

Structural tube on campus

Aluminum bridge spans science departments

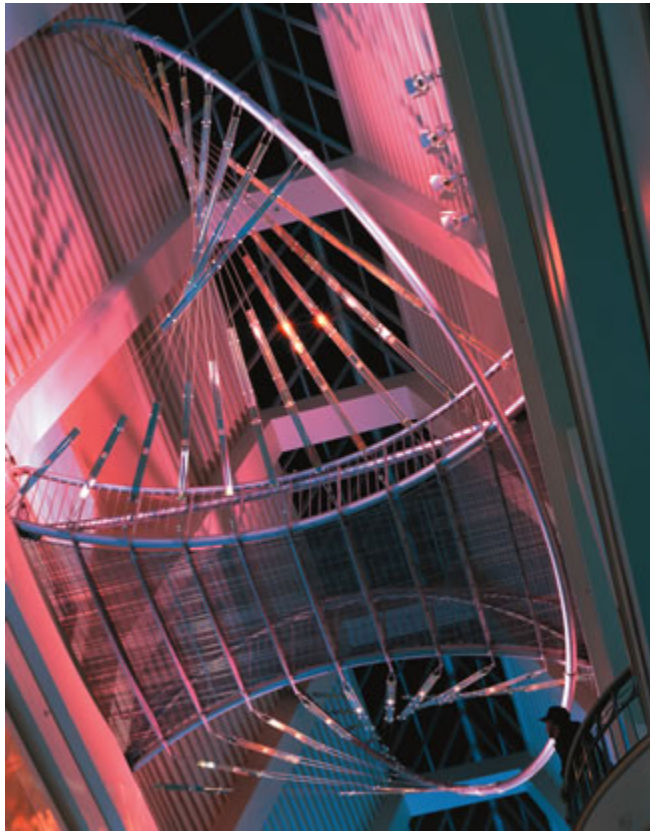
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Central Washington University in Ellensburg, Wash., is known for its strong science programs. “Flying Bridge,” a structure designed by artist and sculptor Ed Carpenter, physically and metaphorically spans the biology and chemistry departments in the university’s new Dean Science Building. Carpenter, who designed the bridge with engineering consultation from Peterson Structural Engineers Inc., teamed up with Albina Pipe Bending Co. Inc. to tackle the project’s material bending and fabrication requirements.

A Sculptor and an Architect

Carpenter specializes in large-scale public installations, including architectural sculptures and infrastructural items. He studied architectural glass art under artists in England and Germany, and this experience is reflected in his use of glass and light, which are integral components of many of his works. “Flying Bridge” incorporates cold-bent tempered glass, encapsulated glass elements, programmed artificial lighting, and unusual tension structures.

Although Carpenter collaborates with consultants, subcontractors, and studio assistants, he personally oversees every step of his projects and installs them himself with a crew of long-time helpers, except for large projects such as bridges.



Aluminum and Glass Meet on the Bridge

“Flying Bridge” was made from aluminum. The main deck span arches were made from 4-1¼-in.-OD by 1¼-in.-wall tubing. The bottom and top rails were made from 4-in. Schedule 80 pipe and 3-1¼-in.-OD by 0.500-in.-wall tubing, respectively. The cable supporting ring that encompasses the bridge also was fabricated from 4-in. Sch. 80 pipe.

Having an unblemished finished appearance is critical to Carpenter's works, and "Flying Bridge" was no exception. All the material was polished to an RG-80 finish before it was bent to minimize the more difficult and time-consuming polishing work that would be required at the end of the fabrication process.

The bend tooling for the project was polished and kept clean throughout the bending process to minimize tool marking and postfabrication polishing. After the material was bent, it was sealed with a clear coating to prevent marring or scratching. In addition, all of the material for this project was handled carefully to make finish polishing easier and more effective.

Because the project required long bend radii, Albina decided that the most effective bending process would be roll bending. All pipe and tubing components in the bridge structure were roll-bent on a custom-made roll bender built specifically for pipe and tubing. The machine's bend die configuration is a pinch type, an arrangement in which the two drive rollers are located close together in a fixed location. The pressure roller is farther away from the drive rollers than on most roll bending machines. The extra distance between the drive rollers and the pressure roller reduces the force needed to accomplish a bend.

"Aluminum wants to stay straight," is how William Smith, CEO of Albina Pipe Bending Co. Inc., described the material's resistance to bending. Aluminum typically does not elongate much before it fails, and therefore it can be a tricky metal to bend.

"Sometimes it takes multiple passes to bend aluminum to the proper radius," Smith said. "It depends on the material, temper, and bend radius. These tubes were made from 6061 aluminum with a T6 temper, and the radii were large, so the bends were done successfully in single passes."

The most critical aspect of roll bending this project was ensuring consistency in radius and having virtually no ovality in the rolled sections, so that pieces that were assembled with internal sleeves on-site went together smoothly. The pinch roller configuration and the extra distance between the drive and pressure rollers help to reduce deformation and ovality caused by forming.

"The tube was completely enclosed inside the rollers. This also helped to eliminate ovality," Smith said.

"Flying Bridge" was assembled using gas tungsten arc welding (GTAW), also known as tungsten inert gas (TIG) welding. This process was chosen because of its effectiveness in making sound structural welds on aluminum. When an experienced and knowledgeable welder uses the proper equipment and an optimal procedure, GTAW results in minimal heat-affected zones and excellent penetration.

"TIG welding allows good control of the heat and penetration," Smith said. "Using this process allowed us to create solid welds. Aluminum can become brittle after it has been

welded, but using a proper procedure—which includes the type of bevel, the filler material, the amount of heat, and other variables—results in a weld that is as strong as, and in some cases stronger than, the parent material,” he said.

The thicker items, such as the 0.500-in.-thick-wall tubing, were preheated to ensure sufficient penetration during the welding process. Each weld was ground smooth and polished to match the surfaces of the rest of the assembly to ensure a uniform, flawless appearance. No appearance of puddle lapping in the weld bead was acceptable, so all welds were performed in a manner that resulted in uniform bead width, depth, and surface consistency.

The bridge was constructed using both internal and external sleeves. All sleeves were drilled, tapped, and marked for on-site assembly. All internal sleeves were chosen for a tight fit and external cable connection sleeves for uniform reveal clearance.

The final bridge assembly was fabricated in sections for ease of shipment, handling, and on-site erection and was installed by Carpenter and his crew. All aluminum was polished after fabrication and sealed with clear metal sealer to give a pleasing aesthetic appearance.

A Span That Illuminates

The bridge connects the chemistry and biology departments, and its appearance captures the essence of both disciplines—its long, curved structures evoke chemical chains, yet it also has a lifelike appearance.

Like a gleaming, light-seeking organism, it hovers beneath the atrium’s 80-foot-high skylight. Its aluminum structure and dichroic glass panels play in the light, casting moving shadows and projections as the sun moves across the sky. At night special lighting casts colored light onto architectural surfaces. Laminated dichroic glass panels accentuate the graphic qualities of the cables that help to stabilize the bridge deck.

It’s a beautiful blend of technology, imagination, tube, and pipe.

Albina Pipe Bending Co. Inc., 12080 S.W. Myslony St., Tualatin, OR 97062, 503-692-6010, www.albinapipebending.com.

Ed Carpenter Studio, 1812 N.W. 24th Ave., Portland, OR 97210, 503-224-6729, www.edcarpenter.net.

Peterson Structural Engineers Inc., 5319 S.W. Westgate Drive, Suite 215, Portland, OR 97221-2411, 503-292-1635, www.psengineers.com.