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/m^3, 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, Cα/Cc=0.04, eo=0.5 and cv=12 m^2/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.

DRAFT

BOLGE / District: TANK E

SONDAJ / Boring: BH-11

Sayfa no :

SONDAJ LOGU / BORING LOG

Sondör / Driller:

PROJE ADI / Project Name : BTC CRUDE OIL PIPELINE

SONDAJ YERİ / Boring Location: YUMURTALIK TANK FARM

KİLOMETRE / Kilometer:

MUH.BOR.DER. / Casing Depth 19.50m

SONDAJ DERİNLİĞİ / Boring Depth : 25.00 m

BAŞ. BİT. TAR. / Start - Finish Date 11.09.2003 22.09.2003

SONDAJ KOTU / Elevation: 131.24m

KOORDİNAT / Coordinate (N-S) y

YERALTI SUYU / Grounwater 9.50m

KOORDİNAT / Coordinate (E-W) x

Sondaj Derinliği / Boring Depth (m)	Num. Cinsi / Samp. Type	Manevra Boyu / Run	Standart Penetrasyon Deneyi / Standart Penetration Test: DARBE SAYISI / No of Blows 0-15 cm	15-30 cm	30-45 cm	N	GRAFİK/GRAPH 10 20 30 40 50	JEOTEKNİK TANIMLAMA / GEOTECHNICAL DESCRIPTION	Profil / Profile	Dayanımlılık / Strength	Ayrışma / Weathering	Kırık %30 / Fracture %30	Karot % / Core Recovery	RQD %
1.00	K1	1.50						**Clayey Sandy Gravel** Grey-brown-black, occasionally clayey coarse sandy coarse, medium dense - dense gravel.					34%	0%
	SPT1		10	13	15	28								
2.00	K2	1.95 – 3.00						Gravels are subangular to subrounded of volcanic origin. Include cobbles from 0.00m-1.00m					36%	0%
3.00	SPT2		12	15	17	32								
4.00	K3	3.45 – 4.50 M											76%	0%
	SPT3		10	11	12	22		**Cobbles Gravelly Clayey Sand** Grey black, occasionally gravelly and frequently clayey dense to very dense coarse sand. Gravels are subangular of volcanic origin.						
5.00	K4	4.95 – 6.00											62%	0%
6.00	SPT4		15	18	21	39								
7.00	K5	6.45											53%	0%

DAYANIMLILIK-Strength			AYRIŞMA-Weathering			İNCE DANELİ - Fine Grained			İRİ DANELİ - Coarse Grained		
I DAYANIMLI	Strong		I TAZE	Fresh		N = 0-2	ÇOK YUMUŞAK	V.Soft	N = 0-4	ÇOK GEVŞEK	Very Loose
II ORTA DAY.	M.Strong		II AZ AYR.	Slightly W.		N = 3-4	YUMUŞAK	Soft	N = 5-10	GEVŞEK	Loose
III ORTA ZAYIF	M.Weak		III ORTA DERECE AYR.	Mod.W.		N = 5-8	ORTA KATI	M.Stiff	N = 11-30	ORTA SIKI	M.Dense
IV ZAYIF	Weak		IV ÇOK AY.	Highly W.		N = 9-15	KATI	Stiff	N = 31-50	SIKI	Dense
V ÇOK ZAYIF	V.Weak		V TAM AYR.	Comp. W.		N = 16-30	ÇOK KATI	V.Stiff	N > 50	ÇOK SIKI	V.Dense
						N > 30	SERT	Hard			

KAYA KALİTESİ TANIMI-RQD			KIRIKLAR - 30 cm Fractures			ORANLAR - Proportions					
%0-25	ÇOK ZAYIF	V.Poor	<1	SEYREK	Wide	%5 <	PEK AZ	Slightly	%5 <	PEK AZ	Slightly
%25-50	ZAYIF	Poor	1-3	ORTA	Moderate	%5-15	AZ	Little	%5-20	AZ	Little
%50-75	ORTA	Fair	3-10	SIK	Close	%15-35	ÇOK	Very	%20-50	ÇOK	Very
%75-90	İYİ	Good	10-20	ÇOK SIK	Intense	%35 >	VE	And			
%90-100	ÇOK İYİ	Excellent	> 20	PARÇALI	Crushed						

SPT :	Standard Penetrasyon Deneyi / Standard Penetration Test	K :	Karot Numunesi / Core Sample	SONDAJ MÜHENDİSİ / Drilling Engineer	İMZA / Sign	TARİH / Date
D :	Örselenmiş Numune / Disturbed Sample	P :	Presiyometre Deneyi / Pressuremeter Test			
UD :	Örselenmemiş Numune / Undisturbed Sample	VST :	Vane Deneyi / Vane Shear Test			

DRAFT

Sayfa no :

SONDAJ LOGU / BORING LOG

BOLGE / District: TANK E
SONDAJ / Boring: BH-11
Sondör/Driller:

PROJE ADI / Project Name :	BTC CRUDE OIL PIPELINE		
SONDAJ YERİ / Boring Location:	YUMURTALIK TANK FARM		
KİLOMETRE / Kilometer:		MUH.BOR.DER. / Casing Depth	19.50m
SONDAJ DERİNLİĞİ / Boring Depth :	25.00 m	BAŞ. BİT. TAR. / Start - Finish Date	11.09.2003 — 22.09.2003
SONDAJ KOTU / Elevation:	131.24m	KOORDİNAT / Coordinate (N-S) y	
YERALTI SUYU / Grounwater:	9.50m	KOORDİNAT / Coordinate (E-W) x	

Sondaj Derinliği Boring Depth (m)	Num. Cinsi Samp. Type	Manevra Boyu / Run	Standart Penetrasyon Deneyi Standart Penetration Test: DARBE SAYISI No.of Blows 0-15 cm	15-30 cm	30-45 cm	N	GRAFİK/GRAPH 10 20 30 40 50	JEOTEKNİK TANIMLAMA GEOTECHNICAL DESCRIPTION	Profil / Profile	Dayanımlılık / Strength	Ayrışma / Weathering	Kırık %30 / Fracture %30	Karot % / Core Recovery	RQD %
								(CONTINUED FROM PAGE 1)						
		7.50												
	SPT5		22	24	32	56	>							
8.00		7.95												
	K6	8.45						8.5					64%	0%
	K7	9.00						**Cobbles Gravelly Clayey Sand** Grey black, occasionally gravelly and frequently clayey dense to very dense coarse sand. Includes cobbles					69%	0%
9.00	SPT6		15	18	20	38								
		9.45												
10.00	K8							Gravels are subangular of of volcanic origin.					63%	0%
		10.50						10.50 M						
	SPT7		32	27	22	49		**Gravelly Sandy Clay** Grey-brown, angular fine gravelly fine to medium sandy hard clay						
11.00		10.95												
	K9												50%	0%
		12.00												
12.00	SPT8		6	8	11	19								
		12.45												
	K10												69%	0%
13.00		13.00												
	K11	13.50											41%	0%
	SPT9		21	25	50	R	>							
		13.90			10									
14.00	K12												40%	0%
		14.50												
	K13	15.00											38%	0%
15.00	SPT10	EMPTY	12	18	24	42								
		15.45												
	K14												40%	0%
		15.90												
16.00														

İŞİ JOB	ÜNVANI Title	ADI SOYADI Name Surname	İMZA Sign	Tarih Date
YAPAN Logged By	Sondaj Mühendisi Drilling Engineer			
KONTROL Checked By	Sondaj Şefi Drilling Chief			

DRAFT

BÖLGE / District: TANK E

SONDAJ / Boring: BH-11

Sayfa no :

SONDAJ LOGU / BORING LOG

Sondör/Driller:

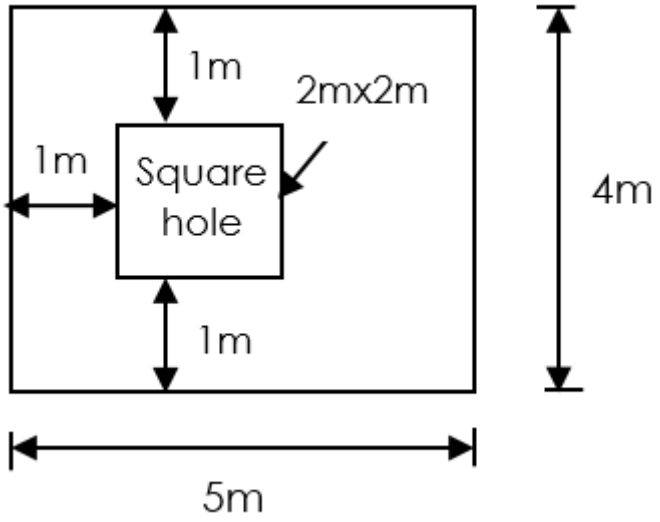
PROJE ADI / Project Name :	BTC CRUDE OIL PIPELINE
SONDAJ YERİ / Boring Location:	YUMURTALIK TANK FARM
KİLOMETRE / Kilometer:	
SONDAJ DERİNLİĞİ / Boring Depth :	25.00 m
SONDAJ KOTU / Elevation:	131.24m
YERALTI SUYU / Grounwater:	9.50m
MUH.BOR.DER. / Casing Depth	19.50m
BAŞ. BİT. TAR. / Start - Finish Date	11.09.2003 — 22.09.2003
KOORDİNAT / Coordinate (N-S) y	
KOORDİNAT / Coordinate (E-W) x	

Sondaj Derinliği Boring Depth (m)	Num. Cinsi Samp. Type	Manevra Boyu / Run	Standart Penetrasyon Deneyi Standart Penetration Test — DARBE SAYISI No of Blows 0-15 cm	15-30 cm	30-45 cm	N	GRAFİK/GRAPH 10 20 30 40 50	JEOTEKNİK TANIMLAMA GEOTECHNICAL DESCRIPTION	Profil / Profile	Dayanımlık / Strength	Ayrışma / Weathering	Kırık %50 / Fracture %50	Karot % / Core Recovery	RQD %
	K15	16.50						(CONTINUED FROM PAGE 2)					68%	0%
	SPT11	EMPTY	10	12	14	26								
17.00	K16	16.95 / 17.50						**Gravelly Sandy Clay** Grey-brown, angular fine gravelly fine to medium sandy hard clay					52%	0%
	K17	18.00											54%	20%
18.00	SPT12		50			R								
	K18	18.05 / 18.65	5										43%	0%
19.00	K19	19.50											62%	0%
	SPT13		50			R								
20.00	K20	19.60 / 20.25	10										30%	0%
	K21	21.00											36%	0%
21.00	SPT14		50			R								
	K22	21.08 / 21.80	8										34%	0%
22.00	K23	22.50						22.50 M					57%	0%
	SPT15	BOŞ	50			R		**Gravelly Clayey Sand**						
23.00	K24	22.53 / 23.25	3					Black brown gray, occasionaly gravelly and frequently clayey very dense coarse sand.					68%	0%
	K25	24.00						Gravels are *angular* of volcanic origion					74%	0%
24.00	SPT16		50			R								
	K26	24.05 / 24.75	5										18%	0%
25.00								25.00						

İŞİ JOB	ÜNVANI Title	ADI SOYADI Name Surname	İMZA Sign	Tarih Date
YAPAN Logged By	Sondaj Mühendisi Drilling Engineer			
KONTROL Checked By	Sondaj Şefi Drilling Chief			

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%)

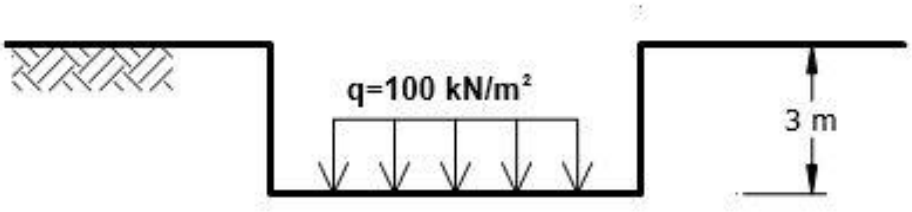
The following CPT data is obtained at the site**.** Plot the given data with respect to depth and identify different soil layers. Estimate the undrained shear strength of the soil at the depth of 4.0 m assuming the cone factor as N_k=18.

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)	**q_c (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/m^3, 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 $\phi = 32^0$ and c= 0 kPa. The unit weight of soil, γ, is 18.5 kN/m^3. 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 $c'= 0$, $\varphi'= 37°$, $\gamma=19.2$ kN/m^3. 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?