HOMEWORK – 1

Due on 03.04.2015, 17:00

You have to drop your homework to the CE 366 Homeworks Box inside the Soil Mechanics Laboratory

Question 1 (25%)

At Adana Ceyhan Crude Oil Tank Farm, a steel tank with a diameter of 90 m will be carrying a uniform pressure of 200 kPa, at the ground surface. An example borehole log for this site is given below. Assume that all soils have a dry and saturated unit weights of 19 and 20 kN/m³, respectively. Use 2V:1H stress distribution.

- a) (%7) Is the borehole depth sufficient? Make some calculations and comment in a few sentences.
- **b)** (%7) Calculate the immediate settlement using the Standard Penetration Test data and equation 4.18(c) in CE366 Lecture Notes (no need to consider shape factor, fs, and other factors).
- c) (%7) Calculate the primary consolidation settlement of the clay layer. Since the clay layer is thick, subdivide the clay into two sublayers with equal thicknesses. Laboratory consolidation tests on undisturbed samples taken from this clay indicated that the OCR = 1.5, Cc = 0.3, Cr/Cc = 0.2, C α /Cc=0.04, eo=0.5 and cv=12 m²/year.
- **d)** (%2) How long time will it take for the 95% of the primary consolidation settlement of the clay layer to occur.
- e) (%2) Calculate the amount of secondary consolidation settlement of the clay layer 10 years after construction of the tank.

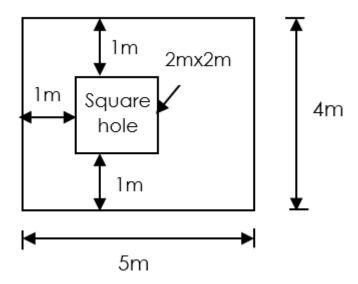
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Question 2 (10%)

The figure below shows a plan view of a rectangular footing with a 2m x 2m square hole (through its entire thickness). The hole is located at 1 m from the left edge and is equally positioned between the top and lower edges of the footing. If the uniform contact pressure under the footing is 200 kPa, compute the vertical stress at a point 2m below the center of the square hole.



Question 3 (15%)

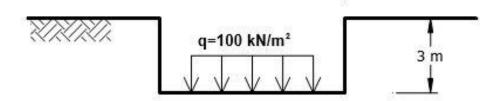
The following CPT data is obtained at the site. Plot the given data with respect to depth and identify different soil layers. Estimate the undrained shear strength of the soil at the depth of 4.0 m assuming the cone factor as $N_k=18$.

The soil is normally consolidated with a unit weight of $\gamma=19kN/m^3$ to GWT at depth 3 m and $\gamma_{sat}=20kN/m^3$ for below GWT

Depth (m)	qc (MPa)	q _s (kPa)
1	0.5	20
2	0.7	31
3	1.1	55
4	1.4	42
5	0.8	35
6	0.6	27
7	0.6	27
8	0.8	24
9	0.9	45
10	1.1	22
11	1.5	15
12	2	24
13	2.2	20
14	2.6	26
15	2.7	32
16	2.1	27
17	1.8	29
18	1.6	16
19	2.6	21
20	3	30

Question 4 (5%)

Estimate the net foundation pressure after the application of a gross foundation pressure of 100 kPa at a foundation depth of 3 meters. Unit weight of the soil can be taken as 19 kN/m^3 .



Question 5 (10%)

At 5 m depth, a silty sand layer was encountered and a Standard Penetration Test (SPT) was performed. For the first, second and third 15 cm increments, the blowcounts were reported as 4,7,8 blows, respectively. Safety hammer of an energy ratio of 55 % was used during the test. The borehole diameter was reported as 110 mm and the SPT sampler used was a standard sampler with constant inside diameter (no room for liner). The length of the rod from the bottom of the safety hammer to the sampler at 5 m depth was measured as 6.2 m. Estimate the overburden and procedure corrected SPT blowcounts ($N_{1,60}$) for 30 cm penetration of the sampler (water table depth is at 3 m and the unit weights of soil above and below water tables can be assumed as 18 and 19 kN/m³, respectively)

Question 6 (10%)

A square footing is 3 m by 3 m in plan. The sandy soil supporting the foundation has a friction angle of ϕ = 32⁰ and c= 0 kPa. The unit weight of soil, γ , is 18.5 kN/m³. Determine the safe net load on the foundation with a factor of safety 3. Assume that the foundation depth is 2 meters, ground water table is well below the foundation depth, and that a general shear failure occurs in the soil.

Question 7 (25%)

A bearing wall carries a total load 220kN/m. It is to be supported on a 0.4 m deep continuous footing. The underlying soil is a medium dense sand with c'=0, $\phi'=37^{\circ}$, $\gamma=19.2$ kN/m³. The groundwater table is at a great depth.

Compute the minimum footing width required to maintain a factor of safety of at least 2 against a bearing capacity failure. (Express your answer to the nearest 0.1 m.)

Bonus Question (50%)

- a) Under a strip loaded area, applied at ground surface, having a width B and carrying a uniform pressure of q , plot vertical stress increase, $\Delta\sigma_v$, contours (as in CE366 Lecture Notes Figure 1.4 (a)) using Excel, Matlab etc.
- b) Based on your plot, at what depth below the loaded area (at what ?B value), the vertical stress increase becomes equal to 0.1 q?