

Exam Soil Mechanics

Bachelor 2nd year, CiT/CTW

Module/course code: 202000065-1A: Safety and Risk in Delta's – Soil Mechanics

Date: 20 October 2022

Time: 13.45-15.45 (+25% for students who may use extra time)

Module-coordinator: Maarten Krol

Instructors: Vanessa Magnanimo and Floriana Anselmucci

Type of test: Exercises, Open questions.

Allowed aids: Scientific calculator, formula sheet, English-Dutch dictionary.

Attachments: Formula sheet.

Exercise 1

A layer of clay 4 m thick lies between two layers of sand each 4 m thick, the top of the upper layer of sand being ground level. The water table is 2 m below ground level, but the lower layer of sand is under artesian pressure, the piezometric surface being 4m above ground level. The saturated unit weight of the clay is 20kN/m^3 and that of the sand 19kN/m^3 ; above the water table the unit weight of the sand is 16.5kN/m^3 .

- a) Sketch the situation described above.
- b) Calculate the total vertical stress, pore pressure and effective vertical stress at the top, bottom and in the middle of the clay layer.
- c) Sketch the pressure profiles.
- d) Check the safety of the soil against boiling (heaving). Refer to the bottom of the clay layer. What would happen if the upper layer of sand is removed by excavation?
- e) Based on your results, discuss the effect of artesian pressure on the risk of boiling and the role of surcharge.

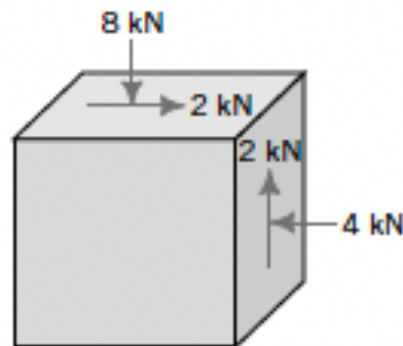
Exercise 2

A consolidation test on a saturated clay gave the following results: $C_c=0.2$ and $C_e=0.04$, and $OCR=4.5$. The existing vertical effective stress in the field is 120 kPa. A building foundation will increase the vertical total stress at the center of the clay by 80 kPa. The thickness of the clay layer is 1.5m. The water content is 36% and the specific gravity $G_s=2.65$.

- Sketch the graph of void-ratio against effective-vertical-stress (natural logarithm) and briefly describe its parts.
- Locate the initial and final states of the soil in your plot at a).
- Calculate the consolidation settlement.
- What would be the difference in settlement if OCR was 1.5 instead 4.5?
- What would be the final settlement if the constructor decides to lay down an extra layer of 2m sand ($\gamma_d=14 \text{ kN/m}^3$, $\gamma_{sat}=18 \text{ kN/m}^3$), before installing the foundation? Such intervention is often conducted to regularize the ground surface and facilitate water drainage under the foundation.
N.B. For this question, you must refer to the case with clay OCR=1.5.
Compare your result with that at point d) and comment on the difference.

Exercise 3

A soil specimen (100mm x 100mm x 100mm) is subjected to the forces shown in the figure.



- Plot the Mohr's circle.

Determine:

- the magnitude of the principal stresses,
- the orientation of the principal stress plane to the horizontal,
- the maximum shear stress,
- the normal and shear stresses on a plane inclined at 20° clockwise to the horizontal.

For each of the questions from b) to e), compare the analytical solution with the results that you can obtain graphically via the Mohr's circle.