CV3013 PYP 2017/18

1) a) Project Assessment and office / desk study

↓

Field reconnaissance or site visit

↓

Detailed planning of SI task

↓

Subsurface exploration or drilling
Sampling and in-situ testing

↓

Laboratory testing

↓

Groundwater exploration & monitoring

↓

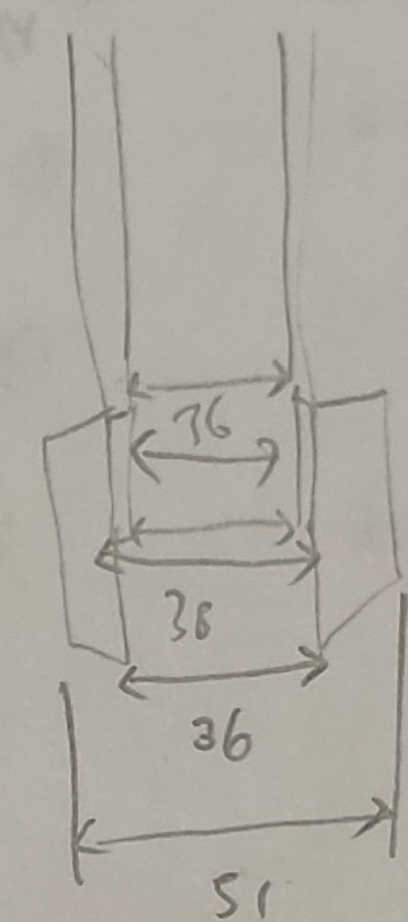
Synthesis of data & interpretation

b) ~~For long steel tube,~~

~~$C_a = \frac{d_w^2 - d_c^2}{d_c^2}$~~

~~$= \frac{47^2 - 38^2}{38^2}$~~

~~$= 52.98\%$~~



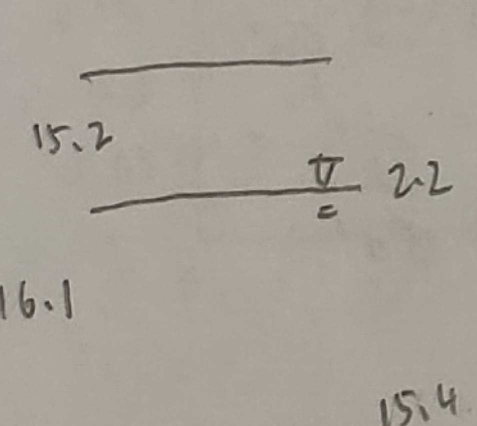
For cutting shoe

$C_a = \frac{51^2 - 36^2}{36^2}$

$= 100\%$

It is not possible to obtain undisturbed sample as both $C_a > 10\%$.

c)



$(N_1)_{60} = C_N N_{60}$

$C_N = \frac{A}{B + \sigma'_{v0}}$

NC fine sand, $A = 200$, $B = 100$

$\sigma'_{v0} = 15.2(2.2) + (16.1 - 10)(15.4 - 2.2)$

$= 113.96$ kN

$C_N = \frac{200}{100 + 113.96} = 0.935$

$(N_1)_{60} = 0.935(20) = 18.7$

$(N_1)_{60} / I_D^2 = 60$

$I_D^2 = (N_1)_{60} / 60$

$I_D = 0.558 = 55.8\%$

d) q_c @ 15.4 m = 11.2 MPa

$I_D = -1.21 + 0.584 \log \left(\frac{q_c}{(\sigma'_{v0})^{0.5}} \right)$

$= -1.21 + 0.584 \log \left(\frac{11.2 \times 10^3}{(113.96)^{0.5}} \right)$

$= 0.554$

$\approx 55.4\%$ ✓

$\phi'_{max} = 6.6 + 11 \log \left(\frac{q_c}{(\sigma'_{v0})^{0.5}} \right)$

$= 6.6 + 11 \log \left(\frac{11.2 \times 10^3}{(113.96)^{0.5}} \right)$

$= 39.83°$ ✓

2) a) The purpose of foundation is to transmit building loads to soil safety, in a process known as soil - structure interaction. Foundation needs to fulfill two principal performance requirement in order to perform in a satisfactory way. The first one being strength, where the capacity / resistance must be sufficient to support the loads applied. Next is serviceability where excessive deformation must be avoided under the loads which might damage the support structure or lead to lost of function. Other performance requirement may include constructability & cost.

b) i) DA1C1

$\gamma_{cu} = 1.0$ $\quad c_{u,d} = \frac{32}{1.0} = 32\ kPa$

$\gamma_\gamma = 1.0$ $\quad \gamma_d = \frac{18}{1.0} = 18\ kN/m^3$

$q_b = s_c N_c c_u + \sigma_q$

$s_c = 1.0 + 0.2\frac{B}{L} = 1.0 + 0.2\left(\frac{1}{1}\right)$
$= 1.2$

$q_b = 1.2(2+\pi)(32) + 0.6(18)$
$= 208.2\ kPa$

$R = q_b A = 208.2\ kN$

DA1C2

$\gamma_{cu} = 1.4$ $\quad c_{u,d} = \frac{32}{1.4} = 22.86\ kPa$

$\gamma_\gamma = 1.0$ $\quad \gamma_d = 18\ kN/m^3$

$q_b = s_c N_c c_u + \sigma_q$

$q_b = 1.2(2+\pi)(22.86) + 18(0.6)$
$= 151.84\ kPa$ ← , DA1b govern.

$R = q_b A = 151.84\ kN$

ii) $s_i = \mu_0 \mu_1 \frac{qB}{E}$

$d/B = 0.6/1 = 0.6$, $\mu_0 = 0.95$

$H/B = \infty$, $L/B = 1$, $\mu_1 = 0.65$

$s_i = (0.95)(0.65)\frac{0.85(1)(1)}{200(32)}$
$= 8.2mm$

$\Delta\sigma' = \frac{85 \times 1m^2}{(1+z)^2} = \frac{85}{(1+z)^2}$

$\sigma_0' = 0.6(18) + (19-9.81)z$
$= 10.8 + 9.19z$

infinite layers?

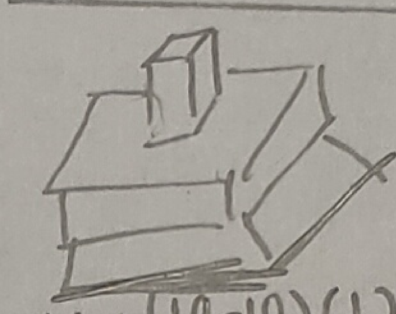
↓ 10% increase in stress. (Zone of influences).

D/2
B/2
1B — B
– 2B — B
(stress bulb)

ii) For square footing,
Try 4 layers

Layers	z(m)	$\Delta\sigma'$(kPa)	H(m)	σ_0'	σ_f'	soed
1	1	21.25	2	19.8	41.05	0.0594
2	3	5.3125	2	37.8	43.1125	0.0107
3	5	2.361	2	55.8	58.16	0.0034
4	7	1.328	2	73.8	75.13	0.0015

$\Sigma\ Soed = 0.075$



① $\sigma_0' = (18\times0.6) + (19-10)(1)$
$= 19.8\ kPa$
$\Delta\sigma' = \frac{85\times1\times1}{(1+1)(1+1)} = 21.25\ kPa$.

② $\sigma_0' = (18\times0.6) + (19-10)(3)$
$= 37.8\ kPa$
$\Delta\sigma' = \frac{85\times1\times1}{(1+3)(1+3)} = 5.3125\ kPa$

③ $\sigma_0' = (18\times0.6) + (19-10)(5)$
$= 55.8\ kPa$
$\Delta\sigma' = \frac{85\times1\times1}{(1+5)(1+5)} = 2.361\ kPa$

④ $\sigma_0' = (18\times0.6) + (19-10)(7)$
$= 73.8\ kPa$.
$\Delta\sigma' = \frac{85\times1\times1}{(1+7)(1+7)} = 1.328\ kPa$.

$Soed = \frac{H}{1+e_0}\left[C_r \log\left(\frac{\sigma_p'}{\sigma_0'}\right) + C_c \log\left(\frac{\sigma_f'}{\sigma_p'}\right)\right]$

For NC clay ⇒ $Soed = \frac{H}{1+e_0} C_c \log\left(\frac{\sigma_f'}{\sigma_0'}\right)$

$= \frac{2}{1+0.6}(0.15)\log\frac{\sigma_f'}{\sigma_0'}$

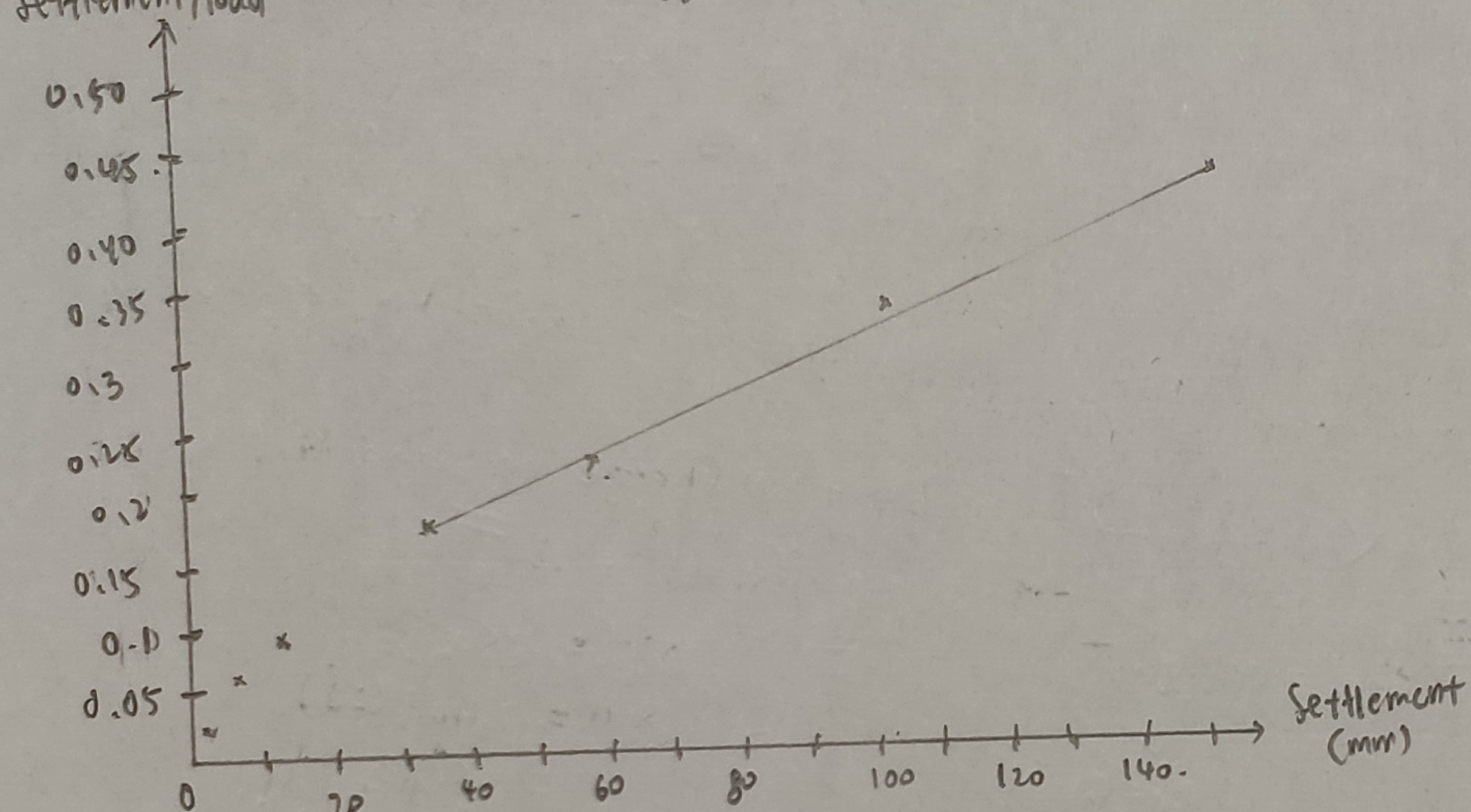
$= 0.1875 \log\frac{\sigma_f'}{\sigma_0'}$

$S_c = \mu_c\ soed$
$= (1)(0.075)$
$= 75mm.$

~~a~~ are two main approaches in determine side resistance of a pile foundation. The first one is the total stress method or α method and it is used for undrained soil. shaft resistance $\tau_{int} = \alpha C_u$ where α is a function of the method of installation, soil type and pile dimension.
Another method is the effective stress method or β method and it is used for drained soil. $\tau_{int} = \beta \sigma_z'$ where $\beta = k \tan \delta'$ and $k = \frac{\sigma_{ho}'}{\sigma_{vo}'}$

b) i)

Load (kN)	settlement	settlement / load
50	1.5	0.03
100	6.4	0.064
150	13.1	0.0873
200	35.2	0.176 ←
250	57.3	0.2292
300	102.0	0.334
350	153.7	0.439 ←



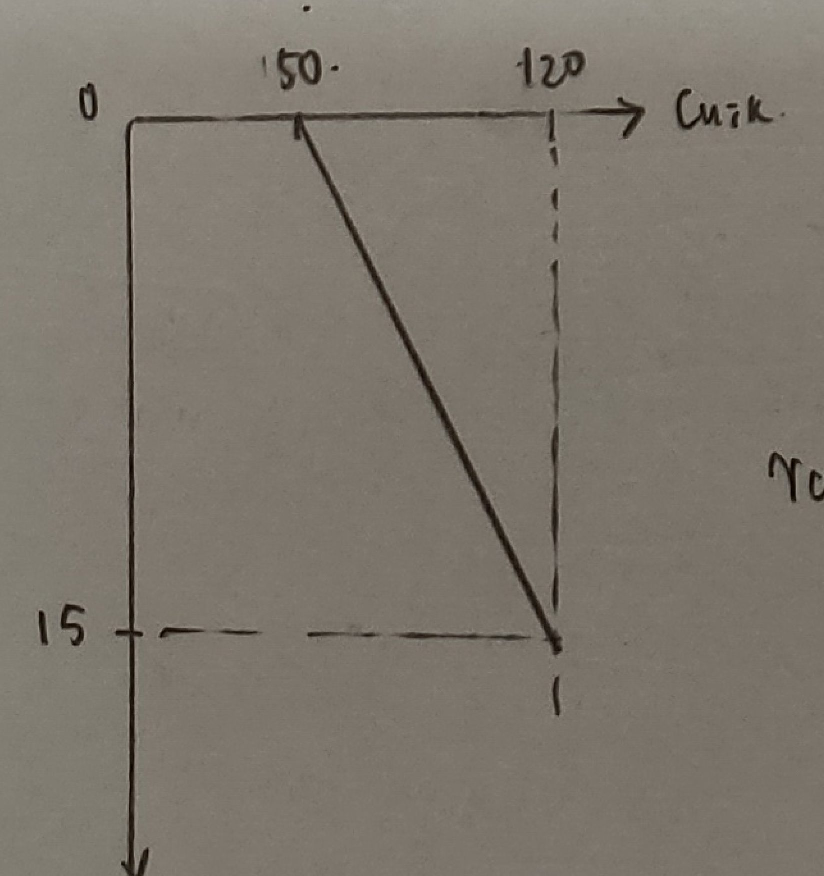
Gradient $= \frac{1}{P_{ult}} = \frac{0.439-0.176}{153.7-35.2} = 2.22 \times 10^{-3}$

$P_{ult} =$ ~~570.34~~ kN
450.6

ii) For n = 1, $\xi_1 = \xi_2 = 1.55$

$R_k = \frac{\text{~~570.34~~ } 450.6}{1.55} =$ ~~367.96~~ 290.71 kN

iii) DA1b A2 + M1 + R4



γ_{cu} = ~~1.4~~ ~~C_{ud} = $\frac{50+4.67z}{1.4}$ = 35.714 + 3.333z~~

$\gamma_\gamma = 1.0$ $\gamma_d = \frac{18.5}{1.0} = 18.5 \text{ kN/m}^3$

$C_{uk} = 50 + (\frac{120-50}{15-0})z$

$= 50 + 4.67z$

$\gamma_{cu} = 1.0 \Rightarrow C_{ud} = 50 + 4.67z$

σ_{vo}

$$\frac{4 \times 0.2 \times 1.29 \left[\frac{(50+4.67z)^{1.75}}{1.75(4.67)} \right]_0^{12}}{1.4 \times 1.5}$$

$= 0.49(313.72)$

$= 153.725$

iii) $d/B = 12/0.2 = 60$
$B/L = 0.2/0.2 = 1$ } $N_c = 9.0$

$Q_{bn} = A_p(N_c C_u + \sigma_a)$

$$Q_{b,d} = \frac{A_p[s_c N_c (\frac{C_u}{\gamma_{cu}}) + (\frac{\gamma}{\gamma_\gamma}) L_p]}{\xi \gamma_{Rib}}$$

$$= \frac{0.2^2[9(50+4.67\times12) + 18.5(12)]}{1.4(1.7)}$$

← for driven piles (base)

$= 19.8$ kN

~~$\alpha = 1.16 - \frac{C_u}{185}$ for $30 < C_u < 150$~~

~~$\alpha = 1.16 - \frac{35.714 - 3.333z}{185}$~~

~~$= 1.16 - 0.193 - 0.018z$~~

~~$= 0.967 - 0.018z$~~

~~$$Q_{sid} = \frac{A_s \int_0^{12} \alpha \frac{C_u}{\gamma_{cu}} dz}{\xi_s \gamma_{Ris}}$$~~

~~$$= \frac{(4\times0.2)\int_0^{12}(0.967-0.018z)(35.714+3.333z)dz}{1.4(1.5)}$$~~

$= \frac{8}{21}\int_0^{12} 34.535 + 2.582z - 0.06z^2 \, dz$

$= \frac{8}{21}(34.535z + 1.29z^2 - 0.02z^3)_0^{12}$

$= 215.47$ kN

★ For driven piles.

$\tau_{int} = \alpha c_u$ (12)

$\sigma_{vo} = (18.5 - 9.81)z =$ ~~4.345z~~ 52.14.

For depth 0 to 12m, $\frac{C_u}{\sigma_{vo}} \geq 1.0$

$\alpha = 0.5 F_p (\frac{C_u}{\sigma_{vo}})^{-0.25}$

$\frac{L_p}{D_o} = 60$, $F_p = 1 + (\frac{60-50}{120-50})(0.7-1.0)$

$= 0.96$

$\alpha = 0.48(\frac{C_u}{\sigma_{vo}})^{-0.25}$

$= 0.48(\frac{50+4.67z}{\text{~~4.345z~~ } 52.14})^{-0.25}$

$\tau_{int} = \alpha C_u$

$= 0.48(\frac{50+4.67z}{\text{~~4.345z~~ } 52.14})^{-0.25}(50+4.67z)$

$$Q_{suid} = \frac{4\times0.2 \times \int_0^{12} 0.48(\frac{50+4.67z}{\text{~~4.345z~~ } 52.14})^{-0.25}(50+4.67z)}{1.4\times1.5}$$

$= 0.183 \int_0^{12} (50+4.67z)^{0.75} (\frac{1}{4.345z})^{-0.25} dz$

$=$

iv) The pile may break as driving pile into sand layer would be difficult. Hard driving may cause delays & replacement changes or suffer damage.

↳ surcharge applied to the clay layer causing the clay layer to consolidate & generate -ve pwp.

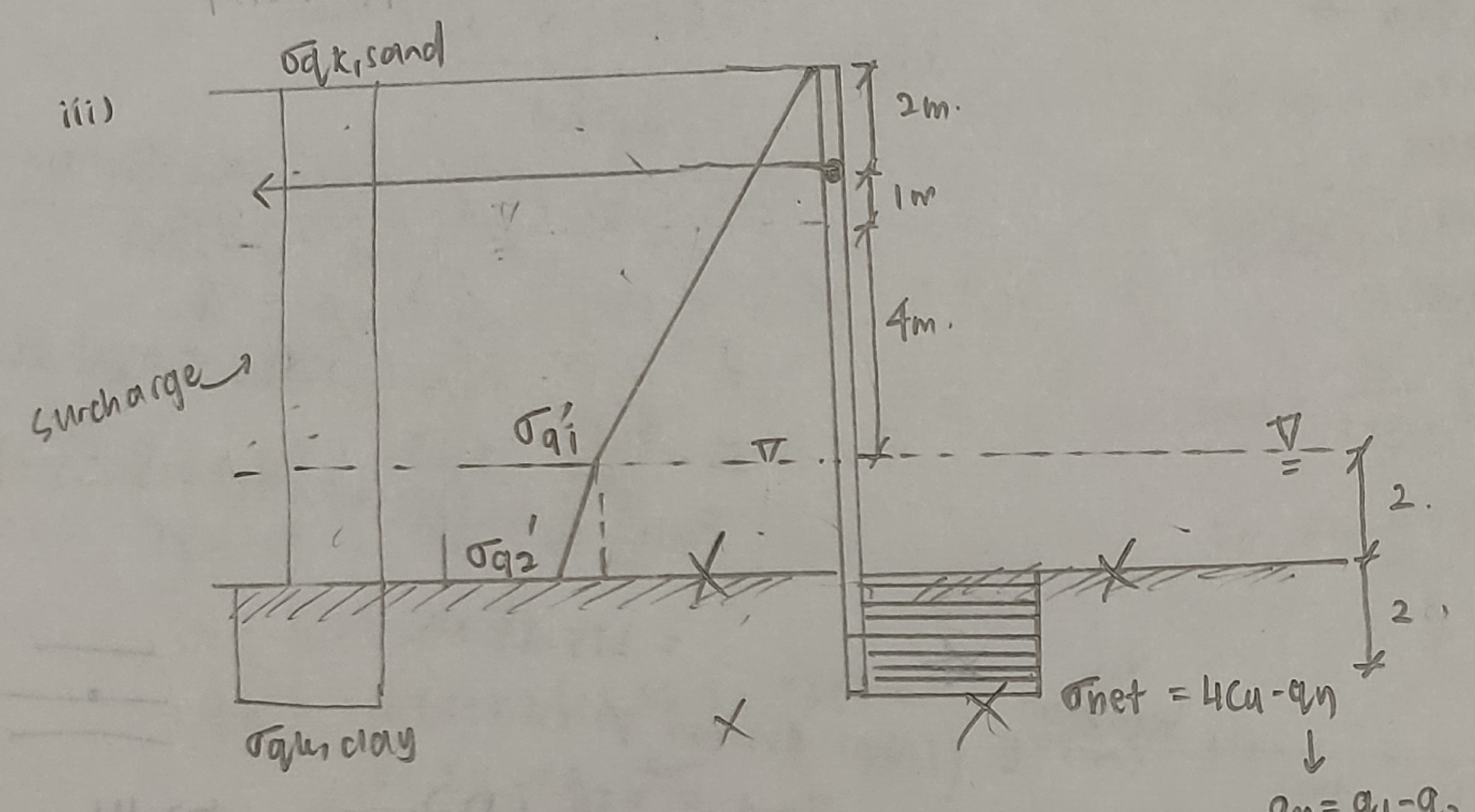
✓ pile longer (no sufficient, acc for -ve skin friction)

4) a) i) The main assumptions for free earth support method is that the wall is rigid compared to the soil. Also, the base of the wall is assume to be entirely free to rotate and there is no passive resistance to backward movement of the wall. The point on the wall at which the anchor / prop is attached will move forward sufficiently to develop active pressure on the back of the wall. The depth of penetration D required for equilibrium is determined by taking moments abt the anchor point. This yields a cubic equation in D which can be solved by trial & error.

ii) Low tide water level is more critical as the active pressure is higher in sand.

* water on both sides of the wall are at the same level & cancel out

iii)



DA1b - Rankine

$\gamma_\phi' = 1.25$ $\quad \phi'_d = \tan^{-1}[\tan(30)/1.25] = 24.8°$ ✓

$\gamma_{cu} = 1.4$ $\quad c_{u,d} = c_{u,k}/\gamma_{cu} = \frac{84}{1.4} = 60$ kPa. ✓

$\gamma_\gamma = 1.0$ $\quad \gamma_{k\,sand} = \frac{18}{1.0} = 18$ kN/m³

$\gamma_{k\,clay} = \frac{16}{1.0} = 16$ kN/m³

$K_a = \frac{1-\sin\phi_d'}{1+\sin\phi_d'} = 0.409$ ✓

$\sigma_{a1}' = K_a\gamma H = 0.409(18)(7) = 51.534$ kPa

$\sigma_{a2}' = K_a\gamma H = 0.409(18\times7 + (18-10)(2)) = 58.078$ kPa

For clay at z = 9m.

$\sigma_a = 18(9) - 2(60) = 42$ kPa.

$\sigma_p = 2(10) + 2(60) = 140$ kPa.

—or—

For clay at z = 11m.

$\sigma_a = [18(9) + 16(2)] - 2(60) = 74$ kPa.

$\sigma_p = [2(10) + 16(2)] + 2(60) = 172$ kPa

$\sigma_{net} = \sigma_p - \sigma_a = 98$ kPa.

— or —

$\sigma_{net} = 4c_u - q_n = 4(60) - [18\times9 + 2\times10]$

$= 98$ kPa.

q_n = $q_1 - q_2$

$q_1 - q_2 = 18(9) - 2\times10$

iv) Using single source principle

Active pressure (kPa)	lever arm (m)	Moment
$\frac{1}{2}(7)(51.534)(1.0) = 180.369$	$(2/3)(7) - 2 = 8/3$	480.984
$(51.534)(2)(1.0) = 103.068$	$5+1 = 6$	618.408
$\frac{1}{2}(58.078-51.534)(2)(1.0) = 6.544$	$(2/3)(2)+5 = 19/3$	41.44
ΣPa,d = 289.981	ΣMo,d =	1140.832
Passive pressure (kPa)		
$98\times2\times1.0 = 196.$	$1+4+2+1 = 8$	1568

$ODF = \frac{\Sigma M_{R,d}}{\Sigma M_{O,d}} = 1.37$ //

Sum forces horizontally

$T + P_p = P_a$

$T = P_a - P_p$

$= 289.981 - 196$

$= 93.981 \times 2$

$= 187.962$ kN / anchor //

b). + surcharge on sand fill

20 $\quad \gamma_{Q,dst} = 1.3$

$\sigma_a' = K_a q$

sand $= 0.409(20)$

$= 8.18$

K_a ($\phi = 0$)

σ_a' clay $= 1.0\times20$

$= 20$.

For sand, design lateral pressure

$= 8.18(1.3) = 10.63$ kPa.

For clay $= 20(1.3) = 26$ kPa

no surcharge, $\sigma_{net} = 98$ kPa.

with surcharge, $\sigma_{net} = 98 - 26 = 72$ kPa.

Active pressure

289.981		1140.832
$10.63\times9 = 95.67$	$\frac{9}{2} - 2 = 2.5$	239.175
		1380.1
$72\times2\times1.0 = 144$	8	1152

$ODF = \frac{1152}{1380} = 0.835$ //

not satisfied!!