**DELFT UNIVERSITY OF TECHNOLOGY**

**Faculty of Civil Engineering and Geosciences**

# Soil Mechanics I – MOCK EXAM I

**CT1091**

**BSc EXAMINATION 2012**

FOURTH PERIOD

Answer ALL Questions

Other instructions

**Write your name and student number on each answer sheet**

**Clearly identify the answer in the answer box**

1) A 6 m wide 2.5 m deep culvert is to be constructed adjacent to a river for 150 m at a distance of 10 m from the bank. The soil at this location is comprised of a clay layer 4 m thick, underlain by a permeable sand. The clay has a permeability of $3.6 \times 10^{-8}$ m/s and a saturated volumetric weight of 19 kN/m$^3$.

   In normal conditions the river surface is 1.5 m below the ground level and the area is protected by a 3 m tall embankment flood defence.

   a. When the culvert is being constructed, at what depth of excavation would seepage be expected to begin? **[3 marks]**
   b. What volume of water is expected to be pumped each hour from the excavation at full depth? [**8 marks**]
   c. At what depth of excavation is liquefaction first likely to occur? [**8 marks**]
   d. If the river rises due to rainfall, what water level will cause liquefaction to occur? [**6 marks**]

2) A sample of soil is collected from a site. The sample is weighed on site at 557 g and is collected via a sample tube of 40 mm diameter and 300 mm length. In the laboratory, the sample is first dried at 110°C for 24 hours and again weighed. The sample weight is now found to be 502g. The sample is again placed in the oven, this time at 900°C for 24 hours, after which time the sample was found to weigh 397g. The remaining part of the sample is then sieved, with the volume and mass remaining on each sieve recorded in the table below. The density of the organic material (peat) $\rho_{s,peat} = 1100$kg/m$^3$.

   a. What is the volumetric weight of the original sample? [**3 marks**]
   b. Use the sieve data to determine the volume and weights of the clay, sand and silt fractions. [**5 marks**]
   c. Determine the volume percentage of peat, sand, water and air in the original sample. [**3 marks**]
   d. What is the porosity of the original sample? [**3 marks**]
   e. Draw the grain size diagram? [**6 marks**]
   f. Find the uniformity coefficient and classify the soil. [**5 marks**]

[**QUESTION CONTINUED OVERLEAF**]

| Sieve size, $\mu$m | Volume, ml | Mass, g |
|---|---|---|
| 1 | 17 | 32 |
| 2 | 35 | 78 |
| 63 | 61 | 117 |
| 100 | 63 | 133 |
| 200 | 12 | 28 |
| 600 | 5 | 9 |
| 2000 | 0 | 0 |

3) During a site investigation it is found that the ground is made up of a number of layers. The ground level is at -1.5 m NAP. The first layer is a sand of 7m thickness, where in a trial hole the phreatic water level is found to be -4.25 m NAP and the soil has a capillary rise of 0.75 m. Below this is a clay layer 6 m thick, underlain by a second sand layer. In this second sand layer a monitoring borehole gives a phreatic surface of -2 m NAP. The material properties have been determined in a laboratory as follows:

$\gamma_{clay} = 16$ kN/m$^3$, $C_{p,\,clay} = 15$, $\gamma_{d,sand\ 1} = 17$ kN/m$^3$, $\gamma_{sand\ 1} = 19$ kN/m$^3$, $\gamma_{sand\ 2} = 21$ kN/m$^3$

a. Draw the total stresses, effective stresses and pore water pressures over depth, identifying clearly the main points and soil layers. [**10 marks**]

A train line is going to be built in this location; therefore a 3.5 m high embankment is planned. This will be constructed from sand with a dry volumetric weight of $\gamma_d = 18$ kN/m$^3$.

b. For a point in the middle of the clay layer, determine the total stresses and effective stresses before and after the embankment has been constructed. [**5 marks**]

c. Based on 3 layers, what is the final deformation after the embankment has been constructed? [**10 marks**]

4) A building is to be constructed and various foundation types are being considered to support the structure. The most expensive is a raft foundation, followed by two strip foundations, with the cheapest option being pad foundations. However there is concern over possible deformations, with a limit set to 11 cm at any location.

The building is constructed on a clay with $C_{10}$ = 115 and a volumetric weight of $\gamma_{clay}$ = 16.0 kN/m$^3$. The building exerts a uniform load of 150 kPa and is 15 m wide. The length has yet to be finalised, but is likely to exceed 100 m. For structural considerations the spacing of the pad foundations if used must be 12 m.

a. As an initial design check, calculate the stresses at 2 m, 7 m and 15 m depth at the centre of the raft foundation, assuming that it is similar solution to a flexible plate of radius 7.5m. [**5 marks**]
b. Calculate the stresses at 2 m, 7 m and 15 m depth at the centre-line of a strip foundation of 0.5 m width. [**5 marks**]
c. Calculate the stresses at the centre of pad foundations at 2 m, 7 m and 15 m depth. [**8 marks**]
d. Calculate the final displacement for the strip foundation based upon 3 layers; the first 4 m thick, the second 6 m thick and the third 10 m thick. Is this displacement acceptable? [**7 marks**]

**[END OF EXAM]**