ZIMBABWE

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

HIGHER EDUCATION EXAMINATIONS COUNCIL (HEXCO)

HIGHER NATIONAL DIPLOMA

IN

CIVIL ENGINEERING

SUBJECT: Geotechnology **PAPER NO: 778/17/S01**

DURATION: 3 Hours

MARCH/ APRIL 2025 EXAMINATION

REQUIREMENTS

1. Semi logarithmic sheet
2. Non programmable calculator
3. Answer booklet

INSTRUCTIONS TO CANDIDATE

1. Answer any five (5) questions.
2. All questions carry equal marks.
3. Do not tear off pages from the answer booklet.

This paper consists of 5 printed pages.

PAPER NO: 778/17/S01 – GEOTECHNOLOGY

QUESTION 1

a) A three layered soil system consisting of fine sand, coarse salt, and fine silt in horizontal layers is shown in Fig Q1.

Beneath the fine silt layer there is a stratum of water bearing gravel with a water pressure of 155KPa. The surface of the sand is flooded with water to a depth of 1m. Determine the quantity of flow per unit area in mm^3/s and the excess hydrostatic heads at the sand/coarse silt and the coarse silt/fine silt interfaces. (10 marks)

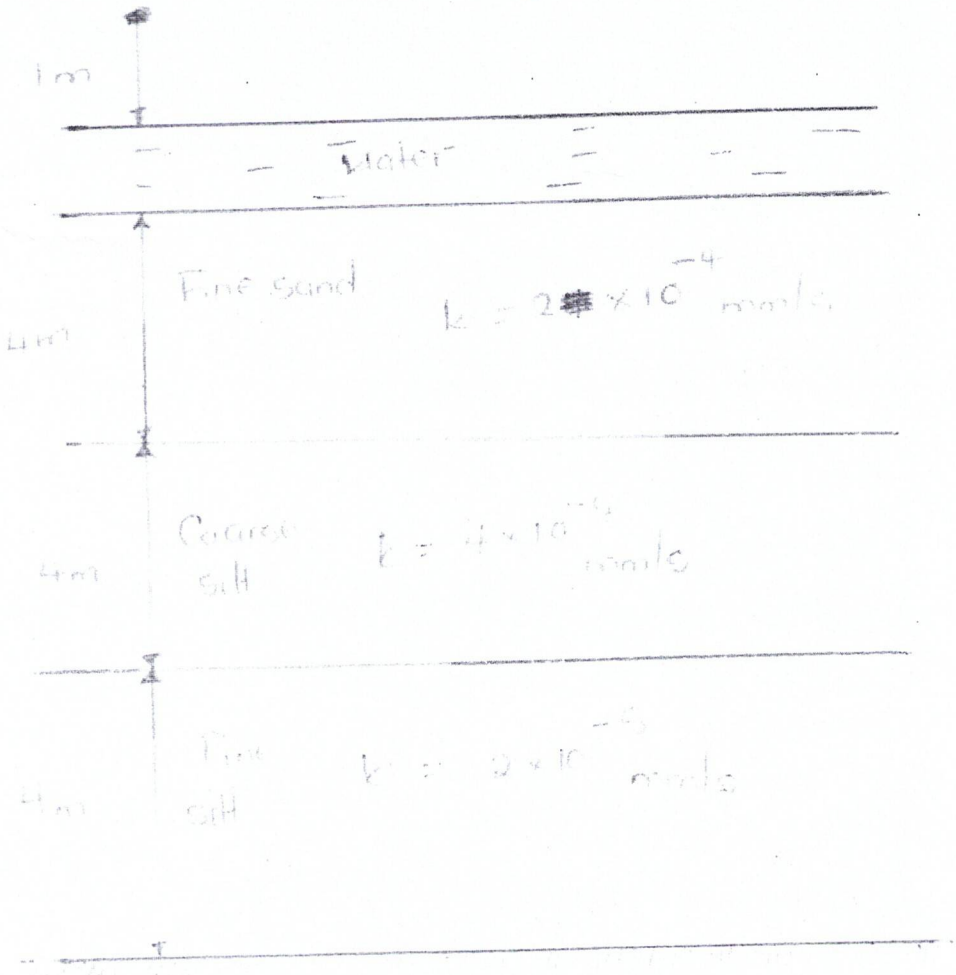


Fig Q1

b) Discuss the different methods used for stabilizing soil. (10 marks)

QUESTION 2

a) List five (5) assumptions made in Terzaghi's theory of one dimensional consolidation. (5 marks)

b) The following compression readings were taken during an oedometer test on a saturated day specimen (G_s = 2,73) when the applied pressure was increased from 214 to 429kN/m^2:

Time (min)	0	¼	½	1	2¼	4	9	16
Gauge (mm)	5,00	4,67	4,62	4,53	4,41	4,28	4,01	3,75

Time (min)	25	36	49	64	81	100	200	400	1440
Gauge (mm)	3,49	3,28	3,15	3,06	3,00	2,96	2,84	2,76	2,61

(15 marks)

After 1440min the thickness of the specimen was 13,60mm and the water content was 35,9%. Determine the coefficient of consolidation from both the log time and the root time plots and the values of three compression ratios. Determine also the value of the coefficient of permeability.

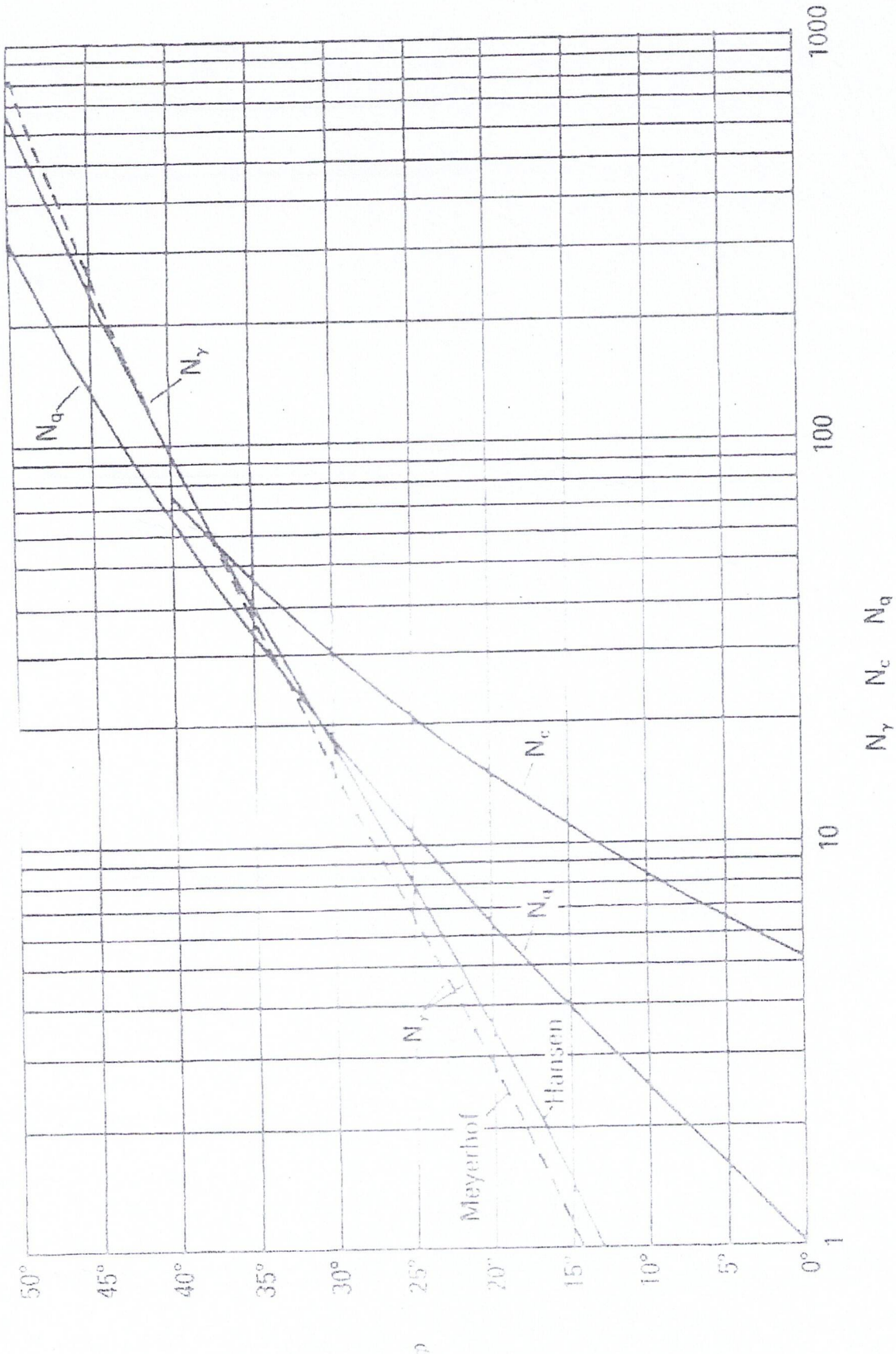
QUESTION 3

a) Evaluate the importance of a retaining wall. (5 marks)

b) The base of a long retaining wall is 3m wide and is 1m below the ground surface in front of the wall the water table is well below base level. The vertical and horizontal components of the base reaction are 282 and 102kN/m respectively. The eccentricity of the base reaction is 0,36m. appropriate shear strength, parameters for the foundation soil are $c^1 = 0$ and $\emptyset^1 = 35^\circ$, and the unit weight of the soil is 18kN/m^3. Determine the factor of safety against shear failure. (10 marks)

c) Explain the meanings of reinforced earth and grouting in geotechnical engineering.

NB: Please use Fig Q3b attached for bearing capacity factors.
(5 marks)


1000
100
10
1
N_γ N_c N_q
N_q
N_γ
N_c
N'_γ
N'_γ
Meyerhof
Hansen
50°
45°
40°
35°
30°
25°
20°
15°
10°
5°
0°
φ

QUESTION 4

a) Analyse types of failure slips. (10 marks)

b) A cohesionless soil with a void ratio of e = 0,6 and specific gravity of soil solids G_s = 2,65 exists at a site where the water table is located at a depth 2m below the ground surface. Assuming a value of coefficient of earth pressure at rest k_q = 0,5, calculate the following quantities at a depth of 5m below the ground surface: total stress δ_V and δ_H, effective stress δ_V^1 and δ_H^1 and pore water pressure u.

Assume soil to be dry above the water table and saturated below the water table, use $\gamma_u = 9{,}81kN/m^3$. (10 marks)

QUESTION 5

a) Describe any in situ ground improvement techniques used in geotechnical engineering. (13 marks)

b) Describe the components of a site investigation report. (7 marks)

QUESTION 6

a) Define the following terms used in geotechnical engineering:

i) Particle specific gravity (2 marks)
ii) Critical hydraulic gradient (2 marks)
iii) Capillarity (2 marks)
iv) Effective stress (2 marks)
v) Void ratio (2 marks)

b) A 3m layer of sand of saturated unit weight 18kN/m^3, overlies a 4m layer of clay of saturated unit weight 20kN/m^3. If the groundwater level occurs within the sand at 2m below the ground surface, determine the total and effective vertical stresses acting at the centre of the clay layer. The sand above groundwater level may be assumed to be saturated. (10 marks)

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