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 two tests, a mid-term exam and a final exam. Moodle will be used to submit some assignments 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: to be determined
Mid-Term Examination: 25% - Tentative date: to be determined
Assignments: 5% - Due dates will be announced.
Test 2: 20% - Tentative date: to be determined
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**
  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**
  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**
  Extreme wind events- Nature of hurricanes and tornadoes - Classification systems
  - Region of occurrences - Impacts of these events on buildings and structures

  **Week 4**
  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**
  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**
  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
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
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
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
Directional Procedure Continued

Week 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
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
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
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
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
Reading Day 1: Wednesday May 8
Reading Day 2: Thursday May 9
Final Exam Week: Friday May 10 to Thursday May 16