

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

UNIVERSITY EXAMINATIONS FOR:

THE DEGREE OF BACHELOR OF SCIENCE/TECHNOLOGY IN CIVIL
ENGINEERING

(Y4S1)/(Y3S2)

ECV 4417: FOUNDATION ENGINEERING I,

TCV 4324: FOUNDATION ENGINEERING

SPECIAL/SUPPLEMENTARY EXAMINATION

SERIES: JULY 2025

TIME: 2 HOURS

INSTRUCTIONS TO THE CANDIDATE:

1. You should have the following for this examination:
 - **Answer booklet.**
 - **Mathematical Table/Pocket Calculator.**
 2. This paper consists of **FOUR** questions.
 3. Answer question **ONE (Compulsory)** and any other **TWO** questions.
 4. This paper consists of **FIVE** printed pages.
 5. **Do not write on the question paper.**
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Question ONE: Earth pressures

- a) The active lateral earth pressure, at the bottom of a smooth vertical back of a retaining wall, exerted by a “c – φ”- soil, with a horizontal top surface, is given by the expression

$$p_a = z K_a - 2c \sqrt{K_a} \quad (1.1)$$

From basic principles, derive equation (1.1)

(12 Marks)

- b) Details of a retaining wall are given in Figure 1.1. Ignoring tension cracks:
- (i) Draw the active lateral earth pressure diagram on the back of the wall,
 - (ii) Determine the magnitude and location (above the base) of the total active thrust on the back of the wall per metre run.

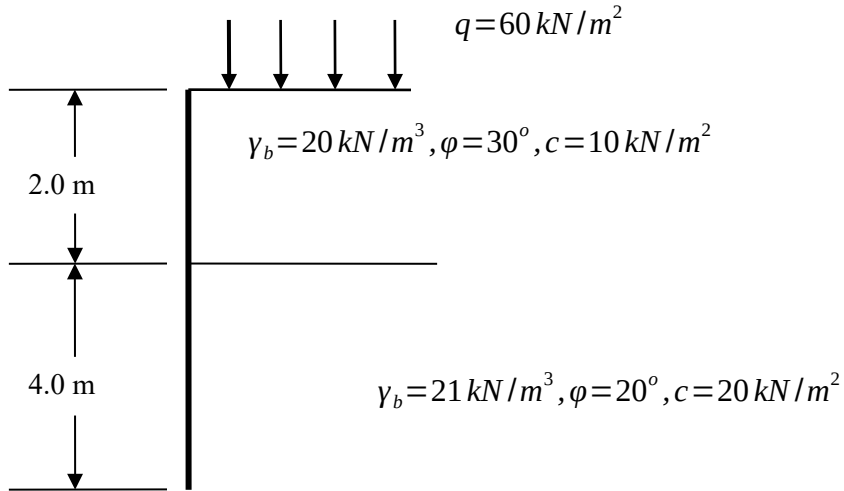


Fig. 1.1: Retaining wall

(18 Marks)

Question Two: Stability of slopes

- (a) For a circular-slip slope failure in a “c - ϕ ” soil, the factor of safety against sliding is given by the expression

$$F = \frac{cr\theta + \sum N \tan \phi}{\sum T} \quad (2.1)$$

Using a neat sketch, derive equation (2.1) from the basic principles.

(8 marks)

(b)

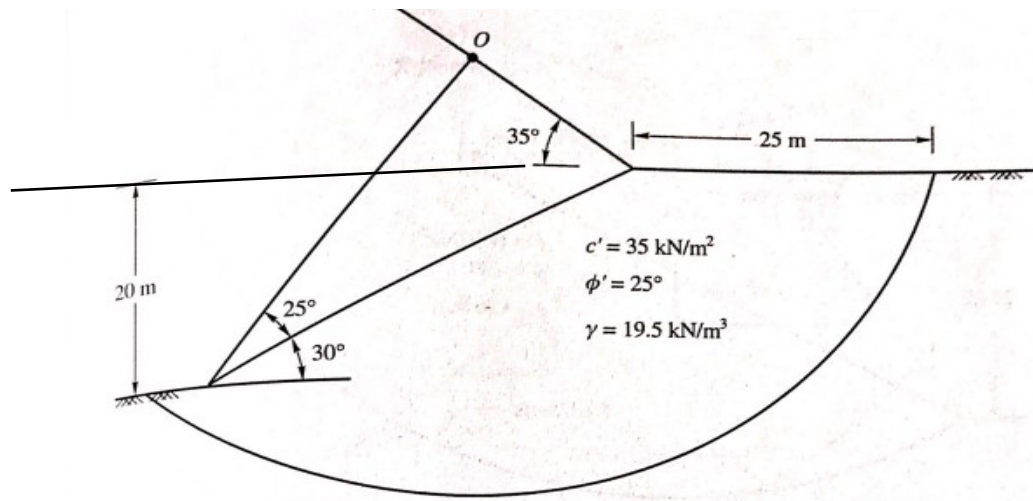


Figure: 2.1

A proposed cutting is to have the dimensions shown Figure 2.1. The soil has the following properties: $\phi = 20^\circ$, $c = 10 \text{ kN/m}^2$, $\gamma = 19 \text{ kN/m}^3$. Ignoring tension cracks, determine the factor of safety against slipping for the slip circle shown.

Hint: Calculations layout:

Slice No	Area (m ²)	Weight W (kN)	Normal component N (kN)	Tangential component T (kN)
1				
2				
n				
		Totals	$\sum N$	$\sum T$

(12 marks)

Question Three: Bearing capacity of soils

(a) Explain the following soil bearing capacity terms:

- Ultimate bearing capacity,
- Maximum safe bearing capacity,
- Allowable bearing capacity.

(4.5 marks)

(b) From first principles, derive an equation for the determination of bearing capacity of purely cohesive soils, based on slip circle analogy.

Hint:

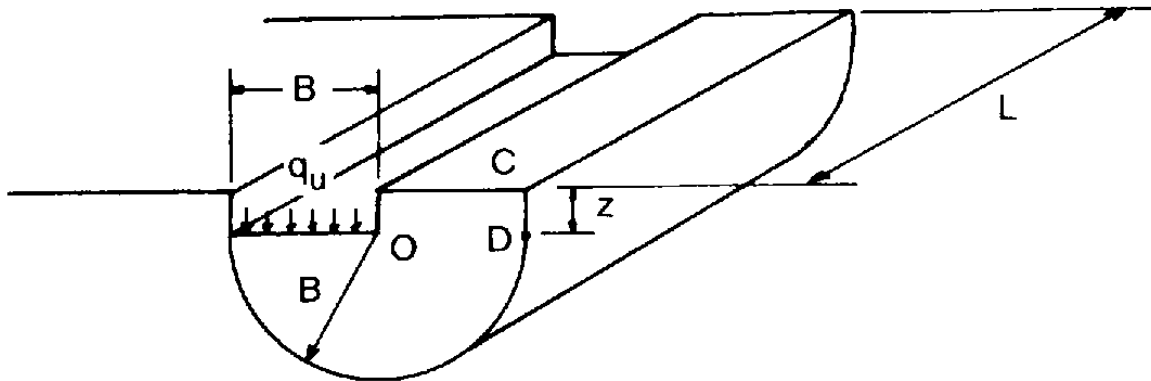


Fig. 3.1: Slip circle failure mechanism

(10 marks)

(c) A strip footing 2.5 m wide is located at a depth of 3.0 m. Determine the safe bearing capacity for this footing if:

- (i) Cohesion $c = 65 \text{ kN/m}^2$,
- (ii) Bulk unit weight $\gamma_b = 18 \text{ kN/m}^3$,
- (iii) $\phi = 10^\circ$
- (iv) Factor of safety = 3

Table 3.1: Bearing capacity factors

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

(5.5 marks)

Question Four: Settlement

- (a) State and explain the stages of settlement experienced by a clay soil due to foundation loading.

(7.5 marks)

- (b) Results obtained from a consolidation test on a clay sample for a pressure increment of 100 - 200 kN/m^2 were:

Table 4.1: Oedometer test results

Sample thickness (mm)	Time (min.)
12.200	0
12.141	0.25
12.108	1
12.075	2.25
12.046	4
11.985	9
11.922	16
11.865	25
11.827	36
11.809	49
11.800	64

Table 4.2: The relationship between U and T

U	10	20	30	40	50	60	70	75	80	90
T	0.008	0.032	0.070	0.125	0.197	0.290	0.410	0.485	0.570	0.848

- (i) Determine the coefficient of consolidation of the soil,
- (ii) How long would a layer of this clay, 20 m thick and drained on its top surface only, take to reach 75% primary consolidation?

(12.5 marks)