The University of Texas Department of Civil Engineering

CE 387L.1 Consolidation and Shearing Properties of Soils (Unique No.: 15955)

FALL 2013

Instructor: Prof. Chadi El Mohtar
Office: ECJ 9.227B
Office Hours: - Monday/Wednesday 10:00 AM – 11:30 AM; Room ECJ 9.227B
- By appointment: ElMohtar@mail.utexas.edu

Class Hours: MWF 1:00 – 1:50 PM, ECJ B.226

Lab Hours: Friday 2:00 – 5:00 PM, ECJ 5.416 (Lab)

Purpose:

CE 387L.1 is an introductory graduate course covering the stress-strain, strength and consolidation properties of soils. The purpose of this course is to provide you with a broad understanding of these topics, not a treatment in depth. This broad understanding will prove useful in other courses, in your individual research, in further reading of the literature, and in engineering practice.

This course is offered every year, while many of the other geotechnical engineering courses are offered only once every three semesters, or once every two years. This course is offered frequently because an understanding of shear strength and consolidation properties of soils is important for a number of other courses, e.g. Earth Retaining Structures, Slope Stability, Foundation Engineering, Landfill Design, and Earth Dams. At the conclusion of this course, you should have the knowledge of shearing and consolidation properties of soils that can be used in numerous courses and applications.

Technique:

The material will be presented via lectures, augmented by reading assignments in the literature, and supplemented by laboratories. Lectures pertaining directly to the laboratory will be given during the scheduled laboratory time. Homework problems will be assigned on occasion. The laboratories serve to help you learn the material covered in this course and get your hands “dirty”. Because this class has homework and lab at the same time, the lab portion will be focused mostly on interpreting the outputs and running the analysis rather than spending a long time on the experimental details. A separate class is offered for the experimental measurements of soil properties in the lab.

You will need to spend a considerable amount of time outside of class reviewing and studying concepts presented in class and reading papers from the literature. You will also need to spend some time outside of the scheduled laboratory periods performing tests, reducing and interpreting your data, and preparing short laboratory reports.

Reading Assignments:

You will be assigned a number of papers from the literature to read during the semester. Several advantages result from reading the original papers: (1) you see the original data; (2) you read views that may differ from those of the instructor and, thus, obtain a broader perspective; (3) you become accustomed to seeking information from the original sources, rather than from textbooks or class notes; (4) you learn to be critical of what you read; (5) you learn the names of people doing work in the field and develop opinions about their level of knowledge. The major disadvantage of reading the literature is that it is very time consuming.

A limited number of papers will be assigned. Reading assignments will have a due date and you will be expected to be prepared to discuss the paper on that date. This will be done during the lab hours when no new labs are being taught.

Copies of each paper will be made available as Adobe "PDF" files in the "Course Documents" folder Blackboard. You may read this copy or read from the original publication available in the Engineering Library.

Preparing a short digest of each paper and including the points that you think are most important is the best practice to make the most out of your reading assignments. These points should be studied first when preparing for an exam.

Laboratory:

The major topics in both shear strength and consolidation will be thoroughly covered while the details of the laboratory testing will be covered in more details in a separate course (CE 392L- Measurement of Soil Properties).

The laboratory portion of CE 387L.1 will emphasize soil behavior, rather than details of laboratory apparatus and test procedure. However, you must still have sufficient knowledge of the apparatus and procedures in order to perform tests properly. Lecturing on laboratory test apparatus and procedures to prepare you for the laboratories will be held during the scheduled laboratory meeting times.

You will be required to prepare short laboratory reports for each of the laboratories. Emphasis will be placed on the test results and their interpretation rather than on a lengthy discussion of test procedures and errors.

Due to the large number of students in the class, you will be divided into groups or 5 or 6 students during the lab sessions. You are then responsible to turn in the laboratory reports as individuals.

Examination:

There will be two exams given during the semester and a third exam given in the scheduled final examination period. The two exams during the semester will be two-hour long examination either during the laboratory or at some other time that may be least partially extend outside the normally scheduled, 50- minute lecture period. If not held during the laboratory and depending on student's schedules, the examination may start one hour before or extend one hour beyond the normally scheduled meeting time, or examinations may be scheduled at another time of the day.

Because of the longer (two-hour) examination during the semester and its comprehensive nature, the final exam will be covering primarily (but not restricted to) material which was not covered on the earlier semester examination. The exam will, however, require comprehensive knowledge of all the material covered in the course.

Grading:

Your final grade will be based on examinations, homework, class participation and laboratory work. The percentages on the three exams will be distributed such that, for each student, the highest percentage will be given to the exam on which he/she received the highest grade.

Exam I	15%
Exam II	20%
Exam III	25%
Homework	15%
Laboratory reports	15%
Class participation	5%

The final exam will be held from 9 AM to 12 PM on December 14th, 2013.

In accordance with University regulations, students who miss examinations will receive grades of zero. Exceptions to this rule will be made only on a carefully considered individual basis, and only if the student contacts the instructor before the exam.

Drop Policy:

Dropping a course after the twelfth class day will be difficult and will not be approved except for extraordinary nonacademic reasons. Poor performance in the course is not an acceptable reason for dropping. Students are strongly urged to make any changes in their course

schedules during the first week of classes so that other students who need to add the course(s) can be accommodated. Here is the official university policy on graduate students dropping a course:

> *From the 1st through the 4th class day, graduate students can drop a course via the web and receive a refund. During the 5th through 12th class day, graduate students must initiate drops in the department that offers the course and receive a refund. After the 12th class day, no refund is given. No class can be added after the 12th class day. From the 13th through the 20th class day, an automatic Q is assigned with approval from the Graduate Advisor and the Graduate Dean. From the 21st class day through the last class day, graduate students can drop a class with permission from the instructor, Graduate Advisor, and the Graduate Dean.* ***Students with 20-hr/week GRA/TA appointment or a fellowship may not drop below 9 hours.***

Course Evaluation:

A course/instructor evaluation will be conducted in class near the end of the semester. The standard form and procedure from The University of Texas Measurement and Evaluation Center (MEC) will be used.

Students with Disabilities:

The University of Texas at Austin provides upon request appropriate academic adjustments for qualified students with abilities. For more information, contact the Office of the Dean of Students at 471-6259, 471-4241 TDD or the College of Engineering Director of Students with Disabilities at 471-4321.

CE 387L.1- Shearing Properties of Soils

Tentative Topic Outline

I- Basic Geotechnical Engineering Knowledge

(This section is meant to be an overview of what you should already know with a little more depth than the basic level. The following is a list of some of the possible topics that will be covered quickly in class)

- Composition and classification
- Basics of ground water flow
- Stresses in soil deposits
- Effective stress concept
- Mohr Circle
- Stress Paths

II- Shearing Properties of Sands
(possible topics depending on available time)

Part 1- Basic Concepts and Laboratory Measurements

- Failure envelopes; Direct shear test
- Triaxial test
- Skempton's A and B parameters
- Modified Mohr-Coulomb Diagrams
- Types of test conditions/Effect of drainage
- Failure Criteria
- Energy corrections

Part 2- Shearing Properties of Dry and Saturated Sand

- Static loading in triaxial apparatus
- Plane strain shear test
- Triaxial compression versus triaxial extension versus plane strain
- Cyclic loading and liquefaction

III- Consolidation Properties of Soils (possible topics)
(again, possible topics depending on available time)

Part 1- Classical Analysis

- One dimensional analysis for total settlement
- Terzaghi's theory

- Time dependent loading
- Layered systems
- Radial Flow

Part 2- Laboratory Testing

- Incremental loading tests
- Constant loading tests
- Rapid loading tests

Part 3- Relevant Topics of Interest

- Secondary effects
- Stress distribution
- Cementation
- Collapsing soils
- Settlement of footings on sand/clay

IV- Shearing Properties of Clays
(again, possible topics depending on available time)

Part 1- Shearing Properties of Saturated Clays

- Normally consolidated clay
- Over-consolidated clay
- Strength water content relationships
- Correlation of ϕ' with index properties
- c/p ratio
- Sensitivity/Thixotropy/Cementation
- Residual shear strength
- Anisotropy
- Creep
- High speed loading

Part 2- Shearing Properties of Unsaturated Soils

- Total stress envelopes
- Pore water pressures
- Pore pressure coefficients
- Effective stresses

Lecture #	Day	Date	Topic-Lecture	Topic - Lab
1	Wed.	Aug. 28	Introduction-Soil Composition and Classification	No Lab
2	Fri.	Aug. 30	Ground water flow	
**	Mon.	Sept. 2	**No Class**	Introduction to Testnet and transducer calibration
3	Wed.	Sept. 4	Stresses in Soil Deposit	
4	Fri.	Sept. 6	Mohr's cirlce and stress path	
5	Mon.	Sept. 9	Introduction to Shear Strength of Soils	Direct shear test
6	Wed.	Sept. 11	Direct shear Testing I	
7	Fri.	Sept. 13	Direct shear Testing II	
8	Mon.	Sept. 16	Triaxial Testing	Direct shear test
9	Wed.	Sept. 18	Triaxial Testing	
10	Fri.	Sept. 20	Triaxial Testing	
11	Mon.	Sept. 23	Shearing Strength of Sand I	Consolidated UnDrained-Sand
12	Wed.	Sept. 25	Shearing Strength of Sand II	
13	Fri.	Sept. 27	Shearing Strength of Sand III	
14	Mon.	Sept. 30	Shearing Strength of Sand IV	Consolidated UnDrained-Sand
15	Wed.	Oct. 2	Shearing Strength of Sand V	
16	Fri.	Oct. 4	Shearing Strength of Sand VI	
17	Mon.	Oct. 7	1-D analysis for total settlement of saturated clays I	Over View of other testing setups
18	Wed.	Oct. 9	1-D analysis for total settlement of saturated clays II	
19	Fri.	Oct. 11	1-D analysis for total settlement of saturated clays III	
20	Mon.	Oct. 14	1-D analysis for total settlement of saturated clays VI	Oedometer Deformation - Incremental Loading
21	Wed.	Oct. 16	Terzaghi's Theory- Time rate of Consolidation I	
22	Fri.	Oct. 18	**EXAM I**	
23	Mon.	Oct. 21	Terzaghi's Theory- Time rate of Consolidation II	Consolidation lab
24	Wed.	Oct. 23	Terzaghi's Theory- Time rate of Consolidation III	
25	Fr.	Oct. 25	Consolidation from Incremental Loading Tests	
26	Mon.	Oct. 28	Secondary Consolidation I	Consolidation lab
27	Wed.	Oct. 30	Secondary Consolidation II	
28	Fri.	Nov. 1	Secondary Consolidation III	
29	Mon.	Nov. 4	Extensions to Terzaghi's Basic Theory I	Consolidation lab
30	Wed.	Nov. 6	Extensions to Terzaghi's Basic Theory II	
31	Fri.	Nov. 8	Extensions to Terzaghi's Basic Theory III	
32	Mon.	Nov. 11	Preloading, Surcharge and Stress Distribution	
33	Wed.	Nov. 13	Radial Flow and Radial consolidation	
34	Fri.	Nov. 15	Shearing Strength of Cohesive Soils I	
35	Mon.	Nov. 18	Shearing Strength of Cohesive Soils II	UnConsolidated UnDrained-Saturated and Partially Saturated
36	Wed.	Nov. 20	Shearing Strength of Cohesive Soils III	
37	Fri.	Nov. 22	**EXAM II**	
38	Mon.	Nov. 25	Shearing Strength of Cohesive Soils IV	UnConsolidated UnDrained-Saturated and Partially Saturated
39	Wed.	Nov. 27	Shearing Strength of Cohesive Soils V	
**	Fri.	Nov. 29	Thanks Giving Weekend	
40	Mon.	Dec. 2	C/P ratio	UnConsolidated UnDrained-Saturated and Partially Saturated
41	Wed.	Dec. 4	Thixotropy and Sensitivity	
42	Fri.	Dec. 6	Partially Saturated Cohesive Soils I	