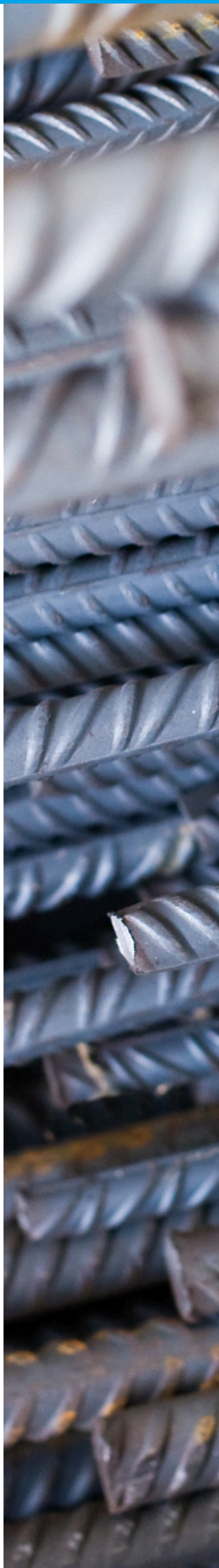
Steel

10 Things Every Structural Engineer Should Know

JANUARY 2026



01 Steel mills account for ~90% of steel industry cradle-to-fabricator-gate GHG emissions.

Steel mills typically fall into one of the two categories: an integrated mill which utilizes a blast furnace combined with a basic oxygen furnace (BOF) or a mini-mill which utilizes an electric arc furnace (EAF). Both processes result in a raw steel material that can then be further processed into different steel alloys and structural members. The remaining 10% of emissions associated with the steel industry are due to secondary processing, transportation, and fabrication.

02 The blast furnace is a common machine in steel manufacturing, producing an intermediate material in the process of making steel.

A blast furnace converts iron ore (rocks or minerals from which metallic iron can be efficiently extracted) into an intermediate processed form of iron known as pig iron. Coke (fuel created by heating and processing coal or oil) is utilized to develop extremely high temperatures. Additional inputs include flux materials such as limestone. Additional outputs include slag which can be processed into a useful supplementary cementitious material for use in concrete or used as an aggregate.

03 A basic oxygen furnace (BOF) is a complementary component to the blast furnace which produces the raw steel material.

A BOF converts pig iron into raw steel material. This is achieved primarily through an oxidation process that removes excess carbon from the pig iron. Additional inputs include flux materials such as limestone and steel scrap metal that can be utilized up to 30% of the total raw material input. Additional output is slag material, although BOF slag is not typically of a quality to be used as a supplemental cementitious material in concrete and is typically landfilled.

04 An electric arc furnace (EAF) is an alternative manufacturing method that is powered by electricity instead of by processing coal or oil.

An EAF converts steel scrap into raw steel material through the introduction of an electric current. iPig iron, direct reduced iron (DRI) or hot briquetted iron (HBI) processes can be used to convert iron ore into a usable input if inadequate steel scrap is available. Sometimes additional carbon, oxygen, or natural gas are introduced during the process as well. Additional output is slag material, although EAF slag is not typically of a quality to be used as a supplemental cementitious material in concrete and is typically landfilled. Nearly all domestic rolled shapes are produced using EAFs.

05 Steel scrap and recycling are important aspects of steel manufacturing that reduce the climate impact of the industry.

The steel industry is driven by recycling and steel scrap has high value in the domestic economy. Steel can be continually and completely recycled (cradle-to-cradle). Its magnetic property allows it to be easily removed from various waste streams. Domestic structural steel on average contains 90% or more recycled content and 98% of structural steel is recovered at the end of the material's life for recycling. The steel industry is the largest recycler in the US by mass.

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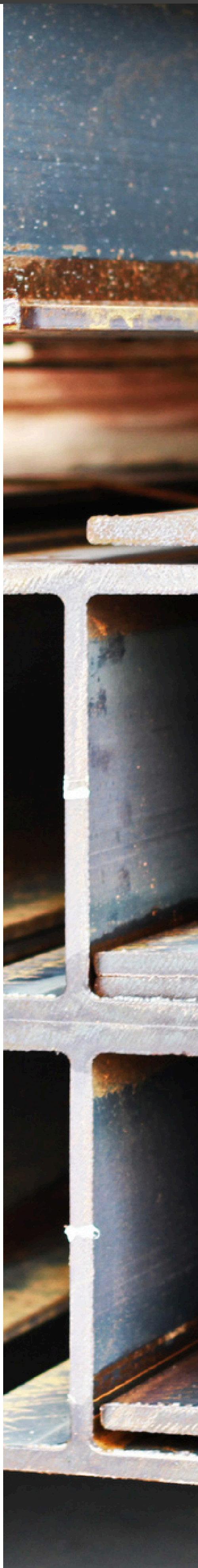

06 The domestic climate impact of steel is less than the global impact of the sector due to a large degree of efficient production processes.

The US is a leader in the efficient production of steel. The average CO2 intensity per ton of steel produced in the US is less than half that of steel produced in China and two-thirds that of steel produced in most European facilities. This is a result of high amounts of EAF usage (68.3% of production compared to 28.6% for the world average). The US also has high availability and a mature market for steel scrap collection and use. The steel industry accounts for 8% of global GHG emissions and 2% of domestic GHG emissions. Note that the built environment accounts for 59% of the total steel used domestically and more specifically buildings account for 32%. The following values published by the World Steel Association highlight the order of magnitudes of different production processes: 2330 kg-CO2e/metric ton for integrated mills, 1370 kg-CO2e/metric ton for mini-mill production with high DRI content, and 680 kg-CO2e/metric ton for mini-mill production with high scrap content.

07 Environmental product declarations (EPD) are important documents that describe a material's climate and environmental impacts.

EPDs are readily available for a variety of different steel products including HSS members, WF members, plate material, steel decking, rebar, and joists. The domestic structural steel industry has a near 100% coverage rate for facility-specific EPD representation. When reviewing an EPD it is important to understand if it represents an industry average, a specific product/ supplier, or a specific facility. Additionally, users should note whether a steel EPD is displaying a cradle-to-mill-gate, cradle-to-manufacturer-gate, or cradle-to-fabricator-gate scope; as the A1-A3 definitions change based on the perspective of the EPD author. Note that there can be significant variation in the embodied carbon reported in EPDs for different types of steel products depending on the impacts of secondary processing and the source of raw materials and electricity. As an example, the GWP reported in the industry-average EPD for HSS is greater than that for WF due to use of coil material produced in integrated mills by some manufacturers, however steel products must be evaluated on a functional basis rather than a mass basis.

08 Several opportunities exist to reduce the climate impact of steel production at the steel mill level.

Reduction opportunities can be categorized by the two types of mills described in item 1. For a mini-mill, reductions are driven by the source of electricity. This could include increasing the share of renewable energy in the grid or the owner of the mill investing directly in on-site or off-site renewable energy. For an Integrated Mill, it is likely to involve a combination of direct carbon capture and storage, green hydrogen fuel, and transitioning production to alternative production methods (I.E. DRI combined with an EAF).

09 Designing steel components for efficient material usage is effective to reduce the climate impact of steel.

Build smart through early design decisions and build light with the goal of reducing the amount of steel used on the project (reducing emissions and costs if done effectively). Consider steel specific material strategies such as cambering, castellated beams, designing load-optimized members, addressing fireproofing, using high-strength materials, and involving a local fabricator as early as possible. Also consider solutions applicable to all materials including structural optimization, maximizing design utilization, refining serviceability criteria, engaging in "smart" coordination, utilizing parametric design methods, and conducting floor bay studies.

10 Circular construction practice like steel reuse can drastically reduce the climate impact of steel construction.

Steel reuse can result in significant reductions in emissions and strengthens the circular economy and cradle-to-cradle nature of the steel industry. Steel reuse may involve full building reuse, reuse of components from an existing building on site, or reusing components from an offsite location. Steel component reuse has the advantage of avoiding the emissions associated with raw material production (i.e., the emissions that occur at the steel mill).