Artistic Arch

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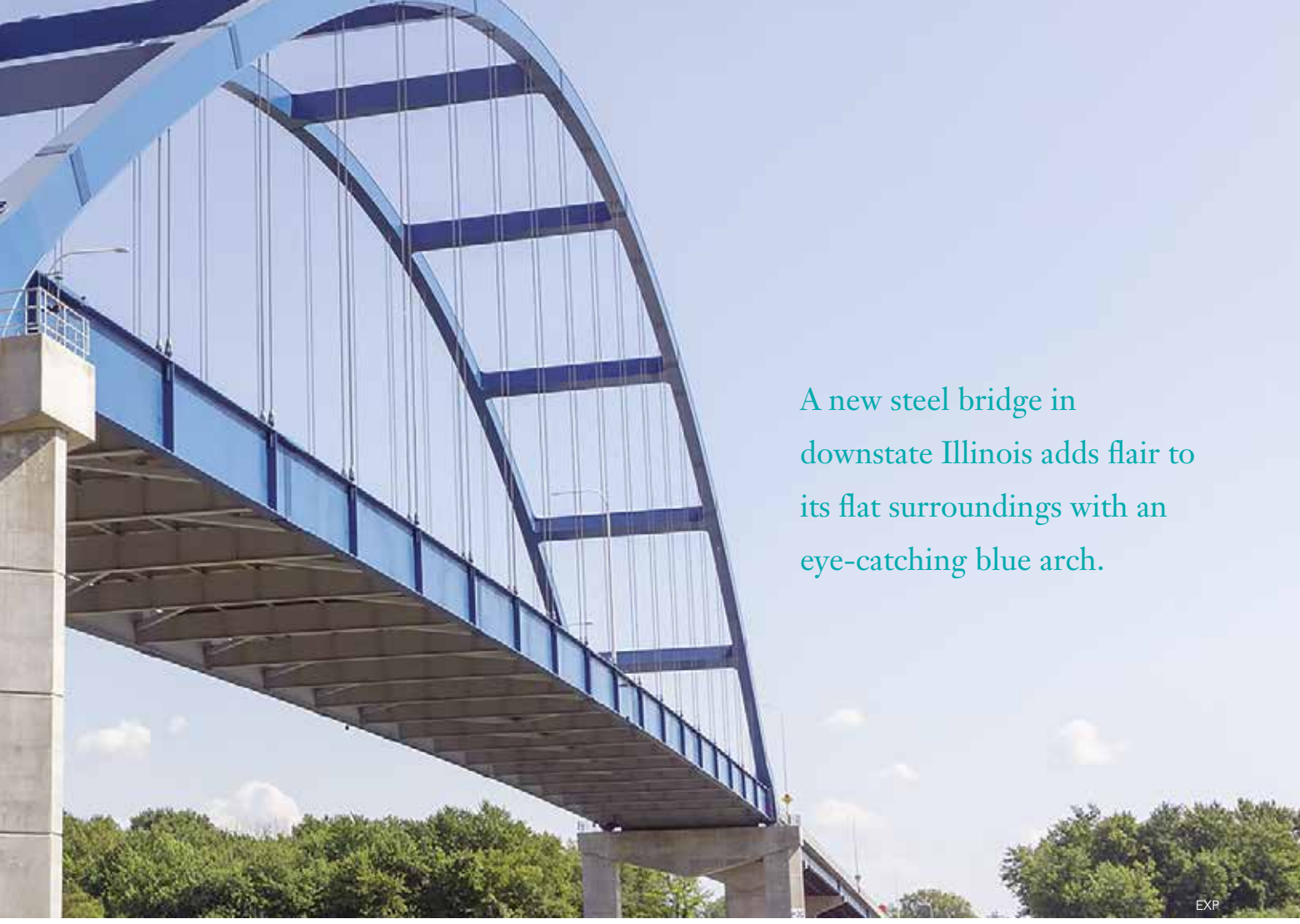
IN THE VILLAGE of Meredosia, Ill., small-town charm is a staple of everyday life. Located roughly 45 miles west of the capital city of Springfield, the town's 1,000 residents relied on an existing crossing, built in 1936, of Illinois Route 104 (IL-104) over the Illinois River. By 2007, the bridge was deemed structurally deficient and the following year, design firm EXP was authorized to begin planning for its replacement.

As Meredosia and the region awaited a new bridge crossing the Illinois River, the big questions became where and whether a river crossing would be available during the bridge replacement. The bridge served as a backbone to the region's mobility and transportation network, and its closure would have required an extensive detour and greatly impacted the region's commercial traffic and many farmers. A new bridge bypassing the village would not be good for the local businesses. Finding an optimum solution for the bridge's replacement required creativity and close collaboration with the community and several agencies. An extensive environmental assessment and a context-sensitive solutions study were completed, evaluating multiple alignments and bridge types in search of a solution that would be efficient and aesthetic while still keeping the traffic flowing through the village.

The study determined the ideal location of the replacement bridge to be approximately 255 ft north of existing bridge, as it met the project's primary purpose of providing a reliable and safe river crossing as well as the local and regional economic needs. After selecting the alignment, a bridge-type study evaluated truss, tied-arch and cable-stayed configurations for the new bridge. A tied-arch bridge was selected for ease of inspection and maintenance as well as the Illinois Department of Transportation's (IDOT) experience and familiarity with tied arch bridges. The new 2,125-ft-long bridge features a 590-ft-long tied-arch main navigation span and nine welded plate girder approach spans ranging from 142 ft to 200 ft, requiring approximately 3,360 tons of steel in all. The new bridge



A new steel bridge in downstate Illinois adds flair to its flat surroundings with an eye-catching blue arch.

carries two 12-ft lanes and two 10-ft shoulders and provides nearly 74 ft of vertical navigation clearance above normal pool. The bridge's design required complex analysis and used state-of-the-art programs to determine loads and perform design checks. With the arch rising nearly 200 ft above the water, the new crossing opened this past summer to an excited crowd and will serve as an attractive gateway to the region for the next 100 years.

A Tied Arch Seen from the Distance

Part of this attractiveness is due to the paint job. Now known by residents and onlookers for its piercing blue arch, and serving in stark juxtaposition to its surroundings, the new bridge features a simple and direct approach to design and steel detailing. Form followed function in design, aesthetics and implementation, a strategy that allowed the bridge to take its distinctive presence.

During the construction phase, the previous bridge remained open to traffic to reduce mobility restrictions and economic impacts to the village. The contractor elected to erect the arch through cantilevered erection, with stay towers erected on top of the main river piers and inclined back-stays anchored to the approach superstructure near the adjacent approach pier on both sides of the arch span. The uplift component of the tension in the back-stays was resisted by vertical hold-down cables anchored in to the approach pier footing and the horizontal component was balanced by the thrust at the arch knuckles, all through the approach superstructures. This allowed for the completion of the 590-ft span without falsework towers in the river and an unrestricted navigation channel for the river traffic. The fully constructed arch span, including the concrete deck, was designed for prestressed assembly to counteract flexure in the ribs and ties due to dead load. The bridge was also designed for additional load combinations beyond those required in AASHTO LRFD, as arches can be particularly sensitive to certain unbalanced load patterns.

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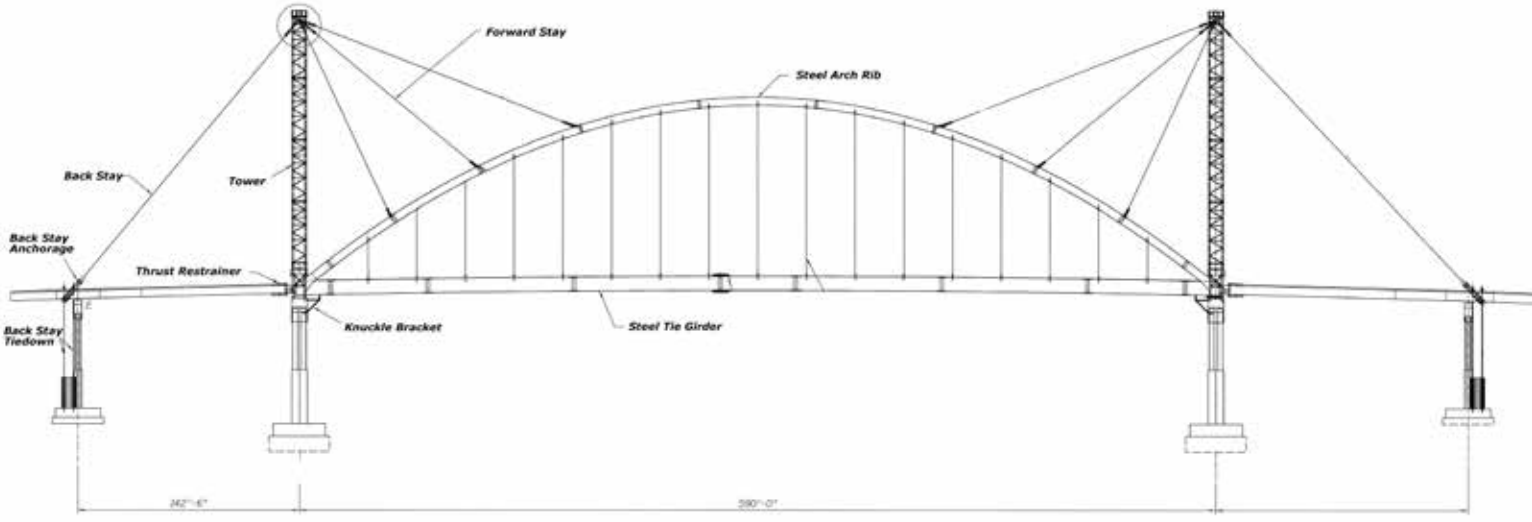
The blue arch creates a new structural icon for the area.

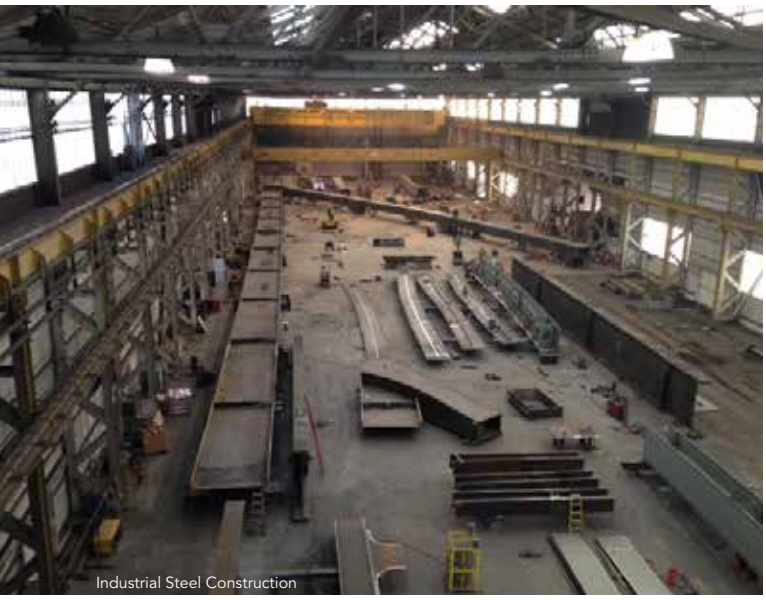
The substructures consist of stub-type abutments and architecturally enhanced hammer-head approach piers and dual-column portals for the main span, all founded on steel H-pile foundations. The foundations were designed with all vertical H-piles counting on the soil-structure interaction to resist lateral loads. Using all vertical H-piles as opposed to conventional batter piles resulted in a simple and constructable pier and cofferdam system, and helped reduce foundation costs by 40%.

The tied arch span uses 9-ft-deep I-shaped tie girders that greatly reduce fracture-critical and long-term inspection and maintenance concerns. The curved arch ribs (box sections) were all fabricated by Industrial Steel Construction, including bending the top and bottom flanges of the rib box sections, then welding the flanges and the side (vertical) web plates together to form the curved rib segments. Nicholas Petkus, the company's vice president of sales and estimating, worked closely with the EXP design team and comments, "The I-Girder design of the ties proved to be very economical, in both cost and time, compared to the welded or bolted boxes that we typically see. This helped, not just throughout the fabrication process, but also in the standup assembly of the deck floor system. When it came time to drill the connections, it was not necessary to have our people working inside the boxes; this was a major time saver. The girders were easier to handle compared to boxes.

An elevation view of the new bridge during erection.



Courtesy of Hanson Professional Services, Inc.



Fabrication of the new 2,125-ft-long bridge, which features a 590-ft-long tied-arch main navigation span and nine welded plate girder approach spans ranging from 142 ft to 200 ft, requiring approximately 3,360 tons of steel in all.

The main span of the bridge, coming together in the middle.

The new bridge carries two 12-ft lanes and two 10-ft shoulders and provides nearly 74 ft of vertical navigation clearance above normal pool. The bridge's design required complex analysis and used state-of-the-art programs to determine loads and perform design checks.

This switch was the most interesting on the project."

The uniqueness of the I-shaped tie resulted in an unusual but efficient rib to tie connection at the arch knuckle. Careful detailing of features such as simple floor-beam-to-tie-girder connections, Vierendeel arch rib bracing with large strut spacing and struts offset from the hanger locations made the structure more efficient and easier to construct.

The new IL-104 bridge required extensive coordination amongst the owner, agencies, designer, contractor, steel fabricator and community to create a transportation landmark to replace an obsolete and structurally deficient span. Innovative design methods, coordination and precise steel fabrication resulted in the enhancement of a traditional tied arch bridge, yielding a striking new gateway to let visitors and locals access Meredosia's small-town charm. ■

Owner
Illinois Department of Transportation (IDOT)

Structural Engineer
EXP, Chicago

Contractor
Halverson Construction, Springfield, Ill.

Construction Engineering
Hanson Professional Services Inc., Springfield

Steel Team

Fabricator
Industrial Steel Construction, Gary, Ind.

Detailer
Graphics for Steel Structures, Inc., Hicksville, N.Y.