Getting More Bang For Your Buck On Steel Projects

AISC focus groups offer advice on improving completion schedules on steel projects

There seems to be an overwhelming need today to get projects built quickly. Even for "normal" projects, contractors are under pressure to complete them as quickly as possible. Typically, owners do not tell contractors to take their time completing a job. To one degree or another all projects are schedule-driven and anything which can be done to either keep them on schedule or speed up the schedule is viewed as beneficial.

Much has been written and discussed over the years about the relative merits of one project delivery method over another from the general contractor's and owner's point of view. A recent conference in Michigan sponsored by the Associated General Contractors of America examined the latest developments in lump sum contracting, construction management, design-build, program management and partnering. Much of the discussion had to do with issues of overall project cost, quality, safety and of course, speed. Not much has been written specifically about how just the building structure fits into the project delivery equation and even less about steel structures in particular.

With the emphasis today on speed, the AISC decided to study how to improve completion schedules for projects using structural steel. In order to do so we assembled two focus groups, one in the Midwest and one in the West. The groups included an architect, engineer, general contractor, steel fabricator, steel detailer, steel erector, structural mill representative and AISC representatives. Each group met at a neutral and non-threatening site, one where there were no specific project issues at stake.

If you are looking for ways to make your structural steel projects move more quickly and more smoothly, the following nuggets of information should be helpful. They come from many years of collective experience of respected construction industry representatives.

In the early discussions some individuals felt that speed meant higher cost and maybe even lower quality. As it turned out, we found that speed does not always mean higher cost. There are positive steps that can be taken to make a project proceed more quickly and also reduce the cost of the structure! It also became clear that all the parties involved in the design and construction process can make a major difference. There is something for everyone to contribute; the owner, architect, engineer, fabricator and contractor. What follows represents the collective thinking of both focus groups.

Speeding up project delivery often brings to mind the design-build or team approach with the overlapping of design, working drawings, purchasing and construction. This method does offer a lot of advantages that were discussed by the groups. However, getting the structural steel portion of a project designed, fabricated and erected more quickly does not necessarily require a design-build approach. There are a number of positive steps that can be taken even in a conventionally bid project with design, working drawings, bidding, purchasing and construction linked end-to-end. The focus groups looked at the schedule-driven project in broader terms, and looked at steps that could be applied in a variety of project delivery methods. They broke down into the following categories:

- *Communications and Coordination*
- *Design*
- *Teaming*
- *Purchasing*

By Andy Johnson

Communications and Coordination

In a schedule-driven project, the tendency sometimes is to proceed full speed ahead with design. In these litigious times it is best to avoid potential problems between owners, designers and contractors at the very outset of a project by adopting a recognized and agreed upon contract language. The easiest way to do this is to accept contract language which is already in existence such as that prepared by AIA, AGC or ASA. Once that basis for understanding is established, the project can proceed as quickly as practical, starting with the building program and design.

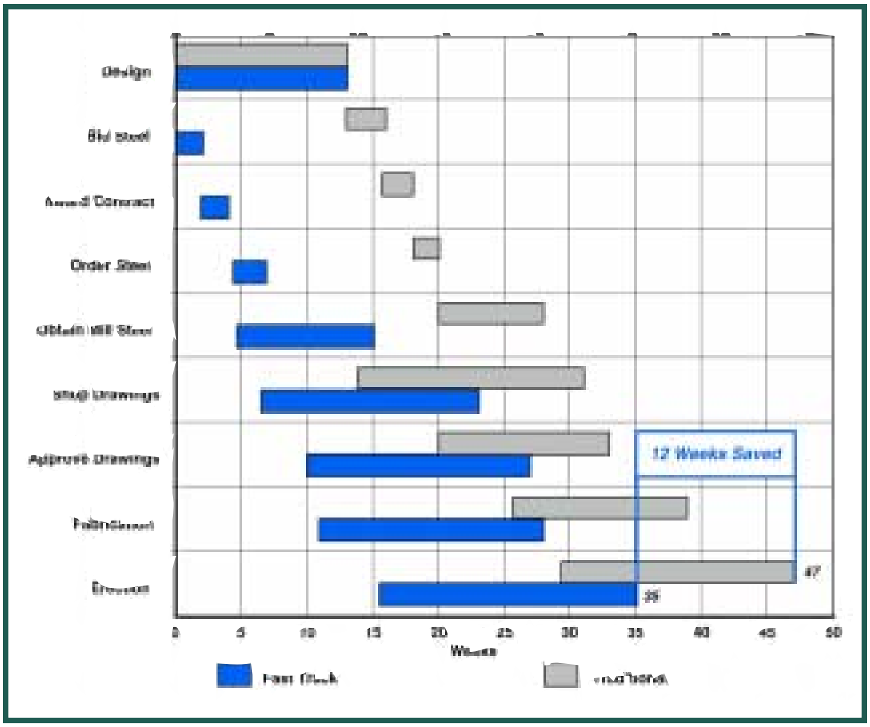
Architects and engineers are, by nature, technically oriented. They have been trained to be precise in their calculations and attention to detail. The ability to communicate effectively is just as important; it is the lubricant that allows the technical expertise of the architect and engineer to be put to its best use for the project. For example, it is critical that the architect be able to communicate to the owner that schedule-driven projects require a commitment to the process and an understanding that there are numerous owner decisions which must be made in a timely manner in order for a project to meet a schedule. Furthermore, the effective architect, with a knowledge of the kinds of decisions necessary to keep a project moving, can help the owner determine a realistic schedule in the first place. In addition, the effective architect prioritizes the efforts of his own staff to resolve issues so that early construction packages can be developed.

One of the first things to get done, of course, is the structural design so that the steel can be ordered. The ability to do this depends greatly upon the architect's ability to provide good workable details in a timely manner. Owners typically understand flow charts wherein structural design is one element. After all, they use this type of planning procedure to manage many of their own non-construction type projects. What they often don't realize is that the structural design as one item has its own internal flow chart as a subset of the overall project. The engineer can be a great help by communicating very clearly to the architect (and thereby to the owner) just what is needed in the way of information so that he can do two critical things:

- Prepare drawings sufficient to allow the fabricator (or in some cases the contractor) to place a mill order for the steel and then,
- Prepare design drawings that will allow the fabricator to prepare shop detail drawings for fabrication.

Every project has its own personality so what is needed may not be exactly the same in each instance. However, there are some guidelines which do apply generally. In order for the fabricator to purchase material he needs only the information to determine proper sizes i.e., member size, foot weight and length, material grade and a general concept of connections. First, here is the information which must be supplied by the owner and architect to the engineer so that he can prepare a mill order set of drawings for the fabricator:

- The building grid dimensions or bay sizes tied down (To the extent possible the architect should choose uniform bay sizes in order to speed up design and fabrication, see DESIGN).
- Floor-to-floor elevations clearly defined.



- Floor and roof loadings determined (which have a profound effect on member sizes).
- Every attempt should be made to provide the location of floor and/or roof loads imposed by mechanical units. Often these get by passed until later in the project with the consequence of considerable time lost and cost added later to modify the structure to handle the additional loads. It is far better to make some very conservative assumptions regarding these loads. Equipment locations should also be pinned down in as much as the ductwork can be run from any point under the steel. At this stage in the project all that is required is additional material. When changes are made farther along, it means adding both material and shop and/or field labor with the latter having the greatest impact on time and cost.
- Vibration limits, which can also affect member sizes. The type of office layout, for example, can affect member sizes in relation to available damping from interior partitions, or lack thereof in open plan schemes. Special limits due to sensitive production laboratory equipment and instrumentation can also affect member size.
- The approximate location of major floor openings such as stairways and elevator shafts and major roof openings such as for atria and large mechanical units.
- An elevation sufficiently defined so that column locations and bracing can be located.

In order to prepare the contract drawings that will allow the fabricator to produce shop drawings for fabrication, the engineer needs the following information from the architect:

- All of the remaining dimensions of the floor plate, i.e., exact floor elevations and duct clearances as well as exact dimensions of openings for such things as elevator shafts, stairways and mechanical equipment (floor or roof mounted).
- Edge of slab dimensions around the building perimeter as well as around floor openings.
- Dimensions and a general understanding of fastening method for wall systems as well as the loads involved.
- Other structural requirements unique to the project such as facades, setbacks, canopies, skylights and interstitial space for high-tech manufacturing facilities.

At this stage the architect needs to be substantially complete with the design except for interior finishes, waterproofing details and details of the wall system (as long as the method of fastening and the loads are determined).

In a perfect world it would be relatively easy to make all of the necessary determinations at the proper time in order to allow an orderly and expeditious progression of the job. Obviously, the more complicated the project the more difficult this is. One thing is certain, however, the more details that remain to be worked out or have to be changed after a mill order has been placed or after shop drawings have been prepared or fabrication started, the more cost and delay will be added to the project. Rework and field modifications are very expensive and time consuming.

In spite of the best intentions, it is not always possible to determine all requirements ahead of time. In order to keep the structural part of a job moving, certain things can be left to the erector even though this may involve additional cost compared to carrying out the work in the shop. In some cases, speed is the critical factor. Some typical examples are:

- Beam penetrations for mechanical requirements - these can be located, cut and reinforced, if necessary, in the field.
- Frame locations for roof openings - these can be welded up, located in the field.
- Connections for precast panels — these can be handled later by the erector.

Drawings for mill orders and for steel detailing should not be released by the engineer until they are complete. Because of schedule the engineer is sometimes pressured to release these drawings earlier with the almost certain consequence of delay and rework later in the schedule. It ultimately costs all of the players time and money by the end of the job.

The steel details or shop drawings are of course critical; they are the drawings the fabricator needs to fabricate the steel, as designed. Some suggestions to improve the shop drawing phase are:

- During the preparation of shop drawings the fabricator and engineer of record should be able to communicate directly with one another while at the same time keeping the contractor informed. Not having this direct access slows down considerably the process of solving detail questions. Of course, when architectural details or costs are involved, the chain of communications must be through the contractor.
- Complete the design of a particular element or stage of a project and then "freeze" it to avoid the stop and start of shop drawing preparation and release for fabrication. The original concept of "fast-track" construction was the orderly and sequential completion of chronologically linked portions of the project. What it has often become is the partial or non-completion of many of the elements of the project. The result is that the parties know what they want the structure to be, but the fabricator can't complete any logical segment because of open questions. One example would be web openings that might not be defined thereby holding up completion of one or two beams appearing on a dozen different drawings. Another example would be stair openings or atria where it may be difficult to "freeze" the design early. In this case it is better to finalize the remaining bays and release the drawings allowing fabrication to proceed. At the same time provision can be made for field connections, if necessary, for a specific bay or bays.

Fast-track construction should not mean, scramble but rather, think, plan and hustle.

- In the situation described above it may be difficult to nail everything down. If certain elements cannot be finalized, the engineer of record should at least inform the fabricator, architect and contractor as to what has or has not yet been completed on the design drawings.
- The shop drawing review process should not be regarded as an opportunity for the architect, engineer or contractor to start changing the overall design. Once again, there may be imperatives which require it, but these late changes will most likely impact schedule and cost.
- The use of prefabrication conferences to discuss detailing, shop drawing flow and potential delivery problems can greatly improve communications on steel projects.

The importance of the planning and coordination process described above cannot be overemphasized. There is an axiom that states the more time spent in the careful planning of an important task, the less overall time required to accomplish it. This is nowhere truer than in construction where both schedule and cost are at stake.

Design

The design of a structure can have a major impact on its material cost and the amount of time required to fabricate and erect it. In the discussion on Communications and Coordination above we stated that more time spent in the beginning stages on planning and design usually means less time will be required to complete the total project. Along these same lines, undue time pressure on the structural engineer will often result in very conservative designs. These tend to be less efficient and thus more expensive. In some cases, overly conservative design by the engineer may be a necessary and acceptable cost tradeoff in order to gain time; in other cases the additional cost may not be necessary or acceptable. Further, unrealistic time pressure on the engineer can result in a structure which is easy to design but difficult and more time consuming to fabricate and erect. Here's one example:

- The engineer, pressed for time does not investigate stiffener requirements at column flange moment connections but instead indicates "stiffeners as required." The fabricator, due to time pressure, assumes that stiffeners are required and bids accordingly. This impacts the time and cost to fabricate, especially if they were not required in the first place. The unneeded use of stiffeners also needlessly creates erection problems trying to erect the weak axis framing.

Time permitting, the engineer can do things in the design which will allow the steel fabrication to proceed more economically and quickly. Here are some recommendations:

- To the extent possible, design in a way that promotes repetition of members even at the expense of some added weight. This makes detailing simpler, steel erection easier and minimizes field detailing and modifications. A little extra steel in a few places is more than offset by savings in labor costs and overall savings in time. For example, choose uniform bay sizes so that there are fewer different pieces and connections to design, detail and fabricate. Following the same logic, minimize the number of different column sizes. Fewer different member sizes also increases the chance of having mill order quantities for better pricing.
- Maximize the practical column length in order to minimize the number of column splices which are expensive and time consuming to fabricate. The practical limits are determined by the type of building, shipping restrictions and the erection sequence. In many cases column lengths up to 40' are practical. Input from the erector is critical in making this determination.
- Minimize the amount of loose material such as angles on top of masonry, field installed coverplates for moment connections and field installed stiffeners, etc. Loose material is difficult to track and it presupposes field installation which is more expensive and takes longer than shop installation.
- When possible use shop-welded and field-bolted moment connections for the same reasons. Reducing field welding also lowers costs of testing agency services to the owner and scheduling inconvenience to the steel erector.
- The use of single-plate shear connections is also recommend because there are fewer details and they are safer and faster to erect.
- Don't put blind faith in computer programs which size members for least weight. Check member sizes for practicality in making connections. This avoids such conditions as framing a W36 beam into a W18, which is not practical. Encountering such conditions during the steel detailing phase simply slows down the whole process.
- When possible use standard AISC connection details. This facilitates shop drawing review and provides connections which are easy to fabricate and erect.
- When the engineer turns the structural drawings over to the fabricator the connection discussions start. These take a lot of time which could be greatly reduced if the engineer would indicate actual end reactions on the members. Simply specifying connections per a catch all provision such as "Connections shall be designed to one-half the uniform load capacity of the beam," opens the door for many questions and delays. This is also true for connections other than shear connections. For example, if it's not required for strength it's needlessly expensive and time consuming to develop the full moment capacity of a beam in the connection.

Some engineers take the time to indicate end reactions on the drawings because they have to be calculated anyway in order to design the members. But many do not. Indicating actual reactions is especially important with composite beams and more than any other item has the greatest impact on detailing and fabrication speed. This avoids any confusion as to whether or not a member is a beam taking only shear forces or a tension/compression member, or other. It allows greater accuracy; connections have less of a tendency to be over designed and more expensive than need be. Connection strength can be much more closely matched to design requirements. And, because this is a discussion about project speed, much less time is spent in connection design.

Showing end reactions along with beam and girder sizes provides the engineer with another check because a member which is inadvertently undersized may be detected by a sharp estimator or detailer.

For bracing members the axial loads and transfer forces and, their direction should be indicated. For moment connections, shears, moments and axial loads should be shown. For trusses indicate shears, moments (if any), axial loads and their direction.

Most important for purposes of our discussion of schedule-driven projects is the fact that when the engineer puts the above information on the drawings, fabricator bids will be much more responsive and timely. Furthermore, the time required to design the connections can be reduced by 60-80%.

- Joint reinforcement through the addition of web doubler plates and/or stiffeners is very expensive because of extra detailing, welding and shop inspection. Often the structure is more economical and delivery faster with the elimination of reinforcement by increasing member sizes and/or material grade. It is an economic and schedule decision that the fabricator can help make by weighing the cost of extra material against reduced fabrication costs.

If the engineer has determined that column reinforcement is the most economical solution and is therefore, necessary, drawings should show detailed doubler plates and stiffeners where required, or as a minimum show those connections where they are required and indicate the criteria and procedures by which all reinforcement is to be sized, detailed and welded. Doing so will result in more responsive and timely bids from fabricators.

Another way designers can speed up the construction schedule is to look at how every activity interacts with the others and then find ways to make them independent. "Decouple the trades," to coin a phrase. The purpose is to keep critical path activities independent of design input, work or performance of peripheral construction activities. Get items off the critical path to the extent possible. In some cases this may require some calculated compromises in the interest of gaining time. Each project has its own personality so examples of decoupling will vary in each case. With regard to the structural steel, the objective is to free up the fabricator to complete shop details and minimize any need to modify fabrication once underway. Here are some typical illustrations:

- Select a curtain wall system that does not require special holes, or angles or channels to be affixed to the steel frame during the fabrication process or conversely,
- Specify a predetermined curtain wall anchoring system at the outset of a project such as an 4 x 6 x 5⁄16 angle projecting to the face of exterior columns. Along these same lines keep in mind that the tolerances are different for structural steel and facade materials. Finish materials applied directly to the structural steel usually result in the frame tolerances being telegraphed directly into the facade. Therefore, make sure there is some method of making field adjustments to the attachment of facade materials. Doing so avoids discussions and delays toward the end of a job.
- Have the mechanical engineer and contractor establish and hold to the location of horizontal runs and vertical risers.
- Bring the structural steel down to footings rather than a foundation wall or, vice-versa depending upon which material is more critical from a critical path standpoint.
- Make foundation designs conservative so that foundation work can proceed before the steel design is complete.
- Separate masonry facades from the steel as far as vertical loads are concerned. In other words, where possible, make the building skin self-supporting. This allows the two systems to proceed independently and simplifies the detailing and erection of the frame.
- If schedule is really paramount, avoid mixing materials (e.g., structural steel, load-bearing masonry and precast concrete) in the primary framing. The coordination required between these trades can add considerable time to a schedule.
- If roof mounted equipment and roof penetrations cannot be located or sized exactly, rather than holding up the job, allow the erector to assemble and install framing in the field.

Another way to save considerable time and money is to paint the steel only when necessary. Considerable money and time can be saved by painting steel only in corrosive environments (such as paper processing plants) or where it is architecturally exposed and aesthetics dictate. Painting can add 1-2 man-hours per ton to fabrication. Not including surface preparation by blasting or other means which many fabricators provide whether the steel is to be painted or not, a single coat of shop-applied primer can cost $30-40 per ton of steel which is the same as increasing the in-place structural cost by 2-3%. Actual figures will depend on a project's location and individual characteristics. Here are some general guidelines:

- Steel encased in walls need not be painted. This was substantiated by an examination of a number of buildings torn down after as much as 50 years service, which indicated no corrosion of consequence. The study, reported on in 1954, is referenced in the Specification for Steel Buildings, Section M3, Shop Painting.
- There are many industrial applications where the steel is exposed in the interior that do not require painting. Surface rust will not compromise the structural integrity of the members.
- In other industrial and warehouse applications, painting may be required for cosmetic reasons, and in these cases, the most cost-effective way is to first blast clean the steel in the shop. During shipment it will develop light rust which can then be protected adequately with a single coat of field-applied surface-tolerant primer.
- Any buildings where the structure has spray-on fire protection should not be painted.

TEAMING

Even though the focus groups found many things that would help speed up conventionally bid projects, it became evident that forming a select team up-front, to include the steel fabricator, was most beneficial. The focus groups found that in the team approach it was very common for the general contractor or construction manager to consult with mechanical, electrical and plumbing trades and make them part of the team very early in the project. For some reason, it was not the usual practice to make the steel fabricator part of this team. This is a missed opportunity because input from a qualified fabricator in the early design phases of a project has a positive impact on the overall economy and speed of delivery of the structure.

Part of the hesitancy of the owner or contractor to commit to a fabricator early is the same as for other trades, the fear of not getting competitive prices. However, fabricators are capable of guaranteeing unit costs for detailing and fabrication of beams, columns, trusses, girders, girts and other elements. Prices per ton of material and costs for freight and erection can be established ahead of time. All these costs can be verified after the fact. In addition, guaranteed "not to exceed" lump sum prices can be established with the owner sharing in any savings.

Bringing a qualified fabricator and erector on board early in the design process can trim weeks and even months off a schedule. Even if the owner or contractor is not committed to the team approach it is a good idea for the contractor to at least make a short list of qualified fabricators and erectors and then consult with these companies. Their response will be much more meaningful if they have the feeling that their input and investment of time, which can be significant, will provide them with a reasonable chance of getting the job.

On the other side of the coin, the fabricator and erectors need to be able to show key owners and contractors that they have the expertise to help move a project along and the ability to perform as valuable team members. The message the fabricator and erector need to convey is that they are not simply in the business of selling shop hours or field hours; their mission is to construct buildings and to make it easier and faster to do so. The use of teams in construction is increasing and those who make themselves valuable team members will prosper.

What can the structural steel fabricator contribute as a team member? To help illustrate this let's first take a look at the typical scenario in the development of a project where all the activities are strung end-to-end: building program development, design, bid, award, shop drawing preparation, fabrication and erection. The owner meets with the architect to develop the building program, i.e., the building use, size, general aesthetics, layout, space requirements, structural systems and mechanical systems. The structural engineer is brought on board to design the structure according to the architect's wishes or after an analysis by the engineer. The architect continues to refine details and coordinate requirements for mechanical and electrical systems which often require the structural engineer to modify the design for the structural system. After much "back and forth" the structural drawings are ready for bid.

After award of the steel contract to a fabricator, discussions start between the fabricator, general contractor and engineer over details that have to be settled before the fabricator can order material, let alone start to produce shop drawings. For example, in preparing a mill order list the fabricator may have questions regarding columns. Do they run through the floors or do they stop at each floor? Where are the splice points? Furthermore, if the splices have to be located at the floor level, there may be so many other members framing in at this point that it may be very difficult, if not impossible, to locate a column splice at this same location. The fabricator wants to locate the splices above floor level. Answers are needed to be able to order material for columns. Let's assume that there are no additional costs in order to do this. The fabricator submits a RFI (request for information) to the general contractor who after some delay, forwards it to the engineer. The engineer determines that the request is feasible from an engineering standpoint and after an additional delay, sends it back to the contractor. The contractor sends the request to the architect, who after more time for review, forwards the decision back to the contractor. Finally, the RFI, either denied or approved, works its way back to the fabricator. It would not be uncommon for this process to have taken several weeks in order to resolve the issue. If additional cost is involved, reaching a decision can take even longer.

Often, many of the questions have to do with connection types and design, the answers to which may affect the type of material to be ordered, and which must be resolved in order to prepare shop drawings for fabrication. For example, are connections end-plate type or can they be shear tabs? Each requires a different member length. This generates another RFI and the whole process starts over again.

One focus group steel fabricator pointed to a recent project where there were almost 300 RFI's and a corresponding loss of time in the project schedule. One has to ask if there isn't a more efficient way to get a structure designed and built? The answer is yes, and a qualified fabricator team member can help in the following areas:

- Planning and Conceptual Design
- Design

A key to being able to work successfully with steel in schedule-driven projects is the timely and free flow of information between the parties during the conceptual design, detailed design, fabrication and construction phases. This sounds like motherhood and apple pie so let's be specific. The engineer needs information to help design a structure that will be economical and that can be delivered expeditiously. The fabricator needs information which will enable him to do advance work in material ordering, steel detailing and fabrication. In the traditional bidding scenario described above, direct communication between the fabricator and engineer is at best discouraged and often prohibited. This slows down the flow of information, often critical to answering technical questions, which can have a big impact on the schedule. There are structure-related questions that may occur during bidding, or after award of contract, that should not affect the plans or work of the architect or other parties. In these instances the fabricator should have direct communication with the structural engineer of record while at the same time keeping the contractor informed. In cases where costs and/or architectural details are affected, the chain must go through the architect and contractor. This direct communications is particularly critical during the preparation of shop drawings. This same issue was discussed in the previous section on communications and coordination.

With the team approach it is just as critical to have direct communications between the fabricator and the structural engineer. In this case, there is a collaborative psychology with all parties involved having bought in to the process. Regular exchanges of information occur as the project takes shape; free and open verbal communication is followed by written confirmation so that everyone is informed. An additional benefit to this collaborative psychology and free flow of information is that there are far fewer time consuming disputes.

The role of the fabricator as a team member is to help compress the schedule by resolving issues early and at the same time as the structure is being designed. In other words he provides value-engineering up-front at a time when it can have the most favorable impact on schedule and cost.

Planning and Conceptual Design

During the planning and conceptual design phase, the fabricator can help in the following ways:

- The fabricator can provide cost and material availability information by having access to mill-rolling schedules and steel service centers inventories. He can evaluate economy versus availability by weighing the option of making mill and/or service center purchases.
- Early designs can be checked for such things as economical bay sizes, elimination of column splices by increasing member lengths and repetition of member sizes. At the same time the fabricator weighs purchasing and fabrication economies against increased or decreased material weight.
- For complicated or exotic buildings such as those with special slopes, hips or valleys, the fabricator can provide information on suitable connection types. For industrial buildings, he can help decide between end-plate connections, seated connections or other types of moment connections. At this stage the fabricator can help avoid future controversy and waste of time by establishing job standards early.
- It is also at this point where the owner, contractor, engineer, fabricator and erector can determine the construction sequence and how a large project can be broken into sections or staged releases. Whatever is designed and fabricated must be built. The erector is more likely than any other party to know what the site conditions are and how they will affect how the building can be put up. Proper sequencing can have a major impact on the cadence and overall speed of the job.
- It should be added that the erector can also have valuable input regarding connection design and location and member design as they affect the stability of the structure during erection, speed and cost of erection and safety.

Steps to Take to Get Teamwork on Your Job

When schedule is the main driving force or motivation, clear communications becomes paramount. To this end, it is critical that all the players understand not only their individual roles but how their roles affect others in their abilities to propel a project forward. Each member of the design/construction team must contribute to clear, concise and direct communications. Some examples are:

- *The owner must acknowledge the value of bringing the entire team together early in the design phase and using the skills and knowledge of designers and contractors.*
- *The parties need to recognize the importance of "upfront" planning and coordination as a means of spending less overall time in getting the project completed.*
- *The contractor and owner need to strongly consider forming a team of key players, including the structural steel fabricator, in order to help the engineer make the best design decisions affecting cost and speed.*
- *The fabricator needs to position himself not simply as a seller of shop hours but rather as a valuable source of help to the engineer and the other team members to get the structure built at the lowest possible cost in accordance with a demanding completion schedule.*
- *The erector needs to position himself not simply as a seller of field labor but rather as a valuable part of the team who can help get the building erected quickly, economically and safely.*
- *The owner needs to set the tone of the project by being ready to make key decisions early so that design can proceed with a minimum of delay and change.*
- *The architect needs to be able to outline clearly to the owner what those decisions are.*
- *The architect needs to focus on completing work necessary for the definition of early construction packages.*
- *The engineer needs to be able to communicate clearly to the architect what the priorities are for architectural decisions so that the structural design can proceed apace.*
- *The contractor needs to allow direct communications between the fabricator/detailer and engineer during the preparation of shop drawings.*

One final note, if we are interested in continual improvement of the construction process in order satisfy our clients and ultimately enhance our abilities to get future jobs, it makes sense to assemble the team one more time at the conclusion of a project to critique the process. The tendency is to immediately race off to the next job whereas a quick evaluation of what worked best and what needed improvement in the most recent schedule-driven project, would be very helpful for the future.

Design

During the design phase the fabricator can accomplish the following:

- He can submit sketches of proposed details for special conditions and assumptions. As one example, he might recommend providing a continuous angle around the perimeter of the building for easy attachment of curtain wall. The fabricator also continues to advise on shape selection and standardization based on availability and economical design. And, of course, he continues to supply pricing information.
- The mill order can be placed at this time because elevations and

bay sizes will have been determined, and beams, columns and girders will have been sized and material grade selected. If the project is large enough to be designed in sections, the initial mill order would be for the first number of bays.

- Preparation of shop drawings can commence after the mill order is placed and remaining architectural and structural details are determined.
- The fabricator can also help the engineer make the economic determination as to whether or not joints in moment connections should be reinforced by web doubler plates and/or continuity stiffeners or, the columns simply increased in size. Doublers and stiffeners are expensive and time consuming to detail and fabricate, and therefore, in many cases it may be faster and more economical to increase member sizes and use 50ksi steel as a standard minimum.

PURCHASING

In cases where a project is being bid in the conventional manner, some construction managers have contracted directly with a steel detailer for production of shop drawings prior to the selection of a steel fabricator. The objective is to have the steel shop drawings prepared and approved progressively just behind the structural design drawings. Fabricators then bid to a set of already completed and approved shop drawings, thereby saving the time this normally requires after the fabricator has been selected. Although this seems like a straight-forward approach and has been done in a number of cases, it may not be the preferred way of doing things, at least from the fabricator's point of view. Here are two potential problems created by this procedure:

- After contract award there are usually changes that are either owner, contractor or construction generated. Questions then arise as to who will make the changes on the drawings, when they will be made, how they will get communicated to the fabricator and whether or not they will communicated in a timely fashion? And, are they made in such a way that is most expedient and cost-effective for the owner? This way of operating can slow down communications after the contract is awarded and, can affect the progress of the whole project.
- Shop drawings prepared without the benefit of fabricator input (referred to by some fabricators as "rent-a-shop") don't always serve the interests of the owner. For example, suppose a fabricator bid to a set of pre-approved shop drawings and was awarded the contract. The specifications did not call for shop grinding of certain welds but the owner and architect decided after the fact that these welds should be ground which is a very costly procedure. The independent detailer makes the change on the drawings and then they are transmitted to the fabricator who proceeds accordingly. Had the fabricator been responsible for the shop drawing preparation, he may have been able to avoid the grinding and still achieve the result desired by the architect.

Although not willing to condemn altogether the advance preparation of shop drawings by other than the fabricator, it seems that this way of operating should be limited to simpler projects where anticipated changes are minimal.

In other cases where a job is bid in the conventional manner, the schedule may be shortened by the owner pre-purchasing certain items before the structure is completely designed and ready to put out for bid. For example, if bar-joists are a critical delivery item they may be ordered directly by the contractor. Only the standard exact lengths need to have been determined at this time. This procedure can work in those cases where the building is uncomplicated with uniform bay sizes. Usually when one starts making changes in joist sizes, any advantages in delivery time quickly evaporate.

In a similar fashion there are times when the owner or con-

Specifications Available for Public Review

Two proposed AISC Specifications are nearing completion and will be available in draft form for public review and comment.

The AISC *Specification for the Design of Hollow Structural Sections* is a new document that provides design guidelines for hollow structural sections (HSS) in structural applications and their connections. It has been written as a complementary resource to the AISC *Specification for Structural Steel Buildings*.

The AISC *Seismic Provisions for Structural Steel Buildings* is a revised document that provides design guidelines for structural steel members and connections in buildings located in regions of high seismicity. It has been written as a complementary resource to the AISC *Specification for Structural Steel Buildings*.

If you are interested in providing review comments for either document, please fax a note to Charlie Carter (312/670-5403) or send him an email message (carter@aiscmail.com).

tractor can place the mill orders for steel in advance of selecting the fabricator. This assumes that there is sufficient design information to allow this and that either the owner or contractor is willing to live with any consequences of errors in material quantities or sizes.

A more feasible option is to break out the structural steel package and get bids from fabricators before the general package is complete. This way a fabricator can be chosen and a mill order placed. The fabricator is subsequently assigned to the successful general contractor. The main disadvantage is that it takes the general contractor out the decision loop but following this procedure can trim 4 to 6 weeks in lead time.

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