The Built World's Backbone: Working With Steel Fabricators, From Mill to Model

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STEEL ADDS BOTH STRUCTURE AND STYLE TO THE BUILT ENVIRONMENT. LEARN BEST PRACTICES FOR COLLABORATING WITH STEEL FABRICATORS AT EVERY PHASE OF A PROJECT.

It was steel, stacked sky-high on the shoreline of Lake Michigan, that signaled the coming prominence of skyscrapers, which would define cities of the 20th century and beyond. Steel skyscrapers in Chicago's Loop were among the first to use a skeletal structure built from carefully composed and engineered steel and decorated with sumptuous terra cotta, brickwork, or other masonry.

Facade possibilities were endless now that these structural systems were completely independent from their outward appearance. But late-19th century skyscraper triumphs such as Burnham and Root's Reliance Building and Holabird and Roche's Tacoma Building have given way to steel structure systems of increasing complexity, as well as decorative steel facades that are feats of wild sophistication and formal expression.

Steel is among the most versatile structural systems, used in many large commercial, institutional, industrial, public, and residential buildings. It's especially useful for sports stadiums, factories, large-scale agricultural buildings, and warehouses—any building type that requires rugged, durable construction over a large square footage. Given its diversity of uses, steel fabricators have an important role to play in shaping structural steel members long before they arrive at a jobsite.

How Steel Is Fabricated

After being cast from raw materials, lengths of steel arrive at steel-fabrication facilities in long, semifinished casting shapes. Beam blanks have a dog-bone shape, a bit like a typical

I-beam. Billets are square lengths, blooms are rectangular lengths, and slabs are much thinner rectangular lengths.

From these shapes, the slabs are reheated to become malleable and sent to the first steel-fabrication refining step: rolling mills. This is typically a multistep process that further refines their shape. The initial mill, called a breakdown mill, presses each piece of steel into an approximation of its final shape. The last step, the finishing mill, refines details.

Structural beams of steel are typically named by their cross-section shape, which defines their use and purpose. With its iconic profile, the I-beam is used horizontally and vertically because of its ability to resist lateral forces from nearly any direction. Channel beams, with their wide U-shaped channel, are often used for window and door frames where they grasp the adjacent wall and present a flat surface for door or window mounting. Circular hollow pipe sections are used on jobs that need structural members to resist torsion.

After steel beams are cut to length and cooled, they may undergo more refinements through cutting, burning, forming, machining, welding, and mechanical connections. Machining shaves away media with a lathe or drill until the desired shape is achieved. For thinner sections of material, cutting tools (lasers, plasma torches, or high-pressure water jets) can create exactingly complex shapes. These cutting tables are often CNC-controlled and heat the metal to its melting point of more than 2,500 degrees Fahrenheit. Steel members can be welded together or joined with bolts, rivets, or other methods.

Delicately curved steel components, like those in the facades of contemporary buildings, often require additional steps, as well as complicated algorithms to organize them like puzzle pieces onto a building. Advanced steel fabricator Zahner uses a range of methods to form thin metal plates into arcing, hyperbolic geometries, stretching steel to a nearly biomorphic limit, famously used by architects like Frank Gehry. Zahner is experimenting with new methods that are more efficient, less expensive, and require fewer upfront investments on molds and presses.

The company has pioneered a hybrid "English Wheel" method for double curvatures, updating a metal-fabrication tool that's been around for more than 100 years. An English Wheel is a simple steel brace holding two shaping wheels, which bend a flat panel of metal up or down with force. But at Zahner, a robot arm takes the place of the Victorian-era workmen, using machine learning to decode the path of motion needed to warp steel into the desired curvature.

Benefits of Steel Fabrication

Steel's high strength-to-weight ratio and ductility make it popular as a building material. Historically, steel was a precursor to architectural prefabrication; given the diversity of joinery methods available, it rolls off the assembly line ready to be slotted into place. These same qualities make it ideal for full modular or prefabrication projects, as welds and bolts work much more efficiently onsite than concrete pours and wood buzzsaws.

Steel fabrication can be an energy-intensive process, but steel also has several features that mitigate its climate impact. Steel is an exceptionally durable material that's resilient to the elements (wind, rain, salt); resistant to mold and mildew; and inhospitable to pests. Most important, steel is highly recyclable: it suffers minimal degradation when it's reused, which limits new extractive mining operations. Even previously unusable steel by-products such as slag (the impurities pulled out of molten steel during production) are finding their way onto building sites. Slag cement, for example, grinds bits of slag into a fine powder that can replace a portion of Portland cement.

How to Find the Right Steel-Fabrication Company

Most steel-fabrication companies specialize in specific manufacturing sectors (automotive, industrial, or architectural), so it's advantageous find a building expert. Make sure the steel fabricator has the capacity to produce the components you need, from basic billets to bespoke panels, with the attendant level of formal complexity and metallurgical composition.

The steel-fabrication process is increasingly digitized and automated. Builders and designers will benefit when fabricators' digital models can interface with their own software - or at least be easily translated into the relevant

format. In fact, high levels of automation across the entire fabrication process often indicate a superior degree of quality control.

For complicated projects, ensure that fabricators can quickly invest in new staff, fabrication equipment, and techniques. Companies that check these boxes are usually financially sound; paying competitive wages without an overwhelming debt burden and using well-maintained infrastructure. Jobs that are especially complicated can benefit from using a local steel fabricator when possible; this could bring familiarity with zoning and regulatory issues to the table, reducing logistics chain issues. Amid the supply chain chaos of the pandemic, it's also good to look for fabricators with redundant supply lines for raw materials.

Talk to current and former customers - and not just the ones that the fabricators direct you to. This can help you get an idea of how the company handles customer service and product delivery. As with any large-scale, complex business, it's critical that fabricators can work within required timelines, deadlines, and scope. Communication on these issues is perhaps the most important factor in determining if the relationship will be successful.

How to Improve Collaboration With Steel Fabricators

For two decades, Bart Rohal of Steel Detailing Online, Inc., has provided steel detailing services to the Western United States, currently focusing on drawing production and BIM (Building Information Modeling). According to Rohal, the sooner steel professionals are brought into the architecture and engineering process, the greater the potential for cost and time savings.

Rohal envisions a new position he'd like to see, filling a missing role between steel fabricators and architecture and engineering firms. "I believe it would be prudent for the project owner in the architecture and engineering industry to subcontract what I will coin as a 'qualified QCSD,' or quality control steel detailer, to review a steel project between the DD [design development] and CD [construction documents] stage," he says. "This does not require the QCSD to be the contracted steel detailer, but rather more of a steel consultant before it goes out to bid. This can save the owner on a steel project substantial overall costs and delivery time. In addition, the architecture and engineering team will pick up valuable steel tips that can be applied on future projects."

Another way to create an efficient workflow between designers and fabricators is to make sure the entire team is using American Institute of Steel Construction (AISC) standards to document their work. AISC dictates that steel-construction drawings are detailed within tolerances of 1/16-inch and four angle decimal degrees. The challenge for detailers like Rohal is that not all design models follow that specification, requiring him to create a request for information (RFI) to determine the basic steel layout. "Two-D designs and 3D BIM models need to be set to AISC standards at the beginning of a project," he says. "If not modeled to AISC specs, steel detailers would rather start from scratch than recheck or verify the entire [Autodesk] Revit model first."

And although most professionals move from one project to the next without a lot of introspection, Rohal suggests formalizing a post-project review phase when team members can evaluate RFIs, recognize advantages, and unpack complications with the benefit of hindsight. "Architecture and engineering firms should incorporate an [in-house] post-project review on specific projects with steel-savvy RFIs," he says. "This will incorporate ideas on future projects and adjust their standards to suit the most economical and structurally sound process."

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