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 EXAMINATION – OCTOBER 03, 2011
SOIL MECHANICS II - CIVL 311
Instructor: Dr. D. Wijewickreme

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 9.81 kN/m^3.
5. Be brief and to the point. Show ***all work*** for full credit.
6. ***Write your answers on blank spaces and/or pages provided with this question paper***.
7. Show all steps of your calculation to receive full marks.
8. Remember to ***return all pages*** with your answers.

Question 1

(a) Using the space below, draw a schematic plot of void ratio - e vs. log (vertical effective stress, σ'_z) for a clayey soil, and use the diagram to illustrate/express the definitions for the following **(3 Marks out of 22)**:

- Preconsolidation stress (σ'_c);
- Virgin consolidation (NC) part of the e vs. log (σ'_z) curve;
- Recompression part of the e vs. log (σ'_z) curve;
- Overconsolidation Ratio;
- Compression Index - C_c; and
- Recompression Index - C_r.

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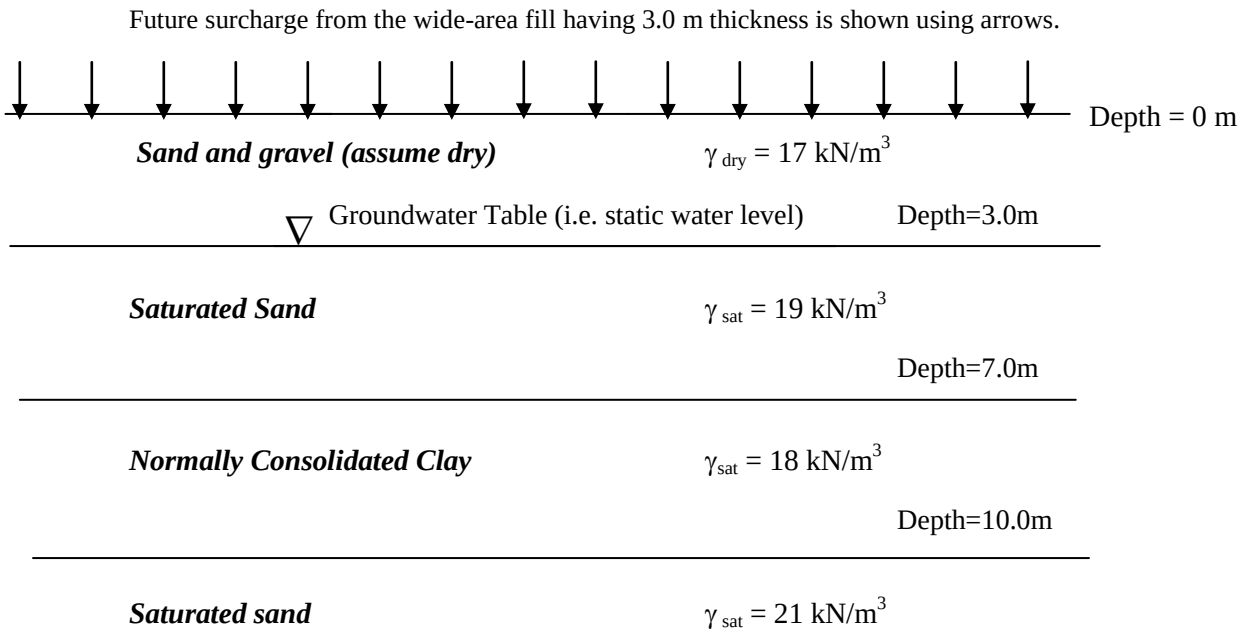
Question 2

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



(i) If the site is to be loaded with a 3.0 m high wide-area fill having a density of 17 kN/m^3 as shown, using the one-dimensional consolidation theory, determine the anticipated primary consolidation settlement (ρ_{pc}) of the clay deposit due to this load. Assume that the stress conditions at the mid-depth of the normally consolidated (NC) clay deposit are representative of the entire layer – no need to subdivide the layer in performing the computations. Also assume that the following relationship between void ratio and vertical effective stress (kPa) was obtained (after applying the appropriate corrections) from 1-D consolidation tests on representative undisturbed samples of the above NC clay: $e = 1.00 - 0.33 \log (\sigma_z'/100)$ where e = void ratio and σ_z' = vertical effective stress in kPa. (Hint: The equation for the NC line is given instead of e_0 and C_c). **(12 Marks out of 22).**

(ii) Compute the estimated time for 90% of this settlement to take place given that the coefficient of consolidation of the clay in the normally consolidated state is 5.0×10^{-8} m^2/s **(4 Marks out of 22)**.

(iii) With regard to the above site, if it was indicated that the clay layer is <u>underlain</u> by impermeable bedrock (instead of the saturated sand deposit shown in the figure) compute the estimated time for 50% of the total settlement **(3 Marks out of 22)**.

Use the next blank pages below to provide your answer for this question.

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EQUATION SHEET

Computation of static effective stresses in a soil mass

$\sigma'_z = \Sigma \gamma_i h_i$; $\sigma' = \sigma - u$;
σ'_z = Vertical effective stress; $\sigma' = \sigma - u$; u = Pore water pressure

Under static groundwater (no flow) conditions: $u = \gamma_w z$

Consolidation Settlements

For a given layer,
$\rho_{pc} = (\varepsilon_z . H_0)$ = Primary consolidation settlement where
$\varepsilon_z = [\Delta e / (1+e_o)]$;
H_0 = Thickness of the layer considered for the calculation of consolidation settlements;
e_o = initial void ratio;
Δe = change in void ratio;

Based on this,

$$\rho_{pc} = \left\{\frac{C_c}{1+e_0}\right\} * \log_{10}\left\{\frac{\sigma'_{z0} + \Delta\sigma_z}{\sigma'_{z0}}\right\} * \{H_0\}$$

σ'_{zo} = initial vertical effective stress; $\Delta\sigma_z$ = increase in vertical stress
C_c = compression index

Rate of Consolidation

T_v = Time Factor

H_{dr} = 0.5*(Thickness of a layer with two free draining boundaries); or
H_{dr} = Thickness of a layer with one free draining boundary;

$$T_\upsilon = \frac{C_\upsilon t_{90}}{H_{dr}^2} = 0.848 \qquad T_\upsilon = \frac{C_\upsilon t_{50}}{H_{dr}^2} = 0.196$$