City & Guilds

9210-105
Level 6 Graduate Diploma in Engineering
Soil mechanics and engineering geology

Sampe Paper

You should have the following for this examination
- one answer booklet
- non-programmable calculator
- pen, pencil, eraser, ruler, protractor

The following data is attached
- Reference booklet
- Worksheet booklets

General instructions
- This examination paper is of **three hours** duration.
- This examination paper consists of **nine** questions over Section A and B.
- Answer **five** questions selecting at least two questions from Section A and at least three questions from Section B.
- All questions carry equal marks. The maximum marks for each section within a question are given against that section.
- An electronic, non-programmable calculator may be used, but the candidate **must** show clearly the steps prior to obtaining final numerical values.
- Drawing should be clear, in good proportion and in pencil. Do **not** use red ink.

Section A

1 The results of a sieve analysis test on a soil sample are shown in Table Q1.1.

Sieve size (mm)	Mass of sieve (g)	Mass of sieve and retained soil (g)
4.75	580.0	580.0
2.36	565.3	913.9
1.70	551.2	677.4
1.18	515.2	628.6
0.85	500.5	608.3
0.60	481.2	578.0
0.425	463.6	533.2
0.25	437.3	496.3
0.075	401.3	461.4
Pan	569.3	588.8

Table Q1.1

a) Plot the particle size distribution curve of this soil sample. (8 marks)
b) Determine the Coefficient of Uniformity and Coefficient of Curvature of the soil. (4 marks)
c) If the soil is non-plastic, classify this soil according to the Unified Soil Classification System (USCS). (8 marks)

2 a) List two factors which affect the field compaction. (2 marks)
b) In order to achieve proper compaction in a road embankment construction, compaction characteristics of the soil were determined in the laboratory. A standard Proctor compaction test was performed on a soil sample obtained from a borrow pit and the results are depicted in Table Q2.1. The volume of the mould is 1000 cm^3. You may use the unit weight of water as 9.81 kN/m^3.

Water content (%)	9.41	12.67	17.02	19.58	24.26	26.29
Mass of soil (g)	1644	1843	1993	1998	1938	1873

Table Q2.1

i) Determine the maximum dry unit weight and the optimum moisture content of the soil. (8 marks)
ii) Draw the phase diagram and derive the following equation with the usual notations. (4 marks)

$$\gamma_d = \frac{(1-A)G_s\gamma_w}{(1+wG_s)}$$

iii) If specific gravity of the soil is 2.7, draw curves for 0 % and 10 % air voids line; hence estimate the air content corresponding to the maximum dry unit weight. (4 marks)

c) If dry unit weight of the compacted soil in the field is 16.0 kN/m^3, what would be the expected degree of compaction? (2 marks)

3 a) Derive an expression for Rankine active earth pressure developed in a soil using Mohr-Coulomb diagram. (5 marks)

b) Details of a retaining wall are shown in Figure Q3. A surcharge pressure of 10 kN/m^2 is being carried on the surface behind the wall. Due to inadequate drainage, the water table has risen to the level indicated. The corresponding unit weights and shear strength parameters are depicted in Figure Q3. You may use the unit weight of water as 9.81 kN/m^3.

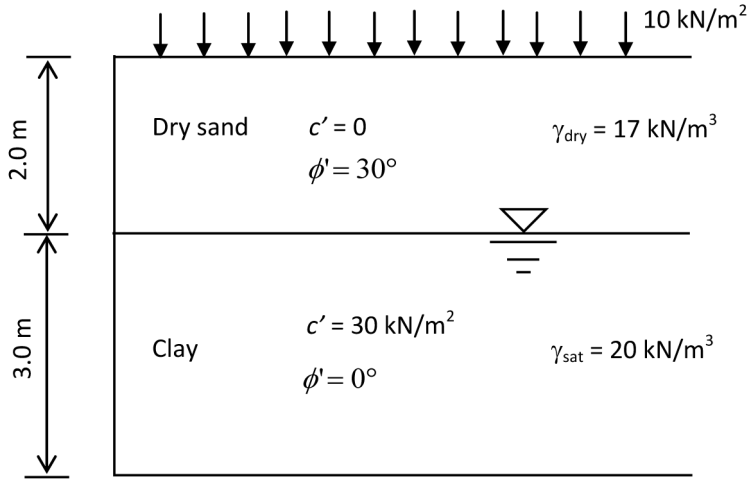

Figure Q3

i) Plot the distribution of effective active earth pressure behind the retaining wall. (7 marks)

ii) Plot the distribution of pore water pressure behind the retaining wall. (2 marks)

iii) Calculate the total lateral force. (4 marks)

iv) Hence, determine the most dominant factor on the development of the active force behind the retaining wall. (2 marks)

4 A layer of sandy clay is overlain by a silty clay layer of thickness 6.0 m. The water table is 3.0 m below the ground surface. Above the water table, silty clay has a bulk unit weight of 17.5 kN/m^3. The saturated unit weight of sandy clay and silty clay are 20.0 kN/m^3 and 18 kN/m^3 respectively. Unit weight of water is 9.81 kN/m^3.

a) Plot the total stress distribution up to a depth of 10.0 m. (5 marks)

b) Plot the pore water pressure distribution up to a depth of 10.0 m. (4 marks)

c) Plot the effective stress distribution up to a depth of 10.0 m. (4 marks)

d) A 3.0 m thick fill material of unit weight 20 kN/m^3 is placed on the ground surface over an extensive area.

i) Determine the total stress, pore water pressure and effective stress at a depth of 10.0 m from the ground surface, immediately after placing the fill. (4 marks)

ii) Determine the total stress, pore water pressure and effective stress at a depth of 10.0 m from the ground surface, many years after placing the fill. (3 marks)

See next page

Section B

5 There is a proposal to construct a new teaching hospital in the centre of a major city. In order to design the foundation for the proposed hospital, it was decided to carry out a comprehensive site investigation.

a) As a junior engineer in the project, what is the information expected from site investigation? List five factors. (5 marks)

b) Write five factors affecting the selection of sub-soil exploration methods. (5 marks)

c) Both disturbed and undisturbed soil samples are used to carry out laboratory tests in order to find physical and engineering properties of soil. Name three laboratory tests under each category. (6 marks)

d) What are the advantages and disadvantages of the geophysical exploration technique over the subsoil exploration technique? List two factors under each category. (4 marks)

6 a) Briefly explain the importance of Geology in the field of Civil Engineering. List four factors. (4 marks)

b) Draw the Rock Cycle with basic processes, which operate within it. (6 marks)

c) Briefly describe the formation of igneous rocks. (5 marks)

d) How do Magma and Lava differ? Briefly describe how the composition of magma can be changed by crystal settling. (5 marks)

7 Explain the following terms with suitable sketches.

a) Dykes. (5 marks)

b) Sills. (5 marks)

c) Laccoliths. (5 marks)

d) Batholiths. (5 marks)

8 a) What are faults? Briefly explain why and how they form. (4 marks)

b) Show the differences between a Normal fault and a Thrust fault with suitable sketches. (4 marks)

c) What are the disadvantages of the presence of joints with reference to civil engineering applications? (4 marks)

d) Show the differences between an anticline fold and a syncline fold with suitable sketches. (4 marks)

e) Briefly describe the term 'Unconformity' with suitable sketches. (4 marks)

9 Write short notes on the following physical properties of rock minerals.

a) Mohs scale of hardness. (5 marks)

b) Cleavage. (5 marks)

c) Fracture. (5 marks)

d) Colour and Lustre. (5 marks)