



Answer all questions.

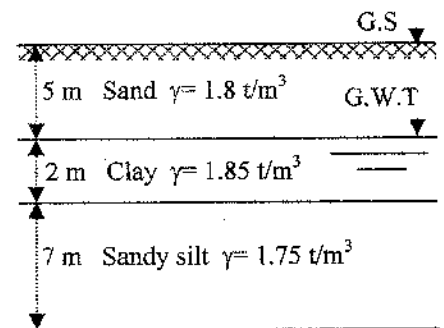
Any missing data to be reasonably assumed.

Question 1 (10 M)

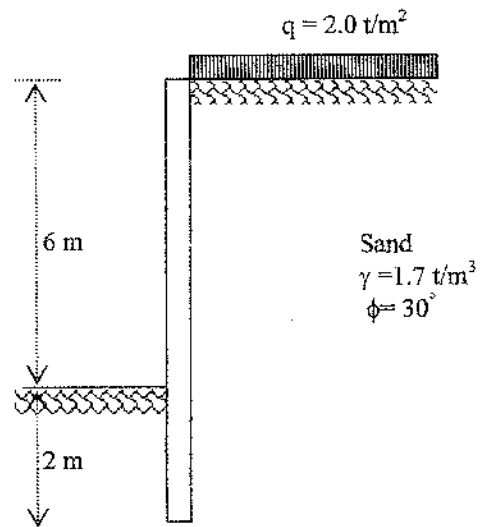
- What are the reasons of differential settlement and what are the measures to be done to reduce foundation settlement in general?
- The unit weight of a soil sample is 1.85 gm/cm^3 and its water content is 19.2%. If the unit weight of solid particles is 2.66 gm/cm^3 , find the void ratio and degree of saturation.

Question 2 (10 M)

- Calculate the vertical effective stress at the center line of sandy silt layer due to the weight of soil.



- Find the lateral forces due to active earth pressure acting on the retaining wall shown in the figure below:.



Question 3 (30)

- Show with clear sketches the types of shallow and pile foundations.
- Design a square footing to support a column $40 \times 40 \text{ cm}$ carries a load of $100 \text{ t} = 1000 \text{ kN}$. The net allowable soil pressure is $1.5 \text{ kg/cm}^2 = 150 \text{ kN/m}^2$.
- For the combined footing shown below draw the necessary sections showing the details of reinforcement.





Relationships may be used:

$$w_c = \frac{S_r \cdot e}{G_s} \quad \gamma = \frac{\gamma_w (G_s + S_r \cdot e)}{1 + e} \quad \gamma_d = \frac{G_s \gamma_w}{1 + e} \quad \gamma_d = \frac{\gamma}{1 + w_c}$$

$$\gamma_{sub} = \gamma_{sat} - \gamma_w \quad \gamma_{sat} - \gamma_{sub} = V_t \gamma_w \quad D_r = \frac{e_{max} - e_{field}}{e_{max} - e_{min}}$$

$$K_a = (1 - \sin \phi) / (1 + \sin \phi) \quad K_p = (1 + \sin \phi) / (1 - \sin \phi) = 1 / K_a$$

$$f_{cu} = 25 \text{ MPa}$$

$$f_y = 420 \text{ MPa}$$

$$Q_{us} = 1.5 Q_{ws}$$

$$M_u = 1.5 M_w$$

Punching shear force resisted by concrete V_{CP} is given as the least of:

$$V_{CP} = 0.316 \left(0.5 + \frac{a}{b} \right) \sqrt{\frac{f_{cu}}{\gamma_c}} (b_o d) \quad V_{CP} = 0.316 \sqrt{\frac{f_{cu}}{\gamma_c}} (b_o d) \quad V_{CP} = 0.8 \left(0.2 + \frac{\alpha d}{b_o} \right) \sqrt{\frac{f_{cu}}{\gamma_c}} (b_o d)$$

a/b = long side/short side of column.

α = 4 for interior, 3 for side, and 2 for corner columns.

b_o = length of critical perimeter around the column = $2[(a+d)+(b+d)]$

γ_c = 1.5 (Factor of safety for concrete strength)

The factored beam shear capacity of the concrete is given by:

$$V_{CS} = 0.16 \sqrt{\frac{f_{cu}}{\gamma_c}} (Bd)$$

B = width of critical section of shear

Reinforcement:

$$d = C_1 \sqrt{\frac{M_u}{f_{cu} \cdot b}} \quad A_s = \frac{M_u}{f_y \cdot J \cdot d} \quad A_{s, min} = 0.15\% (bd) \quad \text{Take } C_1 = 3.5, J = 0.75$$

b = width of critical section of moment

J depends on C_1

ϕ mm	Weight	Cross Section Area (cm ²)									
	Kg/m	1	2	3	4	5	6	7	8	9	10
6	0.222	0.28	0.57	0.85	1.13	1.41	1.70	1.98	2.26	2.54	2.83
8	0.395	0.50	1.01	1.51	2.01	2.51	3.02	3.52	4.02	4.52	5.03
10	0.617	0.79	1.57	2.36	3.14	3.93	4.71	5.50	6.28	7.07	7.85
12	0.888	1.13	2.26	3.39	4.52	5.65	6.79	7.92	9.05	10.18	11.31
14	1.208	1.54	3.08	4.62	6.16	7.70	9.24	10.78	12.32	13.85	15.39
16	1.578	2.01	4.02	6.03	8.04	10.05	12.06	14.07	16.08	18.10	20.11
18	1.998	2.54	5.09	7.63	10.18	12.72	15.27	17.81	20.36	22.90	25.45
20	2.466	3.14	6.28	9.42	12.57	15.71	18.85	21.99	25.13	28.27	31.42
22	2.984	3.80	7.60	11.40	15.21	19.01	22.81	26.61	30.41	34.21	38.01
25	3.853	4.91	9.82	14.73	19.63	24.54	29.45	34.36	39.27	44.18	49.09
28	4.834	6.16	12.32	18.47	24.63	30.79	36.95	43.10	49.26	55.42	61.58