1. a) (i) - To evaluate surface site conditions
- To assess variability of subsoil conditions
- To identify geotechnical hazards
- To establish soil profiles for design
- To determine design soil parameters

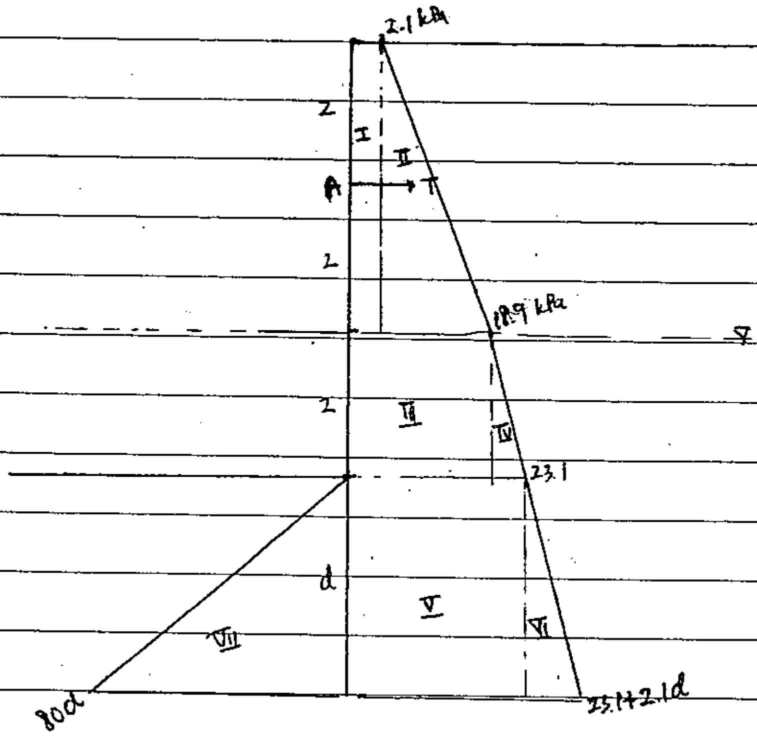
(ii) 1. Project Assessment & office study
2. Field reconnaissance or site visit
3. Detail planning
4. Subsurface exploration or drilling, sampling & in-situ testing
5. Laboratory testing
6. Groundwater exploration and monitoring
7. Synthesis and interpretation

(iii) Y. The first one will save budget more. Sounding test is a reliable test. From the result, we can trace how the subsoil condition is and conduct necessary boreholes only at critical locations rather than doing excessive boreholes, where we may not locate the critical locations and the results of interpolations (soil profile) are not accurate.

1- b)

From log-spiral graph, $K_{ph} \approx 8$

$K_{ah} = 0.21$



	Force	Moment arm from A
I	$2.1 \times 4 = 8.4$	0
II	$\frac{1}{2}(18.9-2.1)4 = 33.6$	$2 - \frac{4}{3} = \frac{2}{3}$
III	$18.9 \times 2 = 37.8$	3
IV	$\frac{1}{2}(23.1-18.9)2 = 4.2$	$2 + \frac{4}{3} = \frac{10}{3}$
V	$23.1d$	$4 + \frac{d}{2}$
VI	$\frac{1}{2}(2.1d)(d) = 1.05d^2$	$4 + \frac{2}{3}d$
VII	$\frac{1}{2}(80d)(d) = 40d^2$	$4 + \frac{2}{3}d$

$$\Sigma M_A = 0$$

$$0 + \left(33.6 \times \tfrac{2}{3}\right) + (37.8 \times 3) + \left(4.2 \times \tfrac{10}{3}\right) + 23.1d\left(4 + \tfrac{d}{2}\right) + 1.05d^2\left(4 + \tfrac{2}{3}d\right) = \tfrac{1}{2}\ 40d^2\left(4 + \tfrac{2}{3}d\right)$$

$$22.4 + 113.4 + 14 + 92.4d + 11.55d^2 + 4.2d^2 + 0.7d^3 = 80d^2 + 13.333d^3$$

$$0 = 12.633d^3 + 64.25d^2 - 92.4d - 149.8$$

$$d = 1.923$$

P.S: heard that most std can't get the "d" within the range.

1 b) (iii) $\Sigma F_x = 0 \rightarrow$ get T value

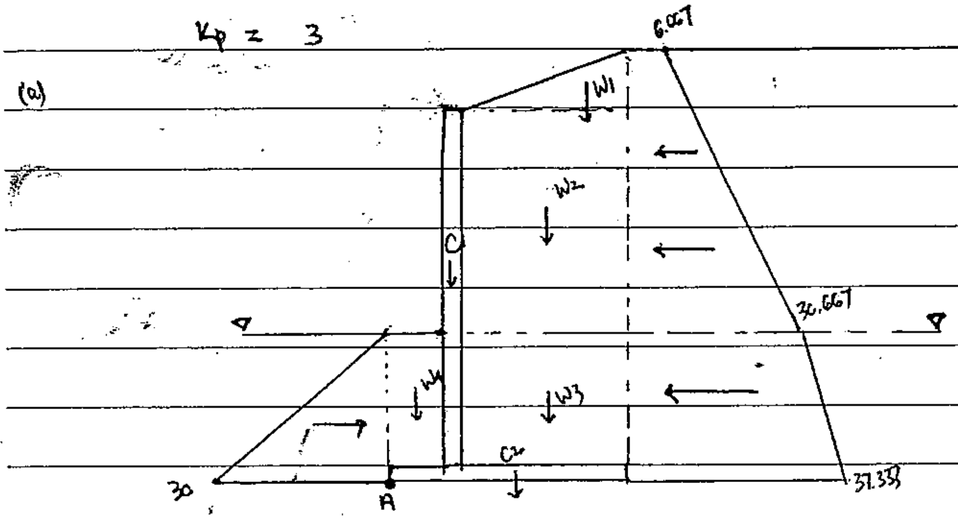
since the tie backs are installed at 2m spacing, the force in the tieback will be 2T

2

Sand $K_A = \dfrac{1-\sin 30}{1+\sin 30} = \dfrac{1}{3}$

$K_p = 3$

(a)



(b) Sliding : Find total weight :

~~$W_1 = \frac{1}{2}(2.4)(1)(18) = 21.6$~~

~~$W_2 = 3 \times 2.4 \times 18 = 129.6$~~

~~$W_3 = (1.7)(2.4)(20) = 81.6$~~ → actually no need to calc if the base is clay

~~$W_4 = (1.7)(20)(0.8) = 27.2$~~

~~$C_1 = (24)(0.3)(4.7) = 33.84$~~

~~$C_2 = (3.5)(0.3)(24) = 25.2$~~

~~319.04 kN/m~~

↳ Adhesion $= (50)(3.5) = 175$ kN/m

$$FS_{sliding} = \frac{\left(\frac{1}{2}\times 30 \times 2\right) + 175}{\frac{1}{2}(6.667+30.667)(4) + 30.667\times 2 + \frac{1}{2}(37.333-30.667)2}$$

$$= \frac{205}{143}$$

$$= 1.434$$

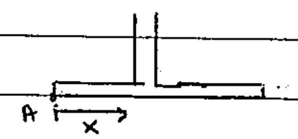
2 (b) Overturning

Overturning Force	Lever Arm (from A)	Moment
$6.667 \times 6 = 40$	3	120
$\frac{1}{2}(30.667 - 6.667)(4) = 48$	$2 + \frac{4}{3} = \frac{10}{3}$	$= 160$
$(30.667 - 6.667)(2) = 48$	1	48
$\frac{1}{2}(37.333 - 30.667)(2) = 6.666$	$\frac{2}{3}$	4.444
		332.444 kNm/m

Counterbalance Force	Lever Arm	Moment
$W_1 = 21.6$	$0.8 + 0.3 + \frac{2}{3}2.4 = 2.7$	58.32
$W_2 = 129.6$	$0.8 + 0.3 + 1.2 = 2.3$	298.08
$W_3 = 81.6$	2.3	187.68
$W_4 = 27.2$	0.4	10.88
$C_1 = 33.84$	$0.8 + 0.3/2 = 0.95$	32.148
$C_2 = 25.2$	$3.5/2 = 1.75$	44.1
passive $= \frac{1}{2} \times 30 \times 2 = 30$	$\frac{2}{3}$	20
		651.208 kNm/m

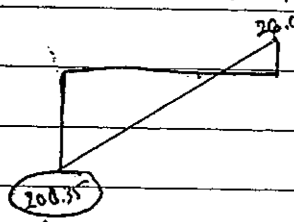
$$FS_{overturning} = \frac{651.208}{332.444} = 1.96$$

(c)



$$x = \frac{651.208 - 332.444}{319.04} = 0.999 \approx 1$$

$\hookrightarrow e = \frac{3.5}{2} - 1 = 0.75$



$$q = \frac{319.04}{3.5}\left(1 \pm \frac{6 \times 0.75}{3.5}\right)$$

$$= 91.15 \pm 117.20$$

$\hookrightarrow$ The design is not satisfactory as $q_{max} > C_u = 100kPa$

2 (d) – Decrease GWT at the left of wall, passive force will increase significantly

3 (a)

(i) Vesic's bearing cap:

$\gamma_{weighted} = 18 \text{ kN/m}^3$

$\underline{\underline{C_{u\,weighted}}} = \frac{25+35}{2} = 30 \text{ kPa}$

$\hookrightarrow$ Total stress analysis

$q_{ult} = c N_c S_c d_c + \sigma_{zD} N_q S_q d_q + 0.5 \gamma B N_\gamma S_\gamma d_\gamma$

$N_c = 5.14$ $\quad S_c = 1 + \left(\frac{1}{1}\right)\left(\frac{1}{5.14}\right) = 1.195$ $\quad k = \frac{1}{2},$ $\quad d_c = 1.2$

$N_q = 1$ $\quad S_q = 1 + \left(\frac{B}{L}\right)\tan 0^\circ = 1$ $\quad d_q = 1$

$N_\gamma = 0$ $\quad S_\gamma = 1 - 0.4 = 0.6$

$q_{ult} = (30)(5.14)(1.195)(1.2) + (18)(1)(1)(1) + 0$

$\doteq 239.1 \text{ kPa}$

(ii) $FS = \frac{q_{ult} - \sigma_{zD}}{q_{net}}$

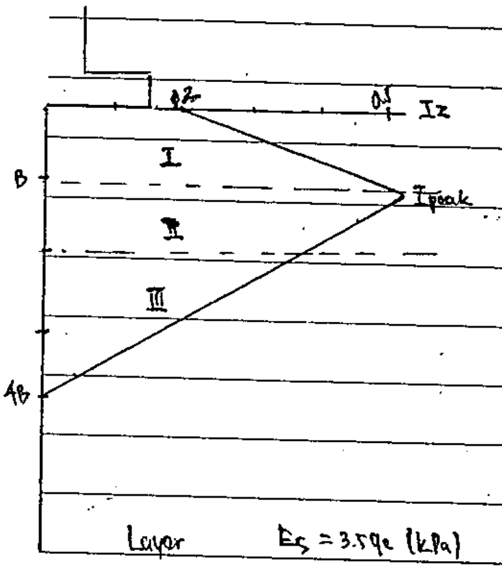
$q_{net} = \frac{239.1 - 18}{3.5} = 63.2 \text{ kPa}$

(iii) Ult bearing capacity will remain unchanged as the failure surface/plane doesnot intersect the hard strata.

3 (b) (i) Because it is difficult to obtain undisturbed sand sample.

(ii) $\frac{L}{B} = 10$ $\quad B = 2m$ $\quad E_s$ use $3.5q_c$

$$p = \frac{222}{2} + \frac{24.5 \times 2 \times 20 \times 1}{2 \times 20} = 135.5 \text{ kPa}$$

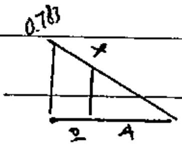


$\Delta p = 135.5 - 15 = 120.5$ kPa

$\sigma'_{zp} = 5(1+2) = 15$ kPa

$I_{peak} = 0.5 + 0.1 \left(\frac{120.5}{15} \right)^{0.5} = 0.783$

Layer	$E_s = 3.5q_c$ (kPa)	I_z	$\Delta z'$	$\frac{I_z}{E_s} \Delta z$ (m/kPa)
I	7000	$\frac{0.2+0.783}{2} = 0.4915$	2	1.4043×10^{-4}
II	14000	$\frac{0.783+0.522}{2} = 0.6525$	2	9.32×10^{-5}
III	10500	$\frac{0.522}{2} = 0.261$	4	9.94×10^{-5}
				$\Sigma = 3.33 \times 10^{-4}$



$\frac{x}{0.783} = \frac{4}{6}$

$C_1 = 1 - 0.5 \left(\frac{5}{120.5} \right) = 0.979$

$C_2 = 1$

$C_3 = 1.03 - 0.03 \left(\frac{20}{2} \right) = 0.73$

$\delta = (0.979)(1)(0.73)(120.5)(3.33 \times 10^{-4})$ m

$= 0.0287$ m

$= 2.87$ cm

4 a) (i) Grade 40

$Fa = \frac{40\ MPa}{4} = 10\ MPa \geq 7.5\ MPa$

↳ According to CP4, $Fa = 7.5\ MPa$

(ii) Clay 1 : $Cu = 20 \rightarrow \alpha = 1$ $fs = (1)(20) = 20\ kPa$

Clay 2 : $Cu = 37.5 \rightarrow \alpha = 0.875$ $fs = (0.875)(37.5) = 32.8125\ kPa$

Clay 3 : $Cu = 100 \rightarrow \alpha = 0.5$ $fs = (0.5)(100) = 50\ kPa$

Side Resistance $= \pi(0.5)\left[20\times2 + 32.8125\times6 + 50\times3\right]$

$= 607.7\ kN$

(iii) $Cu = 100 \rightarrow Nc^{*} = 9$

$qt = (9)(100) = 900\ kPa$

Bearing Resistance $= 900 \times \frac{1}{4}\pi\,(0.5)^2$

$= 176.7\ kN$

(iv)

$Pa = \frac{607.7 + 176.7}{3} = 261.5\ kN$

Structural $Pa = 7.5 \times 1000 \times \frac{\pi}{4}(0.5)^2 = 1473\ kN$

Allowable downward load cap of pile is 261.5 kN

(v) $990 = 0.8\ N\ (261.5)$

$N = 4.73 \approx 5$ piles

4 (b) Construct an imaginary pad footing ~~as~~ with same size as the pile group.

Place the footing at depth $z_i = \frac{2}{3} D$ (D= length of pile). Treat the footing as footing without embedment and calculate the settlement like usual --- (Schmertmann's Method)

(b) When GWT is lowered, there is an increase in effective stress which make the clay deposit undergone consolidation.

During the consolidation process, the pile group capacity will drop because of negative skin friction.

Upon completion of consolidation, the pile ~~g~~group capacity will increase as the downdrag decreasing, but at final point, the capacity is still smaller than initiall capacity before GWT being lowered