SOIL MECHANICS II
CIVL 311

COURSE NOTES
2012

Module 0
GENERAL INTRODUCTION

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CIVL 210 – Quick Review

Characteristics of Soil:

- Origin, nature and composition of soils; basic definitions; phase relationships; grain size, shape and distribution; mineralogical composition; grain arrangement; clay structure (fabric); plasticity of fine grained soils.

Soil Classification:

- Field identification; unified classification system for engineering purposes.

Compaction:

- Moisture density relations; effect of amount and type of compaction effort; control of field compaction.

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Effective Stress Principle

$$\sigma' = \sigma - u$$

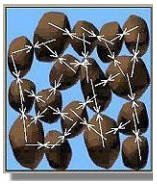
Pore Pressure

(In most instances, cannot measure directly, only computed value)

Effective Stress

(governs soil behavior)

Total Stress



σ → obtained generally from statics of the problem

u → obtained considering flow conditions (hydrostatic if no flow; otherwise require seepage analysis)

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Flow of Water through Soils

- Capillary phenomena; Permeability
- Darcy's Law

$$Q = k\, i\, A$$

where: Q = Flow Rate; k = Hydraulic Conductivity; i = Hydraulic Gradient; A = Area normal to flow direction.

- Analysis of seepage in one-and two-dimension;
- Flow nets;
- Governing equation (Laplace Equation)

h = total head
= *f* (x, y)

$$\frac{\partial^2 h}{\partial x^2} + \frac{\partial^2 h}{\partial y^2} = 0$$

- Erosion and filter design;
- Quick condition.

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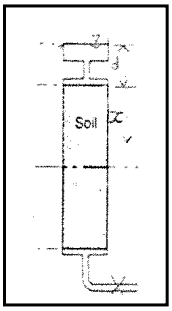
Pore Pressure Summary:



Hydrostatic Pore Pressure

Bernoulli Equation

$$\frac{u_1}{\gamma_w} + z_1 = \frac{u_2}{\gamma_w} + z_2 = \text{Constant } \underline{\textbf{total}} \text{ head, h} \Rightarrow \text{no flow}$$

Where u/γ_w is the pore pressure head
z is the elevation head
Typically the velocities are very small and the velocity head term, $v^2/2g$, may be neglected.

$$u = \gamma_w (d + x)$$

Seepage Flow Pore Pressures

Bernoulli Equation

$$\frac{u_1}{\gamma_w} + z_1 = \frac{u_2}{\gamma_w} + z_2 + friction losses, h_1 \neq h_2 \Rightarrow \text{Flow from (1) to (2)}$$

$$u = \gamma_w (d + x) \pm \gamma_w (ix)$$

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Seepage Flow Pore Pressures (con't)

1-D Darcy Flow: $$q_x = k_x \frac{\Delta h}{L} A$$

2-D Darcy Flow: $$k_x \frac{\partial^2 h}{\partial x^2} + k_y \frac{\partial^2 h}{\partial y^2} = 0$$ (Laplace Equation if $k_x = k_y$)

May be approximated and solved graphically using flow nets.

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Consolidation Summary

Mechanical analogy of consolidation process

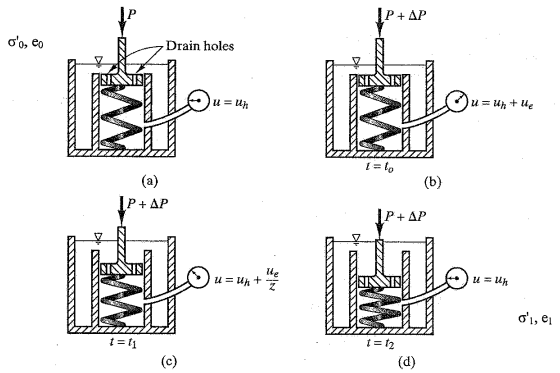

Figure 11.5 Piston and spring analogy.

Soil	Analogy
Soil skeleton	⊠ Spring, its stiffness corresponds to soil compressibility
Pore water pressure (u)	⊠ Water in piston
Drainage conditions	⊠ Valve (on drain holes)
Permeability (k)	⊠ Size of drain holes

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Shear Strength and Effective stress

Elementary concepts only: i.e. s = *f* (σ ′) and not σ

Mohr Coulomb Equation: s = c′ + σ′ tan ϕ ′

‘s’ changes if σ’ changes, i.e. u changes

+Δu → decrease in ‘s’

-Δu → increase in ‘s’

} If Δσ ≠ Δσ′

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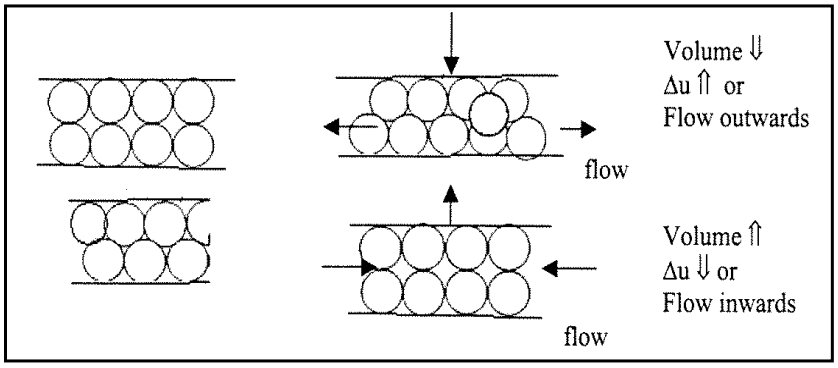
Shear-induced Pore Water Pressures



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Slope Stability

- Total and effective stress analyses
- Method of slices
- Seepage effects } If $\Delta\sigma \neq \Delta\sigma'$
- Assessment of stability of existing slopes and design of embankment and excavation slopes.

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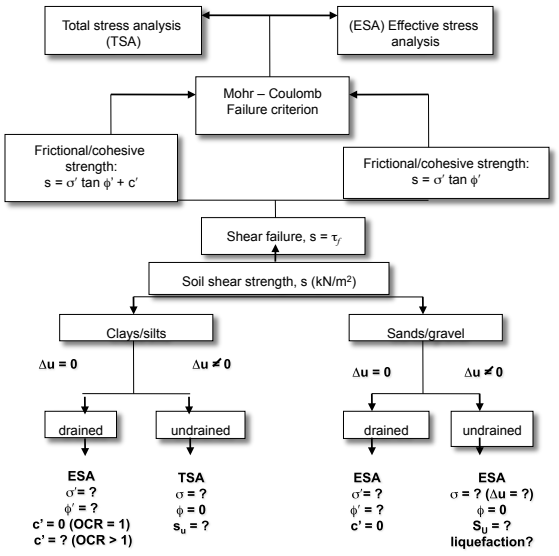
Shear Strength - Summary



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CIVL 311 - Topics Covered:

GENERAL INTRODUCTION

- **Introduction**
- **Review of Basic concepts**
- **Review of Response of Soils to Shearing Forces**

PART 1 – SOIL MECHANICS

- **Module 1: One-dimensional Consolidation of Fine-grained Soils**
- **Module 2: Stresses in Soil from Surface Loads**
- **Module 3: Response of soils to Shearing**
- **Module 4: Lateral Earth Pressures**
- **Module 5: Shallow Foundations**

PART 2 – GEOTECHNICAL ENGINEERING DESIGN

- **Module 6: Site Characterization and Introduction to Geotechnical Design**
- **Module 7: Design of Shallow Foundations**
- **Module 8: Design of Deep Foundations**
- **Module 9: Design of Earth Retaining Structures**

Text Books:

- Selected Chapters from Budhu: Soil Mechanics and Foundation, 2nd Edition and from Foundations and Earth Retaining Structures, 1st Edition, By M. Budhu, John Wiley & Sons. (CUSTOM PRINT)
- "Soil Testing for Engineers", T.W. Lambe, BiTech Publishers, Vancouver (originally published by John Wiley & Sons, 1951).

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Miscellaneous

Course Outline: Posted on WebCT Vista

Course Notes: Copies of the Powerpoint presentations for CIVL 311 will be posted on WebCT as modules as we move forward.

Laboratories:

Details to follow shortly.

Optional Assignments:

Homework problems assigned from time to time throughout the course, but no direct marks will be awarded.

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Miscellaneous

Clickers:

Typically one clicker question/day.

Make up 2% of your final grade, based on participation, not whether your answers are right or wrong.

Further instruction will be given on September 7th.

Quiz #1: Friday, Sept. 28th, 2012

Quiz #2: Friday, Nov. 9th, 2012

Office Hours:

Please e-mail me dharmaw@civil.ubc.ca

Please DO NOT USE OTHER E-MAIL ADDRESSES or just meet after the class.

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CREDIT REQUIREMENTS - ALLOCATION OF MARKS

December exam	56 marks
Lab reports	20marks
Quizzes	22marks
Clickers	2marks
Maximum	**100 marks**

Notes:
A grade of at least 50% is required in the final exam component of marks in order to pass the course and receive credit for completed mid-term exam, laboratory reports, homework problems, and clicker questions. Your final course mark will be what you received on your final exam if your final exam mark is less than 50%. Supplemental exams are not allowed in 3rd year courses.

A total of two "closed-book" quizzes will be held in class (1st on Sept. 28th and the 2nd on Nov. 9th). An individual grade is assigned for each quiz.

Except for medical reasons (supported by a letter from a medical doctor), no credit will be given for missed: (i) mid-term exam; (ii) laboratory work; (iii) homework; and (iv) clicker responses.

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LABORATORY CLASSES

Topics Covered Today

- Undergrad Lab Safety & Personal Conduct
- TA Info and Lab Schedule
- Lab Instructions
- Lab Class format
- Groups/Reports – assignment of students
- Marking

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Undergrad Lab Safety & Conduct

- Safety glasses are to be worn when working with air pressure connections.
- Closed-toed shoes are to be worn in the lab at all times.
- No food is allowed in any of the labs.
- No horseplay – it is expected that you will conduct yourselves in a professional manner.
- Please don't touch anything that doesn't belong to you.
- Report any unsafe situations to the TA.
- Clean up all spills immediately.

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Undergrad Lab Safety & Conduct

- Once a lab has been completed:
  - All tools and equipment are to be returned in working order,
  - All samples are to be disposed of in an appropriate manner, and
  - The working area is to be cleaned up.
- Please clean up after yourselves. Think through your work to include disposal of samples and cleanup of equipment.

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Lab Instructions

- Lab1: Consolidation Test of Fine-Grained Soil
- Lab 2: Undrained Shear Tests of Fine-Grained Soil

- Instruction sheets available on VISTA.
- Use *Soil Testing For Engineers* by T. William Lambe as a supplemental reference
- Familiarize yourselves with the experiments **before the lab periods.**
- TA's will be in the lab to help you. Please don't hesitate to ask any questions.

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TA Info and Lab Schedule

TA INFORMATION		
TA Name	**Contact Email**	**Weekly Office Hours**
Jeremy Groves	jgroves@civil.ubc.ca	Tuesday, 2:00 to 3:00 PM
Amin Rahmani	arahmani@civil.ubc.ca	Monday, 1:00 to 2:00 PM
Ainur Seidalinova	-	-

All office hours and labs are held in CEME Rm. 1008

LAB SCHEDULE		
Lab Section	**Lab 1: 1D Consolidation**	**Lab 2: UU Triaxial**
L1G	Sept. 10, 2012	Oct. 15, 2012
L1E	Sept. 11, 2012	Oct. 16, 2012
L1A	Sept. 12, 2012	Oct. 17, 2012
L1F	Sept. 18, 2012	Oct. 23, 2012
L1C	Sept. 19, 2012	Oct. 24, 2012
L1B	Sept. 20, 2012	Oct. 18, 2012
L1D	Sept. 27, 2012	Oct. 25, 2012

LAB REPORT DUE DATES		
Lab Section	**Lab 1: 1D Consolidation**	**Lab 2: UU Triaxial**
L1G	Sept. 24, 2012	Oct. 29, 2012
L1E	Sept. 25, 2012	Oct. 30, 2012
L1A	Sept. 26, 2012	Oct. 31, 2012
L1F	Oct. 2, 2012	Nov. 6, 2012
L1C	Oct. 3, 2012	Nov. 7, 2012
L1B	Oct. 4, 2012	Nov. 1, 2012
L1D	Oct. 11, 2012	Nov. 8, 2012

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Lab Class Format

- Labs run for two hours, the first ~15 min. will be an introduction.
- All lab instructions and lab sheets will be provided in the lab (students don't need to print it all out).
- **Lab 1**: Test runs for one week, so students need to come into the lab every day to record measurements. TA's will be there from 11:00AM to 1:00 PM on the weekends to let you into the lab room.
- **Lab 2**: Students will complete the lab in the two hour lab period.

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Groups/Reports

- 212 students, 7 lab sections, labs of ~30 students, groups of no more then 3.
- Students can form your own groups within each lab section.
- If we have any groups of 4 or more, students can share the data but will hand in separate reports.
- Each group will write one report for each lab.
- Report format outline posted on VISTA. **Please follow it carefully.**
- Lab 1 to be submitted online as a PDF file to jgroves@civil.ubc.ca by the due dates posted.
- Lab 2 submission method to be determined (either online or hardcopy).

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Marking

- Each member in each group will receive the same grade.
- Reports must include a Report Declaration Statement.

	Total marks out of 50
General Presentation (neatness and composition)	(max. 4) ____
Purpose & Scope	(max. 3) ____
Procedure	(max. 3) ____
Results & Graphs (presentation, titling and labeling)	(max. 15) ____
Discussion	(max. 15) ____
Data and Sample Calculations	(max. 10) ____
Work Practices (participation, conduct and clean-up)	(max. -8) ____

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End of Introduction to the Lab component of CIVL 311

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