DELFT UNIVERSITY OF TECHNOLOGY

Faculty of Civil Engineering and Geosciences

Soil Mechanics II

CT2091

BSc EXAMINATION 2012

FIRST PERIOD

DATE: 2 November 2012 TIME: 09.00 – 12.00

Answer ALL Questions
(Note that the questions carry unequal marks)

Other instructions
Write your name and student number on each answer sheet

Clearly identify the answer in the answer box

1) In a direct shear test, a sample of clean dry sand has been loaded with a vertical applied pressure of 250 kPa. The shear stress at failure is 150 kPa.

   a. Determine the angle of friction mobilised and draw the Mohr's circle of effective stress at failure. [**12 marks**]

   b. Determine the coordinates of the Pole of the circle that has been drawn. [**5 marks**]

   c. Determine the magnitude and direction of the principle stresses. [**8 marks**]

2) Two borehole samples of clay have been consolidated under cell pressures of 200 kPa and 300 kPa. Any excess pore pressures were allowed to dissipate. The samples were then sheared to failure under undrained conditions and indicated principle stress differences at failure of 253 kPa and 362 kPa, respectively. In both cases the pore pressure parameter *B* was found to be constant at 0.85 over the range of σ_3 = 0 – 300 kPa, and *A* was found to be 0.32.

   a. Determine the effective stress parameters, c' and ϕ'. [**10 marks**]

   b. Another sample from the same borehole is tested with a cell pressure of 100 kPa and a pore pressure of 50 kPa at the start of the test (i.e. the back pressure). What is the compression strength? [**6 marks**]

   c. For the test from question (b), sketch the likely stress path for the deviatoric part of the test, by plotting $\left(\frac{\sigma_1' - \sigma_3'}{2}\right)$ against $\left(\frac{\sigma_1' + \sigma_3'}{2}\right)$. [**5 marks**]

   d. On the same figure, plot the total stress path. [**4 marks**]

3) A sheet pile wall is designed as a canal wall with two options as shown in the figure below. The properties of the soil are: γ = 20 kN/m^3, ϕ = 30°, c = 0 kPa. Assume that the groundwater table is at the ground surface.

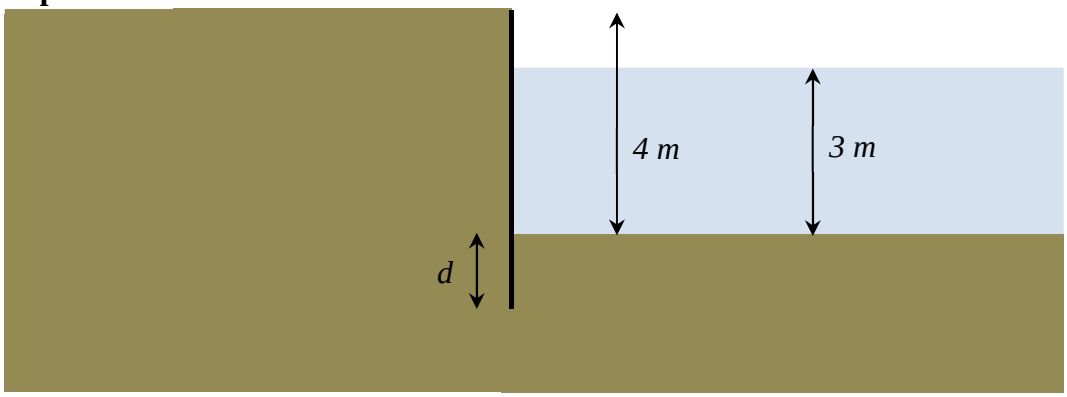
a. Sketch the forces and the location of the action on the pile for Option 2. [**7 marks**]

b. Calculate the minimum embedded depth of the pile for Option 1 with a Factor of Safety of 1.5 against lateral failure. [**10 marks**]

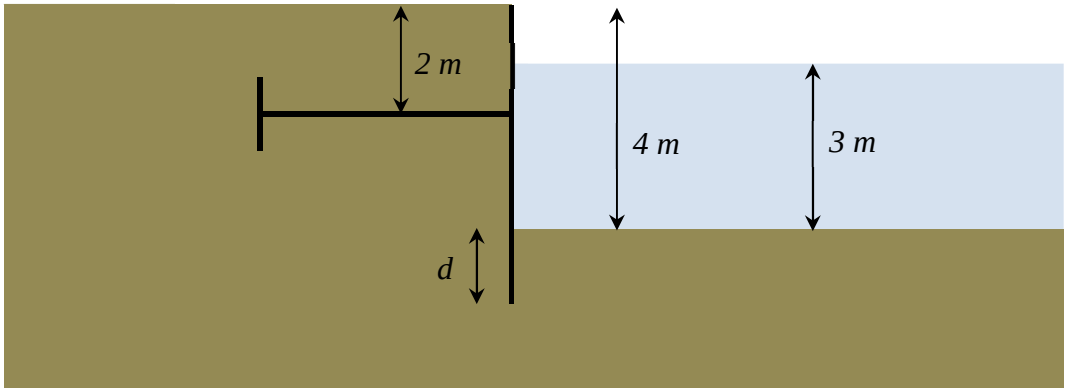
c. Calculate the Factor of Safety if the minimum embedded depth of the pile for Option 2 is specified to be 3m. Assume that the full active and passive forces are developed on the same sides as for horizontal equilibrium. [**8 marks**]

d. Calculate the force in the tension anchor for Option 2. [**5 marks**]

Option 1



Option 2



4) A concrete foundation has plan dimensions of 20m × 10m and is 2.5m thick, and supports the central pier of an arch bridge. The vertical load acting on the foundation from the pier is 50 000 kN. The foundation level is 5m below the ground surface, which is then backfilled after construction.

The soil properties are γ = 20 kN/m^3, ϕ = 20° and c = 10 kPa. Assume that the groundwater level is at the ground surface at all times. The concrete has γ_{conc} = 25 kN/m^3.

Check the Factor of Safety against foundation failure for the following conditions:

a. Final construction as shown in figure 1. **[10 marks]**

b. Temporary construction condition as shown in figure 2, with the vertical load from the pier reduced to 30 000 kN and a horizontal load of 7 500 kN. **[8 marks]**

c. Without calculation, if the bridge and foundation widths were doubled, i.e. the 20m dimension became 40m (and the same load per unit area applied), would the Factor of Safety increase or decrease? **[2 marks]**

Figure 1

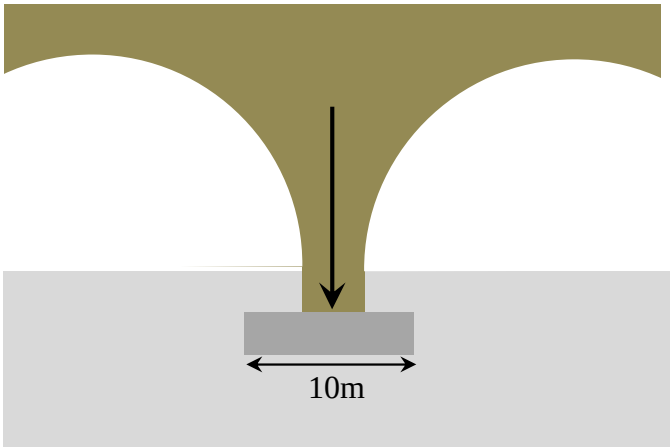
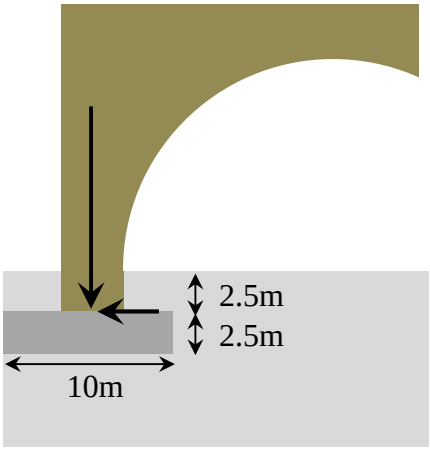


Figure 2



[END OF EXAM]