deck. At the contractor's suggestion, these beams were changed to precast concrete of the same design to accelerate construction. They were attached with 1-in.-diameter dowels grouted into the transfer girder. They act as composite tee-beams after the deck is cast and cured. Given the aesthetic goals, budget constraints, and a shortened construction window that necessitated higher costs, the bridge team made every attempt to keep the design simple and attractive to local bridge contractors. As a result, the cast-in-place transverse box beam and precast concrete beam elements were used in lieu of a post-tensioning solution.

Most of the substructure elements were supported by 16-in.-diameter, cast-in-place pipe piles below a 3-ft-thick by 12.5-ft-wide by 80-ft-long cast-in-place concrete pile cap. Pier 1 required six, 6-ft-diameter drilled shafts, 52 ft deep. This pier is between two existing utilities: a 36-in.-diameter water main and a 7-ft 9-in. by 5-ft 4-in. sanitary box sewer. By using shafts, encroachment was minimized and vibration from pile driving was eliminated.

Construction began June 1, 2008, and was completed in only 18 months. On November 30, 2009, dedication was held to celebrate the re-opening. Public appreciation of the bridge continues to grow ever since.

Mike Avellano is vice president at Woolpert Inc., in Dayton, Ohio.

For additional photographs or information on this or other projects, visit www.aspirebridge.org and open Current Issue.

Curvilinear rail and cantilever slab frame an overlook and view of the Great Miami River.

AESTHETICS COMMENTARY

by Frederick Gottemoeller

Founded at the confluence of four rivers, Dayton, Ohio, needs many bridges. The bridges, taken as a group, provide much of the civic character of Dayton. In the past, the typical Dayton bridge consisted of multiple earth-filled concrete arches. As these bridges are replaced, the challenge is to create new civic assets of equal quality within the resources of local budgets.

Dayton's rivers are mostly wide but not deep, allowing fairly short spans, well within the range of standard precast concrete girders. These have such overwhelming cost advantages that they are the default choice for new superstructures. Adding visual character to precast girder bridges without breaking the budget requires creative thinking about the other parts of the bridge: the piers, parapets, and railings. Most recent replacement bridges in Dayton include details aimed at making a precast girder bridge look a bit like an arch.

At Stewart Street, the city decided instead on a new approach. The bridge is adjacent to the University of Dayton's new research campus, so the city decided to create a bridge with a contemporary appearance but with the rhythm and scale of the traditional arch bridges. A Y-shaped pier provides a repeated, standardized, easy-to-build element that economically meets this goal. The triangular openings in the cross wall lighten the visual weight of the piers and make them more transparent. A precast concrete fascia covers and unites the edge girder and the barrier and recalls the monumentality of the traditional concrete arches. Its upper facet catches the light, creating a striking horizontal band sweeping from bank to bank, interrupted just briefly at the piers. Even the lighting poles pick up the angular theme.

With the new Stewart Street Bridge, Dayton has found a way to bring its tradition of monumental civic bridges into the twenty-first century.

PROJECT

Replacement of the Stewart Street Bridge

by Mike Avellano, Woolpert Inc.

The Stewart Street Bridge over the Great Miami River in Dayton, Ohio, shown experiencing high water in the spring. All photos: Woolpert Inc.

Major Infrastructure Improvement in City of Dayton

The Stewart St. Bridge over the Great Miami River in the city of Dayton, Ohio, is adjacent to the University of Dayton. The original structure was constructed in 1911 by Gephart and Kline. It was designed by the Concrete-Steel Engineering Company of New York, N.Y., and the concrete-encased steel joist supported formwork system is often referred to as a Melan Arch System. It was a seven-span, 660-ft-long, four-lane closed spandrel, earth-filled arch bridge with a roadway width of 42 ft and a 6.5-ft-wide sidewalk on both sides. It had become functionally and structurally deficient. Since Woolpert opened its business in Dayton the same year the original bridge was constructed, it seemed appropriate that Woolpert be involved in this bridge replacement 100 years later.

The Replacement Bridge

The new bridge is a 72-ft-wide, six-lane structure with two 10.5-ft–wide sidewalks (including rail system) for a total deck width of 93 ft. The bridge is set on a 6.7 degree skew with a tangent alignment. It is flanked by 30-ft-long approach slabs. There are constant grades over the first two and a half spans at each end and a short vertical crest curve over the middle 120 ft.

The replacement bridge includes five 110-ft-long spans, measured from the centerline of piers, and two 55-ft-long spans at each end for a total bridge length of 660 ft. The longest superstructure elements consist of 42-in.-deep by 48-in.-wide adjacent precast concrete box beams, which span 84.5 ft between centers of bearings, with a 6-in.-thick cast-in-place concrete composite deck. End span box beams are 41.3 ft long. Architectural precast concrete fascia panels are supported from the exterior box beams by steel tube extensions from the backs of the panels to plates embedded in the top of the beams or in the deck. The panels are 6 ft 8 in. tall and 2 ft 7 in. wide. The locations of embedded plates were closely coordinated with barrier rail post locations and light pole supports, eliminating conflicts during construction.

The choice of concrete as a design material resulted from the study to evaluate the final structure options, and is anticipated to match the durability of the 100-year-old concrete structure that was replaced. Over 1.5 million pounds of epoxy-coated reinforcement were used. To minimize future maintenance costs, semi-integral abutments were utilized and limited superstructure jointing was also incorporated.

The schedule was accelerated to just 18 months.

Community Involvement

The project began with four technical group meetings where interested parties were invited to discuss the aesthetics, maintenance of traffic, and future traffic flow options. Several alternatives were presented, and in the end, the enhanced bridge replacement on the existing alignment option was chosen. Each option presented included preliminary drawings, renderings, and detailed descriptions of the upgrades, along with anticipated costs for each.

The project's architect gave significant consideration to the complex setting and integral nature of the bridge's

profile

STEWART STREET BRIDGE / DAYTON, OHIO

BRIDGE DESIGN ENGINEER: Woolpert Inc., Dayton, Ohio

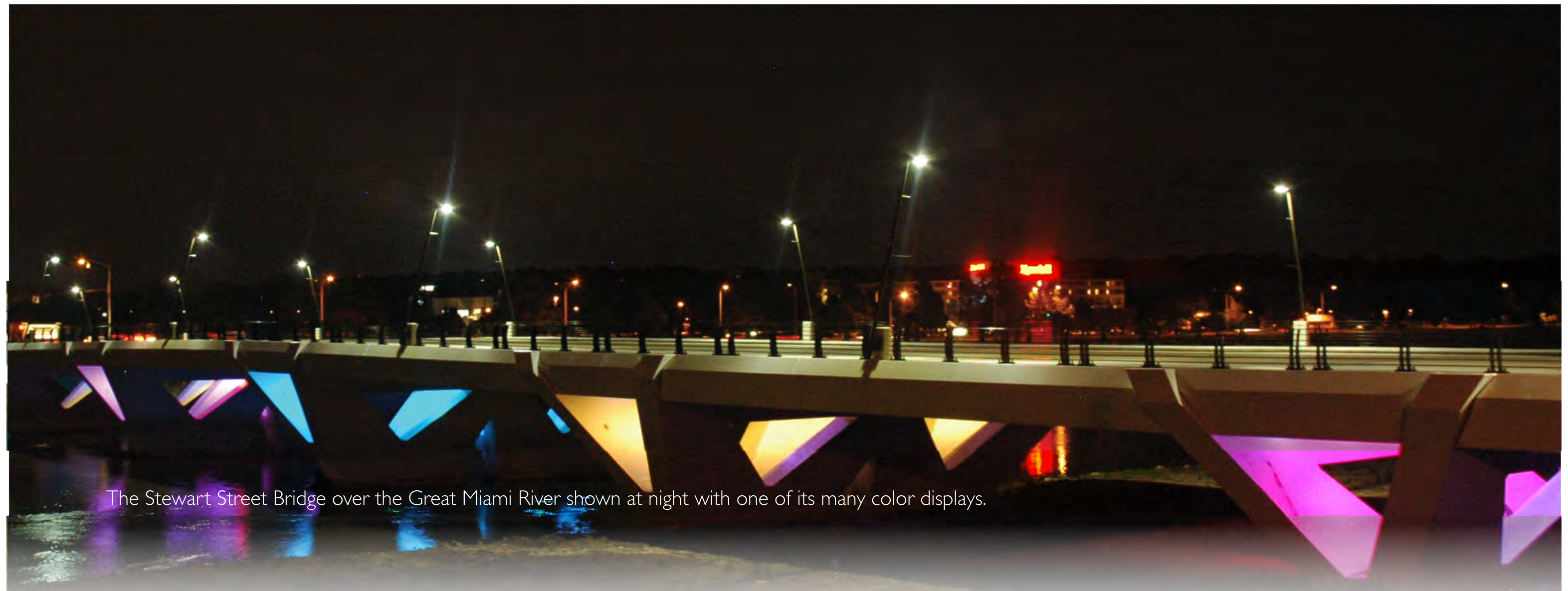
PUBLIC INVOLVEMENT CONSULTANT AND CONCEPTUAL DESIGNER: T.Y. Lin International, San Francisco, Calif.

PRIME CONTRACTOR: Ahern and Associates Inc., Springfield, Ohio

BOX BEAM PRECASTER: Prestress Services Industries LLC, Decatur, Ind., a PCI-certified producer

SPANDREL PANEL PRECASTER: High Concrete Group LLC, Springboro, Ohio, a PCI-certified producer

SOLID TIE BEAM PRECASTER: Ahern and Associates Inc., Springfield, Ohio



The Stewart Street Bridge over the Great Miami River shown at night with one of its many color displays.

location. These included a 1950s-era residential neighborhood, the University of Dayton's sports arena and football stadium, modern office buildings, hotels, the region's largest hospital, a county fairground and the gateway to the University of Dayton.

Maintenance of traffic was an important consideration given the diverse adjacent uses and volume of local traffic. Detours were set to clearly move traffic for significant events (such as early round NCAA basketball tournament games) as well as day-to-day use. Establishing detours eliminated the cost for staged construction and allowed the schedule to be accelerated from the 24 months originally planned to just 18 months.

A public involvement meeting was conducted where many possible aesthetic features for the structure were presented. Rail, lighting (above and below deck), and overlook options were discussed. Four structure alternatives were presented—a precast concrete earth-fill arch and three variations on a Y-type pier design. The three Y-type variations investigated included a true Y shape, a wider delta shape, and a hybrid Y shape that offered a compromise between the Y and delta dimensions. Given the number of recent bridge replacements in the region that echoed the early twentieth century arched structure theme, the hybrid Y was enthusiastically chosen as the preferred design. This choice would enable the bridge team to develop "a design that is a legacy of the twenty-first century," according to one stakeholder.

Piers and Foundation

The maximum height of hybrid Y piers was 32 ft from pile cap to beam seat. Their details and construction presented one of the project's biggest challenges, given the skew and change in profile elevation, which was slightly different at each end. The top legs of the Ys at all piers were designed to be the same length so that the formwork could be reused. Elevations were adjusted by varying the heights of the pier stem below the legs and varying the beam seat elevations. The bridge team held several preconstruction meetings with the bridge contractor in an effort to make sure the forms would work dimensionally and structurally through the construction sequence. As a result, there were no difficulties with the pier construction. The planning and diligence of an experienced bridge contractor paid off.

The piers are developed as strut-and-tie elements both transversely and longitudinally. A 3-ft-deep, cast-in-place transfer box girder is at the top of each leg, providing a tie for each leg transverse to the structure. Longitudinally, the legs of the Y were designed to be tied together with 48-in.-deep, solid, cast-in-place concrete beams, the upper 6 in. of which were to be cast with the 6-in.-thick

The upper surface of the fascia panel catches the light, creating a horizontal band, interrupted briefly at the piers. The lighting poles maintain the same angle.

SEVEN-SPAN BRIDGE USING ADJACENT PRECAST CONCRETE BOX BEAMS, SOLID PRECAST CONCRETE RECTANGULAR PIER TIE BEAMS, AND PRECAST CONCRETE SPANDREL PANELS ON CAST-IN-PLACE Y-SHAPED PIERS / CITY OF DAYTON, OHIO, OWNER

CAST-IN-PLACE CONCRETE SUPPLIER: Ernst Concrete, West Carrollton, Ohio

REINFORCEMENT FABRICATOR: Gerdau Ameristeel, Hamilton, Ohio

BRIDGE DESCRIPTION: A 660-ft-long bridge by 93 ft wide with seven spans (55 ft, 5 at 110 ft, and 55 ft) using 42-in.-deep precast concrete adjacent box beams, 48-in.-deep solid precast concrete tie beams, and precast concrete spandrel fascia panels supported on Y-shaped piers and with a cast-in-place, 6-in.-thick composite deck

BRIDGE CONSTRUCTION COST: $14.8 million

Aesthetics

Several elements provide enhanced aesthetic appeal:

- Precast concrete spandrel panels give the bridge visual continuity along its length
- Horizontal slatted steel railings allow the river to be a part of the bridge crossing experience
- LED lighting illuminates the superstructure
- Custom-designed, above-deck light standards canted over the deck—a design inspired by the angular geometry of the piers
- Wide sidewalks and river overlooks at all four corners inspire a pedestrian-friendly passage, where students and hotel guests can congregate at the overlooks on their way to basketball games at the university arena
- For additional information about the lighting design, see the Creative Concrete Construction article on page 40.

A bridge with no skew would have been much easier to design and construct; however, keeping the existing skew helped maintain the bridge hydraulics with the requirement of no increase in backwater for the Miami Conservancy District prescribed maximum flood levels—a measure based on the historic flood of 1913. This was also the more environmentally friendly option, minimizing impacts on existing mussel beds both up and downstream of the bridge. The alignment also minimized additional right-of-way purchases.

The project integrates the 30-mile Great Miami River Bikeway, which passes beneath the bridge.

Legs of the Y-shaped piers are tied transversely with cast-in-place concrete box girders and longitudinally with precast concrete solid beams.

Solid, 42-in.-deep, precast concrete beams tie the legs of the Y-shaped piers and butt against the ends of 48-in.-deep, precast, prestressed concrete box beams spanning from pier to pier.

The dramatic effects of the precast concrete fascia panels can be seen during their installation.