

Course Curriculum and Content for the Basic Structural Engineer

By Craig E. Barnes, PE, SE

By this time, the reader has been exposed to several magazine articles and through attendance at the National Council of Structural Engineering Associations Annual Conference to the curriculum that structural engineer peers believe is appropriate for training to be a structural engineer. The reader can access that material in an article by Craig E. Barnes, PE – *Basic Education Certification as a Structural Engineer* on the *STRUCTURE* magazine website at www.structuremag.org/education or refer to the curriculum herein (Fig. 1). Academic education, practical experience, and examination are the corner stones of the Basic Education for a Structural Engineer.

This is the first publication of the curriculum content (Fig. 2). Reproduction for further dissemination by readers is encouraged. Electronic versions of the curriculum content are available for downloading from the NCSEA website. A comprehensive survey of colleges and universities was conducted over a three year period to determine those schools offering courses which are appropriate for the basic education of a structural engineer. The survey demonstrated that while many schools do not offer the full course listing, almost 40% of the respondents do. A subsequent issue of *STRUCTURE* magazine will list schools and course offerings.

A major, or minor challenge depending upon one’s perspective, is the implementation of not only the curriculum but the course content.

A supporting article authored by Mr. Daniel Lavrich, P.E., was carried recently in the April 2003 issue of *STRUCTURE* magazine. That article can be read by accessing the *STRUCTURE* magazine website at www.structuremag.org/archives.htm. Dan’s article contains some helpful thoughts on implementation of several components of the Basic Education program. The NCSEA Education Committee encourages responses relative to the curriculum and course content from all readers. Comments should be sent by e-mail to CBI1984@aol.com.

Basic Education Curriculum for a Structural Engineer		
Number of Courses	Semester Credit Hours Per Course	Course
2	3	Analysis
1	3	Matrix Methods
2	3	Steel Design (Including code application)
2	3	Concrete Design (Including code application)
1	3	Timber Behavior and Design
1	3	Masonry
1	3	Dynamic Behavior
1	3	Foundation Design / Soil Mechanics
1	3	Technical Writing
Total:	36	

Figure 1

Basic Education Course Content			
Basic Education for a Structural Engineer			
Course Content			
<i>Analysis I</i>			
Topics			
1.	Introduction to Structures.	7.	Stress-strain relationships.
2.	Forces.	8.	Plane trusses – method of section and method of joints.
3.	Moments/couples.	9.	Frames.
4.	Equilibrium and stability.		
5.	Concept of stress.		
6.	Concept of strain.		

10. Shear and bending moment diagrams – focus on the relationship between load, shear, moment and deflection.

Objectives

1. Identify stable structures.
2. Develop and use free-body diagrams.
3. Evaluate the internal actions (shear, bending, and axial) in commonly used planar structural systems (trusses, frames, and beams).
4. Draw shear and bending moment diagrams.

Analysis 2

Topics

- | | |
|---|--|
| <ol style="list-style-type: none"> 1. Introduction and review of statics. 2. Axially loaded members including indeterminate problems. 3. Bending of beams. 4. Shear and bending in beams. 5. Torsion including indeterminate problems. 6. Compressive members/instability. 7. Formulate and apply stress transformations and related extensions to principal stresses and maximum in-plane shear stress. 8. Compute shear flow and location of shear center for any thin-walled cross-section. 9. Understand the derivation and application of flexural deformation using basic principles <ol style="list-style-type: none"> a. Slope and displacement of a beam by integration. b. Slope and displacement of a beam by moment-area. | <ol style="list-style-type: none"> 10. Indeterminate beam reactions using moment-area. 11. Formulation and application of the Euler buckling formula. 12. Stress transformation, Mohr's circle. 13. Beam deformations: double integration, moment-area, and indeterminate beam analysis. 14. Stability, morphology, and analysis of statistically determinate two- and three- dimensional structural systems. 15. Analysis of articulated beams and frames. 16. Slope-deflection method. 17. Moment distribution for beams and frames. 18. Virtual work – trusses, beams, and frames. 19. Approximate Methods. 20. Influence lines. |
|---|--|

Objectives

1. Compute deformations (axial, shear, and bending) in statically determinate structures using Virtual Work.
2. Compute member actions in statically indeterminate structures using Virtual, Work, Slope-Deflection, and Moment Distribution.
3. Distinguish between different methods and judge when it is appropriate to use each of the methods.
4. Approximate actions in statically determinate and indeterminate structures and judge when it is appropriate to use approximate methods. Use approximate methods to verify computer analysis results.
5. Draw influence lines for statically determinate and indeterminate structures and use these influence lines to specify critical loading combinations.
6. Determine internal stress distributions at discrete points in the beam.
7. Apply relationships between stress and strain under individual and combined loading and determine deformations due to tension.
8. Calculate moments of inertia of regular and irregular shapes.
9. Evaluate determinacy (including degrees of indeterminacy) and stability.
10. Draw deformed shapes for beams and frames.

Matrix Methods

Topics

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|--|---|
| <ol style="list-style-type: none"> 1. Review of matrix algebra. 2. Basic concepts: Flexibility vs. stiffness 3. Flexibility method. 4. Stiffness method: Trusses 8. Introduction to Finite Element Analysis and Nonlinear Analysis. | <ol style="list-style-type: none"> 5. Stiffness Method: Beams & Frames 6. Stiffness Method: Three Dimensions. 7. Stiffness Method: Special Topics. |
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Objectives

1. Understand the theoretical basis of matrix methods.
2. Model and analyze real-world structures appropriately.
3. Understand advanced analysis methods such as finite element analysis and nonlinear analysis.

Steel Design I

Topics

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|--|--|
| <ol style="list-style-type: none"> 1. Historical development of steel as a building material. 2. Loading of steel building structures. 3. Properties of structural steel. | <ol style="list-style-type: none"> 4. Design stresses and factors of safety. 5. Design of laterally braced and un-braced beams. 6. Design of beam-columns, use of AISC interaction equations. |
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Objectives

1. Understand the use of steel as a building material.
2. Understand the properties of steel including the manufacturing processes and types.

3. *Analyze and design tension members, beams, and compression elements.*
4. *Understand the application of AISC – Manual of Steel Construction.*
5. *Recognize, analyze and design combined stress elements.*

Steel Design 2

Topics

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|--|--|
| <ol style="list-style-type: none"> 1. Structural design computations for beams, girders, columns and beam-columns. 2. Design of connections (bolted & welded). 3. Structural working drawings (plan, elevation and connection details). 4. Overview of failure mechanisms and design procedures for plate girders. | <ol style="list-style-type: none"> 5. AISC requirements for prevention of various failure mechanisms. 6. Design of flanges, web, stiffeners and welds. 7. Philosophy of energy absorption in a shear mechanism. 8. Requirements for the design of a link, the adjacent beam and the diagonal bracing of an Eccentric Braced Frame. |
|--|--|

Objectives

1. *Develop framing schemes for steel structures.*
2. *Design moment and braced frame systems.*
3. *Detail structural steel.*
4. *Design composite sections.*
5. *Design plate girders design (buckling shear).*

Concrete 1

Topics

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|--|--|
| <ol style="list-style-type: none"> 1. Materials. 2. Flexural behavior and design. 3. Deflections. | <ol style="list-style-type: none"> 4. Shear. 5. Development of reinforcement. 6. Columns. |
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Objective

1. *Understand material properties of reinforced concrete. Understand concrete member strain and stress states.*
2. *Analyze and design reinforced concrete beams subject to bending, shear, and axial, load including combined stresses.*
3. *Analyze and design reinforced concrete columns the bending, shear and axial load including combined stresses.*
4. *Detail reinforcement to develop required strengths.*
5. *Understand the application of ACI-318.*

Concrete 2

Topics

- | | |
|--|--|
| <ol style="list-style-type: none"> 1. Introduction, general design principle, material and anchorages. 2. Loss of prestress. 3. Analysis of flexural sections. 4. Design of flexural sections. 5. Design of composite sections. | <ol style="list-style-type: none"> 6. Design of shear. 7. Prestress transfer bond, anchorage zone. 8. Cable profile, deflection. 9. Partial prestressed and nonprestressed reinforcement. 10. Design of continuous beams. 11. Post-tensioning two-way slabs. |
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Objectives

1. *Understanding of the reasons and process for selecting prestressed and precast concrete for building systems/elements/architectural use.*
2. *Understand prestressing and precast materials and manufacturing processes.*
3. *Understand structural systems using prestressed and precast concrete members and the importance of connections.*
4. *Design of basic structural members using both pre- and post-tensioning.*
5. *Design of connections.*

Timber

Topics

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|---|--|
| <ol style="list-style-type: none"> 1. Properties of wood and lumber/Grades. 2. Design of members to resist bending. 3. Design of members to resist axial forces. | <ol style="list-style-type: none"> 4. Design of shear walls and diaphragms. 5. Configuration of timber buildings. 6. Design of connections. |
|---|--|

Objectives

1. *Understand the material characteristics of timber.*
2. *Design timber beams and columns for axial, shear, bending, and combined stresses.*
3. *Design plywood shear walls and horizontal diaphragms.*
4. *Understand the capacity of connectors (nail and bolts) used in timber construction.*
5. *Understand timber properties that affect its structural performance.*
6. *Develop conceptual designs for timber structural systems that are stable under vertical and lateral loads.*
7. *Describe the load flow through timber structural systems for vertical and lateral loads.*

Masonry

Topics

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|----|--|----|---|
| 1. | Introduction: types of masonry, masonry construction, properties of masonry, grout, mortar, and reinforcement. | 3. | Design and Analysis of Columns and Pilasters. |
| 2. | Design and Analysis of Beams and Lintels. | 4. | Design and Analysis of Reinforced Masonry Walls: bearing walls and shear walls. |

Objectives

1. *Identify the unique characteristics and behavior of masonry.*
2. *Analyze and design columns/pilasters, beams/lintels, bearing walls, and shear walls.*

Dynamic Behavior (including seismic)

Topics

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|----|--|-----|---|
| 1. | Kinematics of a particle. | 10. | Response of single D.O.F. structural systems to earthquake ground motion; concept of response spectra; design spectra; damping, damping ratios. |
| 2. | Kinetics of a particle: Force and acceleration. | 11. | Response of multi-D.O.F. structural systems subjected to earthquake ground motion; mode shapes and frequencies; earthquake response analysis by mode superposition. |
| 3. | Kinetics of a particle: Work and Energy. | 12. | Inelastic seismic behavior and design of structural systems; concept of ductility. |
| 4. | Kinetics of a particle: Impulse and momentum. | 13. | Behavior of building structures under earthquake loading including reinforced concrete, prestressed concrete, steel, masonry and timber structures. |
| 5. | Planar kinematics of a rigid body. | | |
| 6. | Planar kinetics of a rigid body: Force and acceleration. | | |
| 7. | Planar kinetics of a rigid body: Work and energy. | | |
| 8. | Planar kinetics of a rigid body: Impulse and Momentum. | | |
| 9. | Characteristics of earthquakes; causes, faults, seismic waves, plate-tectonics, magnitude and intensity; strong ground motion etc. | | |

Objectives

1. *Develop a dynamic mathematical model for a rigid body.*
2. *Write the equation of motion for a rigid body.*
3. *Determine the response of a rigid body.*
4. *Apply building code principles to seismic analysis both empirical (static analysis) and modal.*
5. *Understand response of buildings, influence of soil, principles of damping.*
6. *Understand lateral forces on parts of buildings and contents.*

Foundation Design/Soil Mechanics

Topics

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|----|--|----|--|
| 1. | Description and properties of foundation bearing materials | 5. | Shallow foundation (footings, rafts, mats) |
| 2. | Field exploration | 6. | Pile foundations |
| 3. | Lateral earth pressure | 7. | Caisson foundations |
| 4. | Slope stability | 8. | Retaining walls |

Objectives

1. *Understand material properties of soils and ledge.*
2. *Understand the relationship between insitu foundation bearing materials and allowable foundation and lateral pressure values presented in NFPA/IBC codes.*
3. *Be able to determine the empirical strength for insitu bearing material an design and appropriate deep or shallow foundation.*
4. *Understand the effect of seismic forces and liquefaction on foundations.*

Technical Writing

Topics

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|----|--------------------------|----|--------------------------------|
| 1. | Review of basic grammar. | 3. | Report execution. |
| 2. | Report structure. | 4. | Communicating with lay people. |

Objectives

1. *Craft a technical report/paper, well written and prepared for the target audience.*


Figure 2

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THE 2006 EDUCATION SURVEY RESULTS


The following list of schools offer the full curriculum:

Analysis Matrix Methods Steel	Concrete Timber Dynamic Behavior	Masonry Foundation / Soils Technical Writing
Auburn University www.auburn.edu	North Carolina State University www.ncsu.edu	University of Cincinnati www.uc.edu
California Polytechnic University San Luis Obispo www.calpoly.edu	Oklahoma State University Architectural Engineering architecture.ceat.okstate.edu	University of Florida www.ufl.edu
California State Polytechnic Pomona www.csupomona.edu	Oklahoma State University Civil Engineering cive.okstate.edu	University of Idaho Moscow www.uihome.uidaho.edu
California State University Los Angeles www.calstatela.edu	Oregon State University oregonstate.edu	University of Illinois Urbana www.uiuc.edu
Clemson University www.clemson.edu	Pennsylvania State University www.psu.edu	University of Kansas www.ku.edu
Georgia Institute of Technology www.gatech.edu	Portland State University www.pdx.edu	University of Kentucky www.uky.edu
Gonzaga University www.gonzaga.edu	Purdue University www.purdue.edu	University of Missouri Rolla www.UMR.edu
Hofstra University www.hofstra.edu	Rose Hulman Institute of Technology www.rose-hulman.edu	University of Nevada Las Vegas www.unlv.edu
Illinois Institute of Technology www.iit.edu	Santa Clara University www.scu.edu	University of New Orleans Lakefront www.uno.edu
Iowa State University www.iastate.edu	St. Martin's College www.stmartin.edu	University of North Carolina Charlotte www.uncc.edu
Michigan Tech University www.mtu.edu	Syracuse University www.syr.edu	University of Texas Austin www.utexas.edu
Milwaukee School of Engineering www.msoe.edu	Texas A & M University Kingsville www.tamuk.edu	University of Utah www.utah.edu
Montana State University Bozeman www.montana.edu	University at Buffalo (SUNY) www.buffalo.edu	University of Washington www.washington.edu
New Jersey Institute of Technology www.njit.edu	University of Akron www.uakron.edu	University of Wyoming www.uwyo.edu
New Mexico State University www.nmsu.edu	University of Alabama Birmingham main.uab.edu	Virginia Polytechnic Institute State University www.vt.edu
North Carolina A&T State University www.ncat.edu	University of Arkansas www.uark.edu	





























































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Some of the schools did not respond to this latest survey, however the information from the previous survey is included. Please note the "Updated" column for the year the survey response.

SCHOOL	WEB SITE	Updated	Analysis	Matrix Methods	Steel	Concrete	Timber	Masonry	Dynamic Behavior	Foundation / Soils	Technical Writing
Arkansas State University	www.astate.edu	2001	✓	✓	✓	✓			✓	✓	
Blue Mountain Community College	www.bmcc.cc.or.us	2006	✓		✓	✓	✓			✓	✓
Broome Community College	www.sunybroome.edu	2001			✓						
Bucknell University	www.bucknell.edu	2006	✓	✓			✓			✓	✓
California State University - Fresno	www.csufresno.edu	2001	✓	✓	✓	✓	✓			✓	✓
California State University - Sacramento	www.csus.edu	2001	✓	✓	✓	✓	✓	✓	✓	✓	
Christian Brothers University	www.cbu.edu/	2001	✓	✓	✓	✓	✓		✓	✓	✓
The Citadel	www.citadel.edu	2006	✓		✓	✓			✓	✓	
Clarkson University	www.clarkson.edu	2001	✓	✓	✓	✓	✓		✓		✓
Cornell University	www.cornell.edu	2001	✓	✓	✓	✓	✓		✓		✓
Drexel University	www.drexel.edu	2001	✓	✓	✓	✓		✓	✓	✓	✓
Fairleigh-Dickinson University	www.fdu.edu	2001	✓		✓	✓	✓		✓	✓	✓
Florida Institute of Technology	www.fit.edu	2006	✓	✓	✓		✓		✓	✓	✓
Gonzaga University	www.gonzaga.edu/	2006	✓	✓			✓	✓	✓	✓	✓
Howard University	www.howard.edu	2006	✓	✓	✓	✓				✓	✓
Lawrence Technological University	www.ltu.edu	2006	✓	✓	✓	✓		✓	✓	✓	✓
Loyola Marymount University	www.lmu.edu	2001	✓		✓	✓			✓	✓	✓
Massachusetts Institute of Technology	web.mit.edu	2001	✓	✓	✓	✓			✓	✓	✓
Mercer County Community College	www.mccc.edu	2006	✓		✓	✓					✓
Miami University	www.miami.edu	2006			✓	✓	✓				
Missouri Western State University	www.missouriwestern.edu	2006	✓	✓	✓	✓	✓	✓	✓		
Michigan State University	www.msu.edu	2006	✓	✓	✓	✓			✓	✓	✓
Morgan State University	www.morgan.edu	2001	✓	✓	✓	✓			✓	✓	
Northeastern University	www.northeastern.edu	2006	✓	✓	✓	✓			✓	✓	✓
Ohio Northern University	www.onu.edu	2006	✓	✓	✓	✓	✓			✓	✓
Ohio State University	www.osu.edu	2006	✓	✓	✓	✓			✓	✓	✓
Oregon Institute of Technology	www.oit.edu	2001	✓		✓	✓	✓	✓	✓	✓	✓
Prairie View A&M University	www.pvamu.edu	2001	✓		✓	✓				✓	✓
Rochester Institute of Technology	www.rit.edu	2006	✓		✓	✓	✓		✓	✓	✓
San Francisco State University	www.sfsu.edu	2006	✓		✓	✓	✓		✓	✓	✓
San Diego State University	www.sdsu.edu	2006	✓	✓	✓	✓	✓		✓	✓	✓
Seattle University	www.seattleu.edu	2001	✓	✓	✓	✓				✓	✓
Southern Illinois University	www.siu.edu	2001	✓	✓	✓	✓		✓	✓	✓	✓
Southern Methodist University	www.smu.edu	2006	✓	✓	✓	✓			✓	✓	✓
Southern Polytechnic State University	www.spsu.edu	2001	✓	✓	✓	✓				✓	✓
Stevens Institute of Technology	www.stevens.edu	2006		✓	✓	✓			✓	✓	✓
Texas A&M - College Station	www.tamu.edu	2006		✓	✓	✓			✓	✓	✓
Texas Tech	www.ttu.edu	2001		✓	✓	✓	✓		✓	✓	✓
Tri-State University	www.tristate.edu	2006	✓		✓	✓	✓			✓	✓
Tufts University	www.tufts.edu	2001	✓	✓	✓	✓		✓		✓	✓

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Some of the schools did not respond to this latest survey, however the information from the previous survey is included. Please note the "Updated" column for the year the survey response.

SCHOOL	WEB SITE	Updated	Analysis	Matrix Methods	Steel	Concrete	Timber	Masonry	Dynamic Behavior	Foundation / Soils	Technical Writing
U.S. Coast Guard Academy	www.cga.edu	2001	✓	✓	✓	✓			✓	✓	✓
University of California - Berkeley	www.berkeley.edu	2001	✓	✓	✓	✓	✓		✓	✓	✓
University of California - Los Angeles	www.ucla.edu	2001	✓	✓	✓	✓		✓	✓	✓	✓
University of California - San Diego	www.ucsd.edu	2001	✓	✓	✓	✓	✓	✓	✓	✓	
University of Central Florida	www.ucf.edu	2001	✓	✓	✓	✓	✓	✓	✓	✓	
University of Columbia	www.columbia.edu	2001	✓	✓	✓	✓			✓	✓	
University of Evansville	www.evansville.edu	2001	✓	✓	✓	✓	✓		✓	✓	
University of Hartford	www.hartford.edu	2001	✓		✓	✓				✓	
University of Hawaii - Manoa	www.uhm.hawaii.edu	2006	✓	✓	✓	✓			✓	✓	
University of Houston	www.uh.edu	2006	✓	✓	✓	✓		✓	✓	✓	✓
University of Illinois - Chicago	www.uic.edu	2001	✓	✓	✓	✓	✓	✓	✓	✓	
University of Iowa	www.uiowa.edu	2001	✓		✓	✓			✓	✓	✓
University of Massachusetts - Amherst	umass.edu	2001	✓	✓	✓	✓	✓		✓	✓	✓
University of Massachusetts - Lowell	www.uml.edu	2001	✓		✓	✓	✓		✓	✓	✓
University of Memphis	www.memphis.edu	2006	✓	✓	✓	✓			✓	✓	✓
University of Michigan	www.umich.edu	2006	✓	✓	✓	✓		✓	✓	✓	✓
University of Minnesota	www1.umn.edu	2001	✓	✓	✓	✓		✓	✓	✓	✓
University of Mississippi	www.olemiss.edu	2001	✓		✓	✓			✓	✓	
University of Nebraska - Lincoln	www.unl.edu	2001	✓	✓	✓	✓		✓	✓	✓	✓
University of New Hampshire	www.unh.edu	2006	✓	✓	✓	✓	✓	✓	✓	✓	✓
University of New Mexico	www.unm.edu	2006	✓		✓	✓			✓	✓	✓
University of the Pacific	www.pacific.edu	2001	✓	✓	✓	✓	✓		✓	✓	✓
University of Rhode Island	www.uri.edu	2001	✓	✓	✓	✓	✓		✓	✓	✓
University of South Carolina	www.sc.edu	2001	✓	✓	✓	✓			✓	✓	
University of Tennessee - Knoxville	www.utk.edu	2006	✓		✓	✓	✓	✓	✓	✓	✓
University of Tennessee - Martin	www.utm.edu	2006	✓	✓	✓	✓	✓		✓	✓	✓
University of Texas - El Paso	www.utep.edu	2001	✓	✓	✓	✓			✓	✓	
University of Wisconsin - Madison	www.wisc.edu	2006	✓	✓	✓	✓	✓		✓	✓	✓
University of Wisconsin - Platteville	www.uwplatt.edu	2006	✓	✓	✓	✓				✓	✓
Valparaiso University	www.valpo.edu	2001	✓	✓	✓	✓		✓	✓	✓	✓
Villanova University	www.villanova.edu	2001	✓	✓	✓	✓	✓	✓	✓	✓	
Virginia Military Institute	www.vmi.edu	2006	✓	✓	✓	✓	✓			✓	✓
Washington University in St Louis	www.wustl.edu	2006		✓	✓	✓	✓	✓	✓	✓	✓
Western Kentucky University	www.wku.edu	2006	✓	✓	✓	✓			✓	✓	
Worcester Polytechnic Institute	www.wpi.edu	2006	✓	✓	✓	✓	✓		✓	✓	✓

School:	Recommended Curriculum																										
<p>The following is the list of schools which responded to the latest survey.</p> <p>This table denotes how many classes each school offers for each subject of the recommended curriculum.</p> <p>A "+ #" would signify that the school requires that number of additional class at the Masters level, or offers that number of additional class as an elective.</p> <p>Schools which are in bold type have the complete recommended curriculum.</p>	Analysis			Matrix Methods			Steel Design			Concrete Design			Timber Design			Masonry Design			Dynamic			Foundation - Soils			Technical Writing		
	2 Courses Recommended			1 Course Recommended			2 Courses Recommended			2 Courses Recommended			1 Course Recommended			1 Course Recommended			1 Course Recommended			1 Course Recommended			1 Course Recommended		
	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective
Auburn University	3					1	2		1		+2			1			1	1	+2	1		+2			1		
Blue Mountain Community College	<i>Unchanged program from 2004-2005 survey</i>																										
Bucknell University			2			1			1		1			1	<i>None offered</i>			<i>None offered</i>					1			1	
California Polytechnic Univ. - S.L.O.	<i>Unchanged program from 2004-2005 survey</i>																										
Clemson University	<i>Unchanged program from 2004-2005 survey</i>																										
Florida Institute of Technology	2				1	+1	1	2		1			1	<i>None offered</i>				1		1	1			1		1	
Georgia Institute of Technology	1	+1				1		1	+1		1	+3		1			1		2			4			1		
Gonzaga University	1		+1			1	1			1				1			1		1	2			1				
Hofstra University	<i>Unchanged program from 2004-2005 survey</i>																										
Howard University	1	+1				1	1	+1	+1	1	+1		<i>None offered</i>			<i>None offered</i>			<i>None offered</i>			2	+1		1		
Illinois Institute of Technology	2					1	2			2		+1			1			1		2	1			2			
Lawrence Technological University	<i>Unchanged program from 2004-2005 survey</i>																										
Miami University	1			<i>None offered</i>				1			1			1	<i>None offered</i>			<i>None offered</i>			<i>None offered</i>			<i>None offered</i>			
Michigan State University	1		+1			2			2		2	<i>None offered</i>			<i>None offered</i>					1				1			
Michigan Technological University	1	+1			1	+1	0.5		+2	0.5	+3			1.5			.5		1	+1	1		+2		1		
Milwaukee School of Engineering	<i>Unchanged program from 2004-2005 survey</i>																										
Missouri Western State University	1			<i>None offered</i>			1			1			0.5		0.5			<i>None offered</i>			1			1			
Montana State University	2				1	1	+2		2	+1				1			1			1	2	+1		1			
New Mexico State University	3		+1		1		1	+1		1	+1			1			1		1	1			1				
Northeastern University	2				1				2	1		+2	<i>None offered</i>			<i>None offered</i>				1	+1	1		+3	1		
North Carolina State University		1	+3		2	+2			3			4			1			1		1	+2			9		1	
Ohio Northern University	<i>Unchanged program from 2004-2005 survey</i>																										
Ohio State University	1		+1			1			3	1		+3	<i>None offered</i>			<i>None offered</i>					1	1		+1	1		
Ohio University	1			1			1			1			1			1		1			1			1			
Oklahoma State University - Arch Eng	2			1	+1		2	+1		2	+1		1				1	1			2				1		
Oklahoma State University - Civil Eng	1		+6		1		1	+1		1	+2			1			1		1	1		+2		1			
Oregon State University	2				1		1	+1		1	+1		1			1		2		2		+1	2				

School:	Recommended Curriculum																											
<p>The following is the list of schools which responded to the latest survey.</p> <p>This table denotes how many classes each school offers for each subject of the recommended curriculum.</p> <p>A "+ #" would signify that the school requires that number of additional class at the Masters level, or offers that number of additional class as an elective.</p> <p>Schools which are in bold type have the complete recommended curriculum.</p>	Analysis			Matrix Methods			Steel Design			Concrete Design			Timber Design			Masonry Design			Dynamic			Foundation - Soils			Technical Writing			
	2 Courses Recommended			1 Course Recommended			2 Courses Recommended			2 Courses Recommended			1 Course Recommended			1 Course Recommended			1 Course Recommended			1 Course Recommended			1 Course Recommended			
	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	
Purdue University	3		+3	1		+2	1		+3	1		+3			1			1	1		+3	2		+3	1			
Portland State University	2	+3				1	1		+2	1		+3			1			1			3	2		+3	1			
Rochester Institute of Technology	2			<i>None offered</i>			1.5			1.5					1	<i>None offered</i>			1			1			1			
Rose Hulman Institute of Technology	2		+2			2	1		+2	1		+2			2			1	1		+1	1		+2	2			
San Francisco State University	2								2	1		+2	1			<i>None offered</i>					1	1	+1		1			
South Dakota State University	1		+1			1	1	+1		1	+1				1	<i>None offered</i>				1		1		2	1			
Santa Clara University	<i>Unchanged program from 2004-2005 survey</i>																											
Southern Methodist University	3				1		0.5	+1		0.5	+2		<i>None offered</i>			<i>None offered</i>			1		+2	1		+2	1			
Stevens Institute of Technology	2		+1	1		+1	2		+1	1		+2	<i>None offered</i>			<i>None offered</i>					3	1		+2	2			
Syracuse University	1	+1	+2		1	+1			1	+1	+1	1	+1	+2			1		1	+2	2	+2		1				
Texas A&M University - College Station	3		+2			1	1		+2	1		+2	<i>None offered</i>			<i>None offered</i>			1	+1	+3	1		+8	1			
Texas A&M University - Kingsville	3			1	+1		1	+1		1	+2				1			1	1	+1		2			1			
The Citadel	<i>Unchanged program from 2004-2005 survey</i>																											
Tri-State University	<i>Unchanged program from 2004-2005 survey</i>																											
University at Buffalo (SUNY)	2	+1			2		1	+1		1	+1			1				1		2	+2	1	+1		1			
University of Alabama - Birmingham	1		+1		1		1		+1	1		+1		1				1			1			1	1			
University of Arkansas	2				1	1	+1				1	+4				1			1		1	2			1			
University of California - San Diego	2				1	1	+1				2	+1				1			1		2				2	<i>None offered</i>		
University of Cincinnati	3			1	+1		1.5	+2	+1	1.5	+2	+1			1			1	1	+1	+1	2		+2	1			
University of Evansville	1				1	1					1					1	<i>None offered</i>				1	1				<i>None offered</i>		
University of Florida	1	+1		1		+1	1	+1	+3	1	+1	+3			1			1		1		1		+5	1			
University of Hawaii - Manoa	2				2				2			2	<i>None offered</i>			<i>None offered</i>					2	2			<i>None offered</i>			
University of Houston	2		+2		1				2	1		+3	<i>None offered</i>					1	1		+2	2		+2	1			
University of Illinois - Urbana	<i>Unchanged program from 2004-2005 survey</i>																											
University of Kansas	1	+1			1		1		+2	1		+3			1			1			3	1		+2	1			
University of Kentucky	3	+1	+1	1		+1	1	+1		1	+1	+2			1			1			1	2		+1			1	
University of Memphis	<i>Unchanged program from 2004-2005 survey</i>																											

School:	Recommended Curriculum																										
<p>The following is the list of schools which responded to the latest survey.</p> <p>This table denotes how many classes each school offers for each subject of the recommended curriculum.</p> <p>A "+ #" would signify that the school requires that number of additional class at the Masters level, or offers that number of additional class as an elective.</p> <p>Schools which are in bold type have the complete recommended curriculum.</p>	Analysis			Matrix Methods			Steel Design			Concrete Design			Timber Design			Masonry Design			Dynamic			Foundation - Soils			Technical Writing		
	2 Courses Recommended			1 Course Recommended			2 Courses Recommended			2 Courses Recommended			1 Course Recommended			1 Course Recommended			1 Course Recommended			1 Course Recommended			1 Course Recommended		
	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective
University of Michigan	1		+1	1			1		+1	1		+2	None offered					1			2	1		+1	1		
University of Missouri - Rolla			2			1			3			3			1			1			1			2			1
University of New Hampshire	2	+1	+1			1			1	1					1			1			2	2			1		
University of New Mexico			1	None offered					1			1	None offered			None offered					1			1			1
University of North Carolina - Charlotte	Unchanged program from 2004-2005 survey																										
University of Tennessee - Knoxville	2	+2	+1	None offered			0.5	0.5	+2	0.5	0.5	+3			1			1			1	1	+1	+3			1
University of Tennessee - Martin	2					1			1	1					1	None offered					1	1					1
University of Utah	2	+2				1	2		+1	1		+1			1			1	1		+3	1		+5	1		
University of Washington	Unchanged program from 2004-2005 survey																										
University of Wisconsin - Madison	2				1	+1		1	+1		1	+2		1		None offered					2	1		+1	1		
University of Wisconsin - Platteville			1			1			1			1	None offered			None offered			None offered					1			1
University of Wyoming	Unchanged program from 2004-2005 survey																										
Virginia Military Institute	1		+1			1			1	1		+1			0.5	None offered			None offered			1		+1			1
Washington University in St Louis	None offered					1	1		+2	1		+2			1			1			2	1		+1	1		
Western Kentucky University	2		2			1			1			1	None offered			None offered					1	1		+1	None offered		
Worcester Polytechnic Institute			4			2			2			2			1	None offered					2			2	2		3

School:	Recommended Curriculum																										
<p>The following is the list of schools which responded to the latest survey.</p> <p>This table denotes how many classes each school offers for each subject of the recommended curriculum.</p> <p>A "+ #" would signify that the school requires that number of additional class at the Masters level, or offers that number of additional class as an elective.</p> <p>Schools which are in bold type have the complete recommended curriculum.</p>	Analysis			Matrix Methods			Steel Design			Concrete Design			Timber Design			Masonry Design			Dynamic			Foundation - Soils			Technical Writing		
	2 Courses Recommended			1 Course Recommended			2 Courses Recommended			2 Courses Recommended			1 Course Recommended			1 Course Recommended			1 Course Recommended			1 Course Recommended					
	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective
Auburn University	3					1	2		1		+2			1			1	1	+2	1		+2			1		
Blue Mountain Community College	<i>Unchanged program from 2004-2005 survey</i>																										
Bucknell University			2			1		1			1			1			None offered		None offered			1			1		
California Polytechnic Univ. - S.L.O.	<i>Unchanged program from 2004-2005 survey</i>																										
Clemson University	<i>Unchanged program from 2004-2005 survey</i>																										
Florida Institute of Technology	2				1	+1	1	2		1			1			None offered		1		1	1		1				
Georgia Institute of Technology	1	+1				1		1	+1		1	+3		1			1		2			4			1		
Gonzaga University	1		+1			1	1			1				1			1		1	2			1				
Hofstra University	<i>Unchanged program from 2004-2005 survey</i>																										
Howard University	1	+1				1	1	+1	+1	1	+1			None offered		None offered		None offered		2	+1			1			
Illinois Institute of Technology	2					1	2			2		+1			1			1		2	1			2			
Lawrence Technological University	<i>Unchanged program from 2004-2005 survey</i>																										
Miami University	1				None offered		1			1			1		1		None offered		None offered		None offered		None offered		None offered		
Michigan State University	1		+1			2			2		2		2		None offered		None offered		1					1			
Michigan Technological University	1	+1			1	+1	0.5		+2	0.5	+3			1.5			.5		1	+1	1		+2		1		
Milwaukee School of Engineering	<i>Unchanged program from 2004-2005 survey</i>																										
Missouri Western State University	1				None offered	1				1			0.5			0.5			None offered		1			1			
Montana State University	2					1	1	+2		2	+1			1			1		1	2	+1		1				
New Mexico State University	3		+1		1		1	+1		1	+1			1			1		1	1			1				
Northeastern University	2					1			2	1		+2		None offered		None offered			1	+1	1		+3	1			
North Carolina State University		1	+3		2	+2			3			4			1			1		1	+2			9		1	
Ohio Northern University	<i>Unchanged program from 2004-2005 survey</i>																										
Ohio State University	1		+1			1			3	1		+3		None offered		None offered			1	1		+1	1				
Ohio University	1			1			1			1			1			1		1		1			1		1		
Oklahoma State University - Arch Eng	2			1	+1		2	+1		2	+1		1				1	1		2					1		
Oklahoma State University - Civil Eng	1		+6		1		1	+1		1	+2			1			1		1	1		+2	1				
Oregon State University	2				1		1	+1		1	+1		1				1		2		2		+1	2			

School:	Recommended Curriculum																											
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	2 Courses Recommended			1 Course Recommended			2 Courses Recommended			2 Courses Recommended			1 Course Recommended			1 Course Recommended			1 Course Recommended			1 Course Recommended			1 Course Recommended			
	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	
Purdue University	3		+3	1		+2	1		+3	1		+3			1			1	1		+3	2		+3	1			
Portland State University	2	+3				1	1		+2	1		+3			1			1			3	2		+3	1			
Rochester Institute of Technology	2			<i>None offered</i>			1.5			1.5					1	<i>None offered</i>			1			1			1			
Rose Hulman Institute of Technology	2		+2			2	1		+2	1		+2			2			1	1		+1	1		+2	2			
San Francisco State University	2								2	1		+2	1			<i>None offered</i>					1	1	+1		1			
South Dakota State University	1		+1			1	1	+1		1	+1				1	<i>None offered</i>				1		1		2	1			
Santa Clara University	<i>Unchanged program from 2004-2005 survey</i>																											
Southern Methodist University	3				1		0.5	+1		0.5	+2		<i>None offered</i>			<i>None offered</i>			1		+2	1		+2	1			
Stevens Institute of Technology	2		+1	1		+1	2		+1	1		+2	<i>None offered</i>			<i>None offered</i>					3	1		+2	2			
Syracuse University	1	+1	+2		1	+1			1	+1	+2	1	+1	+2			1		1	+2	2	+2		1				
Texas A&M University - College Station	3		+2			1	1		+2	1		+2	<i>None offered</i>			<i>None offered</i>			1	+1	+3	1		+8	1			
Texas A&M University - Kingsville	3			1	+1		1	+1		1	+2				1			1	1	+1		2			1			
The Citadel	<i>Unchanged program from 2004-2005 survey</i>																											
Tri-State University	<i>Unchanged program from 2004-2005 survey</i>																											
University at Buffalo (SUNY)	2	+1			2		1	+1		1	+1				1			1		2	+2	1	+1		1			
University of Alabama - Birmingham	1		+1		1		1		+1	1		+1			1			1			1			1	1			
University of Arkansas	2				1	1	+1				1	+4				1			1		1	2			1			
University of California - San Diego	2				1	1	+1				2	+1				1			1		2				2	<i>None offered</i>		
University of Cincinnati	3			1	+1		1.5	+2	+1	1.5	+2	+1			1			1	1	+1	+1	2		+2	1			
University of Evansville	1				1	1					1					1	<i>None offered</i>				1	1				<i>None offered</i>		
University of Florida	1	+1		1		+1	1	+1	+3	1	+1	+3			1			1		1		1		+5	1			
University of Hawaii - Manoa	2				2				2			2	<i>None offered</i>			<i>None offered</i>					2	2			<i>None offered</i>			
University of Houston	2		+2		1				2	1		+3	<i>None offered</i>					1	1		+2	2		+2	1			
University of Illinois - Urbana	<i>Unchanged program from 2004-2005 survey</i>																											
University of Kansas	1	+1			1		1		+2	1		+3			1			1			3	1		+2	1			
University of Kentucky	3	+1	+1	1		+1	1	+1		1	+1	+2			1			1			1	2		+1			1	
University of Memphis	<i>Unchanged program from 2004-2005 survey</i>																											

School:	Recommended Curriculum																													
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	2 Courses Recommended			1 Course Recommended			2 Courses Recommended			2 Courses Recommended			1 Course Recommended			1 Course Recommended			1 Course Recommended			1 Course Recommended			1 Course Recommended					
	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective			
	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective	Required for a Bachelor Degree	Required for a Masters Degree	Offered as an Elective			
University of Michigan	1		+1	1			1		+1	1		+2	None offered					1			2	1		+1	1					
University of Missouri - Rolla			2			1			3			3			1			1			1			2			1			
University of New Hampshire	2	+1	+1			1			1	1					1			1			2	2			1					
University of New Mexico			1	None offered					1			1	None offered			None offered					1			1			1			
University of North Carolina - Charlotte	Unchanged program from 2004-2005 survey																													
University of Tennessee - Knoxville	2	+2	+1	None offered			0.5	0.5	+2	0.5	0.5	+3			1			1			1	1	1	+1	+3		1			
University of Tennessee - Martin	2					1			1	1					1	None offered					1	1	1				1			
University of Utah	2	+2				1	2		+1	1		+1			1			1	1		1	1		+3	1		+5	1		
University of Washington	Unchanged program from 2004-2005 survey																													
University of Wisconsin - Madison	2				1	+1		1	+1		1	+2		1		None offered					2	1		+1	1					
University of Wisconsin - Platteville			1			1			1			1	None offered			None offered			None offered					1			1			
University of Wyoming	Unchanged program from 2004-2005 survey																													
Virginia Military Institute	1		+1			1			1	1		+1			0.5	None offered			None offered			1		+1			1			
Washington University in St Louis	None offered					1	1		+2	1		+2			1			1			1			2	1		+1	1		
Western Kentucky University	2		2			1			1			1	None offered			None offered					1	1	1		+1	None offered				
Worcester Polytechnic Institute			4			2			2			2			1	None offered					2			2	2		3			