BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
HYDERBAD CAMPUS
First Semester 2022-23
MID-SEMESTER EXAMINATION (Closed Book)

Course No: CE F313
Date: 31.10.2022
Weightage: 30%
Full Marks: 30

Course Name: Foundation Engineering
Time: 1:30 PM – 3:00 PM
Duration: 90 minutes

Answer all questions. Any data, if assumed, should be clearly stated. Separate marks are allotted for each step. Relevant formulae are provided in pages 3 and 4.

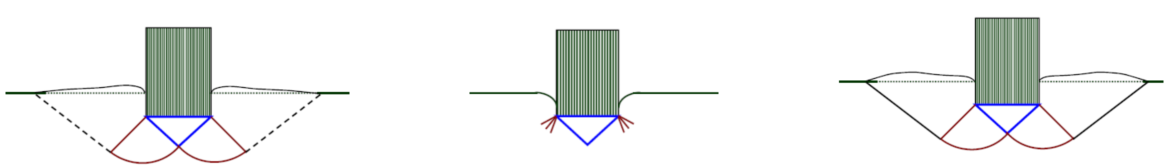
Question No. 1 **[4 + 4 + 4 = 12]**

(a) Find the expression for surcharge loading to be placed on a horizontal backfill of a smooth vertical retaining wall having cohesion c and internal angle of friction φ so that the effect of tensile crack is completely eliminated.

(b) For a vertical retaining wall of height H, with a horizontal backfill, show that the total active pressure on the wall by Coulomb's method (considering the soil-wall friction angle to be equal to the internal angle of friction of soil) is

$$P_A = \frac{1}{2}\gamma H^2 \frac{\cos\phi}{\left(1+\sqrt{2}\sin\phi\right)^2}$$

(c) Identify the following 3 modes of failure from the failure surfaces. Which is the most catastrophic failure among these three and why?



(i) (ii) (iii)

Question No. 2 **[9]**

3 columns in a building are spaced at 4m c/c and carry superimposed loads of 1560 kN, 1230 kN and 816 kN respectively. The size of each column in 0.5 m x 0.5 m. Design a suitable combined trapezoidal footing for the columns. The schematic representation of the foundation is as follows (Fig. 1):

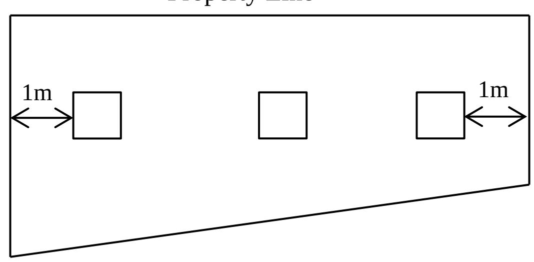


Fig. 1

The ultimate bearing capacity of the soil can be determined from the following observations (by double tangent method) related to a plate load test conducted on a 30cm square plate placed in a cohesionless soil deposit. Consider a FS = 2.5.

Load Intensity (kN/m^2)	0	50	100	150	200	250	300	350	400
Settlement (mm)	0	2.0	4.0	7.0	11.0	16.0	23.0	32.0	45.0

Question No. 3 **[9]**

A 2.5m high on-shore wind turbine near a river bank needs a square foundation of base 3m x 3m to be placed at a depth of 1m below the ground level. The weight of the turbine is 100 kN. The river bank is full of saturated silty sand having cohesion of 30 kN/m^2, φ = 25° and dry and saturated unit weights of 16.5 kN/m^3 and 19.3 kN/m^3 respectively. A resultant horizontal wind load of 25 kN acts on the turbine at its top from one direction. There is no wind load acting from the other direction. Determine the factor of safety with respect to bearing capacity. Use Meyerhof's recommendations.

*******************************ALL THE BEST*****************************

Relevant Formulae

1) $$K_a = \frac{\sin^2(\alpha+\phi)}{\sin^2\alpha.\sin(\alpha-\delta)\left[1+\sqrt{\frac{\sin(\phi+\delta).\sin(\phi-\beta)}{\sin(\alpha-\delta).\sin(\alpha+\beta)}}\right]^2}$$

2) $$\text{Depth of tensile crack} = z_0 = \frac{2c}{\gamma\sqrt{K_A}}$$

3) For cohesive soil, active earth pressure $p_A = \gamma z K_A - 2c\sqrt{k_A}$

4) For a plate load test in cohesionless soil,

$$\frac{S_f}{S_p} = \left[\frac{B_f\left(B_p+30\right)}{B_p\left(B_f+30\right)}\right]^2$$; All dimensions in cm

5) Meyerhof's Recommendations:

(i) Depth Factors:

$$\begin{cases} N_c = \left(N_q-1\right)\cot\phi \\ N_q = e^{\pi\tan\varphi}\tan^2\left(45^0+\frac{\phi}{2}\right) \\ N_\gamma = \left(N_q-1\right)\tan\left(1.4\phi\right) \end{cases}$$

(ii) Shape Factors:

$$\begin{cases} s_c = 1+0.2\frac{B}{L}\tan^2\left(45^\circ+\frac{\phi}{2}\right) \\ s_q = s_\gamma = 1+0.1\frac{B}{L}\tan^2\left(45^\circ+\frac{\phi}{2}\right) \\ s_c = s_q = s_\gamma = 1 \text{ for strip footings} \end{cases}$$

(iii) Depth Factors:

$$\begin{cases} d_c = 1+0.2\frac{D_f}{B}\tan\left(45^\circ+\frac{\phi}{2}\right) \\ d_q = d_\gamma = 1+0.1\frac{D_f}{B}\tan\left(45^\circ+\frac{\phi}{2}\right) \end{cases}$$

Inclination Factors:
$$\begin{cases} i_c = i_q = \left(1 - \frac{\alpha}{90}\right)^2 \\ i_\gamma = \left(1 - \frac{\alpha}{\phi}\right)^2 \\ \alpha = \text{angle of resultant load made with the vertical} \\ \quad \text{(in degrees)} \end{cases}$$

6) $R_w = 0.5\left(1 + \frac{D_1}{D_f}\right)$; $R_w{}' = 0.5\left(1 + \frac{D_2}{B}\right)$