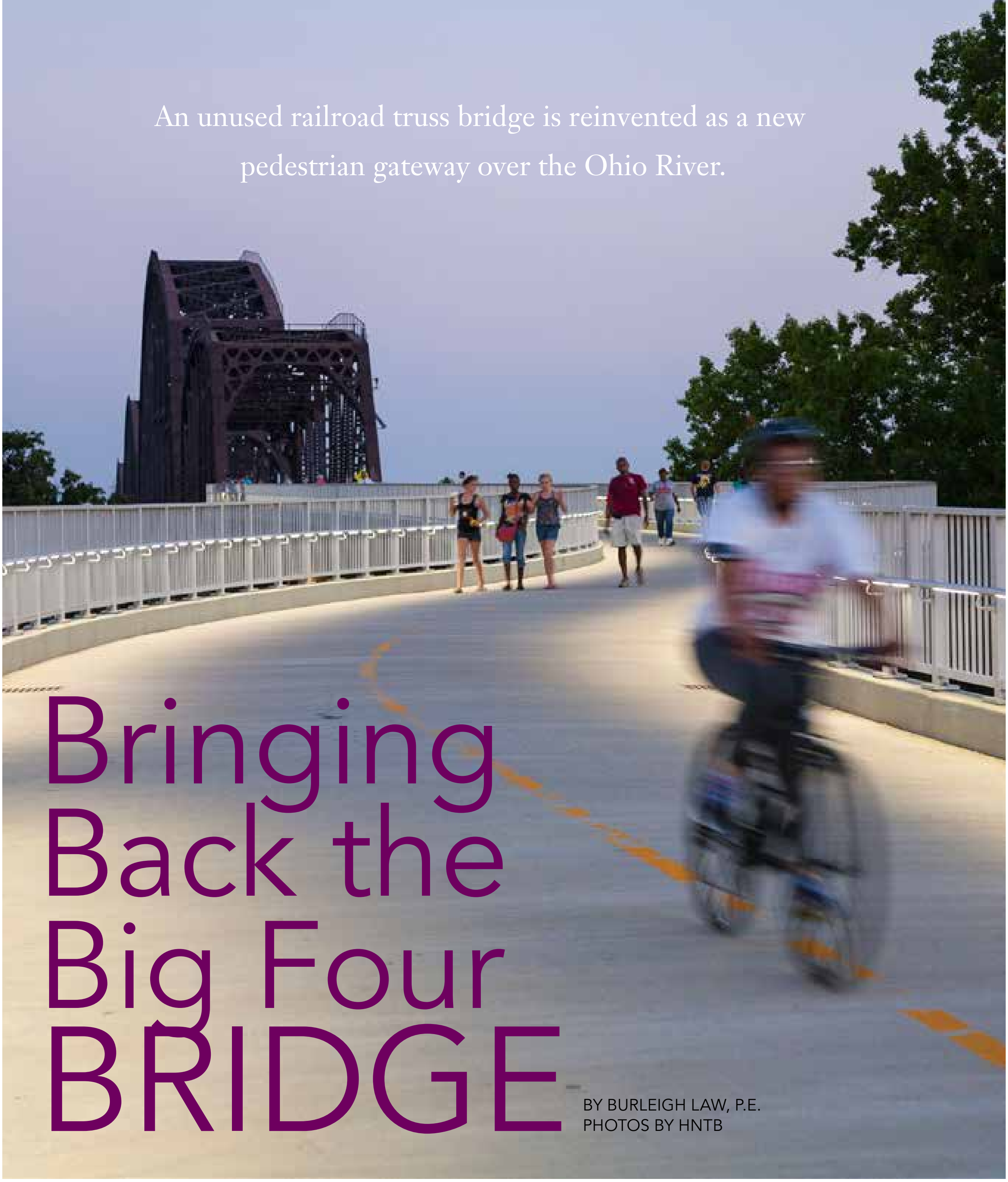

An unused railroad truss bridge is reinvented as a new pedestrian gateway over the Ohio River.

Bringing Back the Big Four BRIDGE

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THE BIG FOUR BRIDGE had a big name to live up to.

Built in 1885 and replaced in 1929, the 2,525-ft-long six-span railroad truss bridge was named for the now defunct Cleveland, Cincinnati, Chicago and St. Louis Railway—also known as the Big Four Railroad—and carried a single track over the Ohio River between Louisville, Ky., and Jeffersonville, Ind. The replacement bridge operated for four decades before falling into disrepair and was eventually deemed a safety hazard. Rail operations ceased in 1969, when rail traffic was rerouted to another bridge, and the approach spans were removed and sold for scrap.

For decades, the bridge was unused, with no access to the main span sitting atop piers that rose 50 ft in the air, earning the bridge the unfortunate nickname of "the bridge to nowhere." The Louisville Waterfront Development Corporation acquired the bridge in 2005 with the goal of converting it

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A stair tower (50 ft from top of footing to highest point) provides access to the Ohio River Greenway and Jeffersonville waterfront 1,000 ft south from where the bridge lands at the Big Four Station.

Special details at the pier diaphragms ensure easier passage of the drain piping and conduit.

into a pedestrian bridge. At the time, pedestrian and bicyclist access over the Ohio River was accommodated by the Clark Memorial (2nd Street) Bridge on the other side of the Interstate 65 bridge, but the sidewalks and shoulders were narrow and adjacent to fast-moving vehicular traffic.

The newly constructed and rehabilitated 21-ft-wide bridge is designed for a 75-year life for pedestrian loading as well as emergency vehicles. The Jeffersonville approach is 1,240 ft long (1,033 ft of bridge and 207 ft of fill approach), the main span is 2,547 ft long and the Louisville approach is 1,181 feet long (693 ft of bridge and 488 ft of fill approach). The bridge was completed in phases, with the Louisville approach opening in 2010 and the main span truss being rehabilitated in 2013.

Outside the Box (Girder)

The last portion, the curvaceous Jeffersonville approach—designed by HNTB—opened just last year, completing the crossing. While steel box girders are often used on curved long-span highway bridges for stability and structural efficiency, they are not generally used on pedestrian bridges. However, this girder type was chosen for the Jeffersonville approach because the girder fascia and bottom soffit create a streamlined look through the S-curve span and the sharp 90° curve at the end of the bridge. There are two steel box girders and, given the length of the spans, field splices were required for fabrication, shipping and erection. The 60-in.-deep box girders for the Jeffersonville approach had spans of 128.5 ft, 128.5 ft, 160.67 ft and 160 ft for Unit 1 and143 ft, 160 ft and 143 ft for unit 2.

The portions of the girders immediately above the piers are painted to prevent staining caused by runoff from the weathering steel as it develops its patina.

➤ The 60-in.-deep box girders for the Jeffersonville approach had spans as long as160.67 ft.

The girders also conceal utilities, which would have detracted from the clean lines if mounted on the outside. Each girder contains an 8-in.-diameter drain pipe and four 2-in.-diameter conduits, including junction boxes and hanger assemblies, all of which run the length of the bridge. The internal intermediate cross frames are standard and the placement of the drain pipes, conduit and hanger assemblies are placed to fit around these. Special details at the pier diaphragms ensure easier passage of the drain piping and conduit. Holes are provided in the bottom flange near the end bent for the drain pipes to exit the bridge and tie into a storm water system, and intermittently spaced standard 2-in.-diameter vent holes with "critter screens" are provided in the webs and bottom flanges to prevent moisture accumulation in the girders.

➤ The girders also house the utilities, which would have detracted from the clean lines if mounted on the outside.

➤ Joining the new approach to the historic main span of the bridge.

The S-curve alignment was selected to minimize utility and right-of-way impacts, cost and coordination, allowing the bridge to avoid historic homes and other buildings along the east side of Mulberry Street. The approach crosses over streets, a proposed future canal and an existing floodwall, which was modified with a wider opening to better connect the new bridge with the Ohio River Greenway trail. To avoid ending the bridge at an intersection, a green space—the Big Four Station—was designed with fountains, a stage, pavilions and playgrounds.

To accommodate a 54-ft elevation change, ADA considerations dictated a long bridge with a constant 4.79% grade. Post-tensioned box girders were initially considered for the superstructure, but it was determined that steel box girders

➤ The Jeffersonville approach is 1,240 ft long.

The S-curve girder sections and the curve at the end of the alignment have 144.4-ft and 155.6-ft radii, respectively.

would work better with the horizontal and vertical alignments (and again, they could be used to conceal drainage pipes and electrical conduit as well as visually match the approaches). The girders are made from ASTM A709 Grade 50W weathering steel; the portions of the girders immediately above the piers are painted to prevent staining caused by runoff from the weathering steel as it develops its patina.

The project and performance constraints required curves at the minimum feasible radii for the fabrication of the steel box girders. A plate and eccentric beam finite element model (created in MDX) and a 3D finite element analysis (created in CSiBridge) were used to accurately design and model bridge behavior under applicable loading. The S-curve girder sections and the curve at the end of the alignment have 144.4-ft and 155.6-ft radii, respectively; industry norm considers a 150-ft radius to be the absolute minimum for the fabrication of widely used steel plate girders, so the radii used on the Big Four Bridge are considered rare for steel box girders—but again, the tight radii helped minimize utility and right-of-way impacts.

When it came to pile driving—HP pile (HP14×73 and HP14×89) was used for the foundations—the team needed to mitigate potential damage to historic homes as a result of vibrations. Structural engineer HNTB wrote specifications that required vibration monitoring and pre-drilling and backfilling of holes prior to driving steel HP pile; this softened the earth the piles were driven through and helped minimize vibration. This method resulted in virtually no vibration readings at any nearby historic homes, and therefore no damage.

Girder erection was particularly challenging in the last curved span. The center of gravity for the last span is well outside of a straight chord or line between substructures, creating a springboard effect. A temporary shoring tower was used to

The precast components of the stairs are supported by W18×50 beams and HSS8×6×⅜ diagonals; these smaller members facilitated a less visually intrusive design.

The S-curve alignment was selected to minimize utility and right-of-way impacts, cost and coordination, allowing the bridge to avoid historic homes and other buildings along the east side of Mulberry Street.

hold the girders in their cambered position until the concrete deck cured and developed a composite system with the girders. This process required precision with jacking and surveying to make sure the girders behaved as expected and the final screed elevations of the concrete deck matched the design.

Strong Stairs

A stair tower (50 ft from top of footing to highest point) provides access to the Ohio River Greenway and Jeffersonville waterfront before the bridge's landing at the Big Four Station, which is 1,000 ft further north. The open stair minimizes security issues while maximizing outward views, and the precast stair risers and landings include a center separator with guide troughs that enable bicyclists to walk their bikes up and down the stairs without having to carry them. The precast components are supported by W18×50 beams and HSS8×6×⅜ diagonals—these smaller members facilitated a less visually intrusive design—and all steel members are welded to embedded steel plates on the face of the concrete stair column. For ease of erection, the connection between the main steel members and embedded plates was made with field-welded steel angles, and temporary bolts were used to hold the members in place prior to welding.

With the last phase now in place, the new incarnation of the Big Four Bridge provides a safer and more pleasant pedestrian experience over the Ohio River between Louisville and Jeffersonville. The enhanced access point has resulted in a recent increase in tourism and development activity in Jeffersonville, a testament to the positive impact of well-planned infrastructure improvements. ■

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City of Jeffersonville, Ind.

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Structural Engineer
HNTB Corporation

Steel Fabricator
Industrial Steel Construction, Inc., Gary, Ind.

Steel Detailer
Tenca Steel Detailing, Inc., Quebec, Canada