Spring 2019

CE 485-102: Design and Construction of Buildings for Wind Forces

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Type of Course:

Undergraduate course/ Special Topic - Lecture format – 3 credits – Monday, from 6:00 to 8:50 pm – Location: FMH 319

Course Overview

As witnessed recently, damages from hurricanes, tornadoes and extreme wind events amount to billions of dollars in the US and around the world every year. These hazards also claim the lives of many people in the affected areas. The quality of building design and construction for these hazards can be improved. Engineers and other building professionals have an important role to play by improving their knowledge in the field and by designing better and safer buildings and structures.

This course discusses the topic of the design and construction of buildings for wind forces and extreme wind events. First, the nature of wind, hurricanes and tornadoes is discussed along with the currently used classification systems and the impacts of these events on buildings and structures. Then expected damages from extreme winds and the corresponding response of a structure are discussed. The course also includes an overview of wind engineering research.

The course also outlines the various structural systems used in buildings to resist the lateral forces of wind. It explains the structural building design process based on the requirements of the latest codes and standards, namely the ASCE 7-16 standard “Minimum Design Loads and Associated Criteria for Buildings and Structures”. The course discusses the structural systems used in tall buildings as well in order to resist wind forces and the principles used in damping systems. Design examples are used throughout the course to illustrate the various wind design methods given in the ASCE 7-16 standard.

In addition to the topics above, the course provides a general overview of wind tunnels, their types and the measurement of wind loads on structures in them, and provides a brief introduction to the wind tunnel procedure of the ASCE 7-16.

Finally, students are introduced to some of the standard procedures used in safety assessment and evaluation of damaged buildings in the aftermath of hurricanes and tornadoes.

Prerequisites/ Required Skills

Prerequisites: undergraduate courses in structural analysis, steel design and reinforced concrete design.
• Required Text


• Required Standard

Minimum Design Loads and Associated Criteria (ASCE 7-16) by the American Society of Civil Engineers, 2017
A form from ASCE will be provided to the students to order this standard directly from ASCE at a reduced student discount price.

• Course Requirements

Students are required to take a test, a mid-term exam and a final exam, in addition to a project. Moodle will be used to submit the project in PDF format and to deliver some course files. The Moodle site is http://moodle.njit.edu. Students need to login with their UCID and password.

Students enrolled in this course are not to schedule vacation trips while the course is ongoing, and on dates that coincide with test dates. The course will end after the final exam is given. Airline tickets must not be booked before the final exam date. The final exam week is from May 10 to May 16.

• Grading Criteria:

Test 1: 20% - Tentative date: Monday February 18
Mid-Term Examination: 30% - Monday, March 25
Project: 20% - Tentative date: Monday April 29
Final Examination: 30% - During the week of final exams between May 10 and May 16

• Academic Integrity

The NJIT Honor Code will be upheld, and any violations will be brought to the immediate attention of the Dean of Students.

• Instructor’s Contact Information:

E-mail: taher@njit.edu
Office Phone: 973-596-3015.

• Office Number and Office Hours:
Office: Weston 521.
Office Hours: Tuesday 11:45 to 12:45 pm and by appointment.
- **Websites**
  
  http://moodle.njit.edu

- **Course Content and Weekly Schedule**

  **Week 1: 1/22 to 1/25**
  Introduction to wind forces - Wind pressure distribution on building surfaces - Nature of internal pressures - Factors that impact wind pressures on buildings - Nature of air-flow around buildings - Basic principles and terms of aerodynamics as they apply to buildings and structures - Brief introduction to the wind provisions of the building codes and the ASCE 7 standard

  **Week 2: 1/29 to 2/1**
  Detailed introduction to the wind provisions of the ASCE 7-16 standard - Risk Categories - Basic terms and definitions given in the ASCE 7-16 standard: open, enclosed and partially enclosed buildings, flexible and rigid structures, diaphragm systems, low-rise buildings, wind hazard maps

  **Week 3: 2/4 to 2/8**
  Extreme wind events - Nature of hurricanes and tornadoes - Classification systems - Region of occurrences - Impacts of these events on buildings and structures

  **Week 4: 2/11 to 2/15**
  Detailed discussion of damages to structures caused by extreme wind events such as hurricanes and tornadoes - Post-disaster investigations and their most important findings from engineering assessment reports by FEMA and other institutions - Analysis of investigation reports - Typical damages to buildings and structures - Lessons to be learned

  **Week 5: 2/18 to 2/22**
  Test 1 Monday February 18
  General overview of wind engineering activities and current research - History of the wind engineering field - Brief description of general research methodologies - Summary of current wind engineering activities and research

  **Week 6: 2/25 to 3/1**
  Structural building systems used for lateral loads: moment resisting frames, shear walls and braced frames - Structural principles used in these three categories of systems - Other important structural notions and elements for lateral loads: diaphragm systems, collectors and torsion - Building irregularities - Application problems that help illustrate how to apply these important structural concepts and principles
Week 7: 3/4 to 3/8
Structural systems used in tall buildings - Principles used in damping systems - Structural history of the skyscraper - Lateral load resisting systems used in tall buildings using concrete, steel and composite steel

Week 8: 3/11 to 3/15
Outline of the wind design procedures of the ASCE 7-16 standard - Main Wind Force Resisting System (MWFRS) and Components & Cladding (C & C) - Wind parameters used in the ASCE 7-16 methods: wind directionality factor, surface roughness categories and exposure categories, topographic factor, gust factor, internal pressure coefficients, velocity pressure and velocity pressure exposure coefficient, external pressure coefficients -

Week 9: 3/18 to 3/22: Spring Recess – No Class

Week 10: 3/25 to 3/29
Mid-Term Examination: Monday March 25

Procedures used to determine wind loads for the purpose of designing the elements of the Main Wind Force Resisting System (MWFRS) - The “Directional Procedure” for buildings of all heights, and enclosed simple-diaphragm buildings with heights not exceeding 160 ft (48.8 m) - Application problems and design examples

Week 11: 4/1 to 4/5
Directional Procedure Continued

Week 12: 4/8 to 4/12
Other procedures used for the Main Wind Force Resisting System (MWFRS) - “Envelope Procedure” for enclosed, partially enclosed and open low-rise buildings, and enclosed simple-diaphragm low-rise buildings - Application problems and design examples

Withdrawal Deadline: Monday, April 8

Week 13: 4/15 to 4/19
Procedures used for building appurtenances and other structure such as solid freestanding walls and signs, open signs, chimneys, trussed towers, single-plane open frames and rooftop structures and equipment - Application problems

Week 14: 4/22 to 4/26
Components and cladding (C & C) - Methods used for enclosed and partially enclosed low-rise buildings or buildings not exceeding 60 ft - Simplified
procedure for low-rise buildings used for enclosed and partially enclosed buildings of more than 60 ft – Application examples

**Week 15: 4/29 to 5/3**
Project due: Monday April 29

General overview of wind tunnels - Types and measurement of wind loads on structures in wind tunnels - Brief introduction to the wind tunnel procedure as discussed in Chapter 31 of the ASCE 7-16 standard – Introduction to the ASCE/SEI 49-12 standard “wind Tunnel Testing for Buildings and Other Structures” - Introduction to “Database-Assisted Design - DAD”

**Week 16: 5/6 to 5/10**
Introduction to safety assessment of buildings in the aftermath of extreme events - Safety evaluation of buildings in the aftermath of hurricanes and wind events

Last Day of Class on Campus: Tuesday, May 7- Friday Schedule
Reading Day 1: Wednesday May 8
Reading Day 2: Thursday May 9
Final Exam Week: Friday May 10 to Thursday May 16

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**Outcomes Course Matrix – CE 485-102 Design & Construction of Buildings for Wind Forces**

<table>
<thead>
<tr>
<th>Strategies, Actions and Assignments</th>
<th>ABET Student Outcomes (1-7)</th>
<th>Program Educational Objectives</th>
<th>Assessment Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Student Learning Outcome 1: Learn about wind effects on buildings and structures</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learn about the nature of wind, hurricanes and tornadoes and the classification systems</td>
<td>4, 5, 6</td>
<td>1, 2</td>
<td>Project, tests and class discussions</td>
</tr>
<tr>
<td>Learn about the impacts of these events on buildings and structures</td>
<td>4, 5, 6</td>
<td>1, 2</td>
<td>Project, tests and class discussions</td>
</tr>
<tr>
<td>Learn from past events to improve design and construction</td>
<td>4, 5, 6</td>
<td>1, 2</td>
<td>Project, tests and class discussions</td>
</tr>
</tbody>
</table>

| **Student Learning Outcome 2: Learn the various structural systems used in buildings to resist the lateral forces of wind and know how these systems work** | | | |
| Learn the basic concepts used to resist lateral loads | 1, 2, 6 | 1, 2 | Project, tests, class problems and class discussions |
| Learn the types of structural systems used | 1, 2, 6 | 1, 2 | Project, tests, class problems and class discussions |
| Learn the systems used in | 1, 2, 6 | 1, 2 | Project, tests, class problems |

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CE 485-102 Design and Construction of Buildings for Wind Forces - Syllabus
CEE Mission, Program Educational Objectives and Student Outcomes

The mission of the Department of Civil and Environmental Engineering is:

- to educate a diverse student body to be employed in the engineering profession
- to encourage research and scholarship among our faculty and students
- to promote service to the engineering profession and society

Our program educational objectives are reflected in the achievements of our recent alumni:

1 – Engineering Practice: Alumni will successfully engage in the practice of civil engineering within industry, government, and private practice, working toward sustainable solutions in a wide array of technical specialties including construction, environmental, geotechnical, structural, transportation, and water resources.

2 – Professional Growth: Alumni will advance their skills through professional growth and development activities such as graduate study in engineering, research and development, professional registration and continuing education; some graduates will transition into other professional fields such as business and law through further education.

3 – Service: Alumni will perform service to society and the engineering profession through membership and participation in professional societies, government, educational institutions, civic organizations, charitable giving and other humanitarian endeavors.

Our Student Outcomes are what students are expected to know and be able to do by the time of their graduation:

1. an ability to identify, formulate and solve complex engineering problems by applying principles of engineering, science and mathematics
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
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Revised: 2/13/18