



Suggestions for Improving the Structural Steel Shop Drawing Process

SEAC/RMSCA Steel Liaison Committee

May 2006

Revised: September 2021

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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 purpose of this paper is to propose suggestions for improving the structural steel shop drawing process. The process of preparing shop drawings is the most time consuming and unpredictable part of the fabrication process.

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, June 15, 2016.
- B. GC - To confirm that the structural steel 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 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. An electronic version (CAD or BIM) of the structural drawings often is provided to the GC and/or Fabricator.
- E. A Pre-Detailing Meeting is held.
- F. Detailing is usually started immediately. Then the Fabricator, Erector and GC discuss the fabrication and erection sequence.
- G. When questions arise or conflicts are found during the preparation of the shop drawings, questions are asked via RFIs to determine direction.
- H. A PDF of the shop drawings is submitted to the GC. In order to help expedite the review turn-



around time, the submittal sometimes is sent to the EOR and/or Architect, with the GC's permission, to help expedite the process.

- I. 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.
- J. 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.
- K. The EOR reviews and makes comments on the shop drawings and returns them back to the Architect.
- L. The Architect reviews the shop drawings and then returns them to the GC.
- M. The GC reviews the shop drawing comments and then returns them to the Fabricator.
- N. 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 latter two actions require a re-submittal.

- O. 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.
 - P. The Detailer corrects the shop drawings and asks questions for clarification from the EOR, Architect, GC, Fabricator, or Erector, as needed.
 - Q. Drawings are released to the shop. Final "For Construction" copies are sent to the GC. The Erector is sometimes copied at this time.
 - R. 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. Key dimensions do not close or are not provided.
 - 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 the structural drawing to be 100% complete. However, the structural drawings may be issued only for information because the accelerated schedules did not allow the EOR to complete the structural drawings. 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", June 15, 2016, 3.1.



- b. For Design Drawings: SEAC “A Guide for Consulting Structural Engineering Services in Colorado”, October 2004, 4.G.1-4.
 4. Even though an electronic version of the structural drawings may be provided to the GC and/or Fabricator, 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 affected by this part of the process. Multiple RFI’s may be indicative of unclear or incomplete Contract Documents. Consequently, the submittal schedule and the cost required to prepare the shop drawings will likely be impacted.
- B. Poor Communication:
 1. The shop drawing submittal and review process is often unclearly specified. Because of this, the GC and/ or Architect will decide on a project specific process. Different EOR offices have different practices with regard to the turn-around time and thoroughness of their review.
 2. The participants in the process (Detailer, Fabricator, GC, Architect, and EOR) often do not communicate effectively. RFI’s can be frustrating to all parties.
 - a. There can be multiple questions asked in a single RFI. The EOR may not be able to answer all of the questions asked.
 - b. Unclear questions without a verbal discussion or sketches may result in a misunderstanding and a delay in a response.
 - c. No solution is proposed.
 - d. References to problems are not clearly defined.
 - e. Sometimes an RFI requests a quick response.
 3. Construction Schedule is not clear
 - a. The construction schedule sometime changes and the affected parties are not informed. Poorly communicated 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 do not know how large the submittal packages will be, if multiple submittals will be provided, or when they will be submitted. Unknown shop drawing package sizes and submittal dates may not allow the EOR to make an expeditious review.
- C. Shop Drawing Review Comments – Review comments:
 1. Can be vague, unclear, cryptic, or unreadable.
 2. May not adequately address or completely answer questions raised.
 3. May make changes outside of the scope of work, thus affecting cost and schedule.
 4. May be deferred to a downstream reviewer and thus may go unanswered.
 5. May be made by a downstream reviewer and not communicated to the EOR.



6. May be specifically avoided due, in some cases, to a concern on the part of the EOR that he or she will become liable when answering a dimensional question.
7. May not clearly convey an intended action.
8. 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 design documents and shop drawings 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. **SUGGESTIONS** for improving the shop drawing process:

A. Complete and Current Contract Documents are necessary:

1. See the AISC “Code of Standard Practice for Buildings and Bridges”, June 15, 2016, Section 3.1 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 Design 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. A field-installed frame detail should be shown in the Structural Drawings.
5. Regarding potential mechanical changes, the Contract Documents could require that an allowance for additional steel not yet shown 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. Use Section 3.1.1 in the AISC Code of Standard Practice of Buildings and Bridges.

B. Poor Communications – Communication: Is defined “To clearly convey information, to have an interchange”:

1. A Pre-Detailing Meeting is essential for larger complicated projects and should be specified in the Contract Documents. Refer to the “Suggested Steel Pre- Detailing Meeting” paper written by this committee.
 - a. Face to face meetings help initiate effective communications.
 - b. Appropriate people need to 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, information flow of updated Contract Documents, coordination with other trades)
 - e. Lotting and special ordering should be discussed.
2. RFI's should: (See October 2005 Modern Steel Magazine and the AISC Code of Standard Practice of Buildings and Bridges Section 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 and screen shots from the Contract Documents.
 - f. Ask a question, when possible, with a proposed graphic 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 communicated electronically as required by the Design/Construction Team. A verbal "follow up" will help convey the nature of the issue, if the electronic information was received, and how the problem may impact the project. Any RFI resolution that involves input from multiple parties (Design/Construction/Owner Team) 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 of the Design/Construction Team members.
 - b. Key Fabricator milestone dates should be made available to all Design/Construction Team members and updated on a regular basis.
 - c. The EOR should be provided a submittal schedule by the GC, and the GC should be provided input from the Fabricator, when shop drawings will be submitted. This schedule with dates 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 PDF 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. Concurrent reviews and markups may result if the normal 2-week turn-around time is unreasonable. It is the responsibility of the Architect and the GC to review all of the comments to determine their appropriateness and clarity.



2. Comments must be readable and clear. All questions must be addressed. If the EOR cannot answer a question, he or she should request that the appropriate party provide the answer. A follow-up phone call may be necessary. 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. Changes or changes in scope should not be documented on the shop drawings ~~be~~ but should instead be separately documented in a PR by the Architect. Upcoming changes could be roughly identified so that the Fabricator knows what to expect.
 6. 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 with the affected trades. This may be different from what GC's prefer to do. The Fabricator should not agree to coordinate other trades 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:**
- Tight document design schedules can result in incomplete Design Documents or multiple Design Document packages which are produced in reaction to compressed construction timelines and the need to order materials. Since structural steel shop (and erection) drawings are an integral part of a steel-framed commercial building, a smooth and expeditious shop drawing process is critical to the overall success of the project. The goal should be that the Design Team in concert with the Construction Team and steel Fabricator clearly define important milestones and then work together to accomplish them. Complete and clear Design Documents, a timely Pre-Detailing Conference, clear and concise RFIs, timeliness responses, clear shop drawing comments, and effective coordination will help ensure that the project will be a success.