



International Society for Soil Mechanics and Geotechnical Engineering
Technical Committee TC306 Geo-engineering Education



Case-study webinar

“Porto Tolle test embankment - A full scale experiment on the consolidation of a thick clay layer”

<https://www.youtube.com/watch?v=hWpyswdglBk>

Delivered by

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Assignment for students

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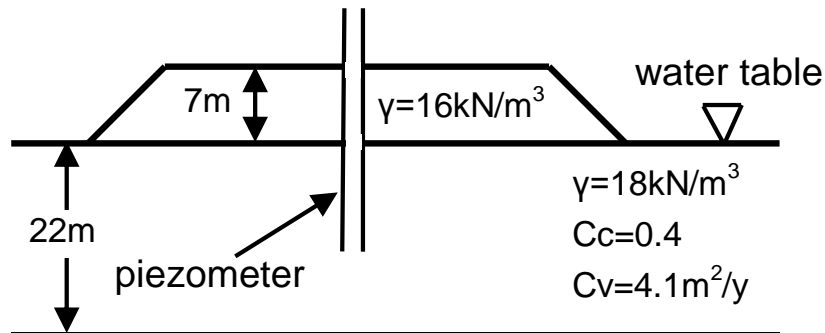
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(the Author is available to send the solution of the assignment to interested instructors)

Problem geometry

Consider a test embankment on a simplified soil profile (see Figure). The water table, which is very close to the ground surface, is assumed to be at the ground surface.



Selection of soil parameters

Soil parameters

EMBANKMENT

Slide 25: embankment “weight” = $\gamma h = 11.4 \text{ t/m}^2 = 111.8 \text{ kN/m}^2$, for embankment height $h = 7\text{m} \rightarrow$ embankment unit weight $\gamma_e = 16 \text{ kN/m}^3$

Slide 8: $w = 40\%$ (estimated average value), $e = w G_s$, I assume $G_s = 2.7 \rightarrow$ $e_0 = 1.08$

CLAY LAYER

$\gamma_c = G_s [(1+w)/(1+e)] \gamma_w \rightarrow$ (saturated) clay unit weight $\gamma_c = 18 \text{ kN/m}^3$

Consolidation parameters

Slide 8: The clay is normally consolidated

Slide 11: Coefficient of consolidation determined in the lab, $C_v = 1.3 \times 10^{-3} \text{ cm}^2/\text{s} = 4.1 \text{ m}^2/\text{y}$

- Repeat calculation for a value of $C_v = 3 \times 10^{-3} \text{ cm}^2/\text{s} = 9.5 \text{ m}^2/\text{y}$, more representative of field conditions

Slide 8: Compression coefficient $C_c = 0.4$ (conservative estimate of average value)

- Repeat calculation for bounding values $C_c = 0.25$ and $C_c = 0.5$ for most data points

Problem statement

A 7-m high test embankment of sandy gravel with unit weight $\gamma_e = 16\text{kN/m}^3$ is constructed on a 22-m thick layer of normally consolidated clay with saturated unit weight $\gamma_c = 18\text{kN/m}^3$ overlying dense sand (not shown in figure). The water table is at ground surface.

Assuming 1-D compression, calculate the following:

- a) the vertical effective stress and the pore water pressure at the mid-point of the clay layer i) immediately after the construction of the embankment (see *Note*) and ii) two years after construction.
- b) the water level inside the piezometer (which is installed at the mid-point of the clay layer in order to monitor pore pressure, as a supplementary information to direct settlement measurement) two years after embankment construction: please (i) calculate the distance between the water level and the mid-point of the clay layer and (ii) show the approximate location of the water level in the figure.
- c) the total settlement due to consolidation of the clay.
- d) the time required for 90% of the total settlement to be completed.

Note

If the Time factor, $T=c_v t/D^2$, is smaller than 0.01 it is reasonable to treat the material as undrained (Duncan, 1996). Therefore, the construction of the embankment (88 days) may be assumed to be quick in relation to the drainage properties of the clay layer ($c_v = 4.1 \text{ m}^2/\text{y}$; $D = 11 \text{ m}$).

Duncan JM (1996). State of the Art: Limit Equilibrium and Finite-element Analysis of Slopes. ASCE Journal of Geotechnical Engineering, 122(7):577-596.