Spring 2019

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

Rima Taher

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Design and Construction of Buildings for Wind Forces
CE 485-102 – Spring 2019
Faculty: Rima Taher, PhD, PE - Senior University Lecturer

- **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](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**