The Integrity of Steel:

Navigating Availability, Cost, Sustainability and Carbon in a Changing Construction Landscape

Prepared by Extreme Steel Inc.
Technical review by Jassiel Vargas, P.E., Structural Engineer

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This document is provided for general industry discussion only and does not constitute project-specific engineering guidance. Project performance depends on design criteria, jurisdictional requirements, material sourcing and execution methods.

Introduction

From high-performance data centers to adaptive reuse of historic infrastructure, steel has long been the structural backbone of modern construction. In today's rapidly evolving environmental and economic climate, the integrity of that backbone is under pressure.

Global demand is rising, supply chains remain volatile and expectations around sustainability are growing more urgent. At the same time, developers, owners and design teams face tighter timelines, stricter carbon mandates and higher scrutiny from investors, insurers and the public. In this context, the conversation around steel is shifting, from "how much does it cost?" to **"how well does it perform for the future?"**

Steel construction today faces mounting pressure from rising costs, unpredictable availability, embodied carbon concerns and growing demands for long-term performance. Meeting these challenges requires more than material strength. **It calls for a new understanding of integrity that includes how steel is sourced, delivered and managed through its entire life cycle.**

Forward-thinking firms are responding with smarter strategies that align performance, sustainability and accountability from start to finish.

The Challenge: Pressure on Steel from All Sides

1. Volatile Availability and Global Supply Shocks

The steel supply chain is increasingly sensitive to geopolitical instability, regional production bottlenecks and commodity speculation. According to World Steel Association data, global crude steel production decreased from 1,962,510 thousand tonnes in 2021 to 1,849,414 thousand tonnes in 2025, a decline of approximately 5.76 percent even as construction demand, particularly in infrastructure and energy, continues to rise.

Lead times for critical steel components have lengthened in many regions, driven by fluctuations in mill capacity and limited availability of key material grades.

2. Pricing Pressures from All Angles

While prices have stabilized significantly since the pandemic-era peak, structural steel remains susceptible to fluctuating raw material costs, energy prices, and labor constraints. The market has moved past the extreme volatility of 2021, when U.S. HRC spot prices reached a record $1,960/ton after rising from $1,000/ton in late 2020.

By 2025, the market established a higher “new normal,” with prices commonly observed in the range of approximately $850 to $950/ton depending on region and timing. Although this represents relative stabilization compared to the 2021 peak, pricing levels remain elevated compared to pre-pandemic conditions, illustrating persistent cost pressures and structural shifts in the modern structural steel market.

In addition, fragmented project delivery models often introduce cost impacts in the form of change orders, missed fit-up tolerances and redundant coordination between separate engineering, detailing, fabrication and erection firms.

3. Sustainability Under Scrutiny

Recent life-cycle assessment literature indicates that, for many building types, the majority of greenhouse-gas emissions associated with construction occur during material production, transportation, and installation rather than building operation. Reported embodied emissions in published studies commonly represent a substantial portion of total building-related emissions, highlighting the importance of material selection and construction methodology.

For structural steel specifically, Environmental Product Declarations (EPDs) typically report cradle-to-gate (Modules A1–A3) embodied carbon values commonly reported in the range of approximately 1.25–1.47 $kgCO_2e$ per kg of steel for certain structural product categories in published EPD datasets, depending on production route, recycled content, and regional energy sources. These boundaries align with federal Buy Clean procurement requirements and common industry reporting practices.

In a construction landscape increasingly influenced by environmental, social and governance (ESG) criteria, documentation and transparency of material impacts are becoming part of bid evaluation and project viability assessment rather than solely a sustainability certification exercise.

4. Lifecycle Expectations Are Increasing

Resilience is now a requirement, not a luxury. From high-wind zones to wildfire-prone regions, steel systems are often selected to support robust load paths and post-event functionality depending on the overall building design and protection strategy. Thermal movement, corrosion resistance, seismic ductility and fire endurance are all under renewed scrutiny.

The Strategic Response: Rethinking Steel for the Long Term

The industry is not without answers. Structural steel, when used intelligently and responsibly, can be both a high-performance material and a low-impact solution. But this requires a full-systems approach.

1. Design for Resilience, Not Just Code Compliance

Codes are a baseline. Many projects incorporate additional detailing strategies to address durability, recovery and environmental exposure. For instance:

- In **seismic zones,** ductile braced frames and moment connections provide controlled inelastic energy dissipation consistent with seismic design principles.
- In **flood and coastal applications,** galvanized coatings, drainage channels and elevated assemblies can reduce corrosion exposure and maintenance frequency.
- In **wildfire regions,** fire-resistive coatings and concealed steel systems provide non-combustible structural load paths as part of the overall fire protection strategy.

2. Use of Green and Low-Carbon Steel

Emerging steelmaking pathways, including electric-arc-furnace and hydrogen-reduction processes powered by lower-carbon energy sources, are being developed to reduce emissions associated with conventional blast furnace production. Published research indicates these approaches have the potential to lower steelmaking emissions depending on energy source, feedstock quality and operating conditions, although outcomes vary by project and regional infrastructure.

Environmental Product Declarations (EPDs) are increasingly available for structural steel components and provide standardized cradle-to-gate environmental reporting consistent with LEED and federal Buy Clean documentation requirements.

3. Integrated Delivery and Coordination

Fragmentation remains one of the largest drivers of cost and carbon waste. When steel engineering, detailing, fabrication and erection are handled by separate subcontractors, risk multiplies. Fit-up tolerances may fail. Field crews adapt in real time. Change orders become routine.

Integrated steel delivery can reduce this coordination friction. BIM-based coordination from engineering/detailing through erection can reduce redundant effort, limit rework risk and improve schedule predictability when implemented effectively.

4. Prefabrication and Digital Modeling as Carbon Tools

Advances in digital workflows such as 3D laser scanning, federated BIM and model-based fabrication improve dimensional planning and installation sequencing.

By enabling more accurate procurement, these technologies can reduce avoidable material overages and staging time. Field coordination efficiencies may also reduce equipment runtime and handling operations.

Published case studies in the construction industry have reported reductions in material waste and associated emissions when integrated digital workflows and prefabrication strategies were implemented, although outcomes depend on project execution and documentation.

Extreme Steel: Integrity Through Integration

At Extreme Steel, integrity is more than a material property, it's an execution process.

We believe that structural resilience, cost efficiency and carbon accountability must work together. That's why our model is built around vertical integration, bringing engineering/detailing, fabrication and erection under one disciplined system, intended to reduce avoidable rework, improve information transparency and support consistent project execution.

We apply this integrated model across a wide range of project types, from mission-critical data centers to retrofits of historically significant structures. In every case, our work is guided by:

Efficiency: Controlled fabrication workflows and automated equipment intended to improve repeatability.

Precision: Digital coordination and field verification practices used to align fabrication with site conditions.

Accountability: Single-source responsibility from shop to site.

When it comes to sustainability, we're already aligned with the next generation of building standards. Our team supports:

- Green steel sourcing and EPD-compliant documentation.
- Thermal break integration and fire-rated assemblies.
- Documentation support for LEED, WELL and Buy Clean submittal requirements.

Building with Integrity, Beyond the Beam

Structural steel will remain central to modern construction but only when used with clarity, care and full-cycle responsibility. As the industry moves toward greater sustainability and resilience, it's not just about what steel is. It's about how steel is delivered, installed and maintained over time.

Extreme Steel builds smarter systems, engineered for demanding conditions and delivered with disciplined execution. In a future defined by higher stakes and tighter margins, that's what integrity looks like.

About Extreme Steel, Inc.

Headquartered in Winchester, Virginia, Extreme Steel Inc. (ESI) along with its partner and recent acquisition Superior Ironworks in Sterling, VA, revolutionizes structural steel solutions with smart technologies and unmatched expertise. Building American Excellence, ESI sets and exceeds standards of excellence in the structural steel industry – with the right people, right tools and right ideas. ESI puts safety first, which accounts for a supportive, creative and professional work environment and a job done right.

Visit https://extremesteelinc.com/

About Jassiel Vargas, Director of Engineering and Drafting, Extreme Steel Inc. and Superior Iron Works, LLC

Jassiel Vargas is a licensed Structural Engineer with over 20 years of experience in steel detailing, connection design and structural engineering. Since joining the team in 2008, he has played a critical role in leading engineering and detailing operations across both U.S. and international teams.

Jassiel is known for his precision, technical depth and ability to deliver efficient solutions in high-profile projects ranging from museums and hospitals to office buildings and warehouses. He works closely with estimating and project management teams to drive value engineering, reduce costs and support successful execution from design through fabrication and installation.

Jassiel holds Professional Engineer licenses in Virginia, Maryland and Washington, D.C. and has earned multiple WBC Craftsmanship Awards for his contributions to award-winning projects across the region.

EXTREME STEEL
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Building American Excellence.

To request a project consultation, schedule a virtual facility tour or to learn more about how Extreme Steel can streamline your next project contact us today.

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