



**University of Technology**  
**Building and Construction Eng. Dept.**  
**Final Exam – First Attempt – 2010/2011**



**Branch :**  
**subject : Foundation Engineering**  
**Examiner :Committee Foundation**

**Class: 4<sup>th</sup> year**  
**Time : 3 Hours**  
**Date : 29/ 5/ 2011**

**Note: Attempt 5 Questions only**

**Q1- A-Discuss five the following terms:**

- 1- S.P.T N-value
- 2- Undisturbed Samples.
- 3- Area Ratio.
- 4- Negative Skin Friction.
- 5-Block Failure.
- 6-Group action.
- 7-Fixed earth support.

(10 marks)

**B- Site investigation is to be carried out on an inner city gap site which is being redeveloped for a six stories building with a raft foundation of (20x30) m and 2m depth below N.G.L. The net applied pressure at the footing base is 100kPa. Geological map show that the soil is of loose deposit with a dry and submerged unit weight of 16 and 9 kN/m<sup>3</sup> respectively. The water table was found at a depth of 2m below N.G.L. Outline a suitable site investigation project for this site, giving details of the boreholes (number, depth , locations) and laboratory test required.**

(10 marks)

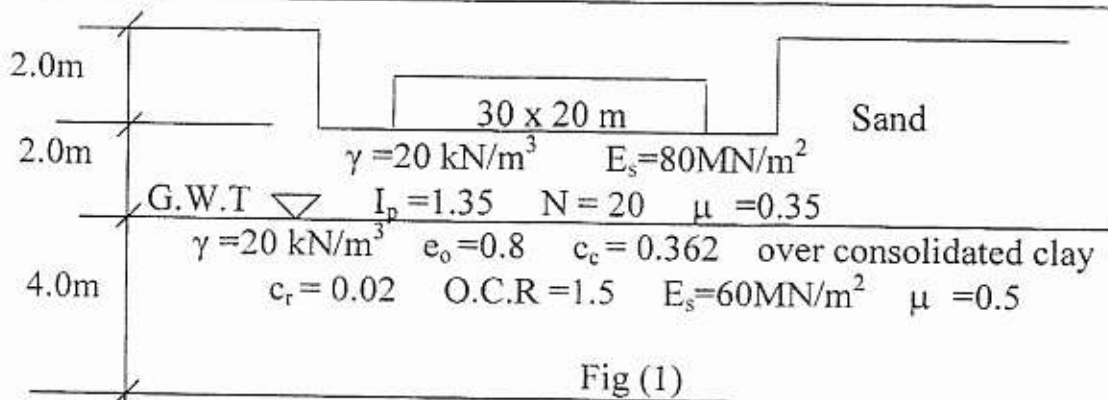
**Q2 : A- Distinguish between the immediate and consolidation settlement and explain which is likely to be more harmful to structures built over a clay layer.**

(5 marks)

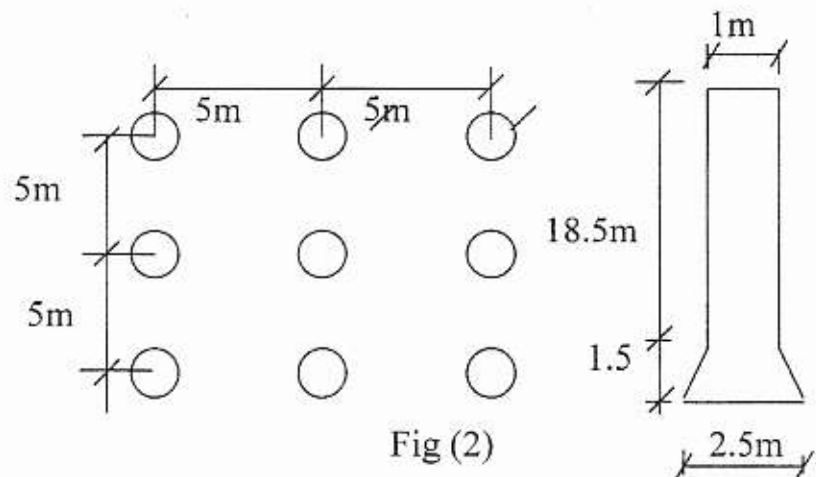
**B- The raft foundation shown in figure (1) of 30 x 20m dimension exerts foundation net pressure of 180 kN/m<sup>2</sup>. For the soil properties given in the fig (1), calculate:**

- 1- Immediate settlement for the two layers.
- 2- Consolidation settlement for the clay layer.

(15 marks)



- Q3 : A group of 20m long and 1m diameter enlarge bored piles as shown in fig.(2), undrained cohesion strength ( $c_u = 80 \text{ kN/m}^2$ ) at the ground surface increasing uniformly to ( $200 \text{ kN/m}^2$ ) at the base. Suggest suitable F.S. and calculate the safe capacity of the group. (20 mark)

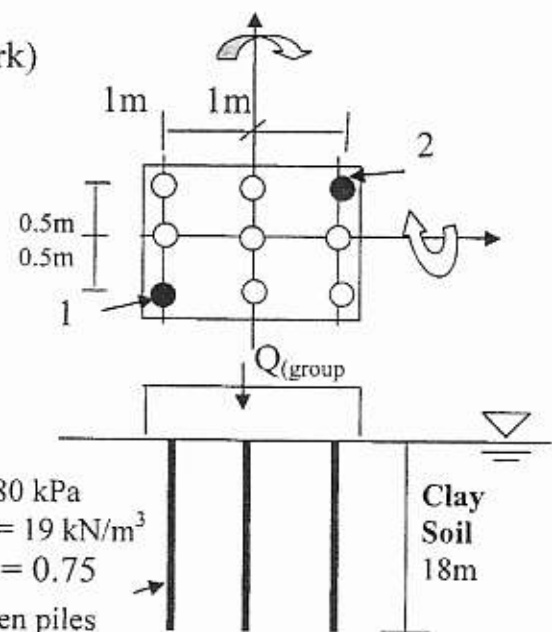


- Q4. A- 0.48m diameter .Vibro tube pile of 12 m length and 0.46m inner diameter driven through loose material and then into dense gravel to give ultimate driving resistance ( $R_u$ ) of the pile  $1500 \text{ kN/m}^2$ , using a 30kN single acting hammer with a stroke of 1.5m. Determine the set ( $S$ ) of the pile if it is fitted with a helmet plastic dolly on top of the pile tube. The weight of the helmet and dolly is 5 kN, and the weight of the pile is 25 kN. ( $k=0.9$ ,  $e = 0.4$  for single-acting hammer ) (10 mark)

B- Calculate load on piles 1&2 due to

$$(Q_{\text{group t}}) = 6000 \text{ kN} \quad M_x = 1500 \text{ kN.m}$$

$$M_y = 1000 \text{ kN.m (and } S = 1.0 \text{ m. ) (10 mark)}$$



Q5- Fig (4) shows an anchored sheet pile embedded in cohesive soil and support a cohesionless soil of 9.1m height. Find the embedded depth (d) and anchored force (T), Using F.S =1.5 on cohesive soil. (use free earth support method) (20 mark)

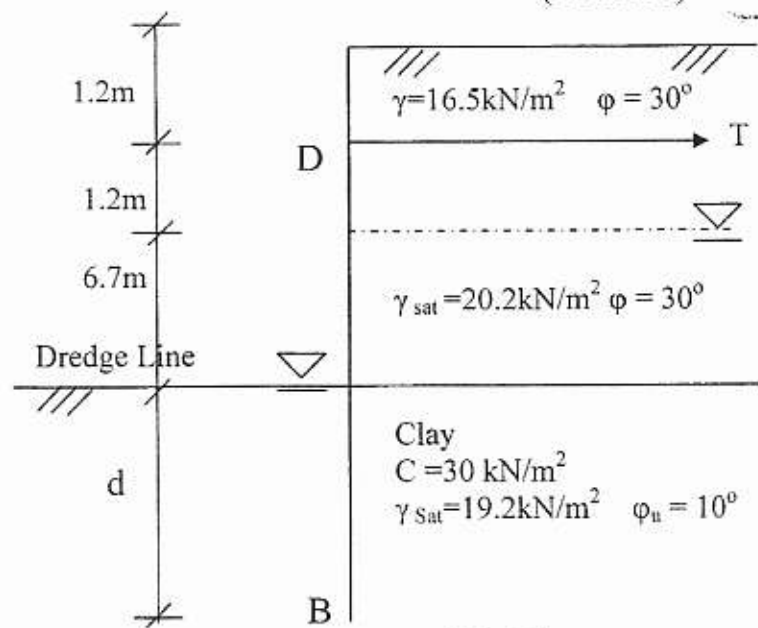


Fig (4)

Q6: A- Check bearing capacity of the 5m circular footing shown in fig.(5) for a F.S = 3. (10 mark)

B- Design a trapezoidal combined footing for the two 50 x 50 cm. columns shown in fig. ( 6) ( assume uniform pressure distribution if  $q_{all} = 120\text{kPa}$ ).

(10 mark)

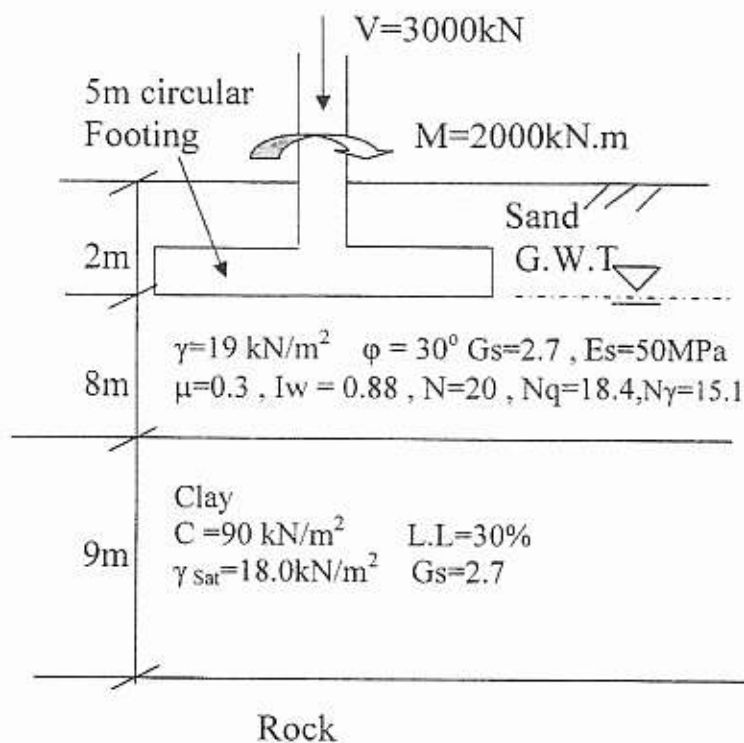


Fig (5)

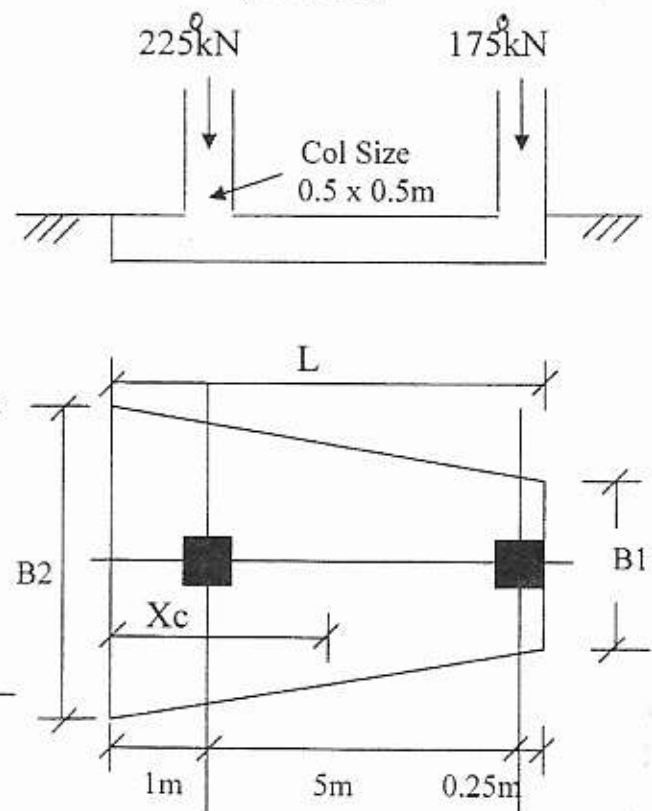


Fig (6)

## Useful Equations

$$S_i = \frac{q B (1 - \mu^2)}{E_s} L_w \quad \text{O.C.R} = \frac{P_c}{P'_o} \quad , \quad P_a = k_a \gamma h - 2 c \sqrt{k_a}$$

$$P_p = k_p \gamma h + 2 c \sqrt{k_p}$$

$$S_c = (C_c / (1 + e_o)) H \log ((p_o' + \Delta p) / p_o') \quad \text{For normally consolidation clay}$$

$$S_c = (C_r / (1 + e_o)) H \log ((p_o' + \Delta p) / p_o') \quad \text{For over consolidation clay If } P_c > P_o' + \Delta P$$

$$S_c = (C_r / (1 + e_o)) H \log (p_c / p_o') + (C_c / (1 + e_o)) H \log (p_o' + \Delta p) / p_c \quad \text{For over consolidation clay If } P_o' < P_c < P_o' + \Delta P$$

$$S_i = \frac{H}{C_s} \text{Log} \frac{P_o' + \Delta P}{P_o'} \quad C_s = \frac{1.5 C_r}{P_o'}$$

$$q_{ult} = C N_c S_c d_c + q N_q S_q d_q + 0.5 \gamma B' N_\gamma S_\gamma d_\gamma$$

$$S_c = 1 + (N_q / N_c) (B' / L') \quad , \quad S_q = 1 + (B' / L') \sin \phi \quad , \quad S_\gamma = 1 + 0.4 B' / L'$$

$$d_c = 1 + 0.4 D / B \quad , \quad d_q = 1 + 2 \tan \phi (1 - \sin \phi)^2 D / B \quad , \quad d_\gamma = 1$$

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

$$K_p = \tan^2 (45 + \phi / 2)$$

$$L = (2B_1 + B_2)$$

$$X_c = \frac{1}{3} \frac{L}{(B_1 + B_2)} \quad V_c = 0.17 \phi \sqrt{f_c'} \quad , \quad \text{One way shear}$$

$$V_c = 0.34 \phi \sqrt{f_c'} \quad , \quad \text{Two way shear}$$

$$R_u = \frac{W \times h \times \eta}{S + C/2} \quad \epsilon = 1 - \frac{\theta}{90} \left[ \frac{(n-1)m + (m-1)n}{mn} \right]$$

$$Q_{ult} = C_u \cdot N_c A_b + C_a \cdot A_s \quad \text{For Cohesive Soils}$$

$$Q_{ult} = s'_b N_q A_b + k_d s'_v \tan \phi A_s \quad \text{For Cohesionless soils}$$

$$Q_{ult} (\text{group}) = Q_{ult} (\text{single}) \times n \times \epsilon$$

$$Q_{max} = \frac{\sum V}{n} + \frac{M_x \cdot Y}{\sum Y^2} + \frac{M_y \cdot X}{\sum X^2}$$

$$q_{max} = \frac{\sum V}{A} \left( 1 + \frac{6e}{L} \right) \quad , \quad C_c = 0.009 (L.L - 10) \quad , \quad \gamma = \frac{G_s + S_e}{1 + e} \times \gamma_w$$

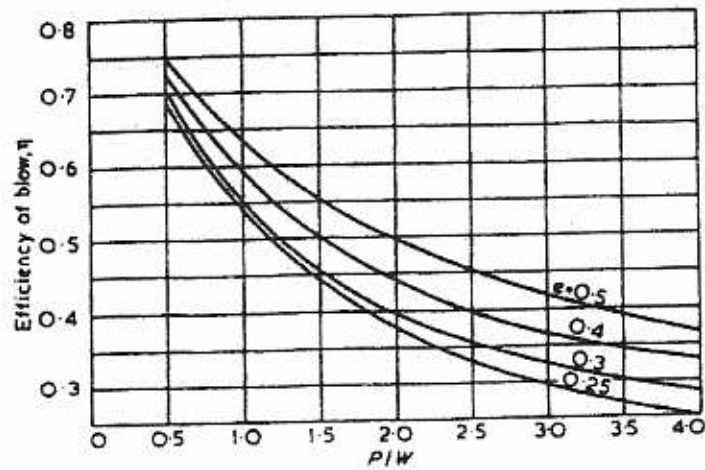


Fig. 1 Determination of efficiency factor,  $\eta$ , for use in the Hiley pile driving formula, after BSP Pocket Book (1969)

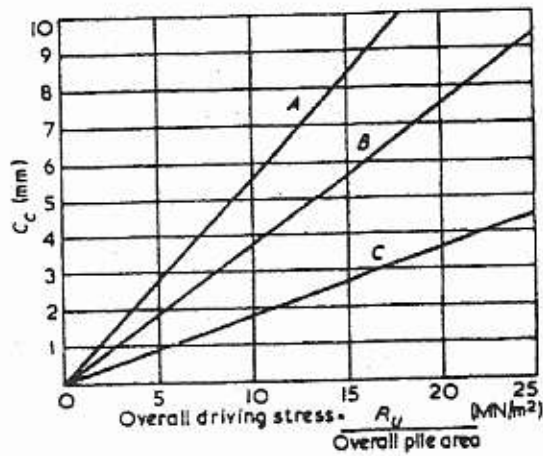


Fig. 2 Determination of temporary elastic compression  $C_c$ , after BSP Pocket Book (1969)  
Key: A = concrete pile, 75 mm packing under helmet; B = concrete or steel pile, helmet with dolly or head of timber pile. C = 25 mm pad only on head of RC pile

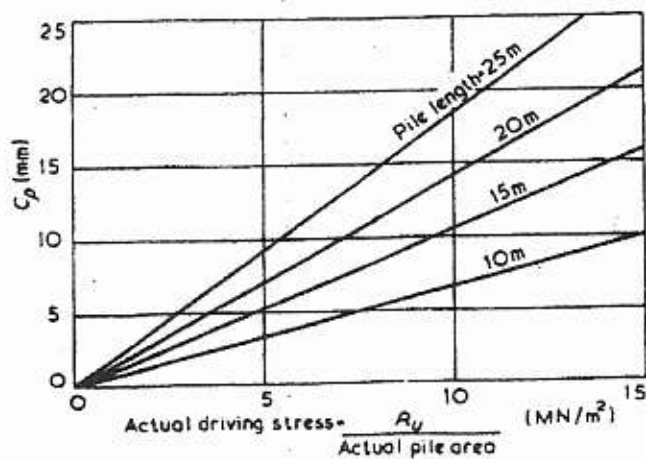


Fig. 3 Determination of temporary elastic compression  $C_p$ , for concrete piles, after BSP Pocket Book (1969)

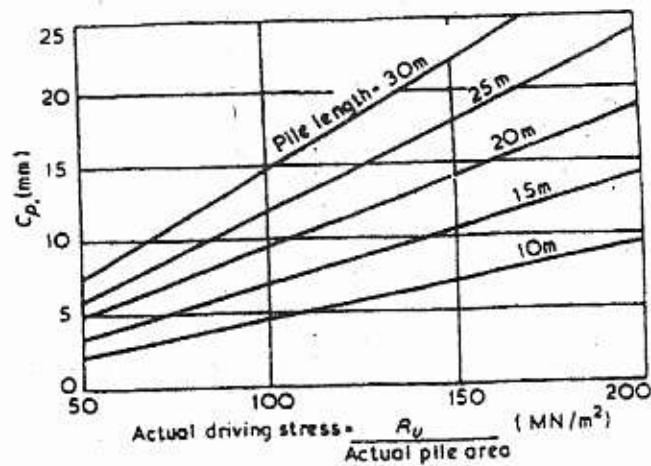


Fig. 4 Determination of temporary elastic compression  $C_p$  for steel piles, after BSP Pocket Book (1969)

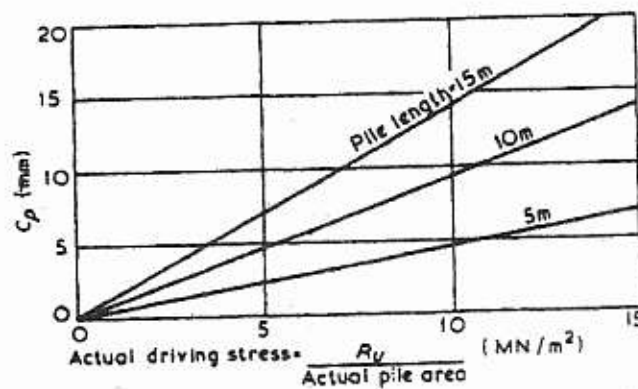


Fig. 5 Determination of temporary elastic compression  $C_p$  for timber piles, after BSP Pocket Book (1969)

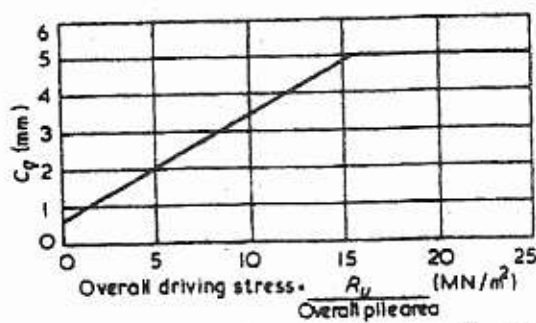


Fig. 6 Determination of temporary elastic  $C_p$ .

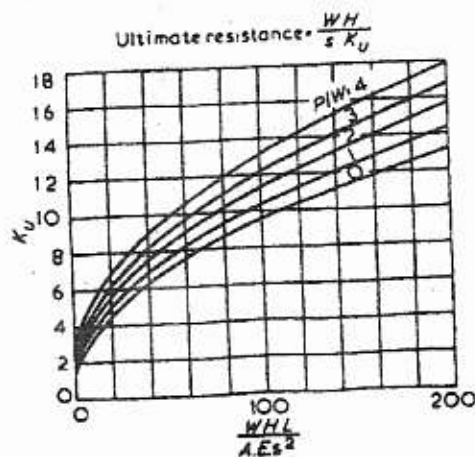


Fig. 7 Design chart for the Janbu pile driving formula