Quality Assurance for Structural Engineers: Are We Where We Should Be?

Quality assurance is a critical ingredient in the structural engineering process, but are we giving it the attention it deserves?

BY DAVID I. RUBY, P.E., S.E.

IN THE STRUCTURAL ENGINEERING PROFESSION, WE ARE ALL CONCERNED WITH QUALITY ASSURANCE—IT IS A CRITICAL INGREDIENT IN HOW WE WORK. We have focused numerous efforts over the past decades on improving the quality of our products—Total Quality Management (TQM), ISO 9000, and the CASE RMP are only the most recent sweeping initiatives that have been used to evaluate each piece of our work process and to improve our engineering product.

But are we where we should be? How do we measure the true quality of our work? Owner satisfaction? Delivery schedule? Project budget met?

I would argue that the structural engineering profession has fallen short of achieving the quality it should be producing and for one primary reason: we have taken our eye off of the ball—or maybe we are playing in the wrong game all together!

Traditional Thinking About Quality Assurance

Documents—drawings and specifications—are the tools that we use to communicate the elements of the design of structures to contractors. They are the product of our expertise, our experience, and our innovation as structural engineers.

Even still, we are getting undesirable results from many of our construction documents. More often than we would like, our documents are providing the opportunity for shrewd contractors to "low ball" a project because important details are not provided. They defer to what is "customary" to them, while their more conscientious counterparts build in the extra cost for doing what they know is needed on the project and price themselves out of the competition. The result? We are forced to select the "low ball" bid and suffer the consequences: budget and schedule overruns, disappointed owners, and a potential risk to the safety of building occupants and the public.

Integrating Engineering, Architecture, and Construction

The root cause of our problems in producing "complete" documents lays in communication. Structural engineers and architects must communicate effectively to produce documents that enable the contractor to develop a competitive bid. Poorly prepared contract documents equal poor contractor selections. Where do we often get tripped up?

Timing. When architects do not provide necessary information in a timely manner, the structural engineer must prepare the documents in a compressed time frame, which results in the issuance of poorly checked or coordinated documents. Having become accustomed to the fact that the architect has traditionally been late with the necessary information, the structural engineer prepares the drawings based on the information provided and deflects any criticism toward the architect.

> For construction drawings, the contractor is our ultimate client, no matter who pays our invoices.

The structural engineer must become proactive within the design process, provide an outline of necessary information for quality documents with required dates, explain the cost and schedule impact of late or incomplete information, provide guidance in structural and fascia system selection, and above all else learn to speak architecture. The structural engineer of record should attempt to develop details that are adaptable to changes; details that the contractor can accurately price but that also can enable minor changes without major cost impact.

Computerization of design. Please do not rely on the computer to design your structure. Use it as a tool for analysis and design alternative development, but reserve the final design decisions to an experienced structural engineer. The computer sees the structural members as lines spanning from point to point. Those lines represent a variety of members from 6" to 40" or more deep, all with unique connection constraints. Do not assign critical connection decisions to the computer or to the fabricator. Consider the impact of through-forces, review the geometry and connection requirements, generate layouts of the connections, and provide complete connection design, including column

David I. Ruby is a principal of Ruby and Associates, P.C., in Farmington Hills, Mich.

web stiffeners and doubler plates.

In my experience, there are several areas that are consistently overlooked:

- Identification of the lateral load resisting system and connecting diaphragm elements;
- Identification of the installation schedule for non-structural steel elements of the lateral-load resisting and connecting diaphragm;
- Special erection conditions or other considerations that are required by the design concept.

And these situations frequently occur:

- Fabrication procedures and tolerances governing the shop cambering of beams and girders are misunderstood;
- Camber is misused to establish final elevations of structural framing;
- Expectations of the in-place geometry of a cambered beam or girder are misplaced; and
- Connection design criteria are incomplete, inaccurate, or impractical.

More often than we would like, our documents are providing the opportunity for shrewd contractors to "low ball" a project because important details are not provided.

As structural engineers, we must clearly understand and stay focused on the reason we create construction documents: to enable the contractor to develop a competitive proposal, and then, upon award, to deliver the project in a manner consistent with their understanding of the scope of the contract documents at the time of bidding. We want to create a level playing field where the best competitor wins. To do this, we need to provide a complete scope of work—from the contractor's viewpoint. No amount of checking calculations or tweaking the design process will produce quality documents if we do not reorient ourselves from an engineering perspective to the contractor's perspective—they are the ultimate clients, regardless of who pays the invoices.