

iv) CPT

- Schmertmann(1970)

; modified later by Schemertmann and Hartman(1978)

- Using strain influence factor (I_z)

$$\text{Settlement} = \int \varepsilon_z dz, \quad \varepsilon_z = \frac{P}{E_s} I_z$$

$$I_z = f(\text{footing geometry}, \nu)$$

→ Fig.1. and 2. in page 2-49,50 (based on theoretical, experimental and numerical results)

((ε_z or I_z)_{max} occurs not immediately under the footing but between 0.6r to 1.5r for circular footing) (r : radius of footing)

→ Vertical strains in sand deposits depend not only on the level of existing and added vertical stress but also on the existing and added shear stress.

→ Horizontal stress increment under the ground decreases more rapidly than vertical stress increment.

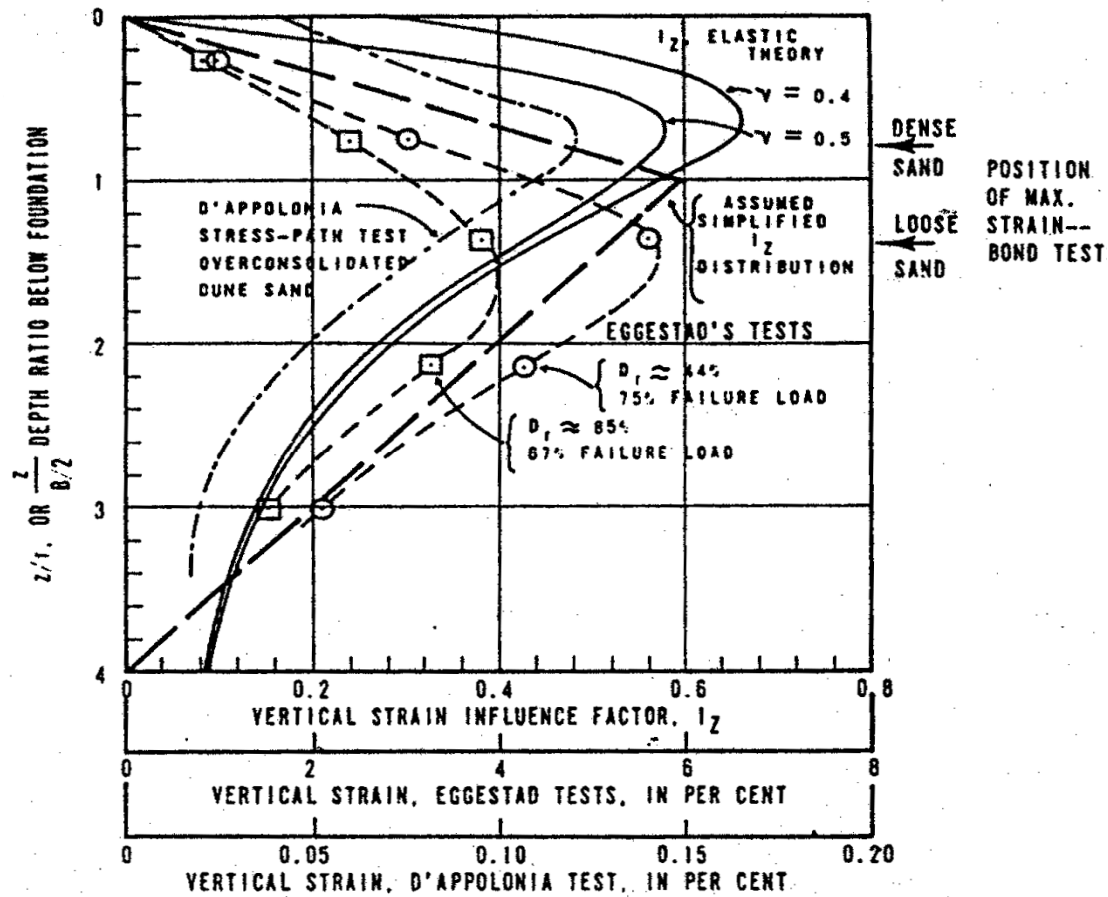


Fig. 1.

Theoretical and experimental distributions of vertical strain below center of loaded area.

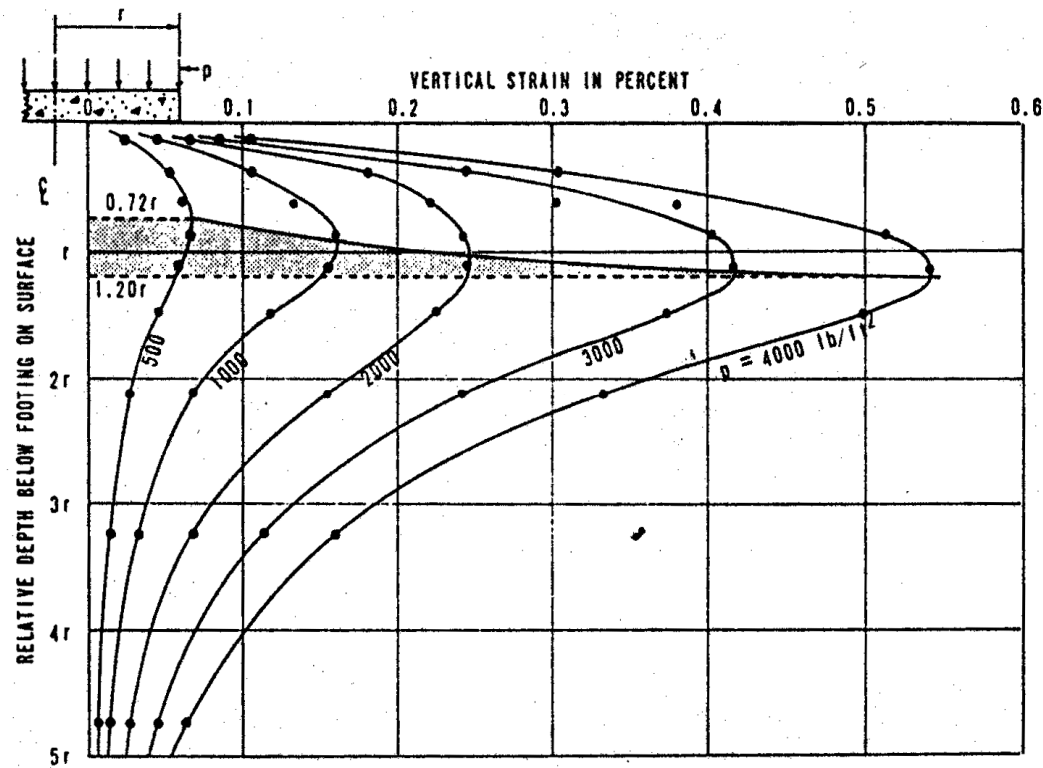
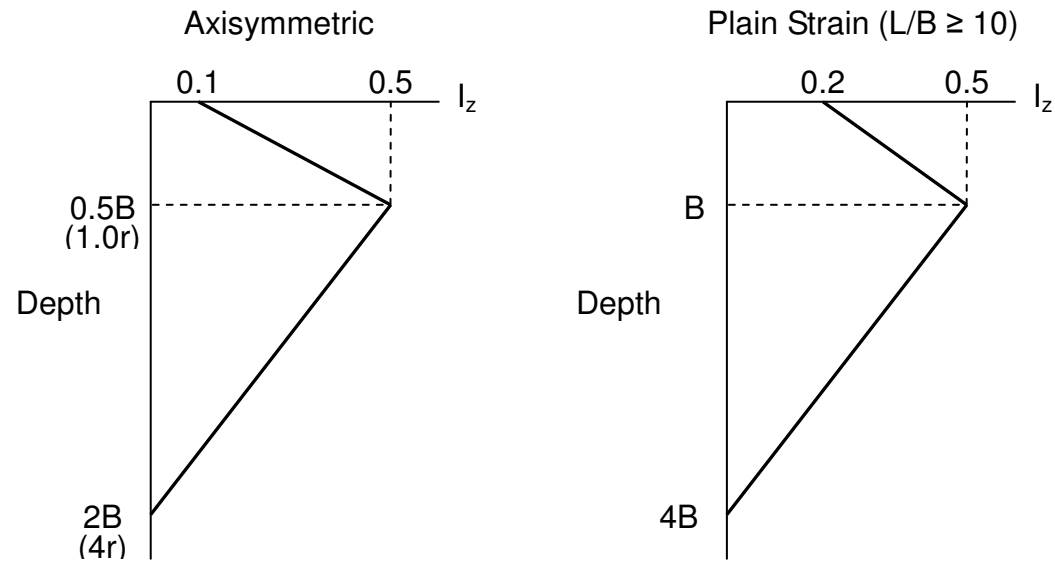


Fig. 2 Nonlinear, stress dependent finite element model prediction of vertical strains under center of 10-ft diam. 1.25ft thick. concrete footing loaded on surface of normally consolidated sand with $\phi=37^\circ$.

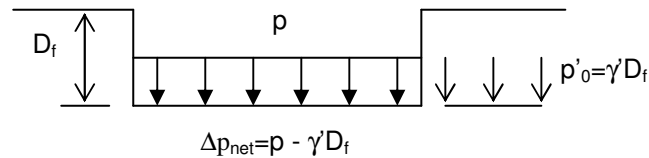
● Recommended simplified form

(modified by Schmertmann and Hartman(1978))



For $1 < B/L < 10$, linearly incorporate the stressed depth and the point of $I_{Z(max)}$.

Thus,



● Computation of immediate settlements.

$$S_e = \int_0^{\infty} \epsilon_z dz = \int_0^{2B \text{ or } 4B} \frac{\Delta p_{net}}{E_s} I_z dz = C_1 C_2 \Delta p_{net} \sum_{i=1}^n \frac{I_{z(i)}}{E_{s(i)}} \Delta z_i \quad \text{----(1)}$$

where n = no. of layers in $2B$ or $4B$.

C_1 = coefficient for depth of embedment.

$$= 1 - 0.5 \frac{p'_0}{\Delta p_{net}} \geq 0.5$$

C_2 = creep coefficient.

$$= 1 + 0.2 \log \frac{t(\text{yrs})}{0.1}$$

t \equiv time when the value of settlement is desired.

- E_s determination with q_c values from CPT

→ Continuous set of readings of q_c . → E_s .

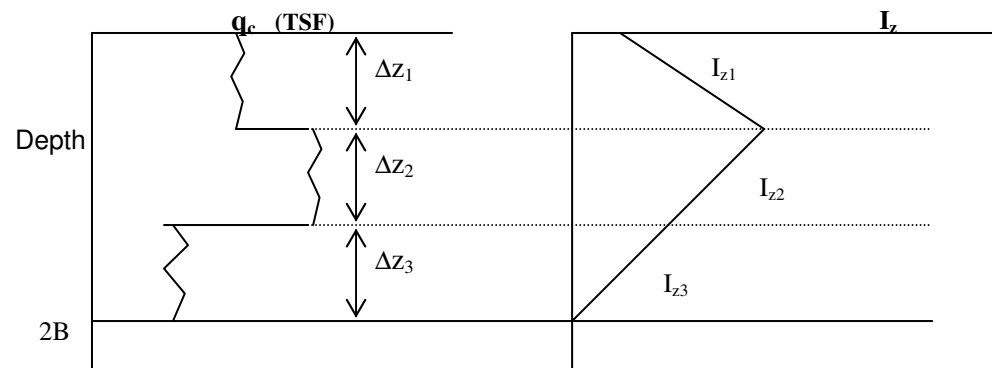
→ Correlating q_c with E_s from screw plate tests.

$$E_s = 2.5q_c \quad (L/B = 1) \quad (\text{Axi - symmetry})$$

$$E_s = 3.5q_c \quad (L/B \geq 10) \quad (\text{Plane strain})$$

● Procedure.

1. Develop static core profile and divide into layers.



2. Fill in chart.

Layer	Δz	q_c	$E_s = 3.5q_c(B/L > 10)$	I_z	$\frac{I_z}{E_s} \Delta z$
1					
2					
3					

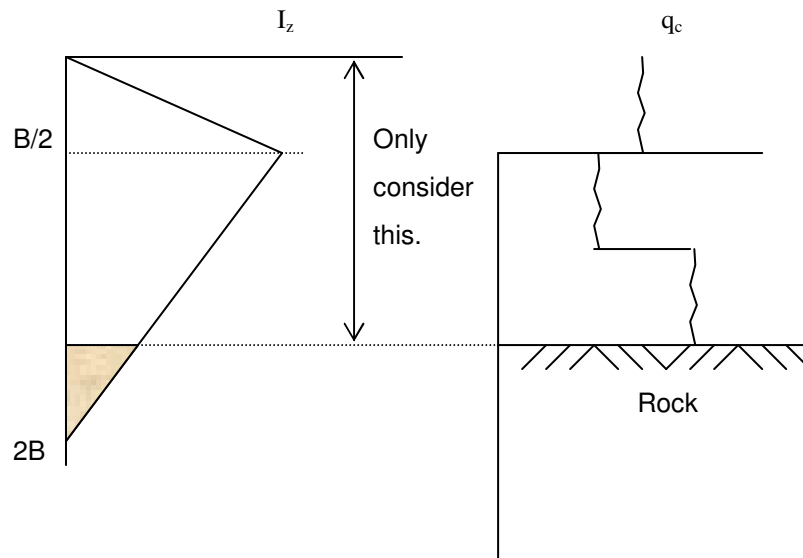
$\sum_{i=1}^3 \dots$

3. Compute C_1, C_2

$$4. S_e = C_1 C_2 \Delta p \sum_{i=1}^n \frac{I_{z(i)} \Delta z_i}{E_{s(i)}}$$

● Comments.

① If rigid boundary is close to foundation level, it can be accounted for by :



② If you have only N values, you can use the following correlations with CPT results.
 (but best to get a site specific N - q_c correlations).

Soil type	$q_c(\text{kg/cm}^2)/N$	E_s/N ($q_c/N \times (2.5 \text{ or } 3.5)$)
i) Silts, sandy silts and slightly cohesive mixtures.	2	5 ~ 7
ii) Fine-medium grained clean sand.	3.5	9 ~ 12
iii) Coarse sand.	5	12 ~ 18
vi) Sandy gravels & gravels	6	15 ~ 21

- ③ Method is valid for first loading cases with adequate bearing capacity.

- ④ Results are conservative, if the sand has been preloaded.
 - **Geologic O.C. state.**
 - **Roller compaction.**

 - (As much as 100% larger than observed).**

- ⑤ Any values of E (i.e. pressuremeter E) can be used, if site specific correlations are made.

- Long – Term Performance. → (Settlement by creep).
 - Constant load. → Not significant.
 - Slightly fluctuating load → might be $1.5 \times S_{\text{immediate}}$ after 30 years.
 - Heavily fluctuating load → might be $2.5 \times S_{\text{immediate}}$ after 30 years.