

Structures with Meaning : Designing for Society

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Abstract

Structural engineering is both a technical and cultural discipline. It shapes not only the built environment, but also the way people live, connect, and remember. This paper explores the essence of structural engineering through three lenses: the creation of new structures, the transformation of existing ones, and the broader responsibility of engineers toward society. By blending performance, aesthetics, and sustainability, structural engineers contribute to spaces that endure and inspire. Their work transcends function—it carries meaning. In an era of environmental urgency and social transformation, the structural engineer's role is more vital than ever: to design not only for use, but for significance.

Keywords: structural engineering, design, sustainability, renovation, social impact, creativity, responsibility, meaning.

1 Introduction

Structural engineering is both a science and an art, a discipline that shapes the built environment and influences societies in profound ways. From towering skyscrapers to resilient bridges, from historic renovations to innovative green buildings, the role of the structural engineer extends far beyond mere calculations and technical design. It is about creating spaces that are safe, functional, and aesthetically pleasing while meeting the evolving needs of society. More importantly, it is about **building for people**, shaping the world in ways that improve lives and foster connections.

Throughout history, structural engineering has been at the forefront of human progress. Civilizations have been defined by their ability to build—whether it be the Roman aqueducts, the Gothic cathedrals of Europe, or the modern high-

Figure 1 : The High Line in New York, a transformed



railway structure turned into an urban park, illustrating how engineering can serve both function and community. Arch. James Corner, Piet Oudolf

speed railway bridges that connect people and economies. Behind each of these feats stand generations of engineers, problem-solvers who dared to imagine what others thought impossible. **To the young engineers of today: you are the**

architects of tomorrow's world. Your ideas, your innovations, and your dedication will define the landscapes and infrastructures of the future.

Beyond concrete and steel, structural engineering is about responsibility. Engineers must ensure that structures not only stand tall but also serve communities in meaningful ways. Whether reinforcing a century-old bridge to extend its legacy or designing a sustainable building that minimizes its carbon footprint, engineers hold a unique power to shape society's future.

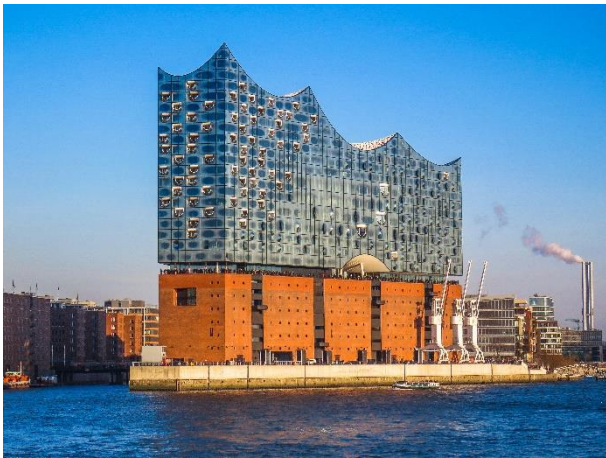


Figure 2 : The Elbphilharmonie in Hamburg, arch. Herzog & de Meuron show-casing the integration of a historic warehouse foundation with a modern glass structure.

This paper explores the fundamental essence of structural engineering by addressing three key aspects: the design of new structures, the preservation and adaptation of existing ones, and the broader societal responsibilities of engineers. Through this discussion, we aim to highlight the impact of structural engineering not only on the built environment but also on the people who inhabit it. **To those embarking on this journey, remember: every beam placed, every foundation laid, every bridge constructed carries with it the promise of a better, more resilient world.**

2 Designing Structures: Innovation and Harmony

Designing a new structure is one of the most fundamental and visible acts of structural engineering. It is the moment when creativity and technical mastery converge to bring something

entirely new into the world—something that will shape the lives of those who interact with it.

2.1 Performance and Aesthetics

A structure must first fulfil its essential role: to carry loads safely and efficiently. But beyond this, a well-designed structure resonates with its environment and the people it serves. **Performance and aesthetics are not contradictory goals;** when brought together, they elevate a structure beyond utility. The elegance of a bridge's span, the rhythm of a façade, or the lightness of a cantilevered roof—all of these can spark emotion and create identity.

Engineers work closely with architects to achieve this harmony. By understanding the spatial and emotional aspirations of a project, they can translate them into structural systems that are both expressive and rational. The best solutions often emerge not from compromise but from shared ambition—a vision that embraces both the visible and invisible aspects of design.

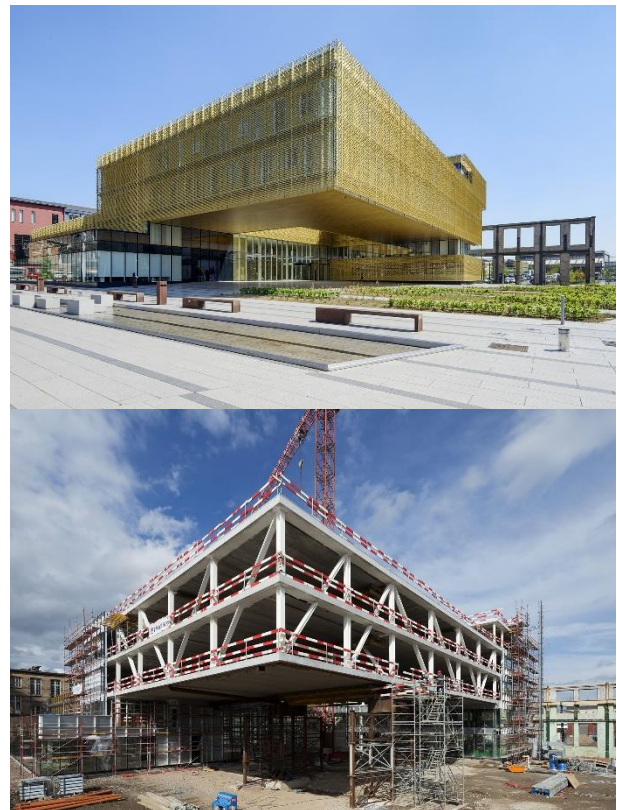


Figure 3 : John Cockerill Headquarters in Seraing. Arch. Reichen & Robert. The two images show the completed building and the structural frame —

revealing how complexity gives way to apparent simplicity. The design hides its effort behind clarity and calm, illustrating how good engineering feels inevitable.

2.2 Sustainability in Engineering

To design for today is not enough. Structural engineers must now design for decades, even centuries, of use. **Sustainability is no longer a feature—it is a foundation.** This includes choosing low-carbon materials, designing structures that can be disassembled or reused, and minimizing the need for maintenance through robust and adaptable systems.

The integration of sustainability into structural design requires innovation and foresight. It also demands humility: the recognition that every structure becomes part of a larger ecosystem—social, urban, and environmental. Engineers must ask not only “how do we build this?” but also “why should it be built, and how will it serve?”

A crucial part of this mindset is the rational and efficient use of materials. Reducing carbon emissions starts not with technology, but with restraint: designing with minimal waste, optimizing structural forms, and avoiding unnecessary mass. **Structural efficiency is not just a technical achievement—it is a moral imperative.** When a structure uses only what it needs, it expresses a kind of elegance born from necessity. It reflects not excess, but intention.



Figure 4 : Hoge Brug, Maastricht. With its slender arch and minimal structure, this pedestrian and cyclist bridge embodies elegance. Every detail serves its function, and nothing is superfluous — demonstrating how a refined use of materials can

create a strong visual and societal presence. Arch. Greisch

This is where engineering meets economy in its deepest sense—not just cost, but the responsible allocation of resources. By designing lean, resilient structures, engineers contribute directly to climate goals while upholding the timeless principle that **simplicity often yields the most enduring beauty.** It’s about creating forms that stand strong not only under physical loads but also under the weight of societal expectation and environmental responsibility.

3 Restoring and Reinventing Structures

Preserving and transforming existing structures is an act of both respect and reinvention. Unlike new construction, which begins with a blank slate, working with the built environment requires listening to what already exists. It involves deciphering the intentions of past designers and responding to the accumulated layers of history, use, and decay.

Restoration is not about freezing a structure in time. Rather, it is about extending its life and relevance—making it safe, functional, and inspiring for present and future users. This process demands technical precision, sensitivity to materials, and above all, judgement. The engineer must balance the desire to preserve with the responsibility to adapt. It is not simply about fixing what is broken, but about deciding what to preserve, what to enhance, and what to respectfully transform.

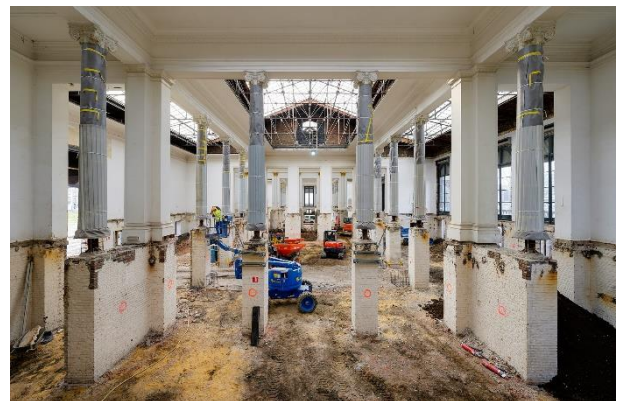


Figure 5 : La Boverie Museum, Liège. The structural renovation of this early 20th-century building demonstrates how heritage can be preserved while

accommodating new functions and forms. Arch. Riciotti et p. HD

When adapting a structure, the engineer enters into dialogue not only with the original design but also with its cultural significance and the way it is perceived by its users. Preserving authenticity often means embracing imperfections, scars, and historical layers rather than erasing them. It also means acknowledging that no intervention is ever neutral: each technical decision carries symbolic weight.

Some structures are conserved with minimal intervention. Others are reimagined for new purposes—industrial buildings become cultural centers, obsolete bridges are turned into parks, and train stations become vibrant civic spaces. These transformations require creative strategies: reinforcing without disrupting, adding without overwhelming, renewing without replacing. Often, the most powerful interventions are the ones that feel natural, as if the structure had always been meant to evolve in that way.



Figure 6 : Gastronomia, Seraing. The former industrial hall has been transformed into a contemporary public space while preserving its industrial character. The intervention feels natural, as though the new programme had always been destined to inhabit the old structure—demonstrating how adaptation and authenticity can coexist. Arch. Reichen & Robert - Canevas

The reuse of structures is not only a cultural or historical gesture—it is also a deeply sustainable one. By building upon what already exists, we conserve materials, energy, and memory. We reduce the carbon footprint not only by avoiding

demolition, but by giving value and purpose to what others might see as obsolete. In this way, engineering extends its impact from the technical to the ecological, from the individual building to the collective future.

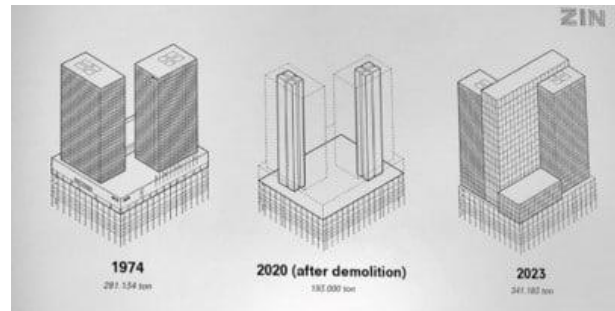


Figure 7 : ZIN, Brussels. The transformation of this 1970s office tower preserved the original concrete cores while reconstructing new, energy-efficient volumes around them—demonstrating how structural reuse can serve both heritage and sustainability.

When successful, these projects remind us that structures are not disposable. They are cultural artefacts, collective memories, and resources to be nurtured. They ground us in continuity while offering opportunities for renewal. **In this way, structural engineering becomes a dialogue across generations—between those who built, those who rebuild, and those yet to come.**

4 The Structural Engineer: Science and Creativity

Structural engineering is often perceived as a world of numbers, codes, and calculations. And while it is true that precision is at the heart of the discipline, it is equally true that behind every successful structure lies a creative mind — an engineer who dares to imagine, to interpret, and to shape. Structural engineering is a discipline where intuition, experience, and vision are as important as formulas and software. Every design is an act of invention within constraints, and every constraint is an opportunity for innovation.

4.1 Beyond Calculations

The tools of our profession are mathematics, mechanics, and materials. But its essence lies in interpretation. Each structure is a response to a unique set of constraints, and the engineer's role is

to find clarity within complexity — to give form to forces and meaning to matter.

In the design process, engineers must imagine how a structure will behave, but also how it will feel — how it will be approached, perceived, and used. **This is where intuition meets logic, and where creativity becomes a structural act.** A good design resists gravity. A great one uplifts the people who encounter it.

Creativity in structural engineering is rarely loud or showy. It reveals itself in the subtle curve of a beam, the elegant path of a load, or the seamless integration of form and function. It is the result of iteration, dialogue, and vision. The engineer must translate complex requirements into structures that are not only efficient, but also poetic in their simplicity. **In this sense, engineering becomes a language — spoken through proportion, rhythm, and material.**



Figure 8: Viaduc de Millau, France. The structure was designed by Michel Virlogeux and Norman Foster, while the execution studies were carried out by the Greisch engineering office — revealing how technical ingenuity and aesthetic vision can converge in a structure that speaks to both function and emotion.

4.2 Impact on Society

Structures shape the way we live, move, and connect. They define public spaces, guide urban rhythms, and often become symbols of collective identity. A well-conceived bridge is not only a link between two banks, but between communities. A renovated station is not only a place of transit, but of encounter and memory.

The work of the structural engineer extends into the daily lives of citizens, sometimes quietly, sometimes monumentally. **Our interventions influence comfort, access, safety, and even dignity.** In this way, engineering is not neutral—it is an act of design with social implications.



Figure 9: Gare de Liège, Belgium, design Santiago Calatrava. This structural and architectural statement shows how an infrastructure project can transcend utility to become a place of identity, memory, and civic pride.

Beyond the visible, structures contribute to how people experience space — how open a square feels, how natural a walkway flows, how protected one feels under a canopy. The best engineering often disappears in the background, leaving users with a sense of ease and coherence. That is its power. It shapes without dominating. It protects without enclosing. It allows places to come alive.



Figure 10: "L'Enjambée" footbridge, Namur. This bridge reestablishes a human-scale link between neighborhoods, inviting people to cross, meet, and enjoy the river. It embodies how structural interventions can promote urban cohesion and social inclusion. Arch. Greisch

Structural engineering also plays a role in healing urban fabric: reconnecting districts divided by infrastructure, revitalizing disused industrial sites, or extending the life of aging buildings. **Each intervention is a gesture toward cohesion and inclusion.**

4.3 Responsibility in Engineering

With creative power comes responsibility. Engineers must navigate complex tensions: between safety and innovation, between durability and economy, between present needs and long-term impact. They must also stand firm in ethical judgement, particularly when decisions affect public well-being, the environment, or cultural heritage.

In an age of climate crisis and shrinking resources, engineers are called to think not only structurally, but ecologically. Every choice — every tonne of steel, every cubic meter of concrete — carries weight beyond the drawing board. To act responsibly is to think systemically, to anticipate consequences, and to strive for balance.



Figure 11: Passerelle d'Auby, France, arch. KVDS. This pedestrian bridge exemplifies how structural decisions—materials, geometry, and construction sequence—extend beyond the drawing board to shape environmental, visual, and logistical impact.

To be a structural engineer is to engage with the world not only as it is, but as it could be. It is to build with purpose, with care, and with a constant awareness that what we create today becomes the legacy of tomorrow.

Ultimately, our structures will outlive us. They will carry our decisions, our values, and our hopes into the future. That is the privilege — and the burden

— of structural engineering: to design not only for use, but for meaning.



Figure 12: Mobile footbridges over the Gave de Pau, Lourdes. These elegant and functional footbridges serve not only as a means of access, but also as symbols of renewal and accessibility—linking the spiritual and the civic, the local and the universal. A structure designed with purpose and meaning. Arch. Greisch

5 Conclusion : Building the Future

Structural engineering is more than a technical profession—it is a cultural act. Through every column and cable, every beam and joint, engineers shape the way we live, connect, and grow as a society. They do so quietly, often invisibly, but with profound and lasting impact.

To design a structure is to engage in a dialogue between the past and the future, between necessity and imagination. It is to work with matter and meaning, to build what is needed while questioning what is truly valuable. Structures that endure are not only well calculated—they are well considered. They serve their purpose while expressing something more: a sense of place, of care, and of commitment.

As we face the challenges of our time—climate change, urban transformation, social cohesion—the role of the structural engineer will become ever more essential. We will need not just more structures, but better ones: structures that are efficient, resilient, and meaningful. Structures that give something back.

To those who design them: let your work speak not only of strength, but of intention. Not only of form, but of humanity. Because what we build today becomes part of who we are tomorrow.