structural forum

Real World Problem Solving

Preventing Undergraduate Structural Drawing Illiteracy

By Major Craig Quadrato, PE

Many undergraduate structural engineering programs are not properly equipping their graduates to adequately communicate their designs through structural drawings. This valid criticism has been raised in many professional publications, by professional members of our faculty advisory board, and I have personally witnessed this shortcoming in my own career as a professional engineer, educator, and Army officer. Though it is difficult to balance the requirements of a well rounded general education with the technical rigors of an undergraduate civil engineering degree, there is one step that any structural analysis or design instructor can take to help alleviate structural drawing illiteracy.

"I have had great success in using structural drawings as the basis for homework problems."

In my structural steel design course at the United States Military Academy, I have had great success in using structural drawings as the basis for homework problems. This has helped my students understand how to read structural drawings and prepare their own CAD drawings, without having to dramatically revamp course scheduling or add lessons at the expense of other topics.

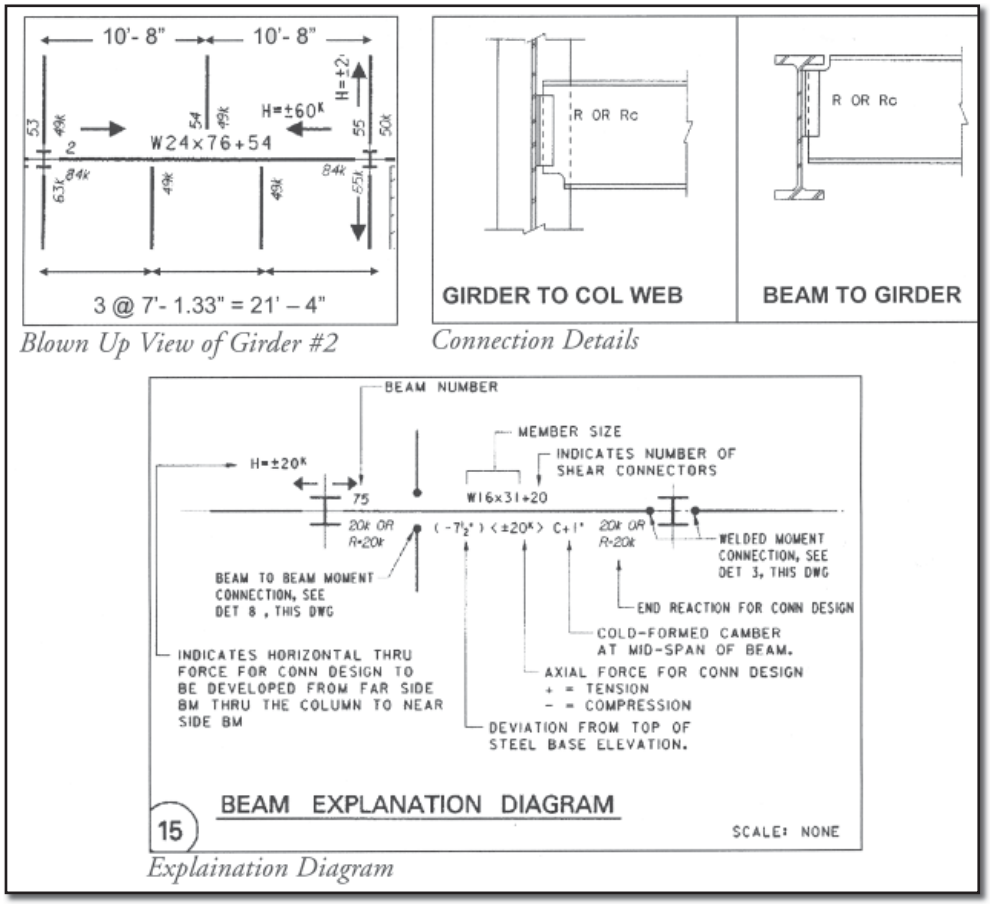
"…craft problem statements that incorporate and require students to use existing structural drawings."

Before the widespread use of CAD drawings, giving students access to structural drawings was limited. But now, with electronic versions of working drawings and the ease with which they can be reproduced and disseminated via hardcopy or electronic methods, the use of structural drawings in routine homework is no longer logistically difficult. All that remains is for instructors to craft problem statements that incorporate and require students to use existing structural drawings. Instead of assigning text book problems (which are primarily narrative and use non-standard graphics) or problems using graphics I create, my homework problems use plans, elevations, details, and notes extracted from a real set of structural drawings. These problems make students responsible for finding the necessary geometry, loads, support conditions, and other parameters required for solving design and analysis problems. This allows my students to familiarize themselves with structural drawings without adding lessons to our curriculum. See *Figure 1* for a typical problem.

The problem statement in *Figure 1* is given early in the year, so it uses focused drawing extracts and is crafted to help the student read and interpret plans, sections, elevations, notes, and details. As the year progresses, my problem statements require students to extract information from full sheets of structural drawings and interpret engineering parameters (such as bracing or end conditions) on their own. This gradual increase in difficulty sequentially builds their ability to interpret structural drawings and, during their capstone design the following semester, create their own CAD drawings. *Figure 2* shows a problem statement given later in the year that builds on previously learned structural drawing reading skills (along with the problem statement below, students are given access to working drawings referenced via the course website).

"…extract information from full sheets of structural drawings and interpret engineering parameters…"

Integrating structural drawings into an existing curriculum is not easy work. It takes time to establish meaningful and clear



Blown Up View of Girder #2

Connection Details

Explaination Diagram

Figure 1

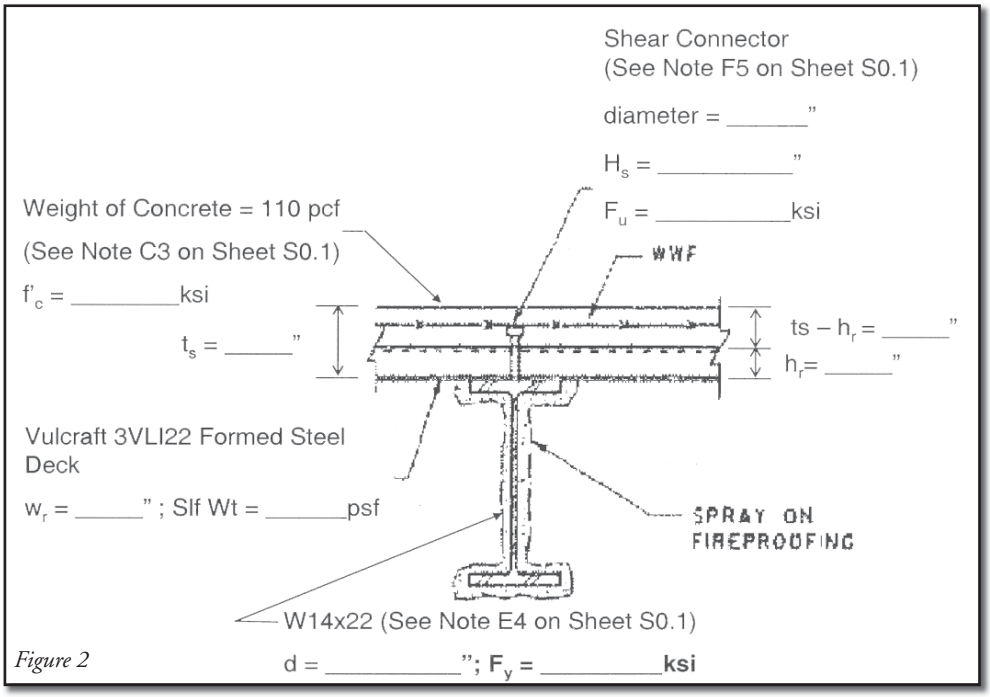


Figure 2

homework assignments by culling through working drawings to find the right part of a structure to teach targeted concepts. It takes time to appropriately sequence homework so that the students' ability to interpret the complexity of a full set of structural drawings is grown rather than expected with no or limited experience. But I have found that the return has been worth the investment.

> *"…the relevance of in-class work to professional practice…"*

I have seen the return via an increased quality of student prepared CAD drawings and in student understanding of structural drawings in other projects. This is evident when students brief faculty and clients on their capstone designs and independent study projects. Additionally, and perhaps most importantly, using structural drawings has shown my students the relevance of in-class work to professional practice, and the importance of using structural drawings to effectively communicate structural designs. My student course survey validates these results. Of 27 respondents last semester, no student had negative feelings about using structural drawings. Furthermore, 78% of my students preferred using structural drawings rather than non-standard drawings. My students have been very receptive to using structural drawings because they too understand the importance of effectively communicating structural designs, and using "real-world" products makes them more confident that what they are learning in class will apply to engineering practice after graduation.

As a licensed engineer and member of ASCE, I am charged to "provide opportunities for the professional development of those

> *"…a new dimension of professional development…"*

engineers under [my] supervision" (ASCE Code of Ethics Fundamental Cannon #7). Using structural drawings in my homework problems has added a new dimension of professional development to my student's education, and helps avoid structural drawing illiteracy. While using structural drawings in homework does not take the place of formal drafting training, it does help students understand how to read structural drawings and prepares them to create their own CAD drawings. Such an integration of classroom requirements, technology, and professional products efficiently teaches students the essential elements of the body of knowledge and will help them on their journey towards professional licensure. ■

Major Craig Quadrato is an Associate Professor at the United States Military Academy at West Point, New York.