CV3013

PYP 2014/2015 Sem 1

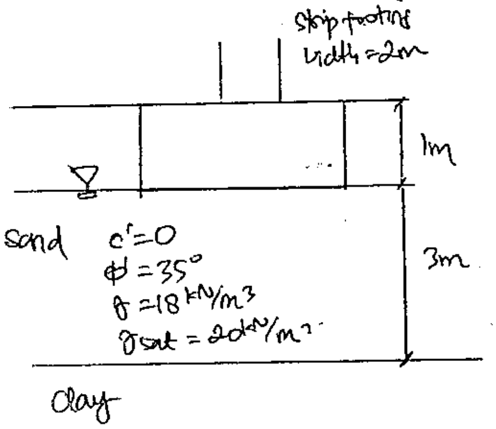
a) Shallow foundations : If a soil stratum near the surface is capable of adequately supporting the structural loads it is possible to use shallow foundations. Arbitrary definition : Shallow foundations refer to those where $d/B < 1$ or when $d < 3m$ (according to CP4)

e.g : Spread footings and Mat foundations

Deep foundations : If the soil near the surface is incapable of supporting the structural loads, piles, or other forms of deep foundation such as piers or caissons, are used to transmit the applied loads to suitable soil (or rock) at greater depth where the effective stresses (and hence shear strength) are larger

e.g : Driven piles and Drilled shafts

b)



Use Drained Condition

$$q_f = s_c N_c c' + s_q N_q \sigma'_q + 0.5\gamma B s_\gamma N_\gamma \quad (c' = 0)$$

$$N_q = \frac{(1+\sin 35)}{(1-\sin 35)} e^{\pi \tan 35} = 33.3$$

$$N_\gamma = 2(N_q - 1)\tan 35 = 45.23$$

$s_q = 1 \quad (\frac{B}{L} = 0$ for strip footing)

$s_\gamma = 1$

(i) $q_f = s_q N_q \sigma'_q + 0.5\gamma B s_\gamma N_\gamma$

$= (1)(33.3)(1 \times 18) + 0.5(20-9.81)(2)(1)(45.23)$

$= 1060.29$ kPa

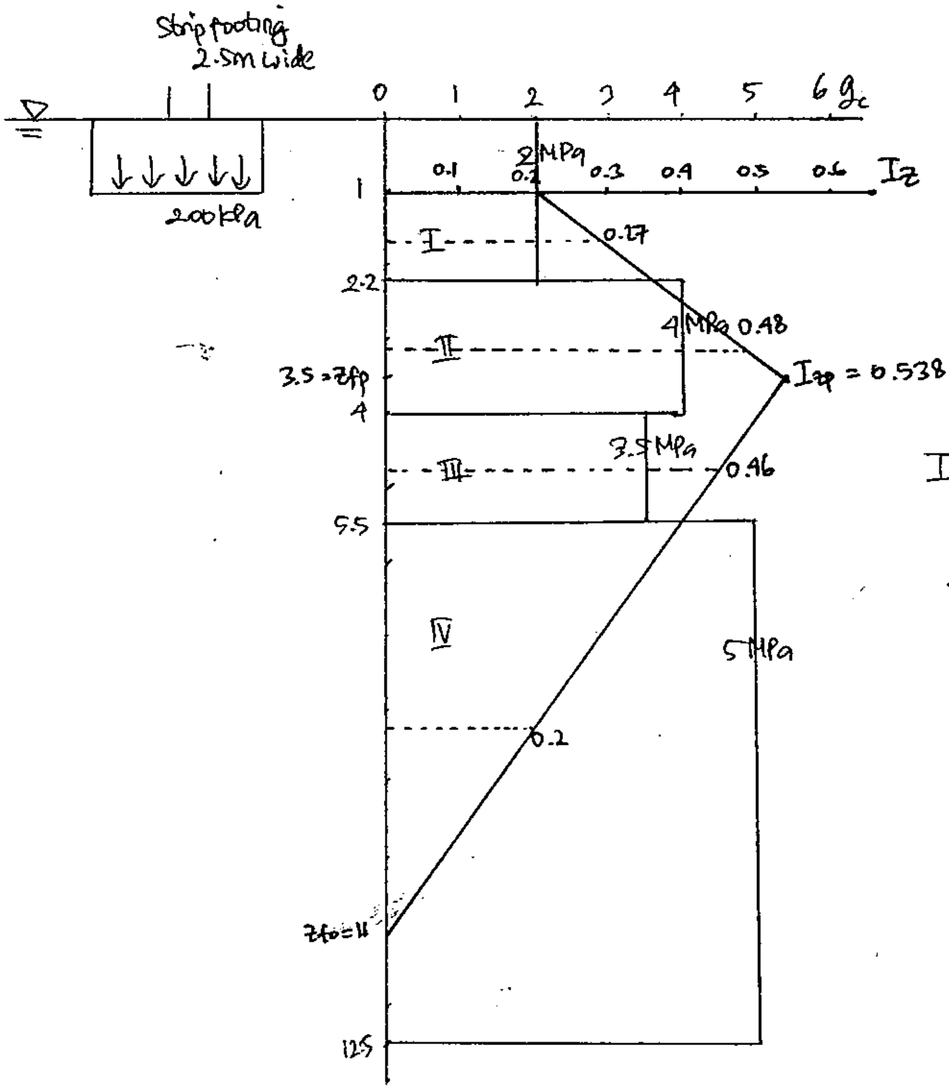
(ii) Change in σ'_q

$q_f = s_q N_q \sigma'_q + 0.5\gamma B s_\gamma N_\gamma$

$= (1)(33.3)(1 \times (20-9.81)) + 0.5(20-9.81)(2)(1)(45.23)$

$= 800.22$ kPa

1 c)



$I_{zp} = 0.5 + 0.1\left(\frac{q_n}{\sigma'_p}\right)^{0.5}$

$q_n = 200kPa$

$\sigma'_p = 3.5 \times (18 - 9.81)$

$= 28.665 kPa$

$I_{zp} = 0.538$

Layer	Δz	I_z	q_c	$E = 3.5q_c$	$\frac{I_z}{E}\Delta z$
I	1.2	0.27	2	7	0.0463
II	1.8	0.48	4	14	0.0617
III	1.5	0.46	3.5	12.25	0.0563
IV	5.5	0.2	5	17.5	0.0629

$\sum_0^{z_{fo}} \frac{I_z}{E}\Delta z = 0.2272$

$C_1 = 1 - 0.5\frac{\sigma'_q}{q_n} = 1 - 0.5\frac{1\times(18-9.81)}{200} = 0.98$

$C_2 = 1 + 0.2\log\left(\frac{t}{0.1}\right) = 1 + 0.2\log\left(\frac{99}{0.1}\right) = 1.6$

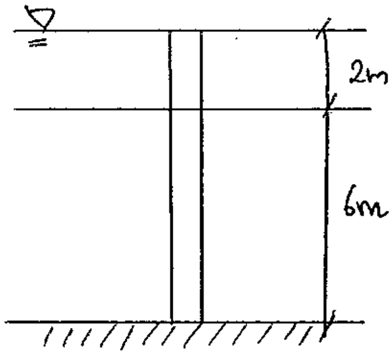
$S = C_1 C_2 q_n \sum_0^{z_{fo}} \frac{I_z}{E}\Delta z$ = ~~0.98 × 1.6 × 200 × 0.2272~~ = 71.25 mm

1) a) The structures above transfer the loads into piles. Then the piles transfers the load to the soil by two methods, using shaft resistance and bearing renstance. Shaft renstance comes from shear or friction of piles and soils. while bearing renstance happens when end of piles reaches a firm stratum.

End bearing piles : The end of the piles reach firm stratum. The resistance comes from shaft and bearing.

Floating piles : The end of the piles don't reach firm stratum. The resistance is gotten from shaft renstance only

b)



Downdrag happens on consolidating layer, in this case only clay consolidates, so downdrag only happens in clay layer.

→ Alpha Method

"penetrated" → displacement piles

$$\frac{C_u}{\sigma'_{vo}} = \frac{25}{2\times(20-9.81)+3\times(18.5-9.81)} = 0.538 \leq 1$$

$$\frac{L_p}{D_o} = \frac{6000}{225.68} = 26.6 < 50$$

→ Find Equivalent D_o by using Equivalent Area Method

$$\frac{\pi}{4}D_o^2 = S^2$$

$$D_o = \sqrt{0.2^2 \frac{4}{\pi}} = 225.68\,mm$$

$\Rightarrow F_p = 1.0$

$$\alpha = 0.5\,F_p\left(\frac{C_u}{\sigma'_{vo}}\right)^{-0.5} \text{ for } \frac{C_u}{\sigma'_{vo}} \leq 1$$

$$= 0.5\,(1)\,(0.538)^{-0.5}$$

$$\alpha = 0.6815$$

$$F_{downdrag} = \tau_{int} \times A$$

$$= \alpha\, C_u \times A$$

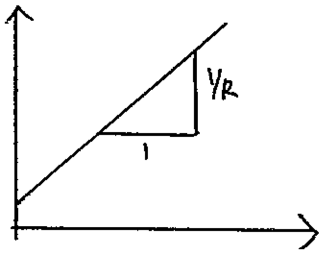
$$= 0.6815 \times 25 \times 4 \times 0.2m \times 6m$$

$$= 81.79\,kN$$ //

c)

Load (Q)	s	s/Q
0	0	—
100	0.5	0.005
200	1	0.005
300	1.8	0.006
400	2.8	0.007
500	4.2	0.0084
600	6.1	0.0102
700	8.2	0.0117
800	11.1	0.014
900	14.9	0.0166
1000	20.1	0.0201

Plot s/Q v s



$P_{ult} = \frac{1}{\text{gradient}} = \ldots$

d) $R_k = \min\left[\frac{R_{avg}}{\xi_1}, \frac{R_{min}}{\xi_2}\right]$

$R_{avg} = \frac{1290 + 1350}{2} = 1320\text{kN}$

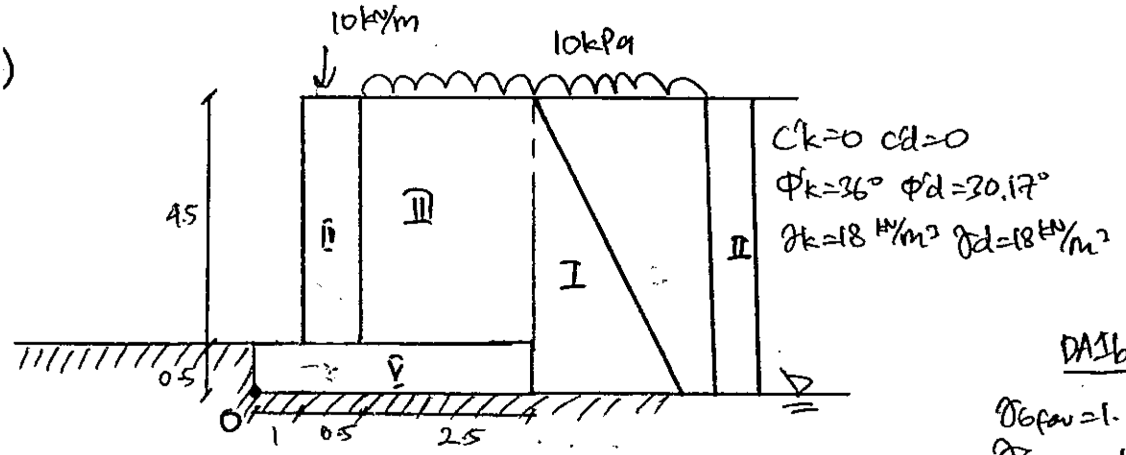
$R_{min} = 1290\text{kN}$

For $n = 2$, $\xi_1 = 1.47$
$\xi_2 = 1.35$

$R_k = \min\left[\frac{1320}{1.47}, \frac{1290}{1.35}\right]$

$= \min[897.96, 955.56]$

$R_k = 897.96\text{kN}$ //



DA1b

$\gamma_{G,fav}=1.0$	$\gamma_{\tan\phi}=1.25$
$\gamma_{G,unfav}=1.0$	$\gamma_{c'}=1.25$
$\gamma_{Q,unfav}=1.3$	$\gamma_{cu}=1.4$
$\gamma_{Q,fav}=0$	$\gamma_{\gamma}=1.0$

$C_{w,k}=150$ kPa $\quad C_{w,d}=107.14$ kPa

$C_{u,k}=200$ kPa $\quad C_{u,d}=142.86$ kPa

$\gamma_k=20$ kN/m³ $\quad \gamma_d=20$ kN/m³

$\gamma_{conc,k}=25$ kN/m³ $\quad \gamma_{conc,d}=25$ kN/m³

Using Rankine Method

$$K_a=\frac{1-\sin\phi'_d}{1+\sin\phi'_d}=0.33$$

a) HORIZONTAL FORCE

Label	Force	Lever arm (m)	Moment (kNm)
I (due to earth pressure)	$1.0\times\frac{1}{2}\times0.33\times18\times5^2=74.25$ kN	5/3	123.75 kNm
II (due to surcharge)	$1.3\times10\times0.33\times5=21.45$ kN	2.5	53.625
	$F_H=95.7$ kN		$M_H=177.375$ kNm (destabilizing)

HORIZONTAL RESISTANCE

$H_R=C_{w,d}\times4=107.14\times4=428.57$ kN

∴ since $H_R>F_H$, sliding ULS check is satisfied

b) Vertical FORCE

(i)

Label	Force (kN)	Lever Arm (m)	Moment (kNm)
III	$1.0\times18\times4.5\times2.5 = 202.5$	2.75	556.875
IV	$1.0\times25\times4.5\times0.5 = 56.25$	1.25	70.3125
V	$1.0\times25\times4\times0.5 = 50$	2	100
Surcharge	$1.3\times10\times2.5 = 32.5$		
Lineload	$1.3\times10 = 13$		

$F_v = 354.25\text{ kN}$

$\Sigma M_v = 727.1875$ ↑ stabilizing

(ii) $e = \frac{B}{2} - \frac{M_v - M_H}{F_v} = \frac{4}{2} - \frac{727.1875-177.375}{354.25} = 0.448\text{ m}$

eff. width of base $B = 4-2e = 3.1\text{ m}$

inclination factor $i = \frac{1}{2}\left(1+\sqrt{1-\frac{H}{A' C_{ud}}}\right) = \frac{1}{2}\left(1+\sqrt{1-\frac{95.7}{3.1\times142.86}}\right) = 0.943$

$q = 0.5\times20 = 10\text{ kPa}$, $S_c = 1$ (strip footing wall)

$R_v = [(\pi+2)C_{ud}\, s_c\, i_c + q]A'$

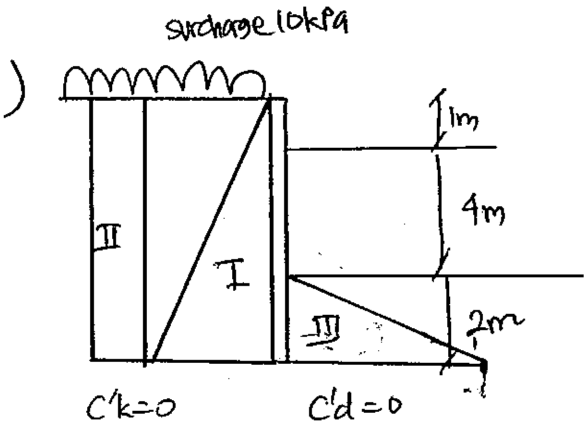
$= [(\pi+2)(142.86)(1)(0.943)+10]\,3.1$

$= 2178.25\text{ kN}$

(iii) & (iv) since $R_v > F_v$, bearing resistance ULS is satisfied

c) ΣM_v (stabilizing) $> \Sigma M_H$ (destabilizing)

Rotational ULS is satisfied //



$c'k = 0$ $\quad$ $c'd = 0$

$\phi'k = 32°$ $\quad$ $\phi'd = 32°$

$\gamma k = 20\ kN/m^3$ $\quad$ $\gamma d = 20\ kN/m^3$

$\delta' = 2/3\ \phi'$

DA1a

$\gamma_{G,unfav} = 1.35$ $\quad$ $\gamma_{\tan\phi'} = 1.0$

$\gamma_{G,fav} = 1.0$ $\quad$ $\gamma_{c'} = 1.0$

$\gamma_{Q,unfav} = 1.5$ $\quad$ $\gamma_{cu} = 1.0$

$\gamma_{Q,fav} = 0$ $\quad$ $\gamma_{\gamma} = 1.0$

a) Based on graph C.1.3 and C.2.3 on appendix, $\delta/\phi' = 0.66$ and $\beta/\phi' = 0.00$

$K_{aH} = 0.26$ and $K_{pH} = 5.7$

Pressure due to soil on left side (retained side) is considered active, while on the restraining side is considered passive. This is because the soil on retained side tends to overturn the wall.

(i) → Actions on Retained Side

Layer	Force	Lever Arm (m)	Moment (kN m)
I	$\underset{\gamma_{G,unfav}}{1.35} \times \frac{1}{2} \times 0.26 \times 20 \times 7^2 = 171.99\ kN$	$14/3 - 1$	630.63
II	$\underset{\gamma_{Q,unfav}}{1.5} \times 10 \times 0.26 \times 7 = 27.3\ kN$	2.5	68.25
	$F_{dest} = 199.29\ kN$		$\Sigma M_{dest} = 698.88$

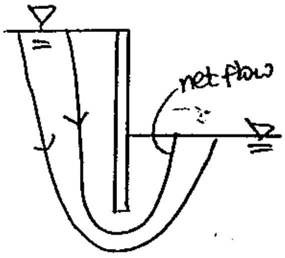
→ Actions on Restraining Side

Layer	Force	Lever Arm (m)	Moment (kN m)
III	$\underset{\gamma_{G,fav}}{1.0} \times \frac{1}{2} \times 5.7 \times 20 \times 2^2 = 228\ kN$	$4/3 + 4$	1216
	$F_{stab} = 228\ kN$		$\Sigma M_{stab} = 1216\ kNm$

(ii) Since $\Sigma M_{stab} > \Sigma M_{dest}$, Rotation ULS is satisfied

(iii) Since $F_{stab} > F_{dest}$, ~~strut force is zero.~~ However, a further evaluation should be made on K_{pH} used. The movement of wall may be not enough to activate $K_{pH} = 5.7$, lesser value of K_{pH} should be used

b) (i) There would be flow flowing from higher GWT to lower GWT, causing seepage



On retained side, seepage is acting downward, increasing the effective strength of soil, causing active earth pressure to increase

On retaining side, seepage is acting upward, decreasing the effective strength of soil, causing passive earth pressure to decrease.

(ii) Since active pressure ↑ and passive pressure ↓, overall stability of wall will be reduced.