EGERTON UNIVERSITY

UNIVERSITY EXAMINATIONS
NJORO CAMPUS

SECOND SEMESTER, 2013/2014 ACADEMIC YEAR

SECOND YEAR EXAMINATION FOR THE DEGREE OF

BACHELOR OF SCIENCE IN WATER & ENVIRONMENTAL ENGINEERING

WEEN 216: SOIL MECHANICS II

STREAM: **TIME:** 2 HRS

DAY: WEDNESDAY, 3 – 5 P.M. **DATE: 28/05/2014**

INSTRUCTIONS

Answer **question 1** and **any other two** questions
Required charts are attached at the back of this question paper

Question1. (30 marks)

(a) A saturated clay specimen was consolidated in a shear box at a vertical stress of $80kN/m^2$. The specimen was then sheared rapidly and the maximum shear stress observed was $50kN/m^2$. The effective stress shear parameters of the clay were $C' = 10kN/m^2$ and $\phi = 28^0$

(i) What was the excess pore water pressure on the shear surface at failure? **(3marks)**

(ii) A sample of this soil is tested in a Triaxial test at a cell pressure of $300kN/m^2$. Determine the major principal stress at which the sample will fail. **(3marks)**

(b) Determine the vertical stress increase at a depth of 3 m below corner X on the L-shaped foundation shown in Figure Q1B, when the foundation is subjected to a uniform pressure of 150 kPa. **(6marks)**

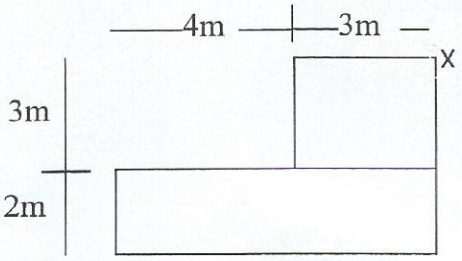


Fig. Q1B

(c) A flexible raft foundation with plan dimensions 24m x 12m is founded 4m below the ground level. At this particular site, the soil profile consists of 10m saturated clay of $E_u = 20MN/m^2$ underlain by a further 20m of saturated clay of $E_u = 40MN/m^2$. The soil layers rest on a rigid rock stratum. Estimate the average immediate settlement beneath the foundation if the net increase in stress is $100kN/m^2$. **(7marks)**

(d) Use Terzaghi's theory to determine the width of a square foundation required to carry a total load of 294kN, if the foundation is placed at a depth of 1.0m in sand of unit weight $20kN/m^3$ and angle of shearing resistance $\phi = 35^0$. A factor of safety of 3 against shear failure is specified. **(5marks)**

(e) A clay layer 3m thick is sandwiched between a layer of sand and impervious bed rock. The total consolidation of the layer is calculated to be 20mm. If the coefficient of consolidation $Cv = 0.96mm^2/min$, calculate the time required for

(i) 50% consolidation settlement. **(3.5marks)**

(ii) A settlement of 14mm. **(2.5marks)**

Question2. (20 marks)

(a) A group of 9 piles is driven to a depth of 9m in a deep deposit of soft clay. Each of the piles is 30cm in diameter and the piles are arranged in a square array at 90cm centre to centre. The clay has cohesion of $45kN/m^2$ and the adhesion factor is 0.75. If a factor of safety of 2.5 is applied,

$Q_g = Q_b + Q_s$

(i) Determine the capacity of the pile group based on single pile capacity. **(6marks)**

(ii) Determine the block capacity of the piles. **(5marks)**

$\alpha \bar{C}_u \times$

(b) A square pile 0.2m x 0.2m is driven through 5m of sand into underlying gravel. The sand has an average SPT $\bar{N} = 20$ and the gravel has SPT $\bar{N} = 40$. Given

$$q_b = \frac{40\bar{N}D}{B} \leq 400\bar{N} \quad (kN/m^2)$$

$$f_s = \bar{N} \quad (kN/m^2)$$

(i) Determine the depth of penetration into the gravel required to give sufficient end bearing capacity. **(2marks)**

(ii) Determine the total allowable load that can be carried by the pile. (use F=3).**(7marks)**

Question3. (20 marks)

Figure Q3, (which is drawn to scale), shows a ~~20m~~ 12m high slope of 35^0, in soil with the following properties: -

Angle of shearing resistance	$\phi = 20^o$
Cohesion	$C = 20kN/m^2$
Unit weight	$\gamma = 19.3kN/m^3$

(a) Estimate the depth to which tension cracks could develop at the slope crest. $z_o = \frac{2c}{\gamma K_a}$

(3marks)

(b) Estimate the factor of safety along the potential failure surface shown (ignore any tension cracks). The weight of each slice is given in the figure. **(17marks)**

Question 4 (20marks)

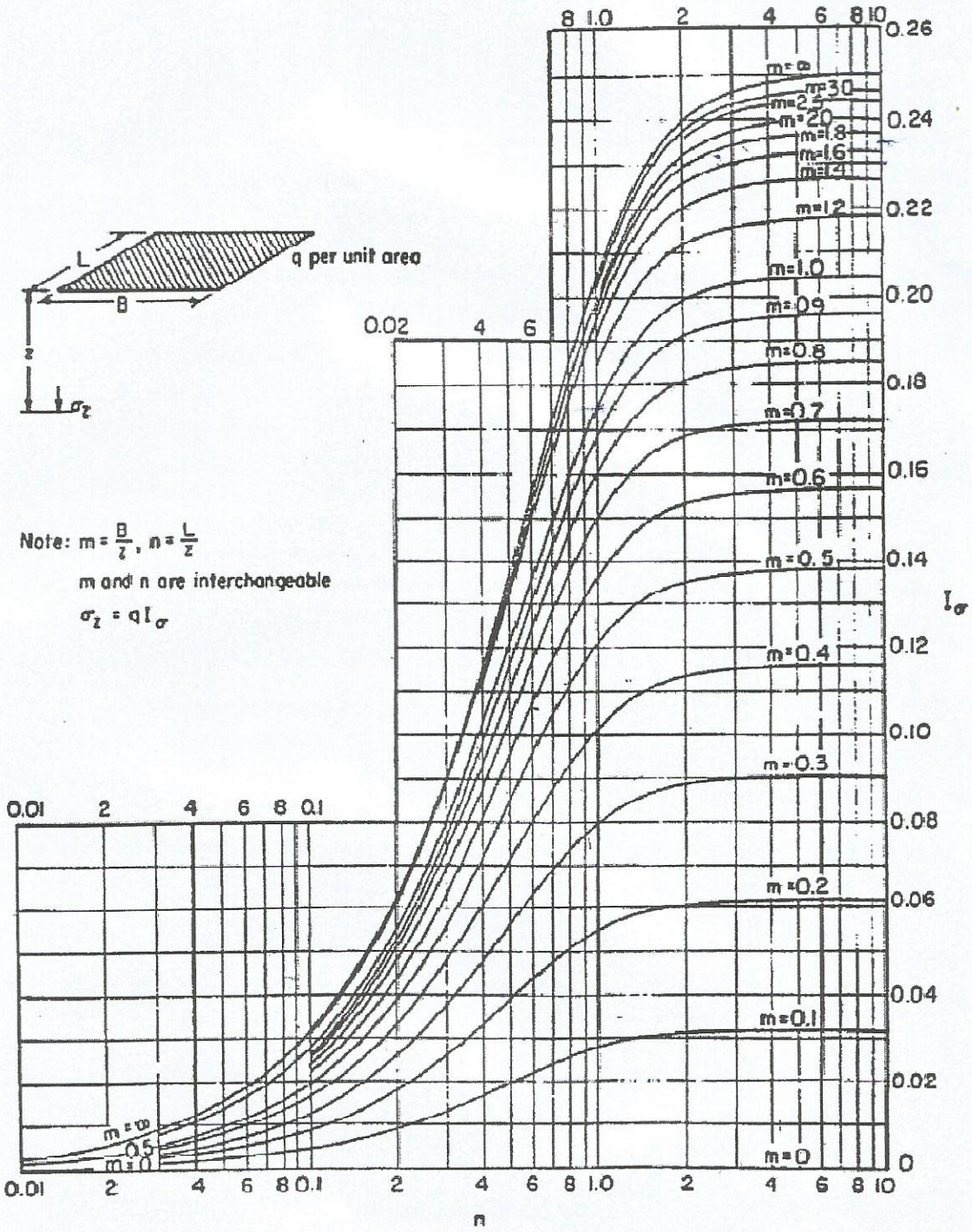
Figure Q4 shows a retaining wall in which the materials properties are as follows: -

Material	Unit weight (KN/m^2)	Angle of shearing resistance ϕ	Cohesion (KN/m^2)
Soil 1	20	36	0
Soil 2	18	30	0
Concrete	24		

Determine the factor of safety against

(a) Overturning. **(15marks)**

(b) Sliding along the base. **(5marks)**



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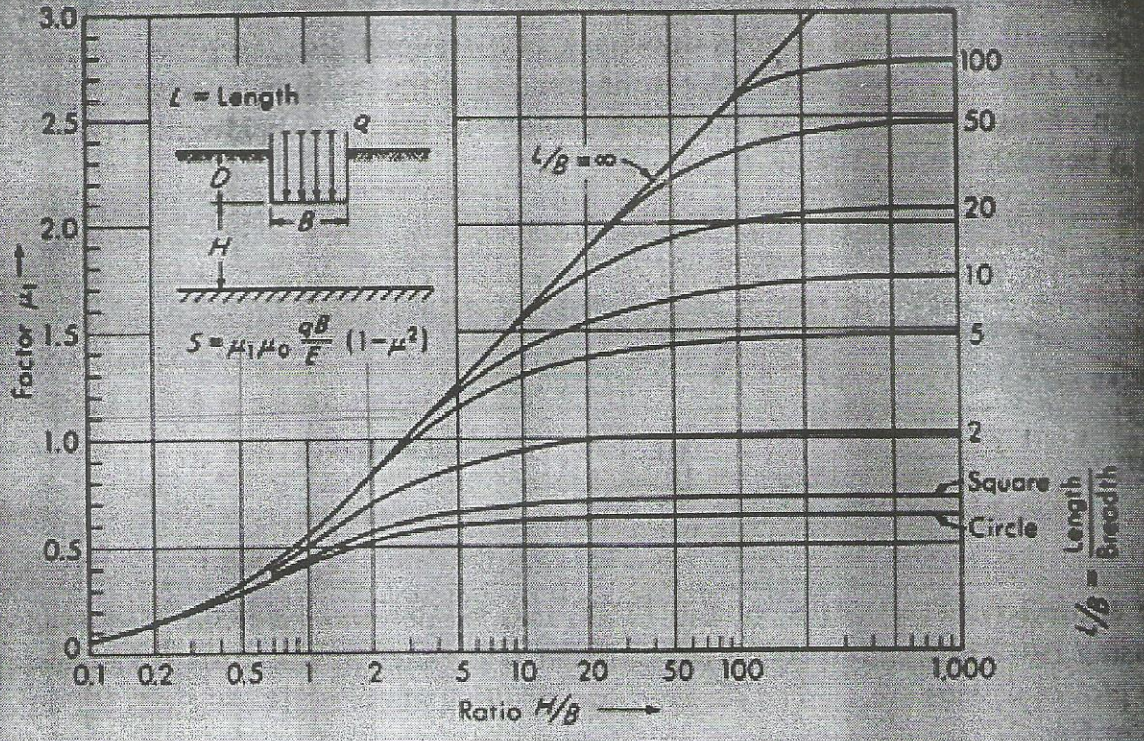

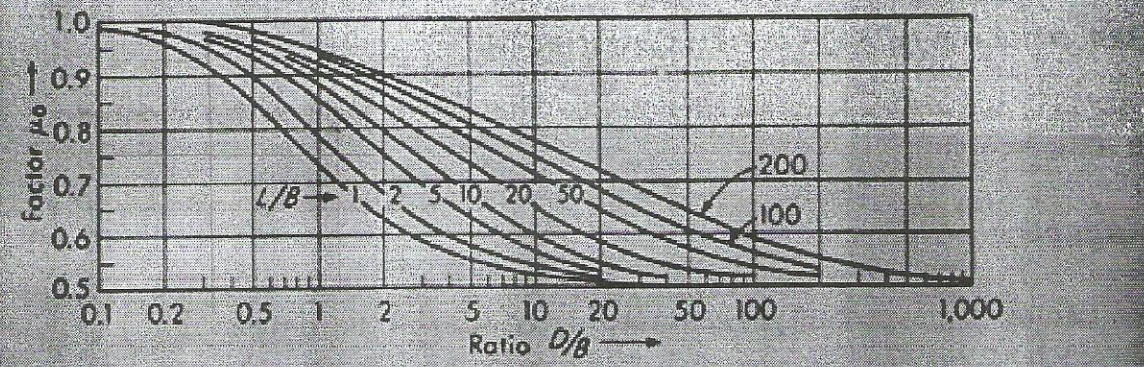

Fig. 2-21 Values of μ_0 and μ_1 for settlement computations using Eq. (2-44). (From Janbu, Bjerrum, and Kjaernsli [31].)

Terzaghi's bearing capacity factors

ϕ	N_c	N_q	N_γ	ϕ	N_c	N_q	N_γ	ϕ	N_c	N_q	N_γ
0	5.7	1.0	0.0	**17**	14.6	5.45	2.18	**34**	52.64	36.5	38.04
1	6.0	1.1	0.0	**18**	15.1	6.04	2.59	**35**	57.75	41.44	45.41
2	6.3	1.2	0.0	**19**	16.6	6.7	3.07	**36**	63.53	47.16	54.36
3	6.62	1.4	0.1	**20**	17.7	7.44	3.64	**37**	70.01	53.8	65.27
4	6.97	1.5	0.1	**21**	18.9	8.26	4.31	**38**	77.50	61.55	78.61
5	7.34	1.6	0.1	**22**	20.3	9.19	5.09	**39**	85.97	70.61	95.03
6	7.73	1.8	0.2	**23**	21.8	10.2	6.00	**40**	95.66	81.27	115.3
7	8.15	2.0	0.3	**24**	23.4	11.4	7.08	**41**	106.8	93.85	140.5
8	8.60	2.2	0.4	**25**	25.1	12.7	8.34	**42**	119.7	108.8	172.0
9	9.09	2.4	0.4	**26**	27.1	14.2	9.84	**43**	134.6	126.5	211.6
10	9.61	2.7	0.6	**27**	29.2	15.9	11.6	**44**	152.0	147.7	261.6
11	10.2	3.0	0.7	**28**	31.6	17.8	13.7	**45**	172.3	173.3	325.3
12	10.8	3.3	0.9	**29**	34.2	20.0	16.2	**46**	196.2	204.2	407.1
13	11.4	3.6	1.0	**30**	37.2	22.5	19.1	**47**	224.6	241.8	512.8
14	12.1	4.0	1.3	**31**	40.4	25.3	22.7	**48**	258.3	287.9	650.7
15	12.9	4.5	1.5	**32**	44.0	28.5	26.9	**49**	298.7	344.6	832.0
16	13.7	4.9	1.8	**33**	48.1	32.2	31.9	**50**			1073