Steel Bridge NEWS
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Taking Flight

BY TIM RICHEY, AIA

Lara Swimmer Photography

An aviation museum's new pedestrian bridge pays homage to flight via a complex yet elegant design.

SEATTLE'S TIES TO THE AVIATION INDUSTRY ARE WELL KNOWN; THE CITY IS THE BIRTHPLACE OF BOEING AND STILL THE CENTER OF THE COMPANY'S ASSEMBLY OPERATIONS. So it's not surprising that Seattle's Museum of Flight, located adjacent to Boeing Field in Tukwila, Wash., is one of the largest air and space museums in the world. Besides its jumbo-sized exhibits, the museum will soon boast another eye-catching attraction: a striking 340-ft steel pedestrian bridge linking the current museum to a remote exhibit space and future development site across a busy traffic arterial.

Vapor Trail

A conventional, utilitarian public works bridge design would have been possible but inadequate to convey the spirit of the museum and the area's aviation history. Instead, the bridge's design is inspired by the phenomenon of a contrail, a stream of crystallized vapor created in a plane's wake. The metaphor is carried out in the bridge's unusual tube-shaped truss design, made of crossing circular steel pipes surrounding an inner glass enclosure. The bridge interior includes exhibit panels describing aviation history in the area, as well as colored LED lights along its path and a sound installation by local artist Paul Rucker with audio sampling from aerospace history and nature.

Precast structural shapes and cast-in-place concrete solutions were studied, but the narrow aperture through which the structure needs to pass—above the roadway clearance and below the power lines—limited the amount of structural depth that could be accommodated below the bridge deck. Using a steel truss allowed the structural depth to surround the partially enclosed interior space and also maintained consistency with the existing museum's architecture.

Not Your Ordinary Truss

The unique structure of the bridge evolved from the design collaboration between the architect, structural engineer, and steel fabricator. By bringing these parties together as early as possible in the design process, the team was able to push the design beyond a conventional solution toward something extraordinary.

Through a series of creative charrettes, architect SRG Partnership and Magnusson Klemencic Associates, the engineer, devised a unique structural design that didn't rely on conventional truss webs, but instead distributed the vertical shear in the bridge structure through a matrix of curving steel pipes. The cross-section of the bridge is widest at the center of the span, tapering at its ends as if the contrail was dissolving into the sky. This exciting and dynamic form, however, had the potential to be overly complex and unachievable within the project budget.

Jesse Engineering was chosen as the fabricator, based on their experience with another pedestrian bridge—at a shopping center in Bellevue, Wash.—that was admired for its craftsmanship. But it was expertise in 3D computer modeling from MKE Detailing and Jesse Engineering's capacity to cut complex pipe curves, or "fish mouth" shapes, that allowed the design form to be broken down

SRG Partnership

Lara Swimmer Photography

1 A matrix of curving steel pipes replace the conventional truss webs.

2 A large waterborne crane lifts the tube truss onto a barge in Tacoma's industrial waterways.

3 Inspired by the phenomenon of a contrail, the 340-ft-long pedestrian bridge stretches across the street to connect museum visitors to a remote commercial aircraft display.

4 Blue LEDs give the structure a nighttime glow.

into simple components. Jesse Engineering worked with the design team to detail the truss structure, using mostly standard steel shapes with constant-radius pipe bends and repetitive connection types, to achieve the complex bridge form economically. Casey Carver of Jesse Engineering explained, "The challenge of a project like this for a fabricator is starting with basic concepts and growing it into something to work with. Normally, fabricators only get involved after design has already been established." According to MKA principal Jay Taylor, "Our intention in this structural design was to take simple shapes and use them in unique ways."

Tapered and Tubular

The result is a complex yet elegant 340-ft-long bridge made of crossing circular steel pipes, spanning 140 ft across a major road. The main tube-shaped truss, measuring 200 ft in length, is composed of a series of crossing 5-in.-diameter pipe hoops tilted at 45°. The radiused bend of the hoops varies from 22 ft at the center of the span to 19 ft at the tapered ends. Although the curvature of the hoops is a true radius, when tipped at an angle an elliptical interior space is created. In total, the project uses approximately 10,000 linear ft of steel pipe weighing a total of 190 tons.

Within the truss, the semi-enclosed environment protects pedestrians from Seattle's infamous gray and rainy weather. Overhead, a translucent polycarbonate roof suspended beneath the overhead steel pipes filters direct sunlight while glass panels on the south blocks the winter winds.

The bridge deck was originally specified as cast concrete over metal deck, but the weight of the material remained a problem over the longest bridge span. Once an extruded aluminum deck plank was identified, the significantly lower dead load allowed the steel to be reduced in weight, resulting in a savings to the project and a more elegant design.

Minimal Closure

One construction challenge was navigating through a dense network of below-grade infrastructure and overhead power lines that remain critical to Boeing's local research and manufacturing facilities. However, general contractor Sellen Construction helped accelerate the project schedule by compressing the on-site utilities and foundation work with the off-site truss fabrication at Jesse Engineering. Although unusual, several subcontractors, including electrical, lighting, and glazing, worked together off-site at Jesse's shop, enabling a greater degree of prefabrication and less on-site construction over the busy roadway.

Steel fabrication began in the spring of 2008, and by early July the two trusses were welded, painted, and ready to be transported to the job site, along with the aluminum floor system, the electrical conduit, lighting, and some glazing mounts already in place on the truss. Jesse Engineering's location along the industrial waterways of Tacoma allowed the truss to be shipped by barge 40 miles north through Puget Sound and down the Duwamish River in Seattle, and unloaded just a few hundred yards from the final erection point. To install the bridge over the traffic arterial, the construction team negotiated with the City of Tukwila to divert traffic for a full day, then raced against the clock to erect the two trusses, weld each in place, and remove the crane equipment within a 24-hour window. The planning paid off, as the roadway was clear and open for traffic by 6 a.m. the following morning. The bridge, already a winner of the AIA Washington Council's 2008 Civic Design Awards program as an unbuilt project, opened in October. MSC

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