CE 366-FE 1

(www.ce.metu.edu.tr/~ce366)
Spring' 2010-2011
Homework 1

Release Date : **March 31, 2011, Thursday**
Version : **1.1**
Due On : **April 07, 2011, Thursday (5:00 PM – Strict)**

Rules for Homework:

1. Please submit your homework on the boxes labeled "**CE 366**" and located in the **Soil Mechanics Laboratory**. The deadline is strict and **NO EXTENSIONS** will be given.
2. Make sure that you check our website regularly. All announcements and corrections (if necessary) will be made available through our website.
3. Try to be clean, precise when you present your work. State your assumptions if you make any.
4. Discussion with your friends is strongly encouraged, however, homework needs to be solved and submitted individually.
5. Whenever you have a question about the homework, please contact your teaching assistant first. Remember that all TAs have office hours during the week. If you need further help, you can also contact your sections' instructor.

Version History:

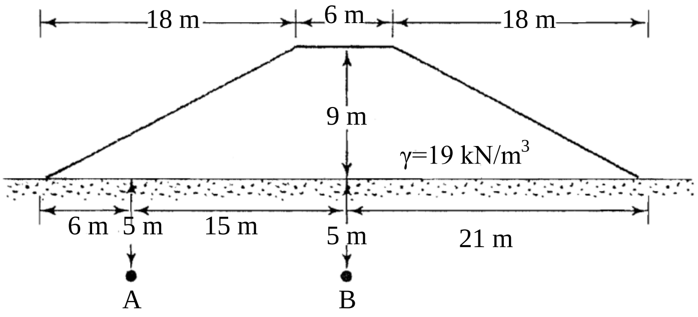
1.0. *(March 31, 2011)* Homework is released.
1.1. *(April 1, 2011)* The formulas for Question 1 is updated.

Question	Grade
1 (20%)	
2 (20%)	
3 (20%)	
4 (20%)	
5 (20%)	
Total (100%)	

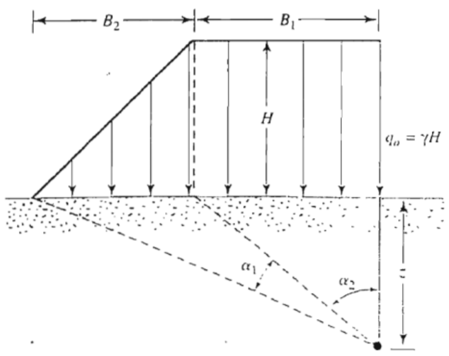
Surname, Name	
Signature	
Section You Are Registered For	

Question 1: (20%)

a. A highway embankment is shown in the figure given below. Estimate the stress increase under the embankment at points "A" and "B".



Hint:

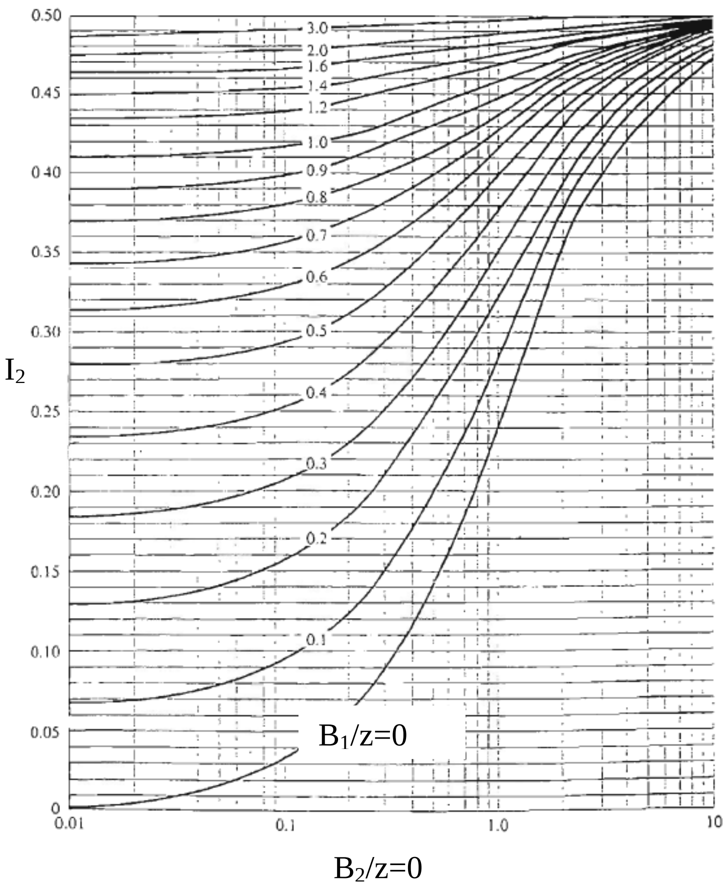


$$\Delta\sigma_z = \frac{q_o}{\pi}\left[\left(\frac{B_1 + B_2}{B_2}\right)(\alpha_1 + \alpha_2) - \frac{B_1}{B_2}(\alpha_2)\right]$$

where $q_o = \gamma H$
γ = unit weight of the embankment soil
H = height of the embankment

$$\alpha_1 \text{ (radians)} = \tan^{-1}\left(\frac{B_1 + B_2}{z}\right) - \tan^{-1}\left(\frac{B_1}{z}\right)$$

$$\alpha_2 = \tan^{-1}\left(\frac{B_1}{z}\right)$$



or use simplified equation:

$$\Delta\sigma_z = q_0 I_2$$

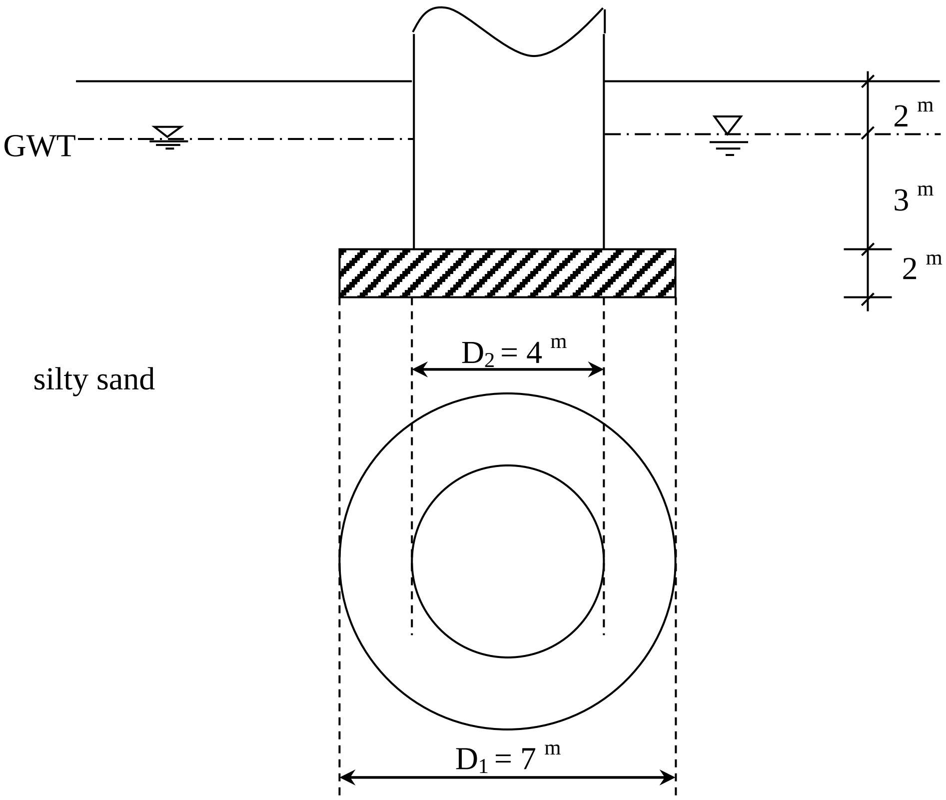
Ostenberg,1957 chart for determination of vertical stress due to embankment loading.

b. Now transform the embankment load into a uniformly distributed load and estimate the average vertical stress increase at depth 5 m by using ii) 2:1 rule, ii) 30 degree rule.

Compare your findings with the values you have estimated in Question 1.a.

Question 2: (20%)

a. A chimney structure, having a diameter fo 4 m is supported by a 2 m thick circular foundation of diamater 7 m and the total weight of the structure including the foundation is 17500 kN. The ground water table is 2 m below the ground surface. If the foundation is seated at 5 m below the ground surface, determine the net foundation pressure. Drained and saturated unit weights of the soil are 17 kN/m^3 and 21 kN/m^3, respectively; and the unit weight of concrete is 24 kN/m^3.



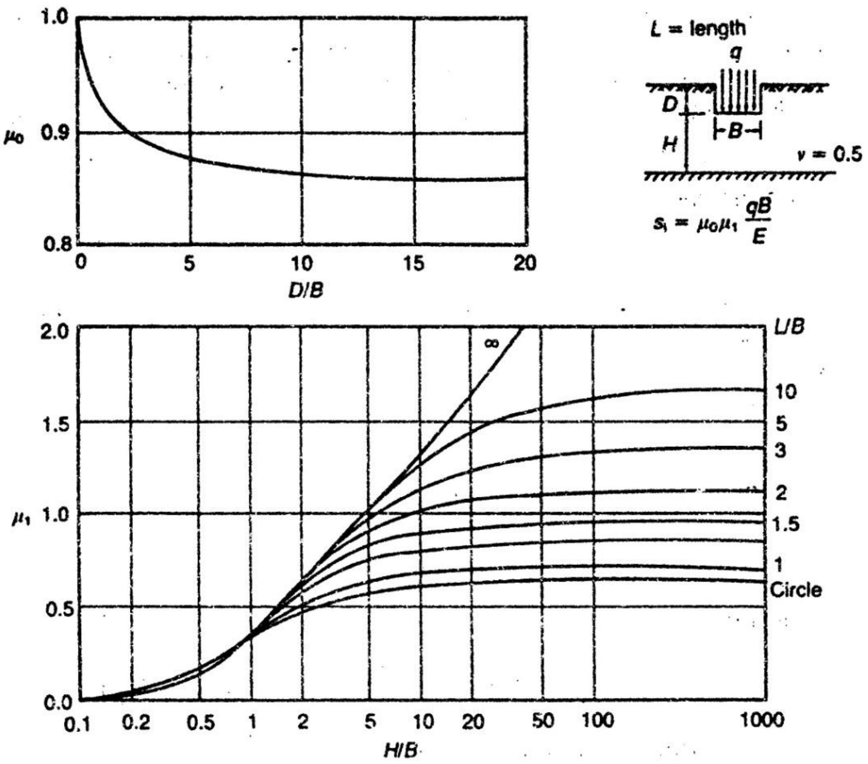
i. calculate the net foundation presure under the rigid mat.

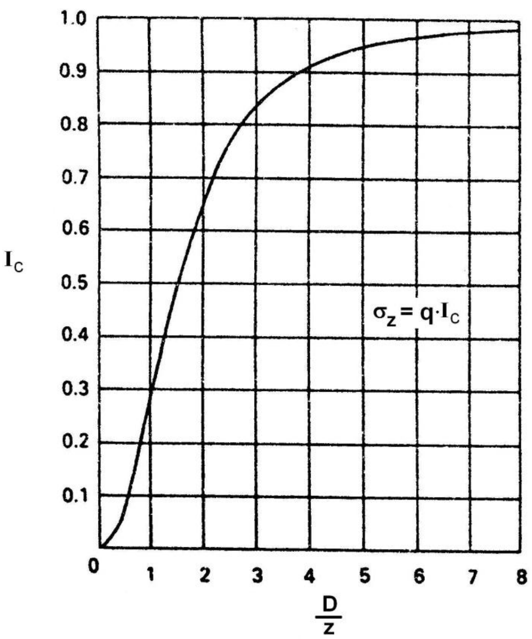
ii. Assuming the ground water table is at the ground surface, calculate the factor of safety against uplift.

b. A foundation of dimensions BxL = 3 m x 6 m is to be constructed over a thick sand deposit at a specific site. Foundation depth is 2 m, and the water table is at the ground surface. If the net foundation pressure is calculated to be 200 kPa, determine the required depth of subsoil investigation using De Beer’s method. Saturated unit weight of the sand is 20 kN/m^3.

Question 3: (20%)

An oil storage tank 35m in diameter is located 2m below the surface of a deposit of clay 32m thick, the water table being at the surface: the net foundation pressure is 105 kN/m^2. A firm stratum underlies the clay. The average value of m_v for the clay is 0.14m^2/MN. The undrained value of Young's modulus (E_u) is estimated to be 40MN/m^2. Determine the total settlement (immediate+consolidation) under the centre of the tank.
HINT: The clay layer below the tank may be divided into 6 sublayers.

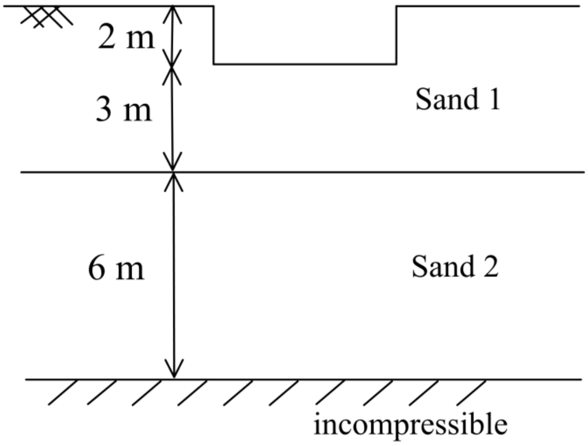




$$s_{OED} = m_v \Delta\sigma' H$$
$$s_c = \mu s_{OED}$$
$$\mu = 0.79$$

Question 4: (20%)

A 4 m x 4 m square footing with applied pressure, q (= q_{gross})= 210 kPa will be constructed at 2 m depth, on the given soil profile. According to the CPT test results, the average cone tip resistances for the first and second sand layers are 4 MPa and 5 MPa, respectively. The unit weight of both sand layers can be taken as 20 kN/m^3. No groundwater table is observed at the site.



a. Calculate the settlement of the footing 1 year after the construction using Schmertmann's method. Present a drawing of strain influnce factors and layers you used in calculations, together with a table showing your values.

b. Go to the website: *www.rocscience.com/settlecalc/schmertmann.html*. Read "Help" section and calculate the settlement of the problem in part (a), and compare in 1 sentence with your hand-calculated result. Show the results with "settlement versus depth below footing" plot in "Results" section. (Note: Do not select "Use Es", "Use Modified Schmertmann" "Subdivide Layers" options).

c. Using the website given above, keeping all other parameters constant:

i. What would be the settlement if the depth of foundation is 4 m instead of 2 m. Is this result expected/reasonable? Comment in 1-2 sentences.

ii. Prepare a plot of settlement versus time for up to 30 years.

Question 5: (20%)

A rectangular foundation (1.5 m x 1 m) is located at a depth of 1 m in a two-layered clay soil profile. Borings indicate that softer clay is located at a depth of 1 m from the bottom of the foundation. No ground water table is observed at the site. (see Figure 5.1)

a. Determine the gross allowable load for the foundation with a factor of safety of 3.
b. How would the result the change if the softer soil was placed at the top, i.e., $C_{u,1}$ = 48 kN/m^2 and $C_{u,2}$ = 120 kN/m^2 and the geometry of the foundation and soil profile remains the same.

Hint: For layered soils, the value of bearing capacity factor, N_c, is not a constant. It is a function of c_2/c_1, where c_2 belongs to the bottom layer, and z/B, where z is the depth measured from the bottom of the foundation to the interface of the two clay layers (see Figure 5.2). The ultimate bearing capacity is given as:

$$q_f = c_1 N_c S_c d_c + \gamma D$$

S_c =1.145, d_c=1.4, $FS = \dfrac{q_{nf}}{q_n}$

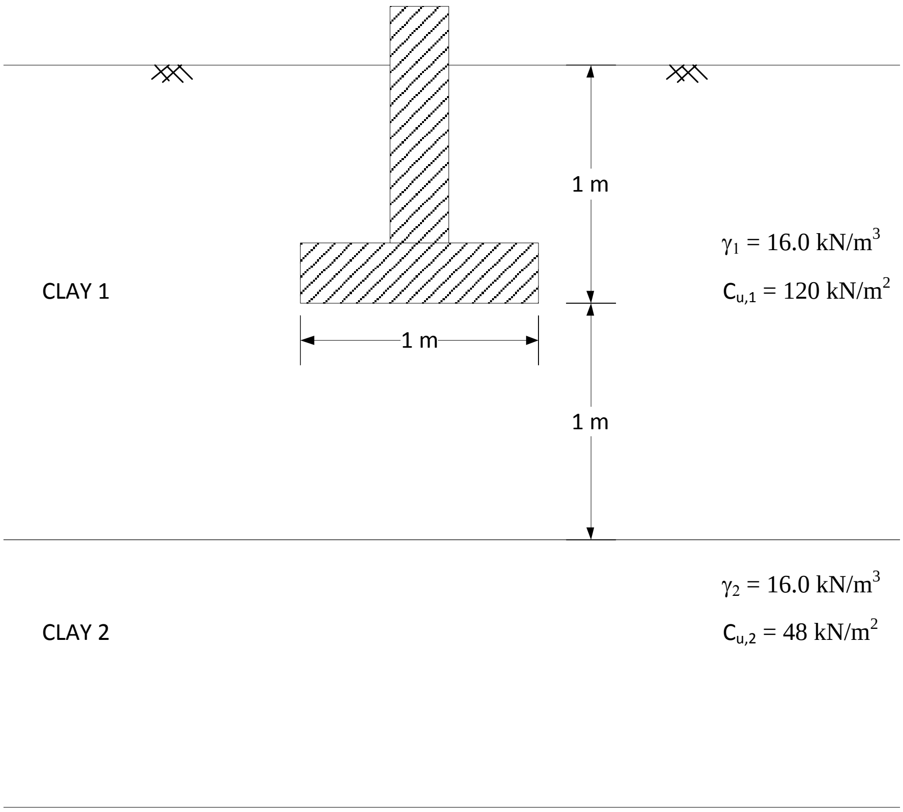


Figure 5.1 Soil profile for rectangular foundation to be built

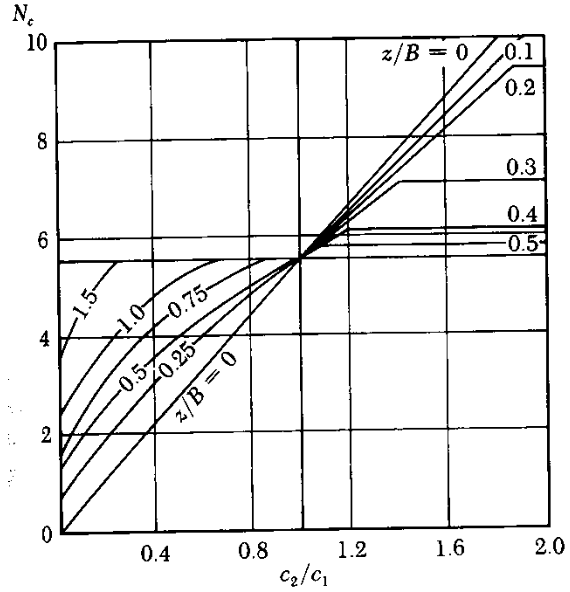


Figure 5.2. Bearing capacity on layered clay soils – q = 0 (Figure is redrawn after Reddy and Srinivasan, 1967)