CEG 6116 Advanced Shallow Foundation Design and Analysis (3 Credits), Fall 2016

Description: Conceptual understanding of (1) soil mechanics and (2) analytical and empirical solutions of soil-structure interaction problems is focused in balance with application of numerical methods to design and analysis of shallow foundations. Structural design, e.g., level of steel reinforcement, is not the main focus of the advanced shallow foundation design, and thus, will not be focused during class. Design of shallow foundation systems means serviceability and strength design on supporting soils.

Prerequisite: None (but read the below)

Students are expected to (1) have good understanding of Solid Mechanics (at undergraduate level), e.g., how to draw Mohr's circles, and (2) have taken prior to this course *or* plan to take reinforced concrete design courses in the future, i.e., CES5726, in order to be adequately read in the reinforced-concrete design topics. CES 5116 Finite Elements is strongly recommended prior to or concurrently or subsequently taking the course. In cases where these courses are not offered, please consult with the instructor regarding what topics you might need to read in addition to the course materials.

Objectives: Students' conceptual understanding of macroscopic soil behaviors based on principles of theory of elasticity and plasticity, acquiring problem-solving skills for use in nonlinear soil-structure interaction analysis of shallow foundation, and becoming proficient in numerical analysis using FB-MultiPier or/and MathCAD software programs.

Lecture Time and Room: MWF – 6th Period (12:50 PM – 1:40 PM) – Weil 238

Instructor: Dr. Jae Chung

Office: 208 Reed Lab, Phone: (352) 294-7831, email: jchun@ce.ufl.edu

Office Hours: TBA after the first week of class (Note: per appointment by email, the instructor is available for a 30-minute meeting per student bi-weekly)

Textbook (optional but recommended): SOIL MECHANICS, ISBN: 0471511927; Authors: T. WILLIAM LAMBE AND ROBERT V. WHITMAN; Publisher: JOHN WILEY & SONS.
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Software: MathCAD/FB-MultiPier/Winkler. FB-MultiPier V4.20s of a six-month academic license would be provided to enrolled students) and WINKLER V2.01. The software is also available for students' use in CE Computer Lab. Students are expected to be familiar with basics of MathCAD worksheet programming. For the first few homework assignments, a template worksheet would be given to students who make requests to the instructor.

Text and Notes: Each class note in PDF may include up to 3-4 lectures for the continuity of relevant topics. The class notes will be posted on Canvas. Additional reading and examples per lecture will be recommended by providing specific page numbers of both the recommended textbook and reference book. Handouts (hard copies) of journal papers will be occasionally given as reading assignment. In case where students need hard copies of a few to several pages of the reference books, e.g., Foundation Design- Principles and Practices written by Donald Coduto; Deformation Characteristics of Geomaterials edited by Di Benedetto et al.; Limit Analysis and Soil Plasticity written by Wai-Fah Chen, students are expected to obtain such in the library.

Students with Disabilities: Students requesting classroom accommodation must first register with the Dean of Students Office. The Dean of Students Office will provide documentation to the student who must then provide this documentation to the instructor when requesting accommodation.

Attendance: Students are strongly encouraged to attend class. This is not only because attendance is a professional courtesy but also because in-class Q&A sessions and subsequent discussion lead to a conceptual understanding of the relevant topics quicker and better.

In-class Participation: In-class participation will include individual and group assignments, such as Reading & Lecture Questions and discussion of literature.

Homework: There will be 7 homework assignments, including two design assignments toward the end of the semester, at minimum. The assignments will be designed to reinforce concepts from the lecture and highlight the most important ideas for the topics. *No late homework will be accepted.*

Exams: There will be 3 exams in this course. Exams will be in-class and 2.5-hour long, and approximately one week after covering scheduled topics in class.

Make-up Exams: Make-up exams are only given for medical reasons. A student may request a make-up exam if they cannot attend the scheduled exam for medical reasons. The student must contact the instructor before the exam to state that he/she will not be able to attend the exam.

Grading: 3 Exams (90%), Homework (10%)

Final letter grades will be assigned based on the following scale:

A >94	A- 94-90	B+ <90 and >=87	B 86-84	B- < 84 and >=80	C+ <80 and >=77
C 76-74	C- <74 and >=70	D+ <70 and >=67	D 66-64	D- < 64 and >=61	E <61

Use of cellular phones and professional courtesy: Cell phones must be turned off at the beginning of class; use of cell phones during class and exam is prohibited. Food, newspaper, and magazines are not allowed during class.

The Honor Code:
We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment."

Detailed course description: In order to understand nonlinear soil-structure interaction in shallow foundation, principles of theory of elasticity and plasticity, and application of numerical methods such as Finite Element and Finite Difference Methods, as analysis tools are emphasized throughout the course. By the end of this course, students should be able to:

1. Categorize the flexibility of soil based on laboratory and in-situ testing measurement, such as triaxial compression and SPT;
2. Define and interpret the stress-strain relationships of soil;
3. Understand the relationship between material nonlinearity, ultimate strength, and various design methodologies;
4. Evaluate the material parameters of geo-materials for use in linear and nonlinear load-settlement analysis and Load and Resistance Factor Design of shallow foundations using the FB-MultiPier software program.

This course is divided into four Topics. The specific objectives of each Topic are described below.

Topic I Soil load-deformation behavior and analysis parameters

Specific objectives:
1. Learn basic principles of in-situ testing methods and interpretation of the field measurement;
2. Identify design parameters and major functional characteristics;
3. Classify soil per geotechnical exploration report;
4. Explain the most important aspects of soil-structure interaction mechanisms.

Topic II Introduction to Theory of Elasticity and Limit Equilibrium Analysis

Specific objectives:
1. Learn fundamental elastic behavior of geomaterial and variables;
2. Understand the shear strength of soil.

Topic III Analysis methods

Specific objectives
1. Determine load-deformation relationships, i.e., stiffness, for given in-situ examples;
2. Explain the stress-strain relationship and corresponding flexibility (stiffness) of shallow foundation
3. Calculate elastic constants using in-situ measurement, theoretical relationships, and experimental laboratory data;
4. Explain limitations of linear assumption and heterogeneity.

Topic IV Design load calculation

Specific objectives
1. Understand Load and Resistance Factors Design and its application to shallow foundation design;
2. Describe how a numerical software is utilized in combination of engineering judgment;
3. Become proficient in determining input parameters relevant to analysis of shallow foundations for use in limit states design.

Tentative Course Outline: The following is a tentative schedule. All dates are approximate and subject to change.

Lecture Topics	Description	Notes
1	Concept of Soil-Structure Interaction Analysis for Foundation Design	Handouts
2	Review of Mechanics of Deformable Bodies	Handouts
3	Review of Theory of Elasticity	Handouts
4	In-situ Testing Method: Interpretation of SPT	Handouts

5	In-situ Testing Method: Interpretation of CPT	Handouts
6	Euler-Bernoulli's Beam Theory and Winkler Model: Assumptions and Application	Handouts
7	Analytical Solution of Plates on Elastic Foundation	Handouts
8	Numerical Solution of Beams on Elastic Foundation	Handouts
9	Boussinesq's Problem and Strain Influence	Handouts
10	Schmertmann's Method: Its Application to Winkler Analysis based on the Secant Stiffness solution approach	Handouts
11	Nathan Newmark's Stress Influence Method and Limits of Application	Handouts
12	Consolidation Processes and Total Settlement	Handouts
13	Differential Settlement Analysis and Construction Phases	Handouts
14	Remediation of Differential Settlement	Handouts
15	Drained and Undrained Shear Strength and Mohr-Coulomb Failure Theory	handouts
16	Interpretation of Tri-axial Compression Tests	handouts
17	Limit Equilibrium Method: Prandtl's Wedge and Reissner's Surcharge	handouts
18	Lower and Upper Bounds of Ultimate Bearing Capacity	Handouts
19	Terzaghi's vs. Meyerhof's method	Handouts
20	Bearing capacity of footings on rock	Handouts
21	Bearing failure mechanisms in transversely anisotropic conditions	Handouts
22	Bearing Failure Modes of Two-Layered Soil	Handouts
23	Nonlinear Constitutive Relationships: Duncan and Chang's Hyperbolic Model with Small-Strain or Janbu's Modulus	Handouts
24	Introduction to FB-MultiPier and Concept of Discretization	Handouts
25	Model Validation and Bench-Marking per Texas A&M Prototype Test Data	Computer Lab

26	LRFD of Bridge Abutment	Computer Lab
27	Interpretation of FB-MultiPier Analysis Output	Computer Lab
28	LRFD of Mat Foundation: Design Homework	Computer Lab
29	Q&A	Computer Lab
30	Q&A	Computer Lab

No classes:
September 5: Labor Day; October 14-15: Homecoming; November 11: Veterans Day; and November 23-24: Thanksgiving break