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THE OPENUNIVERSITY OF SRI LANKA
DIPLOMA IN TECHNOLOGY (CIVIL) – LEVEL 04
Final Examination 2012/2013
CEX4230 – SOIL MECHANICS AND INTRODUCTION TO ROCK MECHANICS

Time allowed: Three Hours. Index No. _____

Date: Friday,16th August, 2013 Time: 0930-1230

PART A:

Answer all questions.All questions carry equal marks. Attach Part A of this paper to your answer script. You are advised to spend approximately One (1) hour for Part A. Circle the correct response.

(3x12 = 36 points)

1. Which one of the following statements is false?
   a. Limestone is a sedimentary rock type formed from Calcite.
   b. Basalt is formed from lava flows.
   c. Gneiss is formed under high temperatures and pressures.
   d. Granite is a metamorphic rock type.
   e. Granite and Gneiss are used as construction materials. a b c d e

2. When dry sand is poured on to a flat surface, a heap is formed. The angle between the horizontal surface and the conical surface is termed the angle of repose. Which of the following statements are true?
   A. Angle of repose depends on particle shape.
   B. Angle of repose is less in a well-graded soil.
   C. Angle of repose is unique for a given granular material.
   D. Angle of repose depends on the density of granular material.
   a. A, B and C b. B, C and D c. A, B and D d. A, C and D
   e. A, B, C and D a b c d e

3. Which of the following statements are true?
   A. Atterberg limit tests are performed on the fraction passing 0.425mm sieve.
   B. Liquid Limit Test and Plasticity Index Test is used to classify fine-grained soils.
   C. Soils with per cent fines greater than 12 are classified based on Liquid Limit and Plastic Limit tests, only.
   D. The fine fraction, as per British Standard is determined based on 0.063mm sieve.
   a. A, B and C b. B, C and D c. A, B and D d. A, C and D
   e. A, B, C and D a b c d e

4. Which one of the following statements is false?
   a. Formations with a dispersed clay structure are compressible than formations with a flocculated clay structure.
   b. Formations with a flocculated clay structure show good interlocking properties compared to formations with a dispersed clay structure.
   c. Dispersed clay structures tend to adsorb more water.
   d. Formations with a dispersed clay structure are suitable to carry building loads.
   e. High plasticity clay soils tend to form dispersed structures. a b c d e

5. Specific Gravity of sand grains is about:

   a. 1.7 b. 1.85 c. 2.45 d. 2.65 e. 2.9 a b c d e

6. Which of the following parameters have values between 0 and 1?

   A. Degree of Saturation

   B. Void ratio

   C. Relative Density

   D. Water content

   a. A and B b. A and C c. A and D d. B and C e. B and D a b c d e

7. The in-situ bulk density of a soil is 1.88 g/cm3; Water Content is 8.5% It's dry density is:

   a. 1.51 b. 1.57 c. 1.65 d. 1.73 e. 1.81 a b c d e

8. Hydrometer test was performed on the soil fraction passing 0.063mm sieve. Following data were obtained during a hydrometer test:

   Weight of dry soil specimen = 235.3g

   Weight of oven dried specimen retained on 0.063mm sieve = 121.5g

   The per cent finer than 0.063mm sieve size is:

   a. 37.5 b. 42.9 c. 44.3 d. 48.4

   e. 51.6 a b c d e

9. A 1.5m x 1.5m square footing is subjected to an allowable contact pressure of 100kPa. The stress acting at a depth of 3m, along the centreline of the footing (refer Figure 9) is:

   a. 8 b. 10 c. 13 d. 17 e. 20 a b c d e

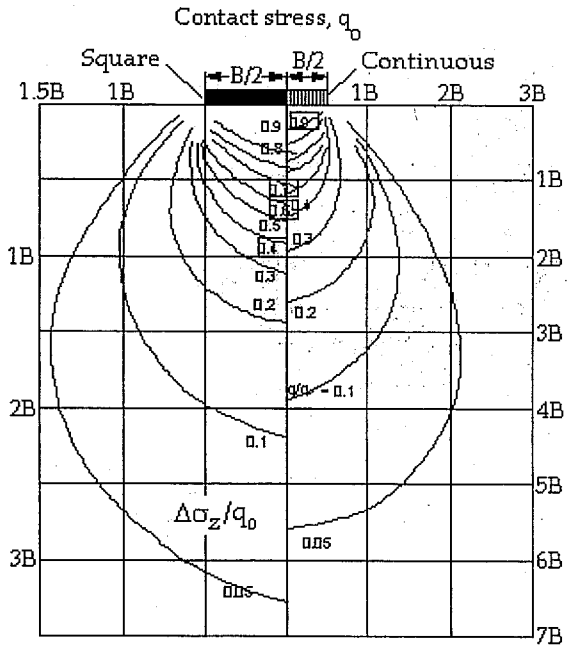


Figure 9

10. Which of the following statements are true?

A. Zero Air Voids curve relate water content to dry density of soil, at S=0.

B. Points on the compaction curve, represents all three phases.

C. Zero Air Void Curve depends on specific gravity of solids.

D. The compaction curve intersects the Zero Air Void Curve at higher water contents.

a. A, B and C b. B, C and D c. A, B and D d. A, C and D

e. A, B, C and D a b c d e

11. Identify the correct relationship for the following three earth pressure coefficients:

a. $K_a < K_0 < K_p$

b. $K_0 < K_a < K_p$

c. $K_p < K_0 < K_a$

d. $K_0 < K_p < K_a$

e. $K_a < K_p < K_0$ a b c d e

12. A saturated soil element in a uniform soil stratum is located 5m below ground surface. The water table is at 1m below ground surface. Which of the following statements are true?

A. The element is subjected to a vertical stress only.

B. A pore water pressure of 39.2kPa acts on the soil element.

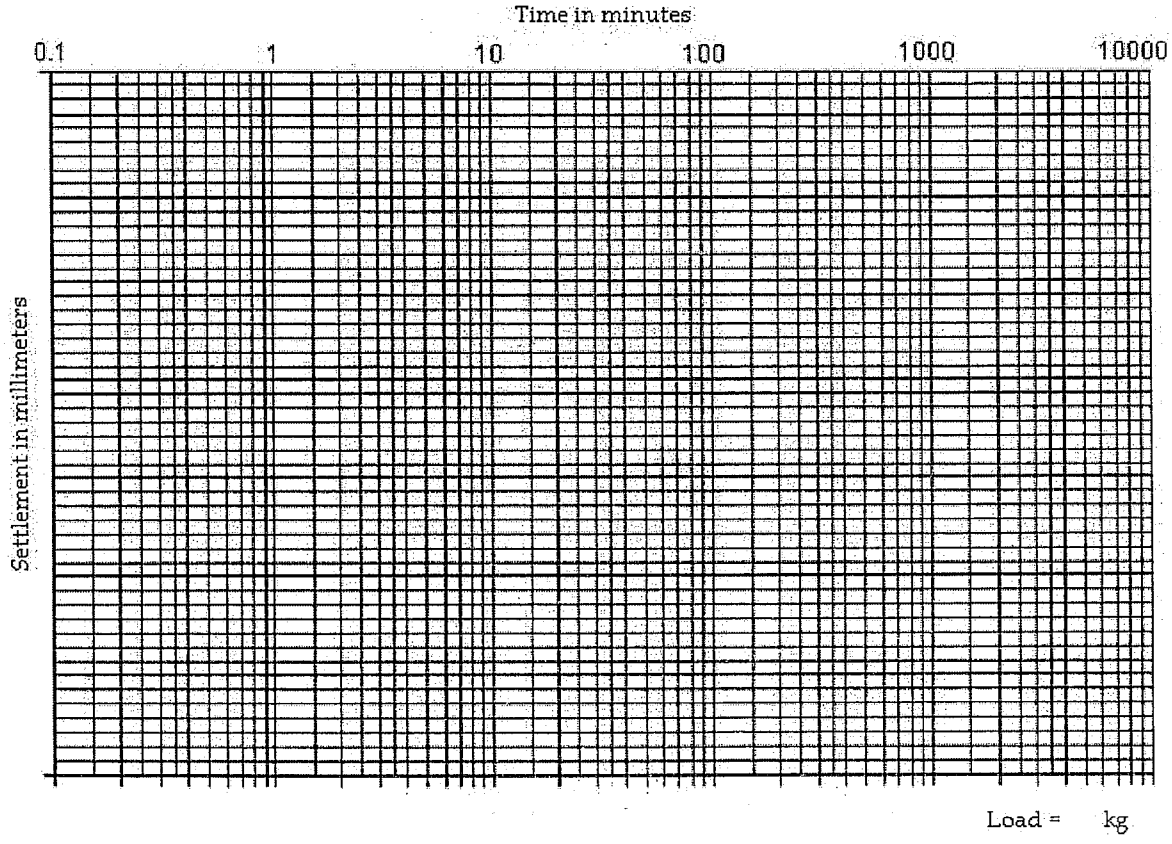
C. The average total stress of a soil element is proportional to its depth from ground surface.

D. Horizontal and vertical stress directions are considered as principal stress directions.

a. A, B and C b. B, C and D c. A, B and D d. A, C and D

e. A, B, C and D a b c d e

Use this graph-sheet for PART B Q5.



PART B:

Answer four questions. All questions carry equal marks. You are advised to spend approximately 28 minutes per question. (16x4 = 64 points)

1. A combined sieve-hydrometer test performed on a soil sample is as follows:

Size (mm)	Per cent finer by weight
6.3	100
2	97
0.6	90
0.212	75
0.063	51
0.035	31
0.02	19
0.01	10
0.008	7

The Liquid Limit and the Plastic Limit is found to be 65 and 35 respectively.

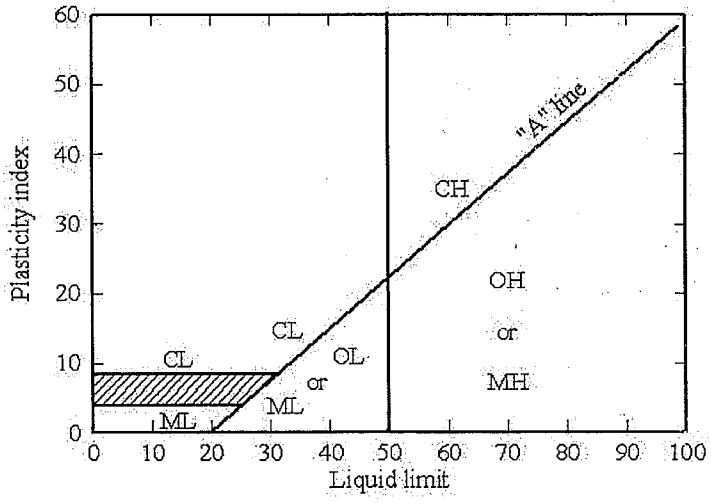
A. Determine the group symbol based on Unified Soil Classification System (4 points)

B. State its Soil Description. (2 points)

C. Describe the Dialatancy Test as explained in the Visual Classification of Fine-grained Soils test procedure. Explain your observation if you had done the Dilatancy Test for the soil mentioned above. (4 points)

D. Statewhether the above soil is a high-plastic soil or a low-plastic soil. State your reasons. (4 points)

E. Compute the Liquidity Index if the natural water content is 0.5. (4 points)



2. The Unconfined Compression (UC) Test is used to determine the Undrained Cohesion, c_u, of a saturated clay soil.

A. Explain why the UC Test cannot be used to test sandy specimens. (2 points)

B. Sketch Mohr's Circles of stress corresponding to i) before loading and ii) at failure situations. Name the two axes. (3 points)

C. Explain how you would determine the stress values to establish the two circles described in 3A. (3 points)

D. State the assumption made when proposing the area correction, and state why it is a valid assumption. (3 points)

E. Explain the effect of natural moisture content on UndrainedCoheshion, c_u. (3 points)

F. Discuss why parameter c_u is determined only for clayey soils and not for sandy soils. (2 points)

3. Figure Q3 shows a typical e-log(p) curve obtained during the 1-D Consolidation Test. The laboratory curve is used to construct the 'ideal' e-log(p) curve (OABC) that represents in-situ consolidation settlements.

A. Explain how you would determine e_0 during the One-Dimensional Consolidation Test. (4 points)

B. Explain how you would establish Point B. (4 points)

A specimen from a saturated Normally Consolidated clay stratum has a natural moisture content of 65%. The Specific Gravity is 2.72. The vertical effective overburden stress is found to be 150kPa. The pre-consolidation pressure is 210kPa. The respective Compression Index and Recompression Index is found to be 0.4 and 0.02.

C. Determine the resulting void ratio due to a load increment of 50kPa. (4 points)

D. Assuming that the clay layer has a uniform thickness of 8.5m, estimate its consolidation settlement. (4 points)

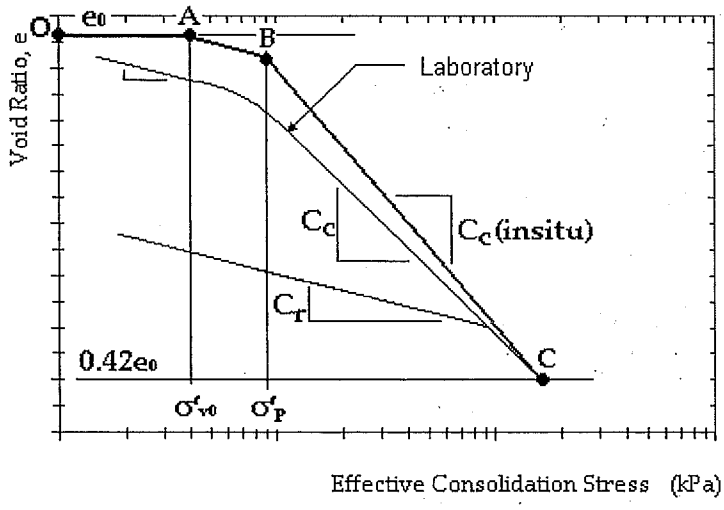


Figure Q3

4. A soil element when subjected to an increasing deviatoric stress, results in a loss of shear strength. The shear stress reaches the shear strength as determined in Mohr-Coulomb failure criterion, causing the specimen to fail.

A. Sketch an element of soil located along the failure plane. Show all stresses acting on the soil element, at failure, assuming that a Consolidated Drained (CD) Triaxial loading test is performed on the test specimen. (4 points)

A soil specimen subjected to a CD triaxial loading test failed at a deviatoric stress of 300kPa. The cell pressure was maintained at 100kPa.

B. Plot the Mohr's Circle at failure on a regular graph sheet. Name the axis. Show principal values on the same plot. (4 points)

C. Assuming that the soil is saturated normally-consolidated clay, draw the Mohr-Coulomb failure envelope. Compute the stresses acting on the failure plane. (4 points)

D. Compute the angle between the failure plane and the horizontal direction. (4 points)

5. Table 5a gives Settlement vs. Time readings for 1kg load, observed during an Oedometer Test. Table 5b gives the variation of two model parameters described in Terzarghi's One-Dimensional Consolidation Theory.

Table 5a: Observed variation of settlement with time.

Time (min.)	Settlement (mm)
0	0.160
0.1	0.176
0.25	0.181
0.5	0.189
1	0.202
2	0.216
4	0.232
8	0.247
15	0.257
30	0.263
60	0.266
120	0.268
240	0.270
480	0.272
1440	0.274

Table 5b: Variation of model parameters.

T_v	U_{avg}
0.008	0.1
0.031	0.2
0.071	0.3
0.126	0.4
0.197	0.5
0.287	0.6
0.403	0.7
0.567	0.8
0.848	0.9
1.163	0.95
∞	1.0

A. Plot Settlement vs. Time on the semi-logarithmic graph-sheet provided in PART A. (4 points)

B. Show on the same plot the regions corresponding to i) Initial Compression, ii) Primary Consolidation and iii) Secondary Compression. Show principal values on the same plot. (4 points)

C. Assuming an average height of the soil specimen to be 18.532mm, compute c_v corresponding to the given load increment. (4 points)

D. Define model parameters T_v and U_{avg}. Explain how these parameters are linked to parameters found during the One-Dimensional Consolidation Test. (4 points)

6. Figure Q6 shows the design chart recommended by Terzarghi and Peck to estimate the allowable bearing pressure for foundations in sandy formations.

A. Provide a sketch of a strip footing indicating dimensions and conditions stipulated in Figure Q6. (3 points)

B. Show on the same sketch the dimensions of the pressure bulb corresponding to a stress level equal to 10% of bearing stress (relevant chart is given in Q9 of PART A. (4 points)

C. Explain why the allowable bearing capacity (refer Figure Q6) drops with increasing footing width, B. (4 points)

D. Show on the same sketch how you would determine parameter N. (3 points)

E. Explain how you would use the design parameter determined from Figure Q6 when designing a footing. (2 points)

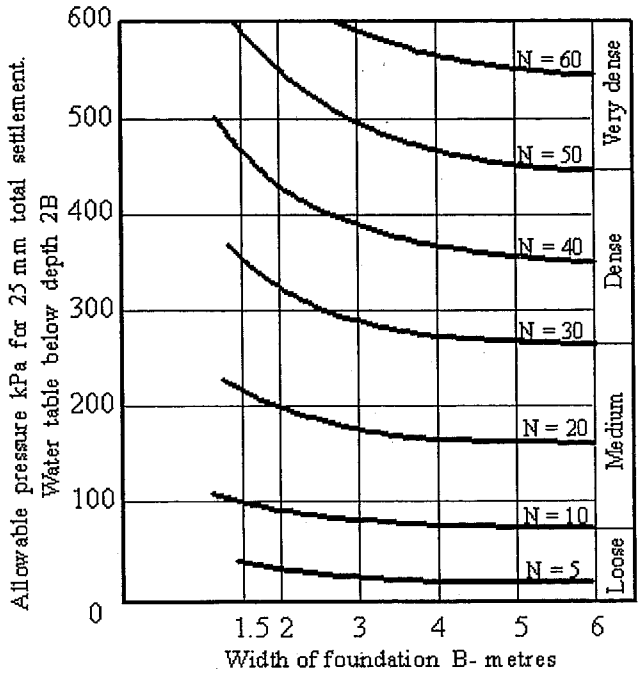


Chart for estimating allowable bearing pressure for foundations in sand on basis of results of standard penetration test (Terzaghi & Peck)

Figure Q6