What's Wrong with Steel Drawings?

Design Drawing Problems and the Impact to Structural Steel Fabricator/Erectors

By Robert (Bob) Hazleton

All trades suffer when contract documents are incomplete, erroneous, or late. Few trades endure the impact sustained by the Structural Steel Contractor. Lead times on raw material usually result in ordering material from the earliest generations of the structural drawings. Unlike trades where the majority of the hours are performed on site by a specific crew, most steel projects have twice as many hours consumed in the shop than the field. Steel fabrication fascilities are often booked a year in advance. Missing material order deadlines and shop issue schedules result in significant costs to cover unabsorbed overhead and overtime. The purpose of this article is to highlight the cost, schedule, and safety impacts related to problems with the Contract Documents.

The American Institute of Steel Construction (AISC) outlines the requirements for Contract Documents in the *Code of Standard Practice for Steel Buildings and Bridges* (CSP). Steel Subcontractors price their scope of work with the understanding that all of the information will be shown on the contract documents prior to starting shop drawings. When the requirements aren't met, impacts and mitigation efforts are unavoidable.

Missing Information

Incomplete Contract Documents resulting in Requests for Information (RFIs) and drawing revisions create more cost and schedule impacts than all other drawings related problems combined. Although missing information can be the result of issues entirely within the control of the Structural Engineer of Record (SER), it is often the result of coordinated dimensions to be provided by the Architect and/or General Contractor that are required to complete the design. The problem may extend beyond these parties all the way to the Owner.

Mechanical/Electrical/Plumbing (M/E/P) subcontracts represent a significant portion of the total budget, especially in healthcare and clean room applications. A protracted negotiation and buy-out period often results. Skin systems are often design/build subcontracts. Therefore design does not start until after the award, further delaying the arrival of coordinated dimensions required to establish the edge of slab. There are instances where the Owner injects delays, unaware of the consequences. Elevator and escalator systems are a classic example, where Owners with multiple campuses delay the award of an elevator subcontract pending negotiations of maintenance agreements.

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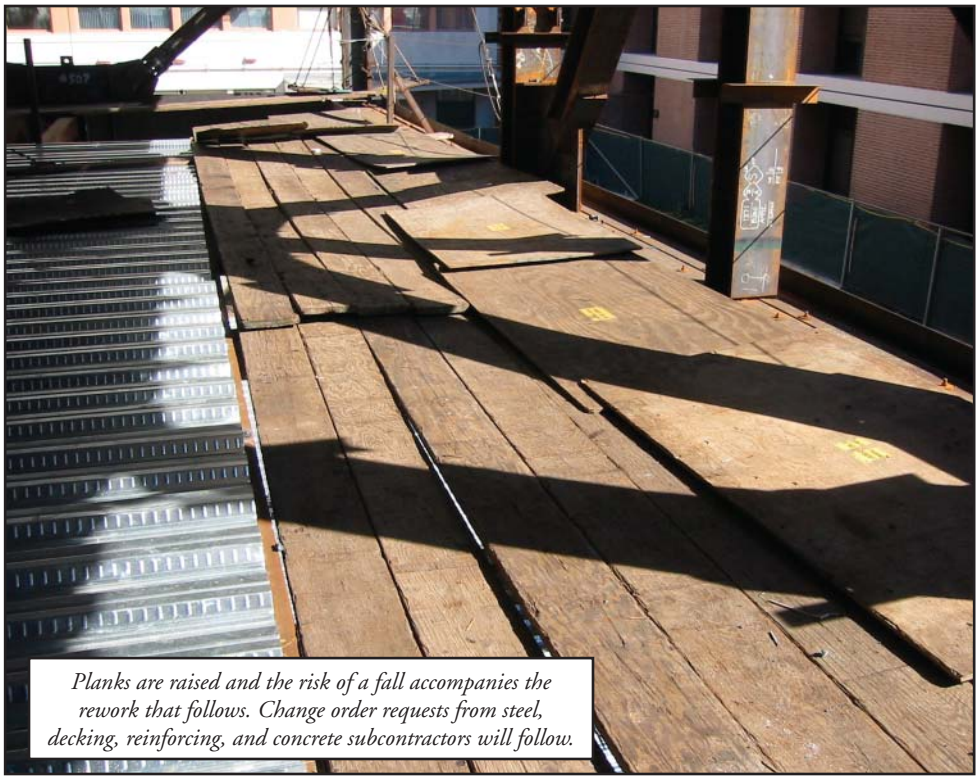
Referring to these as "deferred approval" items is a bit of a misnomer. In most cases, the late approval was preceded by a late award and submittal. Only the Construction Manager can decide if savings from protracted negotiations outweigh the added costs and delays associated with detailing revisions, missing the fabrication window, or revising work in the shop and/or field. An informed Owner usually makes the right decision and funds the impact with trade specific savings, but only when that impact is known.

All members of the project team must communicate drop dead dates for the release of coordination related information. Attaching potential cost and schedule impacts for non-compliance goes a long way in being heard.

When it comes to trades where deferred approvals and missing information impact the progress of structural design and shop drawings, Table 1 below should be considered a list of the usual suspects.

Trade	Areas Subject to Delay/Revision
Elevators	Guide rail support steel, hoist way perimeter framing, hoist way bent plate, ventilation framing, and hoist beams cannot be sized or located until this sub is on board.
Skin/Pre-cast/ Curtain wall	Perimeter bent plate, beams, kickers and back-span bracing cannot be finalized. Brace frame structures present unique challenges. Gussets must be overlaid against windows. Pre-cast panel point loads that are supported by the slab must be coordinated to miss the gusset or kickers must be added to replace the shear and moment capacity lost when the gusset interrupts reinforcement in the slab.
MEPS	Floor and beam penetration framing, interior bent plate, accommodations to support raised and depressed slabs, equipment support beams, and mechanical screen dimensions require coordination.
Stairs/Misc Metals	Stair opening framing, stringer to beam connections, intermediate platform framing, require coordination. Design/build stair systems vary greatly; some are free standing while others rely on the structural framing to provide shear and lateral stability.
Window Wash Equipment	Roof beams to receive window washing davits and tie-back cannot be sized or located. Mechanical screen and parapet wall height/locations are often revised to provide clearance for the davits, platform launch, and clear access to tie backs.

Table 1



Planks are raised and the risk of a fall accompanies the rework that follows. Change order requests from steel, decking, reinforcing, and concrete subcontractors will follow.

Reducing Errors/Omissions/Ambiguities

Most of the following guidelines are basic, and only serve to reinforce what we already know. Others address specific concerns that may or may not be applicable in the market you serve.

- Analyze the capacity of your firm and the man hours required during the design phase and approval process prior to accepting the award. Request submittal schedules from major trades immediately upon award, and staff the project accordingly. Be prepared to commit to specific turn-around times for RFIs and approvals that support the master schedule AND the shop issue schedule developed by the steel fabricator.
- Develop and maintain a comprehensive quality management system that documents internal procedures. Update procedures regularly in response to recurring problems.
- Perform periodic reviews of construction schedules to ensure the dates on your action list net deliverables in accordance with revisions to the sequence and schedule of erection.
- Create checklists that identify quality control points for drawings and specifications to ensure the documents are complete and correct. The Council of American Structural Engineers (*CASE*) provides an excellent example in *CASE DOCUMENT 962D* (2003), available through the American Council of Engineering Companies, Washington D.C., (202)-347-7474.
- A separate checklist may help ensure conflicts or clashes created by changes have been reviewed prior to issuing the revised documents for construction.
- Minimize references to Architectural, Mechanical, Electrical, and Plumbing drawings. Coordinate and consolidate the information on the structural drawings. Cloud dimensions that are missing or to be confirmed.
- Do not deviate from established codes unless absolutely required. Boutique specifications inject cost and ambiguity into the project. Code language is subjected to a vetting process that eliminates errors, ambiguity, and redundancy.

> ***Exception:*** *Refrain from making general references to FEMA-350 and 353. Instead, specific sections should be pulled into the specifications as required. This body of work is a series of recommendations, not a code subject to audits and revisions. Do not apply these requirements to brace frame structures and cantilevers.*

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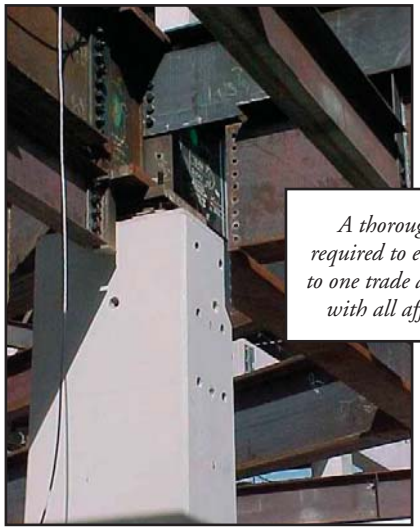
Specific Oversights that Result in Added Costs

- Do not rely solely on the ASD and LRFD *Manuals of Steel Construction*. Consult the *Seismic Provisions for Steel Buildings* to ensure compliance with the requirements stated for the specific type of frame and seismic zone applicable to your project.
- AISC *Seismic Provisions* state that groove weld column splices in Special Moment Frames must be complete penetration welds.
- Scrutinize the quantity and capacity of members designed to stay compression flanges of axially loaded members.
- Check footing, especially starter footings, to ensure size and anchor bolt embedment are sufficient to resist column overturning.
- Items deemed to be Architecturally Exposed Structural Steel (AESS) must be clearly identified on the structural drawings. Adjustable connections must be provided between AESS members and the main structure.
- Identify all columns, beams, braces, including collectors that carry frame specific material requirements with an SFRS or LFRS designation.
- When structural integrity during construction is codependent on multiple trades, establish a meeting with the GC and related trades to communicate the process envisioned when developing the design.



A thorough review is required to ensure revisions to one trade are coordinated with all affected trades.

Safety

I am closing with safety for a reason. Months are invested in planning the fabrication and erection of a structural steel building. This is done to ensure a safe, efficient and timely operation.

Incomplete design documents and revisions are not part of the plan. When the erector is forced to change sequence or return to an area that has already been erected, they do so without the benefit that comes with those months of planning. A typical rework results from a floor opening that is known, but lacks final dimensions required to complete the secondary framing or bent plate. An incomplete working floor is the result. This injects risk into the project that should not be there. The risk is only magnified in cases where the floor has already been released for access by workers from other trades.

Twenty-three percent (23%) of all ironworker fatalities result from falls through floor openings in the interior of the building. Stringent tie-off procedures reduce the risk of rework operations. Nothing can improve the situation as effectively as eliminating rework operations by having a complete design before releasing contract documents for construction.▪

Robert (Bob) Hazleton's introduction to the steel industry began 20 years ago as a welder. After going from the shop to the office, he held positions in estimating, sales, operations, and general management. Bob started with a California based Herrick subsidiary in 1993 and was transferred to Herrick's operations in Thailand in 1996. He returned to the states in 2001 and is currently responsible for Project Management, Engineering, and Procurement at Herrick's corporate headquarters located in Pleasanton, California. Questions or comments may be forwarded to ***bobh@herricksteel.com****.*