APPLICATION FOR NEW COURSE

1. Submitted by College of Engineering ____________________________ Date 2/7/02
   Department/Division offering course Civil Engineering ____________________________

2. Proposed designation and Bulletin description of this course
   a. Prefix and Number CE585
   b. Title* Civil Engineering Failures
      *NOTE: If the title is longer than 24 characters (including spaces), write a sensible title (not exceeding 24 characters) for use on transcripts Civil Engr Failures
   c. Lecture/Discussion hours per week 3
   d. Laboratory hours per week __________________
   e. Studio hours per week __________________
   f. Credits 3
   g. Course description
      Fundamentals of failure investigation and forensic engineering; Failure types and mechanisms; Case studies and discussions on various constructed facilities.
   h. Prerequisites (if any)
      CE 382 or consent of instructor
   i. May be repeated to a maximum of ____________________________ (if applicable)

4. To be cross-listed as
   Prefix and Number ____________________________ Signature, Chairman, cross-listing department ____________________________

5. Effective Date Fall, 2002 (semester and year)

6. Course to be offered ☑ Fall ☐ Spring ☐ Summer

7. Will the course be offered each year? ☑ Yes ☐ No
   (Explain if not annually)

8. Why is this course needed?
   To understand the causes and factors affecting failures of constructed facilities and to avoid future failures based on the failure patterns and mechanisms.

9. a. By whom will the course be taught? Dr. Shien T. Wang
   b. Are facilities for teaching the course now available?
      If not, what plans have been made for providing them? ☑ Yes ☐ No
10. What enrollment may be reasonably anticipated? 20

11. Will this course serve students in the Department primarily?  
   ☑ Yes ☐ No

   Will it be of service to a significant number of students outside the Department?  
   ☑ Yes ☐ No

   Will also serve students from ARC, BAE, ME, and MNG.

Will the course serve as a University Studies Program course?  
   ☐ Yes ☑ No

If yes, under what Area? 

12. Check the category most applicable to this course
   ☐ traditional; offered in corresponding departments elsewhere;
   ☐ relatively new, now being widely established
   ☑ not yet to be found in many (or any) other universities

13. Is this course part of a proposed new program?:  
    If yes, which?  
    ☐ Yes ☑ No

14. Will adding this course change the degree requirements in one or more programs?*  
    If yes, explain the change(s) below

15. Attach a list of the major teaching objectives of the proposed course and outline and/or reference list to be used.

16. If the course is a 100-200 level course, please submit evidence (e.g., correspondence) that the Community College System has been consulted.

17. Within the Department, who should be contacted for further information about the proposed course?
   Name  Dr. Shien T. Wang
   Phone Extension  257-4916

*NOTE: Approval of this course will constitute approval of the program change unless other program modifications are proposed.
APPLICATION FOR NEW COURSE

Signatures of Approval:

[Signature]
Department Chair

[Signature]
Dean of the College

2/22/02
Date

10/21/02
Date

10/29/02
Date of Notice to the Faculty

*Undergraduate Council

*University Studies

*Graduate Council

*Academic Council for the Medical Center

*Senate Council (Chair)

*If applicable, as provided by the Rules of the University Senate

Date

Date

Date

Date

Date

Date of Notice to University Senate

ACTION OTHER THAN APPROVAL
CE 585- Civil Engineering Failures

Catalog Data

Fundamentals of failure investigation and forensic engineering; Types of failures and patterns; Failure modes and mechanisms; Failures of constructed facilities and environmental failures; Causes of failure; Case studies and discussions on various constructed facilities; Criteria for better design to prevent failures.

Textbook


References


Coordinator

Professor Shien T. Wang

Prerequisites

CE 382 or consent of instructor

Topics

Introduction

Civil Engineering Achievements

Failures in Civil Engineering Constructed Facilities

Classification of Failures
Failure Modes and Patterns

Failure Causes and Mechanism

Failure Investigation - Forensic Engineering

Factors Affecting Structural Integrity

Building Failures

General Building Failures
Progressive Failure
Building Failure During Construction
Structural Demonology - Building Façade Problems
Impact, Explosion, Bombing, and Terrorism Failures
Foundation Failures
Residential Building Failures
Earthquake Failures
Case Studies
Discussions

Arena Failures

Causes and Modes of Failure
Case Studies
Discussions

Special Structure Failures

Causes and Modes of Failure
Case Studies
Discussions

Bridge Failures

Causes and Modes of Failure
Case Studies
Discussions

Dam Failures

Causes and Modes of Failure
Case Studies
Discussions
Environmental Failures

Causes and Modes of Failure
Case Studies
Discussions

Criteria for Better Design of Constructed Facilities to Prevent Future Failure

Goals

CE 585 is designed to teach students some basic concepts of failure theories of constructed facilities and the environmental impact of failures. Through failure case studies students will learn the causes and failure modes of various Civil Engineering facilities. The students will also learn the basic procedure on conducting a forensic engineering investigation. Ultimately, based on the knowledge gained they will be able to design better Civil Engineering facilities to reduce the possibility of failure.

Specific Learning Outcomes

Objective 1. Understand basic theory and failure patterns and modes of various constructed facilities.

Objective 2. Understand procedures to conduct a forensic engineering investigation.

Objective 3. Learn from past failure cases in the past.

Objective 4. Set criteria to design better civil engineering facilities to reduce the possibility of failure.

ABET Categories

Engineering science - 1 credits or 33%

Engineering design - 2 credits or 67%

Design Content

67%

Laboratory
None

Course Relevance

This is an upper level technical elective, which is designed for both undergraduate and graduate students who are interested in studying causes and modes of constructed facility failures in the past. It is essential for students and future engineers to understand what happened and why. That knowledge learned from past disasters could help reduce the possibility of future failures.

Assignment

Homework will be assignment each week. Reading assignment will be assigned each period. A term project will be required. Lecture material and handout will be available to students. Additional assignment will be required for students with graduate standing.

Grading

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<table>
<thead>
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<tr>
<td>Homework</td>
<td>30%</td>
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<tr>
<td>Discussion Participation</td>
<td>30%</td>
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<tr>
<td>Term Project</td>
<td>40%</td>
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</table>
Course No.: CE585
Course Title: Civil Engineering Failures
Semester: Fall 2002
Instructor: Dr. Jim Wang
373 Oliver Raymond Building
Department of Civil Engineering
University of Kentucky
Tel: 859-257-4916
Fax: 859-257-4404
e-mail: jimwang@engr.uky.edu

Office Hours: Lectures – TR 2:00-4:50 PM
The instructor is available for consultation 9:00 AM – 4:00 PM Monday through Friday. Students are encouraged to contact instructor regarding course lectures, homework assignments, term project and any other related matters.

Assignment: Homework will be assigned each week. Reading material will be assigned each period. A term project will be required. Lecture material and handout will be available to students. Additional assignment will be required for students with graduate standing.

Grading: Homework 30%
Discussion participation 30%
Term Project 40%
TOPICS:

Introduction

Civil Engineering Achievements

- High-Rise Buildings
- Bridges
- Arenas and Domes
- Dams
- Interstate Highway System
- Airports
- Space vehicles
- Other Constructed Facilities

Why Study Civil Engineering Failures

Failure Education

Education and Training in Failure Analysis - Skills to Prevent Failures

Failures in Civil Engineering Constructed Facilities

Failures on Internet

Definition and Classification of Failures

Causes of Failure

Failure Modes and Patterns

Types of Failure

Failure Mechanism

Failure Investigation – Forensic Engineering

Synthesis of the Investigation

Development of a Failure Profile

Development of Failure Hypothesis
Investigation and Synthesis Process vs. Insight, Awareness, and Method of Quality Control

Litigation and Public Issues

Design Codes and Specifications

Some Factors Affecting Structural Integrity

- Redundancy
- Lifeline Design
- Material Properties
- Construction Method
- Construction sequence
- Communication Among Parties
- Inspection and Resident Engineers

General Building Failures

Progressive Failures

Building Failures During Construction

Arena Failures

Structural Demonology - Building Façade Problems

Impact, Explosion, Bombing, and Terrorism Failures

Residential Building Failures

Foundation Failures

Earthquake Failures

Bridge Failures

Special Structure Failures

Dam Failures

Environmental Failures
Case Studies – Building and Arena Failures

Hartford Civic Center Coliseum
Kemper Memorial Arena Roof
Hyatt Regency Hotel Pedestrian Walkways
L’Ambiance Plaza Building
Hancock Tower
Ronan Point Tower
Bailey’s Crossroads Condominium
Bomb Damage and Collapse of World Trade Center Twin Towers
Oklahoma City Bombing

Case Studies – Bridge Failures

Tacoma Narrows Bridge
Point Pleasant Bridge – Silver Bridge
Mianus River Bridge
San Francisco-Oakland Bay Bridge
Cypress Viaduct
Westgate Bridge
Bridge Over Kentucky River in Frankfort
Bridge Conditions in the 50 States

Case Studies - Earthquake Failures

Recent Earthquakes - Mexico, Kobe, San Francisco, Northridge, Taiwan, Turkey

Case Studies – Dam Failures

Teton Dam
Baldwin Dam
Vaiont Dam
Dam Problems in the 50 States

Case Studies – Special Structure Failures

Formwork Failure on a Cooling Tower
Texas Tower No. 4
MGM Hotel Fire
Texas A&M Bonfire
Case Studies - Environmental Failures

Love Canal
Frankfort Wild Turkey Spill
Coal Refuse Dam Failure Spill
Valley of the Drums - Bullitt County, Kentucky
Stringfellow Acid Pit
Seymour Recycling Facility
Kettleman Hills Waste Landfill

Responsibilities

Recommendations for Better Design and Constructed Facilities to Reduce the Possibility of Future Failures

Criteria and Check List – Learned from Past Civil Engineering Failures
References:


20. Internet Website: http://www.struct.kth.se/research/bridges/Bridges.htm

21. Internet Website: http://www.worldstallest.com/

22. Internet Website: http://www.xs4all.nl/~hnetten/world.html

23. Internet Website: http://www.xs4all.nl/~hnetten/disaster.html

24. Internet Website: http://www.structures.de/DataEnglish.html

25. Internet Website: http://www.bridgesite.com/softwarelinks.html

26. Internet Website: http://www.pubs.asce.org/

27. Internet Website: http://lowery.tamu.edu/ethics/

28. Internet Website: http://englib.cornell.edu/ice/lists/historytechnology/successfail.html

29. Internet Website: http://nisee.ce.berkeley.edu/bertero/html/multiple_defense_lines.html

30. Internet Website: http://www.eerc.berkeley.edu/loma_prieta/astanch.html

31. Internet Website: http://www.antenna.nl/wise/uranium/mdaf1f.html

32. Internet Website: http://doll.eng.sunysb.edu/disaster/

33. Internet Website: http://www.greatachievements.org/

34. Internet Website: http://pyne.kinfolk.org/rbp2/okcbomb.html
35. Internet Website: http://www.wai.com/AppliedScience/blast/


37. Internet Website: http://bridgepros.com

39. Internet Website: http://www.skyscrapers.com

40. Internet Website: http://www.sbi.se/bridges.html

41. Internet Website: http://www.donpearman.com
TERM PROJECT

Objectives:

1. Investigate and describe the physical nature of the facility involved, the way in which it failed, and the immediate aftermath of the failure.
2. Outline the technical reasons for the failure and analyze the interrelation with one another and with the characteristics of the facility.
3. Investigate and describe the process involved in the realization of the facility (planning, regulation, design, construction, and operation) and the roles and actions of the various participants as they relate to the development of the failure.
4. Examine the nature of the individual, group, organizational, and institutional factors that may have affected the processes and the way in which various actors participated in these processes.
5. Analyze the interrelationships between the technical reasons for failure, and the intra-and interorganizational factors characterizing the project process.
6. Suggest, on the basis of your own analysis, what mechanisms might have been introduced to avoid this failure, how these mechanisms may be applicable generally (taking into account other failures discussed on the subject), and what the constraints might be on the implementation of such mechanisms.

Report

The term project report should be 3,000 to 5,000 words (excluding appendices) structured as follows:

1. Abstract of 200 words should outline the nature and major findings of the study.
2. Description of failure should constitute no more than 1/3 of the report; added material can be included in appendices. Drawings, photographs, and other graphic material should be used whenever applicable.
3. Analysis of failure should constitute the major portion of the report, divided into appropriate chapters or sections. Analyses should be detailed, supported by quantitative data where possible. Diagrams, charts, and graphs should be used as much as possible to illustrate the analyses.
4. Conclusions should be of general interest and not restricted solely to the particular case studied. Implications for future design and construction should be suggested here.

5. References should fully support the report. Key papers, studies, reports, or excerpts should be xeroxed and attached as appendices. Standard ASCE publications format should be used for listing references.

Presentation

1. A 20 minutes outline is followed by discussion period.
2. Description of failure should take no longer than 7-8 minutes and should rely heavily on illustrations and other visual aids in order to be comprehensive as possible. Use of Power Point for presentation is suggested.
3. Major portion of presentation should be devoted to analysis and conclusions.
4. Key questions left unanswered by the study should be highlighted for discussion.
5. Implications for future design, construction, organization, and codes should be presented.