Education for the Structural Engineer

Basic Course Curriculum and Content

By Craig E. Barnes, PE, SE

One of the activities of the SEI Business Practice Committee, with members from SEI, NCSEA, and CASE, has been to promote Basic Education for Structural Engineers. The result of the committee's Phase I effort was the development of a Basic Education Curriculum (*Figure 1*). By this time, the reader has been exposed, through to several magazine articles and 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. Academic education, practical experience, and examination are the cornerstones of the Basic Education for a Structural Engineer.

The Phase II effort culminated in the development of course content appropriate to the previously developed curriculum. This is the first publication of the curriculum content. *Figure 2* provides an abbreviated version of the curriculum. 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.

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 Mechanics / Soils
1	3	Technical Writing

Figure 1: Basic Education Curriculum for a Structural Engineer

The reader can access information relevant to the Basic Education series on the **Structural Education** pages of the STRUCTURE website, **www.structuremag.org**.
The following information is currently available:

Curriculum Content
Full Text

Survey of Universities and Colleges
Data

Basic Education Certification as a Structural Engineer
Craig Barnes, PE, STRUCTURE February '04

A Matter of Degrees
Disconnect Between Academia and the Work Place for the Structural Engineer
Eric L. Hung, STRUCTURE Dec/Jan '04

Basic Education-A Practitioner's Point of View
Daniel L. Lavrich, PE, Structural Forum, STRUCTURE April 03

A major challenge, or minor 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 published in the April 2003 issue of STRUCTURE magazine. Dan's article contains some helpful thoughts on implementation of several components of the Basic Education program.

Reproduction of the curriculum and course content for further dissemination by readers is encouraged. See the sidebar on this page for Electronic versions of the curriculum content are available for downloading from the NCSEA website.

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.**■

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Basic Education Course Content

Analysis 1

Topics

1. Introduction to Structures.
2. Forces.
3. Moments/couples.
4. Equilibrium and stability.
5. Concept of stress.
6. Concept of strain.
7. Stress-strain relationships.
8. Plane trusses – method of section and method of joints.
9. Frames.
10. Shear and bending moment diagrams – focus on the relationship between load, shear, moment and deflection.

Objectives(refer to web site)

Analysis 2

Topics

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
   a. Slope and displacement of a beam by integration.
   b. Slope and displacement of a beam by moment-area.
   c. Indeterminate beam reactions using moment-area.
10. Formulation and application of the Euler buckling formula.
11. Stress transformation, Mohr's circle.
12. Beam deformations: double integration, moment-area, and indeterminate beam analysis.
13. Stability, morphology, and analysis of statistically determinate two- and three- dimensional structural systems.
14. Analysis of articulated beams and frames.
15. Slope-deflection method.
16. Moment distribution for beams and frames.
17. Virtual work – trusses, beams, and frames.
18. Approximate Methods.
19. Influence lines.

Objectives(refer to web site)

Matrix Methods

Topics

1. Review of matrix algebra.
2. Basic concepts: Flexibility vs. stiffness
3. Flexibility method.
4. Stiffness method: Trusses
5. Stiffness Method: Beams & Frames
6. Stiffness Method: Three Dimensions.
7. Stiffness Method: Special Topics.
8. Introduction to Finite Element Analysis and Nonlinear Analysis.

Objectives(refer to web site)

Steel Design 1

Topics

1. Historical development of steel as a building material.
2. Loading of steel building structures.
3. Properties of structural steel.
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.

Objectives(refer to website)

Steel Design 2

Topics

1. Structural design computations for beams, girders, columns and beam-columns.
2. Design of connections (bolted & welded).

Objectives(refer to web site)

Concrete 1

Topics

1. Materials.
2. Flexural behavior and design.
3. Deflections.
4. Shear.
5. Development of reinforcement.
6. Columns.

Objective(refer to website)

Concrete 2

Topics

1. Introduction to prestressed concrete, 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.
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.

Objectives(refer to website)

Timber

Topics

1. Properties of wood and lumber/Grades.
2. Design of members to resist bending.
3. Design of members to resist axial forces.
4. Design of shear walls and diaphragms.
5. Configuration of timber buildings.
6. Design of connections.

Objectives(refer to website)

Masonry

Topics

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

Objectives(refer to website)

Dynamic Behavior (including seismic)

Topics

1. Kinematics of a particle.
2. Kinetics of a particle: Force and acceleration.
3. Kinetics of a particle: Work and Energy.
4. Kinetics of a particle: Impulse and momentum.
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.
10. Response of single D.O.F. structural systems to earthquake ground motion; concept of response spectra; design spectra; damping, damping ratios.
11. Response of multi-D.O.F. structural systems subjected to earthquake ground motion; mode shapes and frequencies; earthquake response analysis by mode superposition.
12. Inelastic seismic behavior and design of structural systems; concept of ductility.
13. Behavior of building structures under earthquake loading including reinforced concrete, prestressed concrete, steel, masonry and timber structures.

Objectives(refer to website)

Foundation Design/Soil Mechanics

Topics

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

Objectives(refer to website)

Technical Writing

Topics

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

Objectives(refer to website)

Figure 2