

# **SUGGESTIONS FOR IMPROVING THE STRUCTURAL STEEL SHOP DRAWING PROCESS**

SEAC/ RMSCA Steel Liaison Committee

December 16, 2006

## **Disclaimer**

SEAC, RMSCA, nor its committees, writers, editors and individuals who have contributed to this publication make any warranty, expressed or implied, or assume any legal liability or responsibility for the use, application of, and/or reference to opinions, findings, conclusions, or recommendations included in this document.

This document does not replace and is not to be used as an adjunct to the current edition of the American Institute of Steel Construction (AISC) “Code of Standard Practice for Steel Buildings and Bridges” or Case document 962D.

The following is a discussion of the current status of the process of preparing structural steel shop drawings.

This paper was prepared by the SEAC/ RMSCA Steel Liaison Committee, a coalition of Front Range Fabricators, Detailers, Erectors and Structural Engineers (EOR) dedicated to improving the steel construction industry. The intent of this paper is to propose suggestions for improving the structural steel shop drawing process. The process of preparing shop drawings has become the most time consuming and unpredictable part of the fabrication process.

## **Participating Members of the Committee**

Jim Edwards, Quality Steel Services, Inc.  
Dave Henley, P.E., Vulcraft  
Richard Huddleston, Zimkor LLC  
Robert Leberer, P.E., Anderson & Hastings Consulting Engineers, Inc.  
Curtis Mayes, P.E., LPR Construction Co.  
Nick Miller, LPR Construction Co.  
Eric Moe, P.E., Puma Steel  
Dave Schroeder, P.E., Mortenson  
Tom Skinner, P.E., JVA Consulting Structural Engineers  
Maynard Trostel, P.E., Puma Steel  
Jules Van de Pas, P.E., S.E., Computerized Structural Design  
Bruce Wolfe, P.E., Structural Consultants, Inc.  
Bill Zimmerman, P.E., Zimkor LLC

- I. **PURPOSE** of Shop Drawings – Each participant has a different perspective regarding the use of shop drawings and a different responsibility in the process:
  - A. Fabricator – The transfer of information from the Contract Documents into accurate and complete shop and erection drawings and the development of accurate, detailed dimensional information to provide for the fit up of parts in the field. AISC – Code of Standard Practice for Steel Buildings and Bridges, March 18, 2005.
  - B. GC - To confirm that the system is in general conformance with the Contract Documents and the GC/ Sub-contractor agreement and to also coordinate with the other affected trades.
  - C. Erector – To develop the erection sequence of the steel frame, making sure the structure is safely and economically erectable.
  - D. EOR – To confirm that the structural steel system is in conformance with the intent of the structural design and the Contract Documents.
  - E. Architect – To review the shop drawings for general conformance with the Contract Documents.

## II. The Normal Shop Drawing **PROCESS**

The normal process is described in the following. However, standard practice within any Consultant or GC office can vary significantly. The process for any given project must be discussed and agreed upon. The normal shop drawing process is shown so that problems can be identified and solutions can be suggested.

- A. The GC makes the Contract Documents available to the Fabricator.
- B. The scope of the work is then discussed between the Fabricator and the GC and then a structural steel bid/ proposal is submitted by the Fabricator to the GC.
- C. The Fabricator and GC negotiate the contract. Once an arrangement is made, the Fabricator compares the bid/ pricing drawings to the final Contract Documents.
- D. Detailing is usually started immediately. Then the Fabricator, Erector and GC discuss the fabrication and erection sequence.

- E. When questions arise or conflicts are found during the preparation of the shop drawings, questions are asked via RFI's to determine direction.
- F. Multiple copies of the shop drawings are submitted to the GC. In order to help expedite the review turn-around time, a concurrent copy sometimes is sent to the EOR and/or Architect, with the GC's permission, to help expedite the process.
- G. The GC processes and reviews the shop drawings for accuracy and then passes them on to the Architect. In practice, the GC review is sometimes a cursory review that only verifies that the submittal actually relates to the scope of work.
- H. The Architect sends the shop drawings on to the EOR. In practice, the Architect often performs their review simultaneous with the EOR or after the EOR and adds his comments.
- I. The EOR reviews and makes comments on the shop drawings, keeps one set, and returns the remainder back to the Architect.
- J. The Architect reviews the shop drawings and then returns them to the GC.
- K. The GC reviews the shop drawing comments and then returns them to the Fabricator.
- L. The review process typically consists of reviewing parties taking various actions. These actions tell the Fabricator how to next proceed with the shop drawings. The typical actions indicated by the Architect or EOR are:
  - 1. No Exceptions Taken/ Approved
  - 2. Exceptions as Noted/ Approved as Noted
  - 3. Revise and Resubmit
  - 4. Rejected

The first two actions allow the Fabricator to proceed and fabricate the material without a re-submittal. The later two actions require a re-submittal.

- M. The Fabricator reviews all comments, contacts the appropriate party with questions and/or RFI's, and returns them to the detailer to complete and correct them for fabrication.
- N. The Detailer corrects the shop drawings and asks questions for clarification from the EOR, Architect, GC, Fabricator, or Erector, as needed.
- O. Drawings are released to the shop. Final "For Construction" copies are sent to the GC. The Erector is sometimes copied at this time.

- P. The “For Construction” shop drawings are sometimes not given to the field erection crew until the first delivery truck arrives at the job site.

III. **PROBLEMS** in preparing the shop drawings

A. Incomplete Contract Documents

1. Common concerns voiced by Fabricators
  - a. Dimensions do not close.
  - b. Structural components are not located in plan or in elevation.
  - c. Details are not complete or specific to the project.
  - d. Design Drawings and Specifications are in conflict.
  - e. Structural drawings are not thoroughly coordinated with Architectural or Mechanical drawings.
2. Opposing expectations in level of completion. The Fabricator/ Detailer expects every issue of a structural drawing to be 100% complete. However, drawings may be issued only for information due to accelerated schedules where EOR does not intend for these drawings to be considered as complete. Without complete Contract Documents, the Fabricator has a difficult time defining long lead items, sequencing, connection requirements or any other extraordinary issues.
3. Inconsistent industry guidelines for production of drawings
  - a. For shop drawings: AISC “Code of Standard Practice for Buildings and Bridges”, 3/18/05, 3.1.
  - b. For Design Drawings: SEAC “A Guide for Consulting Structural Engineering Services in Colorado”, 10/04, 4.G.1-4.
4. An increasing trend is for various electronic files of the Contract Documents such as pdf, tif or CAD to be sent to the Fabricator. While this is done to expedite delivery of the shop drawings, it is important to note that the actual printed documents are considered to be the Contract Documents.
5. Specifications may not be supplied with the bid drawings. When specifications are available, they often are not thoroughly coordinated with the Design Drawings.
6. There is a general misconception that the EOR knows the answers to all questions raised and has control over the issues involved. The Architect is responsible for control dimensions and elevations. Common problem areas are: (1) Geometry in plan and space (2) Stair dimensions (3) Canopies and entrances (4) Edge of slab or roof deck (5) Mechanical unit sizes, weights, locations and openings through the structure.
7. Often, RFI’s may result from questions. The timing of the shop drawing submittal can be delayed by this part of the process. Numerous RFI’s can be indicative of unclear or incomplete Contract Documents. Thus the time and possibly the cost required to prepare the shop drawings will likely increase.

## B. Poor Communications

1. The shop drawing submittal and review process is often unclearly specified. Because of this, the GC and/ or Architect decide on a project specific process. Different EOR offices have different practices with regard to the timeliness and completeness of their review methods.
2. The participants in the process (Detailer, Fabricator, GC, Architect, EOR) often do not communicate adequately. RFI's, while the typical vehicle used to clarify missing and conflicting information, are frustrating to all parties.
  - a. There can be multiple questions asked in a single RFI.
  - b. Unclear questions without a verbal discussion or sketches are a set up for misunderstanding and a delay in a response.
  - c. 3<sup>rd</sup> and 4<sup>th</sup> generation faxes are unreadable.
  - d. No solution is proposed.
  - e. References to problems are not clearly defined.
  - f. Sometimes an RFI requests a very short turn-around time for an answer, due to scheduling.
3. Construction Schedule is not clear
  - a. The construction schedule sometime changes and the affected parties are not informed. Unannounced changes in priorities present timing problems for the shop drawing submittal process.
  - b. The EOR may be out of the loop, not understanding or appreciating the milestones.
  - c. The Fabricator's schedule requirements are unknown to the other parties.
  - d. The reviewers have no idea how large the submittal packages will be, if multiple submittals will be provided or when they will arrive. When the EOR often requests a submittal schedule in the specifications, this schedule is seldom provided.

## C. Shop Drawing Review Comments – The review comments:

1. Can be vague, unclear, cryptic or unreadable.
2. Can have mistakes in transferring comments to multiple sets.
3. May not adequately address or completely answer questions raised.
4. May make changes outside of the scope of work, thus affecting cost and schedule.
5. May be deferred to a downstream reviewer and thus may go unanswered.
6. May be made by a downstream reviewer and not communicated to the EOR.
7. May be specifically avoided due to a concern on the part of the EOR that he will become liable for fit up when answering a dimensional question.
8. May not convey an intended action.
9. May unintentionally affect the erector.

## D. Coordination With Other Trades

1. The burden of coordination responsibility is often placed on the Fabricator by the GC. The GC is normally the only party who can determine the most economical or expeditious course of action when discrepancies arise. The Fabricator is generally not provided with needed documents and is not generally equipped to effectively coordinate with other trades.
2. Timing of coordination can be an issue, since other trades are working under their own schedule.
3. The Fabricator usually does not have contractual authority over the other trades, which dilutes obligations, incentives and cooperation.

IV. **RECOMMENDATIONS** to improve the shop drawing process

- A. Complete Contract Documents are necessary.
  1. See the AISC “Code of Standard Practice for Buildings and Bridges”, March 18, 2005, Section 3 for the recommended information needed in the Contract Documents. Engineers and architects should be aware of this needed information and strive to provide it.
  2. Specifications must be provided with the bid drawings. They also must be customized for the specific project requirements, must be coordinated with the Design Drawings, and should have the project indicated on each page.
  3. The EOR should reference and use the AISC Code of Standard Practice of Buildings and Bridges whenever appropriate.
  4. Concerning mechanical openings – The EOR should define the primary structure around openings and allow for field installed frames, field fabricated from stock material, if possible since specific mechanical information may not be available when shop drawings are being prepared. This detail should be shown in the Structural Drawings.
  5. To deal with potential mechanical changes, the Contract Documents could require that an allowance for additional steel be made or, alternatively, the EOR could consider adding language to the Contract Documents placing responsibility for additional costs, including EOR fees, on the party instituting the changes.
  6. The location and magnitude of unusual loads must be provided for the joist supplier.
  7. Flexibility concerning connections should be considered – Shear tabs vs. single angles, welded vs. bolted, specific reactions vs. 60% of uniform capacity.
- B. Poor Communications – Communication: Is defined “To clearly convey information, to have an interchange”
  1. A Pre-Detailing Conference is essential for larger complicated projects and should be specified in the Contract Documents. Refer to the “Pre-Detailing Meeting” paper previously written by this committee.
    - a. Face to face meetings help initiate effective communications.

- b. Appropriate people should attend.
  - c. The Detailer and Fabricator must be familiar with the project ahead of this meeting so that issues can be discussed. Questions should be made available prior to the meeting.
  - d. Procedural issues can be established or confirmed (submittals, RFI's, paper flow of updated Contract Documents, coordination with other trades)
  - e. Lotting and special ordering should be discussed.
2. RFI's should: (See 10/05 Modern Steel Magazine and the AISC COSP 4.6)
- a. Be asked in a timely way so as to not require an immediate response.
  - b. Only ask questions about issues not clearly shown in the Contract Documents
  - c. Be clearly written
  - d. Address only one question or issue
  - e. Reference the problem area(s), using excerpts from the Contract Documents.
  - f. Ask a question, when possible, with a proposed sketched solution that can be answered yes or no.
  - g. Be clearly answered by the respondent. Example question – “What is the top of steel elevation along Grid 4 at the roof ridge on drawing S2.5?” An inadequate answer would be – “The top of steel is at the underside of the steel roof deck.” An appropriate answer would be “136'-10”.”
  - h. State schedule and cost impacts, if appropriate, or at least indicate that there may be cost and schedule impacts.
  - i. Be handled wisely in emails and faxes. These tools are only part of a means for obtaining information. A verbal “follow up” will help convey the nature of the issue, if the email or fax was received, and how the problem is affecting the project. Any issue that involves input from multiple parties will take longer to answer due to the coordination required.
  - j. Be addressed at timely pre-detailing or pre-construction meetings on all projects where procedures, coordination, erection sequence, access, testing, etc. may be discussed.
  - k. Not be used for changes or substitution requests.
3. Construction Schedule
- a. A GC generated schedule with regular updates should be provided to all affected parties.
  - b. Key Fabricator milestone dates should be made available to all affected parties and updated on a regular basis.
  - c. The EOR should be informed ahead of time by means of a submittal schedule provided by the GC, and the GC should be informed ahead of time by the Fabricator, when shop drawings will arrive. This should help expedite the review time. Also, the

normal 2 week turn-around time frame requires that all involved parties in the review process be expeditious in their turn-around time.

- d. An advance copy of a shop drawing submittal to the EOR should be allowed. It should be marked “For Information Only” to avoid confusion.

C. Suggestions For Improving Shop Drawing Review Comments

1. Consider routing only one record set of shop drawings through the reviewers. This will save time and minimize mistakes in transferring comments.
2. Comments must be readable and clear. All questions must be addressed. The comments must address specific issues and locations.
3. The reviewer should not finish his design on the shop drawings.
4. The reviewer should call the Detailer to discuss comments and questions before the shop drawings are passed on.
5. The reviewer should also call the appropriate parties where questions raised on the shop drawings need answers by others and to explain why the EOR cannot answer the question(s).
6. Changes or changes in scope should be expeditiously and separately documented, not on the shop drawings. Upcoming changes could be roughly identified so that the Fabricator knows what to expect. Usually a PR will be issued by the Architect.
7. Corrections should direct the detailer to the appropriate references in the CD’s or supplemental information provided.

D. Coordination With Other Trades

1. The GC is responsible for coordinating the trades, with cooperation from the affected trades. This may be different from what GC’s prefer to do. The Fabricator should not agree to become an unauthorized project manager for the GC.
2. It may be appropriate to have a shop drawing review meeting where all affected parties can jointly participate at the same time, thereby saving valuable time in phone calls and emails. This meeting should be identified as a requirement in the specifications.

V. **CLOSURE**

- A. Construction has become a complicated business. There is always a pull on time, quality and cost. Additionally, projects are much more complex than in times past. Each project has a life of it’s own and many issues must be clearly defined. The EOR should strive to provide complete Contract Documents and the construction community must effectively communicate so that quality projects will be built.



