



MACHAKOS UNIVERSITY

University Examinations for 2024/2025 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

FOURTH YEAR FIRST SEMESTER EXAMINATION FOR DEGREE IN BACHELOR OF SCIENCE IN CIVIL ENGINEERING

ECV 403: FOUNDATION ENGINEERING I

DATE: 14TH JANUARY, 2025

TIME: 11.00 AM – 1.00 PM

INSTRUCTIONS:

Answer question **ONE (Compulsory)** and **any other TWO** questions

QUESTION ONE (COMPULSORY) (30 MARKS)

- a) List any six earth retaining walls applicable to engineering projects (3 marks)
- b) Explain the main reason for studying earth pressure (3 marks)
- c) Explain the difference between the following earth pressure terms; (6 marks)
 - Pressure at rest
 - Active earth pressure
 - Passive earth pressureState the assumptions
- d) Derive from first principles, using Rankine's theory and show that coefficient of lateral active pressure is given by the expression: (10 marks)
$$K_a = \frac{1 - \sin\phi}{1 + \sin\phi}$$
- e) Define the term Dewatering as used in foundation construction (3 marks)
- f) Explain any Five objectives for dewatering in foundation construction (5 marks)

QUESTION TWO (20 MARKS)

- a) Using the Rankine theory, determine the total active thrust on a vertical retaining wall 5 m high if the soil retained has a horizontal surface level with the top of the wall and has the following properties: $\phi' = 35^\circ$; $\gamma = 19 \text{ kN/m}^3$. (10 marks)

What is the increase in horizontal thrust if the soil slopes up from the top of the wall at an angle of 35° to the horizontal?

- b) Describe any six causes of foundation Settlement (6 marks)
- c) Explain any Four circumstances under which structure shoring may be required. (4 marks)

QUESTION THREE (20 MARKS)

- a) Define the following terms as used in foundation design (3 marks)
 - i. Ultimate bearing capacity
 - ii. Safe bearing capacity
 - iii. Allowable bearing pressure
- b) A rectangular foundation 2m x 4m is to be founded at a depth of 1m below the surface of a deep stratum of soft saturated clay (unit weight = 20 kN/m³). Undrained and consolidated undrained tri-axial tests established the following soil parameters; (10 marks)

$\phi_u = 0^\circ$, $C_u = 24 \text{ kNm}^2$, $\phi' = 25^\circ$, $C' = 0$,

Determine the ultimate bearing capacity of the foundation;

 - i. Immediately after construction
 - ii. Some years after construction
- c) A continuous foundation is 1.5 m wide and is founded at a depth of 1.5 m in a deep layer of sand of unit weight 18.5 kN/m³. (7 marks)

Determine the ultimate bearing capacity of the foundation if the soil strength parameters are $c' = 0$ and $\phi' =$ (i) 35° , (ii) 30° .

QUESTION FOUR (20 MARKS)

- a) Describe the procedure of conducting a Standard Penetration Test (SPT) (3 marks)
- b) A granular soil was subjected to standard penetration tests at depths of 3 m. Ground water level occurred at a depth of 1.5 m below the surface of the soil which was saturated and had a unit weight of 19.3 kN/m³. The average N count was 15. (7 marks)
 - (i) Determine the corrected value N' .
 - (ii) A strip footing, 3 m wide, is to be founded at a depth of 3 m. Assuming that the sand's strength characteristics are constant with depth, determine the allowable bearing pressure.
- c) Explain two methods used to determine the bearing capacity of piles (3 marks)

- d) A 5 m thick layer of medium sand overlies a deep deposit of dense gravel. A series of standard penetration tests carried out through the depth of the sand has established that the average blow count, $\bar{N}$, is 22. Further tests show that the gravel has a standard penetration value of $N = 40$ in the region of the interface with the sand. A precast pile of square section $0.25 \times 0.25 \text{ m}^2$ is to be driven down through the sand and to penetrate sufficiently into the gravel to give good end bearing. (7 marks)
- Adopting a safety factor of 3.0 determine the allowable load that the pile will be able to carry.

QUESTION FIVE (20 MARKS)

- a) Describe four techniques for ground water dewatering (4 marks)
- b) Define the following terms as used in foundation engineering design (6 marks)
- Elastic compression
 - Primary compression
 - Secondary compression
- c) The results of a load test on a 0.45 m diameter pile are shown in the **Table Q5b**. Determine (5 marks)
- the ultimate pile load capacity,
 - the allowable load for a factor of safety of 2,
 - the allowable load capacity at 10% pile displacement.

Table Q5b.

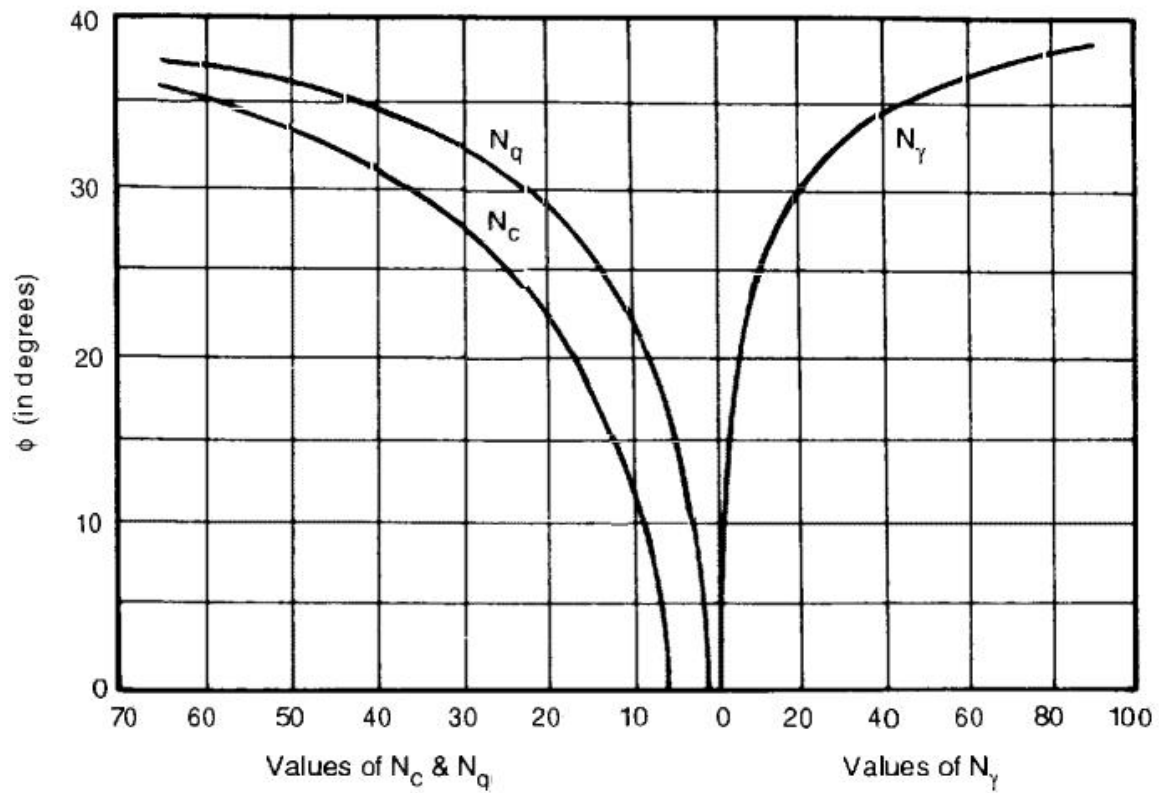
Displacement (mm)	0.0	1.3	2.5	5.1	7.6	10.2	12.7	15.2	17.8	20.3	22.9	25.4	27.9	30.5	33.0
Load (kN)	0	200	350	670	870	1070	1250	1400	1500	1600	1700	1750	1780	1810	1830

Displacement (mm)	35.6	38.1	40.6	43.2	45.7	47.0
Load (kN)	1860	1870	1890	1890	1900	1905

- d) A reinforced concrete foundation, of dimensions $20 \text{ m} \times 40 \text{ m}$ exerts a uniform pressure of 200 kN/m^2 on a semi-infinite soil layer ($E = 50 \text{ MN/m}^2$). Determine the value of immediate settlement under the foundation using the table in the appendix (5 marks)

Appendices

Soil Bearing Capacity :



ϕ	0°	5°	10°	15°	20°	25°	30°	35°	40°	45°
N_c	5.7	7.3	9.6	12.9	17.7	25.1	37.2	57.8	95.7	172
N_q	1.0	1.6	2.7	4.4	7.4	12.7	22.5	41.4	81.3	173
N_γ	0.0	0.5	1.2	2.5	5.0	9.7	19.7	42.4	100	298

Fig. 1 Terzaghi's bearing capacity coefficients

$$\text{True } N = 15 + 0.5 (N - 15)$$

where

N = actual number of blows recorded in the test

True N = number of blows from which N' should be evaluated

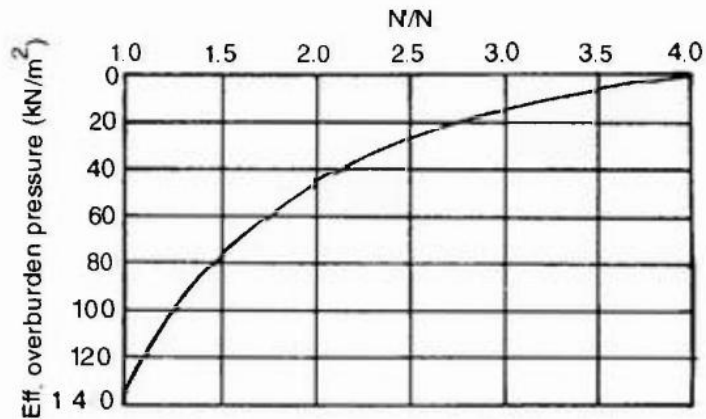


Fig. 2 Estimation of N' from the test value N (after Thorburn, 1963).

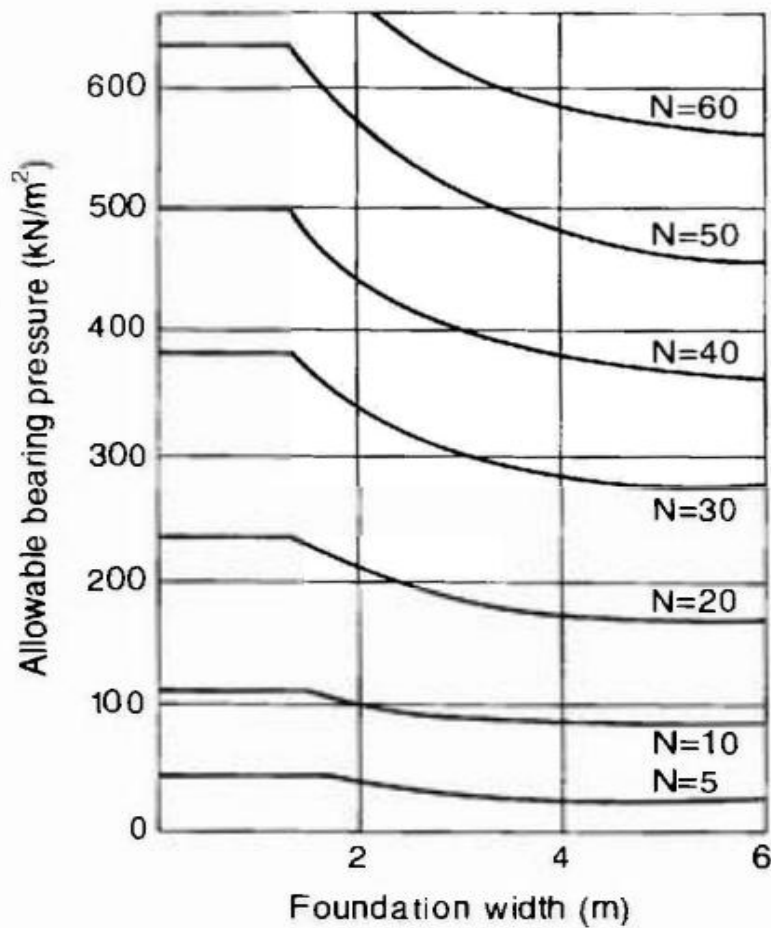


Fig. 3 Allowable bearing pressure from the standard penetration test (after Terzaghi and Peck, 1948)

Settlement and Consolidation

$$\rho_i = \frac{pB(1 - \mu^2)I_p}{E}$$

Where;

B = width of foundation

p = uniform contact pressure

E = Young's modulus of elasticity for the soil

μ = Poisson's ratio for the soil (= 0.5 in saturated soil)

I_p = an influence factor depending upon the dimensions of the foundation.

Skempton (1951) suggests the values for I_p given in

Table

L/B	I_p
circle	0.73
1	0.82
2	1.00
5	1.22
10	1.26