050

THE OPEN UNIVERSITY OF SRI LANKA
BACHELOR OF TECHNOLOGY (CIVIL) – LEVEL 06
Final Examination 2005/2006

CEX6230 – GEOTECHNICS

Time allowed: Three Hours
Date: Thursday, 6th April, 2006 Time: 0930-1230

You may attach the last sheet to your script.
Answer five questions. All questions carry equal marks.

1. Rain induced slope failures are common in the central hill country. It is observed that unstable soil masses move faster during the rainy season compared to little or no movement during the dry season.

   a) Explain what makes the soil mass to loose its shear strength when potential slip surface has saturated conditions. (5 points)

   b) Explain how subsurface drainage could improve stability. (3 points)

   c) During a field investigation you may see signs that may lead to a future slope failure.

      i) List three site conditions leading to such failures. (3 points)

      ii) List three signs of distress that may show imminent danger. (3 points)

   d) Figure Q1 shows a proposed highway cut. Using Taylor's Stability Chart, determine the factor of safety, F. N_s is defined as $N_s = \frac{c_u}{F\gamma H}$. (6 points)

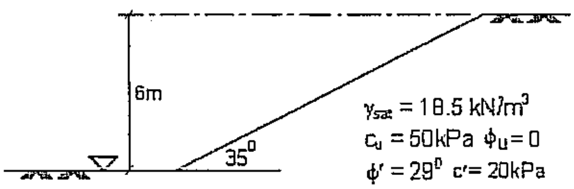


Figure Q1

2. Figure Q2 shows a cross-section of a long clay dam drawn to scale.

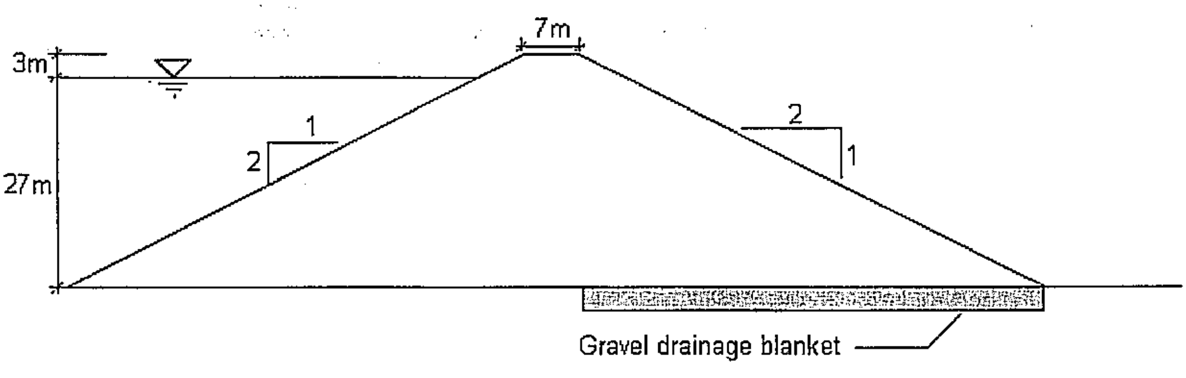


Figure Q2

   a) Determine the head (in meters) that causes flow through the dam (2 points)

   b) State which head (i.e. the heads: pressure, velocity, elevations or the total head) that forces water to flow through sand. (1 point)

   c) Draw the phreatic surfaces. (4 points)

   d) Draw the flow net paying attention to specific rules that you have learnt in sketching a flow net. (8 points)

e) Compute the seepage rate (in m^3/s per meter run) considering that the coefficient of permeability of clay 0.0000015 cm/s.

(5 poi

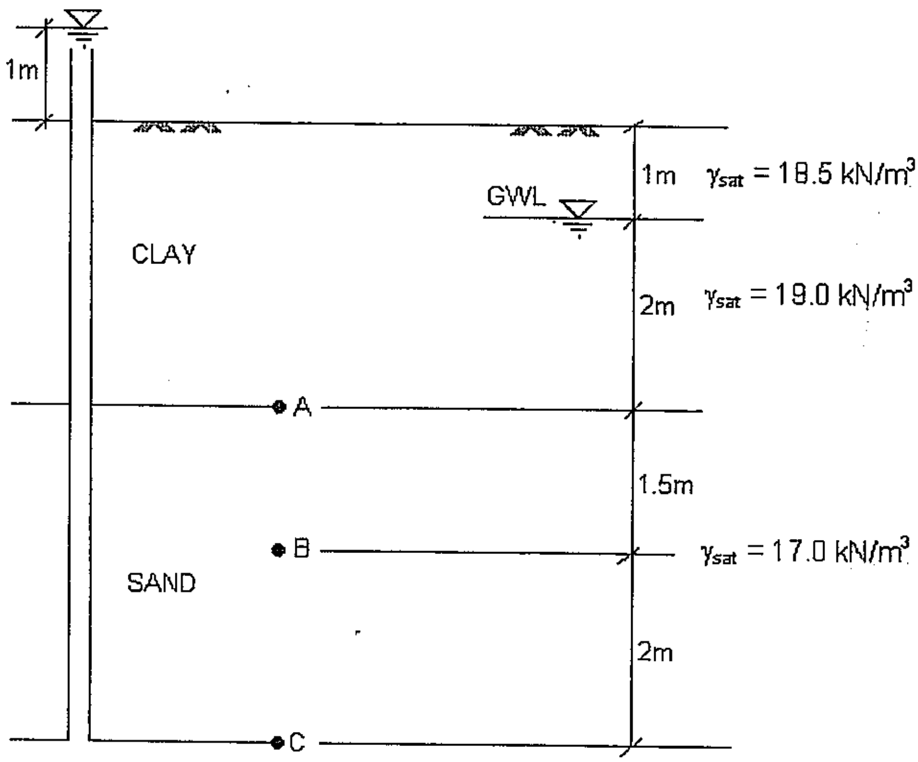
3. Figure Q3 shows a soil profile where the sand layer at point C is under artesian pressure.

a) Draw the total stress, pore water pressure and effective stress distribution with depth, indicating principa values. (10 poi

b) Suppose that the artesian pressure drops to 0.5m below ground surface due to pumping, determine the effective stress distribution in the clay layers. (6 poi

c) Determine the resulting effect of the pressure drop on the clay layer. (4 poi

5.



6

Figure Q4

4. In a triaxial loading test, the soil specimen was allowed to consolidate completely under a cell pressure of 200kPa. The cell pressure was then increased to 350kPa while keeping the drains closed. The correspondin increase in pore water pressure was found to be 144kPa. The sample was strained without allowing drainage The results are shown in the table below.

a) Complete the table below:

Axial Strain (%)	Deviatoric Stress (kPa)	u (kPa)	σ_1 (kPa)	σ'_1 (kPa)	q (kPa)	p (kPa)	p' (kPa)
0	0	144					
2	201	244					
4	252	240					
6	275	222					
8	282	212					
10	283	209					

(6 point

b) Plot the variation of p – q and p – q′ on the same plot. (4 point

c) Calculate the parameter B. (2 point

d) Assuming that the soil is normally consolidated, compute the shear strength parameters based on effectiv stresses; estimate the shear strength parameters based on total stresses. (5 point

e) State whether the plot supports your assumption; give your reasons. (3 points)

5. Candidates are required make their answers brief and to the point.

   a) Sketch a typical plot obtained during a pile load test; list the type of information that are used to verify pile load capacity. (4 points)

   b) Differentiate between individual failure and block failure in a pile group. (4 points)

   c) Explain the concept of negative skin friction. (4 points)

   d) End bearing and shaft resistance of a pile is expressed as $9c_uA_b$ and $[c_a + K_s\gamma D\tan\delta]A_s$, respectively. Define the terms used in these equations. (4 points)

   e) Drained stress-strain behaviour of sands shows that during shearing, loose sand reduces its volume while dense sand dilates. It is also observed that dense sand passes through its peak strength before attaining a residual value. Explain this behaviour. (4 points)

6. Candidates are required make their answers brief and to the point.

   a) Table below shows the results of a series of Unconsolidated Undrained loading tests.

Cell pressure (kPa)	200	400	600
Deviatoric stress at failure (kPa)	222	218	220

   i) Determine shear strength parameters c_u and ϕ_u. (4 points)

   ii) State what additional information is required for you to determine ϕ'. (2 points)

   b) The coefficients of earth pressure K_0, K_a and K_p defines the relationship between lateral and vertical effective stress at a point.

   i) Explain the K_0 condition. (3 points)

   ii) For a soil with $\phi = 30^0$, determine the three K values. (5 points)

   c) Bishop's Pore Pressure equation is expressed as $\Delta u = B[\Delta\sigma_3 + A(\Delta\sigma_1 - \Delta\sigma_3)]$.

   i) Explain the significance of parameter B. (3 points)

   ii) Explain the significance of parameter A. (3 points)

7. Figure Q7(a) shows the variation of pressure on a wall with wall movement.

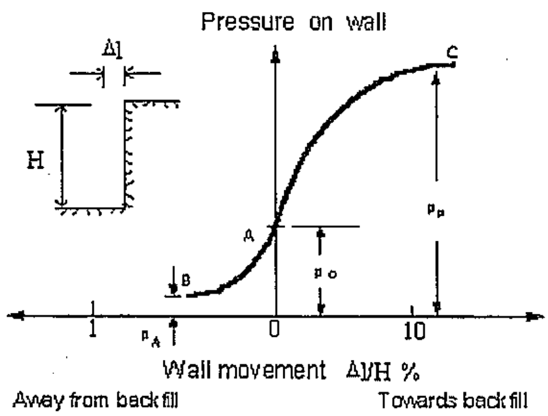


Figure Q7(a)

   a) State the conclusion you have drawn from the information given in Figure Q7(a) (5 points)

   b) Figure Q7(b) shows a braced excavation made on a coarse grained soil.

   i) Determine the force per unit length acting on the three struts. To make the analysis simpler you may consider that two sheet piles are connected at the central strut, by a hinge. (12 points)

   ii) Explain how you intend to control seepage and piping prior to concreting. (3 points)

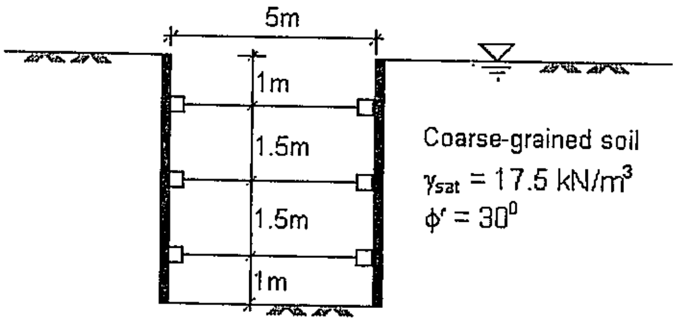


Figure Q7(b)

8. Pad foundation shown in Figure Q8 is to be checked for stability.
   a) Determine foundation width for the square footing for a factor of safety of 2.5 to meet 25mm settlement requirement. (10 poi
   b) Determine the consolidation settlement. (10 poi

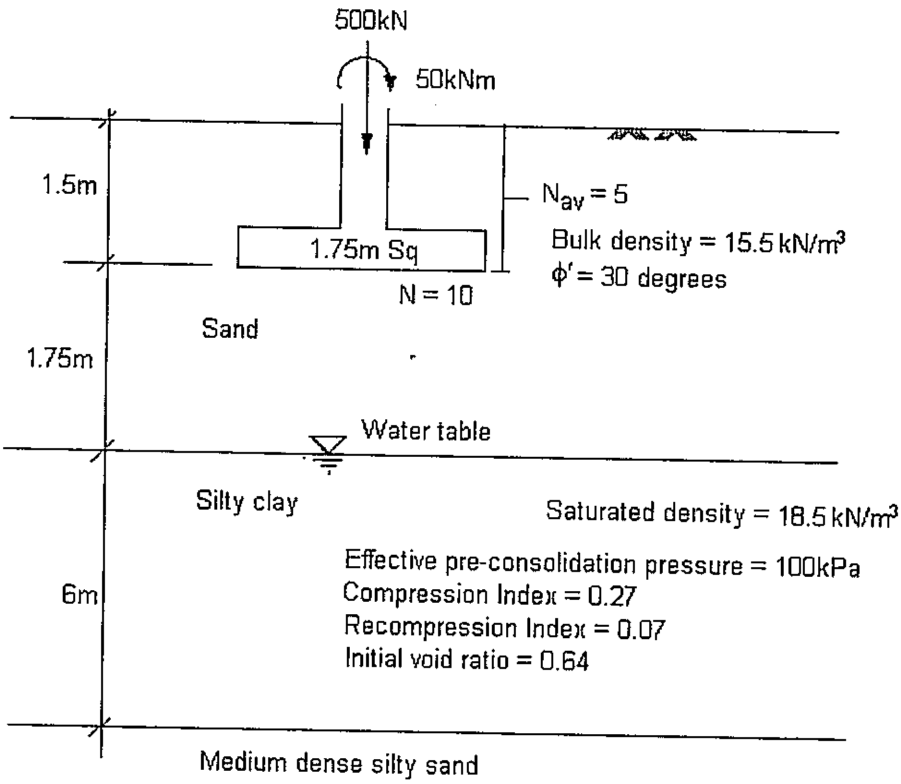
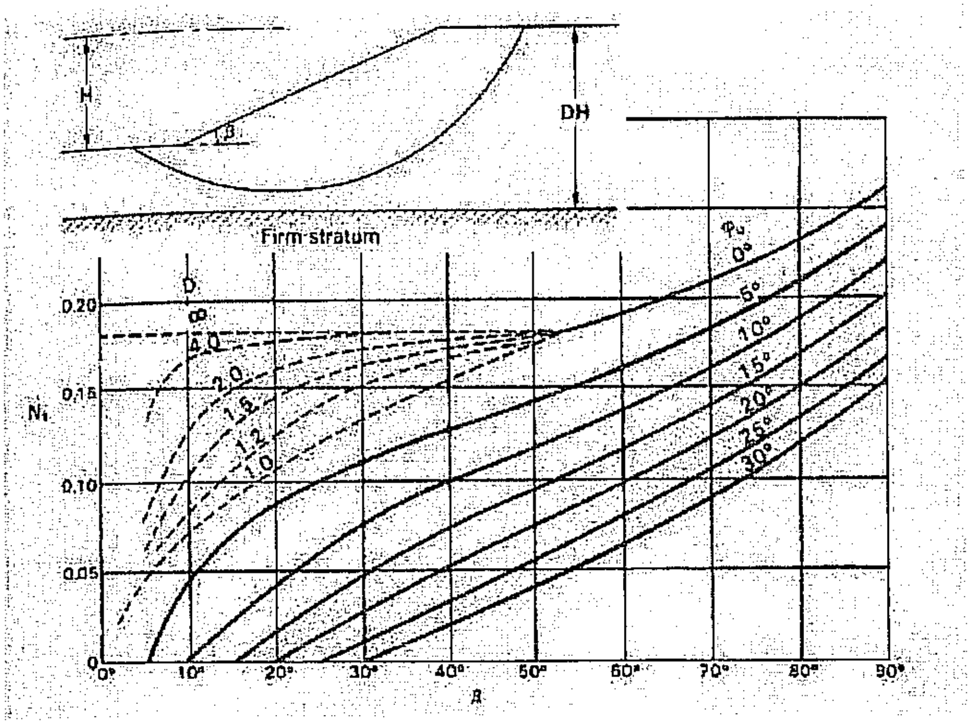
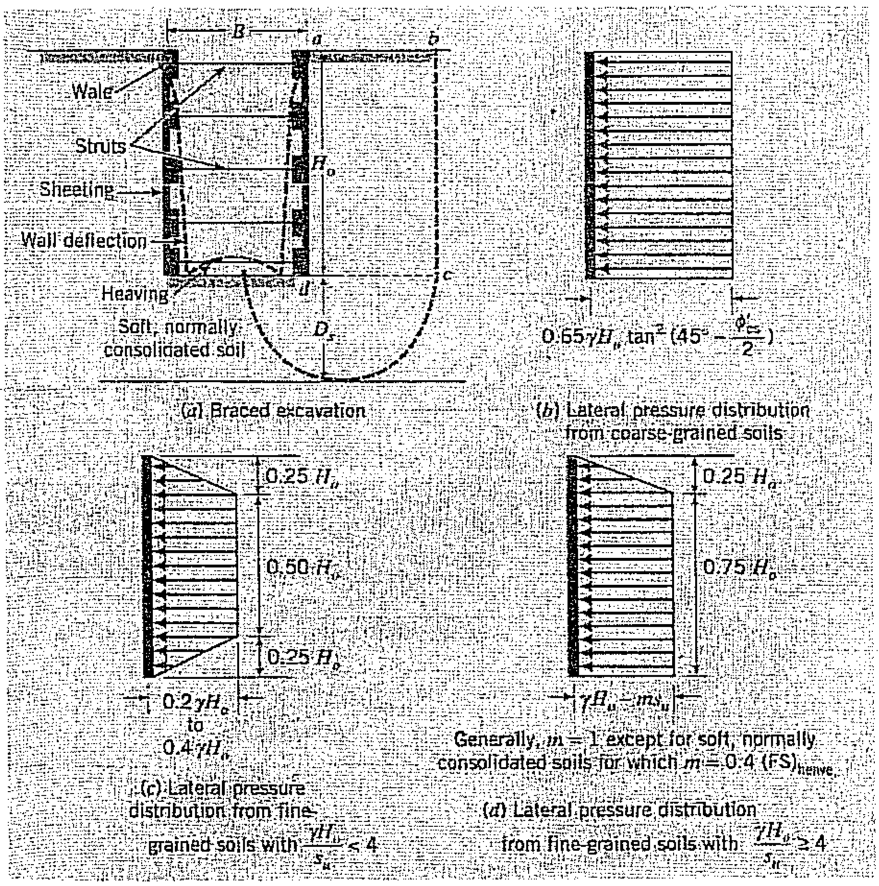


Figure Q8

ttlement
(10 point
(10 point



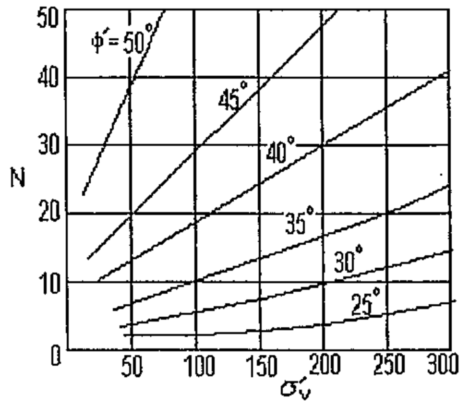


(a) Braced excavation

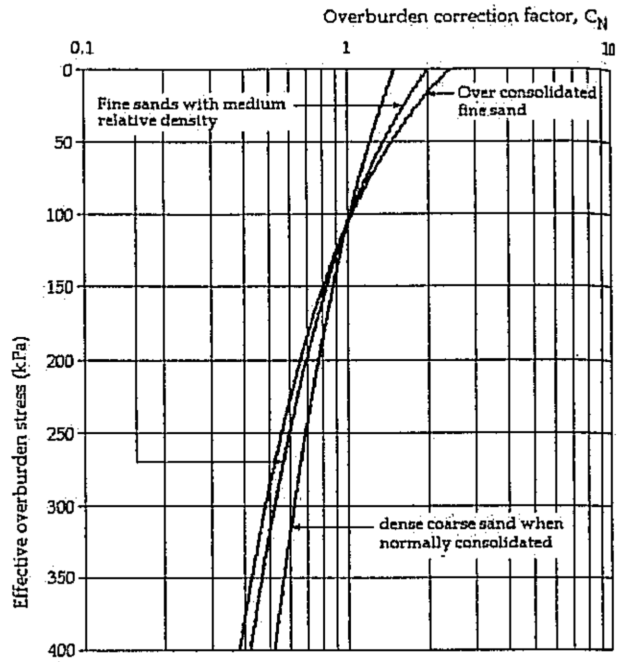
(b) Lateral pressure distribution from coarse-grained soils

(c) Lateral pressure distribution from fine-grained soils with $\frac{\gamma H_o}{s_u} < 4$

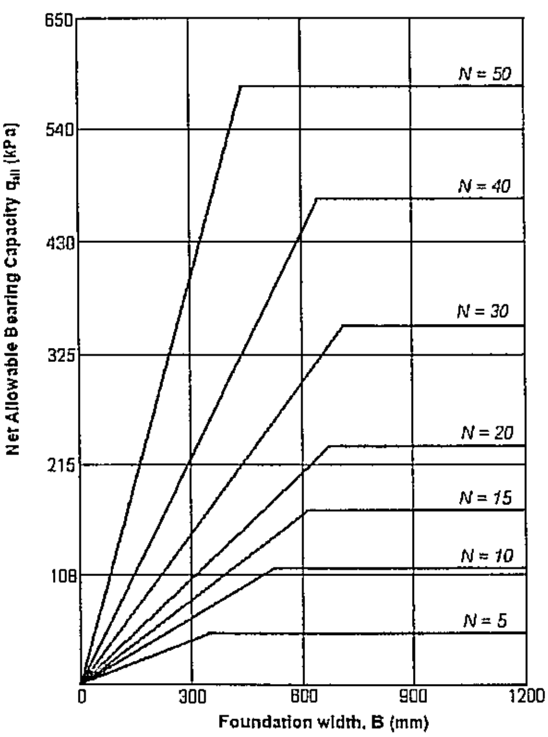
(d) Lateral pressure distribution from fine-grained soils with $\frac{\gamma H_o}{s_u} \geq 4$



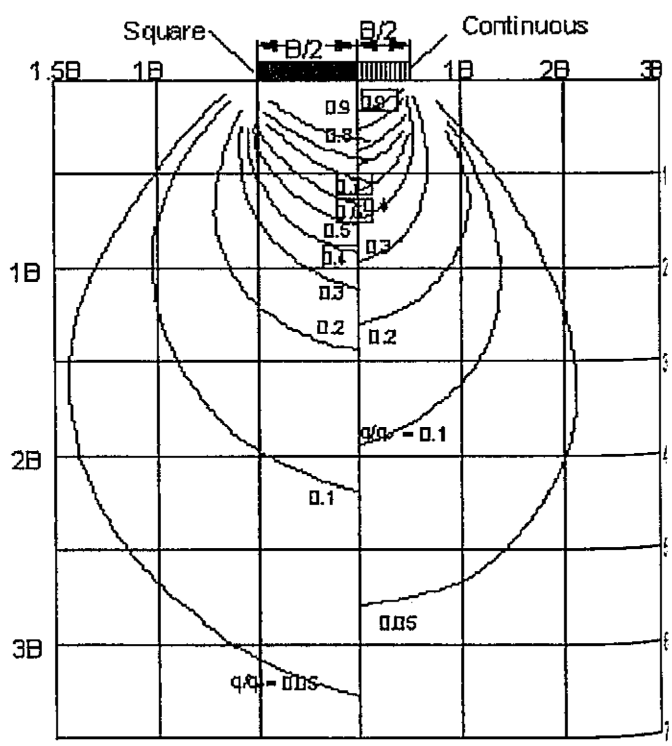
φ′ = 50°
45°
40°
35°
30°
25°
N
σ′v
0
10
20
30
40
50
50
100
150
200
250
300



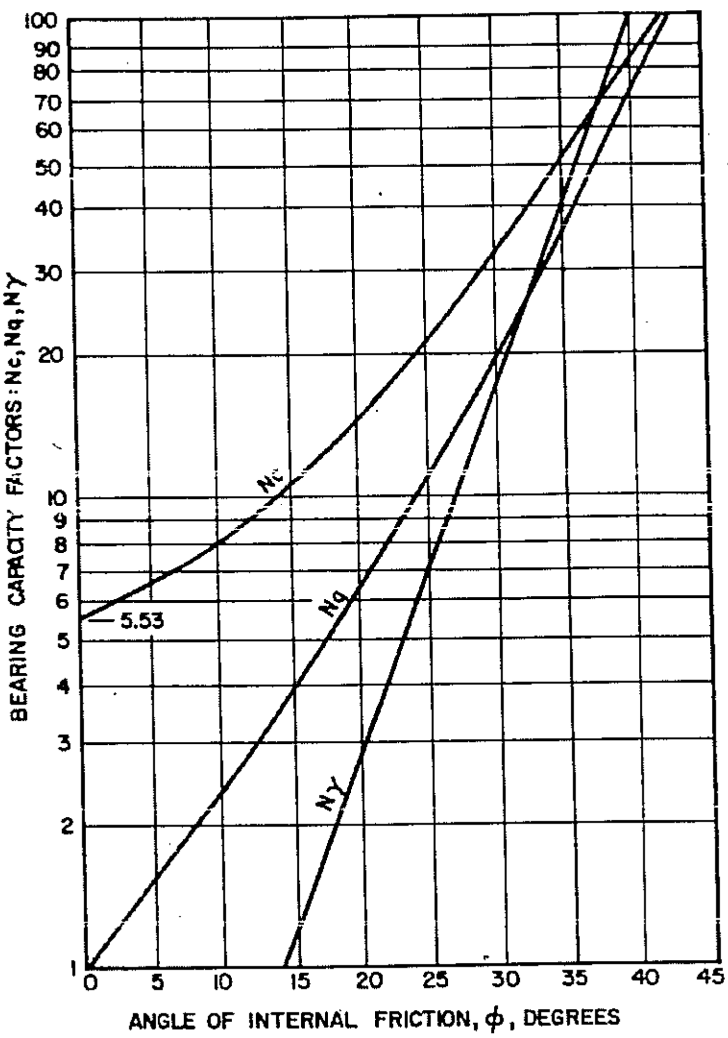
Overburden correction factor, C_N
0.1
1
10
Fine sands with medium relative density
Over consolidated fine sand
dense coarse sand when normally consolidated
Effective overburden stress (kPa)



N = 50
N = 40
N = 30
N = 20
N = 15
N = 10
N = 5
Net Allowable Bearing Capacity q_{all} (kPa)
Foundation width, B (mm)



Square
B/2
B/2
Continuous
1.5B
1B
1B
2B
3B
2B
3B
q/qo = 0.1
q/qo = 0.05



ULTIMATE BEARING CAPACITY = q_{ult}

CONTINUOUS FOOTING; GENERAL CASE

$q_{ult} = q' + q''$

q' = PORTION OF BEARING CAPACITY ASSUMING WEIGHTLESS FOUNDATION SOIL

q'' = PORTION OF BEARING CAPACITY FROM WEIGHT OF FOUNDATION SOILS

$q' = cN_c + \gamma D N_q$

$q'' = \gamma \frac{B}{2} N_\gamma$

$q_{ult} = cN_c + \gamma D N_q + \frac{\gamma B}{2} N_\gamma$

SQUARE OR RECTANGULAR FOOTING

$q_{ult} = cN_c\,(1 + .3\frac{B}{L}) + \gamma D N_q + 0.4\gamma B N_\gamma$

CIRCULAR FOOTING: R = B/2

$q_{ult} = 1.3\,cN_c + \gamma D N_q + 0.6\gamma R N_\gamma$

FOR COHESIONLESS FOUNDATION SOILS (c = 0)

CONTINUOUS FOOTING:

$q_{ult} = \gamma D N_q + \frac{\gamma B}{2} N_\gamma$

SQUARE OR RECTANGULAR FOOTING:

$q_{ult} = \gamma D N_q + 0.4\gamma B N_\gamma$

CIRCULAR FOOTING:

$q_{ult} = \gamma D N_q + 0.6\gamma R N_\gamma$

FOR COHESIVE FOUNDATION SOILS ($\phi = 0$)

CONTINUOUS FOOTING:

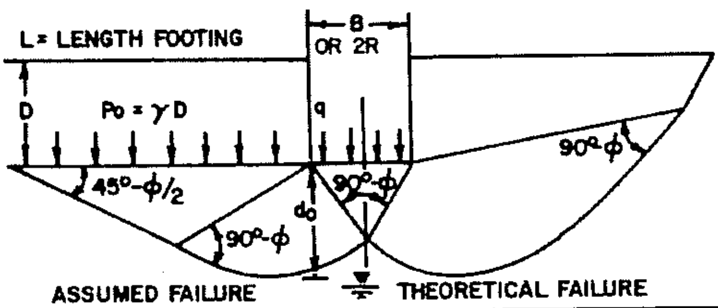
$q_{ult} = cN_c + \gamma D$

SQUARE OR RECTANGULAR FOOTING:

$q_{ult} = cN_c(1 + .3\frac{B}{L}) + \gamma D$

CIRCULAR FOOTING:

$q_{ult} = 1.3\,cN_c + \gamma D$



ASSUMED CONDITIONS:

1. $D \leq B$
2. SOIL IS UNIFORM TO DEPTH $d_0 > B$.
3. WATER LEVEL LOWER THAN d_0 BELOW BASE OF FOOTING.
4. VERTICAL LOAD CONCENTRIC.
5. FRACTION AND ADHESION ON VERTICAL SIDES OF FOOTING ARE NEGLECTED.
6. FOUNDATION SOIL WITH PROPERTIES c, ϕ, γ

FIGURE 1

Ultimate Bearing Capacity of Shallow Footings With Concentric Loads

✂ ________ Attach this sheet to your answer script

Index No. ______