

Western University - Faculty of Engineering
Department of Civil and Environmental Engineering

CEE 9530A –Ground Anchoring Systems
Course Outline – Fall 2016

Objectives:

Strengthening and stabilizing soil and rock masses, and resisting structural movements by anchoring them via prestressed reinforcement is achieved by anchoring. Also, to withstand lateral forces, temporary tie-backs in soil are necessary for construction of shallow foundations. This practical and informative course is aimed for graduate students interested in safe and economic methods for strengthening engineering structures. The objective of this course is to provide an in depth review of design, applications and installation methods for anchoring in rock and soil. This will include: 1) understanding the principles and procedures for designing anchors for soils and rocks; 2) learning how to select the right type of anchors and methods for installation, grouting and prestressing them; 3) becoming knowledgeable about the corrosion protection methods used; 4) gaining insight into the long term behavior of anchors in ground, and 5) reviewing applications of anchoring in excavation, rock and soil slopes, walled excavation, retaining walls, bridge structures, foundations, basins and water reservoirs, loading equipment in field tests and many other applications.

Topics:

- 1) Anchors in Speciality Geotechnical Engineering
A review of all the speciality geotechnical construction techniques, showing methodology , application soils, costs, etc., and highlighting the position of anchors
- 2) Soil Anchors
 - *Types of soil anchors*
 - *Tendon material*
 - *Anchored walls*
 - *Application of ground anchors*
 - *Failure mechanisms of anchors*
- 3) Rock Anchors
 - *Types of rocks*
 - *Rock mass classification systems*
 - *Modes of failure of anchors in rock*
 - *Investigation and evaluation of rocks with regard to anchoring*
 - *Embedment and bond strength*
- 4) Anchor System Design
 - *Selection of Soil Shear Strength Parameters for Design*
 - *Evaluation of Earth Pressures for Wall Design*
 - *Ground Anchor Design*
 - *Anchored Slopes and Landslide Stabilization Systems*
- 5) Corrosion Considerations in Design
 - *Corrosion and Effects on Ground Anchors*
 - *Corrosion Protection of Ground Anchors*
 - *Selection of Corrosion Protection Level*
- 6) Load Testing of Anchor Systems
 - *Monitoring concepts*

- *Testing equipment*
 - *Types of test*
 - *Performance tests*
 - *Proof testing*
 - *Creep testing*
 - *Acceptance criteria*
- 7) Contracting Approaches
 - *Method Contracting Approach*
 - *Performance Contracting Approach*
 - *Contractor Design/Build Approach*
 - 8) Construction Inspection and Performance Monitoring

Note that all topics may not be covered due to time constraints.

Prerequisites:

This course is intended for graduate students enrolled in civil engineering with an interest in geotechnical engineering. It is expected that students will have basic understanding of soil mechanics obtained by taking suitable courses at either the undergraduate or graduate level. Students without a suitable background in soil mechanics should discuss this with the instructor prior to registering for the course.

Corequisites:

None

Antirequisites:

None

Note: It is the **student's responsibility** to ensure that all Prerequisite and Corequisite conditions are met or that special permission to waive these requirements has been granted by the Faculty. It is also the **student's responsibility** to ensure that they have not taken a course listed as an Antirequisite. The student may be dropped from the course or not given credit for the course towards their degree if they violate the Prerequisite, Corequisite or Antirequisite conditions.

Instructor:

Abouzar Sadrekarimi, Ph.D., P. Eng.
SEB3010D, email: asadrek@uwo.ca.

Contact Hours:

Two lecture hours per week.

Course Materials:

The following textbook will be used for this course:

Xanthakos, P. P. (1991). "Ground Anchors and Anchored Structures," John Wiley & Sons Inc.

Due to the practical nature of this course there are also a number of other textbooks and standard codes that cover many of the aspects of the course material and which are available through Western Libraries, either physically or online. These include:

Canadian Foundation Engineering Manual (2006). Canadian Geotechnical Society, 4th Edition, BiTech Publisher Ltd. 506 p.

BA 80/99 (1999) "Design Manual for Roads and Bridges: Use of Rock Bolts" Volume 2, Highway Structures: Design, Section 1: Material Substructures, Part 7.

Federal Highway Administration (1999). "Ground Anchors and Anchored Systems" Geotechnical Engineering Circular No. 4, U.S. Department of Transportation, FHWA-IF-99-015.

Terzaghi, K., Peck, R., and Mesri, G. (1996). "Soil mechanics in engineering practice." John Wiley & Sons, 592 pages. Any newer or more recent textx?

Prepared class notes will be made available through the course OWL site at <http://owl.uwo.ca/>, along with other useful reference material and data for assignments.

Computing:

Assignments will require the processing of data using computer data-analysis software such as MS Excel or similar, and students will be assumed to be proficient in the use of the software of their choice.

Course Project:

Each student will be given a set of parameters to design a ground shoring and anchoring system. The design will include zoning, selecting dimensions, anchor design, wall (sheet pile or soldier pile) design, and global stability analysis. A technical report summarizing the analyses, results and design specifications will be submitted.

Units:

SI units will be used in lectures and examinations

Evaluation:

The final course mark will be determined as follows:

Assignments:	30%
Project:	40%
Final exam:	30%

Total	100%

Use of English:

In accordance with Senate and Faculty Policy, students may be penalised up to 10% of the marks on all assignments, tests, and examinations for the improper use of English. Additionally, poorly written work with the exception of the final examination may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

Scholastic Offences:

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site:

http://www.uwo.ca/univsec/handbook/appeals/scholastic_discipline_grad.pdf.

Plagiarism:

University policy states that plagiarism, defined as the “act or an instance of copying or stealing another’s words or ideas and attributing them as one’s own.” (excerpted from Black’s Law Dictionary, West Group, 1999, 7th ed., p. 1170) is a scholastic offence. In submitting any written work as part of the coursework requirements for this course students must ensure that this work is written in their own words. Whenever students take an idea or a passage of text from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations.

All required papers may be subject to submission for textual similarity review to the commercial plagiarism-detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com (<http://www.turnitin.com>).

A student who is found guilty of plagiarism in respect of any written work submitted as part of the coursework requirements for this course will be given a grade of zero for the submitted work. Repeated acts of plagiarism, either in this course or any other course subsequent to a first offence, will result in the student being given a failing grade for the course in which the subsequent offence occurs, and may also incur further penalties such as requiring the student to withdraw from the program in which they are enrolled in.

Attendance:

Any student who, in the opinion of the instructor, is absent too frequently from class, laboratory, or tutorial periods will be reported to the Dean (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Dean, the student will be debarred from taking the regular final examination in the course.

Accessibility:

Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 x 82147 for any specific question regarding an accommodation.

Conduct:

Students are expected to arrive at lectures on time, and to conduct themselves during class in a professional and respectful manner that is not disruptive to others. Late comers may be asked to wait outside the classroom until being invited in by the Instructor. Please turn off your cell phone before coming to a class, tutorial, quiz or exam.

On the premises of the University or at a University-sponsored program, students must abide by the Student Code of Conduct: <http://www.uwo.ca/univsec/board/code.pdf>.

Sickness and Other Problems:

Students should immediately consult with the Instructor or Department Chair if they have any problems that could affect their performance in the course. Where appropriate, the problems should be documented (see attached). The student should seek advice from the Instructor or Department Chair regarding how best to deal with the problem. Failure to notify the Instructor or Department Chair immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

For more information concerning medical accommodations, please see:
http://www.uwo.ca/univsec/handbook/appeals/accommodation_medical.pdf.

Notice:

Students are responsible for regularly checking their email, and the course OWL site for new notices related to the course.