HIGH Steel News
SPECIAL EDITION
Summer 2018

An American Success Story: High Steel Structures Helps Rebuild Major US Bridge

Supported by fabricated steel from the largest project in High Steel's history, the first four lanes of traffic crossed the new Governor Mario M. Cuomo Bridge – replacing the Tappan Zee Bridge— on August 25th, 2017. The 3.1 mile-long, $3.98 billion steel crossing is the largest active bridge project in the nation and a testament to the work and capabilities of America's steel fabricators, mills, and constructors.

Tappan Zee Constructors, LLC, a design-build consortium composed of Fluor Corporation, American Bridge Company, Granite Construction Northeast and Traylor Bros., is building the new bridge. High Steel Structures LLC, was one of three fabricators who combined to provide more than 110,000 tons of structural steel while playing a key role in the support of more than 7,000 jobs. And just as the fabrication was provided domestically, so too was the steel production.

In mid-August 2017 High Steel celebrated the completion of fabrication on its portion of the steel superstructure for the new bridge, which crosses the Hudson River north of New York City. High Steel fabricated and High Transit LLC delivered over 50,000 tons of steel on time and with superior fit. Neil Napolitano, approach span area manager of Tappan Zee Constructors (TZC), said, "Without a doubt, High Steel showed they were up to the challenge of Tappan Zee."

High Steel provided half of the 20 approach spans on the bridge, which are comprised of five lines of 12' deep girders, associated 18' by 7 ½', 1 ½ ton cross frames, and 2 ½' deep substringers that rest upon the cross frames between the girders to help support the concrete deck. Supplying all elements on schedule was essential to supporting TZC's construction scheme.

High Steel signed its contract with TZC in the fall of 2013 and immediately began preparations to ensure a successful project. High Steel completed an $11.4 million, 30,000-square-foot expansion of its Williamsport facility, installed new state-of-the-art equipment to improve efficiency, and added approximately 200 jobs. The Pennsylvania Department of Community and Economic Development supported the expansion with

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Traffic crosses the Hudson River on the new bridge's first completed span. *New York State Thruway Authority*

Message from the President

Innovations in Bridge Engineering, Technology and Construction

John O'Quinn,
President
High Steel
Structures LLC

I recently had the opportunity to cross over the new Governor Mario M. Cuomo Bridge as its eastbound lanes near completion. I was awestruck by the sight and knowledge of what these bridges truly represent: a resounding success in American steel bridge construction. Built with over 110,000 tons of American steel by American fabricators, these bridges demonstrate the many advances in steel fabrication and bridge construction capabilities that exist today in our great country. This project personifies the meaning of innovation!

The new structures are a testament to how bridge engineering, technology and construction techniques have grown over the decades, from the first wire rope suspended bridges through early riveted trusses to today's long, slender girders of the Tappan Zee replacement. With its durable zinc-based coating, tough High-Performance Steel, and efficient welded connections, the new bridges were built to last over 100 years. They were built efficiently and safely and were delivered on time.

I hope everyone in the bridge community gets the opportunity to see the Governor Mario M. Cuomo Bridge first hand; it is truly awe-inspiring. With this special issue of the High Steel Newsletter, let us celebrate the engineering, fabrication and erection accomplishments achieved on this monumental project. Let them inspire us to still greater excellence in delivering bridge solutions to the American public.

HIGH AND THE NEW NY BRIDGE PROJECT

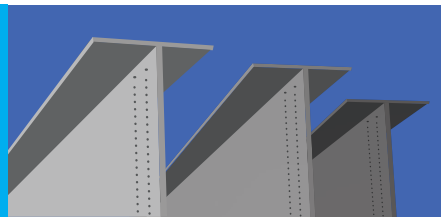
At a Glance

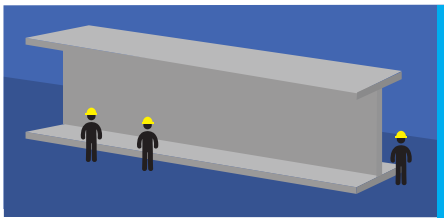
$3.98 BILLION

At $3.98 billion, the 3-mile long New NY Bridge Project in New York is the largest design-build transportation infrastructure project in the history of the United States.

50,000 TONS

High Steel fabricated more than 32,000 individual pieces totalling more than 50,000 tons of steel for the New NY Bridge Project in our Williamsport and Lancaster, PA facilities in the biggest project since High's founding in 1931.



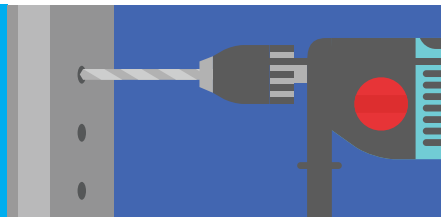


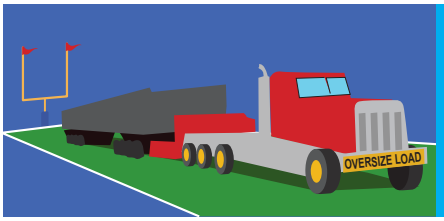
12 FEET DEEP

The massive girders used for the New NY Bridge Project are 12' deep and weigh as much as 100 tons or more.

1.4 MILLION

High Steel precision-drilled 1.4 million holes to allow each girder, crossframe, and sub-stringer to be safely secured in place, earning praise from contractor Tappan Zee Constructors for outstanding fit and finish.



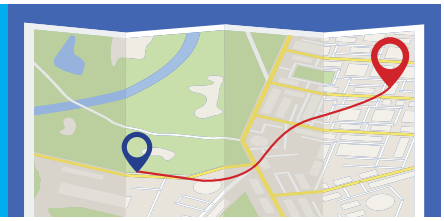


297

Number of High Transit heavy haul "Superloads" using jeep and steerable dolly trailer and requiring a police escort, in loads weighing up to 130 tons and half a football field long.

200 MILES

If laid end-to-end, all the welds High Steel applied to the steel for the New NY Bridge Project would stretch from High's plant in Williamsport, PA to the site of the bridge in Tarrytown, NY.



$11 MILLION

High invested $11 million to expand our Williamsport facility and added more than 200 jobs to support the historic New NY Bridge Project.

An American Success Story: High Steel Structures Helps Rebuild Major US Bridge *continued from page 1*

a $430,000 grant. High Steel detailed the project in-house, producing more than 3,000 shop drawings. The first steel was cut in February 2014, and deliveries began that fall.

High Steel cut, fit, welded, drilled, cleaned, and painted steel plates and shapes to produce 793 girders, 2,852 cross frames, and 1,052 stringers over the better part of four years, with the majority of the work being completed between 2014 and 2016 across all four of the company's fabrication plants in Lancaster and Williamsport. High Steel drilled more than 1.4 million holes and accomplished more than 240 miles of weld passes on the job – enough to weld continuously from Williamsport to the new bridge and beyond.

Minimizing the high cost and hazards of working over water, TZC preassembled 1,100- and 1,200-ton groups of the three elements in a staging area situated 95 miles upriver from the project site at the Port of Coeymans, in Albany County, NY, barged them down stream to the bridge, and then lifted them in place with its extraordinary barge crane, the 1,900-ton capacity "I Lift NY".

The project's first steel girder assembly is set into place. *New York State Thruway Authority*

Finished girders await shipment at High Steel's yard.

Previously used on the West Coast, the crane was brought through the Panama Canal, refurbished in New Jersey, and then pressed into service constructing the new bridge. A custom lifting frame with independent adjustment controls at each of four lifting points provided the flexibility TZC needed to align the girder and stringer connections of the 140 massive assemblies as erection progressed along the bridge.

From the beginning, TZC pursued an aggressive schedule, and deliveries to support their ambitions drove High Steel's critical path — particularly because there were 297 girder superloads on the project. At over 75 tons and half a football field in length, these superloads required police escorts, whose availability challenged the transportation logistics for the project. Law enforcement agencies generally can support about three or four superloads per week; once the superloads started moving in November 2014, they kept up every week almost nonstop for more than a year. The safe, on-time delivery of these loads, with girders lying flat and squeezing through narrow toll booths with inches to spare, is a testament to the extraordinary capabilities of High Transit.

"The New NY Bridge project is a perfect example of High's drive for innovation and excellence. High's coworkers met every design, engineering, fabrication, and transportation challenge presented to us," said Michael F. Shirk, Chief Executive Officer of the High companies. "We are proud to play such a pivotal role in the rebuilding of America's finest infrastructure — one bridge at a time."

On June 15, 2018, Tappan Zee Constructors (TZC) set the final High Steel blue girder in the bridge, bringing major steel operations on the bridge approaches to a close. As demolition of the previous bridge progresses, work continues to complete the new eastbound lanes and fully link the new eastbound structure across the Hudson River.

"This steel connection is another example of progress for the new bridge and sets the stage for the opening of the eastbound span later this year," Governor Cuomo said in June at the completion of major steel operations on the project. "The new Governor Mario M. Cuomo Bridge will not only serve New Yorkers, visitors and the greater Mid-Hudson Valley region for the next century, it will be an important symbol of our commitment to rebuilding stronger, safer infrastructure across the state."

For more than a century to come, more than 140,000 vehicles a day will traverse the Hudson on the completed, stunning new bridge — made by American workers, using American ingenuity, and American steel. The giant blue girders and cross frames no longer fill High Steel's yards, but the Tappan Zee replacement will live long in the hearts of the High Steel coworkers who proudly demonstrated that US fabricators are ever ready to take on the challenges of renewing America's infrastructure.

JUST THE FACTS:

Owner:	New York State Thruway Authority
Contractor:	Tappan Zee Constructors
Bridge Design:	HDR, Inc.
Steel Fabricators:	High Steel Structures LLC and two other domestic fabricators
Steel Detailer:	High Steel Structures LLC
Total Project Cost:	$3.98 Billion
Structural Steel Tonnage:	50,490 (High Steel's portion of the 110,000 Ton Total)
Material:	A588/GR50W

The Tappan Zee Bridge: History Travels along the Hudson River

The Hudson River flows more than 300 miles from the Adirondack Mountains in Upstate New York to New York City at the Atlantic Ocean.

Named for English explorer Henry Hudson, who discovered it in 1609, the Hudson River has a rich history of Native Americans, Dutch, English and French, who traveled and traded along the beautiful river.

At one of the widest points along the Hudson, and 25 miles north of Midtown Manhattan, the view across the river is from Grand View-on-Hudson and to Tarrytown, New York.

A vision of light and shadow on the Hudson River. *© Michael Ver Sprill | Dreamstime.com*

During the eighteenth century, the Hudson River Valley and its inhabitants inspired classic tales by Washington Irving, the first internationally acclaimed American author, who wrote "The Legend of Sleepy Hollow" and "Rip Van Winkle."

To artists, it has been a cherished subject, with the play of light and shadow on the water against the sky above. It's no wonder the Hudson River School of landscape painting evolved in the 19th century as a preeminent American pastoral style of art.

As a cultural icon in American history, the Hudson River separates thriving communities along its banks, slicing through lower New York State. Long ago, the river was traversed by raft-like ferries, sometimes as far as three miles across the river. By the 20th century, it was clear there needed to be a better connection to link South Nyack in Rockland County with Tarrytown in Westchester County in the Lower Hudson Valley.

It would be a monumental task.

Back in the 1920s, a trans-Hudson River crossing from Westchester County was first proposed. It was linked to plans for a highway that would encircle the New York-New Jersey metropolitan area. Plans remained in limbo for more than 20 years. Then, after World War II, demands for a regional highway system and Hudson River crossing were renewed.

In 1949, the New York State Thruway Authority (NYSTA) established as its goal the development of a toll superhighway connecting the major cities of New York State. Originally proposed to end in Suffern, Rockland County, the mainline route was extended into New York City after engineering and fiscal experts suggested that the extension would serve as an integral part of the system.

While earlier bridge plans called a crossing between Dobbs Ferry, Westchester County and Piermont, Rockland County, it turned out that the proposed location fell within the 25-mile radius of the Port Authority, which held jurisdictional rights to Hudson River, and the challenging geography of the lower Rockland County palisades made construction challenging.

So in 1951, the location of the proposed bridge was moved to the Tarrytown-Nyack location, incorporating the proposed New York Thruway extension between Suffern and New York City. In June 1951, the initial test pilings were driven by workers. Steel shortages from the Korean War delayed construction of what would known as the Tappan Zee Bridge. It wasn't until March 1952 that construction began on the Tappan Zee Bridge, which opened to traffic three years later in 1955.

The name Tappan Zee was a tribute to both the Native American and Dutch inhabitants of the region. Tappan comes from the Native American sub-tribe of the Delaware and Lenni Lenape people, and the Dutch word "zee," which means "sea."

The Governor Malcolm Tappan Zee Bridge toll-bridge had a total length of 16,013 feet with a cantilever span of 1,212 feet, at a location some 25 miles north of New York City. The Tappan Zee Bridge is one of the primary crossings of the Hudson River north of New York City, carrying the bulk of traffic between southern New England and points west of the Hudson.

When the Tappan Zee Bridge was built, there were eight underwater concrete caissons supporting about 70 percent of the bridge's dead weight, with steel piles driven into rock.

The original design of the Tappan Zee Bridge included a 1,112-foot steel tied-arch span for the main channel of the Hudson River. Engineers later selected a more economical cantilever design.

To maximize roadway efficiency, the seven-lane bridge utilized a moveable concrete barrier, that was converted in 1992 to a four-lane southbound, three-lane northbound configuration. Prior to 1987, the bridge had a three-lane northbound, three-lane southbound configuration.

When the Tappan Zee Bridge was built in the 1950s, it was originally intended to last for 50 years. By 2000, it was clear that the aging bridge needed to be replaced. Tragedies like the collapse of Minnesota's I-35W Mississippi River bridge in 2007 raised concerns about the Tappan Zee Bridge's structural integrity. The bridge had exceeded its useful service life.

Built with Speed

Achievement of Delivery on High Steel's Largest Project Ever

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

High Steel supplied ten of the approach spans on the Governor Mario M. Cuomo Bridge, and the numbers are staggering: more girders and more cross frames on one project than ever before; 1 ½ million holes punched and drilled; hundreds of miles of welds; and enough delivery miles driven to circle the globe. The amount of work is impressive, but the real story is how two key factors allowed this huge volume of work to be accomplished on time and with excellent fit in the field: excellence in constructability and use of modern fabrication technologies.

Span Length and Plate Girder Configuration

As the Tappan Zee Bridge is being dismantled, the new and old structures offer a steel bridge history and constructability lesson as they briefly sit side-by-side. Most notably, the new approach spans, typically 350' in length, are more than four times longer than the approach spans on the original bridge. That increase cuts substructure work by a quarter, significantly increasing construction speed. But if 350' offers such an improvement, why not go longer and reduce substructure still further? After all, High Steel has recently completed girder bridges with 440' and 500' spans (the Masontown and Hulton bridges, respectively, in Western Pennsylvania). The answer to this question is that the designer chose a highly constructable girder configuration during the process of optimizing the superstructure and substructure economics.

As bridge span lengths extend over 300', girder depth becomes a significant consideration. One of the keys to the success of the New NY Bridge project was the use of 12' deep, parallel flange plate girders with longitudinally unstiffened webs. Girders can be made deeper, but production and delivery times go up exponentially above the 12' deep mark. Fabrication of longitudinally stiffened girders or field spliced haunched girders is time consuming and, most especially, steel plate made to normal mill flatness tolerances is not available over 12' wide. It is only at normal flatness tolerance that which webs, flanges, stiffeners and connections plates can be fit without extraordinary and time consuming effort.

Twelve foot deep girders are also readily shippable over the road. Granted, at this depth, girders must be laid down for shipping, which isn't preferable. However, once a girder is lying down, weight becomes the primary constraint, and as girders get deeper, their weight per foot goes up and reduces the girder lengths that can be shipped effectively. Keeping the girders to 12' depth kept shipping weights reasonable and helped keep the number of loads and associated handling down.

Approach spans during steel erection on the Rockland end of the bridge *New York State Thruway Authority*

Early on, the girder configuration did throw High Steel a curveball: unlike other projects, the bridge was designed with a constant top-of-top flange profile, with top flange thickness changes "into the web" of the girders (see Figure 1). Such thickness transitions are unusual, but TZC chose this approach to provide a uniform top-of-steel elevation to facilitate use of full-depth precast panels for the bridge deck. In the shop, flange thickness transitions that go into individual girders are a challenge for cutting webs, fitting flanges, and accomplishing web-to-flange welds; however, the TZC top flange thickness transitions only occurred at field pieces as shown in Figure 1. Therefore, these were no issue for the shop and provide a good future lesson: if top-flange thickness transitions going down are desired, only use thickness transitions at field splices.

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Figure 1 - TZC top flange thickness transitions were unusual in that they went "down" into the girder webs; however, thickness transitions only occurred at field piece changes, as in "A," "B," and "C" field pieces above, and did not go into individual field pieces

Steel girders and components are assembled at the Port of Coeymans staging area. *Courtesy New York Thruway Authority*

Digital Radiography

The enormity of the New NY Bridge project carried through to the world of inspection, especially regarding radiographic testing (RT) of complete joint penetration flange and web butt splices. The cycle time on x-rays can be several hours, but High Steel cut this time in half through the use of digital RT.

The use of digital RT on this project represented the first use of digital RT on a NY bridge project. In addition to faster cycle times, digital RT provided a number of advantages over traditional film:

- Ease of handling data files versus traditional film
- Improved image clarity
- Ease viewing results on a computer in normal light versus use of a light table
- Avoidance of film storage
- Avoidance for film processing issues, such as fogging, streaks, water marks, chemical stains, scratches, smudges, and tears

With digital radiography, a digital panel is used to capture images instead of film, and then the images are simply populated to a computer where they are both evaluated and stored. Though the New York State Steel Construction Manual (SCM), like the Bridge Welding Code, is silent about this technology, digital radiography was readily adapted to the Manual.

CNC Drilling and Punching

Field connection accuracy is paramount for steel bridge project execution, and with over 1.4 million holes to accomplish, use of CNC drilling and punching was essential to both fit in the field and speed of fabrication – particularly because High Performance Steel (HPS) takes longer to drill than conventional grade 50 steel. Use of CNC equipment reduced the girder bolt hole processing cycle from two days to less than half a shift. Further, under assembly reduction requirements in the NYS SCM, High Steel demonstrated fit quality with check assemblies and then only put 10% of the girders on the job through assembly.

Durability Solution

Durability is essential for in-service performance of bridges, and the durability solution has fundamental implications on fabrication time. For the new bridge, a protective coating system was chosen that would ensure a 100-year life and facilitate fabrication of the steel on time: a three coat paint system with an organic zinc-based primer. Zinc primers (and associated improved steel cleaning) have been used since the 1960's. There are many examples of decades-old zinc primed bridges which have not required maintenance painting; further, coating systems have gotten still better over time.

There are debates in the bridge community about which type of zinc primer, inorganic or organic, provides better protection for steel. On test coupons, studies show that they have comparable life, with a slight edge towards inorganic zinc. However, organic zinc primers are known to be easier to apply, particularly on the various corners and relatively narrow surfaces found on steel bridge girder stiffeners and connection plates and on cross frame elements. Further, systems primed with organic zinc are considerably more damage resistant than shop applied inorganic zinc systems. For these reasons many bridge professionals feel that organic zinc provides better value.

Use of organic zinc (OZ) primer has the additional benefit of facilitating throughput in the shop. In contrast to OZ primers, inorganic zinc (IOZ) primers must have moisture to cure. Atmospheric moisture (humidity) is generally sufficient, but the speed of curing depends upon the amount of moisture in the air. The amount of moisture is a function of absolute humidity and not relative humidity; therefore in the winter, when there is little moisture in the air, cure times can extend to over a day, even with the artificial introduction moisture with through techniques such as misting or puddling on the shop floor. When using IOZ, waiting for proper curing is crucial because once the second coat of the three coat system is applied, the IOZ primer is cut off from moisture, inhibiting any further curing. Hence, in production, IOZ curing can result in prime coat cycle times that can be lengthy and somewhat unpredictable. By contrast, OZ primers do not need moisture to cure, and therefore a second coat can be applied as soon as the primer has dried. Depending on the time of year, the use of OZ primer saved about half a day to a day of curing – for each of 4,697 components painted.

A Model for the Future

With fabrication now complete for over a year, the Tappan Zee replacement project is fading into High Steel's past. However, the largest project in High Steel's history will not be soon forgotten - not because it was big but because it is a model steel bridge project for the future. Constructability in design combined with modern fabrication to facilitate the flow of 100,000 tons of steel through the shop and on-time delivery and exceptional fit in the field. The State of New York has a fine new bridge, and America's bridge community has a fine example of excellence in steel bridge fabrication.

High Steel Structures Ships Last Two "Superload" Girders to The New NY Bridge Project

On March 7, 2017, High Steel Structures reached a major milestone as the last two massive blue "superload" girders were shipped from Williamsport with police escorts and began the four-hour journey to the New NY Bridge project's assembly yard in Port of Coeymans, N.Y.

The trucks High Transit LLC used to ship the superloads are specialty rigs equipped with load-bearing jeeps in the front and steerable dollies in the rear. An escort driver controls the dolly by remote control to navigate curves, corners, tolls, and other obstacles the superload may encounter en route. At twelve feet in height and up to 130' in length, each girder weighed about 78 tons. An additional 34 non-superload girders were shipped in 2017.

The milestone attracted the attention of local media, with several local television stations, newspapers, and radio stations covering the event.

The last superload girders were shipped in March 2017.

The Last Girder Unveiled in Trademark Blue

On August 18, 2017, High Steel held an event at its Williamsport plant to celebrate the completion of its part in fabricating steel for the New NY Bridge project. In a ceremony before a crowd of educators, local dignitaries and co-workers, the company unveiled the last girder, freshly painted in the project's trademark blue color.

"With fabrication complete, we are proud to say that we have hit every engineering and delivery milestone with outstanding quality and superior fit and finish," said Jeffrey L. Sterner, President and COO of High Industries Inc.

Speakers included Chris Ray, Executive Director, Business Development, Workforce Development & Continuing Education, Pennsylvania College of Technology; the Honorable Dr. Gabriel Campana, Mayor of Williamsport; The Honorable Gene Yaw, PA House of Representatives; and Ronnie Medlock, P.E., Vice President of Technical Services, High Steel Structures

After the ceremony, a group photo was taken to commemorate the event, and guests enjoyed a catered BBQ lunch.

Group photo celebrating High Steel's completion of fabrication for the project.

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"Lay down a good weld and give good measure"

Sanford High 1931

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HIGH Steel News

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