CEE 6528 – INTRODUCTION TO BRIDGE ENGINEERING
Fall 2021, MW 12:30 – 1:45, College of Computing 52

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Textbook: Grubb, M.A. et al. (2010). *Analysis and Design of Skewed and Curved Steel Bridges with LRFD*, FHWA-NHI-10-087, December (PDF file) + various supplementary materials

Prerequisites: CEE 4510, Structural Steel Design, or equivalent

Learning Outcomes:

- Evaluate the response of various girder bridge components and structural systems
- Describe the analysis, design, fabrication and construction processes for skewed and horizontally curved steel I-girder superstructures and for horizontally curved steel box-girder superstructures. These structure types constitute a major portion of the steel bridge market in the United States.
- Summarize the unique considerations for the design of skewed and/or curved bridge superstructures
- Apply fundamental concepts along with the AASHTO LRFD Specifications to the design and analysis of skewed and curved steel bridge superstructures, including erection and construction considerations

Outline:

I. Introduction
II. Fundamentals
  1. System and Girder Behavior in Combined Flexure and Torsion
  2. Loads and Force Effects
  3. Influence Lines
  4. Influence Surfaces
III. Structural Analysis
  1. General Considerations
  2. Analysis of Thermal Expansion, Articulation and Design of Bridge Bearings
  3. Line-Girder Based Methods of Analysis
  4. Grid Methods of Analysis
  5. 3D Finite Element Analysis
  6. Proper Selection of Analysis Methods
IV. Design
  1. Layout Considerations in Preliminary Design
  2. Girder Selection and Proportioning in Preliminary Design
  3. Design for Constructability
  4. Service Limit State Design
  5. Design for Fatigue Resistance
  6. Composite I-Girder Flexural Resistance in Negative Bending
  7. Composite I-Girder Flexural Resistance in Positive Bending
  8. I-Girder Shear Resistance
  9. Shear Connector Design
  10. Design of Cross-Frame Members
  11. Design of Bolted Splices
  12. Bearing Design
  13. Bridge Deck Design
  14. Box (Tub) Girder Design
V. Fabrication and Construction
  1. Fabrication of Curved I-Girders
  2. Detailing of Cross-Frames
  3. Shop-Fit and Assembly Considerations
  4. Construction Plans

Grading:

Mid-Term Exam (Wk 10, Wednesday, Oct 27)	30%	Team Project Assignments	35 %
Individual Assignments	35%		

Grading Scale

Your final grade will be assigned as a letter grade according to the following scale:
A 85-100%; B 75-85%; C 65-75%; D 55-65%

If you are close to a letter grade boundary at the completion of the term, class participation (contributing to discussions and/or being attentive with questions throughout the term, regular on-time and complete submittals of Coursework Exercises) and special circumstances (e.g., one or a few low grades due to special circumstances) will be considered in lowering a boundary to elevate you one letter grade.

Additional References

AASHTO (2020), *AASHTO LRFD Bridge Design Specifications*, 9th Ed., available for download from the Georgia Tech library:

Library web -> Find, borrow, request -> Databases -> ASTM Compass – Standards and Journals -> Georgia Institute of Technology -> search AASHTO LRFD

NSBA Resources, https://www.aisc.org/nsba/design-and-estimation-resources/, includes LRFD Simon software, and NSBA Splice software, NSBA Publications, NSBA Collaboration Standards and Guides, FHWA Steel Bridge Design Handbook

Short Span Steel Bridge Alliance, eSPAN140, http://www.shortspansteelbridges.org/

Policies and Operating Procedures

1. Working together on assignments is encouraged, but your individual homework (unless marked as Team based) must be completed in your own "hand."
2. Attendance at all lectures is mandatory. If you must be absent, you should contact me in advance.
3. DO NOT BE LATE to class.
4. Turn off your cell phones in class!
5. Your work must adhere to good professional office practice…. clear documentation is essential: statements of assumptions and the organization of the solution to the problem, highlighting of intermediate steps, and final summary of solution and design recommendations as applicable…. one side of the paper only for any manual work or printed hardcopy, ample white space (don't crowd the different parts of your work together). ***A 10 % grade deduction will be applied to solutions that do not meet this standard. Zero credit will be given for multiple-sided solutions or for pages torn out of spiral notebooks. A 5 % grade deduction will be applied for homework that is not stapled.***
6. Assignment submissions will generally be electronic, e.g., pdf documents of generated or scanned work, program files, etc. Assignments must be submitted by the deadline for full credit. Generally, you should submit all portions of the homework you have completed by the deadline. ***A 10 % penalty is assigned per day for late homework, including weekends.***
7. An example mid-term exam will be provided on the course web site several weeks in advance of the exam.
8. The Course Project and certain HW Assignments will be Team Based. I'll ask you to give me self-selected recommendations for team members, as well as your preferred meeting times, as we get into the second month of the term.

GT Honor Code

I expect compliance with the GT Academic Honor Code; please read and understand this document, available at honor.gatech.edu. Your **signature** on all submissions assures me of your full compliance. ***You are encouraged to work together*** *with other students on individual-based HW assignments, as long as you write up and turn in your own solutions. I encourage you to explore the various materials and concepts we will discuss, and to ask lots of questions!* Tests and exams are to be your work alone. All tests and exams will be closed book and notes, with the exception of 2 pages (one side) of any notes you would like to bring. *For any questions involving these or any other Academic Honor Code issues, please consult me and or* honor.gatech.edu.

Disclaimer

When appropriate or necessary, the instructor reserves the right to adjust, amend, or otherwise modify the information presented in the syllabus.

Travel Schedule

Prof. White will be out-of-town from November 16-19. The class sessions on Nov. 17 will be a combination of streamed lectures and team-project assignments.

Tentative Schedule, Reading, & Assignments

Session	Date	Topics	Reading
1	8/23	PW1.1 Opening Remarks & Introduction PW1.2 Course Introduction & Overview	RM1.1* (47 pp)
2	8/25	Torsion of Thin-Walled Open-Section (TWOS) beams **HW1** (Analysis of I-section member subjected to torsion; hand analysis & Mastan analysis)	Handouts
3	8/30	PW2.1 System Behavior & Torsion	
4	9/1	PW2.2 Limit States, Loads & Load Combinations	RM1.3 (51 pp) ALRFD1.3*
5	9/8	PW2.3 Live Load Force Effects **HW2** (Load Basics) PW3.1 General Analysis Considerations	RM2.1 (49 pp) ALRFD3.6
6	9/13	PW3.2 Bearing Constraints	RM2.2 (36 pp)
7	9/15	PW3.2 **HW3** (Approximate analysis of substructure elements)	
8	9/20	PW3.3a Live Load Distribution Factors, Design by Line-Girder Analysis, Introduction to LRFD-Simon Software **HW4** (Introduction to LRFD Simon)	ALRFD4.6
9	9/22	PW3.3b Approximate Methods of Analysis for Curved I-Girder Bridges	RM2.3 (33 pp)
10	9/27	Overview of FHWA curved test bridge **HW5** (Basic V-load analysis calculations)	Handouts
11	9/29	PW3.4 2D Refined Methods of Analysis	RM2.4 (22 pp)
12	10/4	PW3.4	
13	10/6	NCHRP Findings regarding 2D Analysis Methods **HW6** (Basic grid analysis calculations)	Handouts
	10/11	FALL BREAK	
14	10/13	PW3.5 3D Refined Methods of Analysis	RM 2.5 (63 pp … 21 pp on FE fundamentals)
15	10/18	PW3.5 **HW7** (Other 2D grid model considerations; Modeling of Cross-frames)	
16	10/20	Introduction to CSI Bridge Advanced & Term Project	Handouts
17	10/25	**HW8** (Modeling of example two-girder bridge in CSI Bridge)	
18	10/27	**Mid-Term Exam (Topics through end of Session 15)**	
19	11/1	PW4.1 Preliminary Design Decisions **HW9** (Term Project, Preliminary layout and design proportioning)	RM 3.1 (129 pp)
20	11/8	PW4.1	
21	11/10	PW4.1 **HW10** (Term Project, Creation of CSI Bridge Model for your design)	
22	11/15	PW3.6 Recommended Level of Analysis	RM 2.6 (85 pages), Handouts
23	11/17	PW4.2 Girder Design Verifications **HW11** (Term Project, Preliminary Girder Design)	RM Sections 3.2.1 through 3.2.3 (36 pages)
24	11/22	PW4.2	RM Sections 3.2.4 & 3.2.5 (64 pages)
	11/24	THANKSGIVING BREAK	
25	11/29	PW4.2 Girder Design & PW4.3 Design of Detail Items **HW12** (Term Project, Girder Design Verifications & Design of Detail Items)	
26	12/01	PW4.3 Design of Detail Items	RM Sections 3.3.1 through 3.3.2 (20 pages)
27	12/06	PW5 Fabrication & Construction Considerations	RM Section 4.1 (53 pages) RM Section 4.2 (40 pages)

* RM = Reference Manual (Grubb et al. 2010), ALRFD = AASHTO LRFD Specifications