

Western University
Faculty of Engineering
Department of Civil and Environmental Engineering

CEE9530B – Ground Anchoring Systems

COURSE OUTLINE 2020-2021

DESCRIPTION

Strengthening and stabilizing soil 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 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.

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.

TOPICS

Topic #	Description	Learning Activities	Tentative timeline
1	Introduction to Ground Anchor	Live lecture	Week 1
2	Lesson 1) Anchor Types		
	Soil Anchors	Live lecture hours	Week 1
	Rock Anchors	Live lecture hours	Week 2
3	Lesson 2) Site Investigation for Anchor Design	Live lecture hours	Weeks 3 & 4
4	Lesson 3) Fundamental of Anchor Design	Live lecture hour	Week 5
	Family Day	Holiday	Week 6
5	Lesson 4) Design of Anchored Walls		
	Soil strength parameters	Live lecture hours	Week 7
	Lateral earth pressure		

	Calculation of anchor loads		
	Bond length		
	Pressure-grouted anchors		
	Rock anchors		
	Axial force and moment design	Live lecture hours	Week 8
	Anchored slopes	Live lecture hours	Week 9
	Ground stabilization		
6	Lesson 5) Load Testing of Anchors	Live lecture hour	Week 10
7	Practical Design Examples	Two live lectures	Weeks 11 and 12
8	Project Presentations	Live student presentation	Week 13
9	Project Presentations	Live student presentation	Week 14

SPECIFIC LEARNING OUTCOMES

Degree Level Expectation	Weight	Assessment Tools	Outcomes
Depth and breadth of knowledge	30%	<ul style="list-style-type: none"> • Assignments • Project • Examinations 	<ul style="list-style-type: none"> • Understanding of fundamentals of soil mechanics • In-depth understanding of lateral earth pressure concepts • Understanding of computational and/or empirical methodologies to design anchor loads
Research & scholarship	15%	<ul style="list-style-type: none"> • Project 	<ul style="list-style-type: none"> • Ability to conduct critical evaluation of a ground anchor project in the field • Numerical analysis of ground anchoring forces, moment and design.
Application of knowledge	30%	<ul style="list-style-type: none"> • Assignments • Project • Examinations 	<ul style="list-style-type: none"> • Ability to apply knowledge in a rational way to analyze a ground anchor assignment problems • Ability to use coherent approach to design a particular engineering system using existing design tools
Professional capacity / autonomy	5%	<ul style="list-style-type: none"> • Project 	<ul style="list-style-type: none"> • Awareness of academic integrity • Ability to implement established procedures and practices in the coursework • Defends own ideas and conclusions • Integrates reflection into his/her learning process
Communication skills	10%	<ul style="list-style-type: none"> • Project 	<ul style="list-style-type: none"> • Ability to communicate (oral and/or written) ideas, issues, results and conclusions clearly and effectively
Awareness of limits of knowledge	10%	<ul style="list-style-type: none"> • Project 	<ul style="list-style-type: none"> • Awareness of the need of assumptions in complex scientific analyses and their consequences • Understanding of the difference between theoretical and empirical approaches • Ability to acknowledge analytical limitation due to complexity of practical problems

ASSESSMENTS

Assessment Type	Material Covered	Due Date	Weight
Homework Assignments (two)	Topics 4, 5	March 15 th & 29 th	30%
Project report	Topics 1, 2, 4, 5, 6	April 12 th	30%
Project presentation	Topics 1, 2, 4, 5, 6	April 5 th & 12 th	10%
Online Final Exam*	Topics 1, 2, 4, 5, 6	TBA	30%

* The final exam will be open-book and conducted live through OWL within a certain time. It will be proctored through Zoom. Further details of the proctoring procedure is provided in Section “Online Proctoring Notice” later in this outline.

Live Lectures

Joining and participating the live lectures is mandatory in this course. Synchronous lecture will be recorded and uploaded to course OWL site.

Activities in which collaboration is permitted:

None

Activities in which students must work alone (collaboration is not permitted):

- Homework assignment
- Project report
- Project presentation
- Final exam

CONTACT INFORMATION

Course instructor: Professor Abouzar Sadrekarimi

Email address: asadrek@uwo.ca

Contact policy:

- Contact instructor via email (above) or through messages in OWL
- Weekly Office hours are held via Zoom

OPTIONAL COURSE READINGS

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.

COURSE CONTENT

The lecture notes and online lecture videos are copyrighted to the instructor and legally protected. Do not post these videos and lecture notes on any other website or online forums. The recording of the live/synchronous sessions of the course without the permission from the instructor is prohibited. The illegal posting and sharing of the copyrighted course content could be subjected to legal actions.

CHEATING, PLAGIARISM/ACADEMIC OFFENCES

Academic integrity is an essential component of learning activities. Students must have a clear understanding of the course activities in which they are expected to work alone (and what working alone implies) and the activities in which they can collaborate or seek help; see information above under "Assessments" and ask instructor for clarification if needed. Any unauthorized forms of help-seeking or collaboration will be considered an academic offense. University policy states that cheating is an academic offence. If you are caught cheating, there will be no second warning. Students must write their essays and assignments 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. Plagiarism is a major academic offence. Academic offences are taken seriously and attended by academic penalties which may include expulsion from the program. Students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence (see Western's scholastic discipline regulations for graduate students).

SYNCHRONOUS LEARNING ACTIVITIES

Students are expected to participate in synchronous learning activities as outlined in the course syllabus and/or described by the instructor. If you have issues that will impede your ability to participate in synchronous activities, please discuss with the course instructor at the beginning of the course.

CONDUCT

Students are expected to follow proper etiquette during synchronous and asynchronous activities to maintain an appropriate and respectful academic environment. Any student who, in the opinion of the instructor, is not appropriately participating in the synchronous and asynchronous learning activities and/or is not following the rules and responsibilities associated with the online learning activities, will be reported to the Associate Dean (Graduate) (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Associate Dean (Graduate), the student could be debarred from completing the assessment activities in the course as appropriate.

HEALTH/WELLNESS

As part of a successful graduate student experience at Western, we encourage students to make their health and wellness a priority. Western provides several health and wellness related services (remotely accessible) to help you achieve optimum health and engage in healthy living while pursuing your graduate degree. Information regarding health- and wellness-related services available to students may be found at <http://www.health.uwo.ca/>.

Students seeking help regarding mental health concerns are advised to speak to someone they feel comfortable confiding in, such as their faculty supervisor, their program director (graduate chair), or other relevant administrators in their unit. Campus mental health resources may be found at http://www.health.uwo.ca/mental_health/resources.html
<https://www.uwo.ca/health/psych/index.html>

SICKNESS

Students should immediately consult with the Instructor (for a particular course) or Associate Chair (Graduate) (for a range of courses) if they have problems that could affect their performance. The student should seek advice from the Instructor or Associate Chair (Graduate) regarding how best to deal with the problem. Failure to notify the Instructor or the Associate Chair (Graduate) immediately (or as soon as possible thereafter) will have a negative effect on any appeal. Obtaining appropriate documentation (e.g., a note from the doctor) is valuable when asking for accommodation due to illness.

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 Accessible Education at 661-2111 x 82147 or http://academicsupport.uwo.ca/accessible_education/index.html, for any specific question regarding an accommodation.

ONLINE PROCTORING NOTICE

The final examination in this course will be conducted using Zoom. You will be required to keep your camera on for the entire session, hold up your student card for identification purposes, and share your screen with the invigilator if asked to do so at any time during the exam. The exam session will not be recorded.*

More information about the use of Zoom for exam invigilation is available in the Online Proctoring Guidelines at the following link:

<https://www.uwo.ca/univsec/pdf/onlineproctorguidelines.pdf>

Completion of this course will require you to have a reliable internet connection and a device that meets the system requirements for Zoom. Information about the system requirements is available at the following link:

<https://support.zoom.us/hc/en-us>

* Please note that Zoom servers are located outside Canada. If you would prefer to use only your first name or a nickname to login to Zoom, please discuss this with your instructor in advance of the test or examination.