CE 366 Foundation Engineering – I

2011-2012 Spring Semester

Homework 2

Due on: 11.05.2012

Question 1 (20%)

A vertical concrete column is to carry a total load of 520 kN, inclusive of self-weight above ground level. The column is to be supported by a square concrete footing B x B founded at a depth of 1.5 m in a 14 m thick deposit of firm boulder clay. The clay is fully saturated and overlies Bunter sandstone. The properties of the clay are E = 10500 kPa, pore pressure parameter, A = 0.4 and m_v = 0.00012 m^2/kN. Neglect the difference in density between the concrete and the clay.

(a) If B = 2.0 m, calculate the **total** settlement at the center of the footing. You can use superposition for calculating settlement.

For immediate settlement use:

$$S_i = \frac{qB(1-\nu^2)}{E} I_s$$

Where;

$$I_s = F_1 + \left[\frac{1-2\nu}{1-\nu}\right] F_2$$

(b) Calculate the size of footing required to provide a factor of safety of 3 against an undrained shear failure of the foundation soil.

$$N_c = 5\left(1 + 0.2\frac{D}{B}\right)\left(1 + 0.2\frac{B}{L}\right)$$

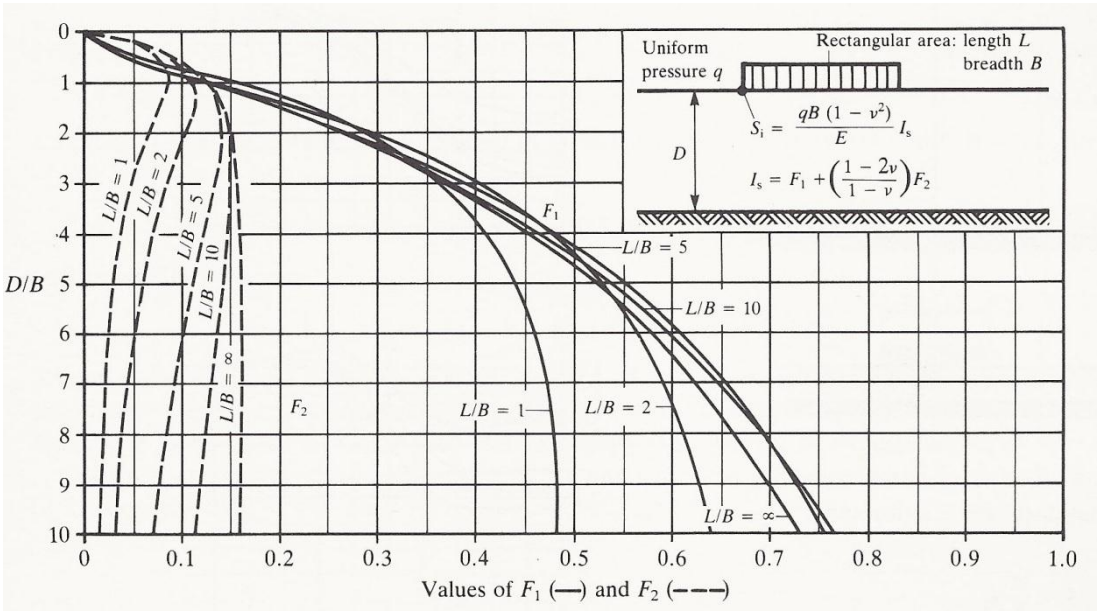


Figure 1. Values of influence factor F_1 and F_2 for calculating the immediate surface settlement S_i under the corner of a uniformly loaded flexible rectangular area on a soil layer of finite thickness (After Steinbrenner)

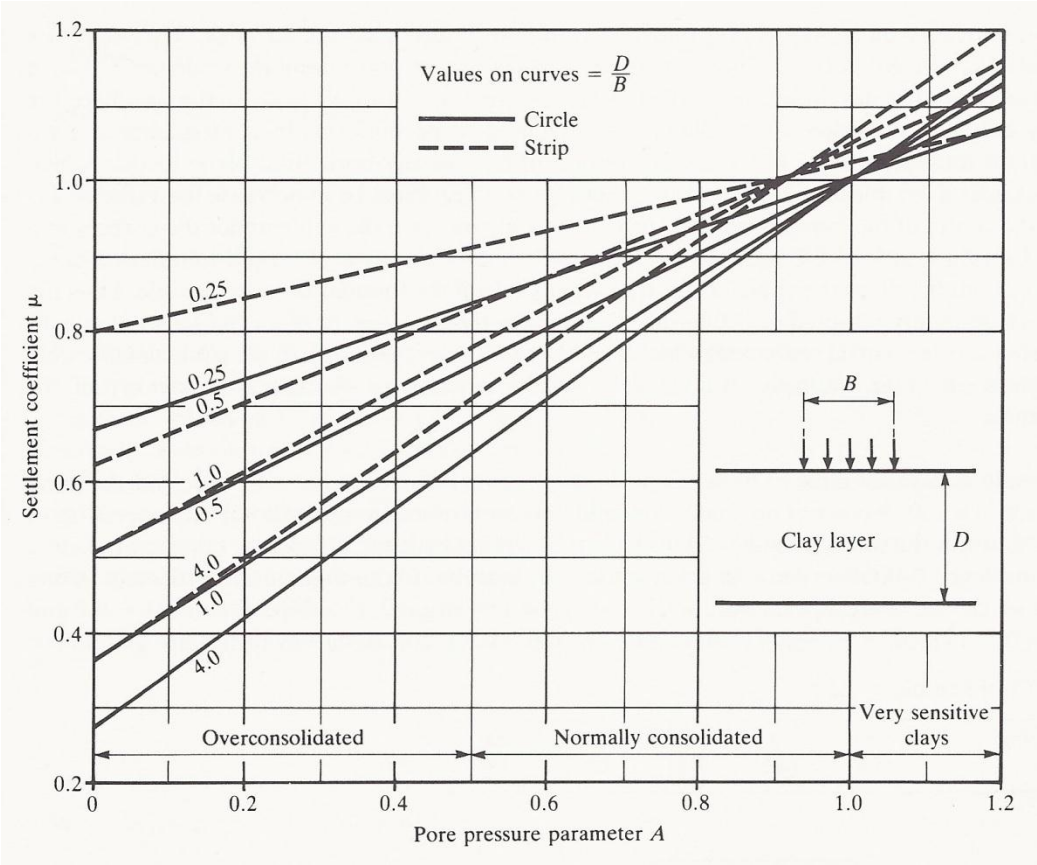


Figure 2. Values of settlement coefficient μ (From Scott, 1963. Copyright Addison-Wesley Inc. Reprinted with permission)

Note that settlement coefficient, μ is the Skempton-Bjerrum correction factor in eqn. 3.5 on page 66 of Lecture Notes

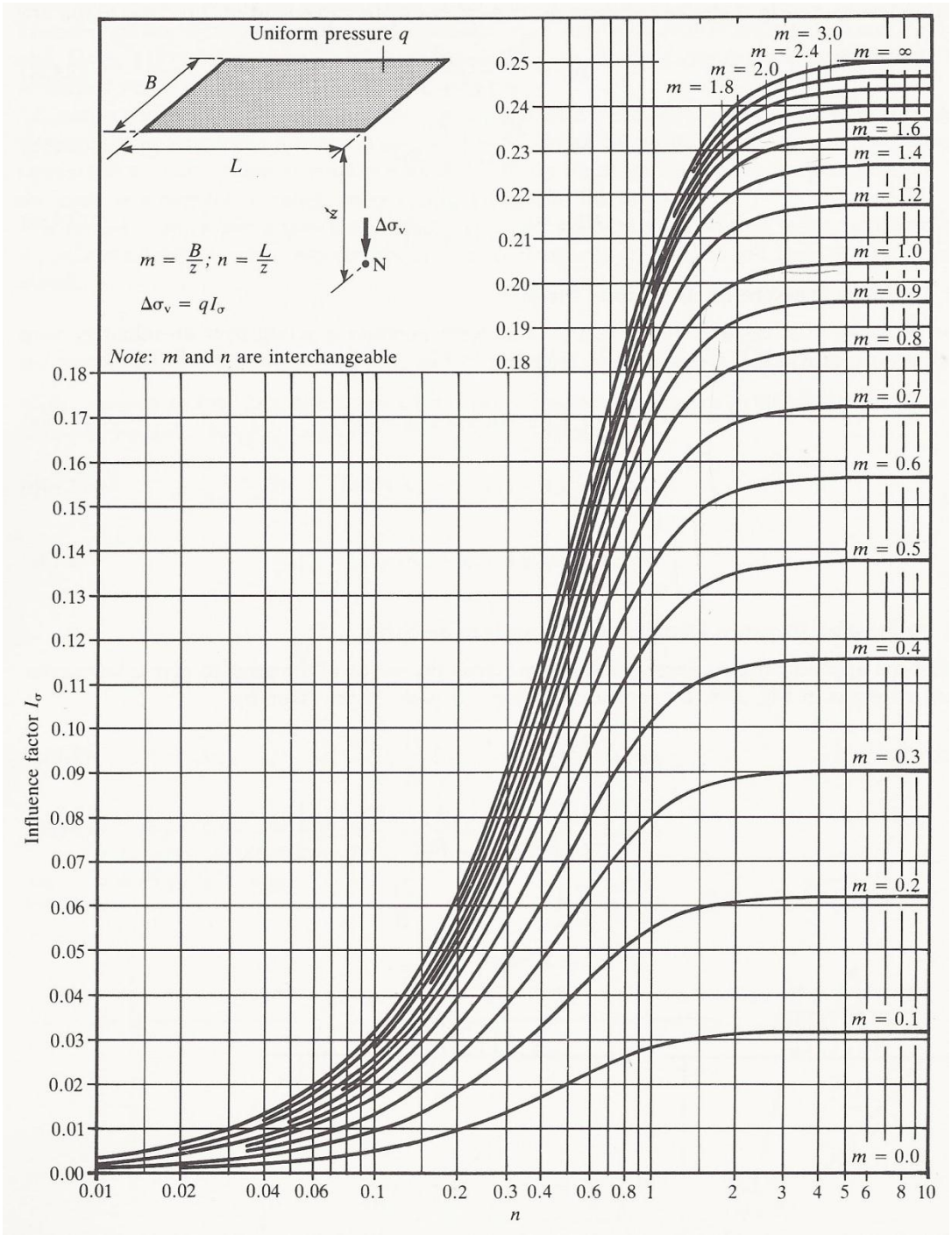
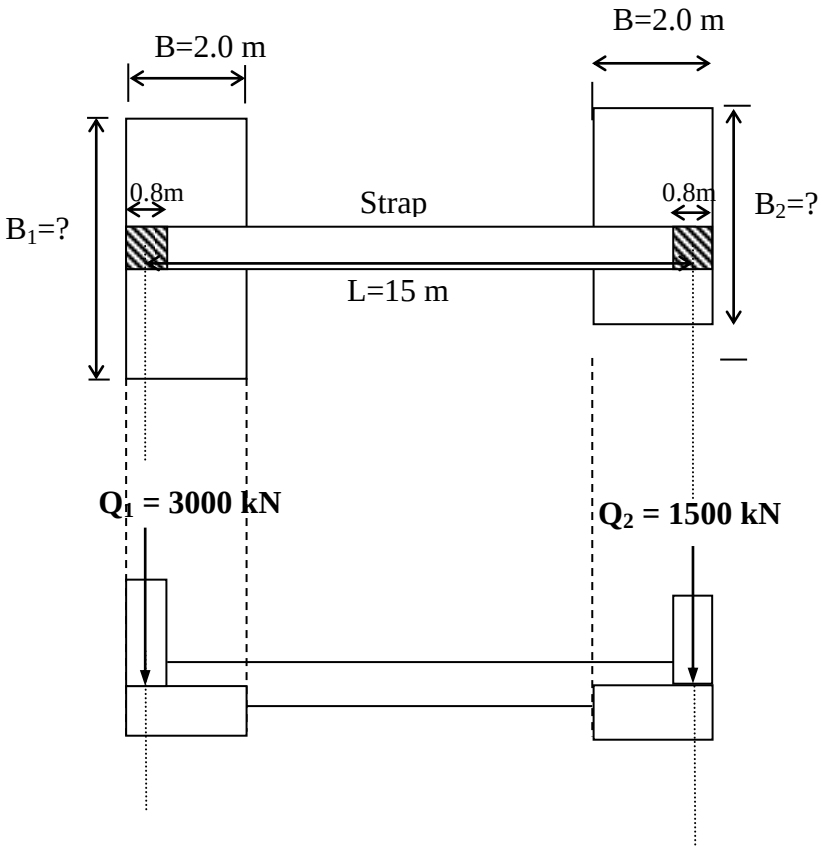


Figure 3. Values of I_σ for calculating increase in total vertical stress $\Delta\sigma_v$ under the corner of a unifromly loaded rectangular area (After Fadum, 1948 and reproduced with permission of Professor Fadum)

Question 2 (10%)

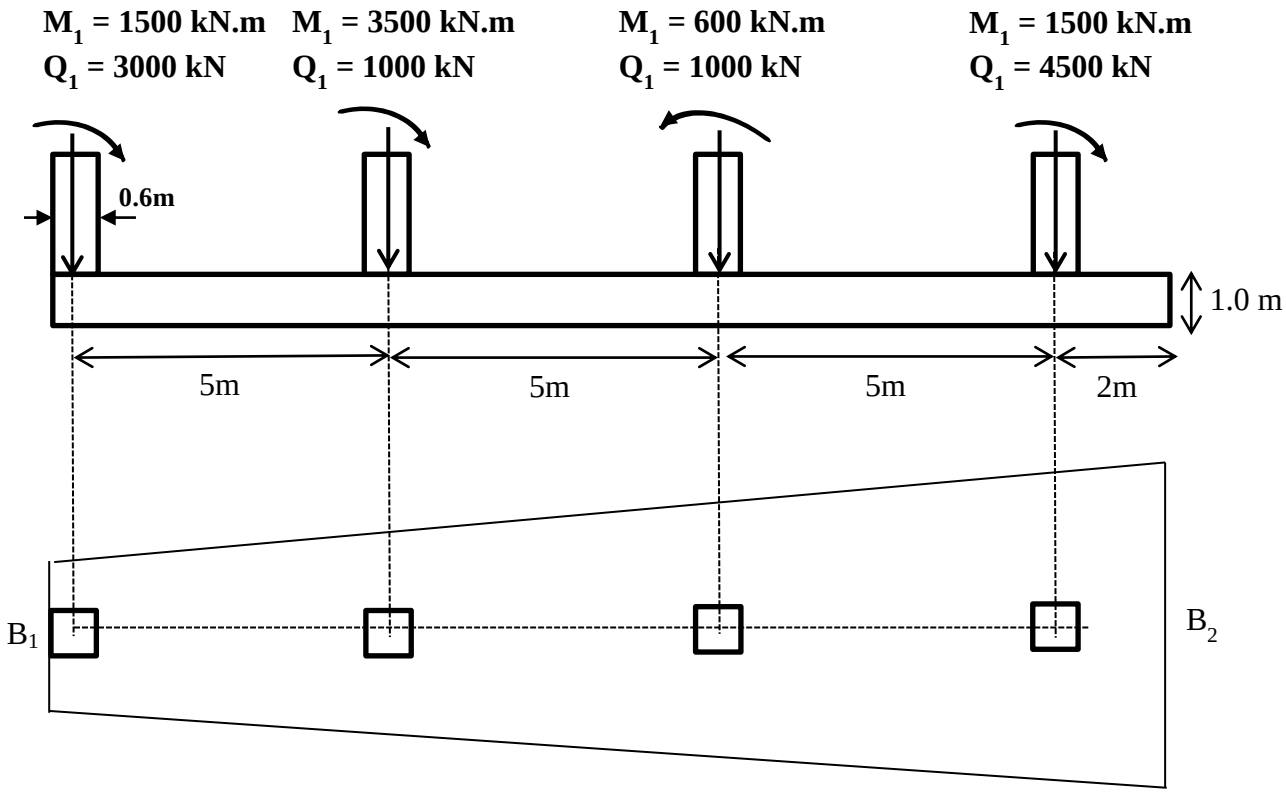
The figure given below shows the foundation plan view and cross-section of a residential building. To achieve uniform pressure distribution beneath the footings two footings were combined by a strap. The net allowable bearing capacity for the foundation soils is estimated as 220 kN/m^2. Neglect weight of footing and estimate the minimum footing dimensions B_1 and B_2. Draw shear and moment distrubutions.



Question 3 (10%)

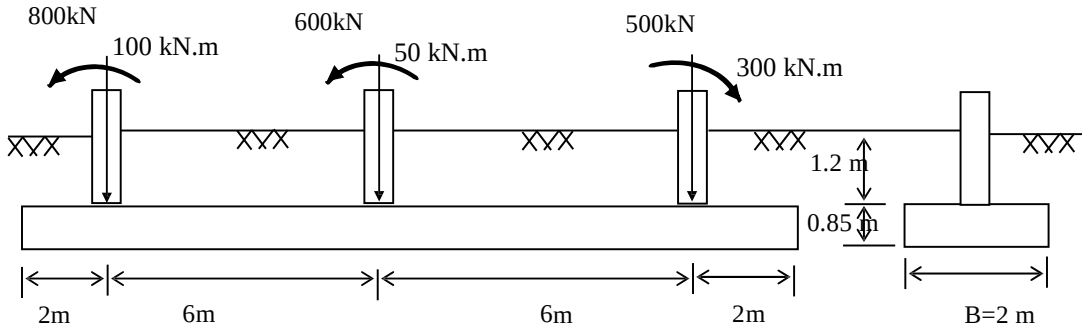
Determine B_1 and B_2 of a trapezoidal footing for a uniform soil pressure of 200 kN/m^2.

(γ_{conc} = 24kN/m^3)

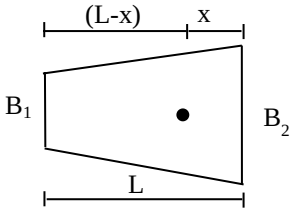


Question 4 (20%)

A rectangular combined footing which supports three columns is to be constructed on a sandy clay layer. The thickness of the concrete footing is 0.85m. Unit weights of the soil and the concrete are 20 kN/m^3 and 24 kN/m^3 respectively. Analyze the footing by rigid method and plot base pressure distribution, shear and moment diagrams.



Hint:



$$x = \frac{1}{3} L \frac{2B_1 + B_2}{B_1 + B_2}$$

$$A = L \frac{B_1 + B_2}{2}$$

Note: Weight of columns and weight of soil above footing are neglected (i.e: Assume that ΣV=2008.8 kN)

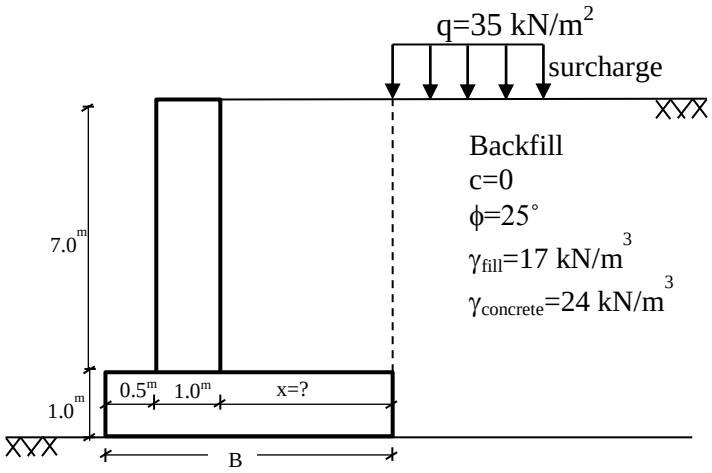
Question 5 (20%)

For the RC retaining wall given in the figure below;

i) Calculate the required extent of the base slab forward the back of the wall such that a factor of safety of 2.0 against overturning is met.

ii) Subsequently check if the required minimum factor of safety of 1.5 is met against base sliding. If not, design a base key. Calculate the passive pressure starting from the bottom level olf the base slab. Also use 2/3 of the shear strenght parameters of the base soil in calculations and apply a FS 2.0 for the passive resistance.

iii)



Base soil (silt clay)

c=65 kPa, ϕ=35˚, γ=20 kN/m^3

Question 6 (20%)

A 9-m high mechanically stabilized earth retaining wall with galvanized steel strip reinforcement in a granular backfill was constructed. Granular backfill has unit weight of 20 kN/m^3 and c'=0 ϕ'=36º. Information about galvanized steel reinforcement: width of the strips 7.5 cm, vertical spacing 60 cm, horizontal spacing 90 cm, yield strength of strip 240 MPa, and soil-strip friction angle 20º, strip thickness 5 mm, strip length 12 m (constant strip length is used). Corrosion rate of galvanized steel strip is 0.025 mm/year and the life span of the structure is 50 years. The first strip is placed at 30 cm below the top of the wall, the lowest strip is placed at 30 cm above the base of the wall.

a) Check whether the thickness and length of the strips are sufficient for satisfying factor of safety of 3.0 against tie break and pullout. If they are not sufficient, determine the new thickness and length to satisfy required F.S values.
b) If you were to use different lengths of strips at different depths, calculate the lengths you would use for the 1^{st}, 5^{th}, 10^{th} and 15^{th} strips from the top of the wall.
c) Comment on how you would incorporate in calculating factor of safety against tie break and pull out, the effect of a surcharge load placed at the ground surface a few meters away from the face of the wall. Sketch the problem, write the equations for F.S. and comment in a few sentences about where in the equations you will incorporate some changes.