

CIV_ENG_352-0
Foundation Engineering
Winter Quarter 2023

Course description: This course applies foundational knowledge of soil, rock, and structural mechanics to the analysis and design of foundation systems and earth retaining structures. The course addresses the capacity and deformation of both shallow and deep foundations, as well as the stability of earth retaining structures. Attention is devoted to analytical and semi-analytical tools that can be employed to develop the analysis of the considered earth-contact structures, but computational approaches are introduced as well.

Course goals: The course builds upon lectures that merge the theory with the practice of foundation engineering. At the end of this course, students will be able to:

- 1) Relate foundational concepts of soil and rock mechanics to the design of earth-contact structures
- 2) Know how to perform site explorations and characterizations to support the analysis and design of earth-contact structures
- 3) Master the key steps involved in the design of earth-contact structures
- 4) Determine the capacity and deformation of shallow and deep foundations
- 5) Determine the capacity and deformation of mat and piled raft foundations
- 6) Determine the stability of earth-retaining structures
- 7) Quantify the interactions between foundations/earth retaining structures and superstructures
- 8) Write technical reports focusing on the analysis and design of earth-contact structures
- 9) Present key results related to the analysis and design of earth-contact structures

Competencies will be tested through (i) 4 individual bi-weekly quizzes, (ii) 2 individual homework problems, and (iii) a group research project.

Course outcomes: The following Course Assessment Table (CAT) relates Course Goals to Accrediting Board for Engineering and Technology (ABET) Outcomes as follows:

Course Goals	ABET Outcome	ABET Outcome Description	Performance indicator
1-7	1	An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	Goal 1-8 Bi-weekly quizzes
8, 9	3	An ability to communicate effectively with a range of audiences	Homework assignments – Form Research project presentation – Form
4-7	6	An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	Homework assignments – Content Research project presentation – Content

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Facilitator	Mr. Andony LANDIVAR MACIAS E-mail: alandivar@u.northwestern.edu
Class times & location	Tuesdays (T) and Thursdays (Th) from 12:30 to 1:50 pm, Annenberg Hall G01
Suggested textbooks	Lancellotta, R. (2008) <i>Geotechnical Engineering</i> , Taylor and Francis Bowles, J. E. (1997) <i>Foundation Analysis and Design</i> , MacGraw Hill
Course assessment	<p>1) Class attendance – 5%. 5 points will be assigned for every attended class on T or Th (total classes considered: 19); one “freebie” absence is granted (graded from 0 to 100).</p> <p>2) Homework assignments – 20%. Assessed through the quality of technical reports summarizing the results of homework problems to be solved individually (graded from 0 to 100). The reports must be written in digital format and composed of three sections: 1) Problem statement and definition of unknowns; 2) Solution; 3) Summary of results and concluding remarks. They should be sent to the instructor by the specified deadline. Both the content and form of the reports will be evaluated, accounting for 80% and 20% of the grade, respectively.</p> <p>3) Bi-weekly quizzes – 50%. Assessed through the results of a quiz composed of 15 questions to be answered in 20 minutes (graded from 0 to 100)</p> <p>5) Group research project – 25%. Assessed through the quality of a technical report and a group presentation given in front of the class (graded from 0 to 100). Both the content and form of the presentations will be evaluated, accounting for 80% and 20% of the grade, respectively. The projects shall be considered an opportunity to expand the subjects addressed by this course. They should consist in a detailed and critical analysis of the state-of-the art of the chosen subject. The technical report should summarize the results of the research in the form of a 10 to 12-page document written in the form of a research paper (such a paper should include the project title, the author names, a 200-word-long abstract, an introduction, an adequate number of core sections and subsections, a concluding remarks section, and the list of references; the paper should be written in Times New Roman, 12-size font). The group presentations should last 10 minutes and include a summary of the performed research. All students should contribute to the development and presentation of the work performed by the group. Students are responsible to form groups of 2 to 3 people maximum to perform the projects and indicate by the end of the second lecture (in a dedicated worksheet on Canvas) the names of the group members and the chosen project. Projects will be assigned on a first come, first served basis.</p> <p>Course grading: A = 100-93, A- = 92-90, B+ = 89-87, B = 86-83, B- = 82-80, C+ = 79-77, C = 76-73, C- = 72-70, D+ = 69-67, D = 66-65</p>

Course content

Week	Day	Lecture	Remarks
Introduction			
1	T	No class – Northwestern Monday	
	Th	Classification of earth contact structures	
2	T	Design process of earth contact structures	<i>Deadline to communicate project teams & subjects</i>
	Th	Fundamentals of failure analyses	
3	T	Fundamentals of deformation analyses	<i>Quiz 1</i>
	Th	Design situations	
Shallow and deep foundations			
4	T	Capacity of footings and beams	
	Th	Deformation of footings and beams	<i>Interim project revision</i>
5	T	Capacity of single piles and barrettes	<i>Quiz 2</i>
	Th	Deformation of single piles and barrettes	
6	T	Capacity of pile and barrette groups	
	Th	Deformation of pile and barrette groups	Homework 1 assigned
7	T	Capacity and deformation of mat foundations	<i>Quiz 3</i>
	Th	Capacity and deformation of piled raft foundations	
Earth retaining structures			
8	T	Capacity and stability of gravity walls	
	Th	Capacity and stability of cantilever walls	Homework 2 assigned
9	T	Stability of diaphragm walls	<i>Quiz 4; Homework 1 due</i>
	Th	Performance of superstructures	
Closure			
10	T	Ground improvement and rehabilitation methods	
	Th	Project presentations	<i>Homework 2 due; project presentations</i>

Proposed research projects

1. History of building foundations in Chicago
2. Problematic performance of historical building foundations
3. Retrofit approaches for existing building foundations
4. Innovations in foundation engineering
5. Analysis and design of tall building foundations
6. Load-transfer methods for foundations and earth-retaining structures
7. Techno-economic analysis of an emblematic case study around the world
8. Foundation engineering in space: challenges and perspectives
9. *Proposed project*

Statements

Academic Integrity

Students in this course are required to comply with the policies found in the booklet, "Academic Integrity at Northwestern University: A Basic Guide". All papers submitted for credit in this course must be submitted electronically unless otherwise instructed by the professor. Your written work may be tested for plagiarized content. For details regarding academic integrity at Northwestern or to download the guide, visit: <https://www.northwestern.edu/provost/policies/academic-integrity/index.html>

Accessibility

Northwestern University is committed to providing the most accessible learning environment as possible for students with disabilities. Should you anticipate or experience disability-related barriers in the academic setting, please contact AccessibleNU to move forward with the university's established accommodation process (e: accessiblenu@northwestern.edu; p: 847-467-5530). If you already have established accommodations with AccessibleNU, please let me know as soon as possible, preferably within the first two weeks of the term, so we can work together to implement your disability accommodations. Disability information, including academic accommodations, is confidential under the Family Educational Rights and Privacy Act.

COVID-19 Classroom Expectations

Students, faculty, and staff must comply with University expectations regarding appropriate classroom behavior, including those outlined below and in the COVID-19 Code of Conduct. With respect to classroom procedures, this includes:

Policies regarding masking and social distancing evolve as the public health situation changes. Students are responsible for understanding and complying with current masking, testing, Symptom Tracking, and social distancing requirements.

In some classes, masking and/or social distancing may be required as a result of an Americans with Disabilities Act (ADA) accommodation for the instructor or a student in the class even when not generally required on campus. In such cases, the instructor will notify the class.

No food is allowed inside classrooms. Drinks are permitted, but please keep your face covering on and use a straw. Faculty may assign seats in some classes to help facilitate contact tracing in the event that a student tests positive for COVID-19. Students must sit in their assigned seats.

If a student fails to comply with the COVID-19 Code of Conduct or other University expectations related to COVID-19, the instructor may ask the student to leave the class. The instructor is asked to report the incident to the Office of Community Standards for additional follow-up.

COVID-19 Testing Compliance

To protect the health of our community, Northwestern University requires unvaccinated students who are in on-campus programs to be tested for COVID-19 twice per week.

Students who fail to comply with current or future COVID-19 testing protocols will be referred to the Office of Community standards to face disciplinary action, including escalation up to restriction from campus and suspension.

Diversity, Equity and Inclusion

This course strives to be an inclusive learning community, respecting those of differing backgrounds and beliefs. As a community, we aim to be respectful to all students in this class, regardless of race, ethnicity, socio-economic status, religion, gender identity or sexual orientation.

Exceptions to Class Modality

Class sessions for this course will occur in person. Individual students will not be granted permission to attend remotely except as the result of an Americans with Disabilities Act (ADA) accommodation as determined by AccessibleNU.

Maintaining the health of the community remains our priority. If you are experiencing any symptoms of COVID do not attend class and update your Symptom Tracker application right away to connect with Northwestern's Case Management Team for guidance on next steps. Also contact the instructor as soon as possible to arrange to complete coursework.

Students who experience a personal emergency should contact the instructor as soon as possible to arrange to complete coursework.

Should public health recommendations prevent in person class from being held on a given day, the instructor or the university will notify students.

Guidance on Class Recordings

This class or portions of this class will be recorded by the instructor for educational purposes. Your instructor will communicate how members of the class can access the recordings. Portions of the course that contain images, questions or commentary/discussion by students will be edited out of any recordings that are saved beyond the current term.

Prohibition of Recording of Class Sessions by Students

Unauthorized student recording of classroom or other academic activities (including advising sessions or office hours) is prohibited. Unauthorized recording is unethical and may also be a violation of University policy and state law. Students requesting the use of assistive technology as an accommodation should contact AccessibleNU. Unauthorized use of classroom recordings – including distributing or posting them – is also prohibited. Under the University’s Copyright Policy, faculty own the copyright to instructional materials – including those resources created specifically for the purposes of instruction, such as syllabi, lectures and lecture notes, and presentations. Students cannot copy, reproduce, display, or distribute these materials. Students who engage in unauthorized recording, unauthorized use of a recording, or unauthorized distribution of instructional materials will be referred to the appropriate University office for follow-up.

Support for Wellness and Mental Health

Northwestern University is committed to supporting the wellness of our students. Student Affairs has multiple resources to support student wellness and mental health. If you are feeling distressed or overwhelmed, please reach out for help. Students can access confidential resources through the Counseling and Psychological Services (CAPS), Religious and Spiritual Life (RSL) and the Center for Awareness, Response and Education (CARE). Additional information on all of the resources mentioned above can be found here:

<https://www.northwestern.edu/counseling/>

<https://www.northwestern.edu/religious-life/>

<https://www.northwestern.edu/care/>