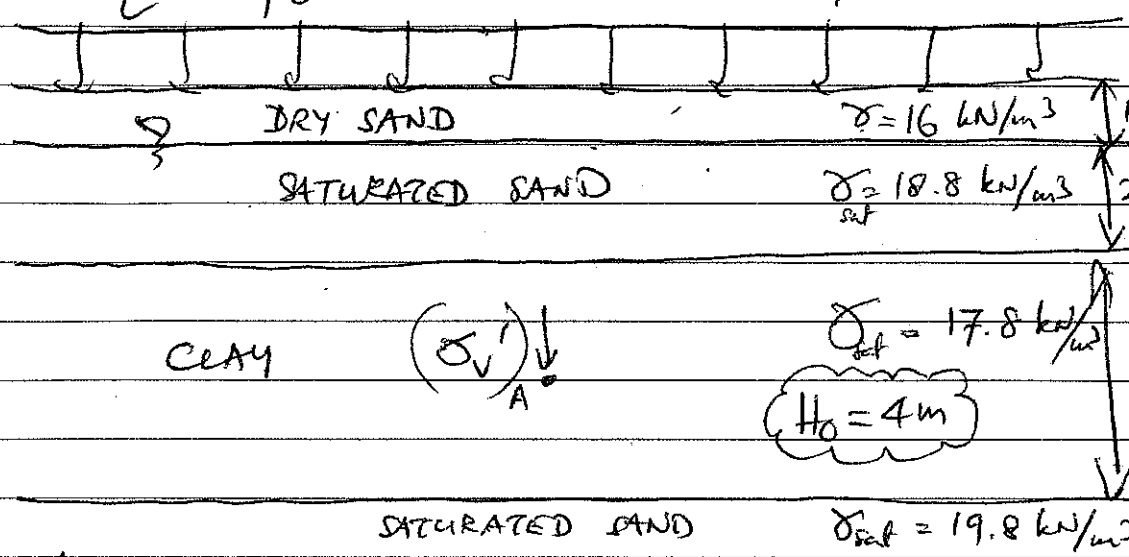
CIVL 311 Dec 2011 Answers — Final Exam

1.



(a) $\sigma_v' = 1 \times 16 + (18.8 - 9.8) \times 2 + (17.8 - 9.8) \times 2$

[1] $= 16 + 18 + 16 = \underline{50 \text{ kPa}}$

[2] In situ void ratio. $e_0 = 0.97 - \frac{0.03}{\log(\frac{50}{10})} \times \log(\frac{50}{10}) = \underline{0.949}$ ←

[2] Recompression index $= \frac{0.97 - 0.94}{\log(100/10)} = \underline{0.03}$ ←

[2] Compression index $= \frac{0.94 - 0.64}{\log(1000/100)} = \underline{0.30}$ ←

[1] Preconsolidation pressure $= \underline{100 \text{ kPa}}$ ←

[1] Overconsolidation ratio $= \frac{100}{50} = \underline{2.0}$ ←

(b) $\left(\frac{\rho}{c}\right)_{\text{after 70 kPa}} = \frac{4}{(1+0.949)} \times \left[0.03 \log \frac{100}{50} + 0.3 \log \frac{50+70}{100}\right]$ [3]

[2] [2]

$= \frac{4}{1.949} \times (0.009 + 0.0237)$ [3]

$= \underline{0.067 \text{ m}}$

(c) $(H_0)_{new} = (4 - 0.067) = \underline{3.933\ m}$ [1]

$e_{new} = ~~0.984~~\ 0.937$ [1]

$$\rho_c = \frac{3.933}{1+0.937} \times 0.3 \log\left(\frac{120+30}{120}\right)$$

[2] [2]

$$= \underline{0.059\ m} \quad [2]$$

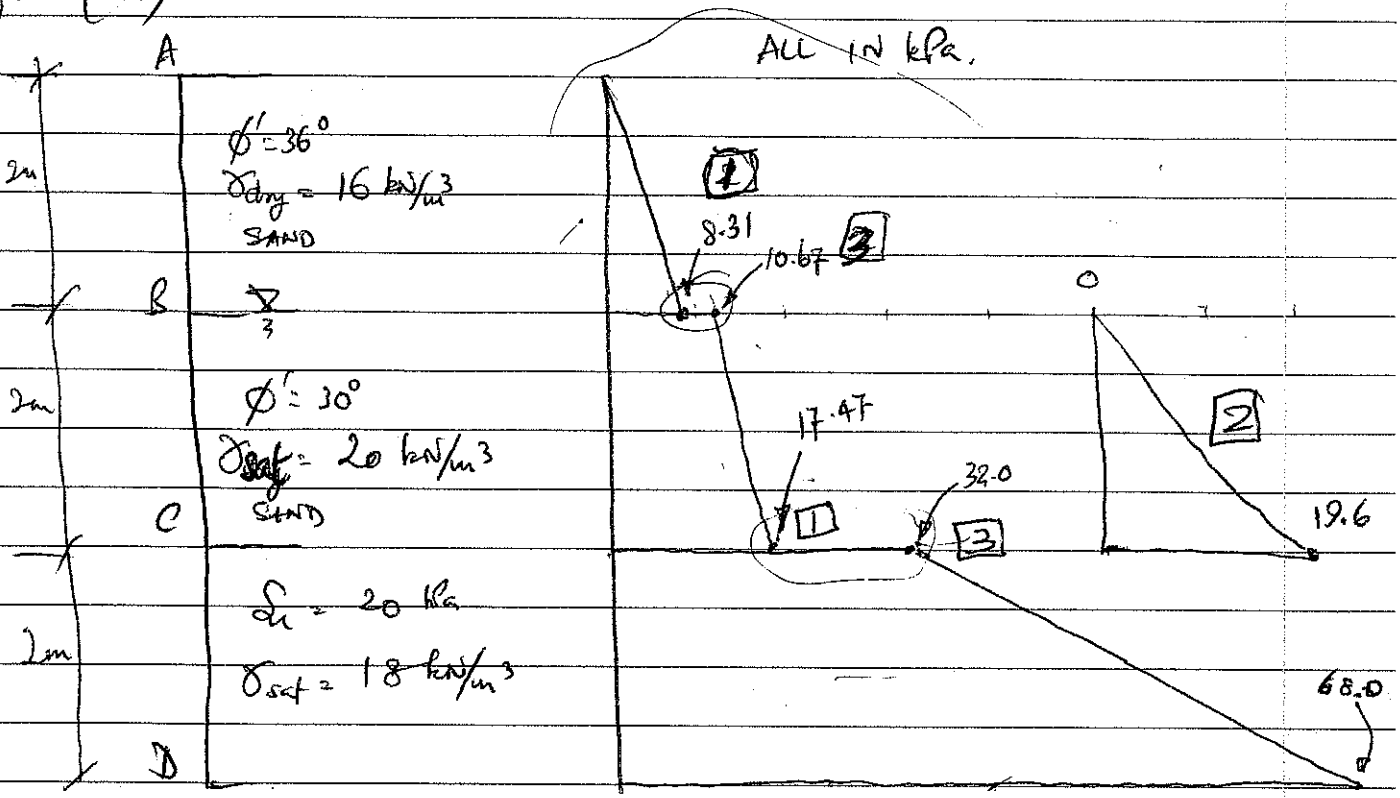
(d) $\dfrac{C_v t_{90}}{H_{dr}^2} = 0.848.$ [3]

$$t_{90} = \frac{0.848 \times (1.966)^2 \times 10^4\ \frac{cm^2}{cm^2}.s}{3.2 \times 10^{-3}}$$

$$= 10242663\ sec$$

$$= \underline{3.9\ months.} \quad [1]$$

(2). (a).

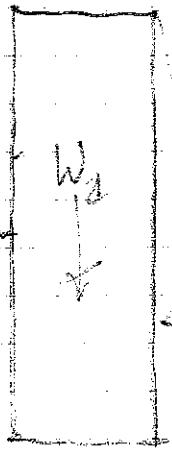


$K_a = \frac{1-\sin 36°}{1+\sin 36°} = 0.2596$ $\qquad$ $K_a = \frac{1-\sin 30°}{1+\sin 30°} = 0.333$

	σ_v (kPa)	u (kPa)	σ (kPa)	σ' (kPa)	
A	0	0	0	0	0 kPa
B	32	0	32.0	32×0.2596	8.31 kPa
				32×0.333	10.67 kPa
C	72	2×9.81 ($= 19.62$)	52.4	52.4×0.333	17.47 kPa
D	108	4×9.81 ($= 39.24$)	68.8	$72 - 2 \times 20$	32.0 kPa
				$108 - 2 \times 20$	68.0 kPa

3 3 3

| 0.75 | 2(b) CIVL 311



$\gamma = 18\ kN/m^3$

$\phi' = 33^0$ $\quad K_A = 0.29$ [1]

$P_A = \frac{1}{2} \cdot 11.75 \cdot 2.25 = 13.2\ kN$ [2]

$(\sigma_{xa}) = 18 \times 2.25 \times 0.29 = 11.75\ kPa$ [1]

$W = 0.75 \times 2.25 \times 24 = 40.5\ kN$ [2]

Sliding. Driving = 13.2 kN

Resisting = $40.5 \times 0.45 = 18.2\ kN$ [2]

$\therefore F.S. = \frac{18.2}{13.2} = \underline{1.38}$ [1]

Overturning	Force	Mom Arm	Mom
Driving	13.2	0.75	9.9 [2]
Resisting	40.5	0.375	15.2 [2]

F.S. = 1.53. [1]

Water table rises to ground surface.

New active pressure = $(18 \times 2.25 - 9.81 \times 2.25) \times 0.29$

= 5.3 kPa. [1]

Active force $= \frac{1}{2} \cdot 5.3 \times 2.25 = 6$ kN [2] Page 2

Water force $= \frac{1}{2} \times 9.81 \times 2.25^2 = 24.8$ kN. [2]

$\therefore$ Driving force $= 30.8$ kN

Resisting $= 18.2$ kN

$\therefore$ Failure. [1]

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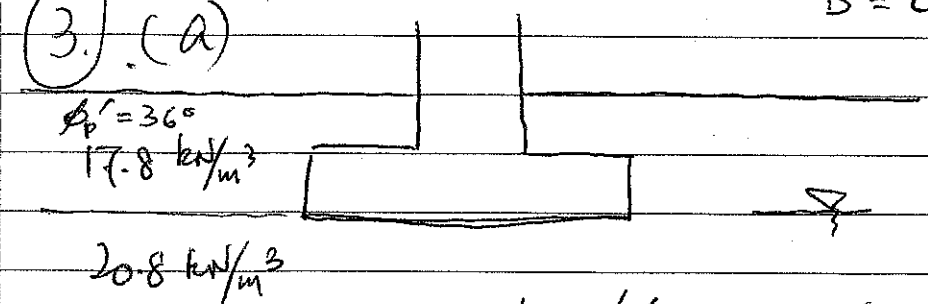
$B' = 2.0\text{ m} \quad 2Q = L'$

$B' = L' = 2\text{ m}.$

3. (a)



$$N_q = e^{\pi \tan \phi_p'} \tan^2\left(45° + \frac{\phi_p}{2}\right)$$

$$= e^{(\pi \tan 36°)} \tan^2\left(45° + \frac{36°}{2}\right).$$

$$= 9.801159 \times (3.85184)$$

$$N_q = 37.8 \quad \boxed{2}$$

$$N_\gamma = 0.1054 \times e^{9.6\phi} \quad (9.6 \times 36 \times \tfrac{\pi}{180})$$

$$= 0.1054 \times e$$

$$= 43.9 \quad \boxed{1}$$

$$S_q = \left\{1 + \left(\tfrac{2}{2}\right) \times \tan 36°\right\} = 1.7265 \quad \boxed{1}$$

$$S_\gamma = 1 - 0.4\left(\tfrac{2}{2}\right) = 0.6 \quad \boxed{1}$$

$$d_q = 1 + \left[2 \times (\tan 36°) \times (1 - \sin 36°)^2\right] \times \tfrac{1}{2}$$

$$= 1.12 \quad \boxed{2}$$

$$d_\gamma = 1. \quad \boxed{1}$$

Case 2 & Case 3 — border — both applies

$D_f = Z.$

$$W_q = 1 \quad W_\gamma = \frac{\gamma'}{\gamma_{sat}} = \frac{(20.8 - 9.8)}{20.8} = 0.529 \quad \boxed{1}$$

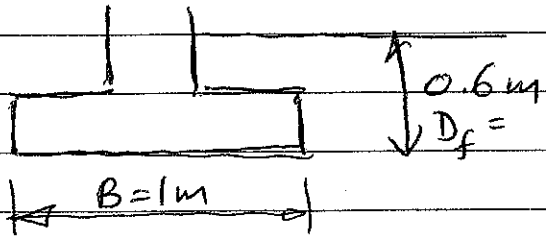
$$q_u = 17.8 \times 1 \times (37.8 - 1) \times 1.7265 \times 1.12 \times 1$$

$$+ 0.5 \times 20.8 \times 2 \times 43.9 \times (0.6 \times 1 \times 0.529)$$

$$= 1266.63 + 289.8 = 1556 \text{ kPa}$$

$$\boxed{1}$$

(b)



$\gamma = 18\ kN/m^3$

$c_u = 40\ kPa$.

$$S_c = 1 + 0.2\left(B'/L'\right) = 1 + 0.2 \times \frac{1}{2} = 1.1 \leftarrow$$ [2]

$\frac{D_f}{B} \leq 1$, $d_c = 1 + 0.33\left(\frac{0.6}{1}\right) = 1.198$. [2]

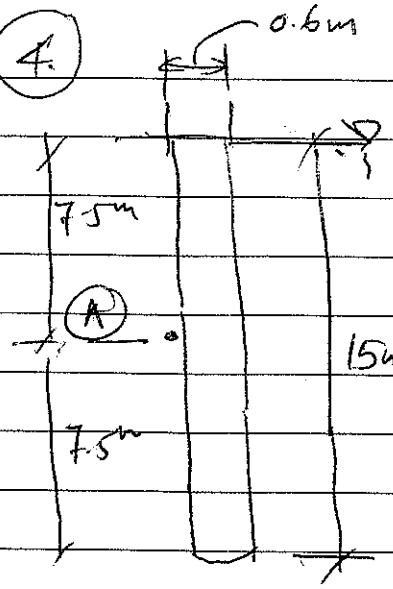
$$q_u = 5.14 \times 40 \times 1.1 \times 1.198$$ [4]

$$= \underline{270.9\ kPa}$$. [2] (10)

(15)

4.

(a)



$(q_u)_{remoulded} = 35$ kPa.

$\gamma_{sat} = 17.8$ kPa.

$\gamma' = (17.8 - 9.8) = 8$ kPa.

$(\sigma'_{zo})_{\substack{7.5m \\ depth}} = 7.5 \times 8 = 60$ kPa. [2]

① $(f_s) = 0.5\sqrt{35 \times 60} = 22.9$ kPa. [2]

② $(f_s) = 0.5 (35)^{0.75} (60)^{0.25} = 20.02$ kPa. [2]

Use 20.02 kPa.

Perimeter $= \pi \times 0.6 = 1.885$ m. [1]

Tip Area $= A_b = \pi \times \frac{0.6^2}{4} = 0.2827$ m^2. [1]

$Q_f = (20.02) \times 1.885 \times 15$

$= 566.1$ kN [2]

$Q_b = N_c (q_u)_b A_b$

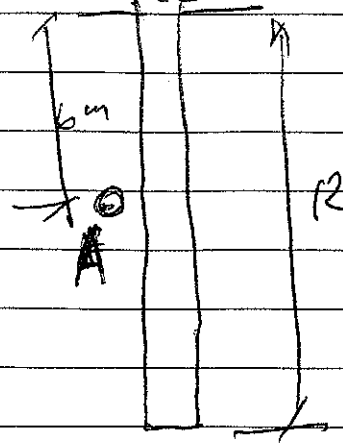
$= 9 \times 35 \times 0.2827$ [2]

$= 89.05$ kN.

$Q_{all} = \frac{Q_{ult}}{3} = \frac{566.1 + 89.1}{3} = 218.4$ kN ⇐

[3]

(4)(b)



(15)

$\phi'_{cs} = 32^\circ$.

$\delta = 27^\circ$

$\gamma_{sat} = 18.8\ kN/m^3$.

$(\sigma'_{so})_{at\ A} = 6 \times (18.8 - 9.8)$

$= 54\ kPa$ [2]

$\beta = (1 - \sin 32^\circ) \tan 27^\circ = 0.2395$. [3]

Perimeter $= \pi \times 0.33 = 1.037\ m$ [1]

Pile End Area $A_b = \frac{\pi \times (0.33)^2}{4} = 0.0855\ m^2$ [1]

$N_q = 0.6 \times \exp[0.126 \times 32]$

$= 33.82$ [3]

$Q_f = 0.2395 \times 1.037 \times 12 \times 54$

$= 160.93$ kN. [1]

$Q_b = 33.82 \times 0.0855 \times (12 \times (18.8 - 9.8))$

$= 312.29\ kN$ [1]

$Q_{ult} = 312.29 + 160.93 = 473.22$ [2]

$Q_{all} = \frac{473.22}{3} = 157.74$ kN. [1]