THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

EXAMINATION QUESTION PAPER MASTER

PROFORMA

Semester: ONE **Academic Year:** 2021

A. DEPARTMENT SECTION

I ACCEPT THAT THIS EXAMINATION PAPER SATISFACTORILY EXAMINES

Subject Code: ~~GZT~~ 431 **Title:** GEOTECHNICS

Number of Questions: 3 **Number of Pages:** 7 pg

1. **Subject Examiner:** LEONNIE PARANDA
   Signature: _____ **Date:** 07/06/21
2. **Subject Co-Examiner:** STEPHANIE KONTS
   Signature: _____ **Date:** 7/06/21
3. **Departmental Examinations Co-ordinator: Checked: YES** ✓ **NO** ____ **(Please tick)**
   Signature: _____ **Date:** 07/06/21
4. **Head of Department and Chief Examiner: Checked: YES** ✓ **NO** ____ **(Please tick)**
   Comments:
   Some mistakes were found in the question paper. But, Ms. Leonnie not available to do corrections.

   Signature: _____ **Date:** 08/06/2021

B. EXAMINATIONS OFFICE SECTION

Examination Masters Received: YES ____ **NO** ____

5. **Examinations Officer Signature:** _____ **Date:** _____
6. **Witness Signature:** _____ **Date:** _____

THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF CIVIL ENGINEERING

CE 431 – GEOTECHNICS

Tuesday, 8th June, 2021 at SLT

TIME ALLOWED: 3 HOURS

12:30pm – 3:30pm

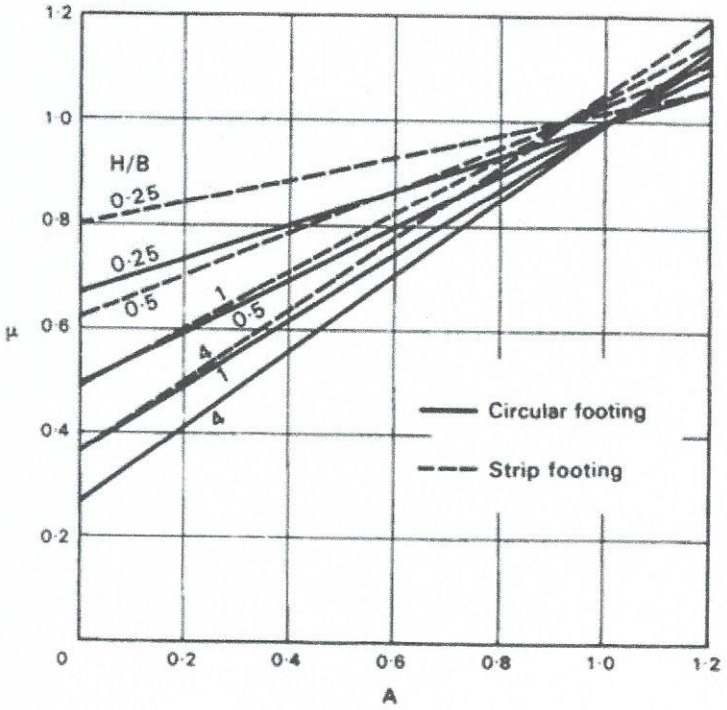
INFORMATION FOR STUDENTS

1. This is a closed book examination.
2. You may use a calculator.
3. Access to internet is prohibited.
4. You have 10 minutes to read the paper. You must NOT begin writing during this time.
5. There are **THREE** questions in this paper. **ANSWER ALL**. Read the questions **CAREFULLY**.
6. All answers must be written on the answer book provided unless otherwise stated. No other written material will be accepted.

WRITE YOUR NAME AND ID CLEARLY ON THE FRONT PAGE. KINDLY DO THAT NOW.

7. You are not allowed to consult your assignments, lecture notes and books.
8. Be NEAT AND CLEAR.
9. Include final answers and procedure to obtain them.
10. Include UNITS. Final numerical answers without units are insignificant (unless dimensionless).
11. Maximum possible mark is 70 in 180 minutes of examination.
12. Questions are not equal weight. Marks allocated to each question are indicated.
13. No mobiles phones are allowed in the exam room.

c. Determine **Total Settlement** with reference to the table below:



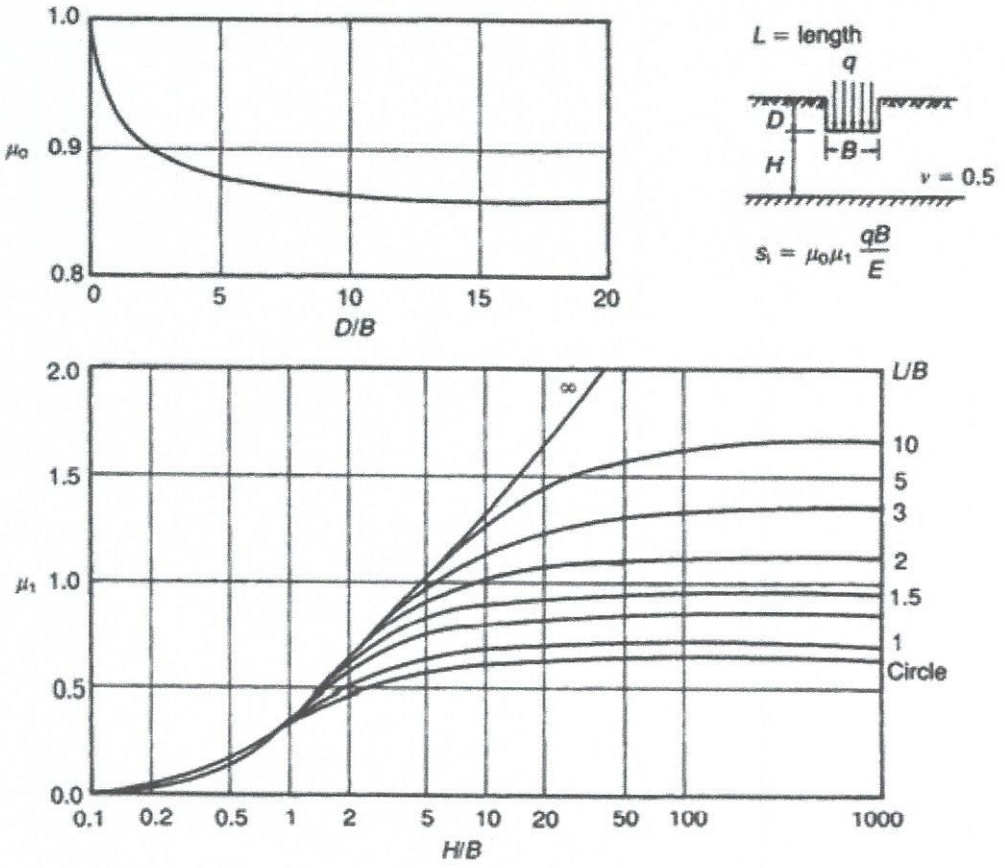
Settlement coefficient. (Reproduced from R.F. Scott (1963) *Principles of Soil Mechanics*, by permission of Addison-Wesley Publishing Company, Inc., Reading Mass.)

Marks = 10 + 10 + 10 =30

b. Solve for **Consolidation Settlement** with reference to the table below:

Layer	*z* (m)	*m*, *n*	I_r	$\Delta\sigma'$ (kN/m^2)	s_{od} (mm)
1	1.5	2.00	0.233	149	58.1
2	4.5	0.67	0.121	78	30.4
3	7.5	0.40	0.060	38	14.8
4	10.5	0.285	0.033	21	8.2
5	13.5	0.222	0.021	13	5.1
					116.6

a. Solve for **Immediate Settlement.** The influence factors can be obtained from the diagram below.



Coefficients for vertical displacement.

QUESTION THREE (3)

SKEPMTON BJERUUM ANALYSIS

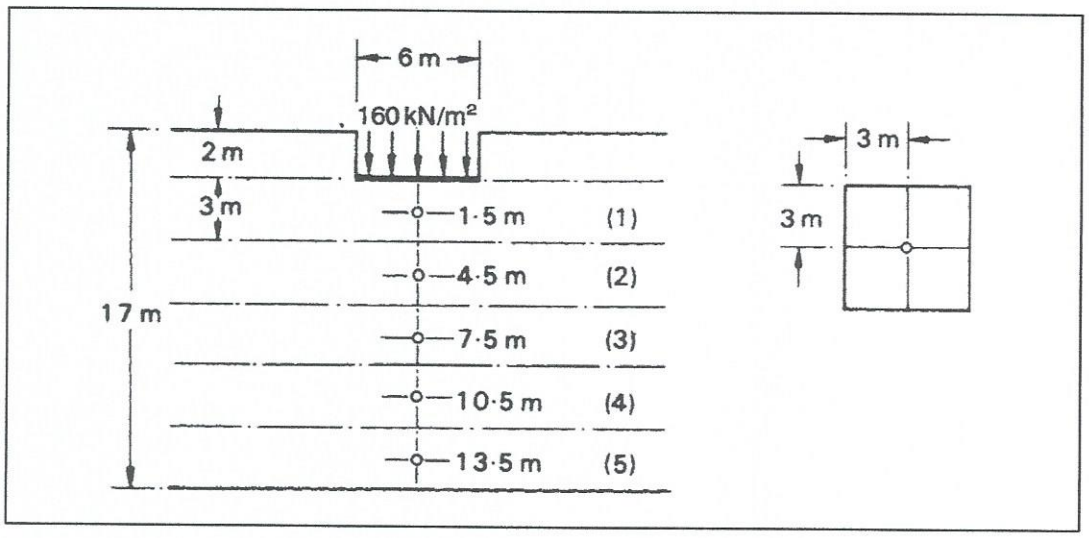
A footing $6m^2$, carrying a net pressure of $160kN/m^2$, is located at a depth of 2m in a deposit of stiff clay 17m thick: a firm stratum lies immediately below the clay.

From oedometer tests on specimens of the clay the value of m_v was found to be $0.13m^2/MN$ and from triaxial tests the value of A was found to be 0.35. The undrained Young's modulus for the clay is estimated to be $55MN/m^2$.

Determine the total settlement under the center of the footing.

There is significant lateral strain in the clay beneath the footing (resulting in immediate settlement).

This diagram is shown below:



Value of μ are typically within the following ranges:	
Soft, sensitive clays	**1.0–1.2**
Normally consolidated clays	**0.7–1.0**
Lightly overconsolidated clays	**0.5–0.7**
Heavily overconsolidated clays	**0.2–0.5**

QUESTION TWO (2)

ANALYSIS OF PLANE TRANSLATIONAL SLIP

A long natural slope in an over consolidated fissured clay of saturated unit weight $20kN/m^3$ is inclined at $\beta = 15^\circ$ to the horizontal. The water table is at the surface and seepage is roughly parallel to the slope. A slip has developed on a plane parallel to the surface at a depth of z =8m.

1. Illustrate the Plane Translational Slip in a diagram and show the slip characteristics.

2. With the relevant *equation(s)*, do the following:

   a. Determine the **factor of safety** along the slip plane using:
      - the critical-state parameter $Ø'_{cv} = 18^\circ$ and
      - the residual strength parameter $Ø'_r = 10^\circ$

   b. Analyse the stability of the slope by the limit state method.
      - The partial factor is 1.25.
      - Water Table at the surface has a value of $m = 1$

3. State whether the overall stability is satisfied for $Ø'_{cv}$ and $Ø'_r$

Marks = 5 + 5 + 5 +5 = 20

QUESTION ONE (1)

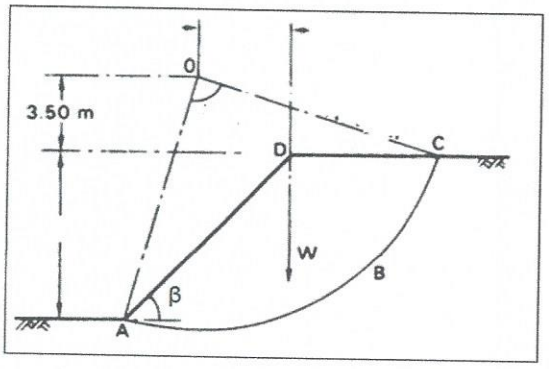
SLOPE STABILITY ANALYSIS USING Ø = 0 method.

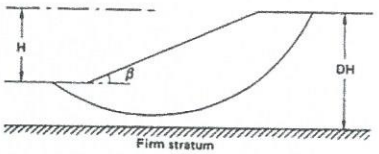
In an earthworks slope design for a retaining wall, the potential failure surface immediately after construction is assumed to be a circular arc of fully saturated clay under undrained conditions.

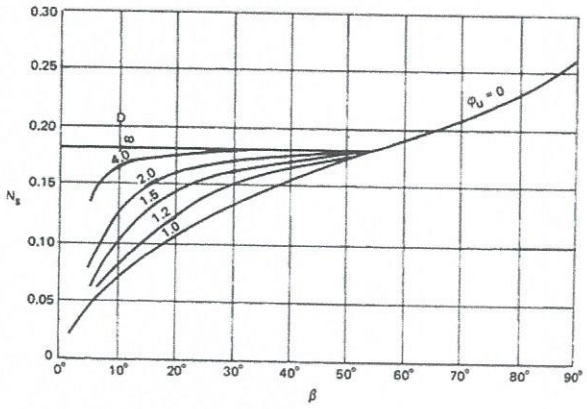
- The excavation depth is 11m
- The unit weight of the soil is $19kN/^3$
- The relevant shear strength parameters are $c_u = 65kN^2$ and Ø = 0
- The cross-sectional area AOCD is $20m^2$
- The centroid of ABCD is 5.5m from 0
- The angle AOC is 88°
- The radius OC is 13.1m
- β is 45°

Depict the parameters in the diagram and solve for the following:

a. The safety factor for the trial failure surface
b. The minimum factor of safety. Assume that D is large and the value of Ns = 0.18.







Taylor's stability coefficients for $\phi_u = 0$. (Reproduced by permission of the Boston Society of Civil Engineers.)

Marks = 5 + 5 + 5 + 5 = 20

FORMULA SHEET

Method of Analysis ø = 0

Factor of Safety:

$$F = \frac{cuLar}{Wd}$$

Minimum factor of safety:

$$Ns = \frac{c_u}{F\gamma H}$$

Analysis Of Plane Translational Slip

Factor of Safety

$$F = \frac{ytan\text{ø}'cv}{tan\beta}$$

Design disturbing force per m^2

$$S_d = \gamma_{sat} z sin\beta cos\beta$$

Design resisting force per m^2

$$R_d = (\sigma - u) \tan \text{ø}'_{cv}$$

Skempton Bjerrum Method of Settlement Analysis

Immediate Settlement $s_i = \frac{\mu_0 \mu_1 qB}{E_u}$

Total Settlement $s = si + sc$