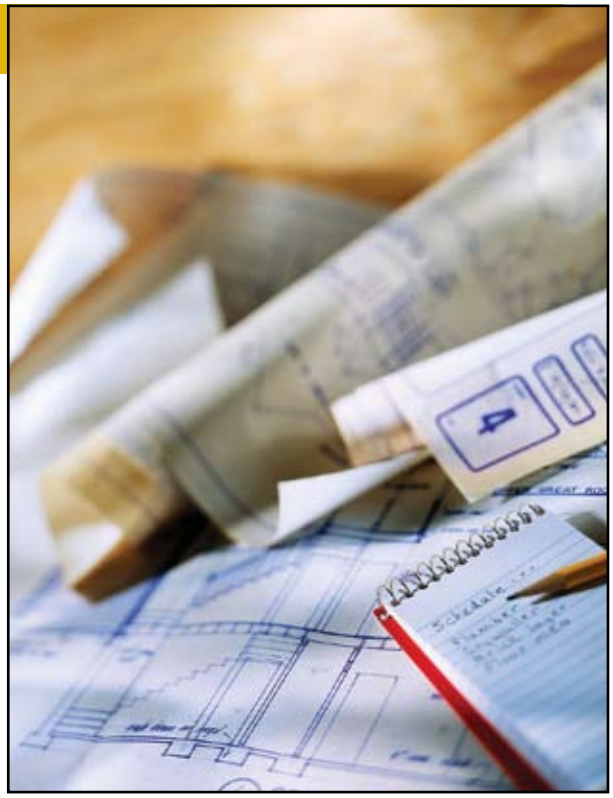
Quality in Engineering Documents

By Wesley G. Britson, P.E., S.E.



In the past several years there have been a number of articles in engineering publications – including STRUCTURE® magazine, expressing an opinion that the quality of Structural Engineering Documents (SED) has been decreasing. I suspect that the average Structural Engineer of Record (SER) has generally ignored criticism of our profession in hopes that it would go away. Well, now that I qualify for an AARP card and am officially a curmudgeon, I would like to express my very wordy opinion on this issue. Ultimately, the only important thing to me is the perception of our profession.

The perceived quality of the SED on any specific project will vary greatly, since each SER will perform each aspect of the project differently and under a different set of circumstances. True, elements shown on the SED are different than they were thirty years ago. On a recent "prototype" building, I counted as few as four structural sheets by another firm and as many as thirteen by our firm for essentially the same building. I will not say who is correct, but one could be construed to be more complete than the other. I also do not know under what circumstances the plans were produced in the case of the four-drawing set. Perhaps the owner or contractor was providing the information that was not shown on the drawings, or the plans were not to be as detailed due to an agreement.

"Thirty years ago, a three- or four-week shop drawing review time was acceptable."

Has the quality of SED really gone down? I have spoken with many material suppliers, engineered product suppliers, sub-contractors, general contractors, or architects, and they generally believe that the answer is YES. However, I have asked many SERs, and they generally believe that it is mostly just a few bad apples and answer NO. Why the great difference? I personally doubt that there will ever be a consensus on this issue.

In the past thirty years, a lot has changed in our profession and current expectations are certainly different than thirty years ago. I think we need to explore the forces that have contributed to the changes that we, as structural engineers, now face. Some of the changes are as follows:

Clients Have Changed

Thirty years ago, most of our clients were architects. It is now not uncommon for owners or contractors to broker the design directly to each discipline. This results in the elimination of a prime professional in charge of the project and the associated coordination. This new client often views the engineer's value as a "stamp" that must be "bought" in order to get a building permit and presents no added value but drives the cost of construction up. Some clients often ask for reduced fees, partially complete plans, and anything else that would cut their costs.

Projects Must be Done Much Faster Now Than in the Past

This is a direct result of the hyper-inflation of the seventies. During this period the cost of borrowing for construction loans exceeded twenty percent, a construction loan was taken out prior to producing the SED, and the debt service during the design phase was more than the entire design fee. Hence, time was much more valuable than the design. This resulted in the design team being forced to meet very demanding schedules. When the inflation rates returned to normal levels, the owners continued to compress the design time even though the cost savings were not as much as before.

Contractors Have Lower Profit Margins and Tighter Schedules

Often contractors can only make money if they are able to reduce overhead by completing projects early. This results in the need for contractors to pressure the design team into shorter review times. Thirty years ago, a three- or four-week shop drawing review time was acceptable. Today, if the SER does not get a call from the contractor requesting a review time of less than two weeks, you might begin to wonder if the contractor is even working on the project. The Request For Information (RFI) came out of this quest for speed, to document modifications and the time it took to respond to questions. Many contractors now routinely fabricate structural members on

Structural Forum is intended to stimulate thoughtful dialogue and debate among structural engineers and other participants in the design and construction process. Any opinions expressed in Structural Forum are those of the author(s) and do not necessarily reflect the views of NCSEA, CASE, SEI, C[3] Ink, or the STRUCTURE® magazine Editorial Board.

unapproved shop drawings in order to reduce schedules, and they accept a risk in doing so. Since there will be a risk taken, the detailer must reduce his risk by extensively using RFIs in lieu of the classical procedure of asking the questions on the shop drawings.

Material Suppliers are Being Forced to Reduce Costs and Delivery Times

This is very similar to what the contractors are faced with, but suppliers have much less control than the contractors in this regard. Engineered product specialty engineers working for material suppliers often, in our experience, do not even see the SED for a project. The specialty engineers rely on non-professionals to interpret the SED and perform the structural calculations to be "sealed" by the specialty engineer after his "review". This can lead to many errors in the interpretation of the plans. It also puts an added burden on the SER to check the calculations very thoroughly, since the SER may not be able to depend on the specialty engineer to have interpreted the SED correctly.

Substitutions are Commonplace

This often results in errors blamed on SED when, and/or if, the "new equipment" no longer fits in the intended place, needs to be relocated, or needs additional support. In my experience, the schedule does not provide enough time to select the mechanical and electrical equipment prior to fabricating the structural elements, thus eliminating the possibility of coordinating any changes. Problems may occur if a contractor does not check that changes made in equipment purchases during the "buy out" of the project fit within the original space allocated.

Engineering Fees are Lower as a Percentage of Construction

There used to be a look-up table published by engineering societies that was used to determine fees. The federal government determined that this was a way to fix pricing and sued the engineering societies, who had developed the tables, to stop the practice. Many of the older generation, me included, remember the good old days when the fee was fair and the selection was on merit. More often than not, the selection is now based on fee, unethical but often the case, or on a perceived fee based on experience with a different SER. In either case, fee often has become a determining factor for selection and has created pressure to reduce scope of services to be more competitive.

Building Codes are More Complex

This can easily be seen by just looking at the size of the volume. The big changes have been in seismic design and detailing, wind loads, and LRFD in steel. I estimate that the actual calculation time required to design the structure has increased approximately fifty percent. Unfortunately, the drafting costs have remained at about the same level, even with computer-assisted drafting. The result is that profits have decreased significantly over the years.

Computer Aided Design and Drafting (CADD) is the Norm

I remember being told that CADD was going to revolutionize how we design buildings and we would no longer need paper. Though CADD has matured, due to liability issues, paper is still the legal document even though the drawings are produced on computers. CADD has allowed changes to, and the production of drawings to occur more rapidly. Unfortunately, changes are now using up all of the potential savings the SER might have gained. Prior to CADD, everyone in the design process had a vested interest in planning the project and reducing the changes. Now, since CADD allows changes to be made quickly, designers have fallen into a habit of issuing changes until the project goes out. Making these last-minute changes often results in poor coordination that must be resolved during construction, and often causes conflicts.

"Many of the older generation, me included, remember the good old days when the fee was fair and the selection was on merit."

Staff Shortages are Increasingly Common

An engineering firm can hire an intern engineer out of school, but the compressed schedules do not allow time for a long learning curve. Thus, the pressure is to hire fewer new graduates and more veteran engineers with experience. I do believe that as we "boomers" retire, there will be true changes in our profession. A significant shortage of experienced engineers may put additional pressure on owners to use "off-shore" engineering firms.

Litigation has Significantly Increased

No one is exempt, and any firm with assets or an insurance policy is a target. What is the SER to do? The typical answer is to close each newly discovered loophole on the plans. The following is a good example that happened to our firm several years ago. A contractor decided that instead of placing a large electrical duct bank down the center of a room, as shown on the electrical plans, and branching into the switchgear, he would replace one duct bank with two and place them directly under load bearing wall foundations. Then the plan was to have the ducts turn up into the switchgear by penetrating the footing. When this change was discovered during a field observation, the contractor asked for a change order, since nowhere in the plans did we say that he could not do this and the electrical plans are schematic. I contend that thirty years ago, we all would have had a good laugh and would have never included details and/or notes on the plans Today, unfortunately, on many

Wesley G. Britson, P.E., S.E. has practiced structural engineering for over 32 years and is currently the manager of structural engineering for Professional Engineering Consultants, P.A. in Wichita, Kansas. He can be reached at **wes.britson@pec1.com**.

projects we include a detail that shows what is required if the contractor decides to reroute the duct banks under footings.

Are the SED different than what they were thirty years ago? Certainly they are different. Are they worse than thirty years ago? Yes and no. My father told me that we put locks on the doors to keep the honest people honest, but that dishonest people will not be swayed by the lock anyway. Those of us that care about our profession will continue to produce quality projects, under demanding schedules, and strive to do so in an economical fashion. Others will continue to produce "discount work" at a "discount fee" for anyone who will engage them, resulting in more complaints about the poor quality of SED in general.

The solution is for all SER's to do the best that they can do within the context of their engagements. An article in the April 2006 issue of *Modern Steel Construction*, "Design!" by James M. Fisher, Ph.D, P.E., deals with good design, and is one that I believe all practicing engineers should read.

I believe that our profession has many challenges, but I also believe deeply that our young professionals will find this a rewarding profession. STRUCTURE® magazine provides a forum that helps our profession to achieve more by discussing issues facing each practicing engineer. We need to remember an old saying that one can produce a project with only two of the following three competing values: a very demanding schedule, thoroughly detailed and coordinated plans, or a highly economical structure.▪

CBI
250 Dorchester Avenue
Boston, Massachusetts 02127
T 617.268.8977 F 617.464.2971
cbiconsultinginc.com
- STRUCTURAL ENGINEERING - ARCHITECTURE
- ROOFING - MOISTURE MITIGATION DESIGN
- HISTORICAL RESTORATION - CONDITION SURVEYS
- BUILDING ENVELOPE FORENSICS
CBI CONSULTING INC.

ADVERTISEMENT
For Advertiser Information, visit www.STRUCTUREmag.org

GT STRUDL
Structural Analysis & Design Software
Results You Can Trust
Georgia Tech - CASE Center
Phone: 404-894-2260
Email: casec@ce.gatech.edu
www.gtstrudl.gatech.edu

ADVERTISEMENT – For Advertiser Information, visit www.STRUCTUREmag.org