DELFT UNIVERSITY OF TECHNOLOGY

Faculty of Civil Engineering and Geosciences

Soil Mechanics I – MOCK EXAM I

CT1091

BSc EXAMINATION 2012

ANSWER BOOK

FOURTH PERIOD

Answer ALL Questions
(Note that the questions carry unequal marks)

Other instructions
Write your name on each sheet

Clearly identify the answer in the answer box

Question No.	Workings	Answer
1a	From inspection, assuming that river is connected to permeable sand and sand is significantly more permeable than the clay, i.e. an upward flow problem:	1.5 m excavation
1b	Specific discharge, q (m/s), is $$q = -k\frac{dh}{dL} = -3.6 \times 10^{-8}\frac{(1.5-2.5)}{1.5} = 2.4 \times 10^{-8} m/s$$ Discharge (m^3/s) = qA = $2.4 \times 10^{-8} \times 6 \times 150 = 0.0000216$ 0.0000216 x 3600 = 0.078 m^3/hour	0.078 m^3
1c	Liquefaction can occur when effective stress equals zero. Total stresses at the base of the excavation = (4 – d) x 19 Where d is the depth of excavation. Pore water pressure in the excavation = (4 - 1.5) x 10 = 25 kN/m^2 Therefore: d = 4 - (25/19) = 2.7m	2.7m
1d	Again, liquefaction can occur when effective stress equals zero. Total stresses at the base of the excavation = (4 – 2.5) x 19 = 28.5 kN/m^2 Where d is the depth of excavation. Critical pore water pressure in the excavation = (4 – d_w) x 10 Therefore: d_w = 4 - (28.5/10) = 1.15m	1.15m

<table>
<tr><th>Question No.</th><th>Workings</th><th>Answer</th></tr>
<tr><td>2a</td><td>

$\gamma = W/V$

W = W(kg) * 10 = 557 / 1000 * 10 = 5.57N

$V = 300 \times \pi \times 40^2 / 4 = 376\,990\ mm^3 = 0.000377\ m^3$

$\gamma = 5.57 / 0.000377 = 14775\ N/m^3 = 14.8\ kN/m^3$

</td><td>

$14.8\ kN/m^3$

</td></tr>
<tr><td>2b</td><td>

Clay on sieve size 1 μm, Silt on sieve size 2 μm, Sand above
Therefore V_{clay} = 17 ml, W_{clay} = 32 /1000 * 10 = 0.32 N

V_{silt} = 35 ml, W_{silt} = 78 /1000 * 10 = 0.78 N

V_{sand} = (61+63+12+5) = 141 ml, W_{sand} = (117+133+28+9) /1000 * 10 = 2.87 N

</td><td>

V_{clay} = 17 ml
W_{clay} = 0.32 N

V_{silt} = 35 ml,
W_{silt} = 0.78 N

V_{sand} = 141 ml
W_{sand} = 2.87 N

</td></tr>
<tr><td>2c</td><td>

Mass of Peat = 502 – 397 = 105g
$V = 105 / 1000 / 1100 \times 100^3 = 95.5$ ml
$\%_{peat}$ = 95.5 / 377 x 100 = 25.3%
$\%_{sand}$ = 141 / 377 x 100 = 37.4%

Mass of water = 557 – 502 = 55g
V = 55x1 = 55 ml
$\%_{water}$ = 55 / 377 x 100 = 14.6%
V = 377 – (17+35+141+95.5+55) = 33.5 ml
$\%_{air}$ = 33.5 / 337 x 100 = 8.9%

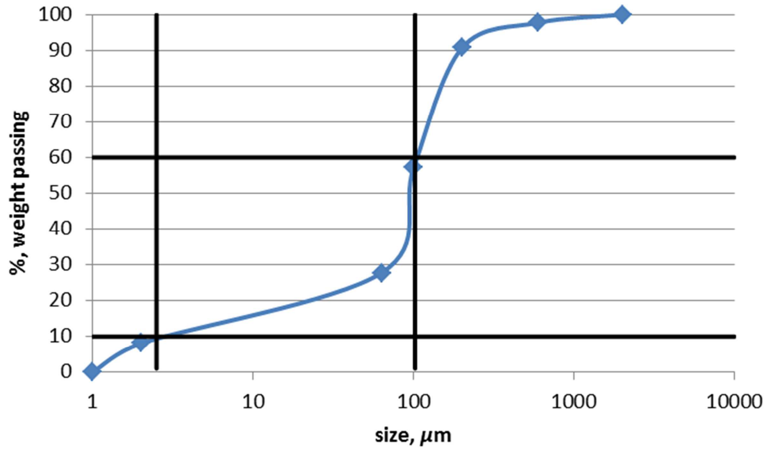
</td><td>

$\%_{peat}$ = 25.3%
$\%_{sand}$ = 37.4%
$\%_{water}$ = 14.6%
$\%_{air}$ = 8.9%

</td></tr>
<tr><td>2d</td><td>

$n = V_p / V_t$
= (55+33.5) / 377 = 0.235 * 100 = 23.5%

</td><td>23.5%</td></tr>
<tr><td>2e</td><td>



</td><td></td></tr>
<tr><td>2f</td><td>

From figure: D_{10} = 2.5, D_{60} = 102
C_u = 102 / 2.5 = 41, Well graded

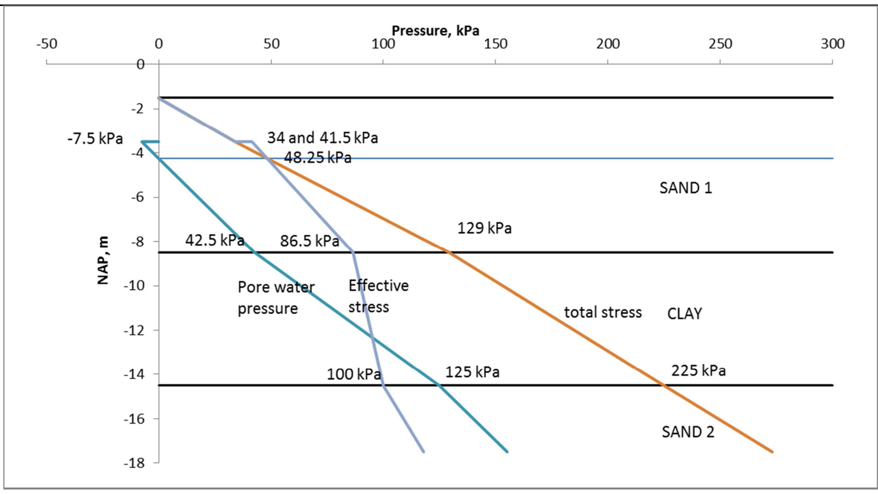
S – sand (or accept Pt – peat) W – well graded

</td><td>

C_u = 41

S W

</td></tr>
</table>

Question No.	Workings	Answer
3a		
3b	Mid height of the clay: σ = (225+129)/2 = 177 kPa σ' = (100+86.5)/2 = 93.25 kPa After embankment, pwp can dissipate therefore stresses are increase by 3.5 x 18 = 63 kPa at all locations. Assumption is 'wide' embankment. σ = 177+63 = 240 kPa σ' = 93.25 + 63 = 156.25 kPa	σ = 177 kPa σ' = 93.25 kPa After σ = 240 kPa σ' = 156.25 kPa
3c	3 layers of 2 m each. Final settlement so no increased pwp or consolidation. Centres of layers (NAP, m): -9.5, -11.5, -13.5 Initial $\sigma' = \sigma'_{-8.5} + (d)\frac{\sigma'_{-14.5} - \sigma'_{-8.5}}{6}$ $\sigma'_{-9.5} = 88.75$ kPA, $\sigma'_{-11.5} = 93.25$ kPA, $\sigma'_{-13.5} = 97.75$ kPA Strain: $\varepsilon = \frac{1}{C_p}\ln\left(\frac{\sigma'}{\sigma'_1}\right)$ $\varepsilon_{-9.5} = \frac{1}{15}\ln\left(\frac{88.75+63}{88.75}\right) = 0.036$, $\varepsilon_{-11.5} = 0.034$, $\varepsilon_{-13.5} = 0.033$ Deformation, *u=2xε* Total deformation = $2 \times (\varepsilon_{-13.5} + \varepsilon_{-11.5} + \varepsilon_{-9.5}) = 0.21m$	0.21m

Question No.	Workings	Answer
4a	Use the flexible plate formulation, r=0: $\sigma_{zz} = p\left[1 - \frac{z^3}{(\sqrt{z^2+a^2})^3}\right] = 150\left[1 - \frac{z^3}{(\sqrt{z^2+7.5^2})^3}\right] =$ $\sigma_{zz2} = 147$ kPa, $\sigma_{zz7} = 102$ kPa, $\sigma_{zz15} = 42.7$ kPa	$\sigma_{zz2} = 147$ kPa, $\sigma_{zz7} = 102$ kPa, $\sigma_{zz15} = 42.7$ kPa
4b	Use the strip foundation equation , x=0: p=150 x w / (2 x StripWidth) = 150x15/(2x0.5) = 2250 kN/m^2 $\sigma_{zz} = \frac{2p}{\pi}\left\{tan^{-1}\left(\frac{a}{z}\right) + \frac{az}{a^2+z^2}\right\} = \frac{2 \times 2250}{\pi}\left\{tan^{-1}\left(\frac{0.25}{z}\right) + \frac{0.25z}{0.25^2+z^2}\right\}$ $\sigma_{zz2} = 354$ kPa, $\sigma_{zz7} = 102$ kPa, $\sigma_{zz15} = 47.7$ kPa	$\sigma_{zz2} = 354$ kPa, $\sigma_{zz7} = 102$ kPa, $\sigma_{zz15} = 47.7$ kPa
4c	Pad foundation. Use point load as no dimensions are given, also will be similar. Would accept if reasonable dimensions were used e.g. 2m diameter. P = 150 x (w/2) x spacing = 150 x 7.5 x 12 = 13500 kPa $\sigma_{zz} = \frac{3P}{2\pi z^2}$ $\sigma_{zz2} = 1611$ kPa, $\sigma_{zz7} = 131$ kPa, $\sigma_{zz15} = 28.6$ kPa	$\sigma_{zz2} = 1611$ kPa, $\sigma_{zz7} = 131$ kPa, $\sigma_{zz15} = 28.6$ kPa
4d	Recognise that the stresses calculated in 4b are in the centres of the prescribed layers. Therefore: (see table below) Therefore 6 cm so acceptable.	6 cm Acceptable

Layer centre	σ_1	σ_{zz}	Strain	thickness	disp
2	32	354	0.0094	4	0.037
7	112	102	0.0024	6	0.015
15	240	47.7	0.0007	10	0.007
				total=	**0.059m**