CIEN E4210 Forensic Structural Engineering

T. Ratay

Review of significant failures, civil/structural engineering design and construction practices, ethical standards and the legal positions as necessary background to forensic engineering. Discussion of standard-of-care. Study of the process of engineering evaluation of structural defects and failures in construction and in service. Examination of the roles, activities, conduct and ethics of the forensic consultant and expert witness. Students are assigned projects of actual cases of nonperformance or failure of steel, concrete, masonry, geotechnical and temporary structures in order to perform, discuss and report their own investigations under the guidance of the instructor.

- **Introduction to the course**  
  About the course  
  Overview of forensic structural engineering  
  1 week

- **Review of “historic” and “recent” structural and construction failures**  
  Ronan Point Tower, Skyline Plaza at Bailey’s Crossroads, Hartford Civic Center Coliseum, Kansas City Hyatt Hotel, Riley Road Interchange, Mianus River Bridge, L’Ambiance Plaza, Boston Central Artery Ceiling, Minnesota I-35W Bridge, Others  
  1 week

- **Loads and hazards**  
  Design, construction, in-service loads [Chapter 7]  
  1 week

- **Modes of failure**  
  [Chapters 11, 12, 13, 14]  
  In steel, concrete, masonry and timber members, assemblies and complete structures under static, dynamic and earthquake loadings  
  1 week

- **Condition assessment of damaged structures**  
  Public Safety Issues  
  Engineering Principles  
  Documentation  
  Case Studies

- **Design codes, standards, specifications and manuals**  
  [Chapter 2]  
  Purpose of codes and standards  
  Load standards (SEI/ASCE 7, SEI/ASCE 37, etc.)  
  Material design codes (ACI, AISC, NCMA, NFPA)  
  Model Building Codes (BOCA, UBC, Southern, IBC)  
  State, city and local building codes (NYS, NYC, Massachusetts, etc.)  
  Bridge design codes (AASHTO, FHWA)  
  Eurocodes  
  1 week

- **Temporary structures in construction**  
  [Chapters 3, 10]  
  What are they?  
  Design philosophies and criteria  
  Design codes and standards (SEI/ASCE 37, FHWA, AISC, etc.)  
  Designer’s and contractor’s roles and responsibilities  
  Construction safety rules, regulations, OSHA and other industry standards  
  Case studies of failures of temporary structures  
  1 week

- **Mid-term quiz and Project assignment**  
  1 week

- **The design-construction process**  
  [Chapter 1]  
  Drawings and specifications  
  Shop drawings, erection plans  
  Value engineering, peer review  
  Project delivery methods  
  Contracting and subcontracting  
  Inspection and testing  
  Approval, acceptance, certification  
  Design and construction records  
  1 week

- **Forensic investigation process**  
  First steps after a failure [Chapter 5]  
  Field observation and reporting of a failure  
  1 week
Assurance of public safety  
Initial engineering assessment  
Initial stabilization, repair and restoration

Engineering investigation after the dust settles [Chapter 6]*  
Familiarization with the project  
Planning the investigation  
Site inspection and collection of physical evidence  
Review of design and construction documents  
Establishing the design, construction and service history  
Formulating possible failure scenarios  
Performing analytical and/or experimental studies  
Evaluating probability of possible failure scenarios  
Selecting most probable failure scenario  
Demonstrating validity of opinion  

Reporting  
Interim communications  
Oral presentations  
Written reports  
Presentation materials and exhibits

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<tr>
<th>Module</th>
<th>Duration</th>
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<tr>
<td><strong>Legal matters and dispute resolution</strong></td>
<td>1 week</td>
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<td>Liability of design professionals</td>
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<td>Legal concerns after a failure [Chapter 17]*</td>
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<td>Litigation and dispute resolution [Chapter 18]*</td>
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<td>*<em>Performance criteria [Chapter 4]</em></td>
<td>1 week</td>
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<tr>
<td>Designer’s standard of care</td>
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<td>Contractor’s duty to perform</td>
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<td>*<em>The expert consultant and witness [Chapter 19]</em></td>
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<td>Role, qualifications, activities, conduct</td>
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<td>Ethics</td>
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<td>Conflicts of interest</td>
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<td>Impartiality versus advocacy</td>
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<td>Reasonable degree of engineering certainty</td>
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<td>Affidavit, deposition, trial testimony</td>
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<td>Liability of experts</td>
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<td>Practice guidelines (ASCE, ASFE, etc.)</td>
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<td><strong>The business of forensic engineering practice</strong></td>
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<td>Solo versus group practice</td>
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<td>Readiness</td>
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<td>When the phone rings</td>
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<td>Agreement</td>
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<td>Timekeeping and invoicing</td>
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<td>Networking and marketing</td>
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<td><strong>Presentation and debate of student project</strong></td>
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<td><strong>Final exam</strong></td>
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<td>Throughout the semester</td>
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<td>Reading and discussion of OSHA construction failure reports</td>
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<td>Monitoring the news of ongoing investigations of recent failures</td>
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<td>Review and discussion of reports from professor’s forensics practice</td>
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<td>Investigation and oral presentations by the students of actual cases of non-performance and failure of structures from professor’s practice (steel, concrete, masonry, building façade, scaffolding, shoring and formwork, foundations and earth retaining structures)</td>
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