# Resolution of Deficiencies in Engineering Education

*By Kevin Dong, P.E., S.E.*

In 2002, practitioners and educators prepared a curriculum that would benefit practicing structural engineers and students desiring to practice. Unfortunately, there remains today a lack of uniformity in the application of this curriculum in schools of higher education. The curriculum can be viewed at STRUCTURE magazine's website (**www.STRUCTUREmag.org**) on the Education pages. There are a large number of schools under pressure to graduate students without exposing them to all of the core building materials – structural steel, reinforced concrete, timber and masonry. This represents a major omission in which a well-rounded engineer should be familiar with to be attractive to a wider employment spectrum.

Often, graduates do not fully realize the deficiency in their education until the employment interview. The long process of assisting schools and stakeholders in the quest for appropriate courses continues. In the meantime, the Basic Education Committee of NCSEA has prepared a curriculum for four of the core courses called "Resolution of Deficiencies." The intent is to provide a topic-driven curriculum for self-education.

Somewhere along the education path, most students heard an instructor say something like this: "School will not teach you everything, but it will teach you how to find it." This article is the first in a three-part series that will present one instructor's idea for the minimum course content that structural engineers should have under their belts. In a complementary effort, The Citadel Professor Timothy Mays is preparing a text for both classroom instruction and self-teaching.

The first in the series is **STRUCTURAL STEEL**.

Steel Design Course Content

- Gravity-load-resisting systems
  - Tension elements
    - Tension on gross area versus net area
  - Column design
    - Buckling about minor or major axis
    - Unbraced length
  - Beam design
    - Limit states
    - Lateral-torsional buckling and unbraced length
    - Shear design
    - Deflection and serviceability limits
  - Beam-column elements
    - Combined stresses
    - Second-order effects and simplified methods per AISC Chapter B
  - Basic connection principles
    - Net shear, block shear, bolt types, bolt capacities in shear and tension, weld types and cost, weld capacities
- Lateral-load-resisting systems
  - Failure mechanisms and required detailing for special concentric braced frames (SCBF) and special moment frames (SMF)
  - SCBF
    - Statics and basic member sizing
    - Unbalanced load condition
    - Amplified loads per ASCE 7
    - Computer modeling to "match" proposed detailing
  - SMF
    - Portal method and assumptions inherent with this approximate method.
    - Rotational restraint at foundation/base level
    - Strong column–weak beam concept
    - Reduced Beam Section design philosophy, methodology, and history
    - Designing for drift versus strength
- Construction Documentation
  - General notes
    - Relation to project specifications
    - Content and purpose of general note sheets
  - Framing plans and "industry standards" for notation
    - Line weights, dimensioning, text work
    - Information required to build; such as openings, dimensioning, and miscellaneous metal pieces
  - Frame elevations
    - Moment frames – detail references and considerations for splice locations, doubler plates, base plates, and reduced beam sections
  - Detailing
    - Load path and detailing for typical gravity connections: beam to beam, beam to column
    - Load path and detailing for moment connections: beam to column web, beam to column flange
    - Relationship of detailing to constructability, construction sequencing, and construction tolerances
    - The bread and butter of the industry, but again, academia does not adequately cover this topic and this is integral to design and ultimately building performance
- Elective Topics – not necessary to achieve the goal of lifelong learning, but helpful to integrate into practice
  - Composite steel design
  - Eccentrically braced frame design and detailing
  - Buckling restrained braced frame design and detailing
  - High-rise construction – systems and behavior
  - Beams with holes – unreinforced and reinforced
  - Base plate and anchor bolt design considering prying action
  - Detailing – preferred slab depression locations and metal deck support, beam to hollow steel section connections, and moment connections with different top of steel elevations

Do experienced practitioners view the approach of creating partial curriculum programs – in particular, the steel design example presented – as a way to bridge educational deficiencies for graduates without the core program? Your comments are needed.

If this is a valid option, then topics, teaching modules, and learning objectives will be needed for most of the nine courses of the full curriculum of Basic Education for Structural Engineers. University of Massachusetts Professor Scott Civjan, under sponsorship of AISC, has prepared a teaching module for structural steel, which can be accessed at **www.aisc.org/content.aspx?id=24858**. Professor Civjan (**civjan@ecs.umass.edu**) would enjoy receiving your comments, as well.▪

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