HIGH Steel News
SPECIAL EDITION
Spring 2017

Lewis and Clark Bridge Spans Ohio River between Kentucky and Indiana

More than 200 years after the historic meeting of navigators Meriwether Lewis and William Clark, the new Lewis and Clark Bridge opened on the Ohio River in late 2016.

The breathtaking 2,500-foot expanse of the Lewis and Clark Bridge provides a connection between Kentucky and Indiana, not far from where the famed partners met in 1803 before setting off to explore the uncharted lands acquired by President Thomas Jefferson in the Louisiana Purchase. Lewis, Clark and their Corps of Discovery would travel 8,000 miles to the Pacific Ocean, clearing the way for westward expansion.

Photo Credit: Aerial Innovations

The project is part of the larger Louisville-Southern Indiana Ohio River Bridges Project, which is intended to stimulate the economy of the entire region by providing two river crossings, with one in the downtown area and another, the Lewis and Clark Bridge, eight miles upstream in the metro area's growing East End.

According to the FHWA, the need for the two crossings plays an integral role in the economic strength of the region.

The Lewis and Clark Bridge connects the east end of Louisville, near Prospect, to southern Indiana, near Utica. The new connection increases cross-river mobility while improving safety, alleviating traffic congestion and connecting highways. The project also enhances transportation in the southern Indiana area, both for area residents commuting between eastern Jefferson County and southern Indiana and for travelers approaching the area from the north or south, who can now use the bridge to bypass the urban traffic of downtown Louisville.

Initial construction activity began in spring 2013, following the Indiana Finance Authority's selection of WVB East End Partners to design, finance, build, operate and maintain the East End Crossing. The project was overseen by the Indiana Department of Transportation, and opened to traffic in December of 2016.

General Contractor Walsh Construction Company / Vinci Construction JV (WVC)

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FAMOUS BRIDGES

Beipanjiang Bridge
Beipan River
Guizhou Province, China

Scared of heights? You might want to steer clear of the world's highest bridge over the Beipan River in the mountainous Guizhou Province of China. If you are the adventurous type, the Beipanjiang Bridge might just be your cup of tea. It rises a dizzying 1,854 feet over the river. With its four-lane, 4,400-foot span, only the bravest of hearts can traverse it without a few palpitations.

Get to Know High Steel's New President, John O'Quinn

High Steel Structures LLC's new President John O'Quinn, was born in Canada, but came to the United States after high school to attend college. It was during that time that he became acquainted with the steel industry, learning the business from the ground up at Carolina Steel as a maintenance worker, fitter, shear operator, and welder. John stayed with the company through a period of substantial growth, while earning promotions to positions of greater responsibility.

In 1993, he left to form O'Quinn Enterprises, a steel fabrication and erection company. His wife, Sherrie, took an active role in the company at a time when few women were involved in the steel industry. "We each had our own strengths and made a great team. Together, we built a very profitable business," said John.

In 2006 John accepted an offer to return to Carolina Steel/Hirschfeld as part of a succession plan that led to being named President in 2015. "I spent a lot of time in airports commuting between the offices in Dallas, Texas, and Greensboro, North Carolina, and then my family home in Knoxville, Tennessee. Not only did coming to High Steel give me the opportunity to work for a well-rounded and grounded company at the pinnacle of the industry, it gave me back a home base and a quality of life," said John. "High was also attractive for its culture; a family-owned business that respects its co-workers, supports the community, and has a long-term view to position the company for the future."

As a major competitor, John had gotten to know High Steel well over the years. I have done my fair share of homework on the company. The High Steel brand has always been an extremely strong one , synonymous with quality, integrity and superior performance. They were routinely a formidable foe on bid day and over the years I gained a great respect for their exemplary values and ethics. We were fierce rivals and yet there was a mutual respect that was fostered by working together to promote the use of structural steel in the industry through the National Steel Bridge Alliance."

John describes his approach to the job as being one member of the team. "Yes, I may have the title of leader but I view myself as a facilitator, someone who understands the nuances in play and finds collaborative solutions for continuous progress." He looks forward to future growth for the company, and setting even higher standards that would allow the company to expand and continue to be the foremost bridge fabricator in the United States.

"It's Been a Great Ride!" –

Steve Bussanmas to Retire this Summer

After nineteen years as the Senior Vice President of Sales, Marketing and Estimating, Steve Bussanmas will be retiring effective this summer.

Steve joined High Steel in May of 1998, having spent his previous career in sales management at New Holland Farm Equipment. Steve joined the company at a pivotal time; during his first few years at the company, our facility in Williamsport was expanded to double its capacity, and we were in the midst of fabricating a series of very large projects for the Mon-Fayette expressway. The TEA-21 transportation funding bill was also coming into effect, which meant gearing up for more projects by adding to our workforce. High Performance Steel and Weathering Steel were also gaining popularity during this time.

According to long-time Sales Manager, Dave Buckwalter, "Steve came in and formalized the technical role of sales and marketing in the company, putting into place a system that prepared us for industry developments, such as the rise of design-build and other alternative project delivery methods. He has been an effective coach as well as an esteemed teammate."

Under Steve's leadership, High Steel has been awarded an impressive array of major bridge projects, most notably the Arthur Ravenel Jr. Bridge cable stay bridge in Charleston, SC; the Virginia HOT Lanes; the Lake Champlain Arch Bridge replacement in NY; and our largest project to date, the 50,000 ton contract for the new Tappan Zee bridge north of New York City.

Steve has also devoted countless hours to providing leadership to the industry in the Mid-Atlantic states, including his service on the Board of Directors at the Associated Pennsylvania Constructors (APC) and the Highway Board of Governors at the Associated General Contractors – New York State (AGCNYS).

Steve writes,

"To all of you that I have worked with and for over the last twenty years please allow me to extend heartfelt thanks. This is a great industry filled with great and dedicated people whom I will miss. The time for me to move on has come and it has been a great ride!"

Floor beams loaded on trailer

awarded High Steel Structures a contract to fabricate 6,670 tons of structural steel for Section 5 of the project, the 2,510 ft main spans of the new cable-stayed bridge. High Steel's scope of work included the fabrication of floorbeams, edge girders, deck anchors, and tower anchor boxes for the cable-stayed bridge, as well as plate girders and diaphragms for the transition spans at either end.

The bridge design called for spans of 540'-1200'-540', with two towers and 115' conventional transition (back) spans at each end. The typical section is comprised of four, twelve foot lanes in each direction with an 11-foot cantilevered multi-use walkway for a total width of 124 feet.

The Prime Consultant on the project was Jacobs Engineering. International Bridge Technologies, Inc. (IBT) was the Bridge Design Consultant / Construction Engineer. Benjamin Soule, PE, of IBT shared the Engineer of Record responsibilities with Marcos Loizias of Jacobs for the project, and shared a detailed description with us of the design process for the steel composite deck and stay cables.

Floorbeams

IBT chose HPS 50W steel for the main span's I-shaped floorbeams, with a relatively straightforward simple span design with the floorbeams spanning from one longitudinal edge girder to the other. The floorbeams' primary function is to carry load from the bridge deck to the longitudinal edge girders. According to Soule, precast concrete deck panels, which comprise the riding surface for the bridge traffic, are placed on the floorbeams non-compositely, so the correct effective section of the floorbeams had to be considered, and can often be governed by construction loads in the non-composite condition.

"Lateral torsional buckling was a high priority item during construction," said Soule.

"Special" floor beams are located at the bridge's towers, piers and ballast regions, and are also HPS 50W steel. These floor beams are subject to unique loads. "These loads transfer transverse forces to the substructure through shear keys, and are typically fracture critical members (FCM), as the loss of transverse fixity or ballast was automatically considered undesirable," Soule explains.

Edge girder with deck anchor in fabrication

In all, High Steel Structures fabricated over 150 floor beams for the bridge.

Edge Girders and Deck Anchors

The longitudinal edge girders are HPS 70W steel with a more complex design than that of the floor beams. As load on the bridge deck is carried through the floorbeams to the edge girders, the edge girders then transfer this load longitudinally (along the length of the bridge) to the stay cables. As one of the major structural components of the bridge, these edge girders carry significant axial load and bending moment. According to Soule, the main design consideration for these pieces is that "the moment demand is much more complex, and can reverse. The effective section is also unclear, and there can be a significant net compression in the section."

High Steel fabricated over 100 edge girder sections for the project. Each section was an I-shaped girder, but rather than having typical truly vertical webs, the girders had web plates which were 6.5 degrees out of plumb. This placed the webs more in the plane of the stay cables. Fabrication of these edge girders was relatively straightforward, until the deck anchorages were included.

The deck anchors are welded assemblies within the edge girders, and are composed of HPS 70W steel, except for the anchor pipes themselves. A deck anchor's primary function is to collect the load of the deck, carried through the floorbeams and the edge girders and into the deck anchors, and transfer it into the relatively small area of the stay cables which connect the edge girders to the bridge's two concrete towers. This means that the deck anchor will be subject to high, concentrated loads, and is a unique piece to design. IBT used extensive modeling, with the program "Simulation Mechanical", to validate hand calculations of many different potential failure modes for these pieces.

When set in place, the stay anchorage bears against the lower ring plate of the anchor pipe. This pulls on the two forks of the edge girder's gusset plate, which are reinforced by stiffener plates. The gusset

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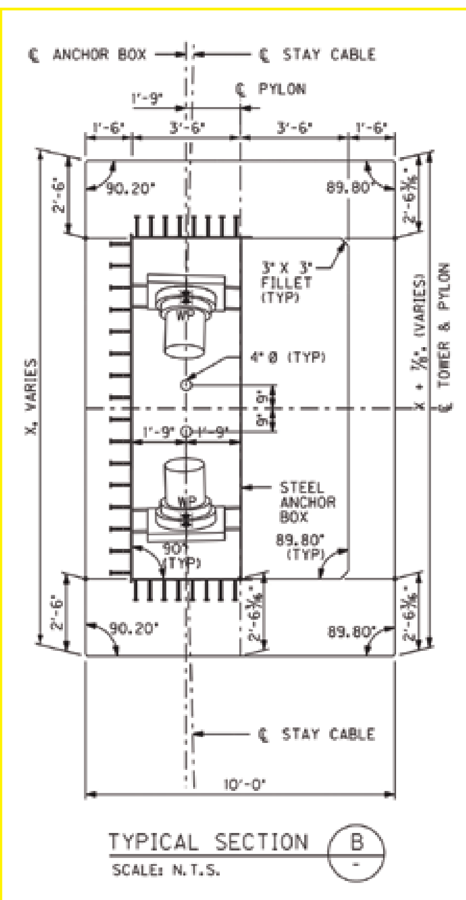
plate is welded directly to the web and top flange of the girder.

At High Steel, the deck anchors were built up in sub-assemblies, starting with the pipe and ring plates. These were eventually built up to include everything except the gusset plate. Gusset plates were cut flat, and welded to the web plates. Welds are at an angle to the web. The top flange was then lowered over the gusset plate and welded. The anchor pipe sub assembly was put in the slots and welded.

Tower Anchor Boxes

The bridge's two towers are approximately 300' tall and hollow, with a modified diamond shape. They rest on a concrete footing, supported on drilled shafts in permanent casings. Within each of the hollow inclined tower legs above the roadway, steel anchor boxes serve both as formwork for construction of the concrete tower legs and reinforcing anchorages for the stay cables supporting the roadway. The anchor boxes, themselves hollow, are a series of 6-foot tall steel rectangles stacked on top of each other within the tower leg. Within the anchor boxes are welded assembles serving as the anchorages for the stay cable connections to the towers.



Typical section, tower anchor box

Fabrication for the tower anchor boxes followed a similar pattern to the deck anchorages, with the anchorage sub assembly fabricated first. The sides of the box were then built up around the anchorage. According to Soule, access to these pieces was a challenging design consideration, both for welding and inspection.

High Steel fabricated a total of 30 anchor boxes for the project - 15 boxes at each tower. The boxes ranged in weight from 9 tons to 15 tons.

Upright edge girder showing slanted design

(Please see the Tech Talk article on page 6 of this issue for more details on the shop assembly and geometry control used for each type of bridge component.)

Steel Detailing

With all the complexities of the design, the steel detailing effort for this project was challenging. High Steel subcontracted the detailing of the project to Upstate Detailing, Inc. (UDI) in Burnt Hills, NY. UDI detailed both the tower anchor boxes and the deck level steel, including the floor beams, edge girders and all cable anchorage assemblies. UDI's primary challenges in the project were the geometric complexities, which required UDI to detail unique components and pieces with minimal repetition; and the fit condition of the structure, which required UDI to predict the edge girder twist required during steel erection.

First, the tower anchor boxes presented a challenge, because the tower and cable geometry required each internal cable anchorage to be unique. Fabrication access and weld joint details were also primary considerations in detailing the anchor boxes, as space within the boxes was limited. UDI overcame these challenges in part by modeling the boxes in SDS/2, thus a 3-D representation of the boxes facilitated investigation of the access and weld joint details. As a further quality control measure, High Steel elected to reconstruct an independent model of the anchor box assemblies using the individual parts modeled and detailed by UDI. This measure provided full confidence that any potential fit issues were averted prior to delivery to the field.

Second, the bridge design required the use of steel tie-downs in each of its four corners, to counteract the forces from the weight of the main span. To avoid having the tie-downs constantly in tension, IBT chose to ballast the back spans in such a manner that the tie-downs are in compression under dead load. The ballast consists of concrete that fills the "cells" created between floor beams with steel diaphragms. This impacted the detailing of that area of the superstructure. The floorbeam-to-longitudinal edge girder connections were the primary challenge related to the fit condition of the structure. Installed in the fully cambered position, the floorbeams induced an out-of-plane rotation in the longitudinal edge girders. This rotation was most evident in the counterweight regions of the back spans.

Due to the counterweight deadload, the floorbeams in this area had appreciable camber. The camber amplified the geometric discontinuity between the floorbeam ends and the longitudinal edge girders. With geometric control being

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Tower anchor box in fabrication

critical to the successful erection of the bridge, UDI was instrumental in coordinating with the erector, and in predicting the amount of edge girder twist required in the field.

Steel Erection and Construction

The height of the two main towers on the 2,500-foot Lewis and Clark Bridge is 300 feet. There are 104 stay cables on the main span of the East End Crossing at a total weight of 1,000 tons. For the bridge, 4,960 tons of rebar was used on the main span, with 24,000 cubic yards of structural concrete. A total of 6,670 tons of structural steel was used for the bridge deck and tower anchor boxes.

Traditional cable stayed bridges are built in balanced cantilever out from the tower. This requires careful staging of both weight and erection crews on each tip of the cantilever, and usually can't begin until the tower is complete. To improve the schedule, WVC elected to erect the backspan steel on falsework, which could be concurrent with the tower construction. On the Indiana side, crane access to the back span was poor, so the deck level steel was launched from the abutment to the tower.

WVC decided to add a false work tower on the main span side. This allowed pre-staging of two cycles worth of panels ahead of tower completion.

"During the Spring of 2015, we were put behind the 8-ball by a couple of months' worth of flooding in the Ohio River that forced us to come up with a recovery plan. The mainspan falsework towers option bought us the three or four weeks of critical path gain needed to hit our contractual open to traffic date. That strategy and the pre-erection of the backspans during tower construction were the keys to the job. Having that framing in place ahead of time shaved days off every composition deck construction cycle," says Doug Vanslambrook, Design-Build Project Manager, The Walsh Group.

The project reached substantial completion in December 2016 with the opening of the Lewis and Clark Bridge. Tolling on the new SR 265 Lewis and Clark Bridge, the new I-65 Abraham Lincoln Bridge and the improved I-65 Kennedy Bridge started Dec. 30, 2016. In February 2017, the first full month of tolling was complete on all three Ohio River bridges connecting Louisville and Southern Indiana.

There were a total of 2,244,476 crossings of the three tolled bridges in January. The highest number of crossings was seen the last full week in January, when an average of nearly 81,000 drivers crossed tolled bridges each day. That number is expected to climb in the coming weeks and months.

Finished bridge before opening *Photo Credit: Aerial Innovations*

Backspan steel erection on falsework

JUST THE FACTS:

Owner:	IFA/INDOT
Concessionaire:	WVB, a joint venture of Walsh, Vinci, and Bilfinger Berger
Contractor:	WVC, a joint venture of Walsh and Vinci
Lead Engineer:	Jacobs Engineering
Sub consultant:	International Bridge Technologies
Steel Fabricator:	High Steel Structures LLC
Steel Detailer:	Upstate Detailing (UDI)
Total Contractor Bid:	$242 Million (Project Section 5)
Total Steel Tonnage:	6,670
Material:	A572/GR50, A588/GR50W, HPS70W

Carrying the torch: Upholding the Skills of our Predecessors in the Fabrication Assembly – Part 3

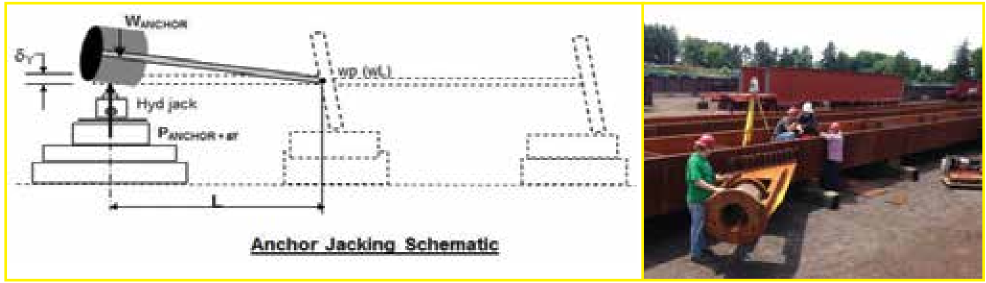
By **Robert A. Cisneros, P.E.,** Chief Engineer High Steel Structures

In parts 1 and 2 of this series, we explored some of the lessons that we've learned at High Steel in the value of pre-assembly. When is it needed? When can virtual assembly augment and/or substitute for actual assembly? How much assembly is needed? Part 2 explored the trial assembly and erection of a moderate span, skewed and curved multi-girder bridge. Here we turn our discussion to longer span bridges.

Case Study #4. The Lewis and Clark Bridge

The subject structure is a three-span, cable stayed bridge with inclined web edge girders (*I* vs the usual I). This article will focus upon the shop-assembly and geometry control of the following four bridge components.

- **Edge girders.** For the fabricator, the slanted *I* presented special considerations since, when stood upright during the building process, these pieces were seven feet tall. Fortunately, the webs were wide enough that the leaning girders could at times be left self-supporting.
- **"Shark-fin" stay-cable anchorages.** Lasers, robotic total station and controlled heat-adjustment methods were employed to align these sub-assemblies to the slanted *I* girders.
- **Grillage Assemblies.** Unit assemblies of edge girders to floorbeams were performed at key portions of the end spans.
- **Tower anchorages.** Large boxes (3'-6" x 14 ft x 6 ft) with integral, inclined pier anchorages also created special alignment and handling considerations as rigidity and geometry stability of the assembly was achieved.



Shark Fin Alignment Adjustment (support and jack point for heat-adjust)

Edge Girders.

Comprised of slanted *I* -Girders with inclined web plates and cable anchorages (the web plates are approximately 6.5 degrees out of plumb), these pieces were over fifteen feet tall with "shark-fin" stay-cable anchorages attached. Initially, a sloped cradle was developed to support the "*T* and *I*" shape of the in-process edge girder until girder flanges were fully welded to flanges (stabilized moment of inertia developed in the building process). As plate girders go, these shop assemblies were relatively stiff and short (45 ft long), and early on we noticed that they lacked the limber flex of the usual line assembly. Thus, camber had to be tightly controlled. Furthermore, the cable anchorage spacing tolerance (0 to 3/16") was tighter than the usual field splice alignment tolerance for traditional I-girder bridges (0 to 3/8"). This necessitated occasional, customized machining of girder ends to hold anchor-to-anchor tolerance for overall bridge fit (~ ¾" maximum across the 108' deck width).

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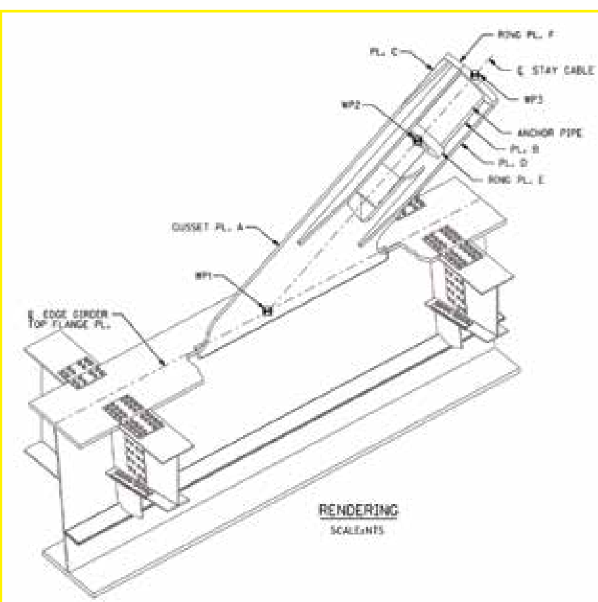


Edge Girder Drawing

Typical Edge girder yard assembly measurement (anchor-to-anchor and field splice alignment)

Alignment was typically held via robotic total station checks against two and three dimensional CAD data. We had to allow for temperature variances since a typical edge girder yard assembly took about one to two weeks to complete.

"Shark-fin" Stay-cable Anchorages.

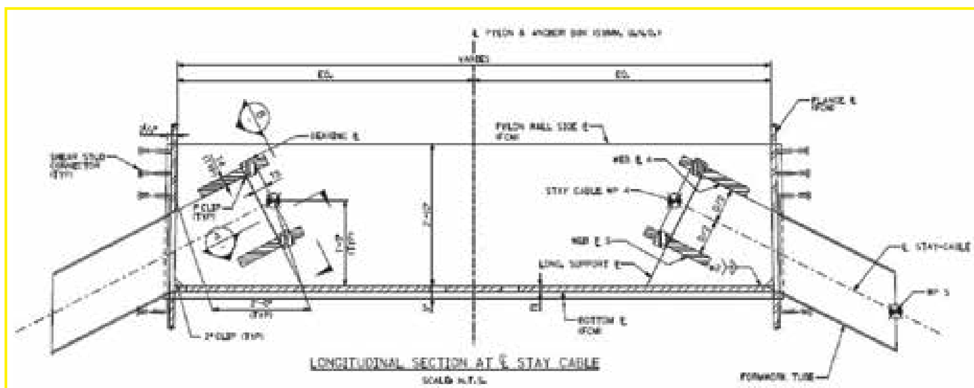
These stay cable anchorage assemblies are made of heavy steel pipe of varying diameters and wall thicknesses (about 2 inches thick) which are attached to the "shark fins", that are in-turn welded to the edge girders. As these sub-assemblies were attached, girder height increased from 7 ft to about 15'-3", and weight to about 38 tons maximum, so that during fabrication handling and transport the eccentricity of the loads had to be considered. Again, the flanges were relatively wide and stiff and so, while it was occasionally unsettling to view, the *I* girders could on occasion be temporarily blocked with flanges level (webs and "shark-fins" leaning in a Pisa-like fashion)…but especially with the "shark-fins" attached, they needed to be secured on custom-inclined stands.

Most of the shark-fin sub-assembly welds are complete joint penetration (CJP) extending three-dimensionally (XYZ axes). Therefore, distortion control was key to successful canister alignment. Consequently, approximate alignment of the shark-fins to the edge girders was first achieved by supporting the large cantilevers. The anchorage canisters were then positioned, tacked and welded with line-of-sight laser sights. Upon yard assembly as described above, the anchorage-to-anchorage dimensions were measured and the shark-fin's fine-tuned via weighted heat-adjustment (due to the loadpath criticality of these elements, heat-bend "shark-fin" adjustment calculations were submitted to the design Engineer of Record for review).

Grillage unit assembly in High Steel yard

Grillage Assemblies.

To facilitate field fit up, certain end span edge girders were fully assembled with their respective floorbeams. Anchor-to anchor, edge girder to edge girder width and squareness of the framing were checked with a robotic total station. This assembly was primarily for portions of the span subject to influence by field ballast (uplift counterweight).



Longitudinal section – Tower Anchor Box

Tower Anchor boxes.

The tower anchor boxes are comprised of steel plate boxes into which are welded anchor canister pipes (cut at a slant or ellipse), these created a challenge which necessitated careful layout and handling pre-planning in order to maintain stability until the assembly was complete.

High Steel utilized tools similar to those used on the steel dead load fit end assemblies to facilitate geometric fit-up; the contractor also applied independent measurement methods to validate the first of similar components, as described in the cover story.

Tower Anchor box showing openings for anchor canister pipes

Summary and Conclusion.

While it is usually feasible to pre-assemble a large bridge in its entirety, this cable stayed bridge's complexity warranted extensive assembly; in such cases, complexity is managed by breaking the structure down into components, so a decision can be made what elements/sub-assemblies are needed.

Measurement/metrology and survey tools can be employed to help facilitate control of difficult bridge alignments and monitor distortion so that, with safe handling stability considerations of the non-standard pieces, the resulting series of assemblies will be constructible in the field.

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Sanford High 1931

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Fast Answers to Your STEEL Questions

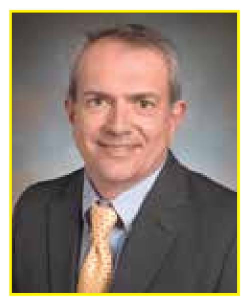
Please address comments or requests for additional subscriptions to editor, Lisa Masters, at lmasters@high.net

HIGH Steel News

In This Issue

Rich Truxel Promoted To VP of Sales, Marketing and Estimating

High Steel has promoted Sales Manager Rich Truxel to Vice President of Sales, Marketing, and Estimating, succeeding Steve Bussanmas. Rich has served as one of our Sales Managers for ten years, having joined us in 2007. Rich holds a Bachelor's degree in Business from Penn State University and an MBA from the University of Pittsburgh. He was born and raised in the Pittsburgh metro area and has an extensive background in the steel industry in sales and marketing roles. Rich can be reached at rtruxel@high.net or 717-207-4303.



Recent Contracts Awarded

Southern Beltway SR0576 Sect 55B
Washington Co, PA • 3,197 Tons
Joseph B. Fay Company

SR62 Sec. B01 over Allegheny River - Hunters Station Bridge
Forest Co, PA • 1,957 Tons
Mekis Construction Corporation

8BOW0C Two Bridges, Design-Build
Ulster Co, NY • 1,429 Tons
Ecco III Enterprises, Inc

1BOW0G, NY Rte 23 over Schoharie Creek
Greene Co, NY • 701 Tons
Harrison & Burrowes Bridge Constructors, Inc.

Monocacy Blvd over Monacacy River
Frederick Co, MD • 684 Tons
Milani Construction, LLC

T-228.54S001-3-02 BR EB-105 over NSRR
Cumberland Co, PA • 604 Tons
Deblin, Inc.