A MESSAGE FROM THE
Executive Director

This month marks a tremendous shift in Washington after the fall elections. Both the House and Senate have switched from Republican to Democratic majorities. The change in majority power has elevated Congresswoman Nancy Pelosi (D-CA), former House Minority Leader, to Speaker of the House, and Senator Harry Reid (D-NV), former Senate Minority Leader, to Majority Leader. Not only has the congressional leadership changed, but all committees have as well. The House Committee on Transportation and Infrastructure will once again by chaired by Congressman Jim Oberstar (D-MN) with Congressman John Mica (R-FL) serving as the top Republican. The Senate Environment and Public Works Committee will be headed by Senator Barbara Boxer (D-CA) with Senator James Inhofe (R-OK) as the top Republican.

One issue that remains at the forefront for NSBA is Buy America. The Buy America law was passed by Congress to ensure that American steel mills and fabricators can compete with foreign bids on taxpayer-funded projects. For two decades, this law demonstrated a national commitment to ensure that taxpayer dollars support projects that create American jobs and stimulate local economic activity. Unfortunately, we continue to learn of cases in which the Buy America law is circumvented by state governments.

We have had many allies in Congress who have helped combat the gradual erosion of the Buy America law, including Congressmen Oberstar and Brian Baird (D-WA). As the 110th Congress begins, the NSBA will continue to work with members of Congress and their staffs to strengthen Buy America and close exploited loopholes and circumventions. The new majorities in the House and Senate provide many new opportunities to pursue our agenda with renewed vigor. As always, the NSBA will continue to seek out your counsel and support for our federal relations agenda as we move forward in the new Congress.

Best regards,
Conn Abnee
NSBA Executive Director

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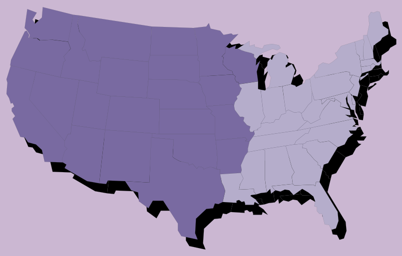
Regional Directors' Territories



Steel Bridge NEWS
NATIONAL STEEL BRIDGE ALLIANCE MARCH 2007

Rethinking Shop Drawings

BY GARY C. WHITED, P.E., AND WALTER J. GATTI

By providing shop drawings to bidders, WisDOT was able to shorten steel delivery times for a complex interchange reconstruction project.

THE MARQUETTE INTERCHANGE RECONSTRUCTION PROJECT in Milwaukee constitutes the largest and most complex highway project ever undertaken by the Wisconsin Department of Transportation (WisDOT). The original interchange, constructed in the late 1960s, is the cornerstone of the state's southeast freeway system. Providing intersections among Interstates 43, 94, and 794, it carries more than 300,000 vehicles per day, making it vital to regional auto transportation.

Located near downtown Milwaukee, the interchange also provides access to residential areas, downtown businesses, the lakefront, and festival grounds. As such, WisDOT vowed to maintain two lanes of traffic in each major direction throughout the project's duration and is committed to finishing the project within four years; it's expected to be completed by November 2008.

A rendering of Milwaukee's Marquette Interchange in its reconstructed form. The interchange will connect I-43, I-94, and I-794. Courtesy WisDOT.

Delays Threaten Schedule

The project includes completely removing the existing bridges and rebuilding them with a combination of steel plate I-girders, steel box girders, and pre-stressed concrete beams, and consists of four main contracts. The West Leg contract, granted in November 2004, involved construction of a 920-ft double box girder structure of 70-psi grade high-performance steel. However, in March 2005 the prime contractor notified WisDOT of an unanticipated eight-week delay in steel delivery to the fabricator.

While the delay for this contract was problematic, similar delays for an upcoming larger core contract could have catastrophic effects on the project schedule. The core project would be two months or more behind schedule before it even began, and WisDOT had scheduled this contract to be assigned in August 2005.

Rethinking Steel Procurement

In typical projects, the prime contractor takes responsibility for procuring the steel, arranging for fabrication, and ultimately building the structure. The contractor first selects the shop drawing detailer and the steel fabricator. The detailer develops preliminary shop drawings, used for ordering steel from the mill for delivery to the fabricator. Thus, the prime contractor assumes the risk for availability and delivery of steel to meet the contract schedule. This highly linear process can add six to eight weeks to

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the project schedule for a complex structure.

As such a delay would, again, wreak havoc on the Marquette Interchange project schedule, WisDOT considered some alternatives for shortening the steel delivery times, including:

- Preparing separate bidding documents for procuring steel directly from the mill. WisDOT would then provide the steel to the prime contractor's fabricator.
- Preparing plans and specifications for procuring structural steel directly from the fabricator for delivery to the site for erection.

However, WisDOT was reluctant to take on the significant economic risk associated with these alternatives. The first alternative would put the department squarely in the middle between two major contractors. It would make WisDOT responsible for delivery schedules, quality of the product delivered, and additional contract administration costs. With the second alternative, WisDOT would risk ordering steel plates with dimensions that did not work efficiently for a particular fabricator.

A Solution Emerges

With the clock ticking, WisDOT turned to the steel industry for advice. One innovative suggestion promised to speed steel delivery while minimizing economic risk. It involved having the department procuring preliminary shop drawings from a detailer for the critical structures. WisDOT would then provide the drawings to all prospective bidders at the bid letting.

This procurement strategy also presented some risk. WisDOT would be responsible for the ordered steel based upon these drawings and for any subsequent delays caused by errors. To minimize risk, the department decided to contract for preliminary shop drawings only on structures that were critical to the schedule. For the remaining structures, the winning contractor would take responsibility for all aspects of the steel procurement, as usual.

WisDOT decided on this option and immediately began procuring preliminary shop drawings from Tensor Engineering for the critical structures that required steel erection in the first 12 months of the project. These activities included making calculation plans, web camber diagrams, flange-cutting diagrams, and diaphragm layouts to the stage, permitting material orders from the steel mills. The shop drawings were to comply with NSBA/AASHTO (National Steel Bridge Alliance/American Association of State Highway and Transportation Officials) standards and be sufficiently generic in nature so that any steel fabricator could use them. All prospective bidders received the shop drawings for bid preparation.

WisDOT awarded the project on September 1, 2005. PDM Bridge, the fabricator, placed the initial steel order eight days later. PDM began fabrication of the critical steel members on November 8 and delivered the fabricated steel to the project in April of 2006.

The procurement decision paid off. Having preliminary shop drawings available to the bidders cut about eight weeks from the steel delivery schedule and helped put the entire Marquette Interchange project ahead of schedule.

Added Benefits

This procurement strategy provided other benefits as well. During development of the preliminary shop drawings, several design issues emerged and were handled by phone and with follow-up documents in the form of Requests for Information (RFIs). Communication regarding RFIs took place within 24 hours. Under conventional contract conditions, these RFIs would have gone to a contractor, then on to the project management team, and then to the designer. The answer would return via this same communication protocol, usually taking a week at best. But the close working relationships among WisDOT, the designer, and Tensor Engineering created a situation where issues were resolved in record time, all prior to the bid date.

Since Tensor Engineering could accurately calculate and lay out all sizes of material, the fabricators received exact sizes for ordering, which reduced the amount of scrap. Estimated scrap savings amounted to hundreds of thousands of dollars.

In several instances, addenda plan sheets provided more accurate structure plans and bidding documents to the contractors. Using the conventional design-bid process, these questions would have had to be researched and answered before shop drawings could be completed and steel ordered, further extending the project schedule.

In addition, the steel mills became aware of data on the amount and size of plates to be ordered ahead of the bid, based on the preliminary shop drawing results. They then tentatively reserved space on their rolling schedules to accommodate the anticipated steel order. This avoided the risk of delay in the event that the fabricator could not get on a mill's rolling schedule in timely fashion.

Steel plate girders being erected. Photo by Robert Wazniak, WisDOT.

The Right Choice

In short, WisDOT's advance procurement of preliminary shop drawings proved to be a highly effective strategy for shortening steel delivery times while minimizing risk, and eliminated two months of unanticipated delays to the Marquette Interchange Reconstruction project. MSC

Gary Whited is with the Construction & Materials Support Center at the University of Wisconsin-Madison. Walter Gatti is president of Tensor Engineering Co.

Owner
Wisconsin Department of Transportation

Designer
Milwaukee Transportation Partners, a consortium led by the Milwaukee offices of HNTB and CH2M Hill

Prime Contractor
Marquette Constructors, Milwaukee, Wisc., a joint venture of Lunda Construction Co., Black River Falls, Wis.; Zenith Tech, Waukesha, Wis.; and Edward Kraemer & Sons, Plain, Wis.

Fabricator
PDM Bridge, Eau Claire, Wis. (AISC member)

Detailer
Tensor Engineering Co., Indian Harbour Beach, Fla. (AISC member)

New Span, New Steel

BY S. VAYNMAN, M.E. FINE, C. HAHIN, N. BIONDOLILLO, AND C. CROSBY

A new steel that doesn't require heat treatment or thermomechanically controlled processing comprises a replacement bridge in suburban Chicago.

LAKE VILLA, ILL. MIGHT NOT BE A PARTICULARLY WELL-KNOWN TOWN, BUT IT IS SIGNIFICANT IN TERMS OF STEEL INNOVATION. The Chicago suburb is home to only the second bridge using a new high-performance ASTM A710 Grade B steel, and the first to use it for main load-carrying members.

The North Milwaukee Avenue bridge carries auto and truck traffic on Illinois Route 83 over the Canadian National Railroad tracks in Lake Villa. The bridge it replaces was originally built in 1930 and was widened in 1964, and again in 1971, to accommodate more traffic; the former structure was removed in stages during construction to permit continued traffic flow.

Completed in October 2006, the new bridge has a continuous span length of 430.6 ft back-to-back of the abutments, where it rests on elastomeric bearings. The span is supported by only two new piers, replacing eight old ones, and there are two new abutments using 12-in.-diameter metal shell piles as foundations. The bridge's overall width between its outer parapet edges is 58 ft. There are two auto lanes, each 15 ft wide, along with a 12-ft central median, and 7-ft-wide sidewalks on both sides of the bridge. The line perpendicular to the center line of the bridge is skewed 70° with respect to the railroad track lines.

Ten plate-girder lines support the 7.5-in.-thick reinforced concrete deck. The plate girders, made composite by use of welded steel studs with the deck, have a nominal depth of 4 ft, with girder center lines spaced 5.75 ft apart. Each girder consists of an ASTM A710 Grade B ½-in.-thick web plate, with 1.125-in. by 16-in. lower flanges, and 0.875-in. by 16-in. upper flanges in the composite areas. In sections over piers, where the girders are non-composite, the upper and lower flanges are 1.875-in. by 16-in. The bearing stiffeners are ¾-in. by 7-in. by 48-in. and milled to bear on the flanges at piers and abutments.

The web-to-flange welds are 5⁄16-in. fillets, with ¼-in. fillets on the stiffeners. Since ASTM A710 Grade B high-performance steel is not yet available in rolled shapes, ASTM A588 weathering steel was used as a substitute for the W16×36 diaphragms.

Composing a New Breed of Steel

The girders, made from new weathering ASTM A710 Grade B copper alloy precipitation-strengthened steel, are in the hot-rolled and air-cooled condition. This new breed of steel was developed and thoroughly investigated at Northwestern University with assistance from S. Bhat, Ph.D., of Inland Steel Company (now Mittal USA). Since no heat treatment after hot-rolling or thermomechanical-controlled processing is required, it can be produced by any steel company in any plate length.

The first use of this new steel, produced by Oregon Steel Mills, was used to seismically retrofit the approaches of the Poplar Street Bridge over the Mississippi River, near St. Louis, Mo., in 2000. The new North Milwaukee Ave. Bridge in Lake Villa is the first bridge to use this steel for main-load-carrying members and only the second use of the steel anywhere.

Breaking it down, the steel has a virtually ferritic microstructure, because the carbon content is very low. Alloying elements, such as chromium and molybdenum, frequently used in martensitic alloy steels, are not added and are limited to residual levels found in steel scrap. A limited amount of nickel (0.9 percent) is added to prevent hot-shortness during hot-rolling. Columbium (0.05 percent) and titanium (0.03 percent) are added to control grain size during hot-rolling and welding. Due to its low carbon content and limits on alloying elements that decrease the weldability of steels, A710 Grade B has the lowest carbon equivalent among high-performance steels. When used for bridge construction, it demonstrated outstanding weldability.

The strength of this high-performance steel is derived from nano-sized copper-alloy precipitates that are formed during air-cooling after hot-rolling (Figure 1). A710 Grade B has a yield strength of 70 ksi or

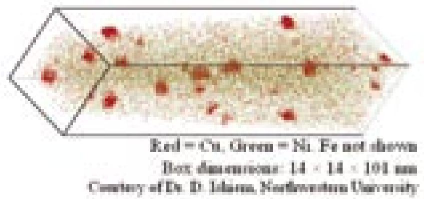


Figure 1. Copper-nickel nano-sized precipitates in A710 Grade B steel.

more for plates up to 2 in. thick (Figure 2). Because of its low carbon, phosphorus, and sulfur contents—and the presence of nano-sized copper precipitates—the steel has remarkably high toughness at low temperatures (Figure 3).

Copper significantly improves the atmospheric corrosion resistance of steel in marine and inland environments. Since A710 Grade B steel contains from 1.3 percent to 1.5 percent copper, it has significantly better weathering and corrosion characteristics than other commercial weathering steels. For example, in the Society of Automotive Engineers J2334 standard accelerated corrosion test performed at the former Bethlehem Steel Corporation (now Mittal Steel USA), A710 Grade B had the lowest penetration losses when compared to other competitive steels. ASTM A36 steel had 133 percent greater penetration; ASTM A588 and ASTM A709 HPS 70W weathering steels had penetration rates 69 percent larger than A710 Grade B (Figure 4). When coated with epoxy-based Carboguard 890 paint, A710 Grade B steel outperformed, by significant margins, other construction steels when exposed to the ASTM D 1654-92 Standard salt-fog test.

The 3/8-in.- to 1 7/8-in.-thick steel plates for the bridge were produced by International Steel Group (now Mittal Steel USA) in Coatesville, Pa. by hot-rolling and air-cooling. The chemical composition of this steel is provided in the table below. The yield strengths of the plates were in the 72 to 90 ksi range, and the ultimate tensile strengths ranged from 82 to 102 ksi, with elongation to fracture over 25 percent. The Charpy V-notch impact energies for most of the plates were over 100 ft-lb at -10 °F, significantly exceeding the 35 ft-lb required for ASTM A709 HPS 70W steel for Zone 2 for fracture-critical locations (Figure 3).

Welding the Girders

When it comes to welding A710 Grade B steel, submerged-arc welding (SAW) is recommended, since flux-core welding without cover gas might lead to lower toughness of weld deposits. Flux-core-arc welds (FCAW) joining A710 Grade B without argon/CO_2 cover gas and appreciable nickel contents (0.4 percent or more) typically have only about 25 percent of the toughness of A710 Grade B. The lower toughness of FCAW is attributed to the higher hydrogen contents associated with flux-core wire, particularly if self-shielded, as compared to the better shielding characteristics of dry flux with SAW, or the moisture-free cover gases used with gas-metal arc welding (GMAW). All specified SAW and GMAW electrodes should contain at least 0.5 to 0.8 percent nickel in their weld deposit chemistry in order to obtain excellent low-temperature toughness when welding A710 Grade B.

The A710 Grade B girders for the North Milwaukee Ave. bridge were fabricated at Industrial Steel Construction, Gary, Ind. The submerged arc web-to-flange welds used Lincoln LA-75 (AWS ENi1K), 3/32-in.-diameter electrodes with a neutral Lincolnweld 960 flux. The flanges were shop-spliced with full-penetration butt welds, using Lincoln LA-85 (AWS ENi5), 3/32-in.-diameter electrodes with MIL 800-HP-Ni flux. This filler metal and flux combination resulted in excellent weld metal toughness. Qualification tests run by Calumet Testing Services for Industrial Steel Construction found that Charpy V-notch impact energy averaged 79 ft-lb (ranging from 52 to 91 ft-lb) at -20 °F. For weld repairs or short-length welds, A710 Grade B can be easily welded with E7018 or E8018 shielded metal-arc welding (SMAW). If A710 Grade B is used as weathering steel, E8018W electrodes are recommended. Toughness values for A710 Grade B welded with E7018 electrodes are typically above 75 ft-lb, even at temperatures of -20 °F. The machining of the A710 Grade B steel is not significantly different from that of other common lower-yield construction steels. Recent milling and grinding tests performed at Machining Research, Inc. have demonstrated that A710 Grade B has equivalent or better machinability than A36 or A709 HPS 70W steels.

An Economical Paint Job

The girders for the bridge were not painted, resulting in a significant cost savings of about $300,000. Unpainted steel

Chemical Composition of the A710 Grade B Steel Used in the North Milwaukee Ave. Bridge (weight percent)												
C	Mn	P	S	Cu	Si	Ni	Cr	Mo	V	Ti	Al	Cb
0.07	0.69	0.008	0.001	1.33	0.41	0.91	0.11	0.07	0.002	0.024	0.044	0.034

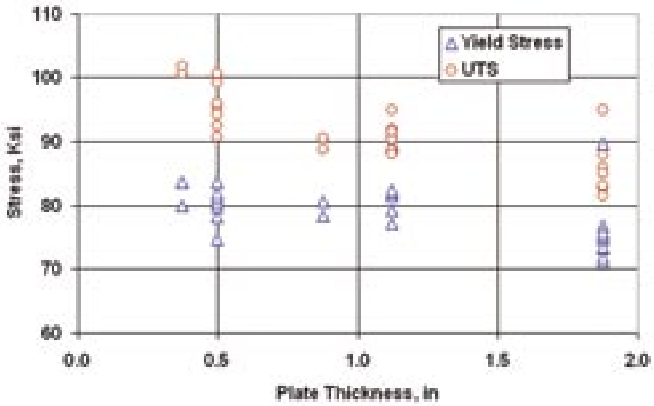


Figure 2. Strength of A710 Grade B steel as a function of plate thickness.

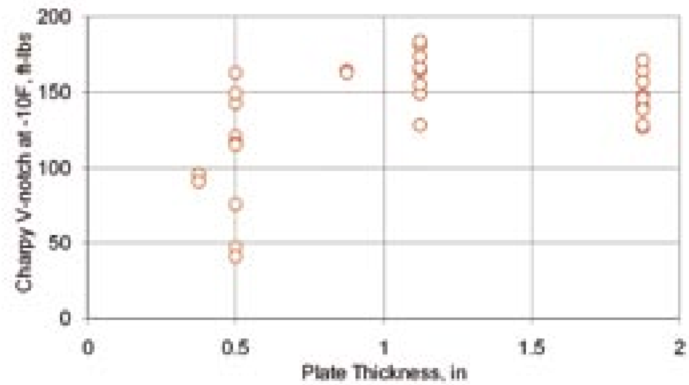


Figure 3. Charpy V-notch impact toughness of A710 Grade B steel at -10 °F as a function of plate thickness.

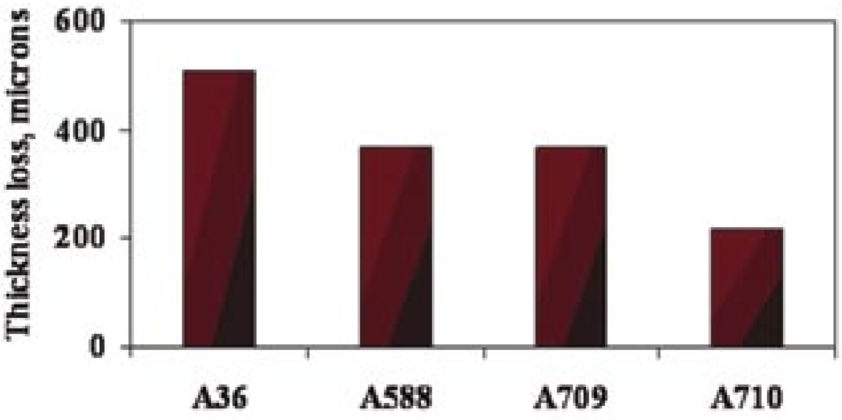


Figure 4. Thickness loss of common structural steels after exposure to Society of Automotive Engineers SAE J2334 accelerated corrosion test, performed by H. Townsend, Ph.D., of the former Bethlehem Steel Co. (now Mittal Steel USA).

girders permit easier handling during assembly, while painted girders require special handling to prevent coating damage. And since repainting will not be required, future maintenance costs will also be reduced.

All the Right Reasons

The construction of the North Milwaukee Ave. bridge clearly demonstrates the advantages of A710 Grade B steel: outstanding mechanical properties, fracture toughness, good weldability, and superior weathering characteristics. It can be produced economically by any steel mill in any plate length, because it does not require heat treatment or controlled hot-rolling and cooling.

Whether they realize it or not, motorists driving over the bridge are relying on a new, yet stable and economical, material to support them on their journey. MSC

Vaynman is a research professor and Fine is a professor, both with Northwestern University. Hahin is an engineer of structural materials with the Bureau of Materials & Physical Research. Biondolillo is a resident engineer, District One, Bureau of Construction, with the Illinois Department of Transportation. Crosby is chief engineer of Industrial Steel Construction.

Owner
Illinois Department of Transportation, District 1, Schaumburg, Ill.

Designer
Graef, Anhalt, Schloemer and Associates, Chicago

Steel Producer
Mittal Steel USA, Coatesville, Pa. (AISC member)

Fabricator
Industrial Steel Construction, Gary, Ind. (AISC member)

General Contractor
Dunnet Bay Co., Glendale Heights, Ill.

Photos and Illustrations
S. Vaynman

Above-Grade, Below Estimate

BY MATT JOHNSON, P.E.

The low bid for this steel plate girder viaduct in Omaha came in 6.4 percent under the engineer's cost estimate.

TranSystems

ONCE IN A GREAT WHILE, SOMETHING ACTUALLY COSTS LESS THAN ESTIMATED.

In early July 2006, the low bid for a 785-ft steel viaduct in southeast Omaha, Neb. came in at $7.4 million—or 6.4 percent—under the engineer's estimate (this price also included sewer line and manholes). When completed this September, the new viaduct will connect 13th Street with Gibson Road, crossing over the mainline tracks of the Burlington Northern Santa Fe railroad, which lead into the railroad's Omaha yard. It will provide access to an industrial area currently served by an at-grade crossing that closes frequently, resulting in blocked vehicle back-up and delayed emergency vehicles.

Structural Overview

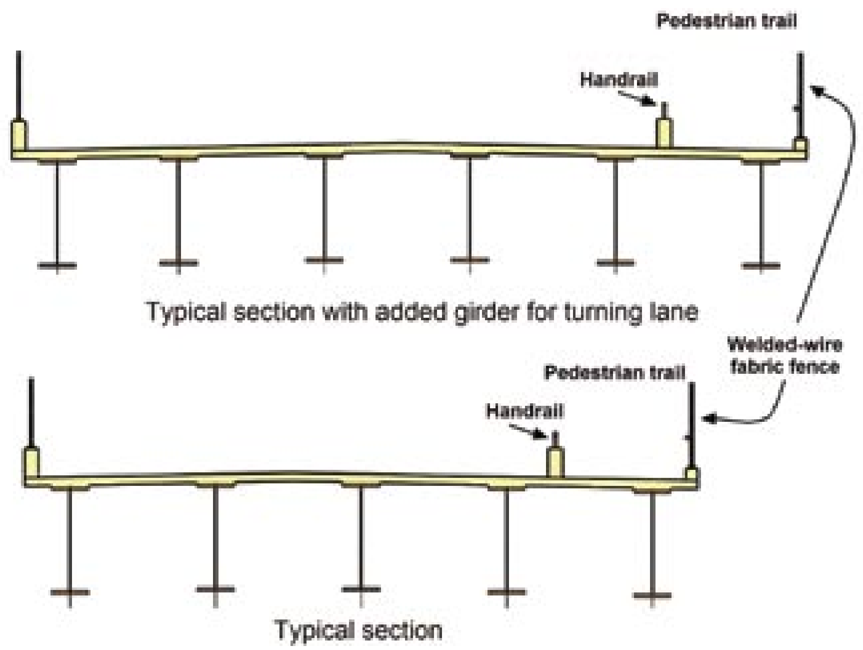
The viaduct is a two-lane, four-span structure primarily measuring 55.5 feet in width, with the first span flaring further out to accommodate a right turn lane for exiting the viaduct. The four span lengths measure 172.5 ft, 220.25 ft, 220.25 ft, and 172.5 ft. The south side of the viaduct has an attached 10-ft trail with level landings to accommodate American Disabilities Act requirements.

The superstructure consists of a welded-plate, five-girder cross section, with girders spaced on 12-ft centers, except for span 1, where an additional girder line accommodates the turning lane. Skew for the two abutments are about 12° and 38° left ahead. The three piers have no skew.

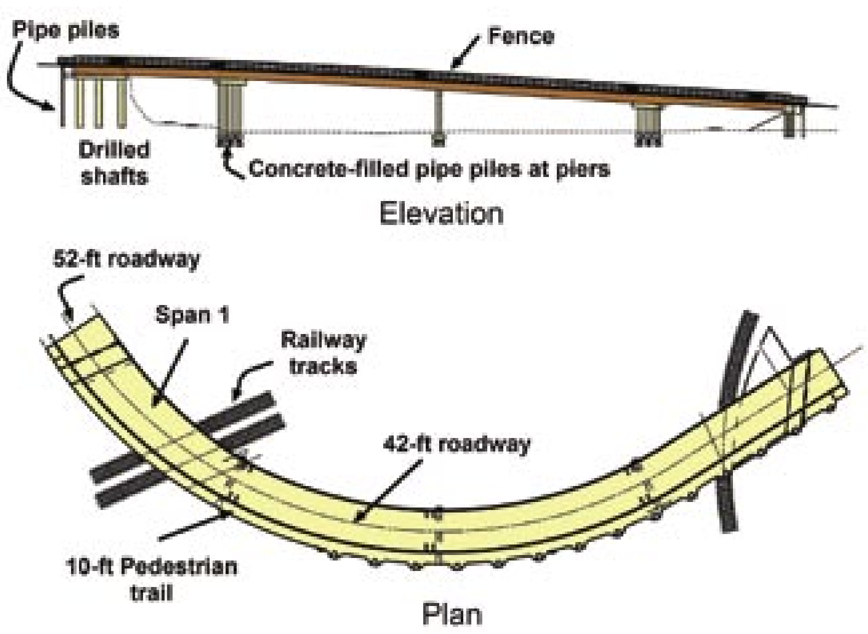
The concrete deck is a constant 8 in. thick, plus a 0.5-in. sacrificial wearing surface. Pedestrians are protected by a full concrete barrier with an attached steel handrail on top between the trail and traffic lanes. An aesthetic welded-wire fabric fence borders the outside of the trail.

The substructure components consist of expansion abutments and three-column frame piers. The piers have column diameters of 4.5 ft and are supported on piles and pile caps. Piles also support Abutment No. 2, but three 4.5-ft-diameter shafts drilled into a bluff support Abutment No. 1 to reduce vibration and the risk of slope failure of the bluff.

The National Steel Bridge Alliance ran a preliminary design during the initial project phase. TranSystems designed the final structure, using AASHTO-LRFD third edition, 2004, and DESCUS software was used to design of the curved girders. The maximum live-load deflection—caused by the standard AASHTO truck and lane load combination—occurs in the outside girder of span 1 and is about 3.25 in.



The hybrid weathering steel welded plate girders are typically 8 ft deep.



The viaduct includes a pedestrial trail along one side that complies with ADA requirements.

Hybrid Steel Superstructure

The superstructure is a continuous, hybrid, welded-plate girder design fabricated entirely of weathering steel by PDM Bridge. Positive and negative moment flanges are 50 and 70 ksi steel, respectively. Flange sizes range from 1x18 in to 2x24 in. Webs generally are 8 ft deep with the exception of span 4. In this area the viaduct crosses a spur track serving a local business. The railroad's overhead clearance requirements dictated a web-depth reduction to 6.5 ft over this track. The web thickness is 0.75 in. for the deeper sections and 0.625 in. for the shallower section over the track.

Field splices were designed to limit the maximum section to 142 ft. PDM Bridge has the option of adding additional splices to accommodate shipping.

Since the viaduct is a curved structure, the diaphragms serve as primary members according to AASHTO criteria. The diaphragm spacing was held to a maximum of 25 ft for the outside girder, and the diaphragms follow a radial configuration, resulting in a spacing of about 22.5 ft at the inside girder. TranSystems designed the diaphragms as K-frames with a top chord and diagonals, each being 5×5×½-in. angles. The bottom chord is a MC10×28.5 channel section. The pier diaphragms have slightly heavier sections.

The girders rest on pot bearings at each of the three piers and TFE fabric pads at the abutments. Strip seals at each abutment accommodate expansion. MSC

Matt Johnson is a senior project engineer with TranSystems.

Owner
City of Omaha, Neb.

Consultant/Designer
TranSystems, Omaha

Fabricator
PDM Bridge, Eau Claire, Wis. (AISC member)

Contractor
Hawkins, Omaha