'These precast schemes have been used individually but never in this exact combination.'

The Perry Street Bridge in Napoleon, Ohio, was replaced with a precast concrete spliced-girder design that replicated the look of the original and was built in only one year. Photo: ©grandlubell.com

Replicated Historic Bridge Opens In Less Than A Year

— Craig A. Shutt

Precast concrete spliced-deck bulb-tee beams helped new bridge reproduce the original bridge's appearance while speeding construction

Fact Sheet

Project: *Perry Street Bridge*

Type: *Bridge replacement*

Location: *Napoleon, Ohio*

Designer: *HNTB Corp., Cleveland*

Engineer (substructure): *E.L. Robinson Engineering Co., Dublin, Ohio*

Contractor: *Frucon Construction Co., Denver*

Owner: *Ohio Department of Transportation, Columbus, Ohio*

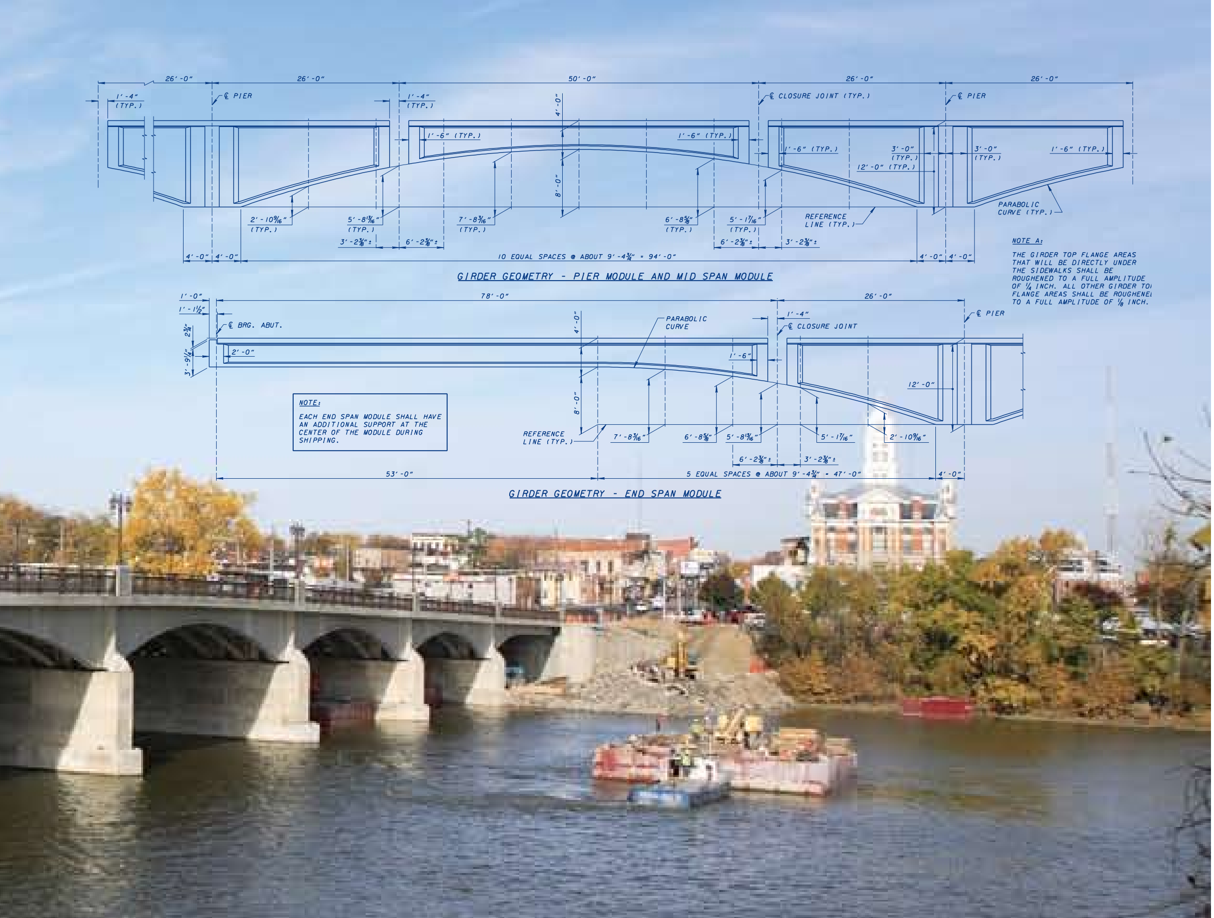
Size: *Seven spans at approximately 103 feet each*

Components: *54 pier modules, 45 mid-span modules and 18 end-span modules*

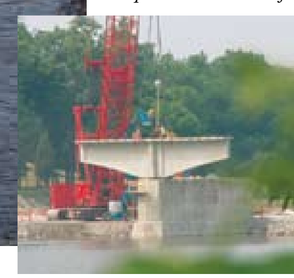
Cost: *Total –$17.35 million*

Built in 1930 and serving as the only local crossing point of the Maumee River, the Perry Street Bridge had well served the citizens of Napoleon, Ohio. But so much traffic took its toll on the sand-filled concrete, barrel-arched structure. Local officials wanted to rehabilitate the bridge, but there wasn't enough left to save. Instead, they decided to build a new bridge that replicated the look of the original design. But because of the bridge's critical importance to the area, they wanted to minimize the time it was out of service. An all-precast concrete spliced-girder, decked-beam design achieved both the appearance and schedule goals.

"Once officials determined that there was no sound concrete left in the existing bridge to create a base for rehabilitation, we were asked if we could develop a design and construction methodology that could



To replicate the original bridge's arched design, variable girders were cast, which required cast-in-place splices to allow them to be transported to the site safely.



build a replacement bridge in one year," explains James M. Barker, vice president of HNTB Corp. The firm initially had been asked to assess options for the bridge when rehabilitation plans fell apart. "After a little thought, we said that if we could time the construction correctly, we could demolish and build a replacement bridge in one year."

Four Key Criteria

In response to public meetings with the citizens of Napoleon, officials at the Ohio Department of Transportation (ODOT) set out four key criteria for the new design:

- It had to have the same shape and same number of spans as the original and match its appearance.
- Construction could not disturb the river bottom from April to June due to fish spawning.
- It had to be constructed in the same location as the original.
- It had to be ready for use one year after demolition.

"We decided to incorporate as much precast concrete as possible," Barker says. "This allowed us to begin casting the pieces in the winter prior to the year of construction. That meant the on-site construction could be limited to building foundations and erecting the precast modules."

Designs for the beam sections were determined by the need to replicate the original arches, he notes. That requirement led the designers to follow design criteria for segmental box girders so they could allow for zero tension in the concrete. "The replication of the arches provided plenty of concrete to carry the stresses, which allowed us to achieve the zero-tension state in both the longitudinal and transverse directions, except for a few longitudinal sections under design live-load applications," he says.

The design provided seven spans measuring 103 feet in length, exactly the same as the original bridge. A five-span structure would have been more economical, he notes, but it would not have replicated the original look. Reproducing the original arch design also meant casting variable-depth sections, which proved too heavy to transport to the site in one piece. As a result, cast-in-place splices were created to provide the reduced length and weight for sections that could be transported easily.

Combination Of Concepts

"Our final concept incorporates a combination of precast, prestressed construction schemes that have been used individually in the past but, to our knowledge, have never been used in this exact combination," Barker says. To ensure the project would be economically feasible, HNTB held several seminars to explain the project and solicited suggestions from local contractors and precasters. "Both

Only three types of precast modules were used to construct the bridge's superstructure.

As one requirement of construction was to not disturb the fish spawning grounds in the river, shafts were drilled through the existing piers to avoid any disruption. To facilitate drilling through the old piers, they were cut off at the water line during demolition, and a leveling course was cast before drilling the new shafts.

groups provided very valuable information and seemed to appreciate the opportunity to participate."

To meet the requirements for constructing the bridge in the same location and not disturbing the riverbed in late spring, shafts were drilled early in the spring through the existing piers, which were founded with spread footings on shale. The new shafts and piers were required because the condition of the existing piers was suspect. The existing piers also did not have sufficient capacity to carry the construction loads. Their bases were left intact from the waterline down, however, ensuring the riverbed was not disturbed.

To further speed substructure construction, piers were designed as cap and column-type piers with precast pier caps. These were divided into three sections that later were post-tensioned together to reduce the total weight. The abutment beam seats were also designed as precast sections. To meet aesthetic requirements for replicating a concrete arch structure, the column and bent piers were detailed with cast-in-place fascia walls surrounding the pier columns so they would resemble well piers.

The superstructure consists of three precast elements: pier modules, mid-span modules and end-span modules. The 28-day design concrete strength for the components was 7,000 psi, which is typical for ODOT projects. The modules were designed with a combination of pretensioned and post-tensioned tendons. The pretensioned strands controlled the stresses during shipping and erection, while the post-tensioned tendons provide continuity.

Decked Beams Speed Work

Construction was expedited by the use of "decked" bulb-tee beams that incorporated the deck panels with the beams, eliminating almost all forming and casting in the field. The technology has been used for more than 40 years, primarily in the Northwest, where it is popular for aiding fast construction. The system also aids projects in rural areas, where labor and ready-mix concrete are not readily available.

During erection, pier modules were installed and temporarily fixed at piers one and two. Then the span-two mid-span module was set in place hanging from strongbacks. Span one's end-span module was erected, closure joints were poured and the four segments were post-tensioned together. Then pier three modules and span three mid-span modules were placed, the closure joints were poured and the tendons were coupled and stressed.

The span-three process was repeated for spans four and five. Finally, the pier-six modules, span-six mid-span modules and span-seven end-span modules were placed, the closure joints were poured and tendons were coupled and stressed. Transverse post-tensioning was performed in each span when erection had progressed at least three spans beyond the last span to be transversely stressed.

In all, the project required 54 pier modules, 45 mid-span modules and 18 end-span modules. HNTB worked closely with the general contractor, Frucon Construction Co. of Denver to build the precast concrete modules. The components were transported using three different trailer configurations because of the three distinctive shapes and weights, Barker explains. The pieces were transported from the precasting site in Toledo, Ohio, and the transporters had to deal with the city's curfew laws to get the heavy loads out of town before or after rush hours.

The components were erected with the assistance of a rock causeway placed in the river, which allowed sufficient flow to maintain the river levels. "They were only flooded out once, which cost them two weeks on the project," Barker says. "But the erectors were two weeks ahead of schedule at the time, so it worked out fine. The temporary causeway proved to be a wise choice with the dry summer we had. Much of the time, the barges were dragging bottom because of the low water levels of the river."

The project met all four key goals that ODOT had set. The new design resembles the original and was ready for use less than one year after work began, opening for traffic in October. "The largest reason the schedule was successful was a high degree of cooperation among the contractor, the ODOT construction personnel and the consulting engineer." Barker says. "Most of the problems were solved before they really became problems and affected the schedule." ■

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