HIGH Steel News

Spring 2018

Award-Winning Greenfield Bridge Built for the Future while Embracing the Past

Nearly two years to the day it was closed, the Greenfield Bridge in Pittsburgh reopened to great fanfare in October 2017. Now rebuilt stronger, safer and more secure the iconic bridge pays tribute to its predecessor's 1921 grandeur.

The project's general contractor, Mosites Construction Co., Inc. awarded High Steel Structures LLC the contract to fabricate 950 tons of steel for the new bridge in 2015. In the months to follow, High Steel worked closely with HDR, Inc. and Mosites Construction Co. to build a new structure that would carry the Greenfield Bridge into the next century.

The Greenfield Bridge project is the NSBA's 2018 National Prize Bridge Award Winner in the Long Span category.

The original bridge had been constructed in 1921. After nine decades, the deteriorating bridge had finally outlived its lifespan. In 2003, a motorist was injured when debris fell from the bridge onto Interstate 376 (Parkway East). Stop-gap efforts to secure the much-used bridge included a $700,000 steel under-bridge that was constructed in 2004 with netting installed to catch the falling concrete.

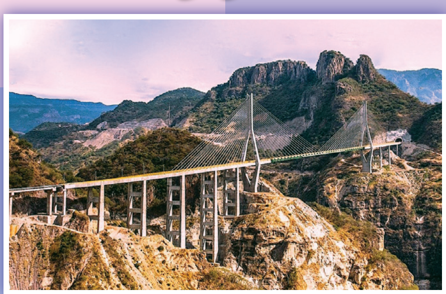
The structure became representative of America's crumbling infrastructure, and was featured in segments on *60 Minutes and Last Week Tonight with John Oliver.* Finally, in 2015, the inevitable came to pass. The bridge would be torn down to make way for a new, safer bridge.

Just after Christmas of 2015, the bridge was demolished by using explosives wired to the massive concrete arches. Care was taken ahead of time to preserve architectural features of the original bridge for future use. The bridge was imploded onto the roadway below, landing on a thick protective cushion of dirt that was spread over the highway. Then the work began to rebuild the new Greenfield Bridge at the same spot.

The bridge replacement process began in 2010 when design firm HDR completed an in-depth inspection of the existing bridge. In 2011, the resulting report included a detailed analysis and ratings of the existing structure and recommendations and costs for rehabilitation. Alternatives were studied including repairing the existing structure, as well as

continued on page 3

BRIDGES *Of the World*



Baluarte Bridge
Mexico

The Baluarte Bicentennial Bridge is a cable-stayed bridge in Mexico that spans the valley below the Durango-Mazatlán Highway. Rising 1,322 feet high, the bridge has a total length of 3,688 feet with a central cable-stayed span of 1,710 feet. The Baluarte Bridge is the third highest cable-stayed bridge in the world, the seventh-highest bridge overall and the highest bridge in the Americas. It was inaugurated in January 2012 and opened to traffic in late 2013, reducing the traveling time between Durango and Mazatlán by 3 1/2 hours.

Message from the President

High Steel University

John O'Quinn, President
High Steel Structures LLC

When Sanford H. High founded High Welding Company in 1931, he began a culture of innovation and customer service. Our company motto, "We Give Good Measure," reflects a philosophy focused on meeting our customer needs, while facilitating an atmosphere where co-workers are respected, recognized and rewarded for their accomplishments.

At High Steel, our reputation rests on the superior skill of our coworkers. So, investment in nurturing those skills in the next generation of fabricators is absolutely vital to our future growth and success. Over the past year, we have made significant improvements to training and new coworker onboarding, formalizing the program under the umbrella of High Steel University (HSU).

HSU's motto is "Excellence through Diligence." Excellence at High Steel is defined as superior quality and delivery; and Diligence is defined as a structured, effective training curriculum for all coworkers.

To support this effort, we have engaged the help of industry veterans with expertise in welding, coatings application and curriculum development. Each HSU class has a training guide and features a combination of lecture and hands-on practice of the skills being learned.

Each trainee will be evaluated on correctly performing all tasks associated with the skill before performing that skill on the shop floor. A mentor coordinates with each HSU graduate to assure that the learned skills are continually being applied.

The University is currently divided into several "colleges", each focusing on core curricula in subjects such as Bridge Basics, Welding, Specialized Fabrication Skills, Coatings Application, Engineering, Quality Control, and Continuous Improvement.

To help accomplish the high demand of welding training needed, we converted the Lancaster welding R&D area into a training facility, outfitted with a significant amount of new training equipment. To facilitate classroom training, we built a classroom and outfitted it with tables and chairs; a computer and projector; and virtual welding equipment. In the future we plan to outfit and staff a similar welding lab and classroom in Williamsport.

High Steel has also increased our engagement with local technical schools. We're educating these schools about what we need via Work Keys, or standard

measures of math, reading, and skills to locate information using shop drawings. We are also encouraging schools to participate in welding capstone projects, during which students receive drawings and use the skills they have learned to build the capstone, which is a toolbox. Students who build it successfully are guaranteed a job interview at High Steel.

What does this mean to you, our customers? You can feel confident that we are investing in our workforce's skills now and in the future to ensure that the product you receive from us is reliably right the first time, with industry-leading fit and finish.

Predicting the Future

By **Rich Truxel,** Vice President Sales & Estimating

Business is risky. Organizations can lessen their risks by determining the future demand for their goods and services through the process of Demand Forecasting. While no forecast will give you a crystal ball, robust demand forecasting provides valuable information about the state of the marketplace going forward. A demand forecast allows an organization to appropriately allocate labor, materials, and other resources in anticipation of future customer demand.

The benefits of forecasting do not accrue solely to the firm creating the forecast. Their partners and customers benefit as well. For example, good demand forecasting by a steel fabricator ensures they are ready to meet the needs of bridge owners and general contractors.

Most businesses, including High Steel, can react nimbly to normal fluctuations in demand. However, unforeseen large fluctuations up or down can be problematic for fabricators and for their customers. Demand forecasting acts as an early warning system for these "Turning Points."

There are numerous methods of forecasting demand ranging from statistical analysis of previous demand to complex causal models. The data we at High Steel are looking for is so granular – the size and quantity of bridge superstructures to be built using structural steel – that these forecasting methods do not work. What do we do instead? We rely on you, Dear Reader. Twice per year we put on our forecasting hats and call many of our colleagues in the industry to help us build a forecast, project by project, from the ground up.

We know we are asking a lot of you to spend your time on the phone telling us about various projects in various stages of development, and we thank you for that. The information you provide is very important to us; and maybe to you as well.

THANKS FOR YOUR HELP!

cost estimates for several replacement structures as a point of comparison.

HDR held discussions with the City of Pittsburgh and PennDOT focusing on the condition of the existing bridge, short and long-term cost comparisons for the alternatives, and impacts to the community and interstate. In 2012, it was decided that a new structure would be the most prudent path moving forward.

Multiple replacement concepts were developed and presented to community stakeholders. While the community supported the need for a replacement structure, they also felt that the new bridge needed to incorporate certain features reflecting its heritage and the unique nature of the site. Most importantly, the arch shape of the structure was significant in maintaining the structure's identity as the "Gateway to the East," referring to the Parkway East.

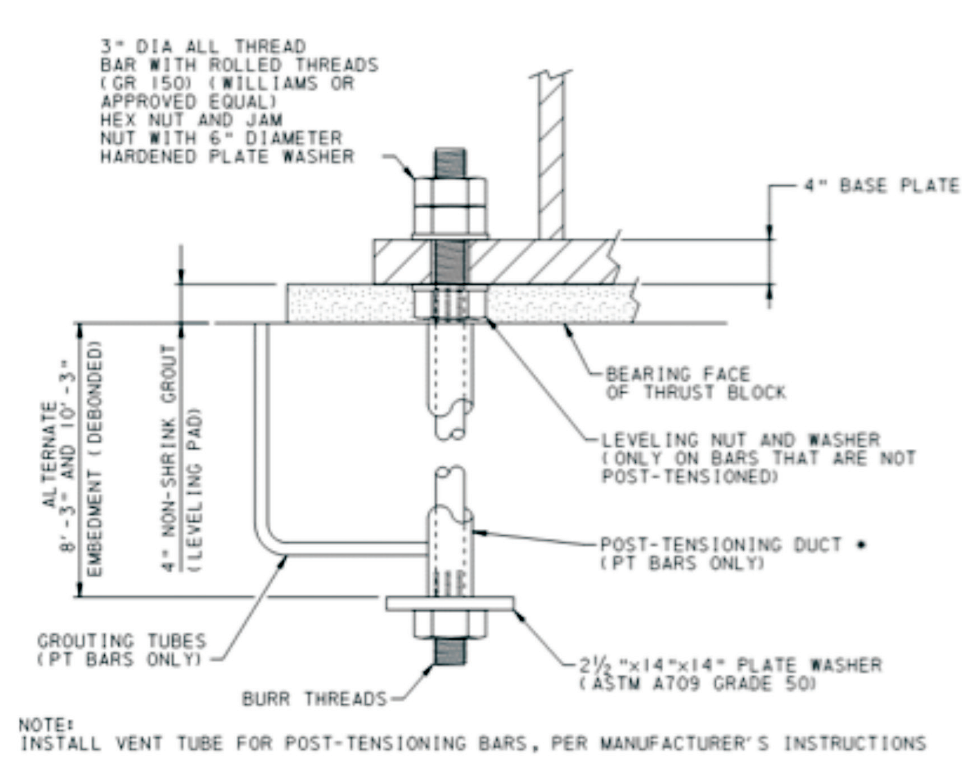
Ultimately, an open-spandrel steel deck arch design with Vierendeel struts was chosen as the preferred alternate in terms of aesthetics and ease of the superstructure erection.

HDR's design for the new bridge called for a 462' long, ~ 54'10" wide steel superstructure featuring two box arch ribs and a floor system composed of 7 stringers and 6 floor beams – four fixed and two guided. The depth of the floor beams and stringers were matched to create a simplified, robust and continuous connection.

Additional design elements included strip seal expansion joints placed behind the abutment backwall to eliminate future maintenance issues and limit future corrosion issues from leaking joints. Any future leakage will drain into a lined trough behind the backwall, which will channel it away from the structural steel.

General Contractor Mosites Construction Company developed an innovative plan to erect the arch ribs and the floor system spanning the Parkway over one weekend closure.

The two arch ribs each consist of three field pieces. The first two pieces were set using a falsework tower as support. The second two segments for each rib were spliced on the ground, with each combined bolted piece erected next. Mosites used leveling bolts to induce the proper moments and rotations, and



ARCH RIB ANCHOR BOLT DETAIL

grouted after the erection was complete.

Because of the tight tolerance for the base plate and anchor bolts, High Steel provided a template of the base plate to Mosites to use in casting the anchor bolt assembly in the field. HSSL worked with Mosites to insure the anchor bolt pattern and base plate matched perfectly, avoiding any delays to setting the arch ribs during the weekend closure of Route 376.

The framed floor system was designed with a large, approximately 46' spacing to minimize spandrels and reduce picks and connections. Rather than stick-building the floor system, Mosites pre-assembled whole segments to be erected.

The portions of the floor system over the parkway were erected during the same weekend closure as the arch rib erection. The remaining portions of the floor system not over the Parkway were erected later without impacts to the parkway.

According to High Steel Project Manager Mike Kennedy, a major fabrication challenge was the assembly of the four large arch rib base plates to the arch boxes.

"This was extremely challenging due to the size and welding requirements. Our project team worked very hard under extreme monitoring conditions to insure the assembly was completed successfully, meeting every FCM design specification," said Kennedy. *(For more information on the fabrication of the structure, please see the Tech Talk article in this issue.)*

Due to the limited amount of storage area available at the jobsite, close coordination was required for the arch rib delivery, with High Transit delivering those pieces just as the weekend closure began.

The new bridge recaptures the beauty of the original 1921 bridge design, incorporating elements including the decorative urns and pylons from that structure. When the bridge was first built, it was officially named the Beechwood Boulevard Bridge, serving as the hub of Beechwood Boulevard, a recreational boulevard that connected the city's three major parks of Highland Park, Frick Park and Schenley Park. The original intention of the bridge was to extend down Washington Boulevard to Allegheny Boulevard enabling motorists to enter Highland Park. Through the years it became known as the Greenfield Bridge, due to its location in the Greenfield neighborhood of Pittsburgh.

Once engineers determined that the Greenfield Bridge was in need of

continued on page 4

replacement, they developed a design and replacement plan that coordinated with PennDOT for traffic impacts. During the replacement progress, there was a need to reroute pedestrian, cyclist and vehicular traffic throughout the duration of the project.

Connecting the community of Greenfield to Schenley Park and beyond, a 10-foot pedestrian sidewalk and dedicated bike lanes on the new structure align with Pittsburgh's efforts to make the rejuvenated city more walkable and bike-friendly. Landscaping of adjacent greenspace and its incorporation as part of Schenley Park complement the appearance of the bridge upon entering and leaving Greenfield.

The Greenfield Bridge replacement took nearly two years, beginning with demolition of the old bridge in December of 2015. During that time, extensive traffic rerouting and road closures created many challenges for drivers and public transportation, which had to be rerouted as well.

The "Bridge is Back" party was held on October 14, 2017 with a family and community celebration that outshone the Bridgefest held two years ago, when the old bridge was about to be demolished. On the following morning of Sunday, October 15, the new and improved Greenfield Bridge reopened to traffic and once again reconnected the vibrant Greenfield neighborhood to the rest of Pittsburgh.

On March 22nd, the National Steel Bridge Alliance (NSBA) announced that the Greenfield Bridge has won its 2018 Prize Bridge Award in the National-Long Span category.

Entries are evaluated on the following criteria: innovation, economics, aesthetics, design and engineering solutions.

"The challenges with terrain and traffic flow made for an exceptionally difficult project. The single span steel arch solution overcame those challenges while providing an elegant solution that complimented the original bridge," said Amber Blanchard, PE, Minnesota Department of Transportation, a judge in the competition.

"The ability to preserve elements of the existing bridge and incorporate those touches into the new bridge is a nod to the past while providing a durable steel solution for the future," added Michael Culmo, PE, CME Engineering, also a judge in the competition.

JUST THE FACTS:

Owner:	City of Pittsburgh
Contractor:	Mosites Construction Co., Inc.
Bridge Design:	HDR, Inc.
Steel Fabricator:	High Steel Structures LLC
Steel Detailer:	High Steel Structures LLC
Total Contractor Bid:	$17,477,777
Total Steel Tonnage:	950
Material:	A572/GR50

Superstructure Takes Shape for CSVT River Bridge

High Steel Structures is fabricating and shipping over 12,000 tons of steel for the largest new highway capacity project in Pennsylvania, the Central Susquehanna Valley Transportation (CSVT) Project.

The 4,500-foot CSVT River Bridge will span the West Branch of the Susquehanna north of Selinsgrove, Pennsylvania, and is being built by the Trumbull Corporation. According to PennDOT, the CSVT project will ultimately provide a 13-mile limited access highway connecting PA 147 in Northumberland County just south of the PA 45 Interchange, to US 11/15 in Snyder County just north of the Borough of Selinsgrove.

We look forward to sharing more news about this project as the bridge takes shape. For photo updates, visit our Facebook page at www.facebook.com/highsteel.

The first of 408 girders have been erected for the CSVT River Bridge. The girders are 10 feet tall, weigh 20 to 47 tons, and range from 74 to 122 feet in length.

Excellent Constructability in Design Facilitated Successful Fabrication of the Greenfield Bridge

By **Ronnie Medlock, PE** VP - Technical Services - High Steel Structures

The Greenfield Bridge Project looking North

High Steel provided the fabricated structural steel for the new Greenfield Bridge, which opened 14 October 2017 and carries Beechwood Boulevard over I-376 in the Squirrel Hill area of Pittsburgh. Designed by HDR and opened with a "Bridge is Back" party, the Greenfield Community celebrated the opening of the new bridge and bid farewell to the original 1922 structure. The steel deck arch fabricated by High Steel was an essential element in the preservation of the well noted and highly appreciated context sensitivity of the original bridge.

There are a number of important details associated with steel deck arch bridges from the perspective of fabrication:

- **Arch Cross Section –** is the arch to have a box or I cross section, and if a box, is the box large enough to work inside (safety standards for welding in confined space apply)? Also, if a box, how are the corner welds accomplished?
- **Arch Radius –** what is the radius of the arch? This impacts how the arch elements will fit in the shop; will be moved and rotated in the shop; and how the arch elements will be shipped.
- **Field Pieces –** how do the field pieces and associated weight and radius facilitate shipping?
- **Field Splices –** are the field splices only bolted connections, or are they also bearing connections?

The Greenfield Arch was detailed internally by the Engineering Department at High Steel. High Steel used a model-based workflow to produce the bills of materials, shop drawings, and CAD/CAM program needed to fabricate the bridge as well as 3D visual aids (see Figure 1) to help the shop with fabrication planning and execution.

continued on page 6

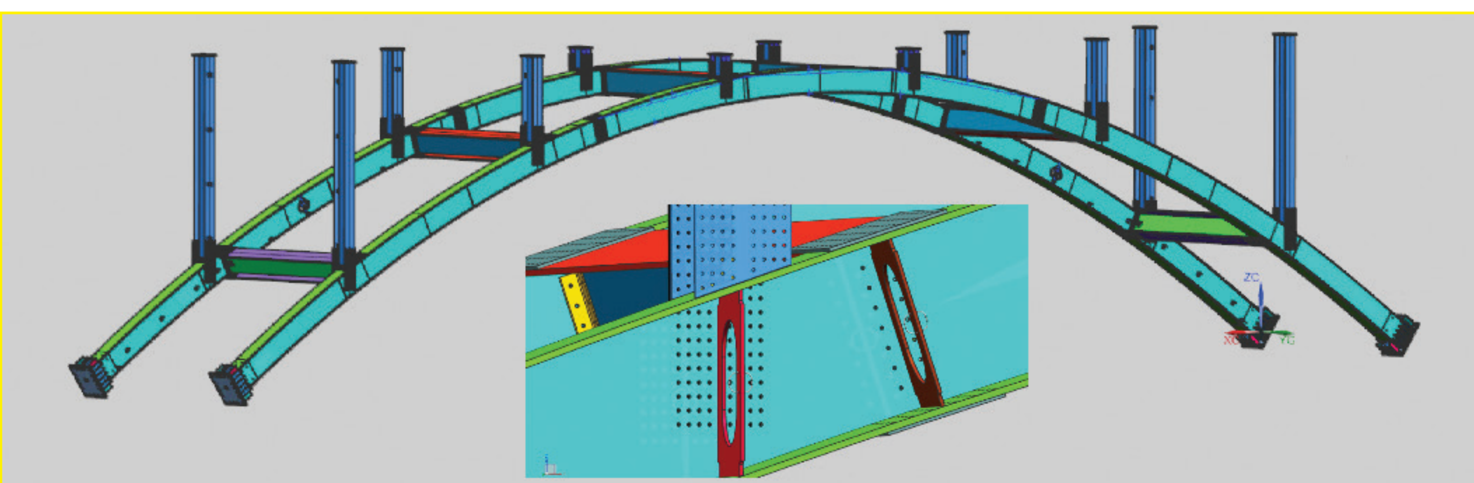


Figure 1 – Detailed in-house, High Steel used a model-based workflow to produce bills-of-materials, shop drawings, and CAD/CAM programs for the Greenfield Arch.

The arch of the Greenfield Bridge is a closed box section. Structural boxes are not uncommon in steel bridges; for example, within the past ten years High Steel has fabricated numerous box pier caps; a truss with box chords; and a tied-arch bridge, the Lake Champlain Bridge, which has inclined-web box ties (with bolted corners).

In fabrication, internal diaphragms (or baffles) are used to establish and hold the shape of the box as it is built. Usually the web-to-flange connections are welded, and if there are internal welds, they are easier to accomplish without the diaphragms in the way.

There can be internal welds at both flanges if the box is large enough to get inside and weld. For ease of fabrication, the best choices in box design are 1) use fillet welds instead of complete joint penetration (CJP) welds when possible, and 2) if CJP welds are indeed necessary, facilitate accomplishment of these from outside of the box, particularly on small boxes.

The Greenfield Bridge arches are 4' – 6" by 3' – 0" boxes, which is large enough to work inside. All four box corners have fillet welds on the outside of the box only (see Figure 2), which reflected the most constructable solution for these connections.

Each arch rib is comprised of three field pieces, with heavy, stiffened base plates where the ribs rest on the thrust block supports. The base plates reflected a particular point of concern for High Steel because they are attached with CJP welds that could only be accomplished from the inside of the box; welding inside the box generally wasn't a large concern, but attaching the base plate closed one end of the box, restricting airflow. Further, the 4" thick base plates required 225 degrees of preheat, making the inside of the box very hot. However, a small hole in the base plate allowed access for ventilation equipment, and the welds were accomplished safely.

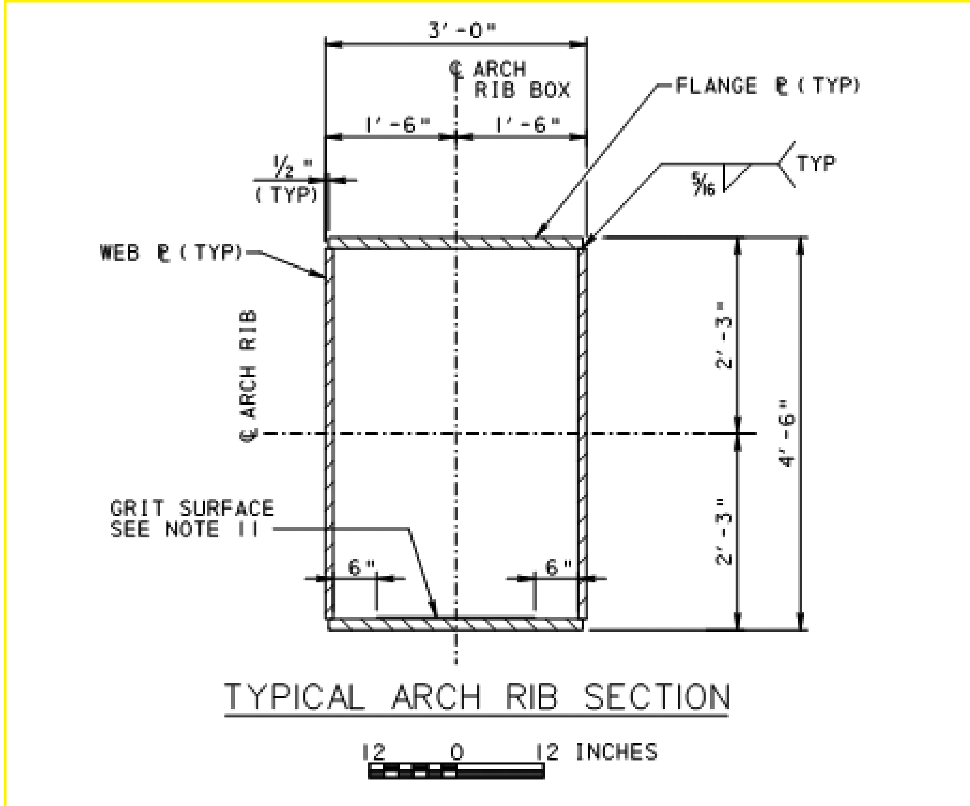


Figure 2 – The arch rib section was highly constructable with welds that were fillet welds and not CJP welds and that were only external.

The base plates were stiffened with a series of one-inch thick plates inside and outside of the arch box section (see Figures 3 and 4). The external stiffeners were connected to the base plate with CJP welds, and internal stiffeners were connected by mill-to-bear condition and fillet welds.

The mill-to-bear condition, which typically requires cycles of stiffener reconditioning to achieve proper bearing, was challenging to accomplish inside the cramped box but was a far better solution than CJP welds. CJP welds require backgouging, and this process cannot be safely or practically performed in such small, confined spaces. Also, the internal stiffeners were arranged without intersections, which is a much more constructable solution than a stiffener grillage pattern.

The biggest challenge faced by High Steel on the Greenfield

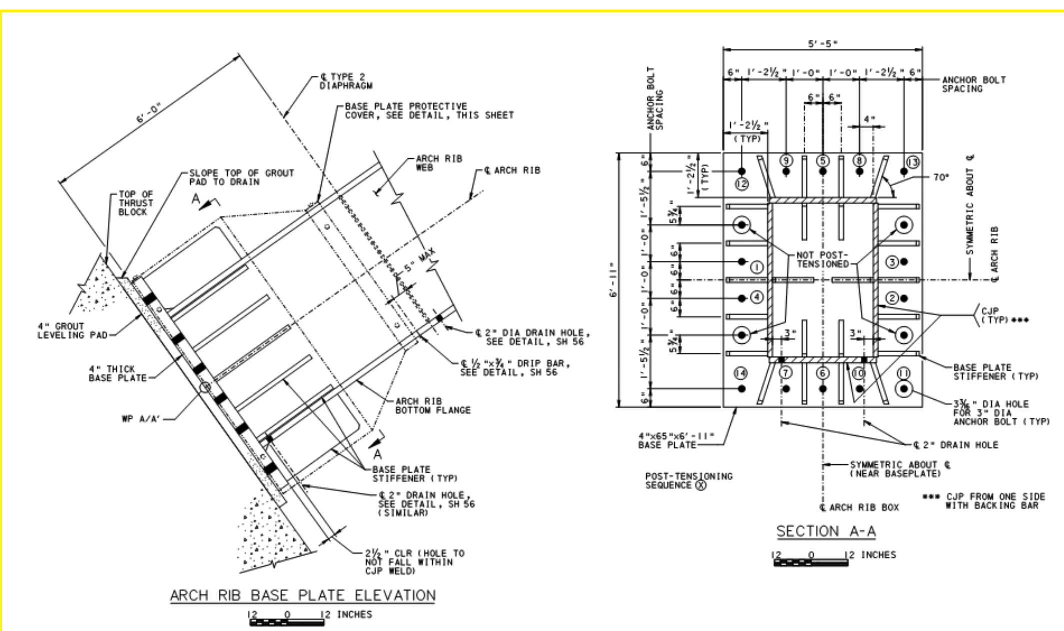


Figure 3 - The arch ribs had external stiffeners that were connected to the base plate with CJP welds and internal stiffeners that were connected to the base plate with mill-to-bear condition and fillet welds. Further, the design did not use a grillage arrangement with associated intersecting stiffeners, greatly improving constructability.

continued on page 7

Bridge was rotating the arch ribs during fabrication. Rotating boxes during fabrication is normal; boxes are turned to facilitate operations, particularly to position boxes for welding. However, rotating curved box elements is unusual as the weight of the elements shifts non-symmetrically as it is turned.

Special fixtures were used to grab the box; these fixtures had multiple pick locations, which could be chosen to keep the load balanced as it turned. High Steel engineering personnel calculated the lifting loads and associated shifting centers of gravity predicted in turning the ribs and provided this guidance as instructions to the shop.

Figure 4 – Photo of five of the six internal bearings stiffeners at one end of one of the arch ribs.

The arch rib field pieces are joined by bolted splices on all four planes – both flanges and both webs, which is typical for joining box sections. Some arch bridges use a combination of mill-to-bear condition and bolted connections at field splices; the load transfer through bearing allows a reduction in the number of fasteners needed in the connection. But, from a fabrication cost perspective the reduction in bolts is not worth the increase in labor needed to achieve the mill-to-bear condition.

As with the bearing stiffener described above, achieving mill-to-bear condition requires considerable effort – first milling the box edges to get them as close as possible and grinding to fit. Not having the mill-to-bear connection, then, made the rib connections easy to accomplish.

Shipping curved sections presents the challenge of encompassing extra lane width to handle field pieces (see Figure 4). Considering their curve, the Greenfield Arch end sections were 11′ – 11″ wide for shipping, and the center sections (shown in the figure) were 14′-3″ wide for shipping. These dimensions are over the legal limit of 8′ - 6″ width and were accommodated with special permitting.

Conclusion

The Greenfield Arch Bridge is a wonderful example of the versatility of steel and of a bridge designed with excellent constructability. The arch superstructure preserves the historic nature of the original bridge that it replaced while providing a graceful structural solution that complements the aesthetics of the local hilly and wooded environment.

Further, the bridge provides a gateway into downtown Pittsburgh from the East. The bridge was designed with the field and shop floor in mind, resulting in details that facilitated fabrication, delivery, and erection.

The bridge is back indeed, and having effectively restored local connectivity, the new bridge offers a superior example of excellent project execution for the engineers in the future.

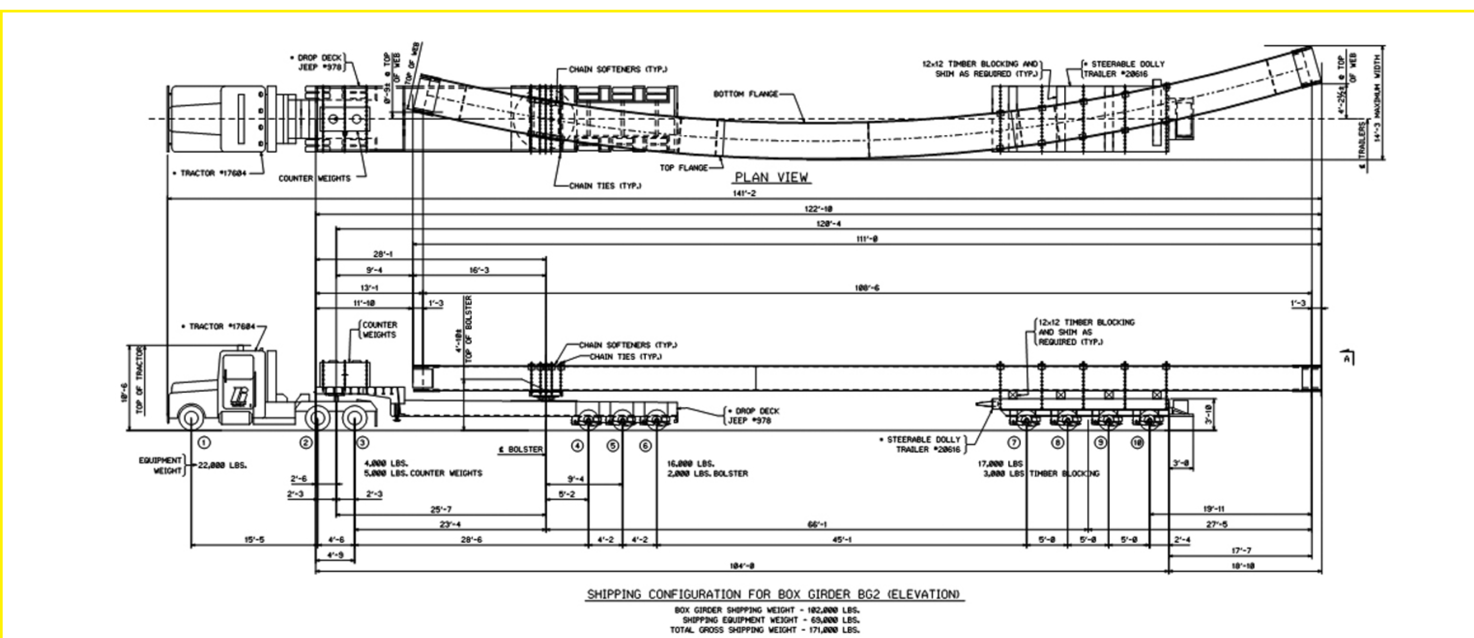


Figure 5– Shipping configuration for the arch center sections

HIGH STEEL STRUCTURES LLC
An Affiliate of High Industries Inc.
1915 Old Philadelphia Pike ▪ P.O. Box 10008 ▪ Lancaster, PA 17605-0008
(717) 299-5211 ▪ Fax (717) 399-4102 ▪ www.highsteel.com
Additional plant location: Williamsport, PA

ADDRESS SERVICE REQUESTED

PRSRT STD
US POSTAGE
PAID
LANCASTER, PA
PERMIT #453

"Lay down a good weld and give good measure"
Sanford High 1931

www.highsteel.com

Fast Answers to Your STEEL Questions

Please address comments or requests for additional subscriptions to editor, Lisa Masters, at lmasters@high.net

HIGH Steel News

In This Issue

Recent Contracts Awarded

DRJTBC Scudder Falls Bridge Replacement
12,232 Tons
Trumbull Corporation

I-294/I-76/Route 42 Interchange
Camden County, NJ
8,680 Tons
South State, Inc.

Southern Beltway Sect 55B
Washington County, PA
3,197 Tons
Ditrich Construction Supply LLC

Rte 7 Hackensack River Wittpenn Br. Contract 4
Hudson Co., NJ
5,461 Tons
George Harms Construction Co, Inc.

Kew Gardens Interchange Van Wyke Expressway
Queens Co, NY
3,744 Tons
Northeast Structural Steel, Inc.

I-270 at Watkins Mill Road
Montgomery County, MD
2,169 Tons
Wagman Heavy Civil, Inc.

SR 351 Sect B10, PA 351 over Koppel Bridge
Beaver County, PA
2,158 Tons
Brayman Construction Company

Jones Branch Connector over I-495
Fairfax Co, VA
1,953 Tons
Archer Western Contractors

MD 4 at Suitland Parkway Interchange
Prince Georges County, MD
1,136 Tons
Cherry Hill Construction