





Creating a New Motor City Gateway COMPLEX BeomeTRy

Detroit's arched bridges were erected using alternative methods that eliminated the need for expensive shoring

By Sheila Bacon

HE INTERSTATE 94 GATEWAY Bridges near Detroit—with their soaring blue arches and footballshaped braces—are a study in complexity. Their design and erection, although simplified through a number of creative approaches to reduce construction costs, had to minimize disruptions to traffic and meet a deadline that could not be extended.

The bridges are located in Taylor, at the east of the Detroit Metropolitan Wayne County Airport and west of downtown Detroit. The \$20-million project is part of a \$75-million reconstruction job that is creating a new alignment along 4.2 miles of I-94 through Taylor.

The twin tied-arch bridges—each supporting a 240-ft-long deck span designed to carry four lanes of traffic—were designed by Lansingbased Alfred Benesch & Co. for the Michigan Dept. of Transportation. AGC of Detroit member Ruby + Associates, Farmington Hills, Mich., was brought on board by subcontractor C.A. Hull Co., Walled Lake, Mich., to do construction engineering.

Ruby proposed an alternate construction

Streamlined engineering made the erection of these landmark Detroit-area bridges easier and less expensive than originally anticipated.

method that eliminated the need for massive and expensive shoring. They also designed a set of lifting devices that would satisfy strict design criteria by lifting each of the 12 arch sections into place without any bolts or welds.

As originally designed, temporary shoring towers were to support not only the bridge deck steel, but also the formwork, rebar, screed machines and deck concrete. The towers, as specified, would have had to support 120,000 lb while maintaining an installation tolerance of plus-or-minus ½ in. for the deck elevation.

The available window below the deck steel for the spandrel system over heavily traveled Telegraph Road was approximately 30 in., says Brian Volpe, Ruby + Associates' project engineer. Creating a spandrel system that was stiff enough to resist 240,000 lb of vertical load over the road while limiting the deflection to ½ in. would not have been cost effective.

The Ruby team came up with an alternate plan that reduced the weight on each shore to just 32,000 lb and minimized tight tolerances during installation. Instead, only the bridge steel would be supported by the shoring towers while the remaining bulk of the span's weight would be shifted to the bridge's arches through the tensioning of the cable strands.

By using the arch to support the dead load

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The Gateway Bridges serve as a welcoming icon for visitors coming to Detroit from the Detroit Metropolitan Wayne County Airport.

during construction, crews were able to use a less expensive, rented shoring system instead of larger, specially fabricated shoring towers.

Had the deck been installed on heavy shoring as specified, the foundations would have likely been driven with pile caps, which would have been required to reduce foundation settling. These foundations would then have to be removed to accommodate final Telegraph Road paving.

The complicated nature of the heavy shoring system also would have made the maintenance of continuous traffic along Telegraph Road more difficult. The smaller shores required only timber mats at the base, and since they were easily removed once the load was transferred, they could be immediately reused for construction of the second bridge.

Additional efficiencies were realized during the pick, lift and placement of the arch system. Each of the four arches (two on each bridge structure) has three members for a total of 12 sections. Each section



Erecting the bridge arches was complicated, requiring specially designed hitches to lift and tilt the steel 25° inward.

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was built on its side, lifted into place, then rotated 25° into its final orientation.

The complex geometry of the arch sections required specially designed hitch fixtures to securely grasp the sections and also tilt the pieces inward once in place. This exercise was complicated by strict design

The Ruby team came up with an alternate plan that reduced the weight on each shore to just 32,000 lb and minimized the tight tolerances during installation.

requirements that did not allow any penetrations or welds to the arches.



The project team simplified the shoring beneath the bridge decks, eliminating the need for a complex support system. Only the bridge steel was supported by the shoring towers, while the remaining bulk of the span's weight was shifted to the arches through cable tensioning.

"The geometrics are this job's largest challenge," Volpe says. "Everything's at a 25-degree slant. There's not a straight line on the bridge."

The three hitches—two outside devices designed to lift the sections and a middle "lever arm" to rotate the arch—never directly touched the steel. Half-inch strips of polyurethane material were placed between the hitches and the arch sections. The polyurethane provided padding and friction resistance so that no bolts or welds were required to be attached to the arch segments.

The friction connection to the arch segments was made with a series of highstrength rods that clamped the fixtures to the arch. Specially designed tower jacking heads were also implemented to support the arches during construction.

In an attempt to minimize the amount of fabrication, the system was designed and located so the same tower heads and rental towers could be reused for both bridge installations.

The two-way jacking heads accommodate adjustability of plus-or-minus 3 in. so they could be accurately located to ensure a precise fit once the arch segments were moved into place.

The intricacies of the Gateway Bridges' construction kept steel erectors on their toes. "It was complex enough that it was enjoyable," says Jim Whaley, vice president of Whaley Steel Corp., Mio, Mich., the project's steel erection subcontractor. "We do a lot of stuff that's square and mundane. This was fun."

Construction of the second bridge took just half as long to build as the first once the kinks were ironed out and processes improved, says C.A. Hull project manager Mike Malloure. "This was the most complex bridge project I've ever managed, and probably the most complex the company has ever been a part of," he says.

The tied-arch design cost \$2 million more than a conventional plate-girder bridge and caused controversy locally. But planners wanted Detroit to have a signature crossing for visitors and the bridges had to be finished before last January's Super Bowl. Design money was raised by local economic development groups. The building team won the race and the Gateway Bridges opened to traffic last fall, with plenty of time to welcome fans to Super Bowl XL.