Procuring Steel through an Early-Release Steel Package

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This paper explores the procurement of steel detailing services early in the design phase of the commercial construction process. Previously, such arrangements have occurred in a fragmented marketplace due to the personal relationships or past project experiences with particular detailers, fabricators, and engineers. In today's dynamic global market, this delivery system is evolving into more of a mainstream approach with multiple firms offering combined detailing and engineering services as a product for the owner or general contractor who wish to gain time on the construction schedule. A specific case study is presented, and a map of the early-release steel design approach is proposed. This approach to procuring steel detail drawings is analyzed with benefits and drawbacks of the approach addressed. For some projects, the early-release approach has the potential to save time on the schedule and produce a more accurate steel pricing package. By understanding the available procurement methods on the market, the owner or general contractor will be able to make a better decision to help achieve success on a given project.

Keywords: Early-Release Steel Package, Steel Shop Drawings, Steel Detailing, Integrated Design

Introduction

Many contractors and owners have commented that steel shop drawings and steel mill orders are often a major schedule driver for commercial construction projects. The American Institute of Architects (AIA) defines shop drawings as "drawings, diagrams, schedules and other data specially prepared for the Work by the Contractor or a Subcontractor, Sub-subcontractor, manufacturer, supplier or distributor to illustrate some portion of the Work." (A201-3.12.1, 1997) To the design industry, shop drawings are often dreaded and require review within hours or days. To the detailing industry, adequate information is not available to produce the required documents, and schedules for preparation of the shop drawings are short. To the construction industry, shop drawings can be expensive and time-consuming to produce. Buildings cannot be constructed without them, and the preparation, coordination, and review of shop drawings are often a source of frustration for all parties involved (Rutledge and Luth, 2004).

In a traditional design-bid-build process, the Structural Engineer of Record (SER) has a contract with the Architect who is under contract with the owner. In contrast, the structural steel fabricator has a contract with a general contractor who is under contract with the owner. In this scenario, the structural steel fabricator who prepares the steel shop drawings has no contractual link with the SER (Figure 1). This lack of contract often causes communication barriers between the SER and the fabricator. Sometimes, "their respective clients...prohibit direct communication even though it is the most effective means by which cost- and schedule-sensitive issues can be resolved in an efficient manner" (Troup, 1999). This lack of communication can lead to substantial delays and back charges.

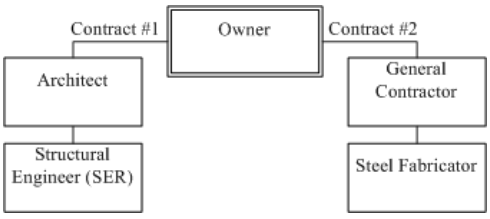

Figure 1: Traditional contractual relationship in commercial construction projects

As an alternative to the traditional method of procuring steel services, this paper considers the hiring of steel detailing services directly by the general contractor or owner simultaneously with procurement of design services for the project. In such an approach known as "early-release steel design" or "integrated steel design", the steel detailer works directly with the design team in an effort to produce the first sequence of shop drawings simultaneously with or immediately after production of contract documents for the project. These drawings can be used to obtain a more exact quote from a steel fabricator and then begin the process of fabricating steel for the job immediately without waiting for shop drawings to be developed by the fabricator. Key concerns for the owner or contractor using this approach center on liability for detailing errors.

Background

Since the early 1980's, the construction industry has moved beyond the traditional design-bid-build mentality (Cross, 2001). Design-build and cyber-track schedules have moved to the forefront. Electronic data interchange (EDI) between designers, contractors, and sub-contractors has become a hot topic in the industry. In the November 13, 2006, edition, *Engineering News Record (ENR)* published a special report on "Progressive Project Delivery-Speed and Quality Drive Changes" (Angelo, November 2006). *ENR* provided multiple methods by which companies can "pick from a broad array of delivery tools to best serve customers' needs, particularly as schedules shrink and budgets tighten". Innovative industry responses are required as the construction industry responds to these increasing challenges.

Since the Hyatt Regency disaster in Kansas City in the early 1980's, the relationship between structural engineers, detailers, and fabricators has continued to evolve (Rutledge and Luth, 2004). Questions of liability and responsibility are typically at the forefront of most discussions that attempt to join these parties on any project (Troup, 1999). Detailers often want a perfect set of contract documents where all questionable items and connections are detailed and engineered completely. Structural engineers increasingly want the detailer and fabricator to take a more active role in the design and responsibility for connections and specialty components. Fabricators see the work of engineers and detailers as "a means to an end". They want to move steel through the shop and have it fit together well in the field.

In their July of 1999 report to the International Group for Lean Construction, Tommelein and Weissenberger addressed the location of "buffers" in structural steel supply and construction processes (1999). They argued that steel procurement and delivery methods are not handled using a just-in-time process but are riddled with limitations to the flow of product through the supply chain. They argued that the processes in steel supply are geared around achieving high equipment and labor utilization rates. The time-consuming process of preparing steel shop drawings after construction documents are completed is an example of one such buffer.

Combining detailing and design services has been done in special circumstances and relationships in the fragmented design and construction market for years. Rutledge and Luth identify a project on which they worked together as early as 1982 in Denver where Rutledge Steel employed KL&A to provide stamped calculations for a steel framed curtain-wall they were fabricating for the 16th Street Mall in Denver, Colorado (2004). Most relationships during the 1980's and 1990's focused on such relationships where structural engineers provided specialized component or connection design for fabricators without necessarily working together to complete contract documents and shop drawings simultaneously.

Nadine Post reported in a February 2004 article in *ENR* entitled, "To Help Save Time, Structural Engineer Wears Harder Hat", that the structural engineer was also hired to detail the structural steel for a high school in Tacoma, Washington. This method proved to be very effective. In this 279,000 square foot project, all of the 1,900 tons of primary steel was detailed by the Structural Engineer of Record concurrently with the design of the project. This procurement method set in place "a chain of events that … sliced at least three months off construction". In this project, there were only thirteen requests for information associated with the structural steel; this compares to hundreds on similar projects of this size and complexity (Post, 2004). *ENR* further reports that "…of 2,908 anchor bolts on the project, …, only four for one base plate required modification. There were no mismatched connections, even though they contained 15,256 bolts. In the school building, there were no problems with 3,045 assemblies."

In September of 2004, *Modern Steel Construction* provided an article entitled "Rapid Replay" which addressed an addition to the north end zone of West Virginia University's Mountaineer Stadium (Martin, 2004). March-Westin, the general contractor, provided complete design-build services for the project. Jamie Ridgeway, project manager for March-Westin, indicated that they elected to employ the fabricator at the same time the design team was selected for the project. He stated, "We do it all the time on projects, because it can save time and money." In this particular scenario, a second structural engineer, Allegheny Design Services, was hired to engineer the structural steel frame and work directly with the steel fabricator and primary structural engineer. David R. Simpson, P.E. for the project indicated, "We worked directly for March-Westin while maintaining coordination with HOK and Thornton-Tomasetti. To complete the design in a three-month period, we had to feed information to the fabricator as we were going along so that they could meet the mill schedules to order steel-while maintaining communication with HOK and their architectural requirements-and while communicating with Thornton-Tomasetti to determine what their foundations could and could not take." In this project, an early-release package was generated; however, the general contractor employed a separate structural engineer to design the frame and work directly with the fabricator.

Firms that provide this type of service vary on whether shop drawings are provided and/or reviewed by the entire design team. In the Washington Tacoma School project (Post, 2004), no shop drawings were submitted for review. Jim Burk, senior project manager for General Contractor Lease Crutcher Lewis, says the approach which went "tremendously smoothly" in this case, "has the potential to fail. One reason is that the detailer's drawings go directly out on the fabricator's shop floor without being reviewed by the general contractor or steel erector. (Post, 2004)"

Methodology

No documented process or quantitative data for early-release steel shop drawings was found in a review of the literature. As a result, a qualitative approach was used. In order to establish a "best practice" guide for an owner or contractor considering the use of an early steel release approach, available literature on specific projects and a specific case study were used as primary sources. The case study is considered relevant and appropriate since the case study is supported by the literature review. Best practices were established using details from both the literature review and case study.

Case Study

In November of 2005, a large international company announced that it was building a large office facility in the Southeastern United States. The new facility was designed by a prominent architecture/engineering (AE) firm to accommodate 1,300 employees and is scheduled to be completed by 2008. The owner hired a Top 500 *ENR* General Contractor (GC) for the project. Total project cost including land development has been estimated at $120 million dollars. Specific names of some companies included in the project have been withheld at their request.

The structure of the building was designed as a composite steel frame with estimated total steel tonnage of 3,200 tons. Faced with the daunting task of completing this important project on-time and starting construction during the winter months, the GC looked for every opportunity to save time on the job. Because of a previous relationship with an umbrella Civil Engineering organization that offered steel detailing services, the contractor contacted that firm in an effort to "speed up" the steel frame on this project. The manager at the GC's office indicated that, "The chief advantage to concrete is that we can start tomorrow. Steel requires shop drawings, and that process takes time. By using an early-release shop drawing process, concrete no longer has that advantage over steel." A direct contract was established between the GC and detailer to provide the steel detailing services for the project well in advance of the completion of design drawings. This allowed steel detailers to work directly with the AE firm to develop detailed steel shop drawings simultaneous with completion of construction documents.

The general contractor worked aggressively with the AE firm and detailer to confirm that items critical to the schedule were included. The early-release packages included beams, columns, girders, decking, and slab edge conditions. Stairs, railings, canopies, and other miscellaneous steel were excluded from the early-release package since these items were not critical to the schedule, and design of many of these items had not been addressed by the architect at the time detailing started. Once the structural portion of the contract documents was completed, the first segment of steel shop drawings was released. A sequencing plan was developed that required sequential production of steel shop drawings in approximately 150 ton increments with a sequence provided every two weeks after the initial release of the first steel shop drawing sequence. Fabricated by a large southeastern fabricator, the shop foreman stated that it was the first time he had ever seen shop drawings before the raw material arrived at the fabrication plant.

The structural engineer (SER) and detailer made use of CIS/2 technology in order to decrease the time it takes to detail the structure. The SER modeled the structure in RAMSteel and provided

files to the detailer so that they could use them as a starting point for detailing the project. The detailer then imported these files into SDS2 (3D automated detailing package) which gave them a "jump start" on the building model. By sharing the model and working closely together, the detailer and SER were able to avoid much of the inevitable RFI process, saving time on the project. Shop drawings were submitted/reviewed as done in a traditional arrangement for this project.

According to a Principal with the detailing firm, the use of an early-release package "basically allowed us to realistically anticipate a December/January erection start date as opposed to a March/April start date. We estimate that we saved the owner approximately $500,000 in rental cost of their currently leased office space alone by using this approach." The senior structural engineer on the project indicated that they issued multiple early-release packages primarily to "identify and secure delivery issues with certain column shapes". He also indicated that the synergy associated with working closely with the detailer created an opportunity to improve the quality of documents produced. A summary of the time schedule in this approach compared to a more traditional procurement process for detailing and fabrication is shown in Figure 2.

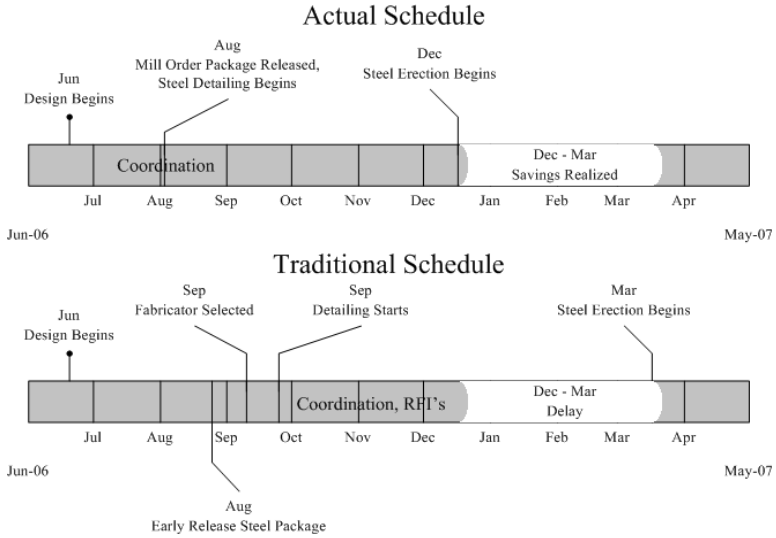

Figure 2: Comparison of actual and traditional schedule for case study project.

A Proposed Process for Early-Release Shop Drawing Procurement

Once the contractor or owner decides to pursue an integrated steel design approach, the first step is to obtain "buy-in" from the design team for the early-release process. "Communication, project organization, and the ability of the owner and architects to make timely decisions were essential to produce a project of this scale on a fast-track schedule" (Fowler, 2003). "Detailers have been trained to think linearly and expect every set of drawings to be complete before they start. Design engineers are used to working with architects and most have never seen a complete set of drawings, much less produced one." (Rutledge and Luth, 2004) All parties must realize that design is an iterative process and work together to move these iterations toward a completed drawing package. The timeliness and importance of communication between all parties cannot be overstated. The motivations for the design team are twofold. First, the general contractor and

architect will have to process fewer RFI's and changes after the drawings are issued. A strong working relationship between the detailer and the structural engineer essentially eliminates this paperwork. Second, the finished structure will fit together better and be a more reliable structure. Problems will be resolved prior to material fabrication instead of on the job site.

The next step would be to establish a contract with the steel detailer who will provide the steel detailing services. In some instances, the structural engineer is willing to assume this role (Rutledge and Luth, 2004). In other cases, the detailer may be a firm that specializes in working with engineers to produce shop drawings concurrently with engineers and architects. Care should be taken if detailers and engineers who have not worked together previously in an early-release package are selected for a new project. The learning curve required for an initial integrated steel project can be steep and a negative drain on a project (Rutledge and Luth, 2004).

It is critical that the contract with the steel detailer specifically identifies how the cost of detailing errors is to be handled. The financial risk associated with the fabrication of steel can be much higher than those in the design field. "The profits one might make on 10 design jobs cannot cover the losses from one design build job gone sour." (Rutledge and Luth, 2004) In practice, almost all fabricators carry some allowance for minor field erection fit-up issues during construction. The person initiating the contract with the detailer should be prepared to carry some allowance (typically 2% to 3% of the costs of the steel on the job). It should be noted that smaller steel detailers carry little or no insurance. Structural engineering firms that provide detailing services often have relatively large errors and omissions insurance policies that would cover major detailing errors. However, many of these policies may not cover indirect losses associated with schedule delays. Structural steel fabricating firms usually are required to carry liability insurance for coverage in the event of a building collapse. However, they typically do not carry insurance for design or detailing errors. If a large steel fabricator were to detail all the steel incorrectly on a particular job, one would be hard pressed to get their insurance company to pay for the claim. If available, the insurance requirements should be specified in the contract, and contract experts should be consulted to establish appropriate contractual ties. Further research is needed in this area as this procurement method continues to evolve.

The detailing of the project will cost slightly more in an early-release package. No literature was found on this subject, but conversations with industry representatives indicate that detailing costs are 20% to 25% higher for early-release detailing. Since design is an iterative process and some rework and a higher degree of coordination of detailing is anticipated in an early-release approach, a higher fee is justified. A 25% increase initially appears high but pales in comparison to the cost of a single major detailing or coordination error on most projects. In addition, the cost of detailing in a steel package is typically only 5% to 7% of the total steel price for the job yielding an increase of only 1% to 1.75% of the total steel price for the job.

After all team members are under contract, it is critical that open communication occur between all parties involved in the process. Based on the schedule, regular telephone meetings should be held with all parties to confirm that team members are working together and that necessary information is flowing in a manner that will allow the schedule to be maintained. This involvement was one of the primary success drivers in the case study discussed previously.

The fabricator for the project can be selected either before or after the completion of drawings. If selected prior to completion of drawings, the fabricator should be provided with a written summary from the detailer on how the project is detailed. The detailer in the case study has developed a standardized set of information for fabricators that detail their standard early-release packages. For example, a fabricator would need to know if the bent closure plate around the perimeter of the building is applied in the shop or in the field. Most detailers who have participated in this process are well aware of the outstanding issues and have appropriate documentation to present to the fabricator. The fabricator should have a chance to review this information and discuss any outstanding issues with all parties to determine the appropriate course of action. If the fabricator is selected by hard bid after completion of the steel shop drawings, these coordination issues are mute.

Based on a review of the literature and personal experience, the author recommends that the shop drawing process occur as a final check. The production of early-release shop drawings is not recommended as a substitute for communication with clients or other parties as required by contract. Contractors should not allow detailers with minimal financial risks and means to forgo the established process of submitting and reviewing shop drawings. Due to their close working relationship, the structural engineer can make a final review of the drawings while they are sent to the architect and contractor. This should essentially limit any shop drawing time on an "early-release" package to approximately one-half the normal time (one week estimated). A summary of the proposed procurement method is shown as Figure 3.

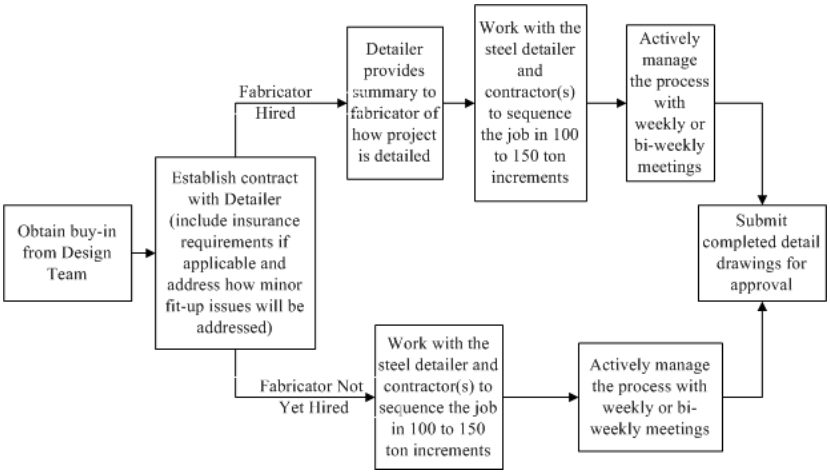

Figure 3: Proposed process flow map for owner or contractor using an early-release approach

Analysis and Conclusion

Procurement of steel through the use of "early-release" shop drawings can provide an effective way to shorten time, save money, and reduce errors on certain construction projects. The use of "early-release" shop drawings paves the way for a paradigm shift where a single owner owns a complete database for a project. In this future scenario, the 3-D model will be shared by designers, detailers, builders, and facility managers through the design, construction, and service life of the building. However, resistance to change in the way buildings are delivered exists among designers, fabricators, and constructors. As a first step in the process, integrated steel

design can serve as a "stepping off" platform for eliminating buffers in the steel industry. As designers, contractors, and detailers work together to provide an integrated steel design project, clear elements and issues will provide sharp focus on areas where critical communication and coordination is needed. A collaborative approach will then breed new ideas to drive BIM to the forefront in this area of the construction market.

Early-release steel detailing works well in certain circumstances. First, there must be a need to accelerate the schedule on a given job. Second, this method works well when all team members are committed to the process and understand the end goal which is to produce a more accurate set of construction documents and shop drawings in an effort to limit coordination after drawings are issued and to have a steel structure that has minimal erection issues. Third, this method works well when the structure is relatively repetitive and majority of the main structural steel on the job can be designed rapidly. Highly complex steel jobs always limit how aggressive the schedule can be on a given project. This is especially true in integrated steel design where major changes late in the design process can lead to large additions of required detailing hours.

Integrated steel design allows an owner/contractor to establish a more exact price for structural steel. In a traditional approach, three different fabricators would submit three different estimates of the tonnage of a given job. With an early-release package, fabricators can bid jobs off completed shop drawings. The exact tonnage of the job can easily be tabulated and a better comparison can be made by a contractor comparing quotes from separate fabricators.

Previous work by Rutledge and Luth (2004) suggests that this approach works well for small jobs. In small projects, the overall steel tonnage is low sometimes leading to a "seller's market" on steel. With completed shop drawings, the job can be bid to multiple fabricators to find the most competitive price. However, detailers prefer working on larger jobs. Some of the job set-up and initial job development is the same for detailers regardless of project size. It is often hard for the detailer to recoup the cost of this set-up on small jobs. Thus, it is questionable whether detailers offering integrated design will rush into small projects ahead of the more enticing, higher margin jobs. Further research is needed on the use of this method in smaller jobs.

Even in a competitive bid scenario, integrated steel design can be considered. In a traditional arrangement where there is a long lead time for the structural steel, the detailing may not start for several months after the contract drawings are issued. The real coordination issues between contract documents and the steel detailer are often not found until this detailing is in process. Thus, the winning fabricator has the ability to "change order" the inaccuracies of the drawings after he is out of the competitive bid scenario. By starting the detailing early in the design process, bids will become "tighter" and change orders by fabricators will be limited since coordination will occur preceding the competitive bid. A case can be made that all jobs of larger size (300 tons and up), regardless of schedule, should be detailed before bids are taken from fabricators to produce a more accurate set of bid documents and reduce change orders.

Early-release steel detailing does not work well in some instances. First, the project and the project team must be amenable to what is required to produce an early-release steel package. From a project standpoint, key decisions must be made to allow the start of detailing on major structural components. The structural grid must be established early and main column and beam

elements identified. Detailers rely on the accuracy of this information. This method is not appropriate for highly complex jobs where design decisions cannot be made early and timely. An example of such a project may be a church where a vast majority of the structural steel is in the miscellaneous section of the job. Second, the project team must be committed to the completion of the contract and shop drawings without exception. A committed detailer with a lackluster design team is sure to fail on an early-release approach. Inevitably, changes late in the design process start to be dealt with as change orders. Such an approach is risky and can extend over many months of the construction phase of the job.

The current path of continuing to push the steel detailer to work at an unsustainable pace to meet construction schedules and fill gaps in the fabrication schedule is difficult to sustain. For the entire system to follow an even-flow philosophy, designers and detailers need to work together in the early design phase to establish schedules so that work flow can be anticipated and planned for the contractor and fabricator. Waiting for shop drawing production and review is substantially reduced or eliminated in an early-release approach. This production-oriented approach will improve the quality of work life for designers and detailers and help eliminate feast or famine loads on the fabrication system in a tight construction schedule. Based on the above discussion on the merits of the system, a proposed method for owners or contractors deciding whether or not to use integrated steel design is proposed in Figure 4.

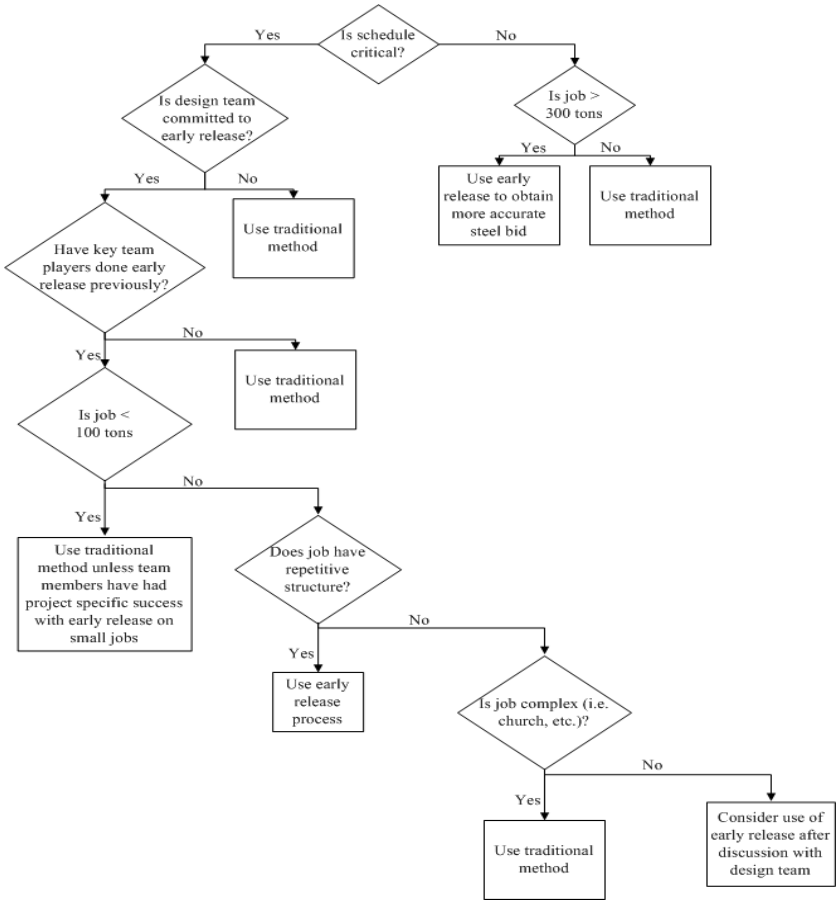

Figure 4: Proposed "Best Practice" Decision Tree for Owners or Contractors Considering Early-Release Steel Packages

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