conference preview

WHEN AESTHETICS GOVERN

BY TERRI MEYER BOAKE

Pedestrian bridges, architecturally exposed structural steel and you.

The Peace Bridge in Calgary, Alberta, is a highly customized project that used extensive brake forming to shape the steel.

CAN ROAD AND RAIL BRIDGES be attractive—even stunning?

Of course they can. Though for the most part, the more pragmatic concerns of safety, economics and efficiency typically govern their designs.

In recent years, we've seen a surge in the construction of pedestrian and cyclist bridges—and in these types of spans, aesthetics are front and center, playing an enhanced role in the decision-making process.

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This has resulted in some challenges to the bridge construction industry. Having an architect on the team can sometime bring challenges to a process that doesn't typically involve architects. As a result, the design of such pedestrian bridges falls across the fields of engineering and architecture, having to answer to equally strong pulls between function and aesthetics. This aesthetic drive creates and must solve problems that are very different from the methods previously established for vehicular bridges.

This increase in the expressive use of structure has been enabled by the marked decrease in live loading for pedestrian bridges and has created a paradigm shift in the standard design of the spanning typology normal to bridges. Pedestrian bridges are creating structurally and visually different ways to span, challenging and inspiring the design community with a multitude of one-off designs. Although many of the spanning methods have been derived from existing structural typologies for heavier bridge types, variations have arisen as a direct result of this unique marriage of structure, architecture and art. In fact, many

➤ The Gateshead Millennium Bridge in Newcastle, England, must rotate to allow for the passage of ships along this waterway. The low-to-the-water design provides easy access along the river for pedestrians and cyclists.

of these new bridges are also being seen as public art, adding politics to the already complex processes of design and fabrication.

Beauty on Demand

Given the demand for beauty, as well as the fact that bridge framing is pretty much always exposed to view, architecturally exposed structural steel (AESS) has become the structural material of choice for the majority of these recent footbridges. Structural steel is excellent in addressing many of the particular design and erection concerns of pedestrian bridges, and AESS in particular is able to provide an excellent variety of aesthetic solutions for this new role of pedestrian bridge as public art. Steel also enables:

- Prefabrication of near-complete elements prior to erection/ installation
- Simplified transportation of large bridge elements to the job site
- Minimal disruption to traffic flow during erection
- Durability and ease of inspection for maintenance

The 2016 AISC *Code of Standard Practice for Steel Buildings and Bridges* (ANSI/ AISC 303, **www.aisc.org/specifications**) Section 10 addresses important aspects of designing with AESS as applied to building elements and pedestrian bridges. Many of these bridges typically need to be designed in accordance with three of the five AESS categories: 3, 4 and C, all of which permit all-welded connections and allow for—but do not require—the grinding of welds (categories 1 and 2 will typically not be applicable for most pedestrian bridges). The treatment decisions for welded connections must be carefully negotiated by the team, as a welded and then ground choice can greatly increase the cost of the structure, but might not necessarily be required to achieve the desired aesthetic effect. (For more details on the AESS categories, see this month's "Buyer Be Aware" SteelWise

▲ The Helix Bridge in Singapore was fabricated from duplex stainless steel in order to resist the tough marine climate. Stainless steel provides a very durable solution but extreme care must be taken in its fabrication and detailing for optimum results.

➤ This mast-and-cable-supported bridge creates a lightness of structure that is only possible for this type of lightly loaded footbridge.

The George C. King Bridge in Calgary, Alberta, seems to skip across the Bow River, landing once before reaching the opposite shore. The flattened elliptical looking tubular arches have been fabricated from round HSS that have been joined by rolled plate sections. The welds on the top surface have been fully remediated, providing a bit of mystery regarding the fabrication process.

This pedestrian bridge crosses over a busy roadway in a single span. The black tube and mesh gridded barrier creates a visual contrast with the inclined trapezoidal truss that forms the main spanning system.

The Puente de Luz in Toronto used plate rolling to create the custom curved box sections that comprise the ribs. The bridge was divided into large segments to allow for quick site bolting during erection, as it spans over a significant train route into the center of the city.

article on page 17.) Here are basic descriptions for these three categories:

- AESS 3: Feature elements viewed at a distance less than 20 ft (6 m)
- AESS 4: Showcase elements with special surface and edge treatment beyond fabrication
- AESS C: Custom elements with project-specific requirements that don't fall into the parameters of the other four categories

The primary influence on the generated typology seems to focus on the specific expression of the structure that is supporting the walking surface, in combination with the overall width of the span as a function of available support points. Here are the most common support systems for pedestrian bridges:

- Support from above. The mast and cable system is designed as a variation of a suspension system. The location of the mast is often eccentric or sloped resulting in a very dynamic appearance to the structure. The structural deck that supports the walkway is quite light
- Support through the middle. Tubular trusses have pedestrians walk through and experience the structure
- Support from below. The structural support system for the deck is located beneath the walking surface. It is less apparent when the bridge is crossed but very apparent when viewed from a distance

This pedestrian bridge provides safe passage over a busy divided highway. A central support breaks the span. The deck is suspended from arched elements, and an artistic barrier prevents falls.

Weather and Site Conditions

When AESS is subjected to the elements, as is the case with most footbridges, corrosion protection must be addressed. Painted finishes remain common as there tends to be a desire to include color in the expression. It is critical that painted finishes are paired with a durable under-treatment such as metallization, as simple priming is generally inadequate. As a primary approach that combines corrosion protection and finish, stainless, weathering and galvanized steels are frequently used. However, it is necessary to detail for durability—with a focus on preventing debris from accumulating or water from pooling—as corrosion protection can ultimately fail if detailing is not done correctly. Roosting birds can also damage the structure and finish.

When planning a pedestrian bridge, the site conditions must be carefully considered. Unlike bridges that support vehicular traffic, the site conditions for urban pedestrian bridges are often significantly constrained. Pedestrian bridges are frequently being constructed as improvements to existing urban neighborhoods that are separated by rail, highway and river corridors, and as a result will have to negotiate between the footprints of existing buildings and respond to inflexible abutment conditions. Although some pedestrian bridges do make use of suspension systems, many have minimal access to their abutment or mid-span conditions and may not afford more than a simple span.

Transportation and erection concerns tend to be the drivers in determining the maximum size of prefabricated elements and the type and placement of splices and internal connections. Connection design presents many challenges to the team as they work to address aesthetic choices in regards to member size, shape and complexity. And if welding is preferred over bolting, they need to maximize shop welding and work towards expedient site erection, which lends itself to bolted connections. Site layout will also constrain the design if there is inadequate space for materials, assembly and crane access. A high level of communication amongst the designers, fabricators and erectors is critical to the success of these projects—perhaps even more so than with vehicular bridge projects.

The design choices for pedestrian bridges are virtually endless, particularly if the project is governed by the use of custom sections rather than standard available shapes, and there is a wide range of detailing strategies that seek to simultaneously address the concerns of aesthetics and good engineering practices. Want to know more? Come to our presentation! ■

This article is a preview of Session B9 "Pedestrian Bridges – Invigorate Design Creativity" at NASCC: The Steel Conference, taking place April 11–13 in Baltimore. Learn more about the conference at ***www.aisc.org/nascc****.*