A precast concrete U-beam segment is transported to the dock facility in Albany, N.Y., before being shipped by barge to the project site. Photo: Fort Miller Precast.

The project team developed the concept through careful planning and in close collaboration with the City of Philadelphia and the Schuylkill River Development Corporation. The initial effort began with a 2016 feasibility study that explored four bridge types and recommended a straight alignment. Ultimately, the alignment was adjusted to incorporate a graceful 950-ft-radius reverse curve to avoid obstructions along the river. This practical and aesthetic decision led to the selection of a cable-stayed bridge with precast concrete U-beams.

After the bridge type was established, precast concrete U-beams became a central element in achieving the objective of providing a landmark structure to connect the communities. Unlike cast-in-place alternatives, precast concrete U-beams could be fabricated in long sections off site. In addition, erection required fewer temporary piers than would be used for a cast-in-place structure, thereby reducing the impact of construction on the community. Equally important, the use of precast concrete U-beams provided a clean, streamlined appearance, free of bolted splices or segment joints that might distract from the bridge's elegant silhouette. The U-beams also paired well with steel cable anchors cast into concrete diaphragms.

The center-cable arrangement required a torsionally rigid superstructure to support loading demands. To address this challenge, the design combined curved, spliced, post-tensioned precast concrete U-beams with a cast-in-place composite concrete deck. Together, these elements create a closed cross section that efficiently resists torsional forces generated by the curved geometry while maintaining durability, safety, and constructability within a highly constrained urban environment. The result is a smooth, modern structure that fits comfortably into the urban landscape and serves as a civic destination.

Advancing Curved U-Beam Technology

The curved precast concrete U-beams used in the Christian to Crescent Bridge exemplify the advances in technology developed over the years. Curved precast concrete U-beams were initially developed by the Colorado prestressed concrete industry during the 1990s, and their use has since expanded across the United States. A collaboration of designers, contractors, and owners developed PCI's *Guide Document for the Design of Curved, Spliced Precast Concrete U-Beam Bridges*.[1]

The U-beam section on the Christian to Crescent Bridge followed the web and top flange proportions recommended in PCI's guide document, but the bottom flange was widened to suit the project's unique needs, and embedded couplers

AESTHETICS **COMMENTARY**

by Frederick Gottemoeller

When it is completed, the Schuylkill River Trail will extend from Tuscarora Springs in Schuylkill County some 120 miles until it joins the Delaware River in Philadelphia's Center City, providing recreational opportunities and pedestrian and bicycle routes in the communities through which the river passes. For most of its length, the trail winds its way through the woods along the riverbanks. But the design challenges are very different in the urbanized sections of the valley, and most different of all in downtown Philadelphia.

In Center City, the riverbanks are already occupied by highways, railroads, and power lines. Therefore, most of the trail's Christian to Crescent section must be over water. (Unlike most river bridges, this one runs parallel to the riverbanks.) Notably, the highways, railroads, and power lines have ramps, bridges, and pylons that not only occupy the riverbank space but also conceal the river itself from the surrounding city. In this setting, the design challenge was twofold: to provide a physical passage along the river and to create a visual symbol that says "Hey, I am here."

To provide physical passage, it made economic sense to minimize the number of foundations in the water, a decision that suggested the use of long spans. Long spans inspired the vision of a cable-stayed structural system that would give the bridge tall vertical elements capable of visually competing with the confining ramps, bridges, and pylons. These aspects of the design were all just applied common sense.

The art of the design is evident in the unique basketweave pattern of the stays. The pattern's peaked profile stands out among its visual competition and inserts a memorable shape into the scene. (The redundant stay pattern also reduces the load per stay, allowing the use of less-expensive, standard wire rope cables and fittings.) The art is also found in the vertically tapered, dramatically truncated towers and in the gradual reversed curves of the bridge's alignment, which, as pedestrians move along the bridge, slowly sweeps their gaze across their surroundings.

Another innovative aspect of the design is the application of a spliced, precast concrete U-beam. To river users, the bridge presents as an enclosed, light-colored element, with no visible hollows or recesses to accumulate dirt, debris, or pigeons.

The result is a memorable urban landmark that fits its environment, is a pleasure to use, and attracts people and activity to the riverfront.