PROJECT

# From Collapse to Commute: Concrete Builds a New Fern Hollow Bridge in 11 Months

by Jason Fuller and Kevin O'Connor, HDR Inc.

Carrying 20,000 vehicles per day on Forbes Avenue in Pittsburgh, Pa., the Fern Hollow Bridge is a critical commuter route through the region and serves as a main detour for Interstate 376. The collapse of the steel bridge in the early morning of January 28, 2022, drew national attention and resulted in extensive local traffic congestion and user delays.

Replacement of the bridge quickly became a priority. Emergency declarations from the state and city cleared the way for urgent action at all levels of government, and a design-build team was selected to replace the important bridge. The team's notice to proceed with the design was issued on February 3, 2022, just six days after the collapse. The City of Pittsburgh delegated the project management of the removal, design, and reconstruction of the bridge to the Pennsylvania Department of Transportation (PennDOT) District 11-0 under a reimbursement agreement. Through collaboration with the Federal Highway

Site preparation work for the west approach to the new Fern Hollow Bridge in Pittsburgh, Pa., on the morning of June 1, 2022. Photo: HDR Inc.

## profile

**FERN HOLLOW BRIDGE** / PITTSBURGH, PENNSYLVANIA

**BRIDGE DESIGN ENGINEER:** HDR Inc., Pittsburgh, Pa.

**OTHER CONSULTANTS:** Construction inspection: SAI Consulting Engineers Inc. with JMT & CCS Inc., Pittsburgh, Pa.; construction management: Michael Baker International with CCS Inc., Pittsburgh, Pa.; survey and right-of-way: Monaloh Basin Engineers Inc., Pittsburgh, Pa.; lighting: Santangelo & Lindsay Inc., New Brighton, Pa.; cultural resources and utility coordination: Markosky Engineering Group Inc., Ligonier, Pa.; landscape architecture: Klavon Design Associates Inc., Pittsburgh, Pa.

**PRIME CONTRACTOR:** Swank Construction Company LLC, New Kensington, Pa.

**CONCRETE SUPPLIER:** Castle Builders Supply and Trucking LLC, New Castle, Pa.

**PRECASTER:** PennStress, Roaring Springs, Pa.—a PCI-certified producer

**OTHER MATERIAL SUPPLIERS:** Column and cap forms: EFCO, Des Moines, Iowa; formliners: Fitzgerald Form Liner, Santa Ana, Calif.; concrete pumping: Howard Concrete Pumping Co. Inc., Canonsburg, Pa.; material chain management for prestressed concrete beams: Weatherspoon & Williams LLC, Houston, Pa.; midspan diaphragms: Shane Felter Industries, Uniontown, Pa.; reinforcing bars: Titusville Fabricators, Franklin, Pa.

Cranes move the 200-kip, 154-ft-long prestressed concrete bulb-tee beams into position on the new Fern Hollow Bridge in late July 2022. Photo: Swank Construction Co.

Administration (FHWA), $25.3 million was allocated toward this reconstruction project thanks to the recently passed Bipartisan Infrastructure Law.

Working alongside PennDOT, FHWA, and Pittsburgh's Department of Mobility and Infrastructure, the design-build team streamlined project delivery in several ways to meet the aggressive construction timeline. The partners worked as a team to transform a tragic incident into a source of community pride.

## February 2022: Project Begins

The first weeks of February 2022 were a flurry of activity. By February 17, all steel and concrete from the collapsed bridge had been removed. Meanwhile, as kickoff meetings were held and major design decisions made, work quickly moved forward on designing the replacement structure.

The team moved urgently to establish items such as the design criteria, typical cross section, substructure, span arrangement, and superstructure. The design team quickly identified the historic Frick Park Gatehouse in the southwestern quadrant and a private street on the eastern bridge approach as key constraints. Given these existing features, and the desire to remain within the City of Pittsburgh's existing legal right-of-way, no changes could be made to the existing alignment. With this knowledge, the team decided to match the 64-ft out-to-out width of the previous structure.

During these early conversations, the Pittsburgh Department of Mobility and Infrastructure expressed a desire to maximize multimodal access across the structure, given the park setting and nearby trail facilities. Therefore, the bridge width was reallocated to increase multimodal space by roughly 50% through the addition of a shared-use path.

That led to a proposed bridge with a typical cross section consisting of the following:

- Four 10-ft-wide travel lanes
- 2-ft-wide outside shoulders
- A 5-ft-wide raised sidewalk on the northern side
- A 10-ft 5-in.-wide shared-use path on the southern side (separated from traffic using a PennDOT PA bridge barrier)
- A curb-to-curb width of 44 ft
- An out-to-out width of 64 ft

### CITY OF PITTSBURGH / PENNSYLVANIA DEPARTMENT OF TRANSPORTATION DISTRICT 11-0, OWNERS

**BRIDGE DESCRIPTION:** Three-span, 460-ft-long, prestressed concrete beam bridge made continuous for live load, with a 5-ft-wide sidewalk, a 10-ft 5-in.-wide shared-use path, and a typical cross section that maintains an out-to-out width of 64 ft

**STRUCTURAL COMPONENTS:** Twenty-one 95.5-in.-deep, 153-ft 8-in.-long PA bulb-tee beams, weighing over 200 kips each; 9-in.-thick total cast-in-place concrete deck (including 1-in.-thick polyester polymer concrete overlay); PA bridge barrier and pedestrian rail with open line of sight for views of park below; cast-in-place concrete pier caps, columns, and drilled shafts; integral abutments founded on drilled steel piles

**BRIDGE CONSTRUCTION COST:** Approximately $12 million ($408/ft$^2$) (all bridge-related items, but only bridge)

**AWARDS:** American Society of Civil Engineers Pittsburgh: 2022 Civil Engineering Achievement Award; Pennsylvania Society of Professional Engineers, Pittsburgh Chapter: Outstanding Engineering Achievement Award; Engineers' Society of Western Pennsylvania: 2022 Emergency Replacement Project of the Year; March of Dimes Pittsburgh: 2022 Transportation Project of the Year; Association for Bridge Construction and Design Pittsburgh Chapter: 2022 Award for Outstanding Multi-Span Bridge; International Bridge Conference 2023: Award of Merit for Emergency Response

Several of the nearly 8-ft-deep prestressed concrete PA bulb-tee beams were erected by early August 2022. The historic Frick Park Gatehouse is barely visible at the far left corner of the bridge. Photo: HDR Inc.


The nearly 154-ft-long prestressed concrete beams were delivered in early August 2022. In this photo, the delivery truck is staged and waiting to be driven backward for a mile to the west side of the project site. Photo: HDR Inc.

The project team carefully considered the superstructure type and final span arrangement for the proposed structure. Multiple options were evaluated, including a prestressed concrete structure, a steel structure, and a steel or concrete arch structure. The team had to avoid adverse consequences for both Tranquil Trail and the Fern Hollow Creek below the structure, while also anticipating how different span arrangements would affect beam delivery and erection.

The design-build process allowed the agencies and designer to develop reasonable options, which the contractor assessed based on which material types were most readily available and cost effective. Ultimately, after weighing the fabrication lead times, delivery routes, aesthetics, effects on the park below the bridge, beam delivery, beam erection, and estimated costs, the team chose a prestressed concrete beam bridge made continuous for live load as the optimum solution. Design then moved forward with the following configuration:

- Three-span composite prestressed concrete structure
- Total length of 460 ft
- A total of 21 PA bulb-tee beams, 7 beams per span spaced at 9 ft 5 in. on center, each measuring about 8 × 154 ft and weighing more than 200 kips
- Two-column piers founded on 8.5-ft-diameter drilled shafts
- Integral abutments located behind the original masonry abutments, which were to be retained
- Height of 100 ft from the bridge deck to the recreational path below

Delivery of the prestressed concrete beams generated considerable attention from local residents and the media. Photo: HDR Inc.

The team knew that it would be challenging to maneuver the large concrete beams through urban streets and neighborhoods to the site for erection. But prestressed concrete beams were the earliest available superstructure material, and their use increased the possibility of reopening the bridge to traffic within a single construction season. Early coordination among the contractor and the representatives from the precast concrete industry was critical to making this structure choice realistic. Working together, they determined that the beams could be delivered and there was a reasonable way to erect them.

The team also discussed at length the appropriate substructure types. Because of the site's proximity to the Frick Park Gatehouse, pile foundations could not be driven. The team sought to avoid fully replacing the existing abutments because that would require extensive shoring and increase the project cost. Instead, the bridge design proceeded with integral abutments and two

East-southeast view of concrete deck work continuing on the east side (span 3) of the new Fern Hollow Bridge in Pittsburgh, Pa., in October 2022. Photo: Swank Construction Co.

8.5-ft-diameter drilled caissons per pier for piers 1 and 2.

Another strategy that accelerated the project was the formulation of a baseline schedule that merged design and construction activities to identify the project's critical path and determine if full- or partial-design submissions were appropriate to meet the aggressive construction schedule.

## March and April: Design Hits Fast Forward

Design activities dominated the next few months. Design commenced from the top down (as is typical for bridges) and from the bottom up, with the designer using experience with local geology and geotechnical data recently developed for a nearby bridge replacement project.

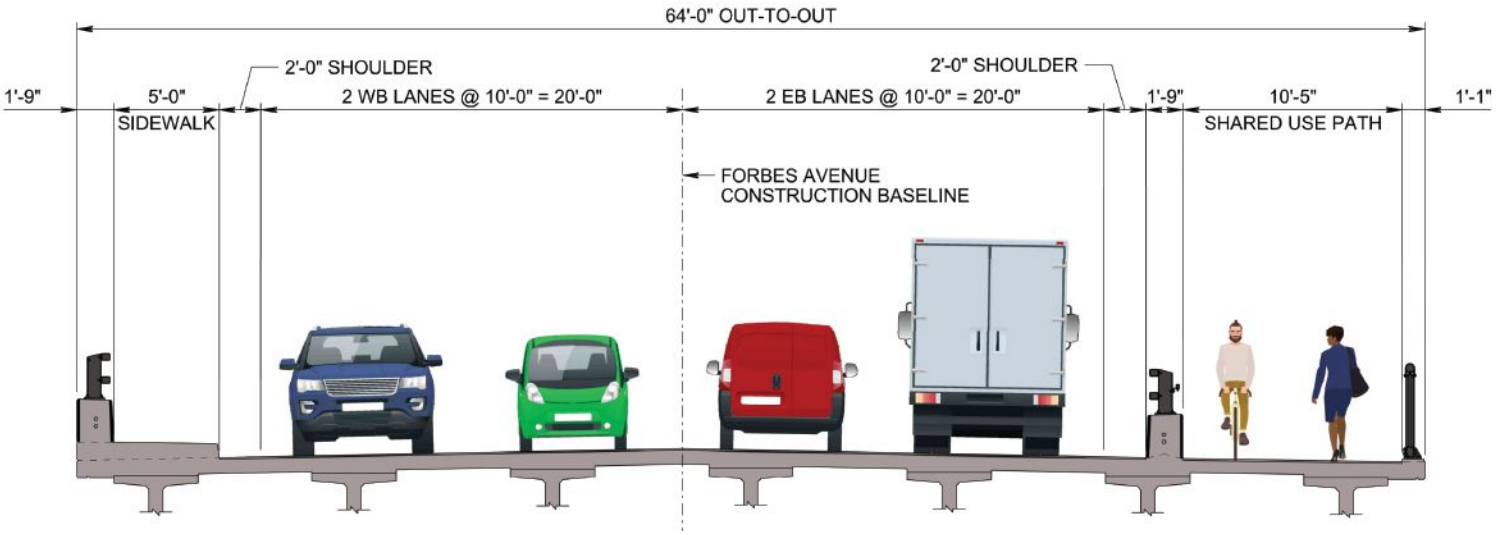
The overall design work was divided into packages, with components likely to have a longer lead time undertaken first. Design-build delivery required the team to design with procurement, fabrication, and construction in mind so that the contractor could start as soon as the winter weather cleared. The first of these design packages, delivered in March, included beams and bearings because they have some of the longest lead times for procurement. Then came the foundations because they would be the first items constructed. The partial submissions for pier and abutment design were submitted in April and accepted in May—a critical step that allowed the contractor to break ground on the new bridge and begin construction.

The partial beam and bearing design packages allowed the team to accelerate procurement of the beams. Using partial submissions and approvals instead of waiting for complete plan sets shaved months off the project schedule. This strategy was made possible because the team had trust in the quality of the designs, the timeliness of the reviewers, and the experience of the fabricator and their ability to produce the shop drawings. Throughout March and April, the general layout of shop drawings began, then details were implemented once partial packages were approved.

By the end of April, the bulk of the bridge design activities had been completed, about three months after the unexpected collapse of the previous bridge. With some exceptions, structure design plans were complete, shop drawings were underway, and materials were being fabricated.

All precast concrete beams were in place on the new bridge by late August 2022. Photo: HDR Inc.

Less than 11 months after the collapse, the replacement bridge was opened to traffic. Photo: HDR Inc.




Typical cross section of the new bridge. Figure: Pennsylvania Department of Transportation.

## May through November: Construction

While design was progressing, the contractor and the project's suppliers worked to prepare for construction to begin in earnest in May 2022. Material procurement progressed throughout the colder months so that construction crews could hit the ground running in May. Construction began with the drilling of the pier caissons in Fern Hollow. With the approval of the beam design package and shop drawings completed and accepted in April, fabrication of the 21 prestressed concrete bulb tees (33-in.-wide and 95.5-in.-deep PA bulb tees) began in May and ended in early June. The beams had a design concrete compressive strength at transfer of 8.5 ksi and a 28-day strength of 10 ksi. Each beam used eighty 0.6-in.-diameter Grade 270 low-relaxation strands. By late July, the site was almost ready for beam erection.

Delivery of the massive beams attracted considerable attention from neighborhood residents and the media. For the beams on the west side of the project, the delivery vehicle had to be driven backward for a mile by an operator at the rear of the vehicle. For much of the way, local residents lined the route and applauded the arrival of the beams.

Big beams require large cranes for erection, and in this case, two large crawler cranes were used to set the beams. For the initial unloading pick, a Manitowoc MLC-650 with a variable counterweight positioning system was used. This type of crane was required because each beam weighed over 200 kips and it was necessary to reach out to the center of the end spans. The massive crane (including counterweights) was delivered to the site on 45 separate trucks, and thirty-eight 10-ton counterweights were required for the lifts at Fern Hollow. Operators used a smaller crane (MLC-300), which was driven down the access road to a crane pad below the bridge after full assembly, to help move beams to the center spans. For span 2, operators of the larger crane temporarily placed the beams on span 1 and then used both cranes for a tandem pick to move the beams from span 1 to their final location in span 2.

Crews worked on deck forming and reinforcing bar installation in August, and started deck placement in late September. The 9-in.-thick deck is composed of an 8-in. composite concrete cast-in-place deck with a 1-in. polyester-polymer concrete overlay. All deck reinforcement is Grade 60 epoxy-coated reinforcing steel. Crews erected beams as simple spans and placed continuity diaphragms at the piers with a continuously reinforced concrete deck over the entire length of the bridge. By October, deck construction was complete and tie-in work began.

## December: Open to Traffic

Less than 11 months after the collapse, the ribbon-cutting ceremony for the new bridge was held on December 21, 2022, and traffic started flowing the next day. Work continues on some components, including a bridge deck overlay, lighting installation, and the midblock pedestrian crossing on the western roadway approach; all of these are scheduled to be completed in summer 2023. At the bridge opening, both politicians and project leaders praised the teamwork and dedication that made the rapid completion of the new bridge possible.

"I was here on January 28 to survey the damage from the collapse, and today, less than a year later, I stand before a bridge that is nearly ready to reopen to traffic," said Pennsylvania governor Tom Wolf. "This is the power of government working for the people in Pennsylvania. It's an honor to be here to celebrate this incredible milestone for Pittsburgh."

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*Jason Fuller is a vice president and senior project manager and Kevin O'Connor is a senior project manager with HDR Inc. in Pittsburgh, Pa.*

### EDITOR'S NOTE

*The new Fern Hollow Bridge is featured in a Project Spotlight article, "Collapsed Pittsburgh Bridge Replaced in Less than a Year," in the May–June 2023 issue of* PCI Journal. *That article describes the exceptional collaborative efforts of the stakeholders to achieve the aggressive schedule and deliver the new bridge in less than one year. It also features additional photos of the challenging beam delivery and erection processes. https://doi.org/10.15554/pcij68.3-06.*