I_{z(1)}}{E_{s(1)}}\Delta z_1$
2	$\Delta z_{(2)}$	$E_{s(2)}$	$I_{z(2)}$	
$\vdots$	$\vdots$	$\vdots$	$\vdots$	
i	$\Delta z_{(i)}$	$E_{s(i)}$	$I_{z(i)}$	$\frac{I_{z(i)}}{E_{s(i)}}\Delta z_i$
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$
n	$\Delta z_{(n)}$	$E_{s(n)}$	$I_{z(n)}$	$\frac{I_{z(n)}}{E_{s(n)}}\Delta z_n$
				$\Sigma\frac{I_z}{E_s}\Delta z$

- I_z at $z = 0$

$$I_z = 0.1 + 0.0111\left(\frac{L}{B} - 1\right) \leq 0.2$$

- Variation of z_1/B for $I_{z(m)}$

$$\frac{z_1}{B} = 0.5 + 0.0555\left(\frac{L}{B} - 1\right) \leq 1$$

- Variation of z_2/B

$$\frac{z_2}{B} = 2 + 0.222\left(\frac{L}{B} - 1\right) \leq 4$$

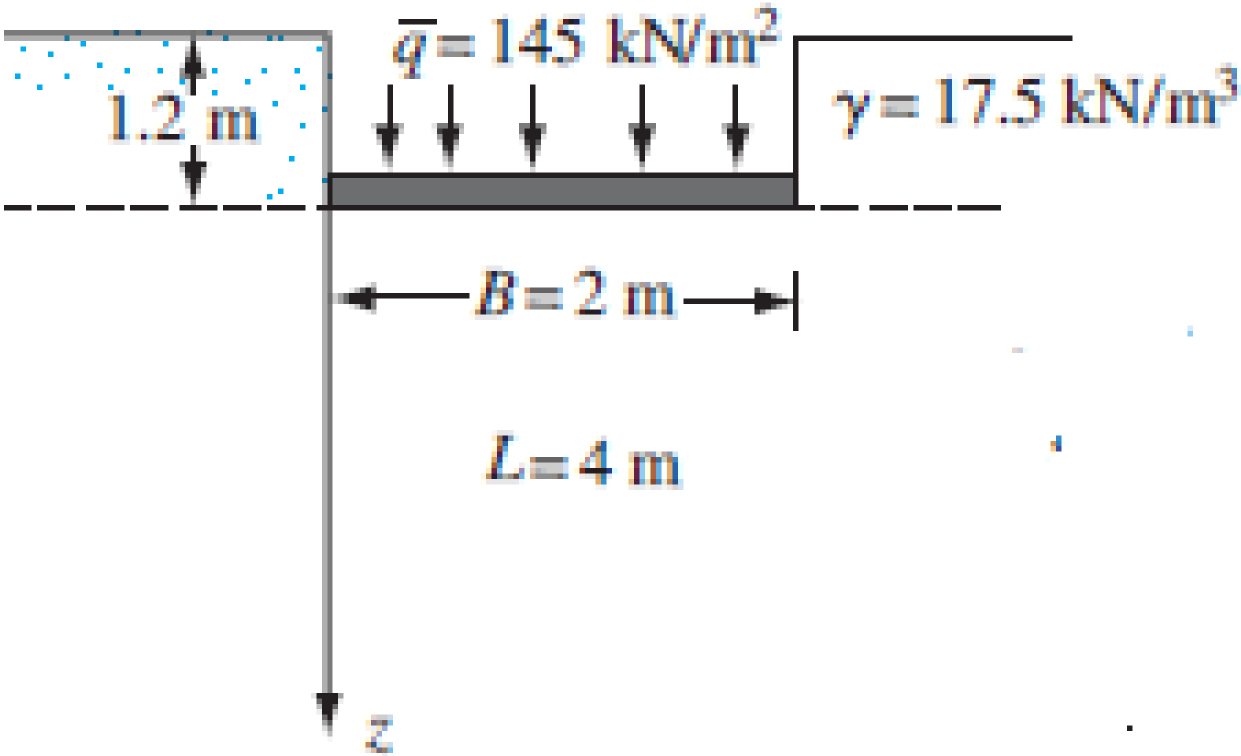
$E_s = 2.5q_c$ (for square foundation)

$E_s = 3.5q_c$ (for $L/B \geq 10$)

$$E_{s(\text{rectangle})} = \left(1 + 0.4\log\frac{L}{B}\right)E_{s(\text{square})}$$

Consider a rectangular foundation 2 m × 4 m in plan at a depth of 1.2 m in a sand deposit,

Estimate the elastic settlement of the foundation using the strain influence factor method.



z (m)	q_c (kN/m²)
0–0.5	2250
0.5–2.5	3430
2.5–5.0	2950

1) z values must be determined
2) I values must be determined
3) I versus z graph must be drawned
4) I_{middle} values must be determined
5) Es values must be determined

$$\frac{z_1}{B} = 0.5 + 0.0555\left(\frac{L}{B} - 1\right) = 0.5 + 0.0555\left(\frac{4}{2} - 1\right) \approx 0.56$$

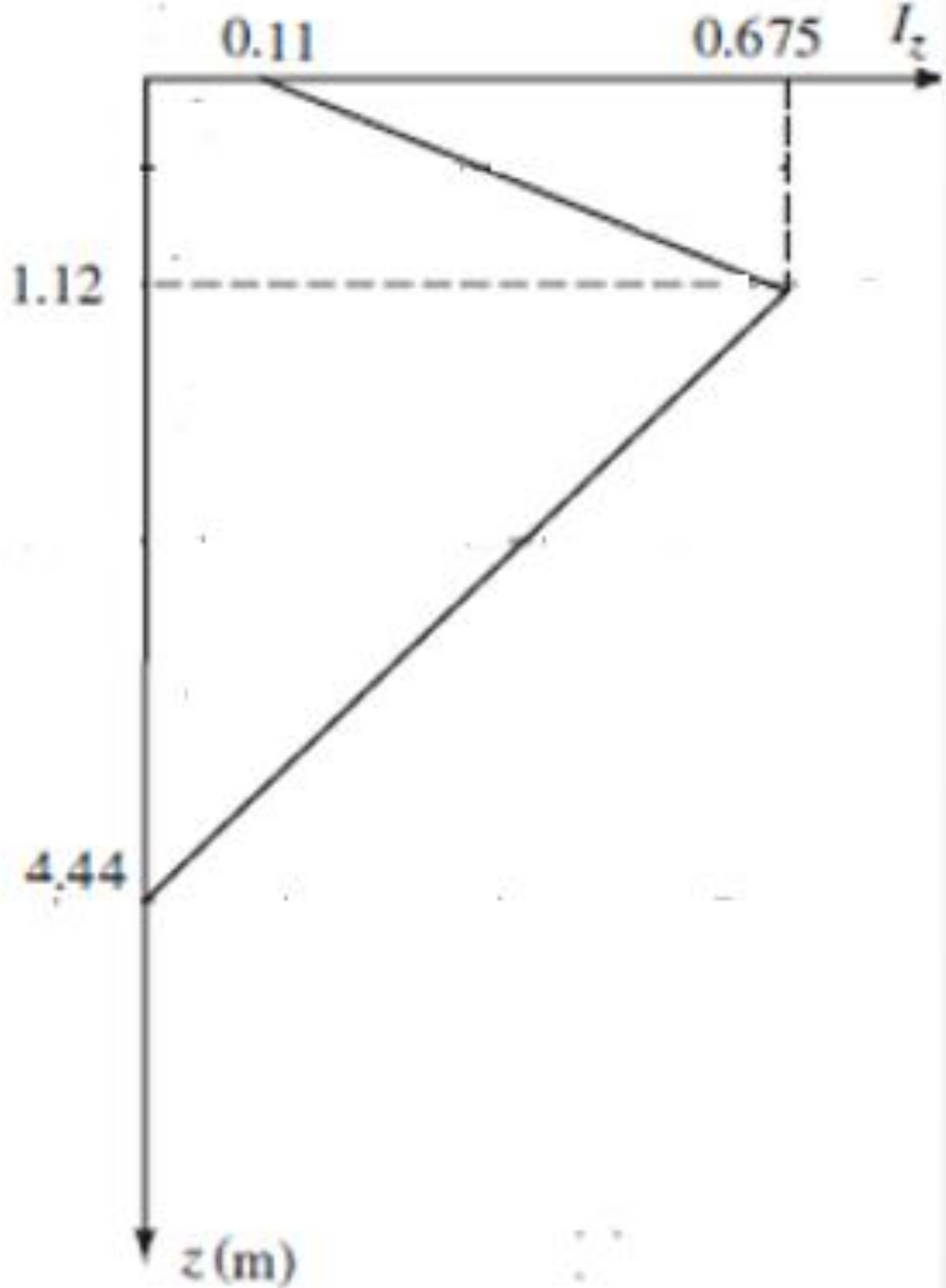
$$z_1 = (0.56)(2) = 1.12 \text{ m}$$

$$\frac{z_2}{B} = 2 + 0.222\left(\frac{L}{B} - 1\right) = 2 + 0.222(2 - 1) = 2.22$$

$$z_2 = (2.22)(2) = 4.44 \text{ m}$$

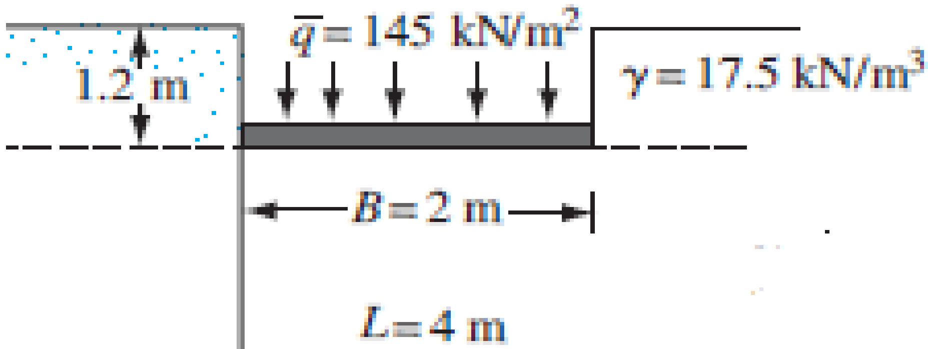
$$I_z = 0.1 + 0.0111\left(\frac{L}{B} - 1\right) = 0.1 + 0.0111\left(\frac{4}{2} - 1\right) \approx 0.11$$

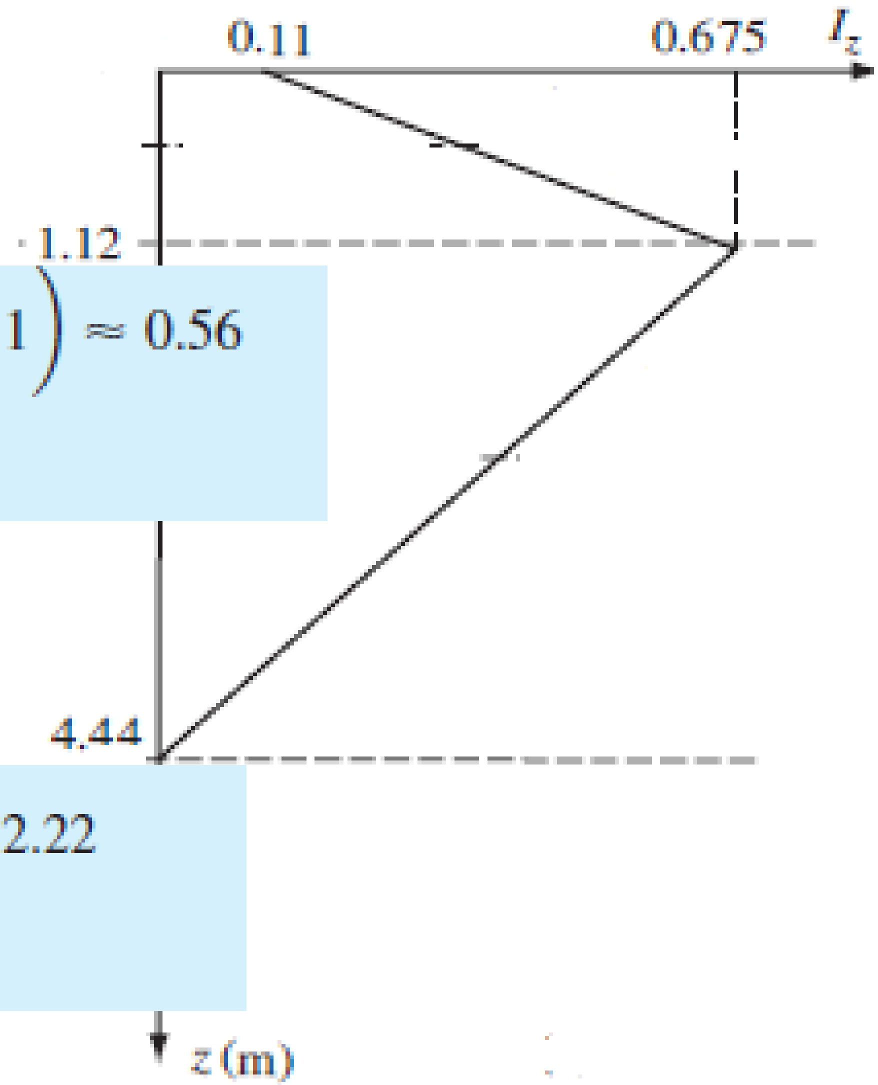
$$I_{z(m)} = 0.5 + 0.1\sqrt{\frac{\bar{q} - q}{q'_{z(1)}}} = 0.5 + 0.1\left[\frac{145 - (1.2 \times 17.5)}{(1.2 + 1.12)(17.5)}\right]^{0.5} = 0.675$$


0.11
0.675
I_z
1.12
4.44
z (m)

$$I_z = 0.1 + 0.0111\left(\frac{L}{B} - 1\right) = 0.1 + 0.0111\left(\frac{4}{2} - 1\right) \approx 0.11$$

$$I_{z(m)} = 0.5 + 0.1\sqrt{\frac{\bar{q} - q}{q'_{z(1)}}} = 0.5 + 0.1\left[\frac{145 - (1.2 \times 17.5)}{(1.2 + 1.12)(17.5)}\right]^{0.5} = 0.675$$



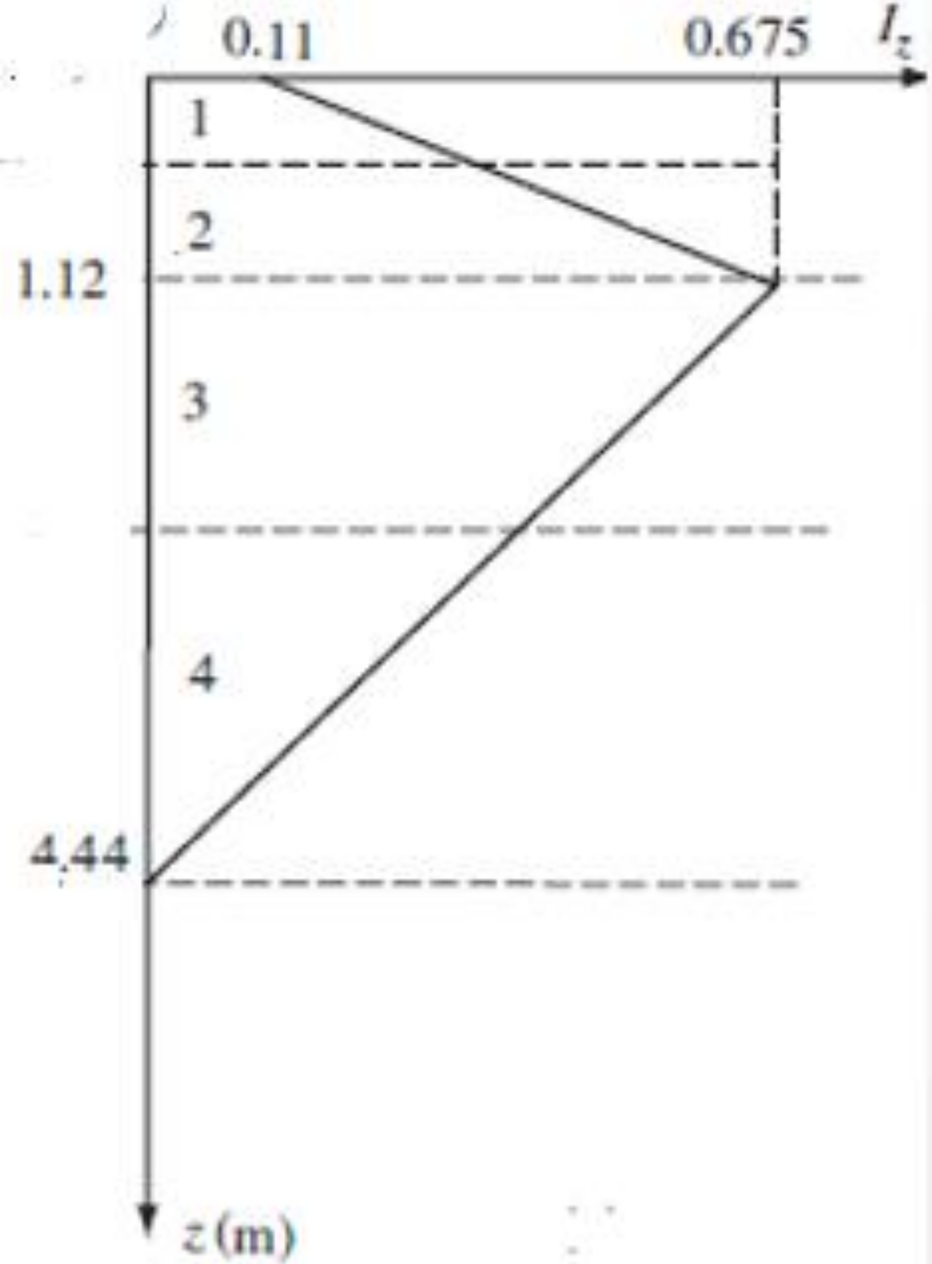


$$\frac{z_1}{B} = 0.5 + 0.0555\left(\frac{L}{B} - 1\right) = 0.5 + 0.0555\left(\frac{4}{2} - 1\right) \approx 0.56$$

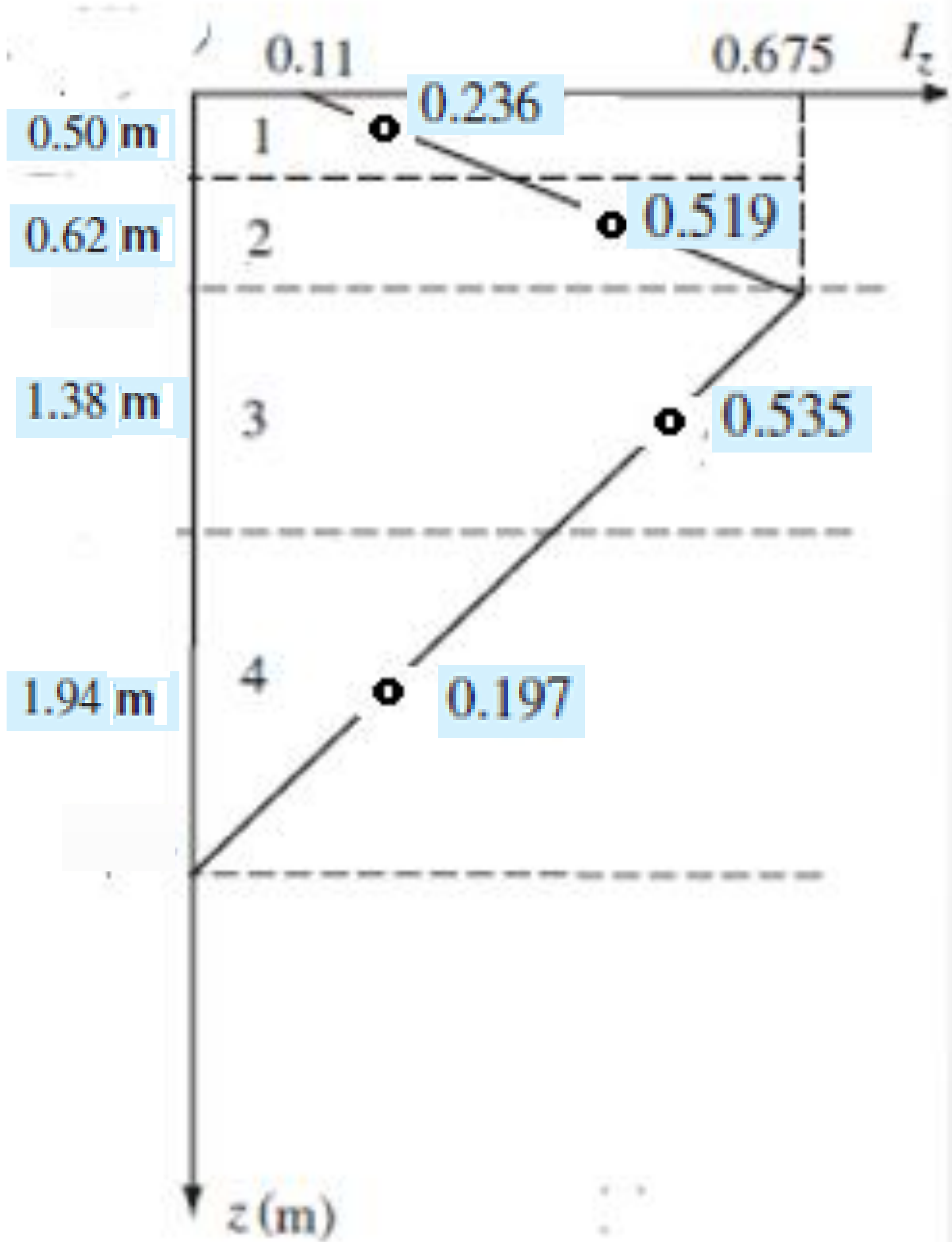
$$z_1 = (0.56)(2) = 1.12 \text{ m}$$

$$\frac{z_2}{B} = 2 + 0.222\left(\frac{L}{B} - 1\right) = 2 + 0.222(2 - 1) = 2.22$$

$$z_2 = (2.22)(2) = 4.44 \text{ m}$$



0.11
0.675
I_z
1
2
1.12
3
4
4,44
z (m)



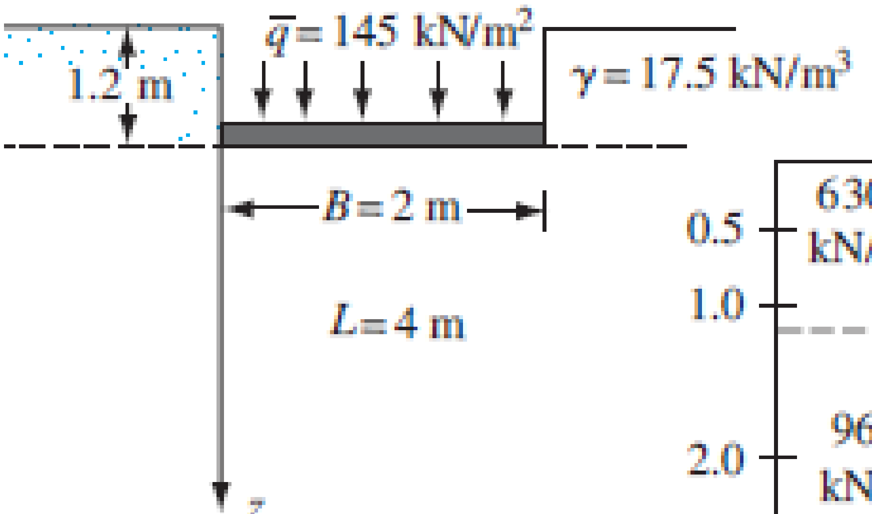
0.11
0.675
I_z
0.236
0.519
0.535
0.197
0.50 m
0.62 m
1.38 m
1.94 m
1
2
3
4
z (m)

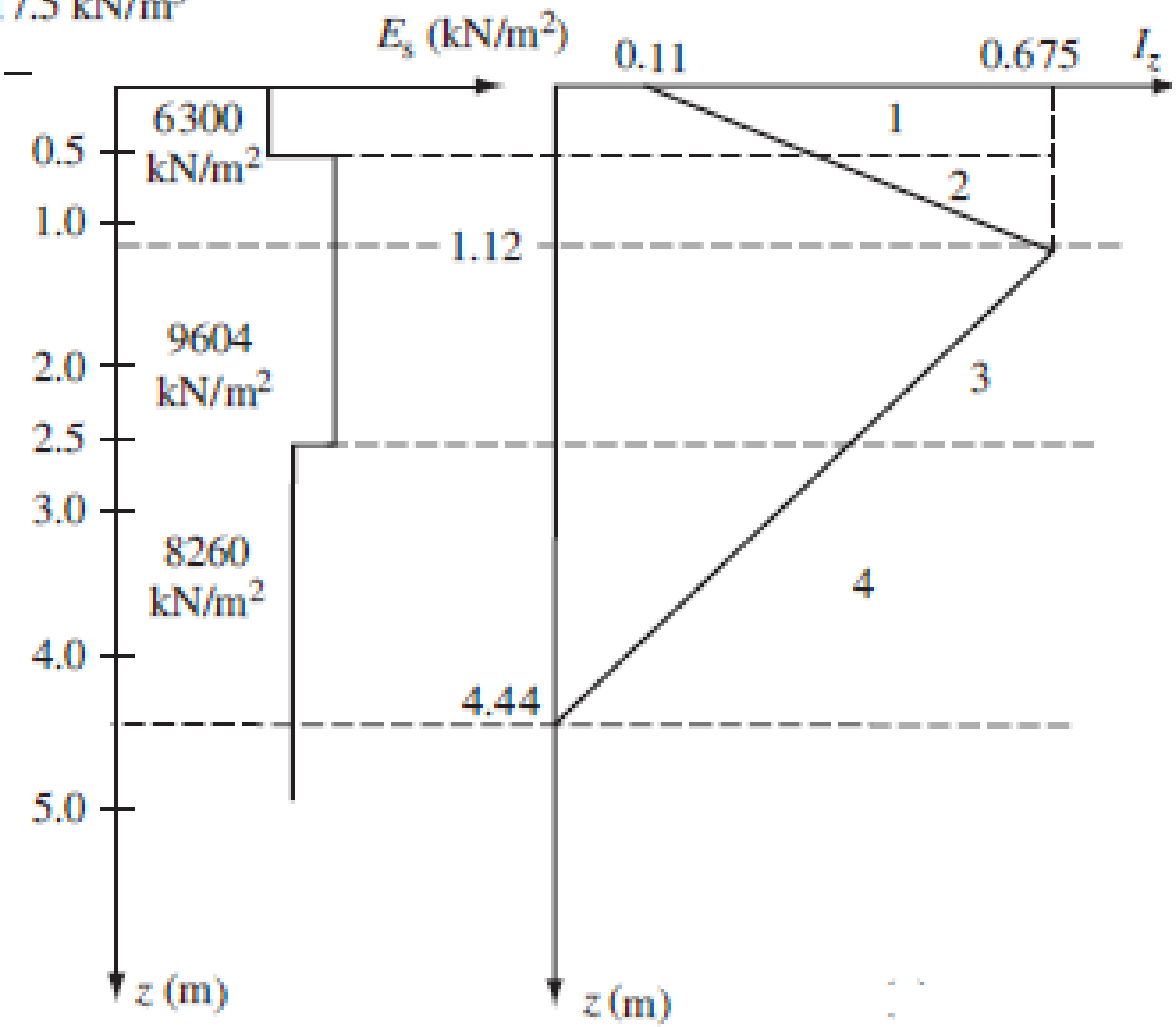
$$E_{s(\text{rectangle})} = \left(1 + 0.4\log\frac{L}{B}\right)E_{s(\text{square})} = \left[1 + 0.4\log\left(\frac{4}{2}\right)\right](2.5 \times q_c) = 2.8q_c$$

q_c (kN/m²)	E_s (kN/m²)
2250	6300
3430	9604
2950	8260

Layer no.	Δz (m)	E_s (kN/m²)
1	0.50	6300
2	0.62	9604
3	1.38	9604
4	1.94	8260

$$E_{s(\text{rectangle})} = \left(1 + 0.4\log\frac{L}{B}\right)E_{s(\text{square})} = \left[1 + 0.4\log\left(\frac{4}{2}\right)\right](2.5 \times q_c) = 2.8q_c$$





m)	q_c (kN/m²)	E_s (kN/m²)
-0.5	2250	6300
-2.5	3430	9604
-5.0	2950	8260

Layer no.	Δz (m)	E_s (kN/m²)	I_z at middle of layer	$\frac{I_z}{E_s}\Delta z$ (m³/ kN)
1	0.50	6300	0.236	1.87×10^{-5}
2	0.62	9604	0.519	3.35×10^{-5}
3	1.38	9604	0.535	7.68×10^{-5}
4	1.94	8260	0.197	4.62×10^{-5}
				$\Sigma 17.52 \times 10^{-5}$

$$S_e = C_1 C_2 (\overline{q} - q) \sum \frac{I_z}{E_s} \Delta z$$

$$C_1 = 1 - 0.5\left(\frac{q}{\overline{q} - q}\right) = 1 - 0.5\left(\frac{21}{145 - 21}\right) = 0.915$$

Assume the time for creep is 10 years. So,

$$C_2 = 1 + 0.2\log\left(\frac{10}{0.1}\right) = 1.4$$

Hence,

$$S_e = (0.915)(1.4)(145 - 21)(17.52 \times 10^{-5}) = 2783 \times 10^{-5}\ \text{m} = \mathbf{27.83\ mm}$$