



ZIMBABWE

**MINISTRY OF HIGHER AND TERTIARY EDUCATION,
INNOVATION, SCIENCE AND TECHNOLOGY DEVELOPMENT**

**HIGHER EDUCATION EXAMINATIONS COUNCIL
(HEXCO)**

NATIONAL DIPLOMA

IN

CIVIL ENGINEERING

SUBJECT: Soil Mechanics

PAPER NO: 578/15/S01

DURATION: 3 hours

MARCH/APRIL 2020 EXAMINATION

REQUIREMENTS

1. Scientific calculator
2. Graph paper
3. Semi-logarithmic sheet

INSTRUCTIONS TO CANDIDATE

Answer any five (5) questions.

This paper consists of 4 printed pages.

QUESTION 1

- a) A sample of soil was placed in a moisture content tin of mass 19.52g. The combined mass of the soil and the tin was 48.27g. After oven drying the soil and the tin had a mass of 42.31g. Determine the water content of the soil. (3 marks)

- b) A BS cone penetrometer test carried out on a sample of boulder clay gave the following results:

Cone penetration (mm)	15.9	17.1	19.4	20.9	22.8
Moisture content (%)	32.0	32.8	34.5	35.7	37.0

Determine the liquid limit of the soil. (5 marks)

- c) A soil has a dry density of 1.9 Mg/m^3 . What is its dry unit weight? (2 marks)

- d) Show that the bulk unit weight of a material, $\rho_b = Y_w \left(\frac{G_s + eSr}{1+e} \right)$ (3 marks)

- e) i) Define a soil. (1 mark)
- ii) Give three (3) groups used to classify rocks. (3 marks)
- iii) State the best type of soil for backfill, suitable for earth dams. Give reasons. (3 marks)

QUESTION 2

- a) A sample of coarse sand 150mm high and 55mm in diameter was tested in a constant head permeameter. Water percolated through the soil under a head of 400mm for 6.0 seconds and the discharge water had a mass of 400g.

Determine coefficient of permeability, K, in m/s. (6 marks)

- b) In order to determine the average permeability of a bed of sand 12.5m thick overlying an impermeable stratum, a well was sunk through the sand and a pumping test carried out. After some time the discharge was 850kg/min and the drawdowns in observation wells 15.2m and 30.4m from the pump were 1.625m and 1.360m respectively. If the original water table was at a depth of 19.5m below ground level, find the permeability of the sand (in m/s). (10 marks)

- c) Deduce the formula to calculate seepage quantities from a flow net. (4 marks)

QUESTION 3

- a) The following results were obtained from a compaction test using the 2.5kg rammer.

Mass of mould + wet soil (g)	2783	3057	3224	3281	3250	3196
Moisture content (%)	8.1	9.9	12.0	14.3	16.1	18.2

The mass of the compaction mould, less its collar and base, was 1130g and the soil had a specific gravity of 2.70. the volume of compaction mould was 1000ml.

Plot the curve of dry density against moisture content and determine the optimum moisture content. On your diagram plot the lines for 5% and 0% air voids. (16 marks)

- b) What do you understand by the term over-compaction? (4 marks)

QUESTION 4

- a) What are the main objectives of site investigation? (8 marks)
- b) What is site reconnaissance with respect to engineering works? (3 marks)
- c) Discuss site exploration methods in engineering works. (8 marks)
- d) What do you understand by the term 'disturbed soil sample' in relation to soil mechanics? (1 mark)

QUESTION 5

The results of a sieve analysis on a soil were:

Sieve size (mm)	Mass retained (g)
60	0
47.5	17.5
35	20.0
24	17
15	10
10	11
6	33
4.5	33
2	119.5
0.6	69
1.16	17
0.063	11

The total mass of the sample was 360g. Plot the particle size distribution curve and from the inspection of this curve, determine the effective size and uniformity coefficient.

Also calculate the coefficient of curvature and classify the soil. (20 marks)

QUESTION 6

- a) Describe how to carry out the triaxial test in the laboratory. (11 marks)
- b) A series of drained triaxial tests were performed on a soil. Each test was continued until failure and the effective principal stresses for the tests were:

Test number	σ_3^1 (KPa)	σ_1^1 (KPa)
1	200	570
2	300	875
3	400	1162

Plot the relevant Mohr stress circles and hence determine the shear strength parameters of the soil with respect to effective stress. (9 marks)

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