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Student Name: ----------; Student Number: ----------

This mid-term paper consists of 7 pages. Please check that you have a complete paper.

THE UNIVERSITY OF BRITISH COLUMBIA
Department of Civil Engineering
MID-TERM QUIZ I – OCTOBER 05, 2015
SOIL MECHANICS II - CIVL 311
Instructors: Dr. D. Wijewickreme & Dr. J.A. Howie

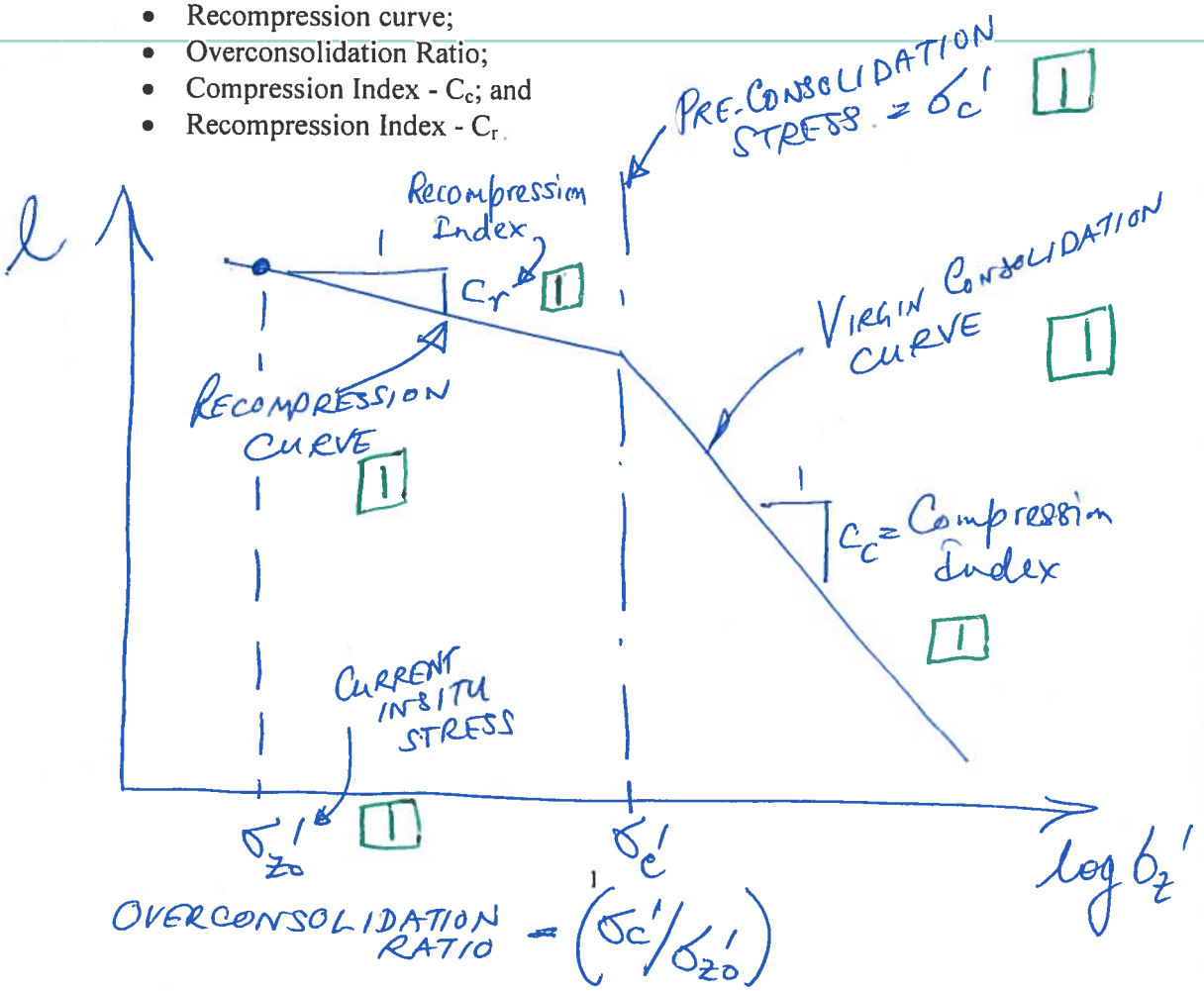
Time: 45 Minutes

1. Closed book exam. Formulae sheet provided (see last page).
2. Answer both questions.
3. Be neat. Use sketches whenever possible.
4. Make any reasonable assumptions, where appropriate, to answer the questions. Take the unit weight of water to be 9.8 kN/m^3.
5. Be brief and to the point. Show ***all work*** for full credit.
6. ***Write your answers on pages provided with this question paper***.
7. Show all steps of your calculation to receive full marks.
8. Maximum total obtainable marks = 66 (Note: Maximum from this quiz to the final mark = 11%)
9. Remember to ***return all pages*** with your answers.

Question 1

(a) Draw a schematic plot of void ratio (e) vs. log (vertical stress - σ'_z) for a clayey soil, and use the diagram to illustrate/express the definitions for the following (use the space below) **(6 Marks)**:

- Preconsolidation stress (σ'_c);
- Virgin consolidation (NC) curve;
- Recompression curve;
- Overconsolidation Ratio;
- Compression Index - C_c; and
- Recompression Index - C_r.



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Question 1 (contd..)

(b) Use the space below to briefly express your understanding (in point form) of the following common processes producing decrease in void ratio in soil: (i) consolidation, (ii) compaction. **(10 Marks)**

1 →
- Consolidation and compaction both lead to reduction of void ratio, but they are not identical.

3 →
- Compaction is densification of soils by the expulsion of air in the voids. Achieved by application of mechanical energy (e.g., compactors, rollers, rammers).

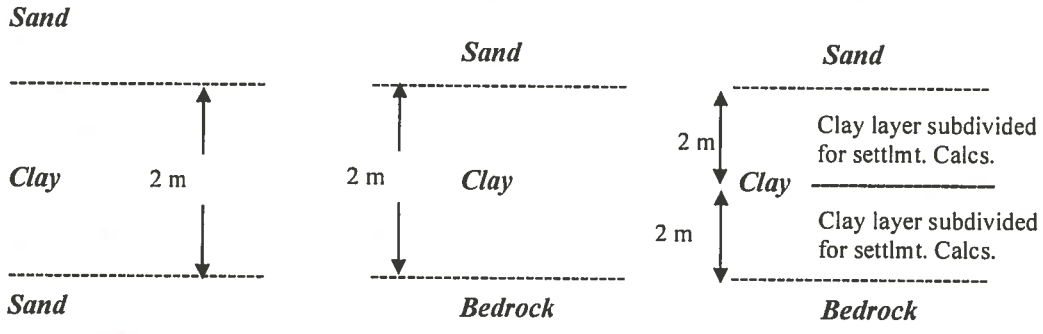
1 →
- No significant changes in the moisture content of the compacted soil zone during the compaction process.

1 →
- The change in void ratio due to compaction is immediate.
- Compaction is not effective if the soils is saturated.

3 →
- Consolidation involves dissipation of excess pore water pressures in the soil generated due to external loads.

1 →
- The change in void ratio due to consolidation could involve significant time durations. Dependent on Cv and drainage path Hdr.

(c) Given that the length of longest drainage path is denoted by the symbol H_{dr}, find the values of H_{dr} in the layer of clay for the cases of consolidation given below. **(6 Marks)**



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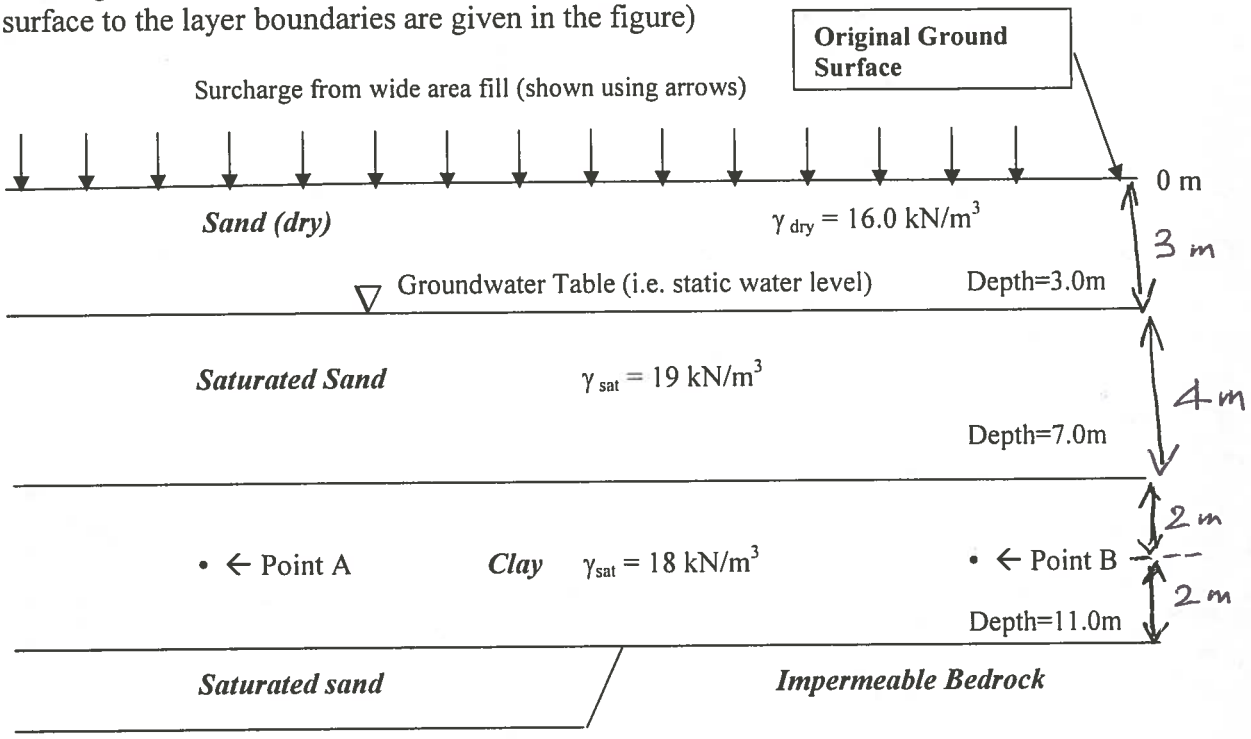
Question 2

The Figure below shows the stratigraphy at a site. (Note: Depths below the ground surface to the layer boundaries are given in the figure)



(1)

- Initial vertical effective stress @ Point A.

$$\sigma'_{z0} = 16 \times 3 + 19 \times 4 + 18 \times 2 - (9.81 \times 6)$$
$$= 160 - 58.9 = \underline{101.1 \text{ kPa}} \quad [3]$$

- $e_0 = 1.10 - 0.32 \log_{10}(101.1/100) = \underline{1.1}$ [3]

- Increase in stress due to wide area fill at (Points A, B) mid point of clay layer

$$\Delta\sigma_z = 18 \times 4 = 72 \text{ kPa}. \quad [4]$$

- C_c of the clay layer → {from equation given} = 0.32

$$\frac{\Delta e}{1+e_0} = \left\{\frac{0.32}{1+1.1}\right\} \times \log\left\{\frac{72+101}{72}\right\} \quad [5]$$

(4)/5

$$\frac{\Delta e}{1+e_0} = \frac{0.32 \times 0.234}{2.1} = 0.036$$ [2]

Ultimate consolidation settlement of clay layer $= 0.036 \times 4^{m}$ [3]

$= \underline{0.142 \text{ m}}$ [2]

(ii) 90% Degree of consolidation

$$\frac{C_v t_{90}}{H_{dr}^2} = 0.848$$

$$t_{90} = \frac{0.848}{4 \times 10^{-8}} \times H_{dr}^2$$

$$= 21.2 \times 10^6 \times H_{dr}^2 \, s$$

(a) Point A $H_{dr} = 2$ m

$$t_{90} = 21.2 \times 10^6 \times (2)^2 s$$ [3]

$$= \frac{21.2 \times 10^6 \times 4}{(3600 \times 24 \times 365)} = \underline{2.69 \text{ yrs}}$$

(b) Point B $H_{dr} = 4$ m [3]

$$t_{90} = \frac{21.2 \times 10^6 \times 16}{(3600 \times 24 \times 365)} = \underline{10.76 \text{ yrs}}$$

5. /5

50% Degree of consolidation

$$\frac{C_v t_{50}}{H_{dr}^2} = 0.196$$

$$t_{50} = \frac{0.196}{4\times10^{-8}} \times H_{dr}^2$$

$$= 4.9\times10^6 \times H_{dr}^2 \ s$$

3

@ Point A $H_{dr} = 2\ m$

$$t_{50} = \frac{4.9\times10^6}{(3600\times24\times365)} \times (2)^2$$

$$= 0.62 \text{ yrs.}$$

@ PointB $H_{dr} = 4\ m$

$$t_{50} = \frac{4.9\times10^6}{(3600\times24\times365)} \times 4^2$$ 3

$$= 2.48 \text{ yrs.}$$

	Point A		Point B	
	Settlmt (m)	Time for settlmt. (yrs)	Settlmt (m)	Time for settlmt. (yrs)
U=50%	0.071	0.62	0.071	2.48
U=90%	0.128	2.69	0.128	10.76

4

ρ @ U = 90% → $0.142 \times 0.9 = 0.128$ m — 2

ρ @ U = 50% → $0.142 \times 0.5 = 0.071$ m — 2

$(t_{90})_A = 2.69$ yrs. $\approx (t_{50})_B = 2.48$ yrs. — 1

So, APPROX DIFF. SETTLEMENT $= (\rho_A)_{90} - (\rho_B)_{50} = 0.13 - 0.07$

$= 0.06$ m 1