CE 468GEOTECHNICAL DESIGN

PILE FOUNDATION DESIGN OF A VIADUCT PIER

Soil investigations revealed the following data for the foundation soil profile at the site of the viaduct pier:

Depth interval 0 – 15m : Stiff clay

Undrained shear strength c_u = 90 kPa
Poisson's ratio μ = 0.35
Pressuremeter net limit pressure P_L^* = 400 kPa
Pressuremeter Modulus E_P = 5500 kN/m^2
Rheological factor α = 0.67
Deformation modulus E_S = ~ 0.75* (E_P / α)
K_h = 120 c_u / B; k_h = 120 c_u

Depth interval > 15m : Hard clay

Undrained shear strength c_u = 200 kPa
Poisson's ratio μ = 0.35
Pressuremeter net limit pressure P_L^* = 3000 kPa
Pressuremeter Modulus E_P = 32000 kN/m^2
Rheological factor α = 0.67
Deformation modulus E_S = ~ 0.75* (E_P / α)
K_h = 120 c_u / B; k_h = 120 c_u

No ground water table is encountered in the site.

Loading Conditions:

Static loads

Bridge slab : 7500 kN
Column : 8000 kN
Pile cap. : 9500 kN

Earthquake loads:

Total horizontal load : 6800 kN
Moment at the base of the pile cap : 44 000 kN-m.

Design Spesifications:

Static loads FS = 3.0
Earthquake loads FS = 1.1
Allowable settlement :40mm
Allowable horizontal deflection at pile head: 20mm

Design recommendations:

* You may use square pattern of piles with 2.5 to 4.0 diameter spacing.

* You may use bored piles with 0.65m, 0.80m or 1.00m diameters.

* Dynamic modulus of subgrade reaction may be assumed equal to the static modulus of subgrade reaction.

* The behavior of the pile group under the lateral loads shall be governed by the upper 15m thick clay layer.

* Moment capacity of the piles may be taken as:

B =0.65m My = 600 kN-m
B =0.80m My = 750 kN-m
B =1.00m My = 900 kN-m

* Uplift friction capacity of the piles may be assumed as 85% of the frictional resistance under compression.

* $E_{concrete} = 2*10^7$ kPa

* Try your best not to overdesign the foundation.

* Make any assumptions if necessary, provided that you clearly state and justify your assumption.

The pile load test performed on the site reveals the following data :

Load (kN)	Pile displacement (mm)
0	0
625	1.10
1250	2.55
1875	3.82
2500	6.15
3125	8.08
3750	10.63

4375	15.08
5000	22.48
3750	20.63
2500	17.50
1250	13.75
0	10.04

Plot the load – settlement curve, and evaluate the ultimate bearing capacity of the pile using : Mazurkiewitch's, Davisson's and Hirany & Khulhawy's methods. Conclude your pile capacity and compare your results with static formula predictions.