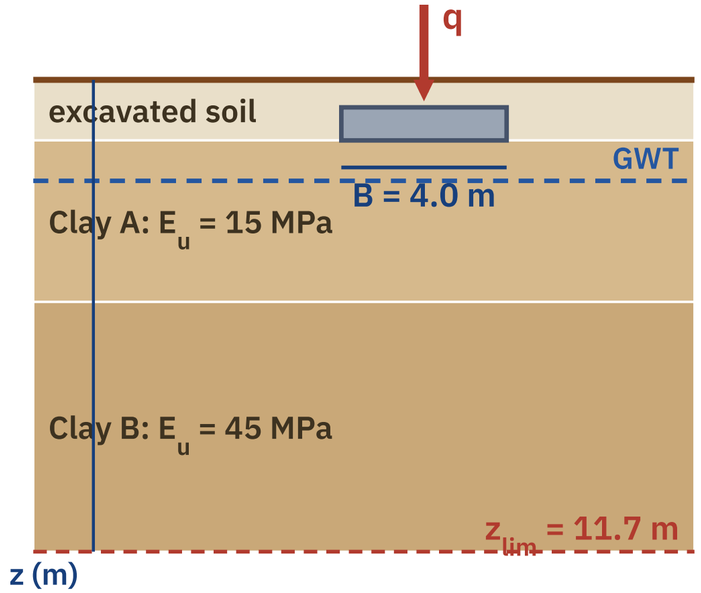
Geotechnical lecture presentation · Settlement

Elastic settlement: cohesive soil

Lecture: from elasticity theory to Steinbrenner coefficients, from a layered profile to flexible and rigid foundations; clay layers behave undrained (E_u, v = 0.5); a worked example on each topic.

- Hooke's law
- Steinbrenner coefficients
- Layered profile
- Net pressure
- Flexible and rigid footing
- Worked examples



What will we learn in this lecture?

- **From Hooke's law** to the settlement integral: $\varepsilon_z = [\Delta\sigma_z - \nu(\Delta\sigma_x + \Delta\sigma_y)]/E$ and $S = \int \varepsilon_z \, dz$
- To compute the **Steinbrenner coefficients** (F_1, F_2, I_s) and to find the **center** and **corner** settlement of a rectangular footing
- To treat cohesive layers as **undrained** ($E_u = \beta \, c_u$, $\nu = 0.5$)
- To sum the **layered profile** using the difference $I_s(z_{lower}) - I_s(z_{upper})$
- Determining the **net pressure** (excavation effect) and the **design depth** (influence depth)
- To distinguish **flexible** and **rigid** foundation settlement (rigid ≈ 0.93 × flexible center)

LECTURE FLOW

Each topic is covered in **three steps**:

1 · **Theory**: what is the rule, why is it so?

2 · **Problem statement**: given and required

3 · **Solution**: step by step, with numbers

Example foundation: 4 m × 6 m flexible rectangular footing, q = 180 kPa, excavation depth 1.5 m, GWT 2.5 m; clay layer. Settlements are in mm.

What does this module calculate?

THEORY

This module addresses **only cohesive** (clay, silt) layers and computes **immediate (elastic) settlement**: the settlement that occurs as soon as the load is applied, without any change in volume.

From the **Boussinesq** stresses of the soil under load, the strain is found **by Hooke's law**, and the integral of the strain is the settlement.

The **consolidation** of the clay (settlement due to expulsion of water) is in the Consolidation module; the sum of the two is in the Total Settlement (2D) module.

The solution is **analytical**: closed-form influence factors and layer-by-layer summation; no finite elements.

Beyond this: the Schmertmann method, SPT/CPT charts, modulus increasing with depth (Mayne–Poulos), foundation rigidity and soil–structure interaction.

LAYER TYPE

	Cohesive
Behavior	undrained
E	$E_u = \beta\, c_u$
v	0.5

Hooke's law and settlement integral

THEORY

Beneath a **perfectly flexible** footing carrying net pressure q_{net}, the soil is a semi-infinite homogeneous elastic medium (Boussinesq stresses). Hooke's law gives the vertical strain, and its integral gives the settlement:

$$S = \int \varepsilon_z \, dz = \int \frac{\Delta\sigma_z - \nu\,(\Delta\sigma_x + \Delta\sigma_y)}{E}\, dz$$

Lateral stresses depend on ν; therefore deformation and settlement vary with **both E and ν**.

As ν increases, lateral stresses **reduce** the vertical strain: at the same E′, a soil with ν = 0.5 settles less than one with ν = 0.3.

Settlement is **inversely proportional** to E: doubling the modulus halves the settlement.

NOTATIONS

q_{net}: net pressure (applied after excavation)

$\Delta\sigma_z$, $\Delta\sigma_x$, $\Delta\sigma_y$: stress increments

E, ν: elastic constants of the layer

ε_z: vertical strain (compression +)

Problem statement

EXAMPLE

Given

Stress increase	$\Delta\sigma_z = 100\ \text{kPa},\ \Delta\sigma_x = \Delta\sigma_y = 40\ \text{kPa}$
Soil	$E_u = 25\ \text{MPa},\ \nu = 0.5$
Slice	**thickness 1.0 m**

REQUIRED

Determine the vertical strain and the compression of the slice; compare with the v = 0 (one-dimensional) assumption.

Solution

SOLUTION

1 Vertical strain

$$\varepsilon_z = \frac{\Delta\sigma_z - \nu(\Delta\sigma_x + \Delta\sigma_y)}{E} = \frac{100 - 0.50(40 + 40)}{25{,}000} = \frac{60.0}{25{,}000} = \mathbf{0.00240}$$

2 Compression of the slice (H = 1.0 m)

$$\Delta S = \varepsilon_z H = 0.00240(1.0) = \mathbf{2.40}\ \text{mm}$$

3 Comparison: v = 0

$$\varepsilon_z = \frac{100}{25{,}000} = 0.00400 \ \Rightarrow\ \Delta S = 4.00\ \text{mm}$$

Lateral stresses (v = 0.50) reduce the deformation by **40%**: 2.40 mm, versus 4.00 mm for one-dimensional.

Check the solution in GeoTerva ↗

Closed-form solution for the corner

THEORY

For the **corner** of a uniformly loaded rectangle the integral has a closed-form solution (Steinbrenner):

$$S = q_{net}\,\alpha\,B'\,\frac{1-\nu^2}{E}\,I_s \qquad I_s = F_1 + \frac{1-2\nu}{1-\nu}\,F_2$$

$$F_1 = \frac{A_0 + A_1}{\pi} \qquad F_2 = \frac{n'}{2\pi}\tan^{-1} A_2$$

m′ = L′/B′ and n′ = z/B′ (B′ is the short side of the corner rectangle). The **center** is the corner of four (B/2 × L/2) rectangles: α = 4, B′ = B/2. The **corner** is the corner of the whole rectangle: α = 1, B′ = B. Any other point is the algebraic sum of the four rectangles having a corner at that point.

> For v = 0.5, (1 − 2v) = 0: **$I_s = F_1$** and (1 − v²) = 0.75.

NOTATIONS

α: number of corner rectangles (4 at the center, 1 at the corner)
B′: short side of the corner rectangle
m′ = L′/B′, n′ = z/B′
z: depth from the footing level
I_s: shape factor

A_0, A_1, A_2 and the slice boundary

THEORY

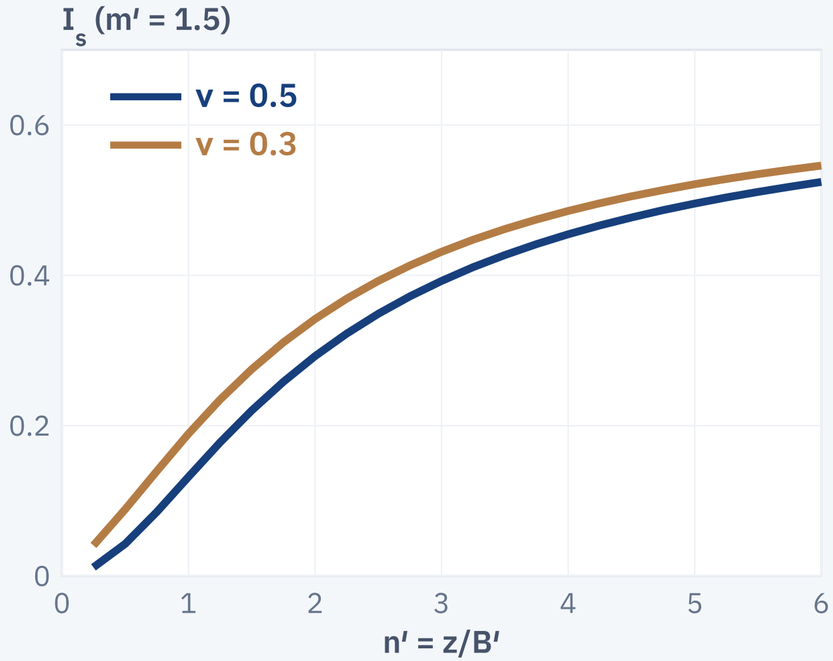
$$A_0 = m' \ln \frac{\left(1+\sqrt{m'^2+1}\right)\sqrt{m'^2+n'^2}}{m'\left(1+\sqrt{m'^2+n'^2+1}\right)}$$

$$A_1 = \ln \frac{\left(m'+\sqrt{m'^2+1}\right)\sqrt{1+n'^2}}{m'+\sqrt{m'^2+n'^2+1}} \qquad A_2 = \frac{m'}{n'\sqrt{m'^2+n'^2+1}}$$

Strip ($m' \to \infty$): $F_1 = \ln(1 + n'^2)/2\pi$ and $F_2 = (n'/2\pi)\tan^{-1}(1/n')$; at its edge $\alpha = 2$, $B' = B$.

The engine computes the formulas directly; no charts or rounded tables are needed.

I_s increases with depth and **slowly saturates**: the contribution of deep layers is limited (on the side $m' = 1.5$).



Problem statement

EXAMPLE

Given

Foundation	**B × L = 4 × 6 m, at depth z′ = 4 m below the center (from the foundation level)**
Corner rectangle	**B/2 × L/2 = 2 × 3 m ⇒ B′ = 2 m, m′ = 1.5, n′ = z′/B′ = 2.0**
Soil	$\nu = 0.5$ **(undrained)**

REQUIRED

Find the values of **A_0, A_1, A_2, F_1, F_2** and **I_s**.

Solution

SOLUTION

1 A_0, A_1, A_2 (square roots: $\sqrt{(m'^2 + 1)} = 1.8028$; $\sqrt{(m'^2 + n'^2)} = 2.5000$; $\sqrt{(m'^2 + n'^2 + 1)} = 2.6926$)

$$A_0 = 1.5 \ln \frac{(1 + 1.8028)(2.5000)}{1.5(1 + 2.6926)} = \mathbf{0.3527} \qquad A_1 = \ln \frac{(1.5 + 1.8028)\sqrt{5}}{1.5 + 2.6926} = \mathbf{0.5662}$$

$$A_2 = \frac{1.5}{2(2.6926)} = \mathbf{0.2785}$$

2 F_1, F_2 and I_s

$$F_1 = \frac{0.3527 + 0.5662}{\pi} = \mathbf{0.2925} \qquad F_2 = \frac{2}{2\pi} \tan^{-1}(0.2785) = \mathbf{0.0865}$$

$$I_s = F_1 + \frac{1 - 2(0.50)}{1 - 0.50} F_2 = \mathbf{0.2925}$$

Since v = 0.5, (1 − 2v) = 0 and **I_s = F_1 = 0.2925**; F_2 does not affect the result.

Check the solution in GeoTerva ↗

Undrained modulus E_u, $\nu = 0.5$

THEORY

Saturated clay **does not change volume** when the load is applied (v = 0.5): this is its immediate settlement. The settlement that occurs as water is expelled is consolidation and is calculated in another module. The undrained modulus is derived from the shear strength:

$$E_u = \beta\, c_u \qquad \nu = 0.5$$

β depends on the plasticity index and the overconsolidation ratio: it varies **from a few hundred to about 1500**.

For v = 0.5, $I_s = F_1$ and $(1 - v^2) = 0.75$.

A clay whose stiffness increases with depth is **divided into several layers**.

β FOR CLAY

β	E_u (c_u = 50 kPa)
300	15 MPa
500	25 MPa
1000	50 MPa
1500	75 MPa

Problem statement

EXAMPLE

Given

Clay	$c_u = 50$ kPa; $\beta = 300,\ 500,\ 1000,\ 1500$
Reference	**For β = 500, single-layer settlement in the multilayer example S = 18.1 mm (Example 6)**

REQUIRED

For each β, $\mathbf{E_u}$ and the ratio of settlement to the reference.

Solution

SOLUTION

1 Undrained modulus (c_u = 50 kPa)

$$E_u = \beta c_u: \quad 300(50) = \mathbf{15}\ \text{MPa},\ \ 500(50) = \mathbf{25},\ \ 1000(50) = \mathbf{50},\ \ 1500(50) = \mathbf{75}\ \text{MPa}$$

β	E_u (MPa)	S (mm)	$S / S_{\beta=500}$
300	15	30.2	1.67
500	25	18.1	1.00
1000	50	9.1	0.50
1500	75	6.0	0.33

Settlement is **inversely proportional** to E_u: between β = 300 and 1500 the settlement changes by a factor of **5** (30 → 6 mm). The modulus of the clay is the most uncertain input of the analysis.

Check the solution in GeoTerva ↗

Excavation first removes the load

THEORY

Excavation removes the **effective overburden stress** at the base level (GWT unchanged). When a single module is used for both unloading and reloading, the elastic heave of the excavation is recovered on reloading; the immediate settlement is governed by the **net pressure**:

$$q_{net} = q_{gross} - \sigma'_{v0}(D_{exc})$$

$\sigma'_{v0}(D_{exc})$: initial effective stress at the excavation base (γ above the GWT, $\gamma' = \gamma_{sat} - \gamma_w$ below it).

If $q_{net} \leq 0$, no settlement occurs (a negative value is elastic heave).

If there is no excavation, $q_{net} = q_{gross}$ (the pressure is applied at the ground surface).

NEDEN NET?

The load equal to the weight of soil removed during excavation is **restored** when the foundation is built. Settlement of the soil arises only from the pressure **added on top of** this load.

Problem statement

EXAMPLE

Given

Load	$q_{gross} = 180$ kPa; **excavation depth** $D_{exc} = 1.5$ m
Soil	$\gamma = 19$ kN/m^3, $\gamma_{sat} = 19.5$ kN/m^3
GWT	**(a) 2.5 m (below the excavation base) · (b) 1.0 m (above the excavation base)**

REQUIRED

In each case, find the $\sigma'_{v0}(D_{exc})$ and q_{net} values.

Solution

SOLUTION

1. (a) GWT 2.5 m > 1.5 m: no water at excavation base

$$\sigma'_{v0} = \gamma D_{exc} = 19.0(1.5) = 28.50\ \text{kPa} \ \Rightarrow\ q_{net} = 180 - 28.50 = \mathbf{151.50}\ \text{kPa}$$

2. (b) GWT at 1.0 m: excavation base is 0.5 m below the water (γ′ = 19.5 − 9.81 = 9.69 kN/m³)

$$\sigma'_{v0} = 19.0(1.0) + 9.69(0.5) = 23.845\ \text{kPa} \ \Rightarrow\ q_{net} = 180 - 23.845 = \mathbf{156.16}\ \text{kPa}$$

If the water is above the excavation base, the effective stress removed decreases and the net pressure **increases** from 151.5 to 156.2 kPa: a high GWT amplifies immediate settlement.

Check the solution in GeoTerva ↗

Influence depth: Δσ = p · q

THEORY

The stress increase under the load decreases with depth but does not become zero; a lower bound on the total is required: **the computation depth z_{lim}**. The module offers two rules:

Influence depth: the depth below the center at which the Boussinesq stress increase falls to **p** (commonly p = 10%): I(z′) = p and $z_{lim} = D_f + z'$.

Base of the profile: the calculation ends at the last layer (a rigid base such as rock or dense gravel; Steinbrenner's layer with a rigid base).

If the profile ends above z_{lim}, the last layer continues to z_{lim} with the same properties.

$$I = \frac{\Delta\sigma_z}{q} = 4\, I_{corner}(m, n) \qquad m = \frac{B}{2z'},\ n = \frac{L}{2z'}$$

z′/B (p = %10 | %20)

L/B	p = %10	p = %20
1.0	2.09 B	1.40 B
1.5	2.55 B	1.70 B
2.0	2.92 B	1.94 B
5.0	4.33 B	2.68 B
strip	6.34 B	3.13 B

Problem statement

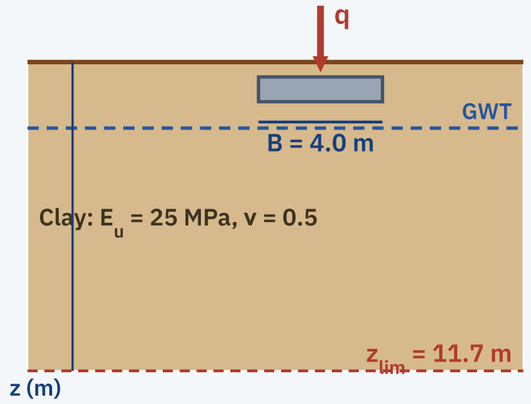
EXAMPLE

Given

Foundation	**B × L = 4 × 6 m (L/B = 1.5), at the excavation base; D_f = 1.5 m**
Rule	**influence depth, p = 10% (I = 0.10)**
Formula	$I = 4\, I_{corner}(m, n),\ m = B/2z',\ n = L/2z'$

REQUIRED

z′ and **z_{lim}**; the value of I for z′ = 4 m and 10.19 m.



Solution

SOLUTION

1 z′ = 4 m: m = 2/4 = 0.5; n = 3/4 = 0.75

$$I = 4\,I_{corner}(0.5;\ 0.75) = 4(0.1071) = \mathbf{0.4283}$$

2 Condition I = 0.10: by bisection

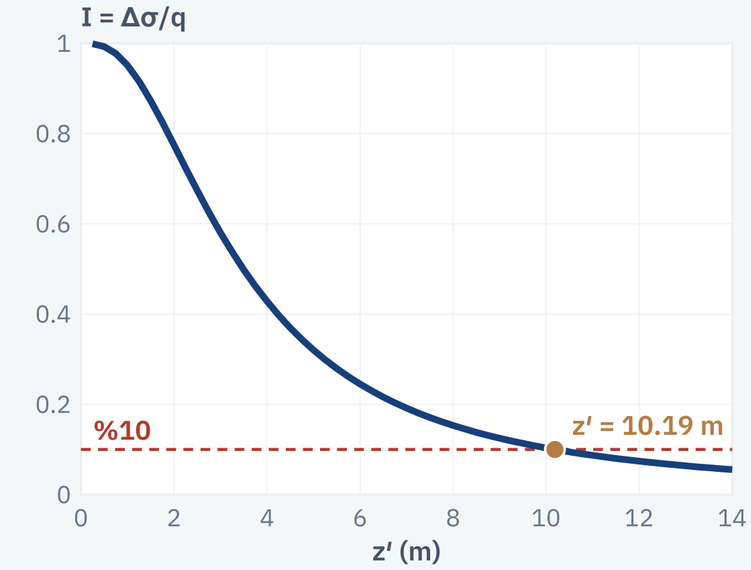
$$z' = \mathbf{10.19}\ \mathrm{m} \quad (= 2.55\,B)$$

$$z_{lim} = D_f + z' = 1.5 + 10.19 = \mathbf{11.69}\ \mathrm{m}$$

3 Check: z′ = 10.19 m ⇒ m = 2/z′, n = 3/z′

$$m = 0.1963,\ n = 0.2945$$

$$I = 4(0.0250) = \mathbf{0.1000}$$



It is summed to a depth of 10.19 m (2.55 B); beyond that is the zone of less than 10% of the pressure. For a square footing 2.09 B, for a strip 6.34 B: **a wide footing acts deeper**.

Check the solution in GeoTerva ↗

Layer contribution: difference in I_s

THEORY

A layer between z_{top} and z_{bottom} (from the foundation level) contributes the **difference of the semi-infinite medium solution between two depths**, with its own E and v:

$$\Delta S = q_{net}\,\alpha\,B'\,\frac{1-\nu^2}{E}\,\left[I_s(z_{bottom}) - I_s(z_{üst})\right]$$

This is the integral of the Hooke deformation over the layer (with homogeneous half-space stresses): for this assumption it is **exact**; the result does not depend on the slice thickness Δz (the slices serve only the tables and the colour areas).

It replaces the **weighted average modulus** in the single-layer formula.

A layer whose stiffness increases with depth should be divided into several layers.

TOTAL

The settlement of the profile is the **sum** of the layer contributions up to z_{lim}: $S = \Sigma\,\Delta S_i$.

Only the part of each layer between the foundation level and z_{lim} is counted.

Problem statement

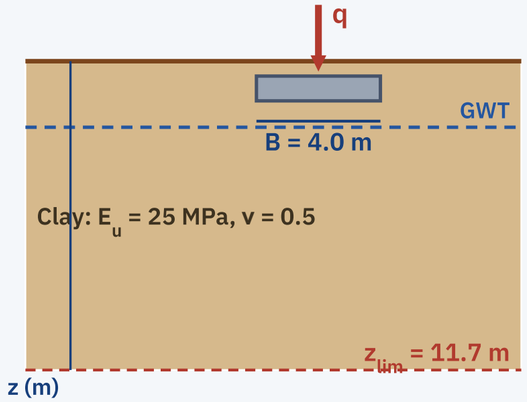
EXAMPLE

Given

Foundation	**rectangular, B × L = 4 × 6 m, base depth D_f = 1.5 m (excavation base)**
Load	$q_{gross} = 180\ \mathrm{kPa}$ **(flexible footing, uniform pressure)**
Soil	**single layer clay:** $E_u = 25\ \mathrm{MPa},\ \nu = 0.5,\ \gamma = 19\ \mathrm{kN/m^3}$**; GWT 2.5 m**
Design depth	**influence depth, p = 10% (Example 5): z′ = 10.19 m, z_{lim} = 11.69 m; the layer continues to this depth**

REQUIRED

Centre settlement **S** of the flexible foundation.



Solution (1/2)

SOLUTION

1 Net pressure (Example 4a) and coefficient k = $q_{net}(1 - \nu^2)/E$

$$q_{net} = 151.50\ \text{kPa} \qquad k = \frac{q_{net}(1-\nu^2)}{E} = \frac{151.50(0.75)}{25{,}000} = 0.004545\ (\text{dimensionless})$$

2 Center: α = 4, B′ = B/2 = 2 m, m′ = 1.5; z′ = 10.19 m ⇒ n′ = z′/B′ = 5.094

$$A_0 = 0.6569,\ A_1 = 0.9097,\ A_2 = 0.0545$$

$$F_1 = 0.4986,\ F_2 = 0.0441 \ \Rightarrow\ I_s = \mathbf{0.4986}$$

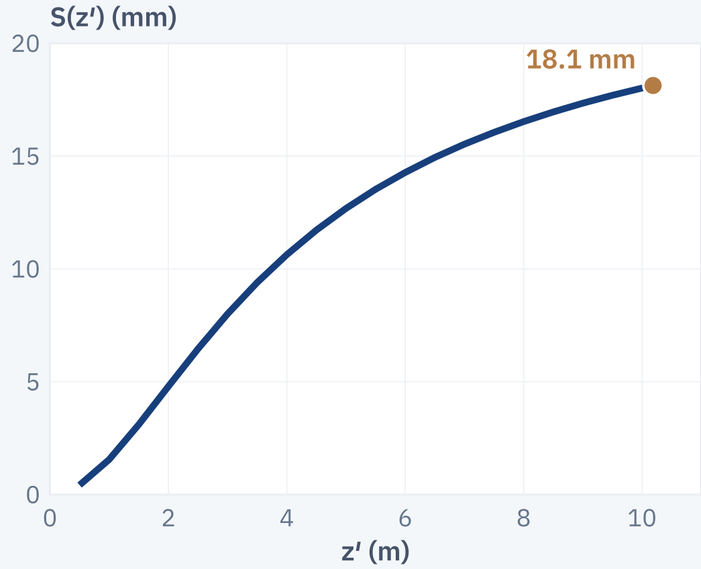
Solution (2/2)

SOLUTION

3 Settlement: $S = k \cdot \alpha\, B' \cdot I_s$

$$S = 0.004545\,(4)(2)(0.4986) = 0.004545(3.9892)$$
$$= 0.01813\ \text{m} = \mathbf{18.1\ mm}$$

Centre settlement **18.1 mm**. In the graph S(z′): most of the settlement occurs within the upper 2B (8 m); the contribution of the deeper layers is small.



Check the solution in GeoTerva ↗

Problem statement

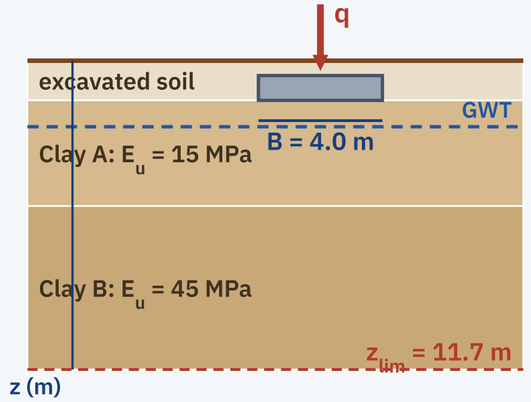
EXAMPLE

Given

Foundation, load	**B × L = 4 × 6 m, q_{gross} = 180 kPa, D_f = 1.5 m ⇒ q_{net} = 151.50 kPa**
Layer A	**4 m thickness from the foundation level:** $E_u = 15$ MPa
Layer B	**below, up to z_{lim}:** $E_u = 45$ MPa
Design depth	**z'_{lim} = 10.19 m**

REQUIRED

Find the **midpoint** settlement of each layer and the total; compare with a single layer.



Solution (1/2)

SOLUTION

1 Layer coefficients k = $q_{net}(1 - \nu^2)/E$ and $\alpha\, B'\, I_s$ (center; Example 2 and 6)

$$k_A = \frac{151.50(0.75)}{15{,}000} = 0.007575 \qquad k_B = \frac{151.50(0.75)}{45{,}000} = 0.002525$$

$$8\, I_s(z' = 4) = 8(0.2925) = 2.3398 \qquad 8\, I_s(z'_{lim}) = 3.9892$$

When the profile is divided into two layers, each layer is summed **with its own modulus**, through the increase of I_s over its own range.

Solution (2/2)

SOLUTION

2 Layer settlements and total

$$\Delta S_A = k_A (8I_s)_4 = 0.007575(2.3398) = 17.7 \text{ mm}$$

$$\Delta S_B = k_B \left[(8I_s)_{lim} - (8I_s)_4\right] = 0.002525(3.9892 - 2.3398) = 4.2 \text{ mm}$$

$$S = \Delta S_A + \Delta S_B = \mathbf{21.9 \text{ mm}}$$

Total center settlement is **21.9 mm** (engine: 21.9 mm). The single layer (E = 25 MPa) gave 18.1 mm: since the upper 4 m is **soft**, settlement increased by **21%**; layer A carries 81% of the total.

Check the solution in GeoTerva ↗

Center, corner and rigid settlement

THEORY

The formulas give the settlement of a **perfectly flexible** footing: **maximum at the center**, minimum at the corner; their difference is the **differential settlement** of the flexible footing. A rigid footing settles **uniformly**: about 0.93 times the flexible center value:

$$S_{rigid} \approx 0.93\, S_{center} \qquad S_{diff} = S_{center} - S_{köşe}$$

Centre: α = 4, B′ = B/2. Corner: α = 1, B′ = B (corner of the full rectangle).

Embedment: the Fox depth factor I_f (depending on D_f/B, B/L and ν) reduces the settlement of an embedded foundation. The module takes I_f = 1: no correction, **on the safe side**.

NOTE

A real footing lies between flexible and rigid. The module gives the two extreme values; intermediate stiffness and soil–structure interaction are outside its scope.

Problem statement

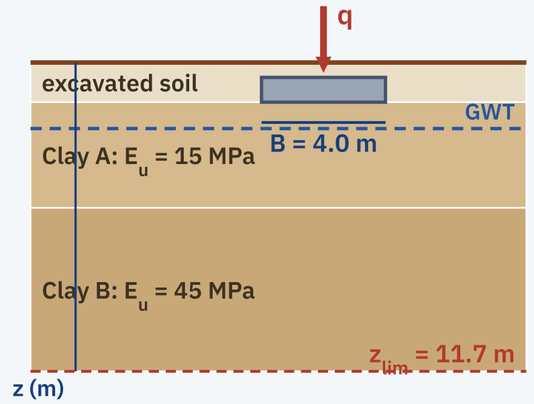
EXAMPLE

Given

Profile	**Example 7: Layer A (4 m) and Layer B; z'_{lim} = 10.19 m**
Foundation	**flexible, 4 × 6 m**
Corner	**α = 1, B′ = B = 4 m ⇒ m′ = L/B = 1.5; n′ = z′/4**

REQUIRED

Corner settlement, **rigid** footing settlement and **differential** settlement of a flexible footing.



Solution

SOLUTION

1 4·I_s values for the corner (n′ = z′/4)

$$z' = 4\ (n' = 1):\ 4\,I_s = 0.5277$$

$$z'_{lim} = 10.19\ (n' = 2.547):\ 4\,I_s = 1.4137$$

2 Corner settlement

$$S_{köşe} = k_A(0.5277) + k_B(1.4137 - 0.5277) = 4.0 + 2.2 = \mathbf{6.2\ mm}$$

3 Rigid and differential

$$S_{rigid} = 0.93(21.9) = \mathbf{20.4\ mm} \qquad S_{diff} = 21.9 - 6.2 = \mathbf{15.7\ mm}$$

Centre 21.9, corner 6.2, rigid 20.4 mm; the differential settlement of the flexible footing is **15.7 mm**. The corner settles only 28% of the centre.

Check the solution in GeoTerva ↗

Problem statement

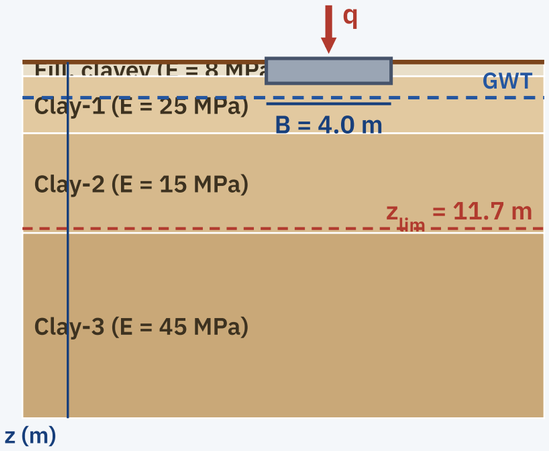
EXAMPLE

Given

Foundation	**B × L = 4 × 6 m, q_{gross} = 180 kPa, excavation depth 1.5 m, GWT 2.5 m**
Profile	**Fill, clayey 0–1 m: E_u = 8 MPa; Clay-1 1–5 m: E_u = 25 MPa; Clay-2 5–12 m: E_u = 15 MPa; Clay-3 12–25 m: E_u = 45 MPa**
Design depth	**influence depth, p = 10%**

REQUIRED

Layer-by-layer **center** and **corner** settlement; flexible center, corner, rigid and differential settlement.



Solution (1/2)

SOLUTION

1 Net pressure (excavation base 1.5 m)

$$\sigma'_{v0}(1.5) = 27.50\ \text{kPa} \quad \Rightarrow \quad q_{net} = 180 - 27.50 = \mathbf{152.50}\ \text{kPa}$$

2 Calculation depth and layers

$z_{lim} = 1.5 + 10.19 = \mathbf{11.69}$ m — the layer above the excavation base is removed

The excavation base (1.5 m) lies within the Clay-1 layer: only the portion of the layers below 1.5 m is counted. z_{lim} = 11.69 m, which lies within the Clay-2 layer, so that layer is truncated.

Solution (2/2)

SOLUTION

Layer	z (m)	H (m)	E (MPa)	k (×10⁻³)	ΔS center (mm)	ΔS corner (mm)
Clay-1 (CL, stiff)	1.50 – 5.00	3.50	25	4.575	9.5	2.0
Clay-2 (CH, hard)	5.00 – 11.69	6.69	15	7.625	14.7	7.5
Total					**24.1**	**9.5**

Centre **24.1 mm**, corner 9.5 mm, rigid 22.4 mm, differential 14.7 mm. The module gives the same values.

Check the solution in GeoTerva ↗

Points to keep in mind when reading the results

THEORY

Assumptions:

- Foundation level = excavation base; uniform pressure on a fully flexible footing.
- In each layer, the stresses of a **homogeneous half-space** (with that layer's ν).
- Each layer is cohesive and settles **undrained** (E_u, ν = 0.5).
- No embedment correction; rigid footing ≈ 0.93 × flexible center.
- Sign convention: settlement is **positive**; the selector in the header switches to the convention where upward settlement is positive.

Out of scope: consolidation and secondary compression of clay; granular layers; Schmertmann, SPT/CPT charts, modulus increasing with depth, foundation rigidity and soil–structure interaction, finite elements.

COLOUR AREAS

Section views show the stress increase, modulus, strain and S(z) settlement with colour bands; the centre value at the footing level is the resulting settlement.

Summary

Key points

Hooke: $\varepsilon_z = [\Delta\sigma_z - \nu(\Delta\sigma_x + \Delta\sigma_y)]/E$; $\mathbf{S = \int \varepsilon_z\, dz}$; inversely proportional to E

Steinbrenner: $S = q_{net}\, \alpha\, B'\, (1 - \nu^2)/E \cdot I_s$; $I_s = F_1 + (1 - 2\nu)/(1 - \nu)\, F_2$; center $\alpha = 4$, $B' = B/2$; corner $\alpha = 1$, $B' = B$

Clay: $E_u = \beta\, c_u$ (β a few hundred–1500), $\nu = 0.5 \Rightarrow I_s = F_1$

Layered: $\Delta S = q_{net}\, \alpha\, B'\, (1 - \nu^2)/E \cdot [I_s(z_{bottom}) - I_s(z_{top})]$; independent of slice thickness

Net pressure $q_{net} = q_{gross} - \sigma'_{v0}(D_{exc})$; **influence depth** $I(z') = p$ (2.09 B for square, 2.55 B for L = 1.5 B, 6.34 B for strip)

Flexible: center > corner (differential settlement); **rigid** ≈ 0.93 × center; no embedment correction ($I_f = 1$)

References

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NOTE

All numerical examples have been produced with the module's own calculation engine; the module gives the same values.

GeoTerva

Online geotechnical analysis

From theory to practice

Compute the example project in this lecture step by step in GeoTerva: the module opens with this model.

Open the module →

Theory page →

Open on your phone
The example modules need no registration.

If you would like to use them in your lectures: info@geoterva.com