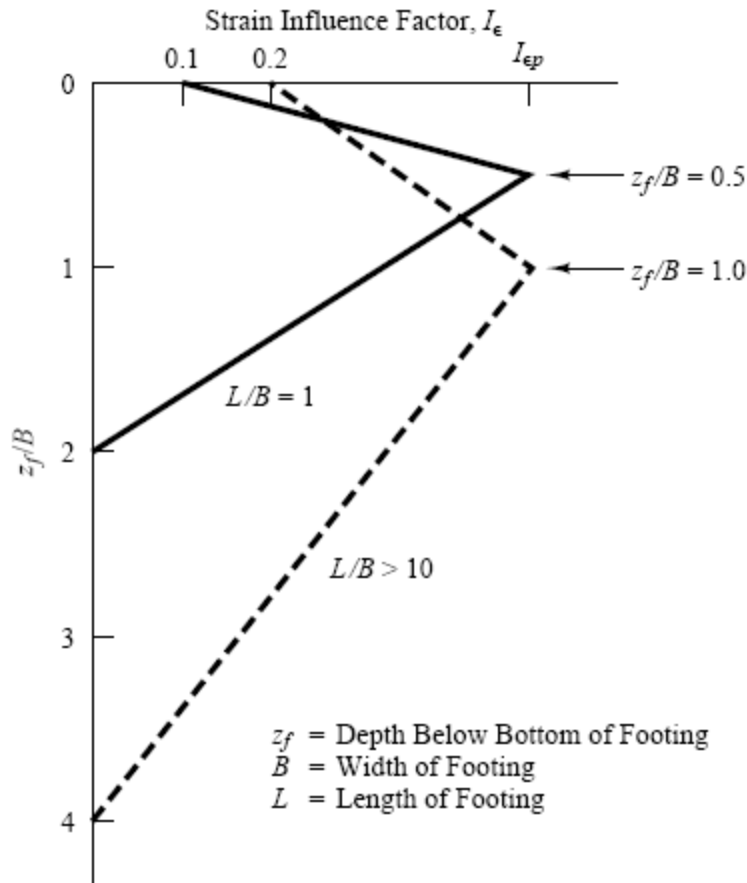


# Schmertmann's 1978 method



Peak value of  $I_\epsilon$ :

$$I_{\epsilon p} = 0.5 + 0.1 \sqrt{[(q - \sigma'_{zd}) / \sigma'_{zp}]}$$

$\sigma'_{zp}$  = value of vertical effective stress at  $I_{\epsilon p}$

$\sigma'_{zd}$  = vertical effective stress at foundation level

$q$  = bearing pressure

# Schmertmann's Method

Used to compute settlement of spread footings on sandy soil

(1) Get modulus  $E_s$  from in-situ test

- CPT, SPT, Dilatometer, pressuremeter, etc.

(2) Calculate

- Strain influence factor,
- Depth factor -  $C_1$
- Creep factor -  $C_2$
- Shape factor -  $C_3$

(3) Combine to calculate settlement

# Schmertmann's Method

$$\rho = C_1 C_2 C_3 (q - \sigma'_{zD}) \sum \frac{I_\epsilon H}{E_s}$$

Where:

$\delta$  = settlement of footing

$C_1$  = depth factor

$C_2$  = secondary creep factor (see discussion in Section 7.8)

$C_3$  = shape factor = 1 for square and circular foundations

$q$  = bearing pressure

$\sigma'_{zD}$  = effective vertical stress at a depth  $D$  below the ground surface

$I_\epsilon$  = influence factor at midpoint of soil layer

$H$  = thickness of soil layer

$E_s$  = equivalent modulus of elasticity in soil layer

$t$  = time since application of load (yr) ( $t \geq 0.1$  yr)

$B$  = foundation width

$L$  = foundation length

$$C_1 = 1 - 0.5 \left( \frac{\sigma'_{zD}}{q - \sigma'_{zD}} \right)$$

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

$$C_3 = 1.03 - 0.03 L/B \geq 0.73$$

# $E_s$ from CPT

**TABLE 7.3**  $E_s$ -VALUES FROM CPT RESULTS [Adapted from Schmertmann, et al. (1978), Robertson and Campanella (1989), and other sources.]

Soil Type	USCS Group Symbol	$E_s/q_c$
Young, normally consolidated clean silica sands (age < 100 years)	SW or SP	2.5–3.5
Aged, normally consolidated clean silica sands (age > 3000 years)	SW or SP	3.5–6.0
Overconsolidated clean silica sands	SW or SP	6.0–10.0
Normally consolidated silty or clayey sands	SM or SC	1.5
Overconsolidated silty or clayey sands	SM or SC	3

# Example of Schmertmann's method

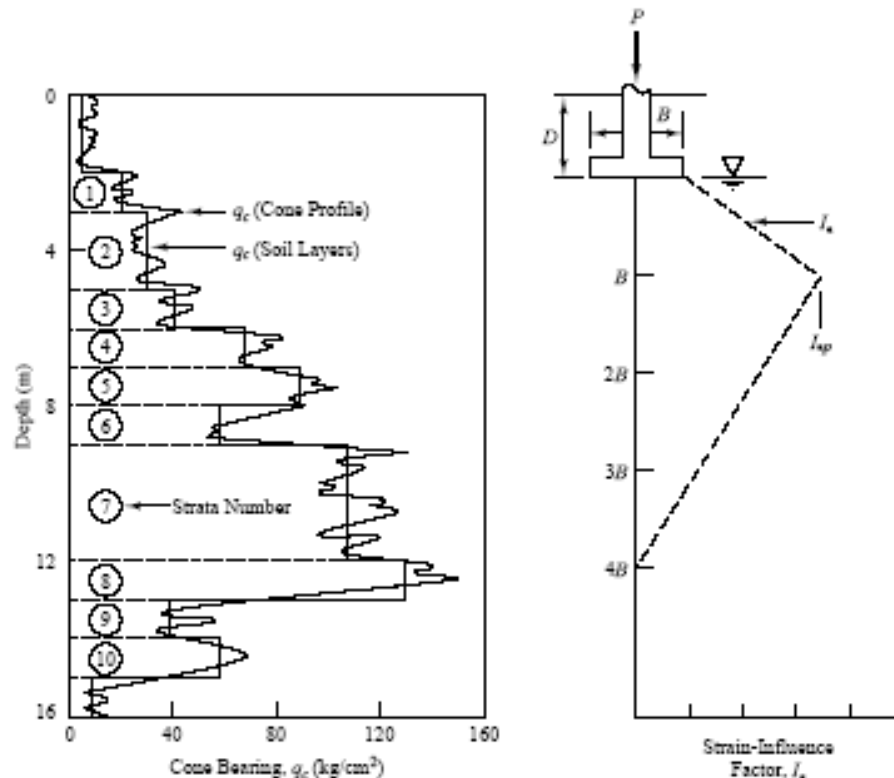


Figure 7.15 CPT results at McDonald's farm (Adapted from Robertson and Campanella, 1988).

$P=375 \text{ kN/m}$  to be supported on a  $2.5 \text{ m} \times 30 \text{ m}$  strip footing

$D=2.5 \text{ m}$

Compute settlement 50 years after construction

Young, n.c. sands

$$E_s = 2.5q_c$$

Depth of influence =  $D + 4B = 12 \text{ m}$

# Construct table

Es= 2.5\*qc

Ip 0.666

Layer	qc (kg/cm2)	qc (kPa)	Es (MPa)	zf (m)	le	H	(le)H/Es
1	20	1962	4.9	0.5	0.29	1	5.97E-05
2	30	2943	7.4	2	0.57	2	0.000156
3	41	4022	10.1	3.5	0.58	1	5.74E-05
4	68	6671	16.7	4.5	0.49	1	2.93E-05
5	90	8829	22.1	5.5	0.4	1	1.81E-05
6	58	5690	14.2	6.5	0.31	1	2.18E-05
7	108	10595	26.5	8.5	0.13	3	1.51E-05
						Total	0.000357

# Calculate Peak Influence Factor

$q=197$  kPa (= Applied load +Wt. concrete)/B – soil excavated)

$I_{\varepsilon p}=0.666$  (Budhu uses  $I_{cp}$ )

Calculate  $\Sigma(I_{\varepsilon}H/E_s)=35.71 \times 10^{-5}$

$$C_1 = 1 - 0.5 \left( \frac{\sigma'_{zD}}{q - \sigma'_{zD}} \right) = 1 - 0.5 \left( \frac{34}{197 - 34} \right) = 0.896$$

$$C_3 = 1.03 - 0.03.L/B \geq 0.73$$

$$\therefore C_3 = 1.03 - 0.03(30/2.5) = 0.67 \quad \therefore \text{Use } C_3=0.73$$

# Accuracy of Settlement Predictions

