Achieving Economy Through Investing in Detailing

BY KERRI S. OLSEN

A good design's constructability hinges on the work of experienced and competent steel detailers.

EVERY STEEL FRAMED PROJECT requires the work of a steel detailer. Steel detailers are the craftsmen who transform the information found in the contract documents into drawings from which the steel fabrication shop can build. In addition to the shop detail drawings, the steel detailer creates the erection drawings that show where all the parts and pieces go for the steel erector who puts it all together in the field. The knowledge required for the steel detailer to perform these tasks correctly takes years of working practice to acquire.

As the computer age has progressed, the introduction and advancement of what are called steel modeling programs have made the work of drawing the pictures easier for the steel detailer. These programs allow the user to set up a computer model of the building with dimensions, elevations, steel member sizes and locations. The modeling program then does the rest of the work. This process of detailing steel using a modeling program saves the detailer a lot of labor in drawing the individual pictures, though the detailer still needs to format and edit the pictures of the parts according to industry standards.

When such a modeling program is used correctly, the result is accurate shop detail and erection drawings. If the information given by the model is incorrectly shown on the drawings, the result is virtual garbage—even if the dimensions are correct.

Experienced steel detailers understand how these drawings will be used by the steel fabricator, the steel erector, the general contractor and the designer. They have learned the requirements for specific presentation of the steel according to industry standards that make the drawings usable. Drawings that do not conform to industry standards cause difficulty for the designer, slow down the approval review and create scheduling issues with the general contractor and his subcontractors. If the details are not shown as expected by the fabricator and erector, the steel is likely to be fabricated incorrectly, causing fit-up problems in the field.

To avoid such difficulties, reputable steel detailing firms have a detailing checker to review the completed drawings for compliance with the contract documents and for workability on behalf of the fabricator and field erector prior to releasing the drawings for approval to the designer. Some lesser experienced detailing firms do not perform the additional check, believing that it is unnecessary if they have used a modeling program in the performance of their work. Eliminating a final check of the drawings allows them to offer lower prices and, presumably, get more work.

However, this "economy" in purchasing steel detail drawings almost always translates into extra work for all the other trades down the line, an expense that is impossible to quantify. But it is an expense that would be avoided if the drawings were checked for industry standards during the approval process.

Consider a project that was subcontracted to a steel detailing firm that was long on software and short on experience. Steel fabricators were very busy at the time and most steel detailing firms were unable to take on additional work without overtime premium costs. The fabricator was approached by an offshore steel detailing company offering to take on the job immediately at 10% of the current market value.

The fabricator had no prior experience working with this detailer, but was assured that because the detailer would use a computer modeling program, the detailing would be completed accurately and in a timely manner. It was a very attractive offer and the fabricator agreed to it.

The fabricator had many years experience in fabrication, but was naïve with regard to detailing. In addition to deciding that a cut-rate detailer using a modeling program was the answer to its budget and scheduling woes, the fabricator assumed high quality and accuracy in the drawings without reviewing them prior to submitting the drawings for approval. The fabricator believed that, once approved by the general contractor and the designer, the shop drawings would be perfect and ready for fabrication.

The ramifications of what the steel fabricator thought was a "good buy" in steel detailing quickly resulted in a train wreck of a project. Problems surfaced as soon as the fabricator began submitting the shop detail and erection drawings for approval. They were incomplete and inaccurate, in addition to being amateurish and almost impossible to follow. The steel had been drawn reading from right to left, backwards compared to standard practice. Beams were detailed at the wrong length and columns at the wrong height. The roof placement plan in this single-story building bore no dimensions; there were no column marks, no shear tab marks on the columns and beams, and the location of the piece marks made them unusable for the erector.

Clearly the detailing employees who edited the shop drawings had little knowledge about how the pertinent information should be shown for the steel fabricator and the steel erector. Completely ignoring the maxim "garbage in, garbage out," the firm was trying to use the computer modeling program to replace experienced steel detailers who know how to show the correct information.

Holes were slotted and new connections were fabricated. Beams were shortened or lengthened. The erection schedule fell months behind.

Fabrication errors and the resulting problematic steel erection created scheduling delays. The general contactor released the original steel fabricator from its contract and engaged a different steel fabricator to finish the work. The new fabricator quickly determined that the model created by the original fabricator's steel detailer was not usable and had the steel re-detailed by a different detailer.

The Root of the Problem

The original steel fabricator was headed for trouble when the detailing was subcontracted to an unknown firm based on a low price without verifying work experience and quality. That bad decision affected the outcome of the entire project. Every trade on this job after the steel was installed was affected by the scheduling delays.

What is the best solution to prevent problem projects like this? To find the answer, we need to first find the root cause of the problem. Let's go back to the beginning.

Review these two pictures. Figure 1 is a structural drawing foundation plan and Figure 2 is an architectural drawing foundation plan. Both show the same location and elevation for a particular building.

The first order of business for the steel detailer is to locate the building column centerlines in order to provide an accurate anchor bolt plan. To be able to complete this task, the detailer requires dimensions to the centerline of the columns, which would mean reviewing the architectural drawings and the structural drawings together to obtain an understanding of the building about to be drawn.

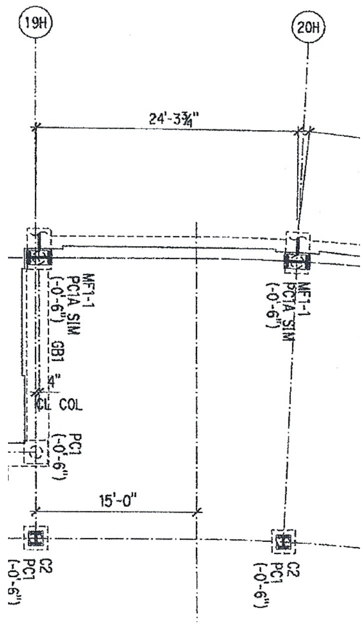

Fig. 1: A portion of the structural foundation plan.

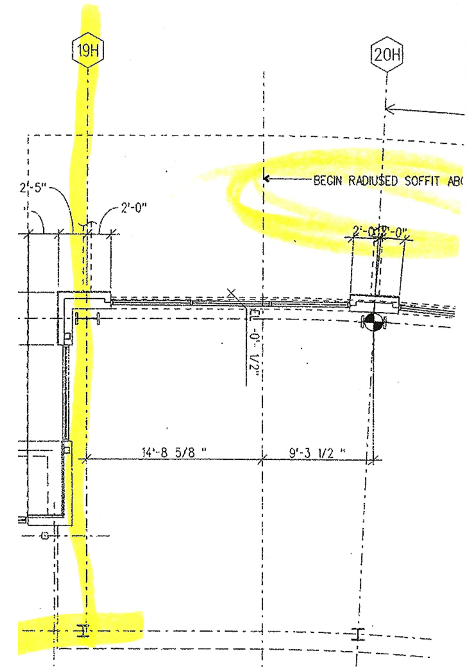

Fig. 2: A portion of the architectural foundation plan.

In Figures 1 and 2 between the grids 19H and 20H, key dimensions are missing and what is shown is difficult to interpret. Given these drawings, an experienced detailer would have sent a request for information (RFI) to the steel fabricator to establish the correct dimensions to be used to locate the centerline of the columns in this area, and then waited for the answer before continuing.

The original steel detailer for this project assumed some dimensions, completed the anchor bolt plan and sent it out for approval, expecting that if the assumption was not correct, the drawings would be marked up by the approvers with the correct information. But the drawings came back from approval without the expected verification.

This was a fast-track project—what project these days is not?—so the steel detailer continued on with the shop drawings, circling the dimensions in question and again asking for verification, but the returned approval drawings did not provide them. Why was this request for verification on the shop drawings not addressed?

The steel detailer did not understand that it is not the designers' responsibility to verify the dimensions on the steel shop drawings. The designers are required to provide dimensions for the presentation of the building they have designed. The dimensions shown on the steel shop drawings by the steel detailer are for trade-specific needs. Designers understand that the dimensions shown on the steel shop drawings are there for different reasons than those covered in their area of expertise. Therefore, the designers cannot assume that the dimen-

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sions the steel detailer is using are accurate with what the contract drawings show. This is why RFIs are used: to get the correct answers. If something is unclear—or if information is clearly conflicting—the steel detailer must submit an RFI, or be held responsible for the fabricated steel not fitting.

Had an RFI been sent for verification of dimensions shown on Figures 1 and 2 prior to developing the anchor bolt plans, it would have created the opportunity for a whole different outcome on this project. As it was, the general contractor's drawing approval made the GC liable for the shortcomings of the original fabricator and detailer. Having been left unchecked so far into the project, the resulting discrepancies in design drawing dimensions became the GC's burden.

The real problem is that everyone involved was trying to do the work too fast. The steel fabricator, who probably never knew what their shop drawings looked like until they were in fabrication, had allowed the steel detailer to ask questions on the approval submittal drawings. The architect and engineer approved steel shop drawings that were of questionable quality. The general contractor, working hard to keep the project on schedule, probably did not realize how bad the steel drawings were until the people in the field tried to use them. Everyone was at fault here, working hard to get the job done and rushing it through, with no one working to make sure it was, in all ways, correct.

The best solution to problems like these is to prevent them, and that can be done by having someone with a working knowledge of standard industry practices review the contract drawings prior to their release for bid. Of course, that raises the question of what is meant by "working knowledge."

A working knowledge of the drawings is the ability to read the design drawings and to interpret that information into what the steel detailers and steel fabricators need to know to be able to do their jobs adequately. When a review is performed by someone who has a working knowledge of the design drawings and the capacity of interpretation required to create the shop detail drawings, the gap between the designer's intent and the steel shop drawings can be bridged at the design level.

Most projects can be reviewed for such issues in a short period of time, and that investment would prevent many problems from developing. The need for addenda, RFIs and change orders would be minimized; in some cases they may be eliminated. The savings in cost and time on behalf of the architects and engineers would be unquantifiable.

Projects in process also can benefit by an independent check of the shop detail drawings by someone with such a working knowledge of the drawings during the approval, on behalf of the designer or the general contractor. These types of reviews may take more time, given the quantity of shop drawings to review together with the contract drawings, but can save much in scheduling by detecting errors at this earlier stage.

Had such a review been done on the project described in the example, many—and perhaps all—of the problems that arose could have been avoided. Workability reviews prevent projects from turning into cost accounting and scheduling nightmares, at least as far as steel fabrication and erection are concerned.

It is the quality of the work all parties do for a project that determines the productivity and efficiency of getting a building built. Low price should not be the only deciding factor in choosing contractors and subcontractors. Rather, sufficient and appropriate resources should be dedicated to those activities upon which accuracy and speed, and therefore efficiency, rely. MSC

There Is a Right Way to Do Things

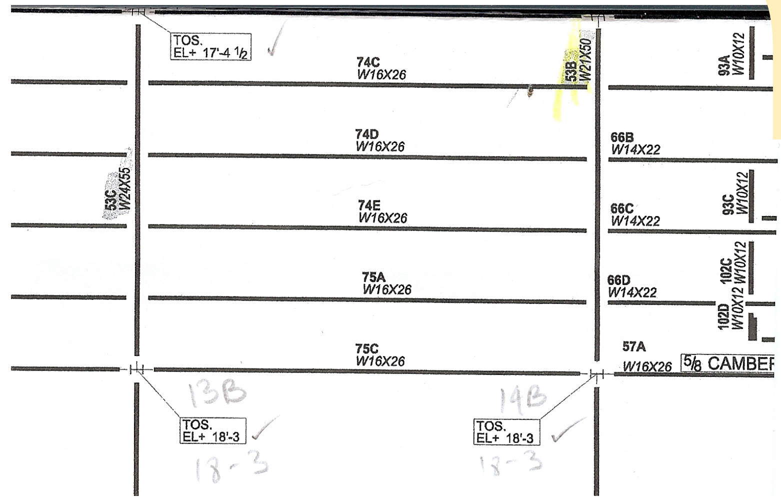
Using standard conventions on design drawings, shop drawings and details makes everyone's life easier. When conventions are ignored in steel detailing, it introduces uncertainty and creates confusion for those using the drawings at all stages of construction, including designers, fabricators, erectors, and inspectors.

Guidelines and standard industry practices have for years been documented in AISC's *Detailing for Steel Construction* (available for purchase at **www.aisc.org/manual**). A statement on page 1 points out the detailer's critical role. "The steel detailer translates design data into information that the fabricator and erector need to actually build the structure." Clearly, the quality of steel detailing on a project affects all parties involved.

For example, the guidelines in Chapter 6 of *Detailing for Steel Construction* include this common sense industry standard: "Erection drawings should be complete enough for the erector to assemble the structure without undue pondering or calls for assistance." On the project discussed in this article, this was completely ignored. Here are some examples of that.

Industry practice dictates that the left hand end of the beam is the erection end of the beam, which is what establishes consistency with steel detailing, steel fabrication and steel erection. Everything works from left to right, the same way as we read. Typically when shown in an elevation view, the erection end of the beam is where the piece mark would go on the part, which tells the field erector the correct orientation.

The erector matches the piece marked end of the beam with the location of that same piece mark shown at the placement plan, thus assuming proper installation without needing to refer to any other drawings.



A portion of the roof framing plan.

The roof plan for this project shows the beam piece marks, but because they are in the center of the span, they do not indicate orientation. Because there are no column marks on the roof plan, one must go to the floor plan to determine which columns the beam frames into. We find beam 75C is to be placed between columns 13B on the left (west) and 14B on the right (east).

Detailing standards dictate that when showing an elevation view, the left hand end of the beam would go to the column on the left at the placement plan, or in this case, the roof plan. Beam 75C shows the piece mark on the left hand end of the beam, which indicates to the erector that the left hand end of the beam would go to the left column (13B) on the placement plan. However, there also is a small triangle, called a delta, at the right hand end of beam 75C. This delta is an old marking indicator used to denote the erection end or left hand end of the beam, which makes this drawing completely ambiguous.

To determine which end is supposed to attach to which column, the erector could consult the shop details for the columns and verify the location of the holes. That would show that the beam had to be turned 180° from the way it was shown on the drawing. The left end on the drawing should go to the right hand column (14B) in the placement plan. Though the dimensions are not off by much, the accumulation of small discrepancies adds up quickly, causing the columns not to be plumb and the erector to ream holes in order to make beams fit. Intermediate framing members would also end up misplaced.

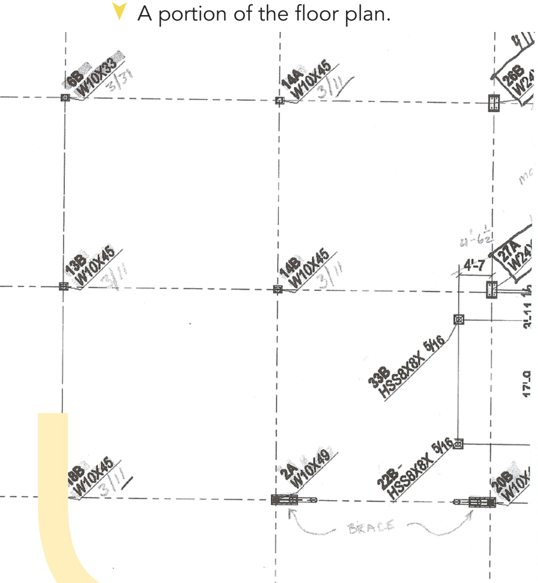
Although this example shows one small discrepancy, the cumulative effect of having to deal with this type of confusion on beam after beam can grow to be significant. And on this project, it did.

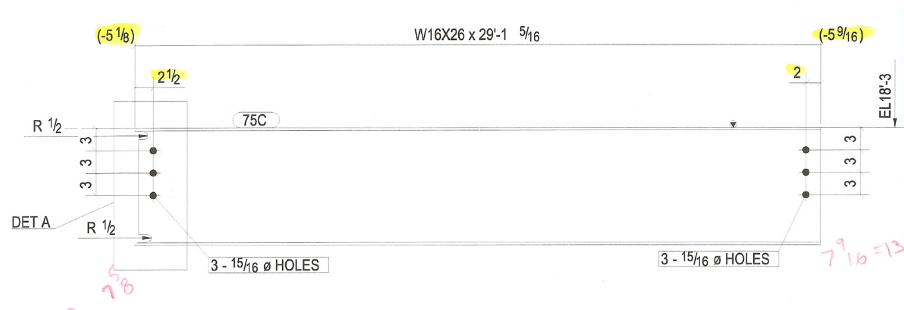
Additional non-standard items to note on these drawings include:

- An absence of shear tab marks.
- A camber note on the erection drawing rather than the shop detail drawing.

The drawings were also filled with dimensional inconsistencies, both in elevation and plan views. Taken in combination with the rest of the non-standard detailing, this drawing package certainly falls short of not requiring "undue pondering or calls for assistance."

A portion of the floor plan.





The shop drawing for beam 75C.