Building Blocks

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Issues Every Structural Engineer Should Consider When Using Foreign Steel

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The option to use structural steel supplied and fabricated in foreign countries for projects constructed in the United States is a realistic one for many projects in today's market. Typically, the most obvious factor that is considered by the project team is the economic impact of doing so. However, in addition to economics, project teams must also consider factors that may have a significant impact on the project outcome, including project-specific issues, design requirements, material substitutions, procurement, fabrication, and construction concerns.

Project-Specific Issues

When considering foreign-fabricated and foreign material-based steel, the first discussion needs to be with the Client. Some Clients already have experience with foreign products and, as a result, have already developed company policies. Clients may already have internal procedures and QC/QA requirements regarding items introduced by sourcing foreign products, such as the procurement of mechanical equipment, vessels, electrical components, and more. In other cases, this may be the Client's first experience with using foreign-fabricated steel or materials, and detailed discussions, meetings, and presentations may be required.

An open dialogue with the Client can help avoid unforeseen roadblocks. For example, depending on the financial arrangements of the project, there could be a "Buy America" clause that prevents the use of foreign-fabricated steel.

Jurisdictions

Local jurisdictions may not accept foreign grade material and foreign-fabricated steel. Also, if the project is within a Union jurisdiction, some Unions may be reluctant or refuse to erect foreign supplied or foreign-fabricated steel.

Design Requirements

United States building codes or Client criteria typically require that the design, fabrication, and erection of structural steel for buildings and structures shall be in accordance with the *Specification For Structural Steel Buildings* (ANSI/AISC 360). In higher seismic regions, the design and seismic detailing of structural steel for buildings and structures shall be in accordance with the additional requirements of the *Seismic Provisions For Structural Steel Buildings* (ANSI/AISC 341) and possibly *Prequalified Connections For Special And Intermediate Steel Moment Frames For Seismic Applications* (ANSI/AISC 358). These American Institute of Steel Construction (AISC) documents include design equations that are based on laboratory testing of standard shapes rolled in accordance with American Society of Testing and Materials International (ASTM) material specifications.

Each of these AISC documents requires that steel materials, shapes, bolts, and weld consumables be in conformance with specific listings of ASTM specifications. Although other material specifications may be used, the burden of proof that the alternate materials are equivalent must be determined by the structural Engineer-Of-Record (EOR). Legal approval of alternate materials rests with the local authority having jurisdiction and its building official (See IBC Section 104). Contractually, these materials may also have to be approved by the Client.

AISC Shapes

Section 1 of the AISC *Steel Construction Manual* includes a catalog of dimensions and properties for structural steel shapes. Some foreign suppliers may have a limited number of available shapes. This limitation would also need to be discussed with the Client as alternate shapes available from foreign suppliers may not match the shapes listed as AISC shapes in the *Steel Construction Manual.* This may be a concern for Clients particularly for future retrofit designs. However, some foreign fabricators do not have problems with obtaining ASTM material and AISC shapes. AISC shapes made in accordance with ASTM materials are now manufactured in many countries throughout the world. This topic should be discussed with each of the proposed foreign bidders.

Connection Design

Connection design must be considered. In certain areas of the country, connection design is delegated to the structural steel fabricator. If a foreign fabricator does not have access to a U.S. licensed engineer who is familiar with that particular state's codes, especially in high seismic areas, this may force the EOR to design all of the connections.

Another issue that is part of the steel calculations in moderate to high seismic areas, and related to the steel material properties, is the requirement in AISC 341 to use R_y and R_t when needed to calculate the expected yield stress or expected tensile strength of a member or connection. These values were developed based on an AISC funded study of U.S. domestic supplied mill certificates with detailed analysis to determine the coefficient of variation. The authors are unaware of any similar studies of foreign-based

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steel materials and are also unaware of any currently accepted procedures for determining R_y and R_t of foreign-based materials.

Software

Commercial CAD and engineering analysis programs typically include databases that contain a limited number of country specific shapes and materials. If a particular set of shapes and materials available from a foreign fabricator are not included in one of the currently available databases, then these would need to be created. Development of a database is time-consuming unless it is available in an electronic format that is compatible with the software platform used for the project.

Material Substitutions

The substitution of alternate materials has always been addressed in the U.S. codes. However, to substitute a material may be complicated and the procedure would need to start with the acceptance from the EOR for the specific project.

AISC 360, AISC 341, and AISC 358 identify approved materials. The EOR is responsible for accepting alternate materials as adequate substitutes. AISC design requirements are validated by physical testing of standard ASTM materials. Alternate materials may not reflect the ductility, fatigue, and fracture resistance that are indirectly accounted for by the physical testing. Chemical composition limits and Charpy V-Notch test results provide some assurance that the alternate materials will perform as expected. The AISC 360 Commentary outlines an extensive "punch list" of considerations and responsibilities for the EOR if alternate materials are supplied. Note that AISC does not provide acceptance criteria for these items.

AISC design documents also require that welding procedures and welder qualifications shall be in accordance with specific American Welding Society (AWS) specifications. AWS provides several prequalified welding procedures that are based on a list of required items and material properties that a foreign-based material may not meet. Most of the materials are based on ASTM specifications. This may require that structural steel welding procedures be qualified by testing, which can be very time-consuming and expensive.

ASTM

A Client may not accept foreign steel that doesn't meet ASTM standards. Alternate material suppliers would have to submit actual testing of all supplied materials. Many foreign material suppliers do not perform all of the equivalent ASTM tests. In addition to the testing documents provided for possible approval, ASTM specifications also require continuous testing of the material and provide very detailed requirements on how often this should occur; i.e., this is not a one-time submittal. For instance, the authors are unaware of any foreign material specification that is equivalent in all respects to ASTM A992.

It is not often understood that ASTM materials and AISC shapes are manufactured around the world by many steel producers. With the advent of adjustable rollers, nearly any shape can be made; it is more a matter of quantity required and the local supply and demand conditions. It should therefore not be assumed that only local material and shapes are available to the fabricator.

Most structural engineers focus on the strength of the steel materials, yield stress, minimum tensile strength, and modulus of elasticity. In higher seismic regions, structural engineers have the additional concerns of maximum tensile strength, yield stress to tensile strength ratio, and minimum elongation.

In cold weather and high seismic regions, structural engineers are concerned with fracture resistance which is intimately related to the chemical composition of the steel materials.

Welding engineers are primarily concerned with chemical composition and especially the deliberately added alloys in the material. Some elements added for strength may contribute to "hot cracking" while others may contribute to "cold cracking." If steels contain higher-than-desirable levels of sulfur, phosphorus, lead, or copper, these elements tend to segregate into the center of the solidifying weld bead which may lead to weld cracking.

High strength bolts are normally purchased by the fabricator through a third party supplier and shipped directly from the supplier to the job site. Bolts need to go through the same material approval process as structural members. There have been historical problems with counterfeit and out-of-specification fasteners. Because of this issue, some Clients ban the use of foreign manufactured bolts and bolt components.

Procurement

All project costs should be captured when evaluating competitive bids. Foreign fabricated steel can attract additional costs and possibly longer schedules than those from local suppliers.

Shipping Cost

Since a foreign fabricator could be located half way around the world, it is critically important that the bid evaluation includes the cost of shipping. A local U.S. fabricator near the job site may have higher unit rates, but when shipping costs are added, they may become the low bidder.

Tariffs

In addition to the shipping costs, a study needs to be conducted to see if there are any duties and tariffs on the foreign fabricator's imported steel. In some cases, there are no duties and tariffs if the project location is in a duty-free zone. If not, the duties and tariffs can be as high as 30 percent. These costs, if any, also need to be added to the pricing summary.

Bid Exceptions

To make sure that all costs are accounted for, each bid needs to be thoroughly reviewed for exceptions or what might be part of the bidder's standards. Some foreign bidder's standards differ from traditional U.S. bidders. For example, some foreign bidder quote fabrication drawings only in metric units, completely exclude the supply of bolts, nuts, and washers, and quote only ASTM A36 plate while the bid documents require ASTM A572 Grade 50 plate. Foreign bidders may also exclude all hollow sections (i.e. HSS and pipe), exclude complete joint penetration (CJP) welds, exclude nondestructive examination (NDE) testing, or exclude the pre-installation of stair treads in the stair stringers. It may be necessary to go back to the bidders to clarify or reject these types of exceptions or fabricator standards.

Timing of Fabricator Selection

Structural steel calculations are intimately related to the materials and shapes used. Selection of materials and shapes should be made before calculations are begun. If alternate materials and shapes are approved as part of the structural steel procurement process, after the structural calculations have begun, rework may affect both project cost and schedule.

Purchase Order/Contract Issues

Many items assumed in a standard bid document may not be specifically noted in the contract documents. For example, projects in the U.S. are typically in English and imperial units and, thus, the fabrication drawings are assumed to be in English and Imperial units. This may not be the case if a foreign fabricator's software defaults to metric units. All the bid documents from foreign fabricators need to be reviewed in detail to identify items that are unacceptable to the project team which may seem standard to the fabricator.

Typically, in the U.S., once the steel purchase order is signed, all pricing and contractual agreements are fixed. However, in certain countries, they consider the signing of the purchase order as the beginning of the negotiation for further changes. It must be emphasized to the successful foreign bidder that once they sign the contract, no changes are permitted unless something very significant occurs and is agreed to by the EOR.

Fabrication

Shop fabrication drawings are typically reviewed by the EOR. For projects in the U.S., it must be clearly stated in the bid documents that shop drawings are to be in English, use Imperial units, follow AISC detailing practices, and that weld symbols be shown in accordance with AWS A2.4.

Shop Certification

Clients or project specifications may not accept uncertified fabrication shops. If AISC shop certification is required, then each proposed fabricator should be verified through AISC's website of qualified shops. It should be noted that many foreign fabricators currently have AISC certification. Note that any steel outsourced by the fabrication shop shall also be AISC certified if required.

Welding Procedures

AISC design documents require that welding procedures and welder qualifications shall be in accordance with specific AWS specifications, which define prequalified weld procedures using steel base metal and weld metal materials that are in conformance with specific ASTM material specifications. Weld procedures using alternate materials may have to be qualified by testing, also defined in AWS specifications.

It is imperative that all Welding Procedure Specifications (WPS) include a copy of the proposed electrode manufacturer's data sheet, as it is likely that the WPS reviewer may not be familiar with this locally manufactured product.

Welder Qualifications

The Client or EOR may require that all welders be AWS qualified. This would need to be verified for all proposed foreign steel fabricators or a procedure developed for accepting foreign welders.

Third Party Material Testing

Until the EOR has worked with and has confidence with foreign steel fabricators, specifically in their procurement of materials, it is strongly recommended that all foreign supplied steel materials be continuously tested by an independent third party testing agency. Some Clients already have third party testing agencies that they have worked with and can make recommendations. Specific tests for mechanical and chemical testing need to be established, as well as their frequency.

Shop Inspection

The *International Building Code* (IBC) requires steel fabrication shops to have a Special Inspector or be acceptable by the local jurisdiction after reviewing the shop's QA/QC document submittals. Most jurisdictions in the U.S. accept AISC shop certification as meeting this requirement. However, if a foreign fabricator does not have an AISC certification, project schedules can be impacted while they obtain it.

Construction Concerns

Due to possible shipping size limitations (i.e. overseas container boxes and skids), the maximum size of members may be restricted. This could result in more column and beam splices.

Schedules

Fabrication and delivery times to the job site need to be discussed. Many foreign fabricators quote longer delivery times than domestic fabricators. The extra time required for shipping, unpacking, and segregating mixed loads needs to be accounted for in the project schedule.

Part of the reason for the extended fabrication schedules from the foreign fabricators is that it is common practice for them to buy the majority of their steel directly from the steel mills; whereas, in the U.S., the majority of the steel is available from local steel service centers. If the project cannot accept the extended schedule of the foreign fabricator, then discussions may be necessary for the procurement of steel by means other than from the mill. This will likely increase the steel unit rate costs which will need to be considered by the project team.

Field Changes

Steel members can be fabricated incorrectly or damaged in shipping. Most U.S. fabricators will immediately resupply the affected members and express ship the new pieces to the job site with little impact to the construction schedule. With a foreign fabricator, resupply will take more time and could impact the construction schedule. Field rework, although not as efficient, may need to be considered in order to have less impact on the schedule.

Conclusion

Although there may be economic reasons to purchase structural steel from foreign sources, it may not satisfy the total needs of the project. This article identifies several factors that the project team needs to consider in order to properly assess the impact of the foreign purchase on the total installed cost of the project and when the project may be put in service by the Client.▪