FINISH STRONG!

CV3013 Foundation Engineering SEM 1 2015 - 2016

1. a) Ultimate limit states are those involving the collapse or instability of the structure as a whole or the failure of one of its components. Serviceability limit states are those involving excessive deformation, leading to damage or loss of function.

1. b) i) $q_f = s_c N_c c_u + \sigma_q$

$= (1.1)(5)(60) + (1)(17)$

$= 347$ kPa

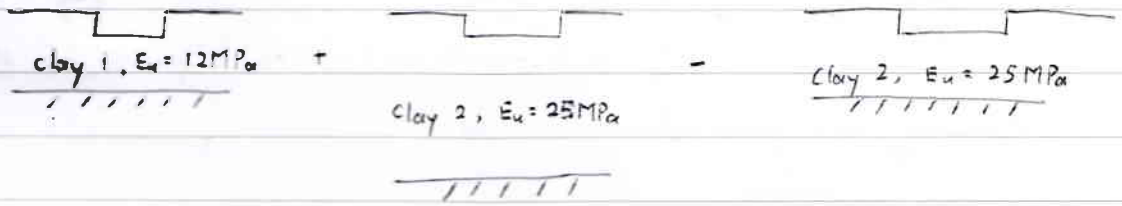
$c_{u1}/c_{u2} = 60/120 = 0.5$

$H/B = 3/5 = 0.6$

$N_c = 5$

$s_c = 1.1$

ii) Using principle of superposition :



$\frac{d}{B} = \frac{1}{5} = 0.2 \rightarrow u_0 = 0.96$

$\frac{H}{B} = \frac{3}{5} = 0.6 \rightarrow u_1 = 0.25$

$S_{i1} = (0.96)(0.25)\frac{(160)(5)}{12\times10^3}$

$= 0.016$m

$\frac{d}{B} = \frac{1}{5} = 0.2 \rightarrow u_0 = 0.96$

$\frac{H}{B} = \frac{8}{5} = 1.6 \rightarrow u_1 = 0.4$

$S_{i2} = (0.96)(0.4)\frac{(160)(5)}{25\times10^3}$

$= 0.012$ m

$\frac{d}{B} = \frac{1}{5} = 0.2 \rightarrow u_0 = 0.96$

$\frac{H}{B} = \frac{3}{5} = 0.6 \rightarrow u_1 = 0.25$

$S_{i3} = (0.96)(0.25)\frac{(160)(5)}{25\times10^3}$

$= 0.008$ m

$S_{i1} = u_0 u_1 \frac{qB}{E_u}$

By superposition, $S_i = S_{i1} + S_{i2} - S_{i3} = 0.272$m

assumption : 1. $v = 0.5$ (fully undrained condition)

2. average settlement

3. flexible area

1. c) $S_{oed} = \frac{H}{1+e_o}\left[C_r \log\left(\frac{\sigma'_p}{\sigma'_o}\right) + C_c \log\left(\frac{\sigma'_f}{\sigma'_p}\right)\right]$

$S_c = \mu_c S_{oed}$

Since $A = 0.5$ (strip footing), $\mu_c = 0.7$

$H/B = 8/2 = 4$

Assume soil is normally consolidate, since OCR = 1.0.

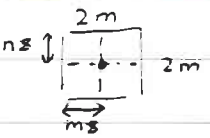
$S_{oed} = \frac{H}{1+e_o}\left[C_c \log \frac{\sigma'_f}{\sigma'_p}\right]$

$= \frac{8}{1+0.9}\left[0.05 \log \frac{110}{100}\right]$

$= 0.0087$ m

$S_c = 0.7\ (0.0087)$

$= 0.006$ m $= 6$ mm



To find σ'_f, $\sigma'_f = \Delta\sigma' + \sigma'_o$

$= 10 + [4(18) + 18 + (20-10)]$

$= 110$ kN/m

$\Delta\sigma' = q I_{qr} \times 4 = 10$

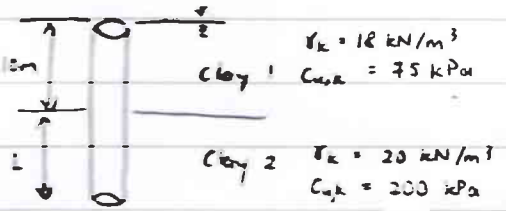
$I_{qr} = 0.025$ since $n = m = 0.25$

2.0) → when action applied to foundation are large

→ when near surface soils have low strength and or stiffness

→ where large structures are situated on very heterogeneous deposits., or where the soil layers are inclined

b)



Combination 2 : $\gamma_{load,\ variable} = 1.3$

$\gamma_{tang} = 1.25$

$\gamma_{c'} = 1.25$

$\gamma_{cu} = 1.4$

$\gamma_{base} = 1.7$

$\gamma_{shaft} = 1.7$

$$Q_{bu} = A_p\,(N_c C_u + \sigma_q)$$

$$= \pi \times 0.4^2 \left(9.0 \times \frac{200}{1.4} + 10 \times \frac{18}{1.0} + \frac{20}{1.0} \times L\right)$$

$$= \pi \times 0.4^2 \,(1465.7 + 20L)$$

$$Q_{bu,des} = \frac{\pi \times 0.4^2 \,(1465.7 + 20L)}{1.7}$$

$$Q_{su} = \bar{\tau}_{int\,1}\,(\pi \times 10 \times 0.8) + \bar{\tau}_{int\,2}\,(\pi \times L \times 0.8)$$

$$= \left[1.16 - \left(\frac{75/1.4}{185}\right)\right]\left(\frac{75}{1.4}\right)(8\pi) + \left[1.16 - \left(\frac{200/1.4}{185}\right)\right]\left(\frac{200}{1.4}\right)(0.8L\pi)$$

$$= 1171.9 + 139.2L$$

$$Q_{su,des} = \frac{1171.9 + 139.2L}{1.7}$$

2. b) $R = Q_{bu,des} + Q_{su,des}$

$= (433.38 + 5.91L) + (689.35 + 81.88L)$

$1.0 \times 2000 \leq 433.38 + 5.91L + 689.35 + 81.88L$

$L \geq 9.99\,m$

2. c) → the soil type

→ the direction of applied load

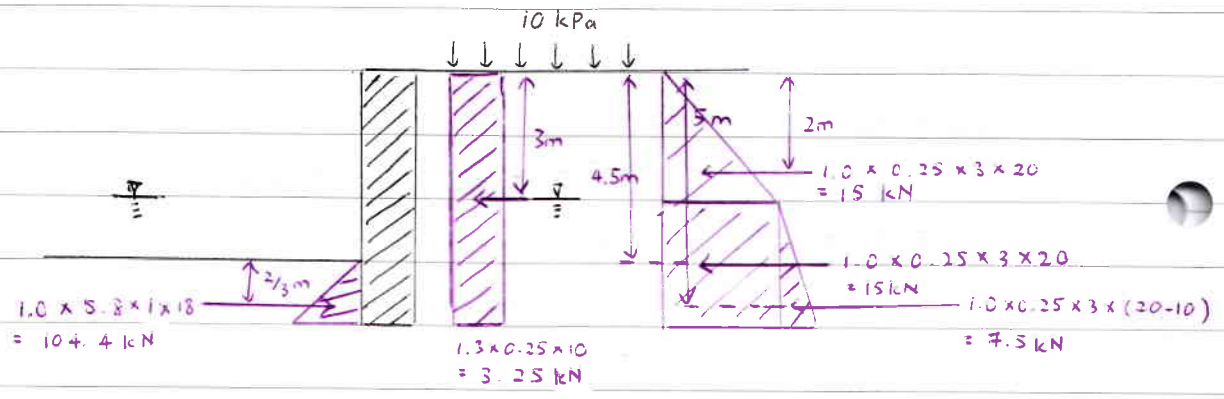
→ the sequence of pile installation

→ the elapsed time since the piles were driven

3. a) → design for low tide level. If tide level is at high level, there will be a water flow from in front of wall towards behind of wall. This will cause effective stress of soil behind the wall to decrease and P_{active} decrease.

∴ we should consider low tide level which is more dangerous.

3. b) i)



$\phi'_{des} = \tan^{-1}\left(\frac{\tan 38}{1.25}\right)$

$= 32°$

from graph, $K_a = 0.25$

$K_p = 5.8$

Total horizontal thrust : $R_{h,d} = (15)(3)(\frac{1}{2}) + (15 \times 3) + (7.5 \times 3 \times \frac{1}{2}) + 3.25(6)$

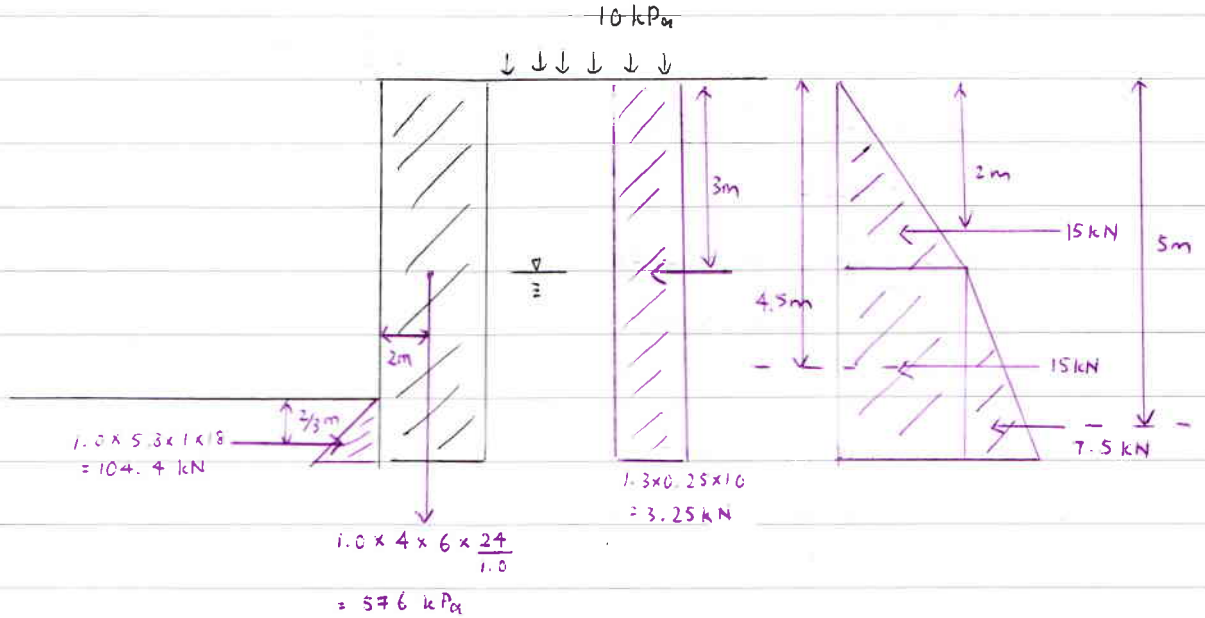
$= 98.25$ kPa

Total design resistance $= 104.4(\frac{1}{2})(1) + 4(\frac{70}{1.4})$

$= 252.2$ kPa

$\Gamma_s = \frac{252.2}{98.25} = 2.57$

b) ii)



Destabilizing moment .

$M_{dst} = 3.25 \times 6(3) + 15(3)(\frac{1}{2})(4) + 15 \times 3 \times 1.5 + 7.5(\frac{1}{2})(3)(1)$

$= 227.25$ kNm

Stabilizing moment

$M_{stb} = 104.4(\frac{1}{2} \times 1)(\frac{1}{3}) + 576(2)$

$= 593.6$ kNm

$x = \frac{593.6 - 227.25}{576}$

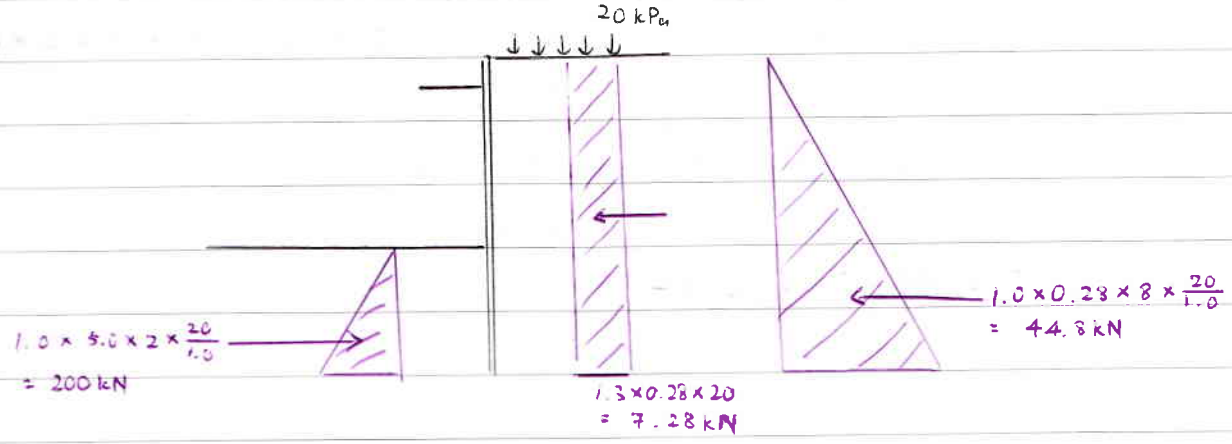
$= 0.636$ m

$e = 2 - 0.636 = 1.364$ m

maximum bearing pressure $= \frac{576}{4}(1 + \frac{6 \times 1.364}{4}) = 438.6$ kPa

$F_b = \frac{200}{438.6} = 0.46 < 1$ ∴ does not satisfy

4.0) :)



$\phi'_d = \tan^{-1}\left(\frac{\tan 36}{1.25}\right)$

$= 30.2°$

from graph, $K_a = 0.28$

$K_p = 5.0$

ii) destabilizing moment

$M_{dst} = 7.28(8)(3) + 44.8\left(\frac{1}{2}\right)(8)(4.333)$

$= 951.25 \text{ kNm}$

stabilizing moment

$M_{stb} = 200(2)\left(\frac{1}{2}\right)(6.333)$

$= 1266.67 \text{ kNm}$

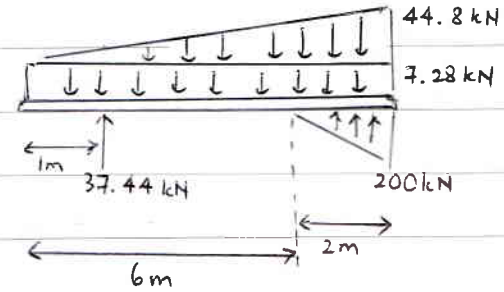
Since $M_{stb} > M_{dst}$. ∴ It satisfies the requirement.

iii) Strut load $= 7.28(8) + 44.8\left(\frac{1}{2}\right)(8) - 200(2)\left(\frac{1}{2}\right)$

$= 37.44 \text{ kN}$ per meter run

$\Sigma F_H = 0$

iv) maximum moment where shear is zero.



4. b) i) Primary objectives → To obtain sufficient information about the ground so as to enable safe and economic foundation design and avoid difficulties during construction

Task :
1. determine sequence, thickness, lateral extent of soil strata and if applicable, bedrock elevation.
2. obtain soil samples for identification, classification, lab testing.
3. perform in-situ tests to assess ground or soil characteristics in the field
4. determine location of ground water level and artesian condition.
5. check for ground contamination.

ii) Clay soil → 1. SPT, standard penetration test to obtain undrained shear strength and compressibility
2. CPT, cone penetration test to obtain undrained shear strength and preconsolidation pressure

Sandy soil. → 1. SPT to obtain relative density and friction angle
2. CPT to obtain relative density and friction angle.

- ALL THE BEST -

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