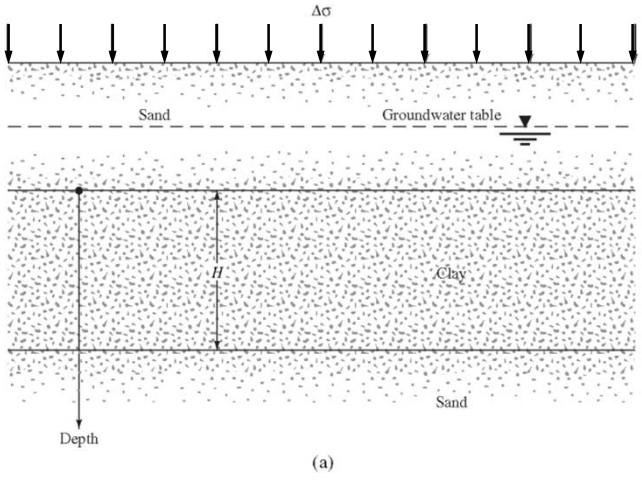
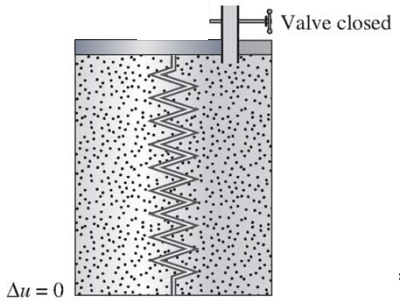
Consolidation

Chapter 9

Consolidation

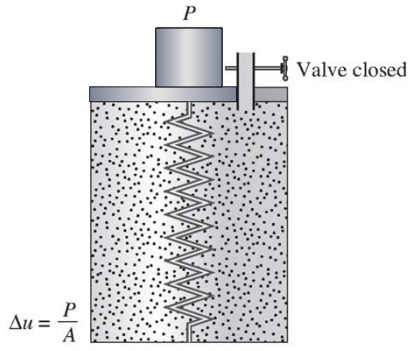


Consolidation Model



(a)

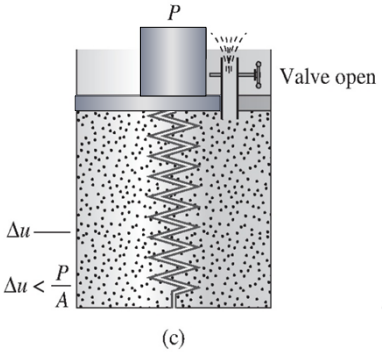
Consolidation Model



(b)

$P = P_s + P_w$ (0)

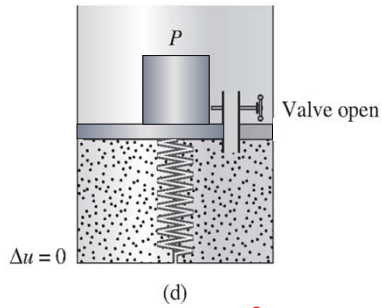
Consolidation Model



(c)

$$P = P_s + P_w$$

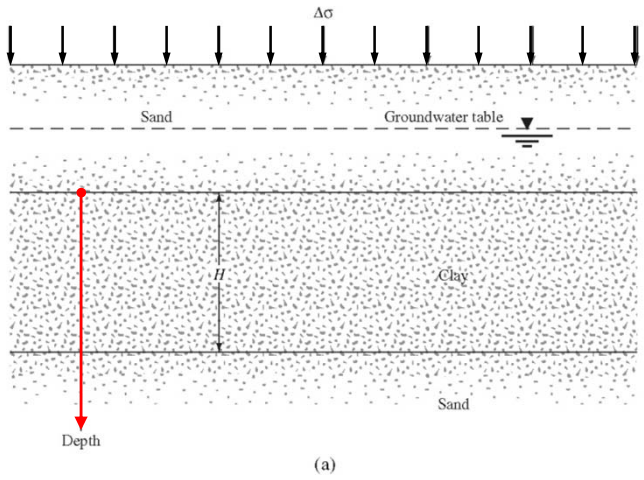
Consolidation Model



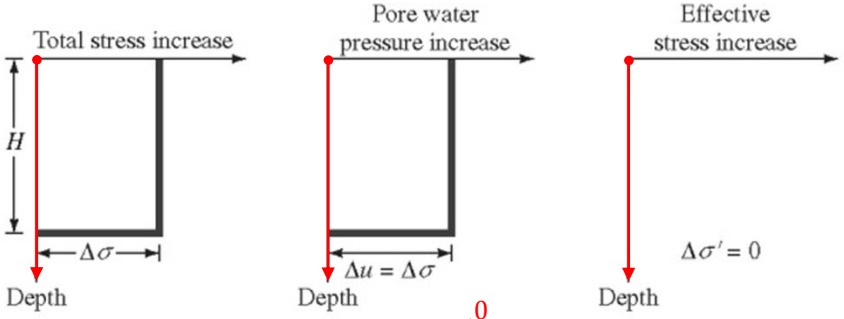
(d)

$$P = P_s + P_w \quad (P_w \rightarrow 0)$$

Consolidation Model



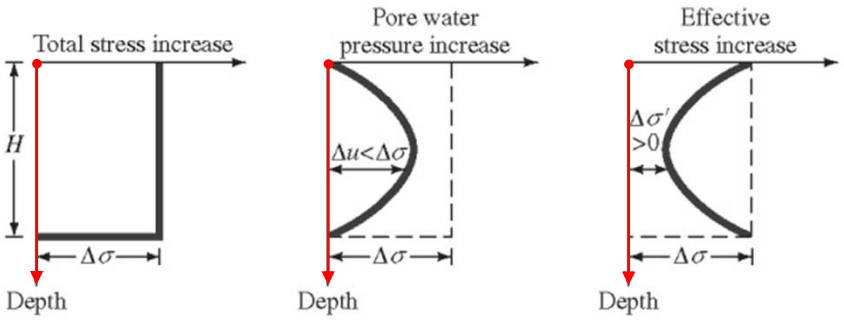
Consolidation Model



$$\Delta\sigma = \Delta\sigma' + \Delta u$$

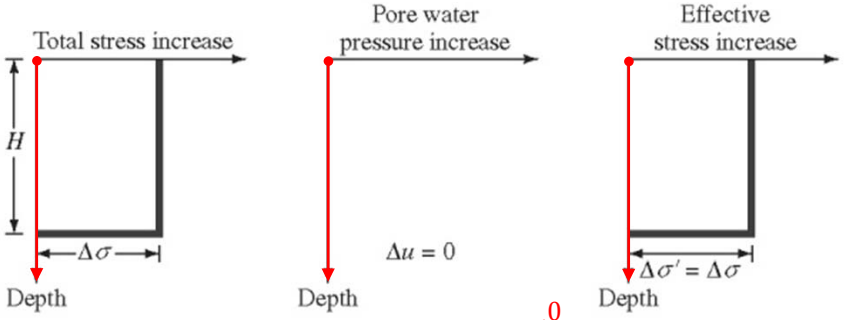
0

Consolidation Model



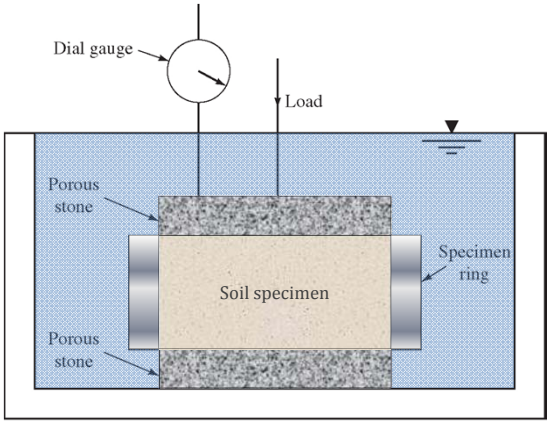
$$\Delta\sigma = \Delta\sigma' + \Delta u$$

Consolidation Model

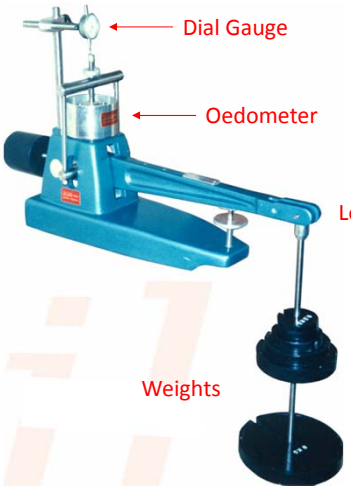


$$\Delta\sigma = \Delta\sigma' + \cancel{\Delta u}^{\,0}$$

Consolidation Test

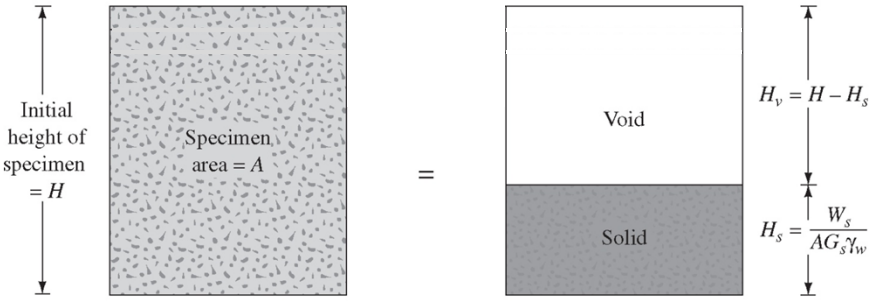


Consolidation Test



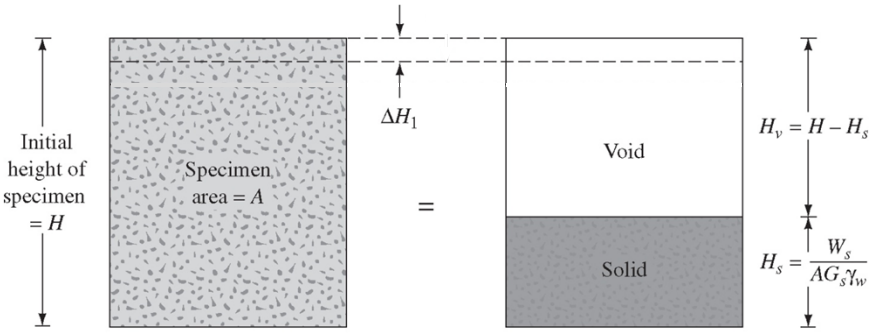
Consolidation Test Results

$$e_0 = \frac{V_v}{V_s} = \frac{H_v}{H_s}\frac{A}{A} = \frac{H_v}{H_s}$$



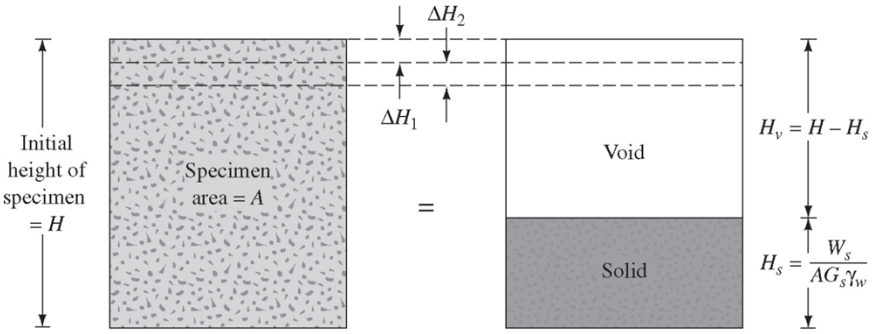
Consolidation Test Results

$$\Delta e_1 = \frac{\Delta H_1}{H_s} \qquad e_1 = e_0 - \Delta e_1$$

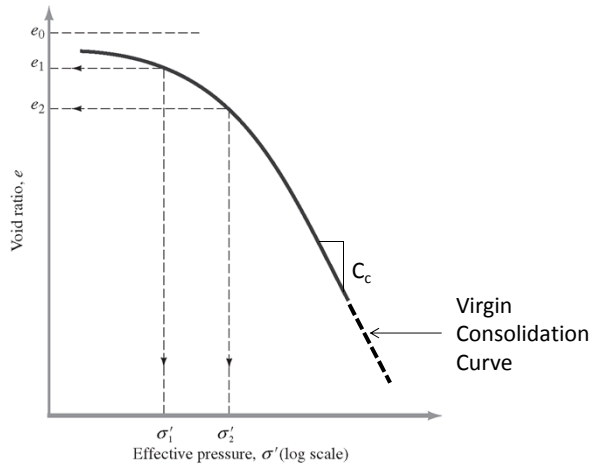


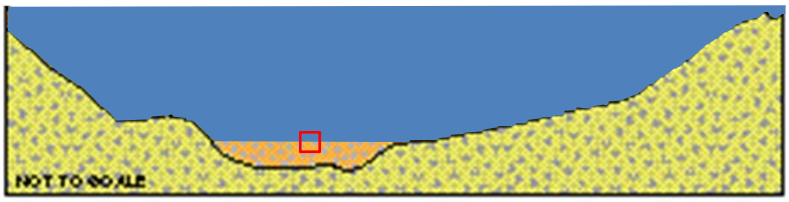
Consolidation Test Results

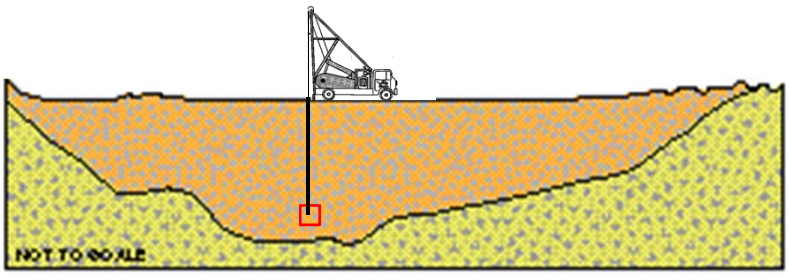
$$e_2 = e_1 - \frac{\Delta H_2}{H_s}$$



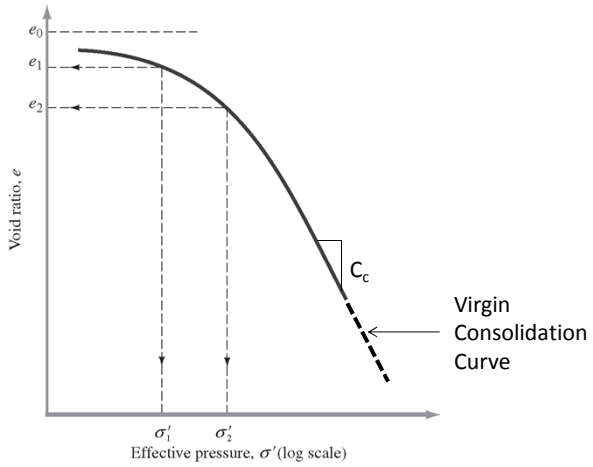
Consolidation Test Results

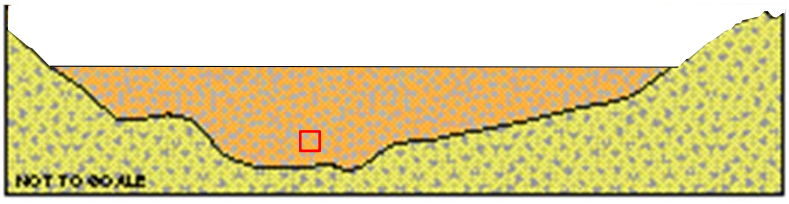



NOT TO SCALE

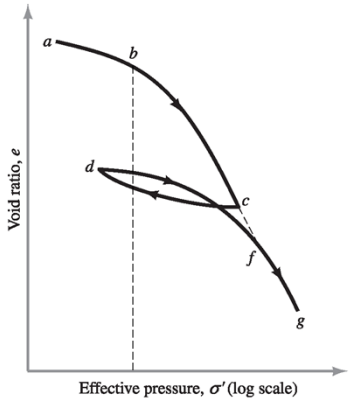

NOT TO SCALE

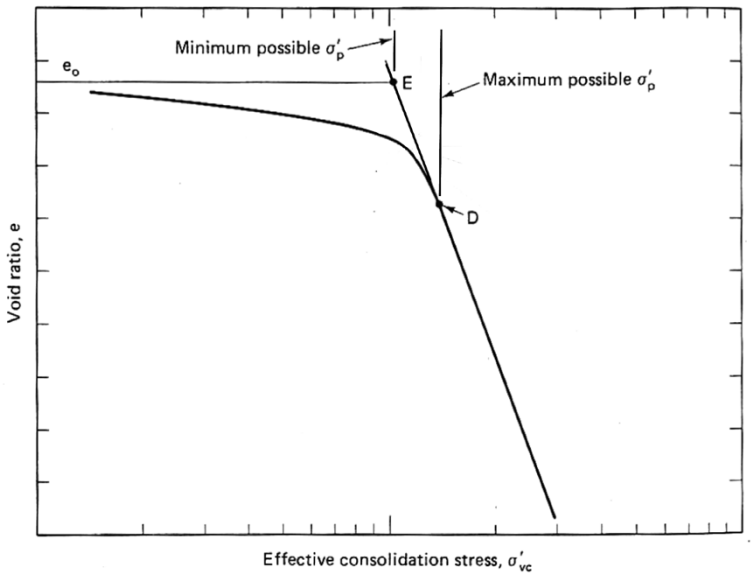
Consolidation Test Results





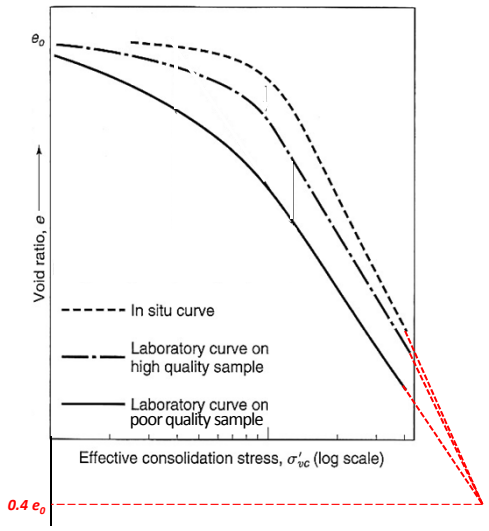
Consolidation Test Results



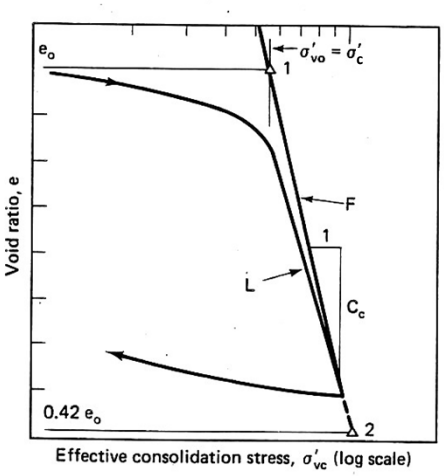


(Holtz & Kovacs, *An Introduction to Geotechnical Engineering*, 1981)

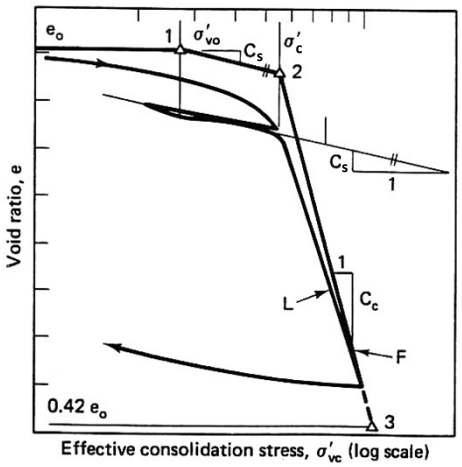
Sample Disturbance



Schmertmann Procedure



Schmertmann Procedure



Consolidation Settlement

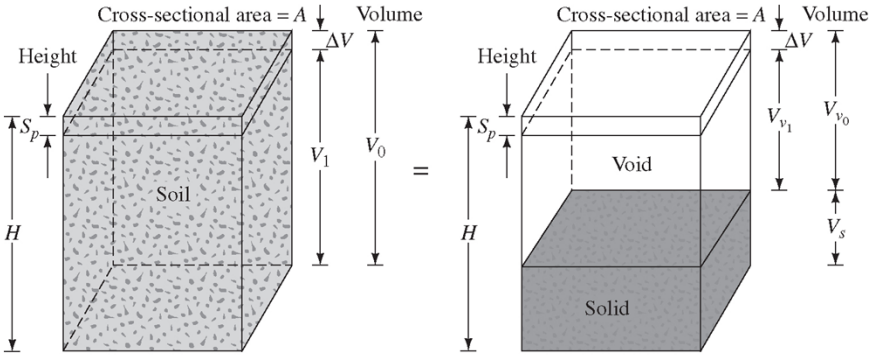


Figure 9.12 Settlement caused by one-dimensional consolidation

Consolidation Settlement

$$S_p = \Delta H = \frac{\Delta V_v}{A} = \frac{\Delta e V_s}{A}$$

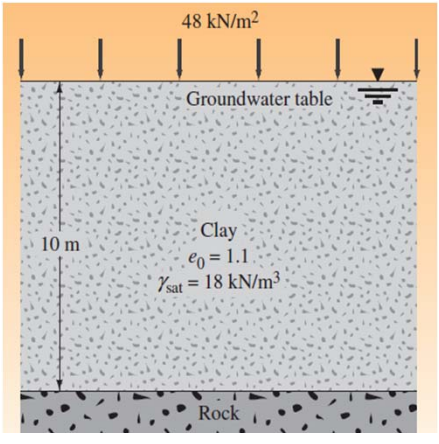
$$V_s = \frac{V_0}{1 + e_0} = \frac{AH}{1 + e_0}$$

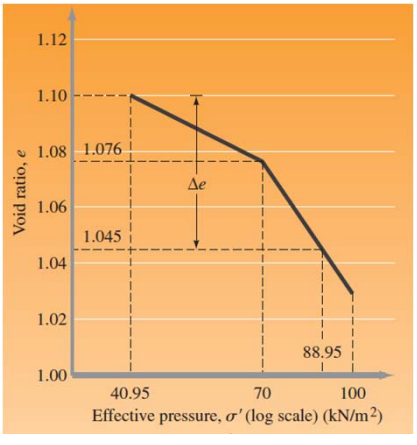
$$S_p = \frac{\Delta e A H}{A(1 + e_0)} = \frac{\Delta e H}{1 + e_0}$$

$$S_p = H\frac{\Delta e}{1 + e_0}$$

Example 9.3

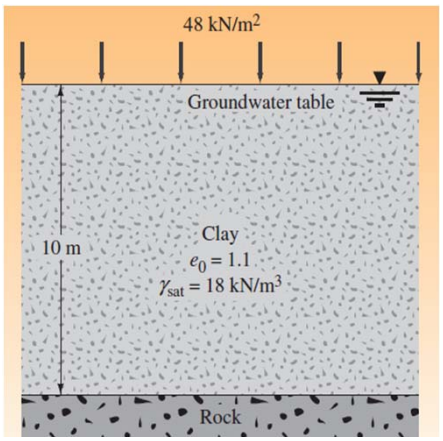
A soil profile is shown in Figure 9.15a. Laboratory consolidation tests were conducted on a specimen collected from the middle of the clay layer. The field consolidation curve interpolated from the laboratory test results is shown in Figure 9.15b. Calculate the settlement in the field caused by primary consolidation for a surcharge of 48 kN/m^2 applied at the ground surface.





Example 9.3

A soil profile is shown in Figure 9.15a. Laboratory consolidation tests were conducted on a specimen collected from the middle of the clay layer. The preconsolidation stress is 70 kN/m^2, the compression index is 0.2 and the swelling index is 0.1. Calculate the settlement in the field caused by primary consolidation for a surcharge of 48 kN/m^2 applied at the ground surface.



Consolidation Settlement

$$S_p = H\frac{\Delta e}{1 + e_0}$$

Normally Consolidated Soil

$$\Delta e = C_c\,\Delta \log \sigma'$$

$$\Delta \log \sigma' = \log(\sigma'_o + \Delta\sigma) - \log(\sigma'_o) = \log\frac{\sigma'_o + \Delta\sigma}{\sigma'_o}$$

$$S_p = \frac{C_c H}{1 + e_0}\log\left(\frac{\sigma'_o + \Delta\sigma'}{\sigma'_o}\right)$$

Consolidation Settlement

$$S_p = H\frac{\Delta e}{1 + e_0}$$

Overconsolidated Soil

$$\Delta e = C_s \log\frac{\sigma'_c}{\sigma'_o} + C_c \log\frac{\sigma'_o + \Delta\sigma}{\sigma'_c}$$

$$S_p = \frac{C_s H}{1 + e_0}\log\frac{\sigma'_c}{\sigma'_o} + \frac{C_c H}{1 + e_0}\log\left(\frac{\sigma'_o + \Delta\sigma'}{\sigma'_c}\right)$$

Example 9.2

A soil profile is shown in Figure 9.14. If a uniformly distributed load $\Delta\sigma$ is applied at the ground surface, what will be the settlement of the clay layer caused by primary consolidation? We are given that σ'_c for the clay is 125 kN/m^2 and $C_s = \frac{1}{6}C_c$.