

Elevating Bridges Through Aesthetic Structural Design

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WORKHORSE BRIDGES

With more than 600,000 bridges in the U.S. National Bridge Inventory – and about 98% of them spanning less than 300 feet – most of our nation's structures are what I call “workhorse bridges.” They're essential to our communities, but too often, they're treated as purely functional, with little consideration given to how they look or how they affect their surroundings. That's a missed opportunity.

In my work, I've made it a mission to show that even the most routine bridges can reflect thoughtful design. With some simple, cost-effective rehabilitation or replacement strategies, we can elevate structure design to better serve not just transportation needs, but community identity and pride.

WHY DESIGN AESTHETICS MATTER

Typically, engineers aim to get from point A to B using a functional structure that's low-cost, low-maintenance, and lasts 75–100 years. Nowhere in that traditional design process are aesthetics formally considered. It's time to change that.

Bridge aesthetics is admittedly uncomfortable territory for many engineers, but the visual perception of a highway bridge is a real part of the public experience. Most bridges in the national inventory are workhorse bridges, not iconic like the Brooklyn Bridge, but they're highly visible and shape the communities around them.



So why should we care? Because aesthetics is part of our professional responsibility. Routine design decisions, including pier alignment, beam depth, and abutment size, have lasting visual consequences. Bridges are built with public money. They stand for generations. They're legacies. Gone are the days when stark functionality alone sufficed. Communities today are informed, vocal, and engaged. Let's honor that.

WHAT HAPPENS WHEN WE DON'T CONSIDER AESTHETICS?

Here's one example: a skewed bridge pier at a cross street, visually overwhelmed by a large sign structure. Functionally sound, perhaps, but visually jarring. With more collaboration and foresight, a far better outcome might have been possible.

Poor aesthetic choices can haunt a project. I remember a bridge I worked on 30 years ago as a young designer. I tried to honor historic elements, such as stone and the arch shape, while meeting modern standards and incorporating all stakeholder ideas. However, the result was awkward and inauthentic. That experience stuck with me and shaped my commitment to designing structures with greater context sensitivity and intent.

WHEN TO CONSIDER AESTHETICS IN A PROJECT

It's critical to understand when to bring bridge aesthetics into the design process. The right time is early during planning, scoping, and conceptual design. That's when decisions about structure type, span length, alignment, and geometry are on the table. That's also when cost-effective aesthetics can be integrated.

Waiting until final design – or worse, construction – to add ornamentation or “dress up” a completed structure is too late. It's also often expensive and ineffective.

BEAUTY IS CONTEXTUAL AND COLLABORATIVE

The U.K.'s Bridge and Roadway Design Manual sets a great example by emphasizing design aesthetics from the outset. It reminds us that beauty is subjective. What looks elegant to one may seem cold or harsh to another. That's why input from fellow engineers, architects, and the community matters.

Collaboration is essential. Whether it's a client workshop, a stakeholder charrette, or a staff design review, the more perspectives we gather early, the better the design outcome will be.

THE SIX DETERMINANTS OF APPEARANCE

Fred Gottemoeller, a leader in aesthetic bridge design and author of the book *Bridgescape: The Art of Designing Bridges*, outlines the seven main determinants of bridge appearance. Each of these elements influences how a bridge is perceived. Let's break down a few:

1. Overall Structural Configuration: Structural engineering defines visual unity. Consistent span lengths and rise ratios are more aesthetically pleasing than abrupt variations.

Though this is one of the costlier attributes to modify, it's also the most visually appealing.

- 2. Superstructure Shape:** Superstructure shape also matters. Slender structures and hunched girders create depth and variation. Wider overhangs cast shadow lines, tricking the eye into seeing a shallower structure – a subtle but effective visual cue.
- 3. Pier and Abutment Shape:** Pier and abutment shapes should taper gradually, lending balance and elegance to mass.
- 4. Color:** Color, though subjective, can help a bridge blend through context-sensitive design.
- 5. Surface Texture and Ornamentation:** Texture and ornamentation work best when designed with traffic speed in mind. Use simple, bold forms that register at 60 mph.
- 6. Signing, Lighting, and Landscaping:** While lighting and landscaping are often impractical for rural bridges, they can greatly enhance urban and pedestrian structures.

HISTORIC COMPATIBILITY VS. APPLIED DECORATION

Designing structures in or near historic districts brings added complexity. The instinct is often mimicking the past by applying stone veneers, faux arches, or decorative motifs, but this often backfires.

A modern bridge doesn't need to pretend it's old; it needs to respect what is old. That means using appropriate materials, scale, and openness. Let the setting tell the story. A false sense of history helps no one.

Even federal regulations support this: do not create conjectural history. Instead, use a context-sensitive bridge design that defers visually to its surroundings.

I've seen projects where good structures were marred by unnecessary decoration. A sleek bridge in a historic corridor was undermined by stone veneer abutments and piers that added visual clutter without value. Another bridge, meant to replace a simple repetitive design along an abandoned railroad corridor, was burdened with excess ornamentation and textures that didn't align with the corridor's identity.

SUCCESS STORIES

The Arizona Department of Transportation's use of subtly tinted concrete in rural environments allows bridges to disappear into the landscape. Georgia Department of Transportation's park-like deck treatments on interstates elevate function into a civic experience. The arch bridge redesign in Hamilton, Ohio, preserved form without the original long-term maintenance liabilities.

Even bridge railings, one of the most debated elements, offer major opportunities. Open rail designs that are crash-tested provide both safety and visual permeability. They let the surrounding environment remain visible through the structure rather than around it.

Additionally, form liners can succeed when they're clearly decorative and not pretending to be historic. At Philadelphia's Gustine Lake Interchange, for example, the geometric liner design adds texture without confusion.

FINAL THOUGHTS: COST, CULTURE, AND COLLABORATION

There's a misconception that aesthetic design increases cost. Often, the opposite is true. Adjusting proportions, selecting thoughtful shapes, or choosing color strategically costs little or nothing. It's about making smarter decisions earlier.

Every bridge exists in a cultural and environmental context. Aesthetics allow us to respond to that. Whether blending with the earth tones of the Southwest or respecting the heritage materials of the Northeast, good aesthetic structural design shows we were listening.

We don't need more "cookie-cutter" bridges that disregard their surroundings. We need bridges that belong structurally, culturally, and visually. It's our challenge, but it is also our opportunity for legacy structures. 



About the Author

Michael Cuddy, PE, Senior Vice President, GFT, is renowned for his bridge design, rehabilitation, and inspection expertise. Throughout his career, he's successfully rehabilitated six of the 10 oldest bridges in the U.S. Michael is widely respected for his innovative approach to evaluating and restoring historic structures.

About the Article

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