

## **Developing Case Studies in Failures and Ethics for Engineering Educators**

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### **Introduction**

Over the years surveys conducted by the American Society of Civil Engineers (ASCE) Technical Council on Forensic Engineering (TCFE) Education Committee<sup>1-5</sup> have documented the following points:

- Engineering students, particularly undergraduates, should be informed about the important and historic failure cases that have shaped the profession – the Quebec Bridge, the Kansas City Hyatt Regency, and others
- With appropriate course materials, these cases can be integrated into a number of civil engineering and engineering mechanics courses
- Most faculty do not have the time to develop case studies themselves, and would welcome a web-based source of case materials. Survey respondents asked in particular for a thorough online bibliography.

In response to the survey results, the National Science Foundation has funded a research project at the University of Alabama at Birmingham (UAB) entitled “Developing Case Studies in Failures and Ethics for Engineering Educators,” as project number DUE 0127419. The two-year project began 1 March 2002. The project is being carried out with the support and input of the ASCE TCFE Education Committee. The case study materials developed so far are available at the following web address:

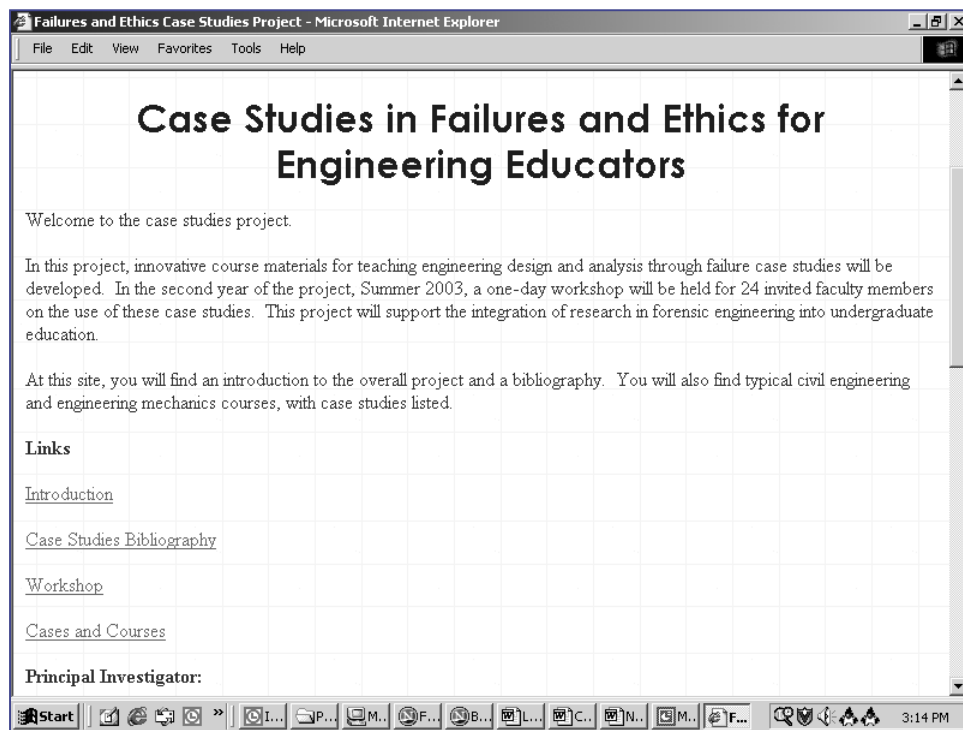
[http://www.eng.uab.edu/faculties/ndelatte/case\\_studies\\_project/](http://www.eng.uab.edu/faculties/ndelatte/case_studies_project/)

The site provides courses, course topics, and case study to illustrate those topics, as well as an extensive bibliography. This web site will be updated frequently during the project. As part of the project, UAB will host a one-day workshop for 24 engineering educators on 12 July 2003. Following the summer 2003 workshop, efforts will be made to provide additional workshops if there is sufficient interest. There is no registration fee for the workshop, and the workshop materials will be provided free of charge.

### **Case Studies Project**

The objectives of the case study “Proof of Concept” project are to:

1. Develop a master plan linking civil engineering and engineering mechanics courses, course topics, and case studies.
2. Identify published materials (articles, technical papers, books) covering those cases, if any.
3. Identify case studies requiring further research and development.
4. Develop some of the case studies identified.
5. Develop instructor's notes to accompany each case study.
6. Develop a web site for courses, topics, and case studies, and a version in print and CD-ROM (with PowerPoint presentations) for field-testing and dissemination. The web site is shown in figure 1.
7. Disseminate these materials through a one-day pilot workshop on 12 July 2003 to 24 faculty members, and follow up with them to determine how they use the materials in the classroom, and how the materials may be improved.



*Figure 1: Case studies project web page*

The project is being carried out through the following steps:

1. Carry out a literature review to further develop the case studies bibliography.
2. Identify courses and lesson topics to which to link the case studies. Lesson topics should be identified for required courses in a civil engineering curriculum, including engineering mechanics courses and related courses in other curricula. Once these have been identified, it is possible to suggest case studies to support the topics.
3. Develop the master plan to link courses, topics and course objectives, and case studies.

4. Draft an action plan to write case studies to fill in the gaps, and begin writing the case studies.
5. Prepare the case studies. These cases will address the following elements of each case:
  - Design and Construction
  - Collapse
  - Cause(s) of Failure
  - Legal Repercussions
  - Technical Aspects
  - Professional and Procedural Aspects
  - Ethical Aspects
  - Educational Aspects
6. Submit selected cases to the ASCE Journal of Performance of Constructed Facilities. This journal has already published two papers written by the author's students<sup>6,7</sup> and has accepted another for publication.
7. Develop the materials in three formats – web, CD-ROM, and print.
8. Disseminate the materials during a one-day workshop hosted by the University of Alabama at Birmingham on 12 July 2003.

### **Web Site Materials**

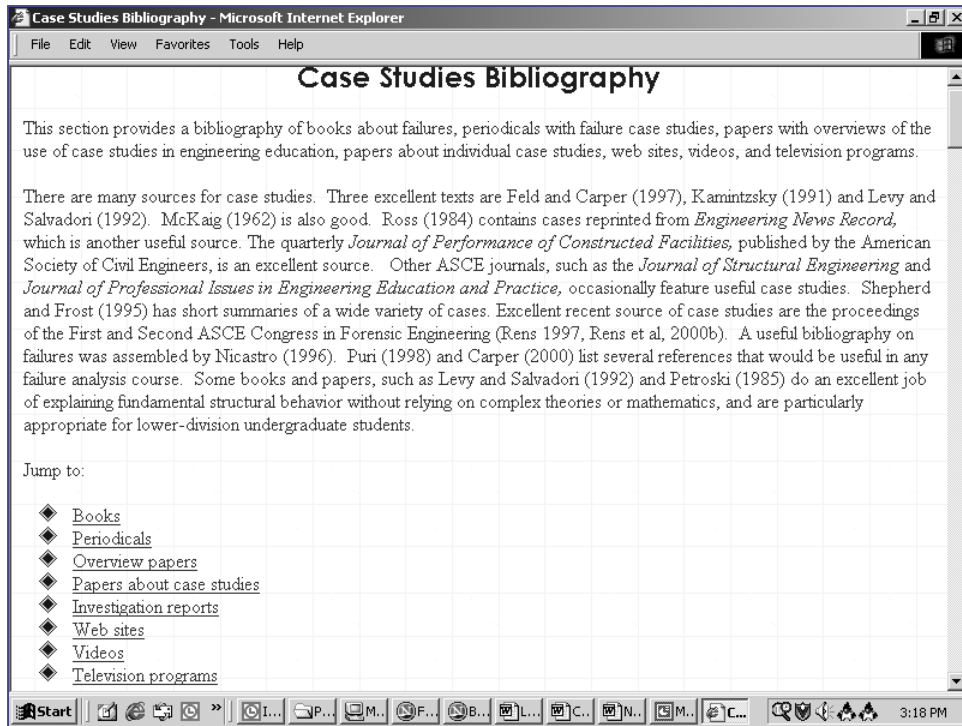
As shown in figure 1, the web site has an introduction that describes the background and rationale for the project, provides the detailed online bibliography, and discusses the faculty workshop. The heart of the web site is contained in the pages that link courses, topics, and cases. The material takes full advantage of the web's hypertext capability.

The background and rationale for the web site has been reviewed elsewhere<sup>5</sup> and will not be addressed here. The online bibliography is an important element requested by respondents to the ASCE TCFE Education Committee surveys<sup>1-5</sup>. The bibliography web page is shown in figure 2.

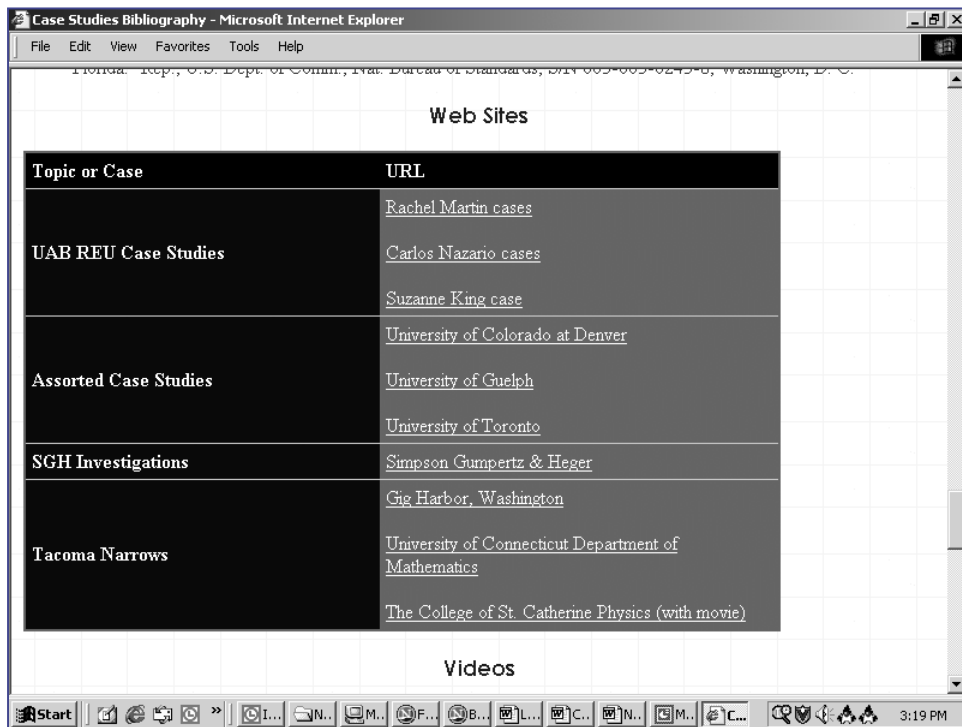
So far the outline bibliography lists the following references:

- 17 books
- 2 periodicals
- 20 journal papers on use of case studies
- 28 journal papers describing case studies
- 5 investigation reports
- Web sites, videos, television programs. The portion of the online bibliography listing web sites is shown in figure 3.

The faculty workshop will be discussed later in the paper. The "Courses" web page lists common courses in the engineering mechanics and civil engineering undergraduate curriculum.



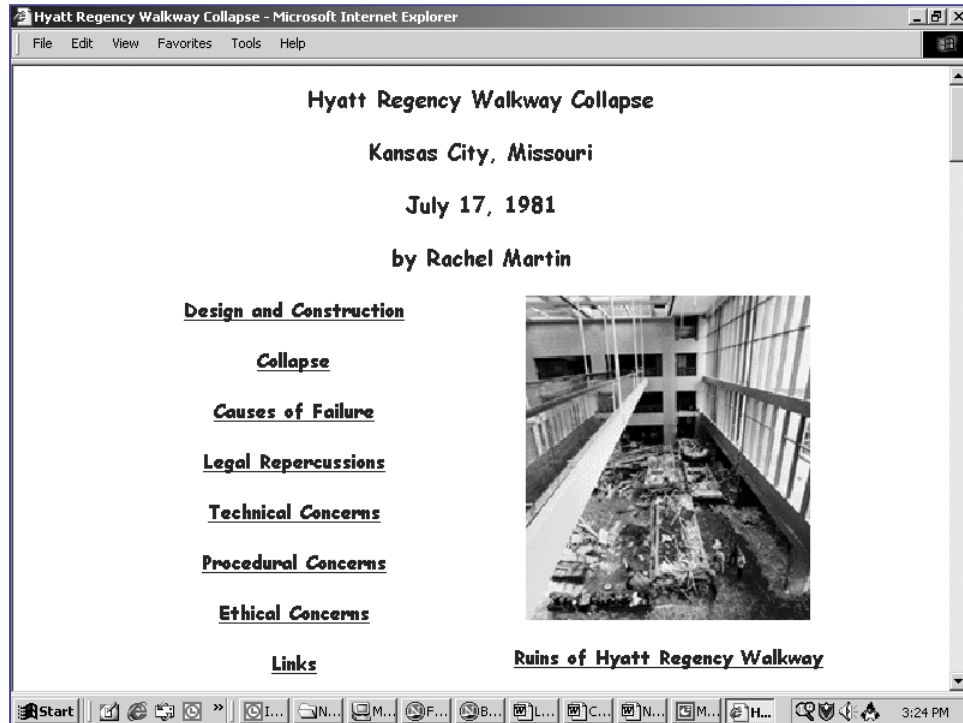
**Figure 2: Bibliography page**



**Figure 3: Bibliography list of web sites**

Each course listed has its own page, with links to cases. A number of the case studies apply to several courses. One example of such a case study courses is the collapse of the Kansas City Hyatt Regency walkways (figure 4). This case study relates to the following topics:

- Statics – free body diagram<sup>8</sup>
- Structural Analysis – load paths
- Design of Steel Structures – connections
- Ethics, Professional Issues, and Capstone Design – responsibility, actions of Missouri board and ASCE

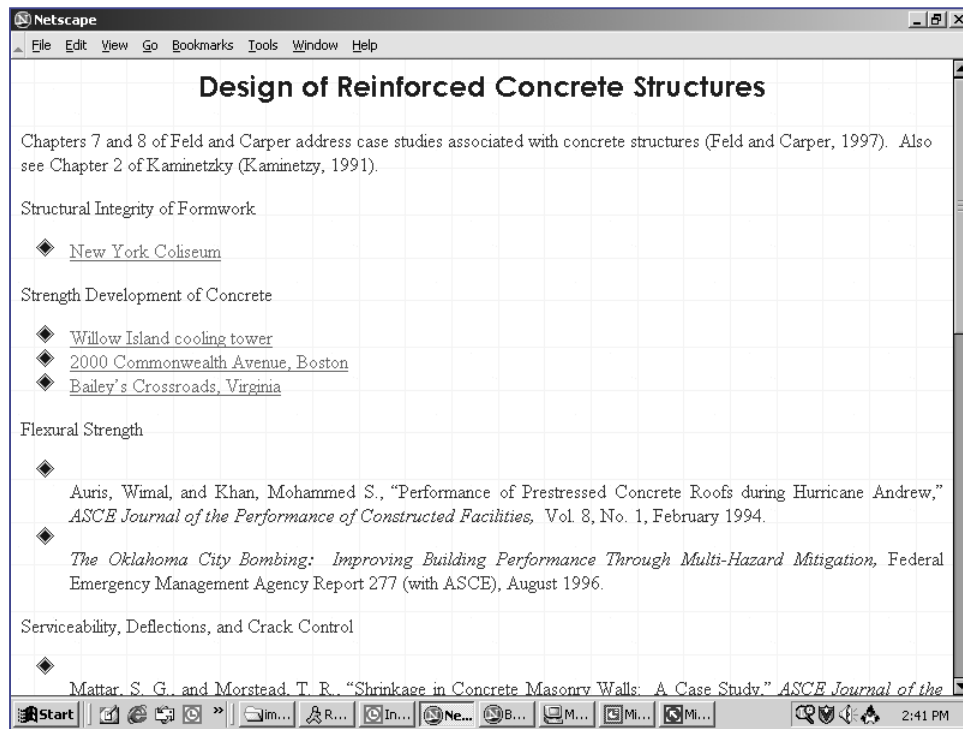


*Figure 4: The Hyatt Regency Walkway case study page*

The cases developed so far, listed on the case studies page, includes:

- Hyatt Regency
- T.W. Love Dam
- Tacoma Narrows
- Hartford Civic Center
- L' Ambiance Plaza
- Quebec Bridge
- New York Coliseum
- Willow Island cooling tower
- 2000 Commonwealth Ave.
- Bailey's Crossroads
- Harbor Cay Condominium
- Citicorp

An example of a course web page is shown in figure 5. The page lists some of the key references and major topics typically addressed in the course. Under each topic, hypertext links are provided to the cases listed on another page.



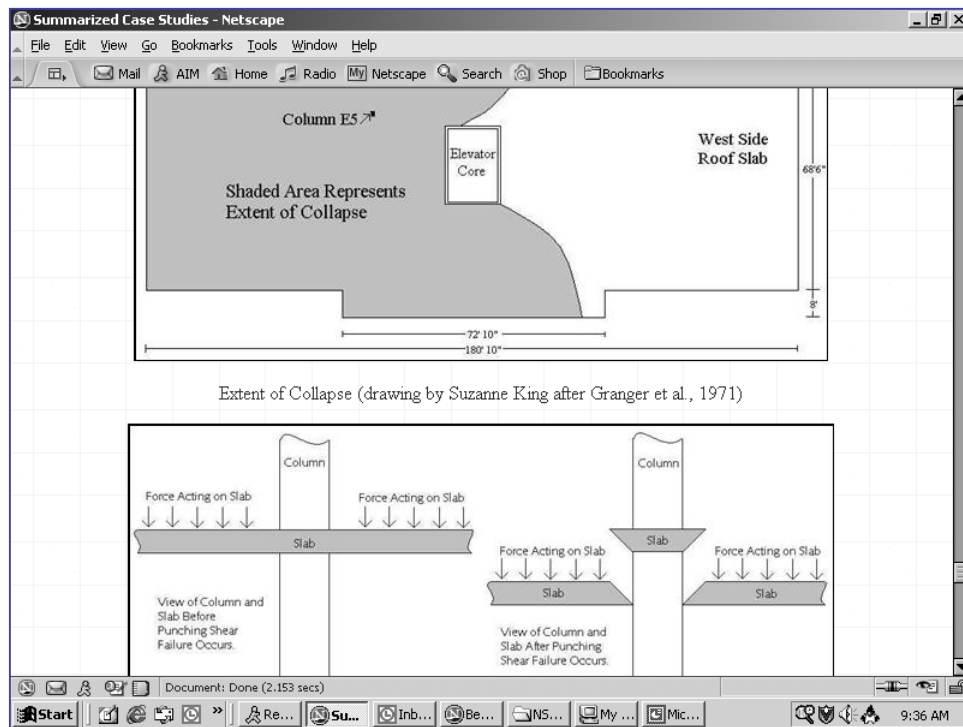
**Figure 5: Design of Reinforced Concrete Structures course page**

The course pages developed so far include:

- Statics and Dynamics
- Mechanics of Materials
- Structural Analysis
- Design of Steel Structures
- Soil Mechanics and Geotechnical Engineering
- Fluid Mechanics and Hydraulics
- Transportation and Highway Engineering
- Environmental Engineering
- Construction Materials
- Ethics, Professional Issues, and Capstone Design

Because this is a work in progress, some of the course pages are developed much more thoroughly than others.

Each case provides a narrative and illustrations. Figure 6 provides an excerpt from the 2000 Commonwealth Avenue case study on punching shear, illustrating the punching shear mechanism. At the end of each case study narrative, a list of references is provided.



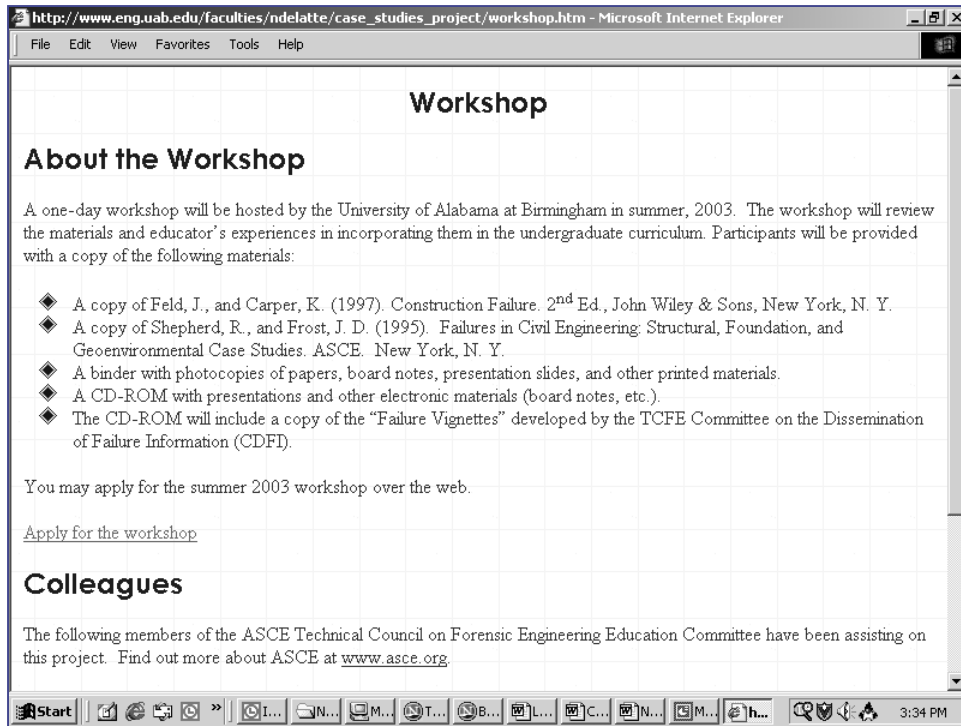
**Figure 6: The 2000 Commonwealth Avenue case study and punching shear**

### Faculty Workshop

The faculty workshop is scheduled for 12 July 2003. Twenty four faculty will be invited to attend the one day workshop. The workshop page, with links to application materials, is illustrated in figure 7.

Participants will be provided with a copy of the following materials:

- A copy of Feld, J., and Carper, K. (1997). *Construction Failure*. 2<sup>nd</sup> Ed., John Wiley & Sons, New York, N. Y.
- A copy of Shepherd, R., and Frost, J. D. (1995). *Failures in Civil Engineering: Structural, Foundation, and Geoenvironmental Case Studies*. ASCE. New York, N. Y.
- A binder with photocopies of papers, board notes, presentation slides, and other printed materials.
- A CD-ROM with presentations and other electronic materials (board notes, etc.).
- The CD-ROM will include a copy of the “Failure Vignettes” developed by the TCFE Committee on the Dissemination of Failure Information (CDFI).



**Figure 7: The faculty workshop page**

The workshop outline is as follows:

- Introduction
- Sources for case materials
- Engineering Mechanics cases
- Structural Engineering cases
- Other CE courses
- Ethics, Professional Issues, and Capstone Design
- Forensic engineering courses
- Group discussion and brainstorming

Several colleagues from the ASCE TCFE Education Committee – Kevin Rens, Paul Bosela, Ken Carper, and Oswald Rendon-Herrero – will assist in the workshop as instructors.

### **Future Activities**

This is a “proof-of-concept” project, and ideally it will be possible to follow up this work by developing additional cases and hosting more workshops. As a result, the next logical step will be to work with the ASCE TCFE Education Committee in order to reach more engineering faculty across the country.



## Summary and Conclusions

The ASCE TCFE Education Committee survey responses indicate that civil engineering departments and faculty across the country want an online case study bibliography and well developed case study materials. The case study materials developed so far are a response to this need, but more work remains to be done.

## Acknowledgements

Support for this research was provided by the National Science Foundation under the project "Developing Case Studies in Failures and Ethics for Engineering Educators," project number DUE 0127419. Some of the cases discussed in this paper were developed by Rachel Martin, Carlos Nazario, Suzanne King, and Cynthia Rouse. The support of members of the ASCE TCFE Education Committee including Kevin Rens, Paul Bosela, Ken Carper, and Oswald Rendon-Herrero is gratefully acknowledged.

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## Biographic Information

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