Structural Steel: An Industry Overview

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American Institute of Steel Construction
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The United States structural steel industry supplied fabricated and erected structural steel framing for over 10,000 buildings, bridges and industrial facilities through a network of producers, service centers, steel fabricators and erectors in 2017 down substantially from a peak of nearly 15,000 in 2006 and 2007. The decrease in market volume was the result of a downturn in overall construction activity. Total industry employment in 2017 was estimated to be in excess of 200,000 individuals in 2,300 firms down approximately 15% from 2006. Total industry revenue in 2017 was estimated to be in excess of 20 billion dollars. It is anticipated that industry employment and revenue will expand by four percent during 2018 based on the current 2018 growth rate of non-residential construction.

Structural Steel Supply Chain

The four distinct components of the structural steel industry are:

- Producers of structural steel products, including hot-rolled structural sections (wide-flange shapes, plate, channels and angles) and manufacturers of hollow structural sections (formerly known as tubular steel).
- Service Centers, which function as warehouses and provide limited preprocessing of structural material prior to fabrication.
- Structural Steel Fabricators, which physically prepare the structural steel for a building or a bridge through a process of developing detailed drawings (the work of a detailer) based upon the construction drawings provided by a structural engineer; material management; cutting; drilling; shop fitting (bolting and welding); painting or galvanizing (when required); and shipping.
- Erectors, which assemble the structural steel members into a structural frame on or off the project site by bolting and field welding structural steel components together according to the construction documents.

Producers

Four structural steel shape producers—Nucor-Yamato Steel/Nucor Berkeley, Gerdau, Steel Dynamics Inc. and Bayou Steel—account for over 95% of all hot rolled sections produced in the United States at six mill locations. Five producers, including the four mills mentioned above, supply the market with other hot-rolled shapes, such as angles and channels. All hot-rolled shapes are produced using electric-arc furnaces with ferrous scrap as the primary feed stock. The use of scrap results in an average recycled content greater than 93% for all hot-rolled structural material produced in the United States.

Hollow Structural Sections (HSS) for building applications are produced by a significant number of manufacturers including Atlas Tube and Nucor Tubular Products, who account for more than 75% of the HSS production for buildings in the U.S. HSS are manufactured from sheet steel that may be produced in either a basic oxygen furnace or an electric-arc furnace. The recycled content of these sections is 33% and 90%, respectively. The domestic market for HSS in 2017 was approximately 1.6 million tons.

Steel plate is used in the construction of both bridges and buildings and is produced domestically in both electric arc and basic oxygen furnaces. The weighted average based on production method for recycled content of plate used in construction applications is 75%. U.S. plate producers serving the construction market include Arcelor-Mittal, Nucor and SSAB. AISC estimates are that 700,000 tons of plate are used annually for construction projects in the United States.

Sustainability

Structural steel has long been considered the premier green construction material, and the structural steel industry continues to improve its leading environmentally friendly position by further reducing greenhouse gas emissions. While numerous legislative and regulatory efforts in recent years have targeted emissions, energy efficiency, and related environmental concerns, the structural steel industry has been proactive in pursuing measures of its own that typically exceed regulatory requirements.

The results of structural steel industry efforts are evident in recent findings on greenhouse gasses, which show that on a per ton basis the iron and steel industry reduced carbon emissions by 36% and energy intensity by 31% since 1990. By comparison, initiatives such as the Kyoto Protocol would have required U.S. industries to reduce emissions by 5.2% by 2012.

At the same time, the industry remains the world leader in the use of recycled material and end-of-life recycling, with the recycled content of the structural steel beams and columns produced at U.S. mills exceeding 93% and a recovery rate of 98%.

Production and Demand

Production of hot-rolled structural shapes in the United States in 2017 exceeded 6.1 million tons, of which 8% was exported. Approximately 4.4 million tons of this total represented wide-flange shapes. Imports of both mill and fabricated material have increased significantly over the past five years. In 2017 21% of the structural steel used in the U.S. was sourced from overseas with 14% of the structural steel erected in the United States fabricated outside the U.S. This increase in imports from countries providing direct and indirect subsidies to their steel industries, has placed significant pressure nthe domestic structural steel producers and fabricators.

A recent update of a 2009 structural steel utilization survey, including HSS, indicated 40% of domestic consumption of structural steel is utilized in building projects under roof, 45% in non-building structures and 15% for non-structural applications.

Industry productivity has increased significantly over the past 40 years helping to reduce the overall cost of construction. The average number of man-hours required to produce a ton of structural steel has decreased from 12 man-hours/ton in 1980 to just over 0.6 man-hours/ton today.

Domestic demand for hot-rolled shapes increased by 3% during 2017 compared to 2016 primarily as a result of increasing demand in the non-residential building sector.

Tariffs

On March 23, 2018 the United States imposed 25% tariffs under Section 232 of the Trade Expansion Act of 1962 on imported mill steel including structural shapes, plate, and hollow structural shapes (HSS). However, these tariffs don't apply to im¬ported fabricated

structural steel. Subsequently, tariffs are also being considered for fabricated structural steel imported from China under Section 301 of the Trade Act of 1974. Since March there has been an increase in the price of domestic mill material resulting in modest increases in the cost of the overall steel package of which mill material represents approximately 30% of the cost. Other materials including wood, concrete and rebar have also seen cost increases during 2018 impacting the overall cost of project. It is unclear what impact higher construction costs will have on con¬struction activity. For up-to-date information on tariffs, visit www.aisc.org/tariffs.

Service Centers

Service Centers stock all types of structural material, and are located throughout the United States. Approximately 65% of material flows through service centers to fabricators, with the remainder of the material being supplied directly from producing mills to fabricators or other direct users of structural material. Service Centers typically hold two to three months of demand in inventory. A listing of AISC member service centers is available at www.aisc.org/servicecenter.

Fabricators

There are more than 1,700 steel fabricators in the United States supplying fabricated structural steel for building and bridge projects and 959 of these are AISC members. Among these 1,700 fabricators are 1,114 facilities certified for the fabrication of buildings and 370 facilities certified for the fabrication of bridges. The typical steel fabricator is a family-owned business employing from 10-to-100 people. Employee classifications include salespeople, engineers, project managers, detailers, shop workers, equipment operators, welders, painters, inspectors, delivery drivers, and administrative personnel. Projects may range from the fabrication of several tons of structural steel for a small retail store to 25 tons for a rural overpass to tens of thousands of tons for a large, high-rise structure or major bridge. A very rough rule of thumb is that one ton of steel is required for every 200 square feet of building area.

Fabrication Process

The fabrication process for a building is driven by plans developed and sealed by licensed structural engineers which specify all design aspects of the structural components based on the building layout developed by an architect. Upon award of the project the fabricator typically is responsible for creating detail drawings of each piece of structural steel which are developed from a 3D model of the structural frame. These details are produced by a steel detailer to develop a dimensionally accurate drawing of each fabrication piece, including all connection details. Steel detailers either work directly on the staff of the fabricator or on a sub-contract basis. The detail drawings are then submitted to the structural engineer for approval.

Following a determined sequence that is optimized for shop flow and project schedule, the appropriate structural steel members are then cut to the proper length and drilled, plasma cut or punched, and all additional shop work is performed on the member. When required, the member is cleaned and coated with paint or galvanized. The members are then grouped in the order in which they will be erected in the field, placed on a truck for shipping and delivered to the project site.

A typical fabrication project will require between 15 and 30 hours of shop time per ton of fabricated steel. Material costs account for between 25% and 30% of the final cost of the fabricated and erected structural steel. Fabrication and erection costs for structural

steel vary greatly based on the type of structure being constructed, the number of pieces, local labor conditions and the complexity of the connections. An AISC member fabricator in the area of the project (a list of member fabricators is available on the AISC website www.aisc.org) is the best source for fabrication costs for a specific project. The practice of minimizing the weight of the structural steel in a building is often short-sighted as lighter sections, while satisfying the strength requirements of the structure, may result in more costly connections and fabrication procedures.

Bridge Fabrication

Although the bridge industry follows a similar fabrication process, it differs in some key areas. If a bridge is selected to be funded, it becomes part of a state's long-term improvement project list. These long-term improvement projects are updated periodically to reflect current needs. Depending on the complexity of the project, it may require more extensive environmental review, public involvement and approval by the State Legislature and the Governor. Projects then enter the design phase where project plans, specifications and estimates packages are prepared. Many states have been forced to reduce engineering staff and are becoming more reliant on consultants for design services. However, states will choose to perform design in-house if possible. At this point the plans, specifications and estimates package are prepared for contractor bidding. A competitive bid letting process is often used for selecting fabricators. Construction may start within 30 to 45 days of the contract being awarded.

Owners are faced with reduced construction and maintenance budgets, and will look for ways to reduce the first time and overall life cycle cost of their bridge assets. Many owners today now see weathering steel as the first choice for corrosion protection and as a way of reducing fabrication, maintenance and overall life cycle costs. However, weathering steel is best suited for specific sites were it is not exposed to moisture for prolonged periods or aggressive salt environments. In these instances, bridge owners can still rely on paint, galvanizing or metalizing.

Bridge construction and maintenance is most often funded by a combination of state and federal taxes and fees. In the case of tollways, revenue generated from tolls is also used as a means of funding bridge construction. Public Private Partnership (P3) are also being looked at as a means of financing, operating, and long-term maintenance of the bridge project.

In May 2012, NSBA conducted a nationwide study to determine the capacity of the domestic steel bridge fabrication industry. The survey asked U.S. bridge fabricators to state their 2010 plant use as a percentage of their overall capacity. Survey results determined that, on average, our nation's significant steel bridge fabricators used only 67% of their total plant capacity in 2010. This result is conservative as stimulus funding from the 2009 American Recovery and reinvestment Act (ARRA) created a higher demand than would have been typical at the time of the survey.

Certification

Many fabricators, both AISC members and non-members, have taken the additional step of obtaining AISC Quality Certification. This program is similar to an ISO certification program but specialized for the intricacies of steel fabrication. Companies are audited on an annual basis; while the program doesn't certify product, it does verify that the fabricator has the processes, equipment, manpower, commitment, and experience to perform the necessary work and meet a minimum level of industry accepted quality standards. A list of AISC certified fabricators is available at www.aisc.org/certification.

Erectors

Erectors are the most visible component of the structural steel supply chain, because they perform the actual construction work at the project site. Most building erection is performed under the same contract as the steel fabrication, with the fabricator either providing in-house erection services or sub-contracting the erection work to a qualified firm. Field erection involves assembling the structural components in proper sequence while maintaining the structural stability of the partially completed structure. Stringent safety standards have significantly reduced the number of injuries occurring during steel erection. The erection team also is responsible for bringing the final building structure into plumbness, level and alignment within the required tolerances.

Over the years, the bridge design and construction industry has looked for ways to reduce delivery time of a bridge project through the implementation of Accelerated Bridge Construction (ABC). ABC represents a wide range of technologies including Prefabricated Elements and Systems (PBES), a nod toward modular construction and its ability to reduce cost, reduce schedule, reduce traffic delays, and improve the safety of both construction workers as well as commuters. For more information about Accelerated Bridge Construction, specifically on Prefabricated Bridge Elements and Systems, visit the FHWA ABC website at http://www.fhwa.dot.gov/bridge/abc/ or Florida International University's ABC-UTC website at www.abc-utc.fiu.edu.

AISC offers a Certification Program for erectors and currently 383 erectors are certified. A list of AISC certified erectors is available at www.aisc.org/certification.

Marketplace Demand for Structural Steel

Structural steel is the leading structural framing material for buildings in the United States, with a 46% market share for 2017 for non-residential and multi-story residential construction. The market share for the closest competing material—reinforced concrete—is only 34%, indicating a strong market preference for structural steel.

Market share values for all structural framing materials over the past nine years for non-residential and multi-story residential building construction based on square footage are as shown in the following table. The increasing proportion of residential construction since 2011 has resulted in an overall decrease in steel market share.

Non-residential construction represented 37% of the overall demand for structural steel with each point of market share being equivalent to 40,000 tons of structural steel. Multi-story residential construction accounted for 8% of the overall demand for structural steel with each point accounting for 500 tons of structural steel. Structural steel's multi-story residential market share, which includes hotels and dormitories, has grown significantly over the past five years and is currently 37%.

The remaining demand for structural steel is comprised of two market segments:

- Non-building structures, which includes open-air stadiums, process and chemical plants, power plants, petroleum refineries, and other buildings that do not have a roof. Structural steel maintains a dominant share in these markets with these non-building structures generating approximately 40% of the demand for structural steel.
- Non-structural applications such as rack systems, marine applications, trailers, transportation and mobile homes comprise 15% of the overall demand for structural products.

Bridges are a special case in that the majority of bridge structures are fabricated from plate steel rather than hot-rolled shapes or HSS. Plate steel is not considered in the supply or demand calculations presented above. Hot-rolled shapes for bridges comprise 6% of the overall market for structural steel and are included in the non-building structures referenced above.

Market Share by Construction Material	2009	2010	2011	2012	2013	2014	2015	2016	2017
Structural Steel	56%	58%	56%	51%	47%	49%	48%	49%	46%
Concrete	20%	21%	22%	28%	31%	31%	33%	32%	34%
Wood	7%	7%	8%	8%	9%	8%	8%	9%	10%
Pre-engineered	7%	6%	6%	6%	6%	5%	5%	4%	4%
Masonry	10%	9%	7%	7%	7%	7%	6%	6%	6%

Source: Dodge Analytics

Key Marketplace Advantages of Structural Steel

The dominant market share of structural steel demonstrates the continuing recognition of the advantages structural steel brings to building projects. Architects, structural engineers, general contractors, transportation departments and building owners choose structural steel because:

- Structural steel is fabricated off-site under controlled conditions, ensuring high-quality and reducing the number of costly fixes at the job site. This also allows for just-in-time delivery, which accelerates overall project schedules.
- Structural steel is reliable and predictable. It's produced to precise tolerances and consistent strength levels. There are no secrets with steel—what you see is what you get. Steel is strong, lightweight, durable, impact resistant, straightforward to inspect and easy to refurbish or repair. This makes steel easier to design and use.
- Structural steel is at full strength as soon as it's erected, which makes project schedules predictably shorter. For the same load and span requirements, a steel girder will require less depth than a corresponding concrete girder efficiently addressing any vertical clearance or complex geometry issues.
- Bridge and building life spans exceeding 100 years are common place. High performance weathering steel and coating technologies provide reliable protection from corrosion when steel is exposed to the elements.
- Structural steel leads the construction industry with a fully integrated supply chain that uses advanced technology at all stages of design and construction. This technology has been proven to reduce or eliminate errors, improve safety and lower project costs.
- Today's modern mills produce structural steel containing over 95% recycled material. At the end of the life cycle of a building, 100% of the steel frame can be recycled (the current recovery rate for structural steel is 98%). Steel is the premier choice for environmentally conscious projects. A new bridge requiring 500 tons of steel would typically use the steel from 300 old cars, 250 dishwashers, stoves and refrigerators, 60 tons of industrial scrap and 50 tons of recycled curbside waste.
- Structural steel provides owners with buildings that generate revenue earlier, maximize the amount and use of floor space, are easy to modify and easier to sell, and are aesthetically pleasing.
- Structural steel is the most economical building framing material for both buildings and bridges. Erection costs are lower because construction with steel is faster and lighter requiring smaller and fewer pieces of equipment for a shorter period. Foundation and pier costs are less because steel is lighter. Less steel is required because steel can take advantage of composite design techniques maximizing the structural contribution of both the steel structure and the concrete deck.
- Structural steel used in bridges and buildings is aesthetically pleasing.
- Structural steel is "Made in America." Domestic production and fabrication capacity is available to meet current demand and any anticipated market growth.

American Institute of Steel Construction

The American Institute of Steel Construction (AISC), headquartered in Chicago, is a non-partisan, not-for-profit technical institute and trade association established in 1921 to serve the structural steel design community and construction industry in the United States. AISC's mission is to make structural steel the material of choice by being the leader in structural-steel-related technical and market-building activities, including: specification and code development, research, education, technical assistance, quality certification, standardization, market development and advocacy. AISC has a long tradition of service to the steel construction industry providing timely and reliable information.

AISC's current membership includes:

Full (producers, service centers and fabricators)	979 firms
Professional (architects and engineers)	30,396 individuals
Affiliate (construction professionals and building code officials)	979 individuals
Educators	1,210 individuals
Students	15,151 individuals
Associate (allied firms and organizations)	490 firms

AISC has developed and administers a certification program for both member and non-member fabricators and erectors. AISC Certification sets a standard for the steel industry. Companies that are AISC Certified have been through a rigorous initial evaluation, and are subject to yearly reviews. An independent auditing company, Quality Management Company, LLC, confirms that companies have the personnel, knowledge, organization, equipment, experience, capability, procedures, and commitment to produce the required quality of work for a given category, whether they are a fabricating plant or erector. There are currently 1,114 AISC certified building fabrication facilities, 370 AISC certified bridge fabrication facilities and 383 AISC certified erectors. In addition, 176 companies hold AISC certification for bridge and highway metal components and 14 firms are certified to fabricate hydraulic structures.

The National Steel Bridge Alliance (NSBA) is a division of AISC focused on providing technical support and market development activities for bridge projects throughout the United States.

AISC has a long tradition of service to the design community and construction industry of providing timely and reliable information. Designers, builders, and developers are encouraged to contact the AISC Steel Solutions Center with any questions related to the use of structural steel.

The Steel Solutions Center can be contacted at 866.ASK.AISC or via email at solutions@aisc.org.

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