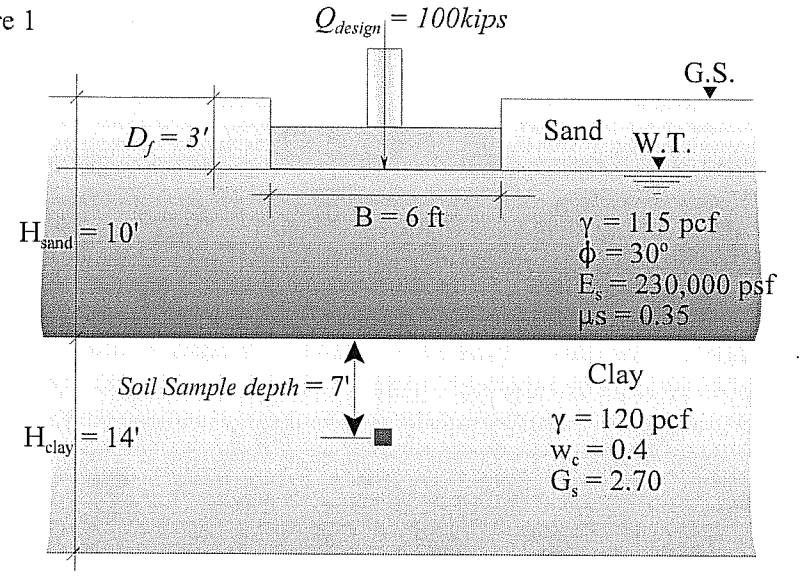
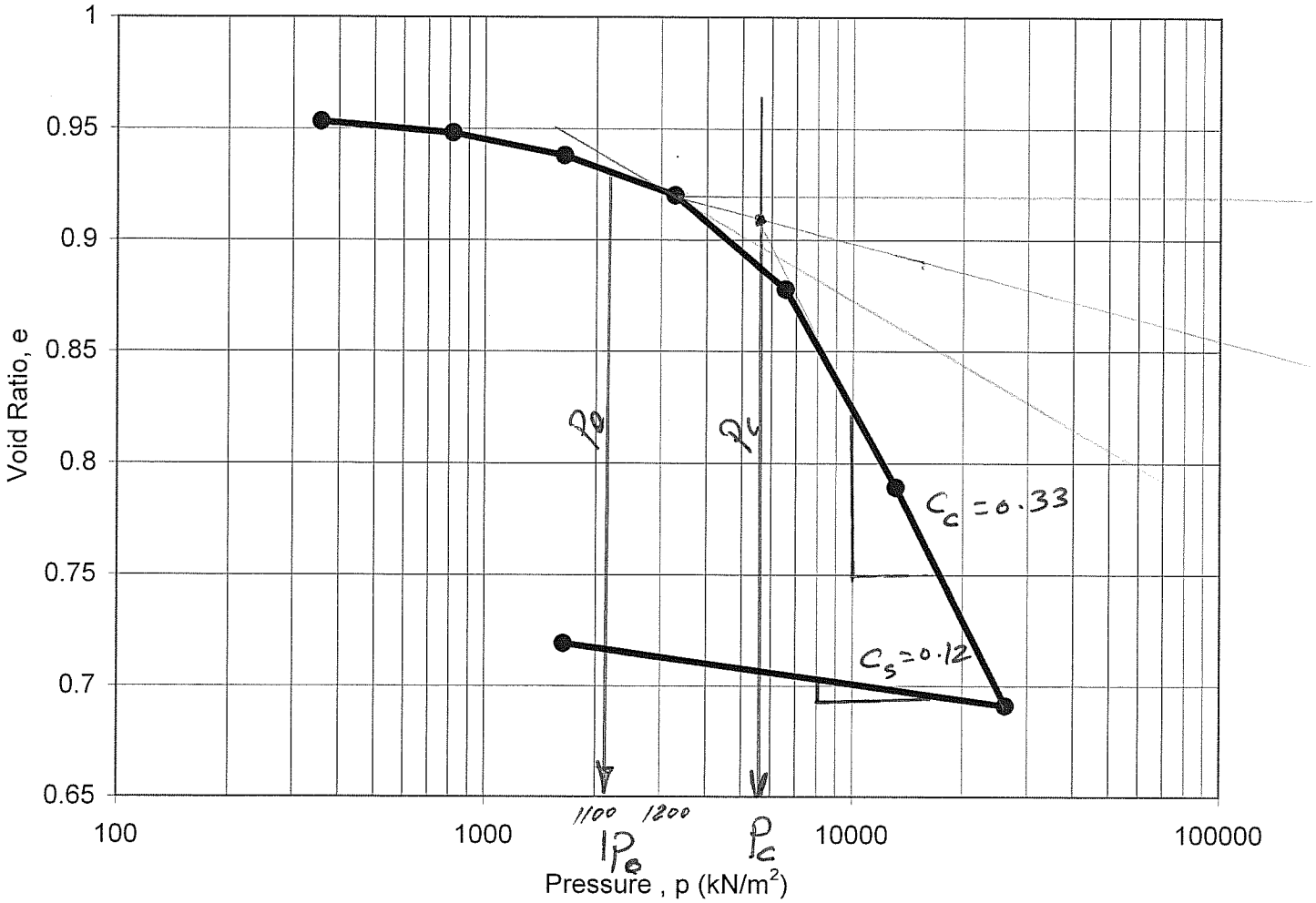
Geotech Example

Given:
Footing on layered soil (Figure1). Determine the total settlement of the footing. The consolidation test on a soil sample obtained from the clay layer is shown in Figure 2.

Figure 1



Questions:
1- Is the clayey soil normally consolidated or overconsolidated soil
2- If the water table dropped from 3 ft to 5ft what would be the effect of this drop on the settlement of the foundation.


1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
Void Ratio, e
100
1000
10000
100000
Pressure , p (kN/m²)
Cc = 0.33
Cs = 0.12
1100
1200

Solution: $S_{total} = S_{e_{sand}} + S_{c_{clay}}$

Initial void ratio for the clayey soil $e_o = w_c G_s$

$e_o = 0.4 \times 2.7 = 1.08$

I. Elastic Settlement in the sand layer:

$$S_{e_{sand}} = \frac{qB}{E_s}(1-\mu_s^2)\alpha$$

$$S_e = \frac{\left(\frac{100{,}000}{6\times 6}\right)\times 6}{230{,}000}\left(1-0.35^2\right)\times 0.97 = 0.06 \text{ ft}$$

$$= 0.74 \text{ in}$$

=

II. Consolidation Settlement in the clay layer

$$S_{c_{clay}} = \frac{C_c H}{1+e_o}\log\frac{P_o+\Delta P}{P_o} \Rightarrow (1)$$ For normally consolidated soil

or

For overconsolidated soil:

$$S_{c_{clay}} = \frac{C_s H}{1+e_o}\log\frac{P_c}{P_o} + \frac{C_c H}{1+e_o}\log\frac{P_o+\Delta P}{P_c} \Rightarrow (2)$$ For Over-Consolidated soil

or

$$S_{c_{clay}} = \frac{C_s H}{1+e_o}\log\frac{P_o+\Delta P}{P_o} \Rightarrow (3)$$ For Overconsolidated soil

What clayey soil do we have ?

1- Normally Consolidated

or

2- Over consolidated

See the e - log P curve that we obtained from the consolidation test in the lab.

Compare P_o = Existing geostatic pressure
and P_c = Preconsolidation Pressure

Calculate P_o

P_o is calculated at the midheight of the consolidated layer (clay layer)

$P_o = 3' \times 115 + 7'(115 - 62.4) + 7'(120 - 62.4)$
$= 1116.4$ psf

P_c is determined using Casagrande graphical method. (Given in the figure)
$P_c = 1450$ psf

$P_c > P_o$ ∴ the soil is Overconsolidated

Which Consolidation settlement equation we need to use ??

The Choice is between (2) & (3)

Now if

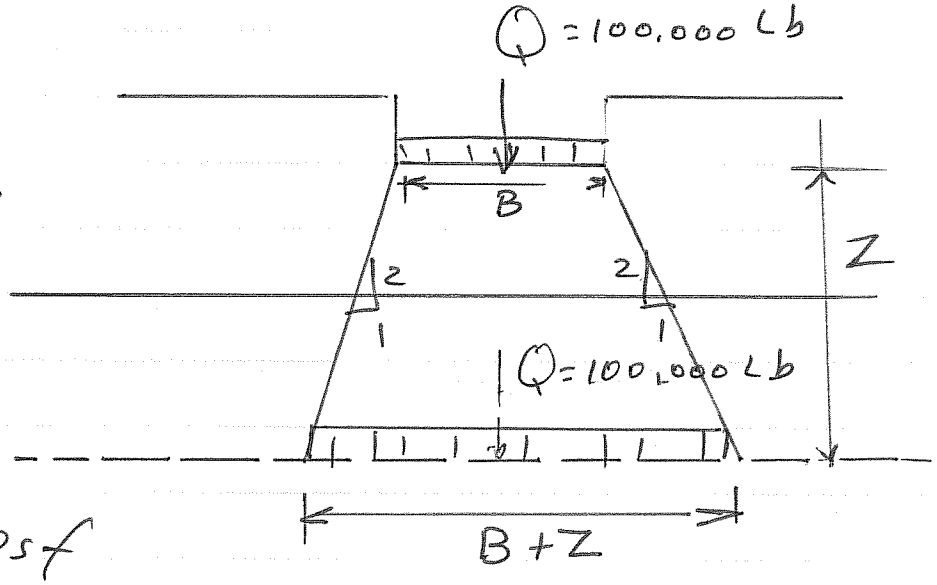
$(P_o + \Delta P) > P_c \Rightarrow$ use (2)

if $(P_o + \Delta P) < P_c \Rightarrow$ use (3)

ΔP is the stress due to the footing at the mid height of the clay layer.

ΔP Calculation

$$\Delta P = \frac{100{,}000}{(6+14)^2} = 250 \text{ psf}$$



$P_o + \Delta P =$
$1116.4 + 250$
$= 1366.4$ psf

$\therefore (P_o + \Delta P) < P_c \Rightarrow$ use equation (3)

Consolidation Settlement of Clayey Soil

$$S_{C_{clay}} = \frac{0.12 \times 14}{1 + 1.08}\left(\log \frac{1116.4 + 250}{1116.4}\right)$$

$$= 0.807 \times 0.087 = 0.071 \text{ ft}$$

$$= 0.85 \text{ in}$$

$$\therefore \text{Total settlement } S_{total} = 0.74 + 0.85$$

$$= 1.6 \text{ in}$$

What is the settlement of the foundation after 3 years from the end of construction.
Take $C_v = 0.004087$ ft²/hr