(10)

Name of the Program: B. Sc. in Civil Engineering
Semester: 8th Semester (Summer)

Date: 03 May, 2023
Time: 10:00 a.m. to 1:00 p.m.

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

Semester Final Examination
Course Number: CEE 4847
Course Title: Sub-surface soil Investigation and In-Situ Testing

Summer Semester: 2021 - 2022
Full Marks: 150
Time: 3.0 Hours

There are 6 (six) questions. Answer all of them. The symbols have their usual meanings. Marks of each question and the corresponding CO and PO are written in brackets. Assume reasonable values for any data not given.

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1 (a) Write about the reasons behind subsoil exploration for- (08) (CO1, PO1)
(i) new project
(ii) failure of existing structure

(b) How do you select the number of bore holes, depth, and arrangement for a project's subsoil investigation? Also explain the BNBC-2020 guidelines for this purpose. (08) (CO1, PO1)

(c) A core stack obtained from rock coring is shown below (Fig. 1) with the average lengths of collected cores. The top 27 cm rock cores are broken into small pieces as shown. The total length of coring is equal to 2.0m. Classify the rock mass based on RQD. Also determine the value of TCR. (06+03) (CO2, PO2)

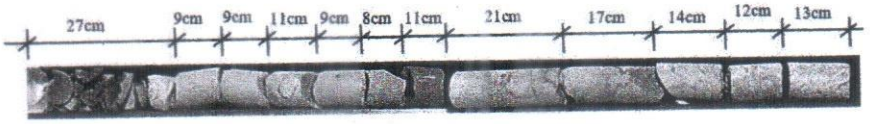

Fig. 1: Question no. 1(c)

2 (a) Define Rock Quality Designation (RQD). Discuss the significance of RQD in the classification of the rock layer. (03+03) (CO1, PO1)

(b) Which subsoil exploration technique do you believe is best for a loose sandy deposit? Discuss its methodology and outline the advantages and limitations of the one you believe is most appropriate. (04+04) (CO1, PO1)

(c) Standard Penetration Test (SPT) is conducted in the field with a donut hammer of efficiency equal to 50%. The SPT value of 35 was obtained at a depth of 18m from the ground surface while conducting SPT in the field. Ground water table is at the surface. If the average saturated unit weight of the deposit is 18.50 kN/m^3, determine the N value corrected for overburden, dilatancy and hammer efficiency (assume, standard hammer's efficiency is equal to 60%). The soil at the SPT level is cohesionless. Also evaluate the compactness of soil and angle of internal friction. Use the attached chart for this purpose. (07+04) (CO2, PO2)

3 (a) Explain engineering geological maps briefly. Also, provide an outline of the general principles for preparing engineering geological maps. (04+04) (CO1, PO1)

(b) Discuss briefly the method of determining the undrained shear strength of clayey soil using vane shear test apparatus. Also, write the advantages and limitations of this test. (04+04) (CO1, PO1)

(c) A well is driven into an aquifer. The following data are available: (09)
(CO2, PO2)

- Height of original piezometric level from the bed of the aquifer = 35.5ft,
- Depth of water in the well at steady state is 15.5 ft.
- Hydraulic conductivity of soil = 0.075 ft/min,
- Radius of well = 4.0 in., radius of influence = 600 ft.

Calculate the yield per hour if -

(i) The aquifer is confined with thickness equal to 20.0 ft
(ii) The aquifer is confined with thickness equal to 12.0 ft
(iii) The aquifer is unconfined

4 (a) What are the reasons for considering block samples as an undisturbed sample? Discuss the method of collecting, preserving and transporting a block sample. (04+04)
(CO1, PO1)

(b) Differentiate between the boring log and the subsurface soil profile with the help of neat sketch. (07)
(CO1, PO1)

(c) The cone penetration resistance (q_c) and sleeve-frictional resistance (f_c) obtained during a subsoil exploration program are shown in the following table. Find the type of soils at all the depth using the Robertson et al. (1986) correlation chart. (10)
(CO2, PO2)

Depth (m)	Point resistance of cone, q_c (MN/m^2)	Sleeve-frictional resistance, f_c (kPa)
1.5	3.98	99.5
3.0	4.89	137.7
4.5	0.69	17.3
6.0	0.81	24.1
7.5	19.6	158.8
9.0	24.3	250.0

5 (a) Discuss briefly the step-by-step procedure of the pressuremeter test (PMT) with the help of a schematic view. Write about the limitations that can be overcome in PMT. (04+03)
(CO1, PO1)

Or

Draw a clear sketch of a standard setup for CPT and show its various components. Also, discuss the advantages and disadvantages of CPT. (03+04)
(CO1, PO1)

(b) What do you mean by geotechnical instrumentation? Explain briefly the reasons for geotechnical instrumentation of a project. (03+04)
(CO1, PO1)

Or

Suppose that you are going to purchase some instruments for the purpose of geotechnical instrumentation in your project. Discuss briefly the key factors you will take into account in selecting those instruments for your project. (07)
(CO1, PO1)

(c) A pressuremeter test was conducted at a site. Following are the readings at a depth of 6.0m based on BX probe. Determine the pressuremeter modulus and limiting pressure at the depth of investigation. The volume of uninflated probe is equal to 535 cm^3. (11)
(CO2, PO2)

Pressure (kPa)	40	80	120	200	300	400	500	600	700	800	900
Volume Change (cm^3)	80	134	177	217	239	259	278	330	418	558	786

6 (a) Explain the necessity of writing limitations in a subsoil investigation report. Write a sample of the typical "limitations" of a sub-soil investigation report. (04+03) (CO1, PO1)

Or

Discuss the contents of a standard subsoil investigation report briefly. (07) (CO1, PO1)

(b) Consider a case of monitoring embankments on soft ground. Prepare a table to show the summary of instruments to be considered for having answers to various geotechnical questions. (08) (CO1, PO1)

Or

What is a standpipe piezometer? Discuss the step-by-step procedure of installing standpipe piezometer with the help of neat sketch. (02+06) (CO1, PO1)

(c) A loading test was conducted with a 450 mm square plate at a depth of 2.5 m below the ground surface in a cohesive soil. The water table is located at a depth of 4.0 m below the ground surface. (10) (CO2, PO2)

Pressure (kPa)	50	100	200	300	400	500	600	700
Settlement (mm)	1.5	2.0	4.0	7.5	12.5	20.0	40.0	85.0

(i) Plot the pressure-settlement curve and determine the failure stress.
(ii) Determine the size of a square column footing to carry a net load of 1750 kN at 2.5m depth.

Or

The results of two plate load tests on a cohesionless soil are given in the following table. (10) (CO2, PO2)

Plate Load Test No.	Size of square plate (m)	Total load (kN)	Settlement (mm)
1	0.305	64.4	20
2	0.610	143.6	20

A square column footing has to be constructed to carry a total load of 1250kN. The tolerable settlement is 25 mm. Determine the size of the square footing.

Table N_{cor} and ϕ Related to Relative Density

N_{cor}	Compactness	Relative density, D_r (%)	$\phi°$
0-4	Very loose	0-15	<28
4-10	Loose	15-35	28-30
10-30	Medium	35-65	30-36
30-50	Dense	65-85	36-41
>50	Very Dense	>85	> 41

Table Relation Between N_{cor} and q_u

Consistency	N_{cor}	q_u, kPa
Very soft	0-2	<25
Soft	2-4	25-50
Medium	4-8	50-100
Stiff	8-15	100-200
Very Stiff	15-30	200-400
Hard	>30	>400

where q_u is the unconfined compressive strength.

Table Details of Core Barrel Designations, Bits, and Core Samples

Casing and core barrel designation	Outside diameter of core barrel bit, mm (in.)	Diameter of core sample, mm (in.)
EX	36.5 $(1\frac{7}{16})$	22.2 $(\frac{7}{8})$
AX	47.6 $(1\frac{7}{8})$	28.6 $(1\frac{1}{8})$
BX	58.7 $(2\frac{5}{16})$	41.3 $(1\frac{5}{8})$
NX	74.6 $(2\frac{15}{16})$	54.0 $(2\frac{1}{8})$

Table Qualitative Description of Rocks Based on *RQD*

RQD	Rock quality
1–0.9	Excellent
0.9–0.75	Good
0.75–0.5	Fair
0.5–0.25	Poor
0.25–0	Very poor

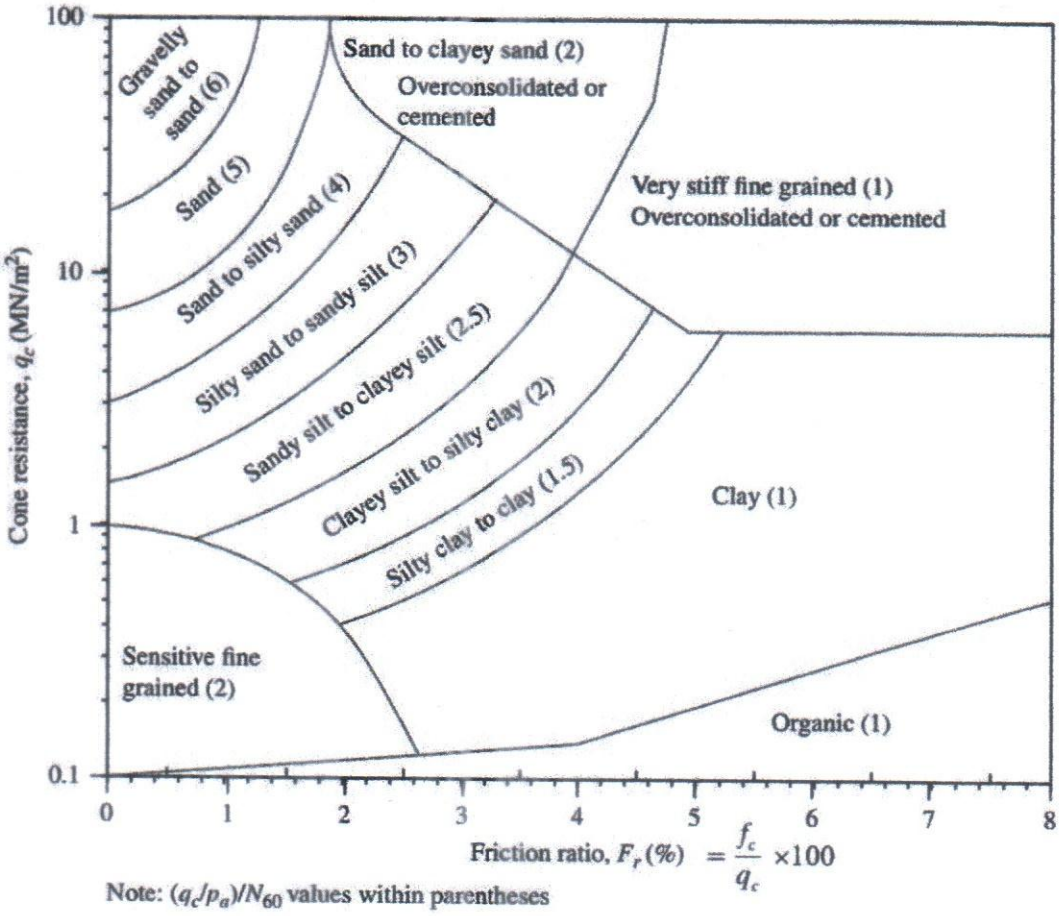

Figure Robertson et al. correlation (1986) between q_c, F_r, and the type of soil (*Based on Robertson et al., 1986*)