



National University of Engineering (UNI)

School of Civil Engineering
Syllabus 2026-II

1. COURSE

CE3G2. Soil Mechanics Applied to Foundations (Mandatory)

2. GENERAL INFORMATION

2.1 Course	: CE3G2. Soil Mechanics Applied to Foundations
2.2 Semester	: 10 th Semester.
2.3 Credits	: 4
2.4 Hours	: 3 HT; 2 HP;
2.5 Duration of the period	: 16 weeks
2.6 Type of course	: Mandatory
2.7 Learning modality	: Face to face
2.8 Prerequisites	: CE2G2. Soil Mechanics II. (8 th Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Soil Mechanics Applied to Foundations is a specialization elective of the Geotechnical Engineering track, taken after Soil Mechanics II, in which the foundation-design and slope-stability topics introduced there at a survey level are revisited in substantially greater depth. The course opens with the identification and classification of foundation soils – including problematic soils such as expansive, collapsible, and dispersive soils, and engineered fills – and the site-investigation criteria required under Peru's RNE Norma E.050. It then develops ground improvement techniques for weak or hazard-prone soils, extends bearing capacity theory to stratified profiles, sloping ground, and seismic loading, and deepens the design of both shallow and deep foundations, including pile load testing and integrity testing. The course closes with the static and pseudo-static (seismic) stability analysis of slopes. Together, these topics prepare students to characterize difficult foundation conditions and design the full range of foundation solutions encountered in professional geotechnical practice.

5. GOALS

- Classify foundation soils from geologic maps and subsurface data, and identify expansive, collapsible, dispersive, and engineered-fill soils and their implications for foundation design.
- Apply Peru's RNE Norma E.050 criteria to define foundation-soil classification and geotechnical investigation requirements.
- Select and design ground improvement measures for soils with inadequate bearing or settlement characteristics.
- Evaluate liquefaction susceptibility of foundation soils using field investigation data.
- Design shallow foundations considering bearing capacity in stratified soils, sloping ground, and seismic loading conditions.
- Design deep foundations (piles) and interpret static and dynamic load test and integrity test results.
- Analyze the static and pseudo-static (seismic) stability of slopes and design stabilization measures.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (Usage)

ABET-2) An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. (Usage)

ABET-6) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions. (Usage)

7. TOPICS

Unit 1: Problematic Soils and Foundation-Soil Classification (17 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	Learning Outcomes
• Types of foundation soils and site characterization from geologic maps and subsurface data • Foundation-soil classification and investigation requirements under Peru's RNE Norma E.050 • Identification and mineralogy of expansive (swelling) soils • Swell potential testing and foundation design measures for expansive soils • Identification and behavior of collapsible (metastable) soils • Identification and treatment of dispersive soils • Specification and quality control of engineered fill for foundation support	• Classify foundation soils using geologic maps and subsurface investigation data [Familiarity] • Apply Peru's RNE Norma E.050 criteria to classify foundation soils and define investigation requirements [Assessment] • Identify expansive soils from mineralogy and index test data [Usage] • Design foundations for expansive soils based on swell potential test results [Assessment] • Recognize collapsible and dispersive soil behavior from field and laboratory indicators [Familiarity] • Specify engineered fill requirements for foundation support [Usage]
Readings : [Cod01], [NM92], [Min18]	

Unit 2: Geotechnical Earthquake Engineering (3 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	Learning Outcomes
• Single-degree-of-freedom dynamic systems and one-dimensional wave propagation through soil deposits • Site response and ground motion amplification • Seismic hazard analysis and design ground motions • Liquefaction susceptibility and triggering mechanisms • Cyclic stress ratio and liquefaction evaluation procedures • Effects of liquefaction on structures and infrastructure • Dynamic soil properties and laboratory testing • Design of foundations for vibrating machinery under dynamic loading • Ground improvement methods for liquefaction mitigation • Lateral spreading and flow failures • Seismically induced settlement and bearing capacity • Performance-based design for geotechnical earthquake engineering	• Formulate single-degree-of-freedom models and one-dimensional wave-propagation equations to characterize seismic wave transmission through soil deposits [Usage] • Explain site response effects and ground motion characteristics [Familiarity] • Determine design ground motions for geotechnical seismic analysis [Assessment] • Evaluate liquefaction susceptibility using field investigation data [Usage] • Calculate cyclic stress ratios and assess liquefaction potential [Assessment] • Assess the consequences of liquefaction on foundations and structures [Familiarity] • Characterize dynamic soil properties from laboratory and field tests [Usage] • Proportion machine foundations considering dynamic soil-foundation stiffness, resonance avoidance, and permissible vibration amplitudes [Assessment] • Select and design ground improvement methods to mitigate liquefaction [Assessment] • Predict lateral spreading displacements and flow failure potential [Usage] • Analyze seismically induced settlement and reduced bearing capacity [Assessment] • Implement performance-based approaches for seismic geotechnical design [Assessment]
Readings : [Kra96], [Das19]	

Unit 3: Ground Improvement Techniques (10 hours)	
Competences Expected: ABET-2	
Topics	Learning Outcomes
• Compaction methods including dynamic and vibratory techniques • Stone columns and vibro-replacement methods • Preloading and vertical drains for soft ground treatment • Deep mixing and jet grouting techniques • Chemical stabilization and grouting methods	• Select appropriate ground improvement methods for specific soil conditions [Familiarity] • Design stone column systems for settlement reduction [Assessment] • Calculate consolidation time reduction using vertical drains [Usage] • Identify geosynthetic types and their engineering applications [Familiarity] • Proportion reinforcement for mechanically stabilized earth structures [Assessment]
Readings : [Koe12], [Das19]	

Unit 4: Bearing Capacity and Design (26 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	Learning Outcomes
• Bearing capacity theory and failure mechanisms • Ultimate bearing capacity equations for various conditions • Settlement analysis using elastic and consolidation methods • Isolated spread footing design • Combined footings and strap footings • Allowable bearing pressure and factor of safety selection • Mat foundation analysis and design • Eccentric and inclined loading effects • Soil-structure interaction effects • Differential settlement and tolerable limits • Continuous (strip) footing design for basement and foundation walls	• Explain bearing capacity failure mechanisms in shallow foundations [Familiarity] • Calculate ultimate bearing capacity using Terzaghi and Meyerhof equations [Assessment] • Predict total and differential settlements for shallow foundations [Usage] • Design isolated spread footings for gravity loads [Assessment] • Proportion combined and strap footings for column arrangements [Usage] • Determine allowable bearing pressures based on strength and settlement criteria [Assessment] • Analyze mat foundations using conventional and finite element methods [Assessment] • Evaluate bearing capacity under eccentric and inclined loading [Usage] • Consider soil-structure interaction in foundation design [Familiarity] • Assess differential settlement and apply tolerable settlement criteria [Assessment] • Design continuous strip footings for basement and foundation walls [Usage]
Readings : [Cod01], [Das19]	

Unit 5: Deep Foundations (8 hours)	
Competences Expected: ABET-2,ABET-6	
Topics	Learning Outcomes
• Pile types and installation methods • Axial capacity of single piles in cohesive and cohesionless soils • Lateral load capacity and p-y method • Pile group behavior and group efficiency • Drilled shaft design and construction considerations • Negative skin friction and downdrag forces	• Select appropriate pile types based on soil conditions and loading [Familiarity] • Calculate axial capacity of piles using static methods [Assessment] • Analyze laterally loaded piles using p-y curves [Usage] • Evaluate pile group capacity and settlement [Assessment] • Design drilled shaft foundations including shaft diameter and reinforcement [Usage] • Interpret pile load test results and verify design assumptions [Assessment]
Readings : [Cod01], [Das19]	

Unit 6: Slope Stability Analysis and Stabilization (6 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	Learning Outcomes
• Infinite slope analysis for simple geometries • Method of slices and limit equilibrium analysis • Circular and non-circular failure surfaces • Factor of safety determination and acceptance criteria • Stability charts and simplified methods • Landslide types and failure mechanisms • Seismic slope stability and pseudo-static analysis • Stabilization methods including drainage and reinforcement • Monitoring systems and early warning for unstable slopes • Probabilistic slope stability analysis	• Perform infinite slope stability analysis for uniform slopes [Assessment] • Apply method of slices to analyze slope stability [Usage] • Analyze slopes with circular and non-circular failure surfaces [Assessment] • Calculate factors of safety and interpret results [Usage] • Use stability charts for rapid slope evaluation [Assessment] • Identify landslide types and their characteristic features [Familiarity] • Evaluate seismic stability using pseudo-static methods [Usage] • Design slope stabilization measures for specific failure modes [Assessment] • Implement monitoring systems for potentially unstable slopes [Usage] • Conduct probabilistic stability analysis considering parameter uncertainty [Assessment]
Readings : [DWB14]	

8. WORKPLAN

8.1 Methodology

Individual and team participation is encouraged to present their ideas, motivating them with additional points in the different stages of the course evaluation.

8.2 Theory Sessions

The theory sessions are held in master classes with activities including active learning and roleplay to allow students to internalize the concepts.

8.3 Practical Sessions

The practical sessions are held in class where a series of exercises and/or practical concepts are developed through problem solving, problem solving, specific exercises and/or in application contexts.

9. EVALUATION SYSTEM

***** EVALUATION MISSING *****

10. BASIC BIBLIOGRAPHY

- [NM92] John D. Nelson and Debora J. Miller. *Expansive Soils: Problems and Practice in Foundation and Pavement Engineering*. John Wiley & Sons, 1992.
- [Kra96] Steven L. Kramer. *Geotechnical Earthquake Engineering*. Prentice Hall, 1996.
- [Cod01] Donald P. Coduto. *Foundation Design: Principles and Practices*. 2nd. Prentice Hall, 2001.
- [Koe12] Robert M. Koerner. *Designing with Geosynthetics*. 6th. Xlibris Corporation, 2012.
- [DWB14] J. Michael Duncan, Stephen G. Wright, and Thomas L. Brandon. *Soil Strength and Slope Stability*. 2nd. John Wiley & Sons, 2014.
- [Min18] Construcción y Saneamiento del Perú Ministerio de Vivienda. *Norma E.050: Suelos y Cimentaciones*. Tech. rep. Reglamento Nacional de Edificaciones del Perú, 2018.
- [Das19] Braja M. Das. *Principles of Geotechnical Engineering*. 9th. Cengage Learning, 2019.