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When an intense fire destroyed the 9 Mile Road bridge, designers took the opportunity to also accommodate future plans.

Emergency Renovation

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ON THE EVENING of July 15, 2009, a fuel tanker traveling on I-75 just north of Detroit struck a column supporting the 9 Mile Road bridge in the city of Hazel Park, Mich. As a result of the ensuing explosion and fire under the northbound portion of the bridge, that section collapsed onto the heavily traveled interstate. Fortunately there were no fatalities, and I-75 was cleared, repaired and reopened to traffic within the week. The 9 Mile Road bridge, however, was beyond repair. Replacing the bridge and reopening this major east-west thoroughfare became a top priority for the Michigan Department of Transportation (MDOT).

Ironically, the 9 Mile Road bridge had recently been restored as part of a $16.5 million MDOT project to restore 16 overpasses. Rather than simply rebuild the crossing, however, MDOT took the opportunity to accommodate future plans for the stretch of freeway in the design of the new bridge. A realignment of I-75 along the horizontal curve located at the 9 Mile Road overpass was already in the planning stages, with the goals of shifting the freeway median to the east approximately 15 ft and widening the freeway to five lanes in each direction.

Normally, designing and building a bridge takes several years. Planning, requesting proposals for design services, awarding the design contract and completing design services typically take between one and two years. The project is then advertised for construction, awarded, and built the following year. However, this project required a different approach in order to reconnect the city of Hazel Park along this vital roadway as quickly as possible. Just two months after the collapse, MDOT advertised a request for proposal. On September 30, 2009, a design-build team was selected to replace the bridge and rebuild the freeway below.

The design team was led by Fishbeck, Thompson, Carr, and Huber in Farmington Hills, Mich. (freeway design) and Bergmann Associates in Lansing, Mich. (bridge design). The key to meeting all of the project requirements within a very aggressive schedule was the inclusion of structural steel plate girders for the new


Bergmann Associates

Steel plate girders provide a clean, low-profile appearance and offer plenty of clearance below the new 9 Mile Road bridge even though the alignment stayed the same and the span increased.

superstructure. The structural steel option provided a low profile superstructure, flexibility in meeting the complex geometry requirements, quick construction, and aesthetic appeal.

Design For the Future

The new structure had to accommodate both the geometry of the proposed immediate solution and the plans for future I-75 realignment and expansion. The freeway width was too great to provide a single span that would allow for a future median shift with no influence on the structure. Consequently, a bridge was designed with both a proposed median pier and a future median pier in mind. The proposed pier, constructed as part of the immediate replacement, is skewed to match the existing freeway horizontal alignment.

The future pier was designed to match the skew created along the median in the future and will match the abutment alignment. However, only the foundation piling for the future pier was constructed as part of this project. When I-75 is widened and realigned, the new pier will be constructed atop the foundation piling installed as part of this project. After it is built, the weight of the bridge will be shifted to its new center support and the "proposed" pier will then be removed.

Accommodating both future and proposed conditions made design of the superstructure much more complex with respect to capacity and detailing. During pre-bid, the D/B team focused on providing a superstructure that could be built quickly, be cost-effective, and could accommodate a shift in the center support, while meeting the stringent geometric constraints on the project. Continuous steel plate girders with a composite concrete deck provided the solution. "With the complex nature of the superstructure, a large bulk of the steel design was done during the pre-bid phase to ensure that material was readily available and bid prices were as accurate as possible," said Mario Quagliata, project engineer at Bergmann Associates.

Concrete options were considered during the pre-bid phase, however, there were several insurmountable challenges associated with each of them. First, the future pier shift would have made design and detailing of a prestressed beam difficult and also would have required post tensioning. The team needed a solution that was proven, familiar to the contractor, and easily constructible. Second, the tight geometric constraints associated with the site required that a thin superstructure be used. Concrete options did not offer this advantage. Finally, the team needed to be able to secure the materials quickly. Because this was a design/build project, the team was able to take advantage of the materials available from the fabricator and streamline design plan and shop drawing development.

Bergmann Associates and general contractor Walter Toebe Construction, Wixom, Mich., coordinated with Lancaster, Pa.-based High Steel Structures on the steel fabrication, quickly proceeding with preliminary design concepts that could take advantage of the steel plate on the ground at High Steel's facility and plate that could be obtained quickly from the steel mills.

The design of the two-span continuous steel plate girders accommodated an unusually large negative moment region as a result of the varying median pier location. The benefits of a composite deck

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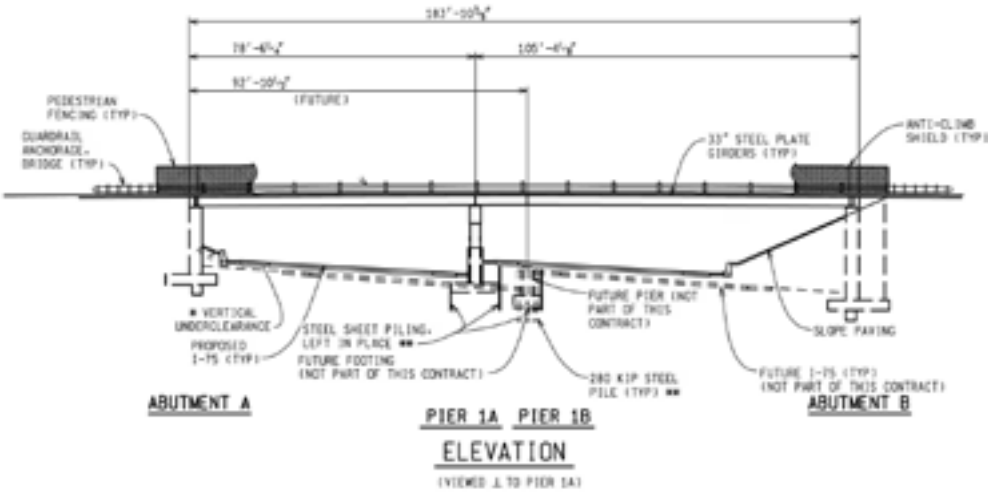
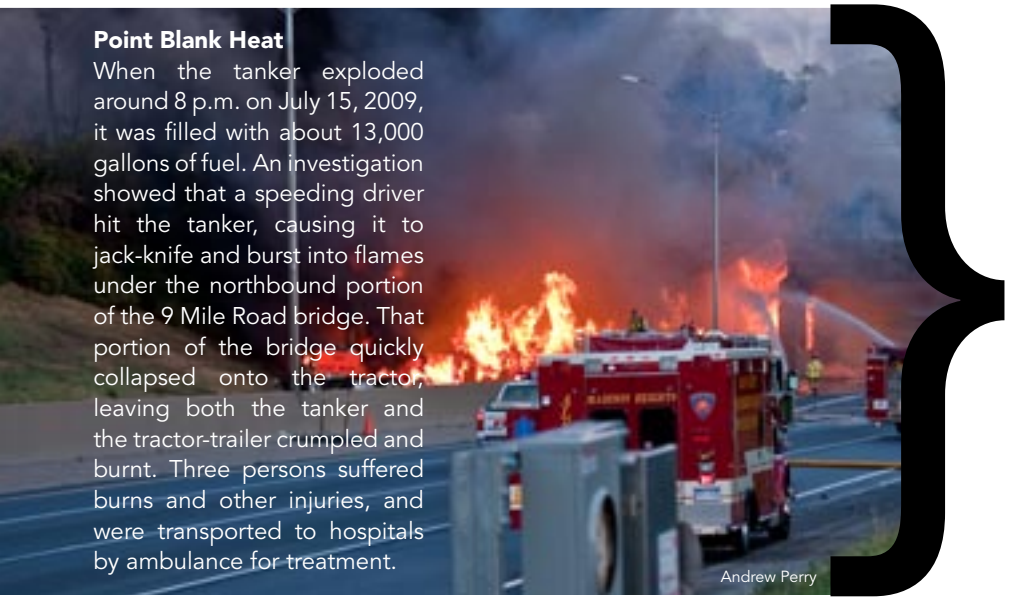


The immediate replacement bridge used a new pier (1A) in the existing median. A new foundation was also installed to accommodate construction of a replacement center pier (1B) when the highway is realigned.

Steel plate girders for the replacement 9 Mile Road bridge over I-75 were delivered to the contractor's staging area for quick job site deployment and erection when the piers were completed.

Point Blank Heat

When the tanker exploded around 8 p.m. on July 15, 2009, it was filled with about 13,000 gallons of fuel. An investigation showed that a speeding driver hit the tanker, causing it to jack-knife and burst into flames under the northbound portion of the 9 Mile Road bridge. That portion of the bridge quickly collapsed onto the tractor, leaving both the tanker and the tractor-trailer crumpled and burnt. Three persons suffered burns and other injuries, and were transported to hospitals by ambulance for treatment.



were significantly reduced because of the large negative moment envelope. This in turn resulted in a challenge to provide an acceptable beam depth which would allow for sufficient clearance for the Interstate below while not affecting the existing intersections located immediately adjacent to the ends of the structure above.

The resulting plate girder design consisted of a 33-in. by ⅝-in. web and 20-in.-wide flanges ranging in thickness from 1.5 in. to 2 in. The span lengths totaled 191 ft, 10 in. with individual unbalanced span lengths varying along each girder line from 78 ft, 6 in. to 113 ft, 4 in.). Bearing stiffeners were designed and fabricated at each abutment support line, the proposed pier support line, and the future pier support line. Shear studs were omitted throughout the entire negative moment envelope created by both proposed and future conditions. The steel conforms to AASHTO M270 Grade 50W and is protected with a three-coat shop paint system.

Splice Design

Typically the field splices for a plate girder would be located at the points of contraflexure along the beam. However, with consideration for a future pier shift in mind, the splice design had to accommodate much larger bending stresses than would normally be encountered. The splice detail had thicker and longer plates as a result. The layout of the intermediate diaphragms also had to accommodate the future shift in the median pier which, along with the larger field splices, created challenges in the framing plan geometry. Close coordination between the engineer and the fabricator on details of the field splices, diaphragms, and conduit supports ensured fabrication could be completed within congested areas of the plate girders.

The team designed the camber for the new plate girders to accommodate the proposed bridge conditions. However, an analysis also was performed to check the deflected shape of the superstructure after shifting the center support. The results showed that there would be no reduction in the design vertical underclearance for the bridge and there would not be significant alterations to the rideability of the roadway above.

High Steel was given notification to proceed with the fabrication on October 2, 2009. On November 13, diaphragms and bolts began arriving at the job site, followed by steel girders four days later. The

All the beams for the 9 Mile Road replacement bridge were set on three consecutive November nights, with one direction of the Interstate below closed to traffic.

beams were set during three consecutive nightly, single-bound closures of I-75.

With the structural steel being one of the major critical path items of work, pressure was immediately on the design team. "We had our design team working day and night in order to complete the steel design as quickly as possible. Design plans were completed within two weeks of the notice of award," said Jeremy Hedden, Bergmann Associates Project Manager. "I catered the dinners each night to keep everyone working as efficiently as possible."

The shop drawing review process was streamlined by the fact that High Steel and Bergmann Associates coordinated details during their development. In the end, High Steel fabricated 317 tons of steel girders, representing $1.1 million of the $12 million bridge replacement and freeway reconstruction project.

Possibly the most important participant during the whole project was Mother Nature. Unseasonably warm temperatures and dry weather assisted the contractor with completing the work quickly. Placement and curing of the cast-in-place concrete deck was completed with the use of heaters from below and insulation above. With good weather and long hours by all involved, the bridge was opened to traffic on December 11, 2009, only 65 days after the project team's notice of award. MSC

Owner
Michigan Department of Transportation

Structural Engineer
Bergmann Associates, Lansing, Mich. (AISC Member)

Steel Fabricator
High Steel Structures, Lancaster, Pa. (AISC and NSBA Member)

General Contractor
Walter Toebe Construction, Wixom, Mich.