CEE 6434 Advanced Steel Design

Fall 2011

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Description: Structural steel elements possess significant ductility and steel structures often have redundancy in the load path. As a result, there is an inherent ability to redistribute loads as localized inelasticity occurs. The use of linear elastic structural models and design methodologies limited by the design capacity of any one member do not accurately predict the behavior of steel structures at ultimate load. This course focuses on steel plasticity, plastic mechanism analysis, and the application of these concepts to design for strength and stability of steel structures. Students will gain an enhanced understanding of how steel behaves on a material level and how steel structures behave when subjected to loads large enough to cause collapse.

Prerequisites: Students should have completed:

- One course beyond CEE 3434 Design of Steel Structures 1.
  Either CEE 5984 (Intermediate Design of Steel Buildings), CEE 5744 (Topics in Structural Steel Design), or equivalent.
- Either CEE 5414 (Finite Element Analysis of Structures) ,corequisite CEE 5424 (computer Analysis of Structures II), or equivalent

Lecture: Monday, Wednesday, and Fridays 10:10 am to 11:00 am
211 Patton Hall

Office Hours: Mondays and Wednesdays 11:00am to 12:00pm and by appointment

Final Exam: 1:05pm – 3:05pm, December 9, 2011

Texts: Required

- Handouts in class

Highly Recommended

- Chen, W.-F. and Han, D.-J. (2007) *Plasticity for Structural Engineers*, Published by J.Ross Publishing (this book covers about half the class material)

Recommended (these books will be on hold at the library)

- AISC (2005) *Steel Construction Manual 13th Edition (14th Edition Coming Soon)*, published by AISC (every structural engineering student should own this)
- Chakrabarty, J. (2010) *Applied Plasticity*, published by Springer (focuses on application of theory of plasticity)

- Salmon, C. G., and Johnson, J. E. (2008) *Steel Structures: Design and Behavior*, 5th Edition Published by HarperCollins (the seminal text on steel behavior)
- Hjelmstad, K.D. (2005) *Fundamentals of Structural Mechanics*, 2nd Edition, Published by Springer (good development of elastic mechanics)
- Wong, M.B. (2009) *Plastic Analysis and Design of Steel Structures*, Published by Elsevier (Short, relatively easy to understand use of plastic design)
- Keyser, C.A. (1986) Materials Science in Engineering, Published by Charles E. Merrill Publishing (contains good introduction to crystalline structure of steel)

Grading:

Homework	35%
Project Report and Presentation	15%
Midterm Exam	20%
Final Exam	30%

Homework: Homework is due at the beginning of class. Late work will not be accepted. Several of the homework will require the use of Matlab or Mathcad programming.

Project: Students will investigate a topic related to steel structure design or behavior and write a research report (10 page minimum). The project will have three phases: definition of topic and outline, preparation of the report, and presentation to the class. The project may be done in teams of two or individually.

Honor System: This class will comply with the graduate honor system. For more information, please see the graduate honor system at: http://ghs.grads.vt.edu/

Course Outline:

I. Plasticity for Structural Engineers
   Steel structure behavior as a multi-scale problem, uniaxial behavior of steel, hardening models, yield criteria for multiaxial stress states, interaction of stresses in the AISC specifications, and plastic flow
II. Plastic Design
   Plastic design concepts, virtual work method, lower bound solution based on equilibrium, upper bound solution based on mechanism kinematics, incremental elastic analysis, applications of plastic design
III. Advanced Analysis (frame stability using inelastic analysis)
   Methods of design for steel structure stability including effective length, story stiffness method, story buckling method, amplified first order elastic analysis, and direct design. Concepts related to advanced analysis, formulation and implementation into FEM code, and applications in design for frame stability.
IV. Bracing and Section Requirements for Plastic Design
   Relative and discrete bracing, required strength and stiffness of bracing, section compactness requirements
V. Yield Line Analysis for Steel Connections (Time Permitting)