Subject : Foundation Eng. | Class: 4th Year
Branch : All Branches. | Time : 3 Hours
Examiner :Foundation Eng. Committee | Date : 16/ 6/ 2014

Attempt Five Questions Only

Q1- a- Site investigation is to be carried out on an inner city gap site which is being redeveloped for a six store building with a raft footing of 20x30m and at a depth of 2.0m below N.G.L. The net applied pressure at the footing base is 100kN/m^2. Geological map show that the soil is of loose deposit with dry and submerged unit weight of 16.0 and 9.0 kN/m^3 respectively Ground water table at a depth of 2.0m below N.G.L. Outline a suitable site investigation project for this site, giving details of the boreholes (number, depth, and locations), insitue and laboratory test required.

b- For the soil profile shown in fig(1), calculate corrected S.P.T –N value at a depth of 20.0m below N.G.L.

(20 Marks)

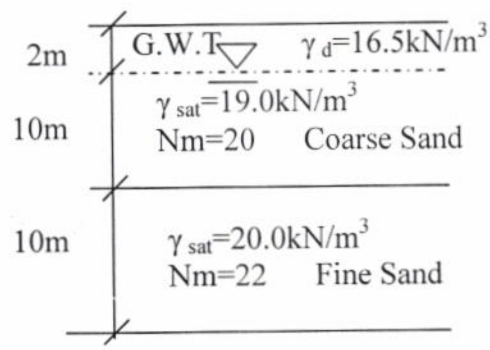


Fig (1)

Q2- Fig (2) shows an anchored sheet pile embedded in cohesive soil and supports a cohesionless soil of 9.1 heights. Find minimum embedded depth (d) and anchored force (T), (Use free earth support) (20 Marks)

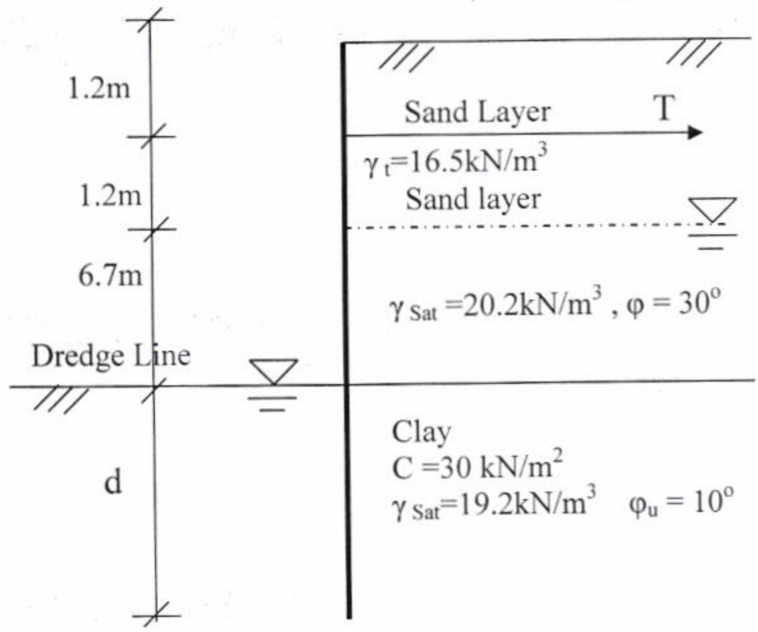


Fig (2)

Q3-For the footing of 4x4m shown in fig (3) :

1- Check the bearing capacity of the footing using General Hansen B.C Eq. and a F.S=2.
2- If fc'=21MPa calculate the footing thickness (t).

(20 Marks)

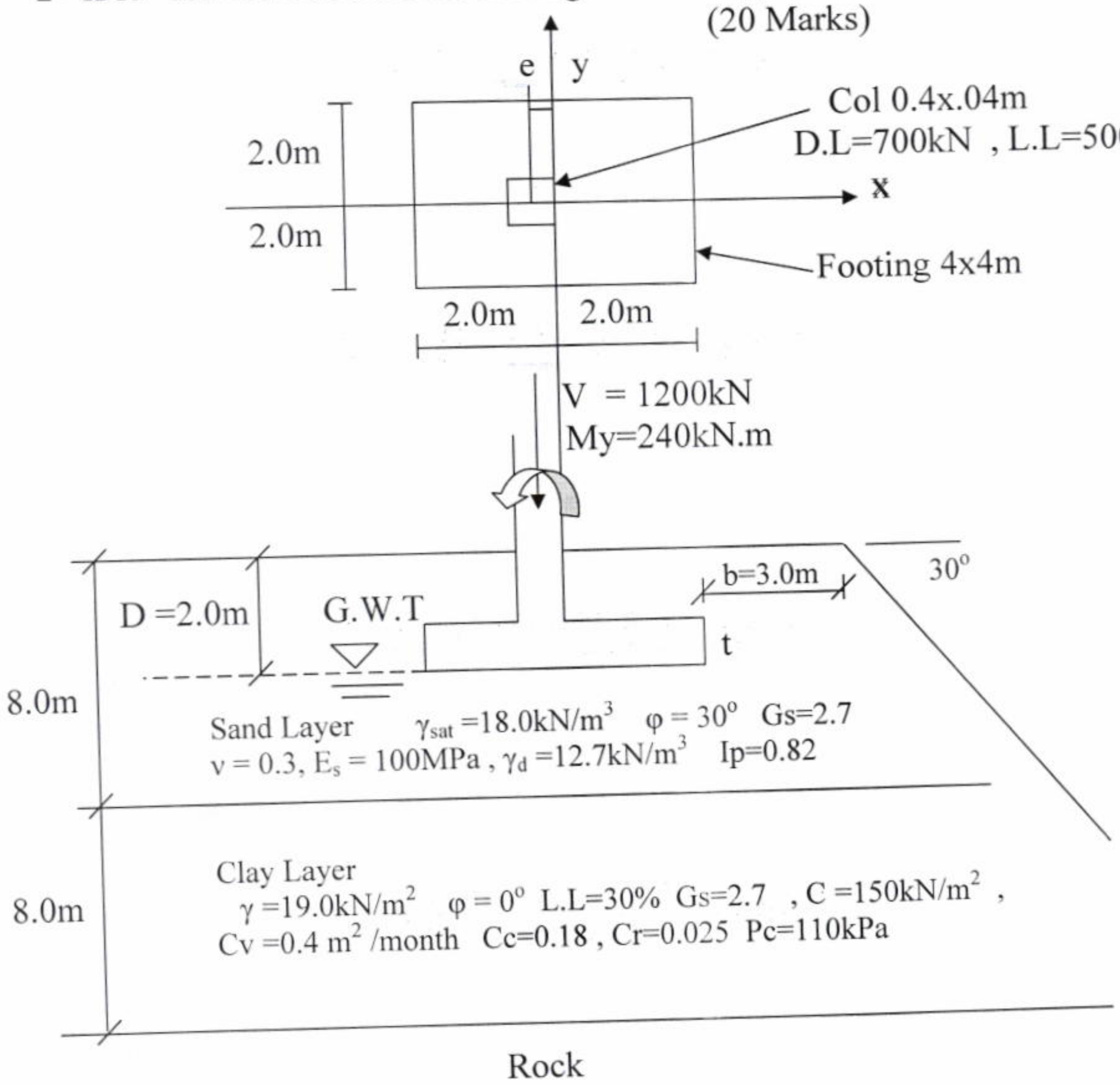


Fig.(3)

Q4- For the footing shown in fig(3) :

1- Calculate the total immediate and consolidation settlement.
2- Calculate the time required for 50% Degree of the consolidation settlement to occur.

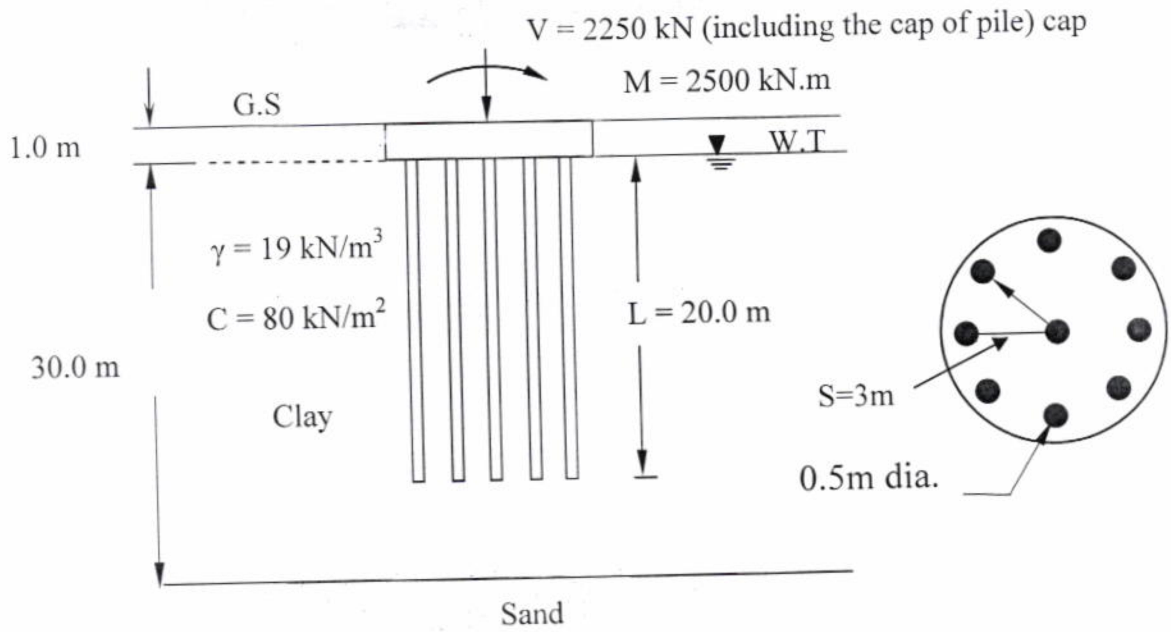
(20 Marks)

Q5- A 0.48 m dia. Vibro tube 15.25m length is to be driven through sandy stratum to get an ultimate pile resistance Ru =100 tons. The following data are available: Wt. of single acting hammer =3.5tons, Wt. of Vibro tube = 4.58tons, height of fall of ram =1.2m, Inner tube diam. 0.46m, Wt. of driving cap & plastic dolly=0.4 tons. To what **set** the tube must be driven?

(20 Marks)

Q6- A group of bored concrete piles foundation of 20.0m length proposed for a structure subjected to centric load of 2250kN (included weight of the pile cap) and moment of 2500kN.m as shown in fig(4). Determine the allowable load capacity of the group if the factor of safety F.S=2.5, then check the adequacy of the pile foundation.

(20 Marks)



fig(4).

الاجوبة النموذجية لاسئلة مادة

هندسة الاسس الدور الاول

٢٠١٣ - ٢٠١٤

Q1 a- No. of Boreholes

Since Building area $= 30 \times 20 = 600\,m^2 > 300\,m^2$

So, Use 5 Boreholes

- layout : Use 4 B.H at the corner and one B.H at the center.

- Depth of B.H. (Z)

1- $Z = 2*B = 2*20 = 40\,m.$

2- 10% of Δq.

$$0.1\,\Delta q = \frac{q\,B.L}{(B+Z)(L+Z)}$$

$$0.1 \times 100 = \frac{100 * 20 \times 30}{(20+Z)(30+Z)}$$

$Z = 52.6\,m$

3- 5% of P_o'

$$0.05\,P_o' = \frac{100 \times 20 \times 30}{(20+Z)(30+Z)}$$

$P_o' = 16 \times 2 + 9Z = 32 + 9Z$

$$0.05 \times (32+9Z) = \frac{100 \times 20 \times 30}{(20+Z)(30+Z)}$$

$Z = 42.3\,m$

The optimum depth of Boreholes is:

$40 + 2 = 42$ m. ⟶ Use 45 m depth.

- Insitue Tests
  - Standard Penetration Test (S.P.T)
  - Plat load Test
- laboratory tests:

1- Gs, Wc, Atterberg limits, Sieve and Hydrometer Analysis, oedoemeter test, Unconfined Unconsolidation test, U.U test Chemical test (Tss, P.H, SO_3, Cl_3).

B -

$$N_{cr} = 15 + 0.5(N_m - 15)$$

$$= 15 + 0.5(22 - 15) = 18.5$$

$$N_c = C_N \times N$$

$$C_N = 0.77 \log \frac{2000}{P_o'}$$

$$P_o' = 16 \times 2.5 + 10(19-10) + 7.5(20-10) = 205 \text{ kPa}$$

$$C_N = 0.77 \log \frac{2000}{205} = 0.761$$

$$N_c = 0.761 \times 18.5 = \underline{14}$$

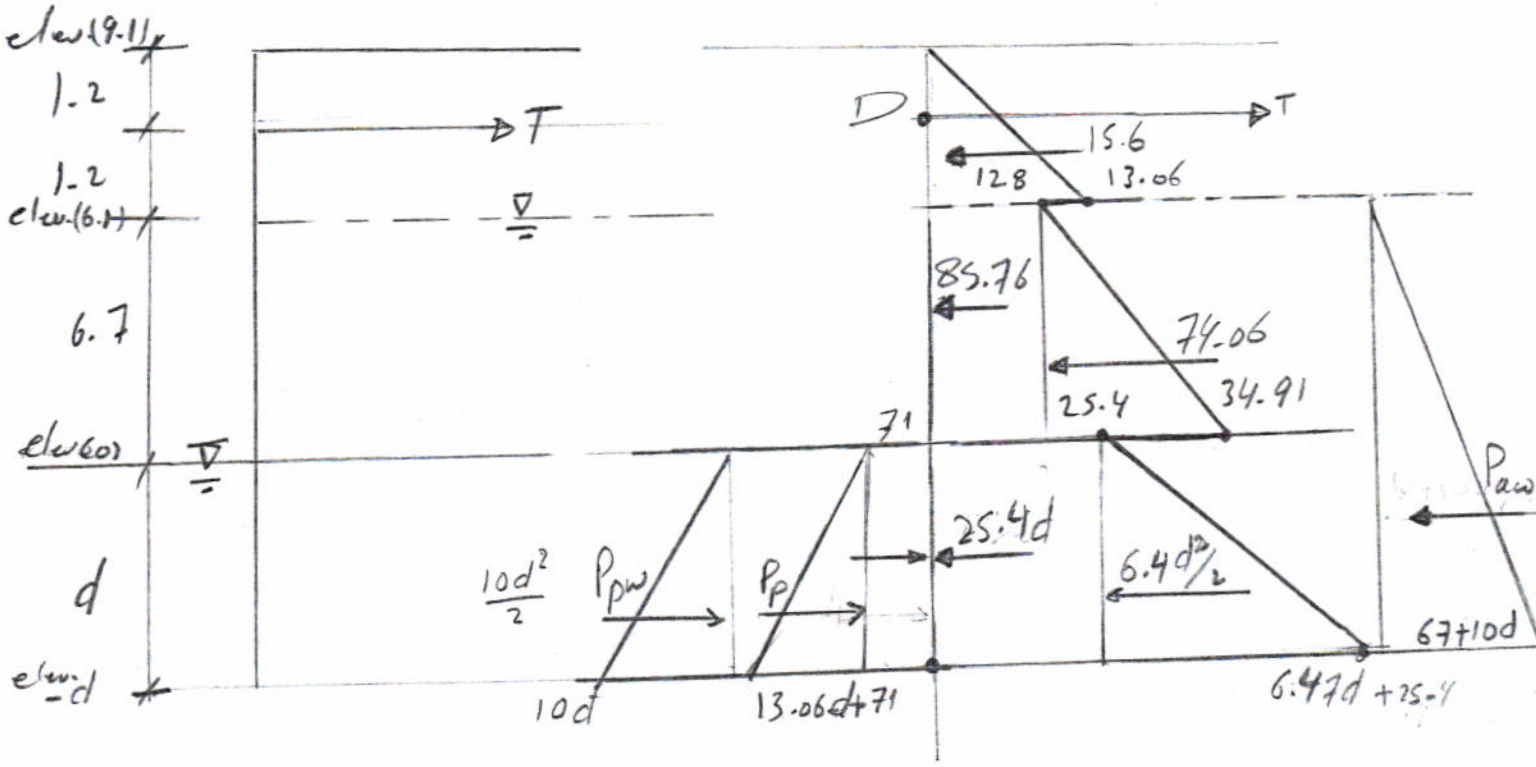
Q_2 - For $\phi = 30^\circ \longrightarrow k_a = \frac{1-\sin 30}{1+\sin 30} = 0.33$

$$P_{a\,elev(6.7)} = k_a \gamma h = 0.33 \times 16.5 \times 2.4 - 0 = 13.06 \text{ kN/m}^2$$

$$h_e = \frac{16.5 * 2.4}{(20.2-10)} = 3.882$$

$$P_{a\,elev(6.7)} = 0.33 \times 10 \times 3.882 - 0 = 12.81 \text{ kN/m}^2$$

$$P_{a\,elev(0)} = 0.33 \times 10 \times (6.7 + 3.88) = 34.91 \text{ kN/m}^2$$



$$h_e = \frac{2.4 \times 16.5 + 6.7 \times 10.2}{(19.2-10)} = 11.7 \text{ m}, \quad k_a = \frac{1-\sin 10}{1+\sin 10} = .704$$

$$P_{a\,elev(0)} = 0.704 \times 9.2 \times 11.7 - 2 \times 30\sqrt{.704} = 25.4 \text{ kN/m}^2$$

$$P_{a(-d)} = 0.704 \times 9.2 \times (d + 11.7) - 2 \times 30 \sqrt{.704} = 6.47d + 25.4$$

$$P_{aw} = (6.7 + d) \times 10 = 67 + 10d$$

$$k_p = \frac{1+\sin 10}{1-\sin 10} = 1.42$$

$$P_{p \, el_w(-d)} = 1.42 \times 9.2 \times d + 2 \times 30 \sqrt{1.42} = 13.06d + 71.0$$

$$P_{w \, el_w(-d)} = d \times 10 = 10d.$$

Taking moment about Point (A) (tied)

$$15.6 \times 0.4 + 85.76 \times 4.55 + 74.06 \times 5.66 + 25.4d\left(7.9 + \frac{d}{2}\right) +$$

$$6.4\frac{d^2}{2}\left(7.9 + \frac{2}{3}d\right) + (67 + 10d) \times \frac{1}{2}(6.7 + d) \times \left(\frac{2}{3}(6.7 + d) + 1.2\right) =$$

$$\left(13.06\frac{d^2}{2} + 71d\right) \times \left(\tfrac{2}{3}d + 7.9\right) + 10\frac{d^2}{2} \times \left(\tfrac{2}{3}d + 7.9\right)$$

$$5.46d^3 + 110.8d^2 + 728.6d + 2085.6 = 7.68d^3 + 138.38d^2 + 560.9d$$

$$2.22d^3 + 27.58d^2 - 167.7d = 2085.6$$

$$d = 8.7 \text{ m}.$$

Q_3 - 1) For $\frac{D}{B} = \frac{2}{4} = 0.5$ & $\frac{b}{B} = \frac{3}{4}$ → $\phi = 30°$

By Interpolation

$N'_c = 28.28$, $N'_q = 15.81$, $N_\gamma = 15.1$

General B.c eq. for footing near slope

$q_{ult} = cN'_c s_c i_c + qN'_q s_q i_q + 0.5\gamma B N_\gamma s_\gamma d_\gamma i_\gamma$

$e_x = 0.2 m$

$B' = B - 2e_x = 4 - 2(0.2) = 3.6 m$

$L' = L = 4.0 m$

$s_q = 1 + \frac{B'}{L'} \sin\phi = 1 + \frac{3.6}{4} \sin 30 = 1.45$

$s_\gamma = 1 - 0.4 \frac{B'}{L'} = 1 - 0.4 \frac{3.6}{4} = 0.64$

$d_\gamma = 1.0$

$q_{ult} = 0 + 2 \times 12.7 * 15.81 * 1.45 + 0.5 * (18-10) \times 3.6 * 15.1 * 0.64 * 1.0$

$= 721.4 \ kN/m^2$

$q_{all} = \frac{721.4}{2} = 360.72 > q_{max}$ ∴ o.k.

$q_{max/min} = \frac{\Sigma v}{B * L}\left(1 + \frac{6e_y}{B}\right) = \frac{1200}{4 \times 4}\left(1 \pm \frac{6 \times 0.2}{4}\right) = 76.3 \ kN/m^2$
$= 74.3 \ kN/m^2$

2) $P_u = 1.4 \times 700 + 1.7 * 500 = 1830 \ kN$

$q_{av.} = \frac{76.3 + 74.3}{2} = 75.3$

$V_c = 0.34 \times 0.85 \sqrt{21} = 1.324 \ MN/m^2$

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

By Substitue in

$$d^2\left(1324 + \frac{75.3}{4}\right) + d\left(1324 - \frac{75.3}{2}\right)\times .4 = \frac{4^2 - .4^2}{4} \times 75.3$$

$$d^2 + 0.383d = 0.222$$

$$d = 0.32\,m$$

check d by beam action

$$V_c = 0.17\phi\sqrt{f_c'} = 0.17 \times 0.85\sqrt{21} = 0.662\ kN/m^2$$

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

$$662 \times 4 \times d = 75.3\left(\frac{4}{2} - \frac{0.4}{2} - d\right) \times 4$$

$$2648d = 301.2(1.8 - d)$$

$$d = 0.183\ m$$

Use larger $d = 32\ cm$

$$t = d + 1.5d_b + 7.5 = 32 + 1.5 \times 2.5 + 7.5$$

$$= 43.2 \longrightarrow \text{Use } t = 45\ cm$$

IF $d_b = 2.5\ cm$

Q4

1) $S_i = \frac{qB(1-\nu^2)}{E_s} I_P$

$= \frac{(1200/16) \times 4 (1-0.3^2)}{100000} \times 0.82 = 0.00223\ m$

$= 2.23\ mm$

$S_c = \frac{C_c}{1+e_0} H_0 \log \frac{P_0' + \Delta P}{P_0'}$

$P_0' = 2 \times 12.7 + 6.0 \times 8 + 4 \times 9.0 = 109.4\ kN/m^2$

$\Delta P = \frac{1200}{(4+10)^2} = 6.122\ kN/m^2$

$P_0' < P_c < P_0' + \Delta P$

$S_c = \frac{0.025}{1+1.125} \times 8 \log \frac{110}{109.4} + \frac{0.18}{1+1.125} \times 8 \log \frac{109.4+6.122}{110}$

$= 0.0146\ m = 14.6\ mm$

$S_t = 14.6 + 2.23 = 16.8\ mm$

2) $T = \frac{\pi}{4}\left(\frac{U}{100}\right)^2 = \frac{\pi}{4}\left(\frac{50}{100}\right)^2 = 0.19$

$t = \frac{T d^2}{C_v} = \frac{0.19 \times 8^2}{0.4} = 30.4$ month 2.5 Year

Q5-

Cross sectional area $= \frac{0.48^2}{4}\pi = 0.18 m^2$

area of tub thickness $a = \left(\frac{0.48^2 \pi}{4} - \frac{.46^2 \pi}{4}\right) = 0.0139$

$\frac{Ru}{A} = \frac{1.0 MN}{0.18} = 5.55 \ MPa$

$\frac{Ru}{a} = \frac{1.0}{0.0139} = 71.94$

$Ru = \frac{W.h.\eta}{S + C/2}$

$W_P = 4.58 + 0.4 = 4.98$ tons , $W_r = 3.5$ tons

$\frac{W_P}{W_r} = \frac{4.98}{3.5} = 1.42$, $e = 0.5$, $\eta = 0.56$

$h = k.H = 0.9 \times 1.2 = 1.08 m$

$C = C_c + C_P + C_q$

$C_c = 2.0 mm$, $C_P = 5.0 mm$, $C_q = 2.0 mm$

$C = 9.0 mm$

$100 = \frac{3.5 \times 1.08 \times 1000 \times 0.56}{S + \frac{9}{2}} =$

$S = 16.6 mm/blow$

Q.6:

$Q_u = Q_b + Q_s$

$Q_b = C_u N_c A_b$

$= (80)(9)\ \frac{\pi}{4}(0.5)^2$

$= 141.3^{KN}$

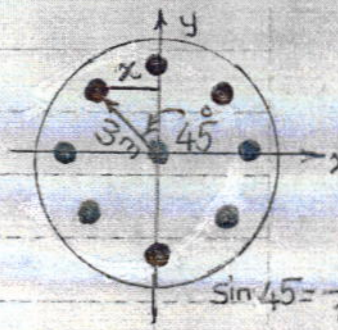
$Q_s = \alpha\ C_u A_s$

$= 0.45\ (80)(\pi \times 0.5 \times 20)$

$= 1130.4^{KN}$

$\therefore (Q_u)_{pile} = 141.3 + 1130.4 = 1271.7^{KN}$ $\qquad (Q_{all.})_{Pile} = \frac{(Q_u)_{pile}}{F.S} = \frac{1271.7}{2.5} = 508^{KN}$

$E_g = \frac{8\left(\frac{13}{16}\right) + 1\left(\frac{8}{16}\right)}{9} = 0.77$



$(Q_u)_{group} = (Q_u)_{pile}\ n\ E_g$

$= (1271.7)(9)(0.77)$

$= 8812.8^{KN}$

$\sin 45 = \frac{x}{3}$

$\therefore x = 2.12^m$

$Q_{ult\ block}$ =

$(Q_{all.})_{group} = \frac{(Q_u)_{group}}{F.S} = \frac{8812.8}{2.5} = 3525^{KN}$

Check the adequacy of the pile foundation:

$P_{max.} = \frac{V}{n} + \frac{M.x}{\sum x^2} \leqslant (Q_{all.})_{pile}$

$= \frac{2250}{9} + \frac{2500(3)}{2(3)^2 + 4(2.12)^2} = 458.4^{KN} < (Q_{all.})_{pile}\ \therefore O.K$

$P_{min.} = \frac{V}{n} - \frac{M.x}{\sum x^2} \leqslant (Q_s)_{pile}$ (if Pmin is tension force)

$= \frac{2250}{9} - \frac{2500(3)}{2(3)^2 + 4(2.12)^2} = 41.6^{KN}$ ([redacted]) $\therefore O.K$