University Of Technology
Building and Construction Eng. Dept.
Final Exam 1st Attempt –2015/2016

Subject : Foundation Eng. | **Class: 4th Year**
Branch : All Branches. | **Time : 3.0 Hours**
Examiner :Foundation Eng. Committee | **Date : 21/5/ 2016**

Note: Attempt (4) Questions only

Q1- For the structure of the grain silo shown in figure (1), two proposals for its foundation are presented.
For a F.S =3 and an allowable settlement of 20mm.Check the suitability of foundation in terms of bearing capacity and settlement for proposal (1). (25 Marks)

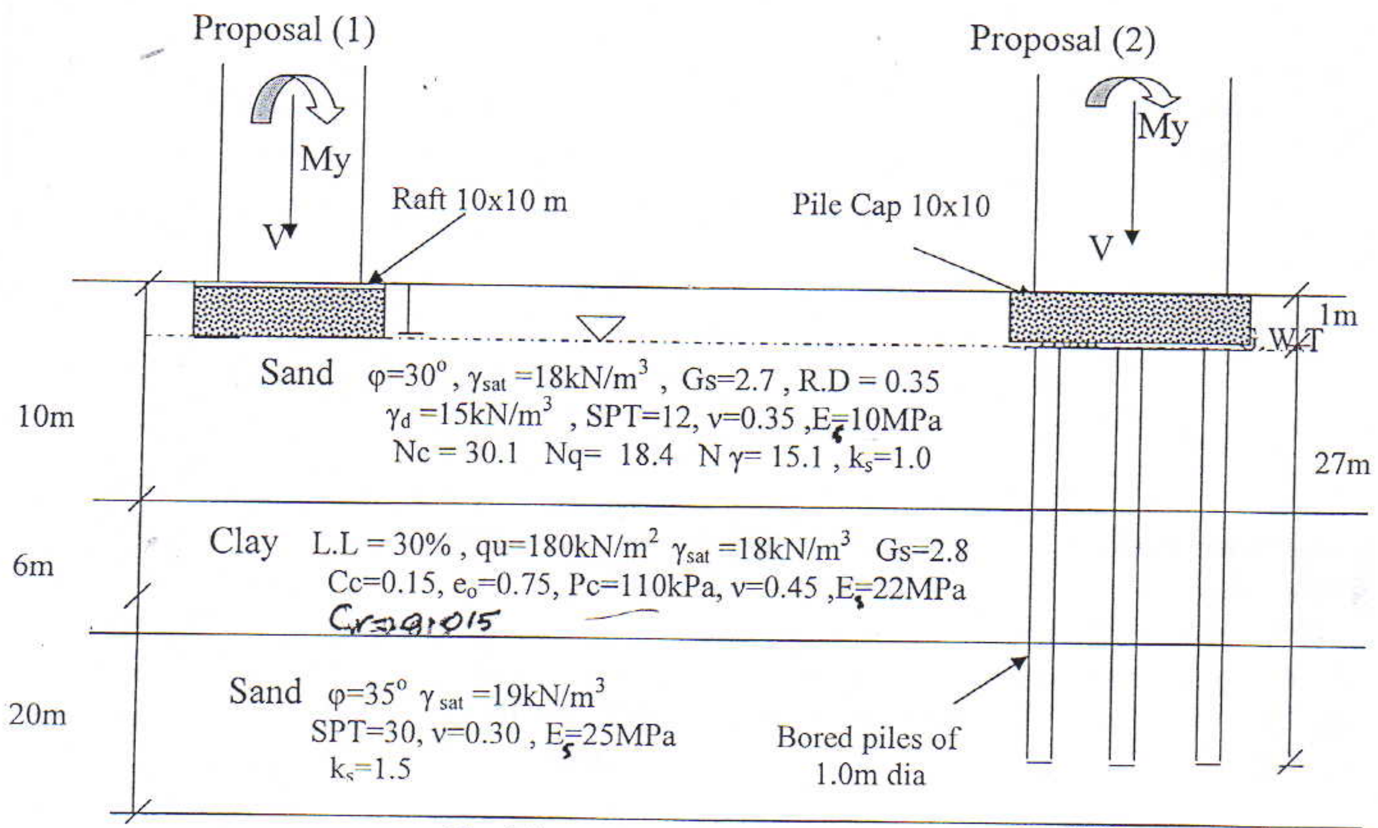
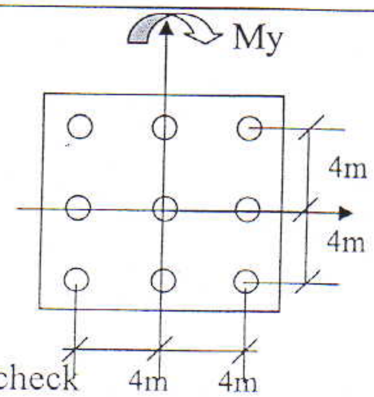


Fig (1)

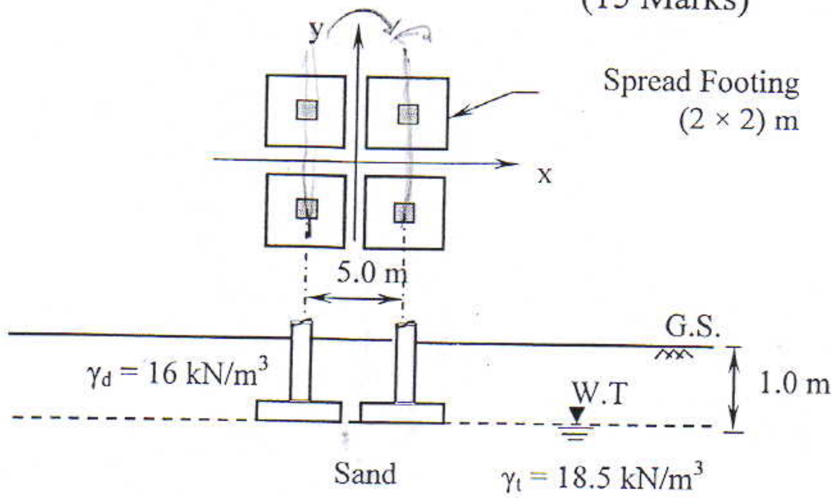


If V = 15000 kN
My = 30000 kN.m
Note : Weight of foundation or cap neglected

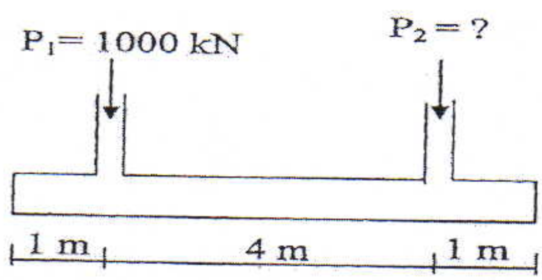
Q2- For the Pile foundation of proposal (2) of fig(1) with a F.S=3.0 and allowable settlement of 20mm, check it's suitability in terms of bearing capacity and settlement only. (25 Marks)
If $E_p = 21 \times 10^6$ kPa.

Q3 : A- The spread footings shown in Figure (2) are subjected to a centric total load of 4000 kN and moment about y-axis of 1000 kN.m. Determine the depth of boring. (15 Marks)

Fig.(2)



B- For the rectangular footing (6×3)m shown in figure (3), find the maximum value of load on column (P_2) if soil pressure is uniform and the allowable bearing capacity is 140 kPa. (10 Marks)



Fig(3)

Q4- A- (0.3× 0.3) m reinforced concrete pile of 20 m length is driven through loose sand and then into gravel to a final set of 3 mm/blow using 30 kN single acting hammer with a stroke of 1.5 m. Determine the ultimate driving resistance (Ru) of the pile if it is fixed with a helmet, plastic dolly and 50 mm of packing on the top of the pile. The weight of the (**Pile + helmet and dolly**) is 78 kN. (k = 0.9 and e = 0.4 for single acting hammer. (15 Marks)

B- For the pile group shown in fig(4) if pile no.2 was broken what will be the load on pile no.5. If the total load on pile cap 3000kN, and pile dia. 0.4m installed with in clay layer with spacing S of (3D). (10 Marks)

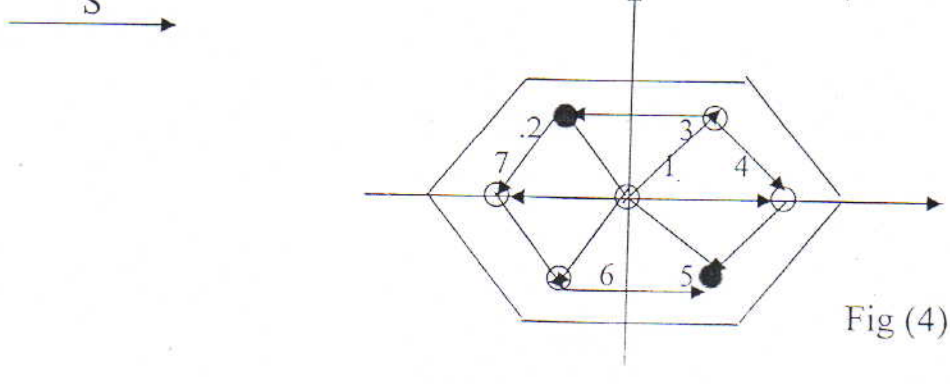


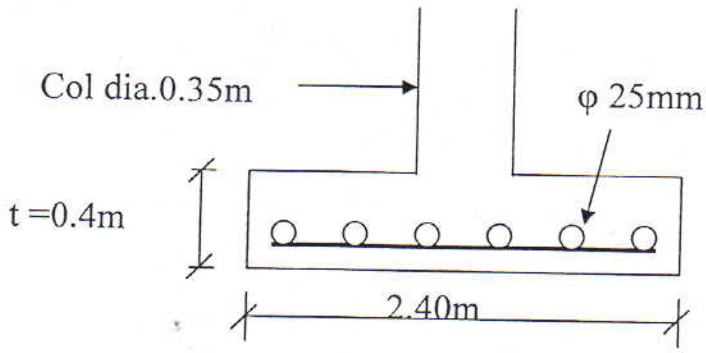
Fig (4)

Q5- A- Check the adequacy of footing thikness only for the square footing shown in fig (5) for the following conditions:

D.L= 320kN , L.L = 310kN, fy = 350MPa , Fc' =20MPa, q_{all} =120kN/m^2

(10 Marks)

Fig (5)



b- For the sheet pile of 9.5m length and soil profile shown in Figure (6) check the suitability of penetration depth

(15 Marks)

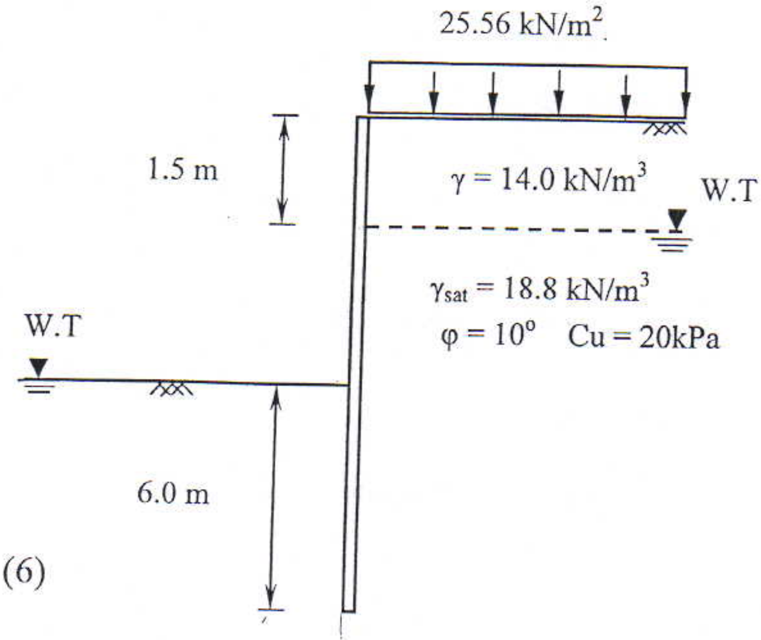


Fig. (6)

$q_{ult} = CNc\ Sc\ dc + q\ Nq\ Sq\ dq + 0.5\ \gamma\ B\ N\gamma\ S\gamma\ d\gamma$, $H = 0.5B \tan^{-1}(45+\phi/2)$

$Sc = 1 + (Nq/Nc)(B'/L')$, $Sq = 1+(B'/L')\sin\varphi$, $S\gamma = 1 - 0.4\ B'/L'$

$dc = 1+0.4D/B$, $dq = 1+2\tan\varphi(1-\sin\varphi)^2 D/B$, $d\gamma = 1$

for $\varphi=0$, $q_{ult} = 5.14\ Cu(1 + Sc' + dc') + q'$ $Sc' = 0.2\ B/L$, $dc' = 0.4\ D/B$

$$Sc = \frac{Cc}{1+e_o} Ho \log \frac{P_o' + \Delta P}{P_o'} \text{ For Nc.c} , \quad Si = \frac{q\,B\,(1-\mu^2)}{Es} I\,p \text{ for } H > 2B$$

$$\delta = S_1 = \frac{(Q_{wb} + 0.5\,Q_{ws})\,L}{A_p\ E_p} , \quad S_2 = \frac{Q_{wb}\,B\,(1-\nu^2)}{A_b\ E_s} I_p , \quad S_3 = \frac{Q_{ws}\,B\,(1-\nu^2)}{A_s\ E_s} I_w$$

$I_w = (2 + 0.35\sqrt{D/B})$ $S_g = \sqrt{(W_g / B\,S_{total})}$

$$Sc = \frac{C_r}{1+e_o} Ho \log \frac{P_c}{P_o'} + \frac{C_c}{1+e_o} Ho \log \frac{P_o' + \Delta P}{P_c} \text{ For O.c.c If } P_o' < P_c < P_o' + \Delta P$$

$$Si = \frac{H}{Cs} \text{Log}_e \frac{P_o' + \Delta P}{P_o'} , \quad Cs = \frac{1.5\,Cr}{P_o'} , \quad Si = \frac{q\,B\,(1-\mu^2)\,\mu_o\,\mu_1}{Es} \text{ for } H < 2B$$

$$T_v = \frac{Cv \cdot t}{d^2} , \quad U = \sqrt{\frac{4.\,Tv}{\pi}} \text{ , For } U < 60\% , \quad Tv = \pi/4\ (Uz/100)^2 \text{ For } U > 60\%$$

$$, \quad Ss = C\alpha\ H \log \frac{t_1 + \Delta t}{t_1} \qquad , \quad Cc = 0.009(L.L - 10)$$

$$Si = C1.C2.\ \Delta P \sum (Iz/2Cr)\,\Delta z , \quad C1 = 1 - 0.5 \frac{Po'}{\Delta P} , \quad C2 = 1 + 0.2 \log \frac{t}{0.1}$$

$$Xc = \frac{L}{3} \left(\frac{2b_1 + b_2}{b_1 + b_2} \right) , \quad q_{max} = \frac{\Sigma V}{L.B} \left(1 + \frac{6e_x}{L} + \frac{6e_y}{B} \right) \text{ for } e < \frac{B}{6}$$

$$q_{max} = \frac{2\Sigma V}{L.B} \text{ for } e = \frac{B}{6} , \quad q_{max} = \frac{4\,Q}{3L\,(B - 2e)} \text{ for } e > \frac{B}{2}$$

$B' = B - 2e_y$ $L' = L - 2e_x$

$$Z_1 = \frac{1}{2}\sqrt{\frac{v_2 - v_1}{v_2 + v_1}} \cdot Xc \;, \quad Z_2 = \frac{1}{2}\left[T_{i2} - 2Z_1 \frac{\sqrt{v_3^2 - v_1^2}}{v_3 \cdot v_1}\right]\frac{v_3 \cdot v_2}{\sqrt{v_3^2 - v_2^2}}$$

$Q_{ult} = C_u . N_c A_b + C_a . A_s$ For piles in Cohesive Soils

$Q_{ult} = \sigma'_v \, Nq \, A_b + Ks \, \sigma_{v(av)} \tan\delta \, As$ For piles in Cohesionless soils

$$\epsilon g = 1 - \frac{\theta}{90}\left[\frac{(n-1)m + (m-1)n}{mn}\right], \quad \theta = \tan^{-1}\frac{B}{S}$$

$Q_{ult(group)} = Q_{ult(Single)} \times n \times \epsilon g$,

$Q_{ult(group)Block} = 2(Bg + Lg) \times L \times Cu' + Cu \times Nc \times Bg \times Lg$

$$Q_{pile} = \frac{\Sigma V}{n} + \frac{Mx \, .Y}{\Sigma y^2} + \frac{My \, . X}{\Sigma x^2}$$

$P_a = Ka\,\gamma\,H - 2c\sqrt{Ka}$, $P_p = Kp\,\gamma\,H + 2c\sqrt{Kp}$

$$F.S\,(Sliding) = \frac{\Sigma P_p}{\Sigma P_a}, \quad F.S\,(\text{overturining}) = \frac{\Sigma M_p}{\Sigma M_a}$$

$$Ru = \frac{W \times h \times \eta}{S + C/2} \quad \gamma_{sat} = \frac{Gs + S \, . \, e}{1 + e}\gamma_w \;, \quad \gamma_d = \frac{Gs \, . \, \gamma_w}{1 + e}$$

$Pu = 1.4\,D.L + 1.7\,L.L$, $Vc = 0.08\,\varphi\left(2 + \frac{4}{B_c}\right)\sqrt{fc'} < 0.34\,\varphi\sqrt{fc'}$ for two way shear

$$d^2\left(Vc + \frac{q_u}{4}\right) + d\left(Vc + \frac{q_u}{2}\right)a = \frac{B^2 - a^2}{4}q_u$$

$Vc = 0.17\,\varphi\sqrt{fc'}$ for one way shear

$$Vc\,b\,d = q_u\left(\frac{B}{2} - \frac{a}{2} - d\right)B$$

Table Influence factors (I_r) for vertical displacement due to elastic compression

Shape	*Flexible**			*Rigid*†
	Centre	*Corner*	*Average*	
Circle	1.00	0.64	0.85	0.79
Rectangle				
$\frac{L}{B}$ 1.0	1.122	0.561	0.946	0.82
1.5	1.358	0.679	1.148	1.06
2.0	1.532	0.766	1.300	1.20
3.0	1.783	0.892	1.527	1.42
4.0	1.964	0.982	1.694	1.58
5.0	2.105	1.052	1.826	1.70
10.0	2.540	1.270	2.246	2.10
100.0	4.010	2.005	3.693	3.47

* After Giroud (1968)
† After Skempton (1951)

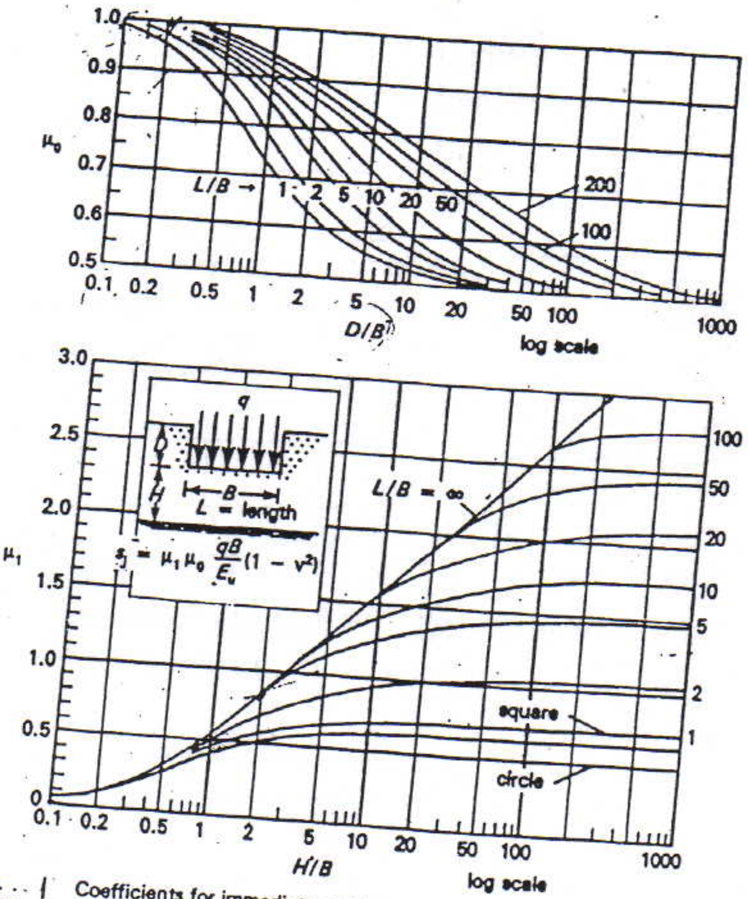


Fig. 1 Coefficients for immediate settlement under a flexible foundation (After Janbu *et al.* 1956)

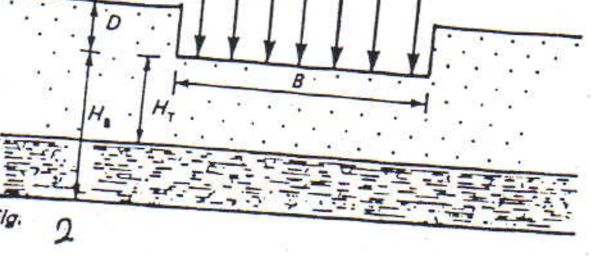


Fig. 2