University of Texas, Arlington
Department of Civil Engineering

CE 5310 - PLASTIC ANALYSIS AND DESIGN OF STRUCTURES
Summer 2013

Prerequisite: CE 4348 Steel Design or Equivalent

Instructor: Dr. Shih-Ho Chao

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Lectures: From June 4 to August 8: Tuesdays and Thursdays, 10:30AM to 12:20PM
NH 112

Office Hrs:

- Tuesdays and Thursdays, 12:30-1:30PM;
- Questions via e-mail;
- Or by appointment

Scope and Outline:

This course will begin with plastic properties and inelastic moment-curvature relations of typical structural steel; followed by discussing methods of plastic analysis to determine the ultimate load-carrying capacity of steel members, and stepwise incremental methods for studying the behavior of steel structures beyond the elastic range up to collapse.

Both XTRACT and PERFORM-2D/3D computer programs will be introduced. The former is used for obtaining moment-curvature curves of sections with any material and geometric shapes; and the latter is used to perform inelastic pushover and dynamic analyses for structures subjected to extreme events such as earthquake loadings.

Methods of plastic design using AISC Specifications and Seismic Provisions will be presented. Structural analysis and design include bridge girders, moment frames (MFs), concentrically-braced frames (CBFs), eccentrically-braced frames (EBFs), buckling-restrained braced frames (BRBFs), special truss moment frames (STMFs), as well as some other framing systems will be discussed. Application to earthquake resistant design, especially a newly developed *Performance-Based Plastic Design* (PBPD) methodology will be included.

Homework:

Homework problems will be assigned each Tuesday (or Thursday) and are generally due the following Monday (or Wednesday). Homework will be collected at the beginning of class on the due date. Late homework loses 30% per day. No credit will be given for homework copied or if your homework has been copied. Students are encouraged to work together on homework, but copying is considered as academic dishonesty and completely unacceptable. Every homework assignment will be counted towards the final grade.

Term Project:

Topics of the term project and members in each group will be announced in mid-July. Final presentation of the term project is on Thursday August 8 during lecture and the report (both hardcopy and electronic copy) is due on the same date.

Examinations:

There will be one mid-term exam (in class: including Distance Learning students) and a final examination (comprehensive exam).

Scheduled exam dates are: Mid-term: July 23 (Tuesday), 10:30AM to 12:20PM
Final exam: August 13 (Tuesday), 10:30AM to 12:30PM

Make-up Exam Policy:

Makeup exams are given only in extreme circumstances; examples of extreme circumstances are serious illness of the student (doctor's note required) or death in the family. I must be contacted before the exam if such a circumstance applies to you.

Grading:

The course grade will be based on:

20% - Homework
20% - Term Project
30% - Mid-term exam
30% - Final exam

100%

Final exam will not be returned, but may be reviewed by students.

The grade assigned to the student's numerical average will be as follows:

(a)	90 to 100 average	=	A
(b)	80 to 89.9 average	=	B
(c)	70 to 79.9 average	=	C
(d)	60 to 69.9 average	=	D
(e)	< 60 average	=	F

Student Learning Outcomes:

After completion of the course, the student should be able to:

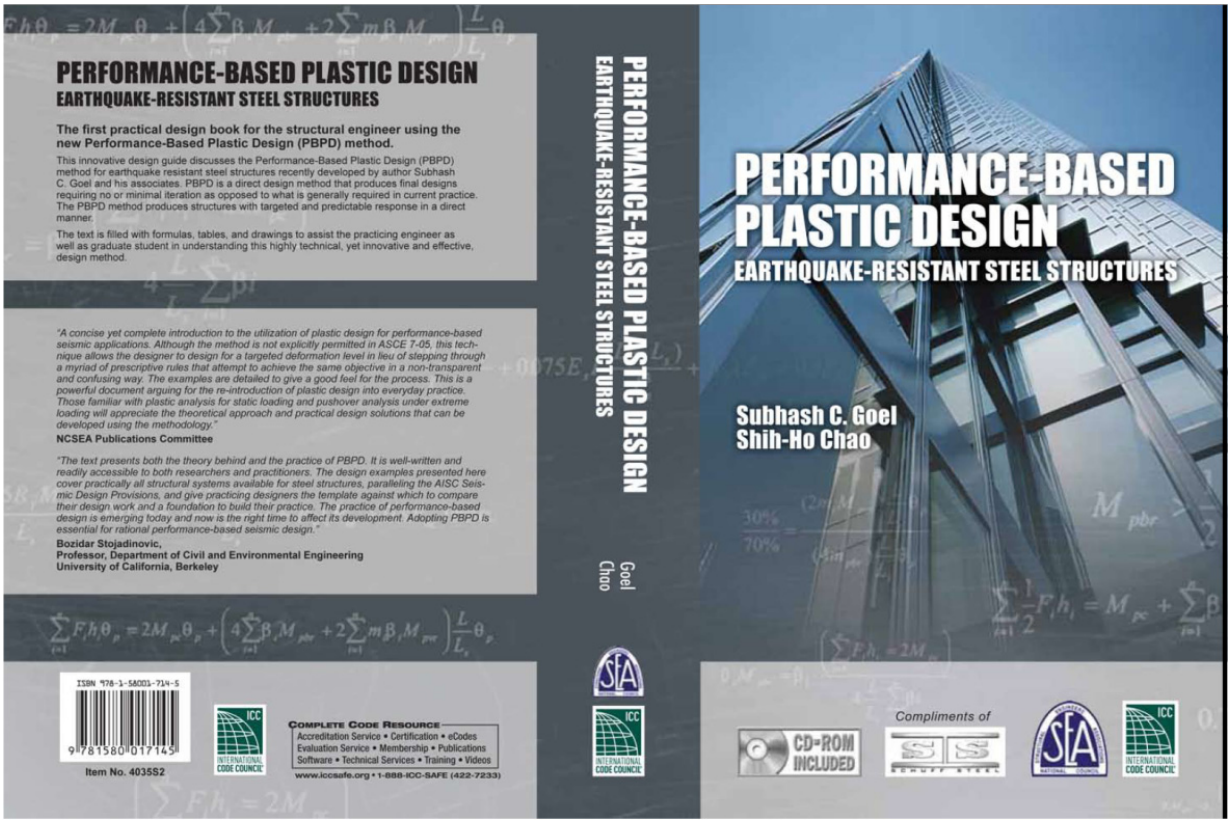
1. Recognize the difference between elastic and plastic behavior of structural members.
2. Determine the yield mechanisms and ultimate strength of structures.
3. Use computer programs to perform nonlinear static (pushover) and dynamic analyses of structures.
4. Design structures by plastic method.
5. Perform seismic design and analysis of structures by plastic methodology.

Textbook:

"*Ductile Design of Steel Structures*" by Michel Bruneau, Chia-Ming Uang, and Rafael Sabelli. Second Edition, McGraw-Hill, 2011.

References:

- Goel, Subhash. C., and Chao, Shih-Ho. (2008). *Performance-Based Plastic Design: Earthquake Resistant Steel Structures*. International Code Council (ICC), 261 pp.
- Powell, G. H. (2010). *Modeling for Structural Analysis – Behavior and Basics*. Computers and Structures, Inc., 365 pp.
- AISC. (2010). *Specification for Structural Steel Buildings*. ANSI/AISC Standard 360-10, American Institute of Steel Construction, Chicago, Illinois
- AISC. (2010). *Seismic Provisions for Structural Steel Buildings*. ANSI/AISC Standard 341-10, American Institute of Steel Construction, Chicago, Illinois.
- AISC. (2012). Seismic Design Manual. 2nd Edition, American Institute of Steel Construction, Chicago, Illinois.



Other useful References:

AISC., ANSI/AISC 358-10, *Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications*, American Institute of Steel Construction, Chicago, Illinois., 2010.

Beedle, L. S., *Plastic Design of Steel Frames*, John Wiley and Sons, New York, 1966.

Bruneau, M., Uang, C.-M., and Whittaker, A., *Ductile Design of Steel Structures*, McGraw-Hill, Book Co., New York, 1998.

Chao, S.-H. and Goel, S. C., *Performance-Based Seismic Design of EBF Using Target Drift and Yield Mechanism as Performance Criteria*, *Report No. UMCEE 05-05*, Department of Civil and Environmental Engineering, University of Michigan, Ann Arbor, MI., 2005.

Chao, S.-H. and Goel, S. C., *Performance-Based Plastic Design of Seismic Resistant Special Truss Moment Frames*, *Report No. UMCEE 06-03*, Department of Civil and Environmental Engineering, University of Michigan, Ann Arbor, MI., 2006.

Chao, S.-H. and Goel, S. C., "Performance-Based Design of Eccentrically Braced Frames Using Target Drift and Yield Mechanism," *AISC Engineering Journal*, 3rd Quarter, 2006, pp. 173-200.

Chao, S.-H. and Goel, S. C., "A Seismic Design Method for Steel Concentric Braced Frames for Enhanced Performance," Proceedings, Fourth International Conference on Earthquake Engineering, Taipei, Taiwan., 2006.

Chao, S.-H., and Goel, S. C., "Performance-Based Plastic Design of Special Truss Moment Frames," AISC Engineering Journal, 2nd Quarter, 2008, pp. 127-150.

Chao, S.-H. Goel, S. C, and Lee, S.-S., "A Seismic Design Lateral Force Distribution Based on Inelastic State of Structures," *Earthquake Spectra*, Earthquake Engineering Research Institute, Vol. 23, No.3, 2007, pp. 547-569.

Chen, W. F. and Sohal, I., *Plastic Design and Second-Order Analysis of Steel Frames*, Springer-Verlag, 1995.

Disque, R. O., *Applied Plastic Design in Steel*, Van Nostrand Reinhold, 1983.

Galambos, T. V. and Surovek, A. E., *Structural Stability of Steel—Concepts and Applications for Structural Engineers*, John Wiley & Sons, Inc., 2008, 373 pp.

Goel, S. C. and Leelataviwat, S., "Seismic Design by Plastic Method," *Engineering Structures*, Vol. 20, No. 4-6, April-Jun, 1998, pp. 465-471.

Goel, S. C., Liao, W.-C., Bayat, M. R., and Chao, S.-H. (2010), "Performance-Based Plastic Design (PBPD) Method for Earthquake-Resistant Structures: An Overview" The Structural Design of Tall and Special Buildings, Vol. 19, pp. 115-137.

Hodge, P. G., *Plastic Analysis of Structures*, McGraw-Hill, Book Co., New York, 1981.

Lee, S.-S. and Goel, S. C., *Performance-Based Design of Steel Moment Frames Using Target Drift and Yield Mechanism*, *Report No. UMCEE 01-17*, Department of Civil and Environmental Engineering, University of Michigan, Ann Arbor, MI., 2001.

Lee, S.-S., Goel, S. C., and Chao, S.-H., "Performance-Based Design of Steel Moment Frames Using Target Drift and Yield Mechanism," Proceedings, 13th World Conference on Earthquake Engineering, Paper No. 266, Vancouver, B. C., Canada., 2004.

Leelataviwat, S., Goel, S. C., and Stojadinović, B., "Toward Performance-Based Seismic Design of Structures," *Earthquake Spectra*, Vol. 15, No. 3, 1999, pp. 435-461.

Massonnet, C. E. and Save, M. A., Plastic Analysis and Design; Volume One—Beams and Frames, Blaisdell, New York, 1965.

Moy, S. S. J., *Plastic Methods for Steel and Concrete Structures*, Second Edition, Macmillan Press Ltd., 1996.

Neal, B. G., *The Plastic Methods of Structural Analysis*, Third Edition, John Wiley and Sons, New York, 1977.

Park. R. and Paulay, T., *Reinforced Concrete Structures*, John Wiley and Sons, New York, 1975.

Sahoo, D. R. and Chao, S.-H. (2010), "Performance-Based Plastic Design Method for Buckling-Restrained Braced Frames," Engineering Structures, Vol. 32, pp. 2950-2958.

Salmon, C. G., Johnson, J. E., and Malhas, F. A. *Steel Structures - Design and Behavior*, Fifth Edition, HarperCollins, New York, 2009.

Americans with Disabilities Act:

The University of Texas at Arlington is on record as being committed to both the spirit and letter of federal equal opportunity legislation; reference Public Law 92-112 - The Rehabilitation Act of 1973 as amended. With the passage of federal legislation entitled Americans with Disabilities

Act (ADA), pursuant to section 504 of the Rehabilitation Act, there is renewed focus on providing this population with the same opportunities enjoyed by all citizens. As a faculty member, I am required by law to provide "reasonable accommodations" to students with disabilities, so as not to discriminate on the basis of that disability. Student responsibility primarily rests with informing faculty of their need for accommodation and in providing authorized documentation through designated administrative channels. Information regarding specific diagnostic criteria and policies for obtaining academic accommodations can be found at www.uta.edu/disability. Also, you may visit the Office for Students with Disabilities in room 102 of University Hall or call them at (817) 272-3364.

Academic Integrity:

It is the philosophy of The University of Texas at Arlington that academic dishonesty is a completely unacceptable mode of conduct and will not be tolerated in any form. All persons involved in academic dishonesty will be disciplined in accordance with University regulations and procedures. Discipline may include suspension or expulsion from the University.

"Scholastic dishonesty includes but is not limited to cheating, plagiarism, collusion, the submission for credit of any work or materials that are attributable in whole or in part to another person, taking an examination for another person, any act designed to give unfair advantage to a student or the attempt to commit such acts." (Regents' Rules and Regulations, Series 50101, Section 2.2).

Student Support Services Available:

The University of Texas at Arlington supports a variety of student success programs to help you connect with the University and achieve academic success. These programs include learning assistance, developmental education, advising and mentoring, admission and transition, and federally funded programs. Students requiring assistance academically, personally, or socially should contact the Office of Student Success Programs at 817-272-6107 for more information and appropriate referrals.

Librarian to Contact:

Sylvia George-williams (Sylvia@uta.edu), Science & Engineering Librarian.

E-Culture Policy:

The University of Texas at Arlington has adopted the University email address as an official means of communication with students. Through the use of email, UT-Arlington is able to provide students with relevant and timely information, designed to facilitate student success. In particular, important information concerning registration, financial aid, payment of bills, and

graduation may be sent to students through email. All students are assigned an email account and information about activating and using it is available at www.uta.edu/email. New students (first semester at UTA) are able to activate their email account 24 hours after registering for courses. There is no additional charge to students for using this account, and it remains active as long as a student is enrolled at UT-Arlington. Students are responsible for checking their email regularly.

Note: I will be using email very often to send class handouts, homework assignments, and announcement; reply questions from students, etc. Please send me your preferred email address if you do not check UTA email.

Final Review Week:

A period of five university class days prior to the first day of final examinations is designated as Final Review Week. During this week, no new assignments will be given; however, previously assigned work may have a completion date during this week. In addition, no portion of the final examination shall be administered during the Final Review Week. Classes are held as scheduled during this week and materials covered in lectures during this week may be included in the final examination.

Grade Grievance Policy:

Grade grievances will be handled according to the policy described in the College of Engineering portion of the Catalog.