Pittsburgh ENGINEER

SUMMER 2019

Quarterly Publication of the Engineers' Society of Western Pennsylvania

BRIDGES:
Focus on Construction

The Governor Mario M. Cuomo Bridge (right) replaces the Tappan Zee Bridge

Pittsburgh **ENGINEER**

Quarterly Publication of the Engineers' Society of Western Pennsylvania

In this Issue...

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On the Cover: The new Governor Mario M. Cuomo Bridge, under contruction, replaces the Tappan Zee Bridge (upper left). Photos courtesy of Warren Kaplan and New York State Thruway Authority, respectively.

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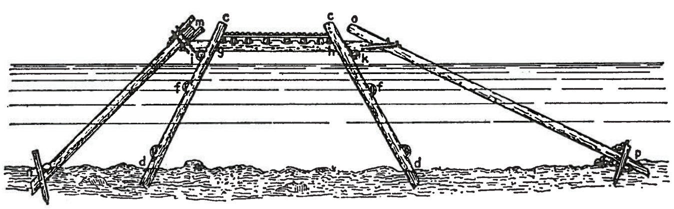
Thomas Leech, Jane-Ann Patton, and George Horas

Guest Editor Column

WHAT DOES IT TAKE TO BUILD A BRIDGE?

" [My soldiers] … caused pairs of balks [i.e. wooden piles] a foot and half thick, sharpened a little way from the base and measured to suit the depth of the river … These [were] lowered into the river by means of rafts and set fast and drove home by rammers; not … straight up and down, but leaning forward at a uniform slope, so that they inclined in the direction of the stream. Opposite to these, again were planted two balks … each pair, slanted against the force and onrush of the stream … So, as they were … clamped together, the stability of the structure was so great and its character such that, the greater the force and thrust of the water, the tighter were the balks held in lock … so that if trunks of trees, or vessels, were launched by the natives to break down the structure, these fenders might lessen the force of such shocks, and prevent them from damaging the bridge …" from Commentāriī dē Bellō Gallicō (known in English as the Gallic Wars) by Julius Caesar, c. 50 BCE, commemorating the 10-day construction of a bridge across the Rhein River near present day Coblentz, Germany.



Caesar's Bridge – c. 50 BCE – from the Ancient Engineers, DeCamp, 1966

The first recorded engineering "article" describing bridge construction was not penned by an engineer or architect, but by a military commander. Written in a third person narrative, Julius Ceasar described battles, intrigues … and bridge construction … that took place in the nine years he spent fighting the Germanic and Celtic peoples in Gaul (modern day France, Belgium, Germany and Switzerland). This narrative, in vivid, yet simple and understandable language marks the beginning of recorded discourses documenting the skills of workers who build bridges.

In this special edition of the *Pittsburgh ENGINEER*, we pay special tribute to all who have built bridges, from the earliest to present times by collecting a series of "articles" on bridge construction, as we honor the laborers, craftsman, tradesman, surveyors, engineers, architects, managers, owners and visionaries who have either contributed a small or large measure of effort to build what we come to know and love as bridges. Unlike Caesar, we have not come to conquer, but to benefit all through the construction of transportation networks, and we celebrate these constructions through an exchange of technology and knowledge.

Enjoy this special edition of our magazine; celebrate the accomplishments of many of our predecessors and our contemporary colleagues as well. Take our Bridge Quiz and see how well you know your bridge history. In addition, enjoy our photo contest with its emphasis on bridges and their constructors.

The Editors.

IN MEMORIAM

2018 marks the passing of two dear members of the International Bridge Conference® community of colleagues. Early this year the bridge community lost John "Fred" Graham and Jim Dwyer. Both gentlemen were among the small group of core founders of IBC and have served continuously on the Executive Committee since it's founding, some 35 years ago. They will be missed.

Jim Dwyer passed away on February 11, 2019 at the age of 85. Originally from New York City, Jim resided in Wexford, Pennsylvania for 36 years before moving to the Washington, D.C., area in 2016. A graduate of Manhattan College in New York City, Jim worked as a civil engineer for the American Bridge Division of U.S. Steel, and the Port Authority of Allegheny County for almost 50 years. His first engagement with American Bridge after graduation, was as a construction engineer for the Verrazano Narrows Bridge, the large suspension bridge linking Staten Island and Brooklyn, in New York City. He frequently reminisced about his days as a young engineer, standing atop one of the towers taking in the New York skyline at the end of a work shift. Jim had a passion for railroads and railroad bridges; and he remained active in railroad committee work up until death.

As with Fred Graham, Jim was one of the half dozen or so founders of the International Bridge Conference® (IBC). Since its founding, Jim has worked tirelessly on the IBC Executive Committee, as well as on many of the IBC subcommittees. As a member of the IBC Awards Committee, Jim was always the fearless champion of railroad bridge entries. Jim had a strong and personal connection with the Engineers' Society of Western Pennsylvania, serving on the Board of Directors for many years and serving as it's President in 1993.

Jim Dwyer (left) and Fred Graham, at the 30th Anniversary IBC

"Fred," as we knew him, Graham passed away on March 14, 2019 at the age of 82. While Fred recently lived with his daughter, near Philadelphia, PA, he remained a Pittsburgher at heart where he was born on April 2, 1936. Fred graduated in 1958 with a B.S. in Civil Engineering and upon graduation went to work immediately for Allegheny County (Pennsylvania). Fred ultimately became Director for Engineering and Construction for Allegheny County, and later became Director of Capital Projects and oversaw the construction of the Pittsburgh International Airport. After retiring from Allegheny County, Fred became the chief engineer of the Pennsylvania Turnpike Commission, and later, an executive in the construction firm, A&L, Inc. Upon final retirement, he worked as a private consultant and was an instructor of Civil Engineering at Carnegie Mellon University. While Fred received many awards during his influential career, none meant more to him than the William Metcalf Award for Outstanding Engineering Achievement given to him by his peers at the Engineers' Society of Western Pennsylvania in 2018.

Fred was one of the original half dozen or so founders of the International Bridge Conference®, and in fact, thirty-five years ago, Fred challenged ESWP to host a conference to rival that of any other. The Engineers Society of Western Pennsylvania obliged and the rest is history. Fred was active on many IBC subcommittees, but his achievement, which we at IBC are most appreciative of, is the recommendation and naming of the Abba G. Lichtenstein Medal, recognizing a recent outstanding achievement in bridge engineering demonstrating artistic merit and innovation in the restoration and rehabilitation of bridges of historic or engineering significance.

the editors

IBC2019 Chairman's Welcome

Steve Shanley

On behalf of the Engineers' Society of Western Pennsylvania (ESWP) and the Executive Committee of the International Bridge Conference®, we would like to welcome everyone to the 36th Annual International Bridge Conference. Once again, we will return to our Nation's Capital and to the wonderful facilities provided at the Gaylord National Resort and Convention Center. This is our fourth year hosting this prestigious conference in the D.C. area. The International Bridge Conference (IBC), is one of the most recognized conferences that provides a plethora of technical papers, workshops, and a wide range of bridge vendor exhibits.

We will start the conference off on the morning of June 10th with three special sessions that include: Construction, New Technology, and Bridge Asset Management. Following these sessions, we will move into our exciting lineup of Keynote speakers that will signal the official start of the conference and will feature:

- Roger Millar, Secretary of Transportation, Washington State DOT. Roger will provide an overview of WSDOT and their multimodal transportation system;
- Aileen Cho, Editor, Transportation, Engineering News Record, Long Beach, CA. Aileen will provide a view from her vast experience on a wide range of construction projects;
- Joey Hartmann, Director of Bridge and Structures, FHWA, Washington, DC. We are excited to get a general overview of the FHWA program and learn of any new programs or regulations that might be on the horizon.
- Greg Andricos, President / COO, of Wagman Heavy Civil, will bring a perspective from the construction side of the bridge industry.

We are honored to have Washington State DOT (WSDOT) as our Featured Agency. WSDOT manages and maintains the transportation infrastructure for the State of Washington. On Monday June 10th, WSDOT will host a Featured Agency Session that will provide an overview of some of their feature projects and their bridge asset management program. They will also be featured in a special area located in the exhibit hall. Please stop by their display to learn more about their special projects and their bridge program.

On the afternoon of Tuesday, June 11th, we will host a site tour of the Arlington Memorial Bridge, currently under construction over the Potomac River. Please make sure you register early to reserve your spot to tour this exciting National Park Service project. Those planning to attend will be picked up in National Harbor and will travel by bus to the construction site. A representative from Kiewit Infrastructure will be the tour representative and will be on hand providing narration at the construction site. You will arrive back at National Harbor in time for Tuesday night's IBC Awards Dinner.

The IBC Awards Committee has reviewed many outstanding nominations this year and selected an impressive group of winners. This includes: Dr. Karl Frank, winner of the John J. Roebling Lifetime Achievement Award. We are honored to present this award to Dr. Frank, currently an emeritus professor of Civil Engineering, University of Texas, Austin, USA. Seating at the Awards Dinner and on the Bus Tour is limited, and a separate registration fee is required for both. Be sure to sign-up early for these annual popular events.

On Wednesday, June 11th we have a full day of quality presentations. Be sure to visit the IBC Exhibit Hall one more time for lunch before the show ends! We greatly appreciate the continued support of our exhibitors and plan diligently to ensure quality time for conference goers to visit and network with our vendors. This year we anticipate having more than 125 exhibitors and the Featured Agency display in our Exhibit Hall, which will provide an excellent venue to network with others from across the bridge community. Our Exhibit Hall will host lunches on Monday, Tuesday, and Wednesday, and an evening reception on Monday. The format will once again enable our attendees to interact with exhibitors and will also allow our exhibitors to attend our technical sessions.

We would like to thank everyone who submitted abstracts from across the United States, and around the world, truly making this an international gathering of bridge experts. We feel these presentations are the heart and soul of the conference. This year, the IBC includes 80 presentations and 13 workshops. We are also excited to incorporate poster sessions this year. The posters will be displayed in a technical session that most closely relates to their topic, providing the opportunity to interact with the presenter on these projects. Another exciting first at the conference at the National Harbor will be a product demonstration area. This will provide an opportunity for vendors to display their products in a working environment.

Please join me in thanking the volunteer Executive Committee members, who have worked diligently over the past year to organize an outstanding program of technical presentations, workshops, exhibits and special sessions. We are excited to welcome four new members to our Executive Committee, Frank Russo, Ph.D., P.E.; William Detwiler, P.E., Jennifer Laning, P.E., and Liji Huang, Ph.D. If you have constructive feedback, please let any of the IBC Executive Committee or staff know so we can continue to make this one of the most recognized bridge engineering events in the United States and Internationally.

Next year we will return to where the conference originally started and was a mainstay for 30 years, Pittsburgh, PA. We hope to incorporate all our conference improvements and attendee feedback into the 37th International Bridge Conference. We thank you for your participation and we hope you agree that this is a premier conference and we hope to see you in 2020 where the Feature Agency will be Iowa DOT and Raymond Hartle will be the conference chair.

Thanks for joining us at the 36th Annual International Bridge Conference!

Stephen G. Shanley, P.E.., is the Director of Allegheny County (PA), Department of Public Works

Bridge Quiz

Can you name the bridge, the nearest city, the feature crossed, and the approximate year each photo was taken?


1
Photo Courtesy of the Library of Congress


2
Photo Courtesy of the Library of Congress


3
Photo Courtesy of the Library of Congress


4
Photo Courtesy of the Library of Congress


5
Photo Courtesy of Wiki Commons


6
Photo Courtesy of Wiki Commons

Bridge Quiz Answers:
Bridge 1: Brooklyn Bridge, New York City, NY, Spanning the East River, c. 1880
Bridge 2: Golden Gate Bridge, San Francisco, CA, Spanning San Francisco Bay, c. 1933
Bridge 3: Hell Gate Bridge, New York City, NY, Spanning the East River, c. 1916
Bridge 4: Eads Bridge, St. Louis, MO, Spanning the Mississippi River, c. 1874
Bridge 5: Manhattan Bridge, New York City, NY, Spanning the East River, c. 1909
Bridge 6: Firth Bridge, west of Edinburgh, Scotland, Spanning the Firth of Forth, c. 1890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Presented by the Pitt Energy GRID Institute &
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Lacey V. Murrow

BUILDER OF THE FIRST LAKE WASHINGTON FLOATING BRIDGE

By M. Myint Lwin

Lacey V. Murrow was a courageous and decisive Chief Engineer, and a visionary Director! After graduating in 1925, Murrow went to work full time for the Washington State Highway Department. Within a few years he was the District Engineer for the Spokane District. He was still in his 20s when Governor Clarence D. Martin appointed him Director of Highways in 1933. He was the second person to hold this title since the position was created in 1929. He took office at the height of the Depression. The Highway Department became one of the primary sources of relief work for the unemployed, and for the first time was responsible for bonded debt as a result of $10 million in emergency relief bonds enacted by the 1933 Legislature. In 1937, he also served as the Chief Engineer for the newly formed State Toll Bridge Authority. Under his leadership, many major road and bridge construction projects were completed, and a new highway code developed. His best-known accomplishment was the first Lake Washington Floating Bridge, known locally as the Mercer Island Bridge.

Murrow was born in 1904 into a Quaker farming family in Greensboro, North Carolina. He was the oldest of three sons, Lacey, Dewey and Edward, of Roscoe and Ethel Lamb Murrow. His younger brother, Dewey, was a major in the Army Corps of Engineers. His youngest brother was the pioneering broadcast journalist Edward R. Murrow. The family moved to Blanchard on Samish Bay in Skagit County, Washington, around 1909. Murrow went to high school in nearby Edison, and then to Washington State College, now Washington State University (WSU-the Cougar). He worked his way through college in a number of jobs, including cutting brush on state highways. He graduated with a B.S. degree in Civil Engineering in 1925.

Murrow enjoyed flying airplanes as a hobby. He was commissioned as a second lieutenant in the Army Reserve in 1936 and was called to active duty in 1940. He resigned as Director of Highways on September 15, 1940 and joined the Army Air Corps as a lieutenant colonel the next day. He served with the Second Air Force as a command pilot during World War II and remained in the military after the war, rising to the rank of brigadier general and receiving numerous military honors. He retired from the Air Force in 1953 and spent his last years in Arizona working for an engineering company. He was a heavy smoker. He died of lung cancer in 1966 at the age of 62.

LAKE WASHINGTON

Lake Washington is located in northwest Washington State. It is a fresh water lake, 1 to 3 miles wide, 20 miles long, and 100 to 200 feet deep. The bottom of the lake consists of soft clay and peat, extending another 100 to 200 feet deep. This material is incapable of supporting foundation loads.

Lake Washington separates Seattle from Mercer Island and other rich agricultural regions of eastern Washington State. In the early 1900s, transportation planners and engineers took the route of least resistance and built highways around the north and south ends of the lake to link the communities. These highways traversed through mountain passes and wound arduously through the foothills and around the lake. Having only slow-moving vehicles to accommodate, the curves and grades were not a major issue in the early period of highway development.

By the middle of 1930s, the demands for speed and ready access to points of interest and commerce were requiring the construction of new highways and the reconstruction of old ones to make them as broad, straight and level as possible. The highway planners and engineers were challenged to cut travel time and improve safety by overcoming the obstacles caused by Lake Washington. It was clear that a bridge was necessary to cross Lake Washington at the most strategic location. But what type of a bridge should be built?

Bridging Lake Washington became the focus of highway planners, engineers and the citizens. Several schemes to bridge Lake Washington had been proposed and advanced since the 1920s.

A fixed bridge, spanning 1.5 miles in great depths of water and soft deposits, was considered very expensive or impractical. A floating bridge of timber barges or obsolete ship hulls was proposed, but was considered to lack strength, rigidity and durability for a major highway.

HADLEY'S IDEA

Homer M. Hadley, a Seattle Engineer with the Portland Cement Association, had designed and built barges of reinforced concrete for the Navy during World War I. The service records of many concrete ships and barges built in the mid-1890s and early 1900s were providing convincing evidence that reinforced concrete was structurally strong, stable, and could be made to last in fresh and salt water. In 1920, Hadley was working for the Seattle School District and living in a home overlooking Lake Washington, when he conceived an idea of spanning the lake with a permanent bridge with reinforced concrete pontoons. His idea consisted of a series of concrete barges, joined end-to-end, with a roadway on the upper deck. He understood that the location for the bridge was an important part of project development. One Saturday afternoon he went out and walked several miles along Mount Baker Ridge and found the perfect spot for the bridge. When he proposed his idea and attempted to seek support and funding, he was faced with criticism and ridicules. His idea was considered as "not workable", "screwball", "Hadley's folly" and "concrete would become waterlogged and sink in five years". He did not give up and persisted in promoting his idea.

Opening Day Celebration, July 2, 1940

In June 1933, Hadley had a chance to present his proposal to Murrow, the Director of Highways. After the meeting with Murrow, Hadley wrote in his diary: "Lacey clicked and said to go ahead with more data ….". Perseverance paid off – Hadley's design idea was taking roots!

A BOLD INNOVATION

After accepting Hadley's design concept and route, Murrow began further studies on the feasibility of a concrete floating bridge on Lake Washington, while preparing preliminary design by his engineers at Office of the State Toll Bridge Authority. One of the studies involved a panel of engineers from the U.S. Bureau of Public Roads, Portland, Oregon, the San Francisco-Oakland Bay Bridge and members of the State Highway Department. The panel reached a unanimous opinion that the conditions at Lake Washington were uniquely favorable for a pontoon bridge, and concluded that concrete pontoons, with necessary anchors, would be most cost effective and provide the most stability under traffic and environmental loads. The State Highway Department conducted an experiment with concrete barge anchored in Lake Washington, on the proposed route, from December 1937 to March 1938. Instruments on board recorded the tension in the anchor cables, wind direction and speed, the list of the barge, and the height of the waves. This experiment provided information about the lake conditions and the possible behavior of pontoons.

The Board of Consulting Engineers approved a preliminary design in February 1938, along with a plan of financing the project by a bond issue to be retired from tolls. Meanwhile, the preparation of detailed plans and specifications was underway. The final plans included a 200-foot drawspan for navigation as required by the War Department.

A VISION REALIZED

Construction began January 1, 1939 and was completed on July 2, 1940, as a toll bridge. The construction company for the bridge project was composed of a group of individual construction companies under the name of "The Pontoon Bridge Builders" and included Puget Sound Bridge & Dredging Company of Seattle, J.H. Pomeroy & Company of San Francisco, Parker & The Schram of Portland, Oregon, and Clyde Wood of Los Angeles. Construction cost for the project, including approaches, was approximately $9 million. It was partially financed by a bond issue of $4,184,000. Tolls were removed on July 2, 1949, much earlier than planned.

The First Lake Washington Floating Bridge was formally dedicated with great fanfare on June 2, 1940. Over two thousand people gathered on the bridge to witness the cutting of ribbon, the smashing of an urn containing water from 58 streams and lakes in Washington against the side of the bridge, an army band playing for the crowds, and other festivities. The bridge was opened to traffic on July 2, 1940. A few critics donned life jackets and carried life-boat #1 on top of their cars when they crossed the bridge on opening day!

The Bridge was constructed with 25 reinforced concrete pontoons connected rigidly end-to-end to form a continuous structure. A typical pontoon measured 350 feet long, 59 feet wide, 14 feet 6 inches deep and had a water draft of 7 feet. The interior was divided into compartments with watertight bulkheads to control flooding. It was 6,620 feet long and carried 4 lanes of traffic and 2 sidewalks. It had a 200-foot drawspan for the passage of large vessels. The area of the drawspan had been the site of many traffic accidents, because of the horizontally curved roadway geometry made necessary by the drawspan. The drawspan was replaced with a straight and fixed span in 1981 to improve safety. Since then large vessels had been by-passing the floating bridge and went under a high-level bridge constructed over the east channel of the lake. The bridge served the communities very well for half a century. (See the "Footnote" below for more information.)

CLOSING REMARKS

Lacey V. Murrow was a visionary and courageous Chief Engineer, a creative and decisive Director of Highways, and a brave and decorated Command Pilot. His civilian service contributed to swift, safe and comfortable transportation in Washington State. His military service brought victory to our country and peace throughout the world. The Washington State Legislature passed a resolution to rename the First Lake Washington Floating in his honor. On March 1967, the bridge was officially renamed as "The Lacey V. Murrow Memorial Bridge"!

The bridge resulted in great savings in distance, time, energy and operating costs to more than a million vehicles annually. Traffic on the bridge was increasing at a very fast pace. The bridge also brought growth and prosperity to communities on both sides of Lake Washington.

Readers are invited to visit Seattle, Washington, to experience the exciting feeling of driving on floating bridges and enjoy other beauties of the Pacific Northwest!

Footnote: The 1940 Lacey V. Murrow Memorial Bridge served the communities very well for half a century! Over the years, traffic on the bridge increased greatly, far exceeding the capacity of the 4-lane bridge. In June 1989 the bridge was closed to traffic for renovation. The renovation would upgrade the bridge to modern standards for a 3-lane one-way eastbound bridge with shoulders. The plan was to remove the existing sidewalks and rebuild with cantilevers to widen the deck for 3 traffic lanes and 2 standard shoulders. During demolishing of the sidewalks, strong winds and heavy rains blasted the construction site throughout the Thanksgiving weekend in November 1990. The rainstorm caused water to fill portions of the pontoon under sidewalk removal, resulting in sinking of 8 pontoons, each 350 feet long. A renovation project turned into a bridge replacement project. The construction of the replacement floating bridge started in January 1992. High performance concrete containing silica fume and fly ash was used in the pontoons for high strength, impermeability and durability. The new Lacey V. Murrow Memorial bridge, carrying 3 lanes one-way eastbound traffic, was completed and opened to traffic on September 12, 1993.

About the author...

M. Myint Lwin is currently an independent consultant with special interest and services in engineering education and training, QC/QA assessment, constructability and peer reviews of bridge projects. He is the former Director of the Office of Bridge Technology, Federal Highway Administration (FHWA). He was the State Bridge and Structures Engineer with the Washington State Department of Transportation (WSDOT). He was an adjunct lecturer in Civil Engineering Department, St. Martin University, Lacey, WA. He is a Guest Professor of Chang'An University, Sichuan, China. He conducts training internationally in LRFD Bridge Design, Construction, Inspection, Maintenance and Preservation.

He holds a BSCE degree from the University of Yangon, Myanmar, and holds an MSCE degree from the University of Washington, Seattle, WA. He is a registered Professor Engineer in Civil and Structural Engineering, the 2013 IBC John A. Roebling Medal recipient, and a Life Member of ASCE. He has authored/coauthored numerous papers and books in structural and bridge engineering

Editor's Note: Myint Lwin led the design team and provided construction support in the replacement of the Lacey V. Murrow Bridge. He was recognized by the Engineering News-Record Magazine as one of "Those Who Made Marks" in the construction industry in 1993 for his contributions in the design and construction of the replacement bridge.

The Intersecting Legacies of Roebling & Cooper and the Allegheny River Crossing

By Thomas Leech and Linda Kaplan

There are many famous bridge luminaries of the nineteenth century. Among them are John Roebling, the noted engineer of the Brooklyn Bridge, and Theodore Cooper, who is best known for standardized railroad loading. Their legacies intersected in a unique way in Pittsburgh in the early 1890s.

> "… the wire is in as good condition as new, … the anchorages are so thoroughly protected that they are good for at least one hundred years …"
>
> *...J. H. Hildebrand, 1888*

Joel Henry Hildebrand was employed to examine the cable and anchorages of John Roebling's, third and last Pittsburgh Bridge, the iconic Allegheny River Suspension Bridge, connecting the City of Allegheny (presently the North Side) with the downtown business district at the site of the present day Sixth Street Bridge. The graceful bridge was punctuated with cast iron towers with parabolic suspension cables and stay cables radiating from each of the towers. In 1888, Hildebrand foresaw a limitless future for this bridge with such beautiful and graceful lines.

Within two years, a quantum shift in technology took place – the electric street car came into use, and this beautiful, but light and flexible bridge crossing could not capably support the heavier vehicles, and its lifetime, a mere thirty years, came quickly to an end.

> "… the Allegheny Suspension Bridge was long noted as the most beautiful and graceful in its lines …"
>
> *...W. G. Wilkins, 1895, looking back in time.*

In 1890, electric street-cars came to Pittsburgh. Sixth Street (former St. Clair Street) was the main thoroughfare between the business districts of Pittsburgh and the City of Allegheny. Tracks were laid on the Roebling Suspension Bridge with unsatisfactory results. Horse drawn wagons, plodding across the bridge, were slowing down the "rapid transit" and vibrations and deflections from the electric street-cars were a concern. The bridge toll owners determined that a replacement bridge was necessary and devised a scheme to construct the new bridge around the suspension bridge so that both pedestrians and electric street-car traffic could continue without interruption.

Design for the new bridge was tasked to Theodore Cooper, a renowned bridge engineer, who had personally served as the chief inspector of construction on the Eads Bridge over the Mississippi River. Cooper proportioned an elegant bow string truss with a design based on his own "1890 Highway Bridge Specifications". His 'specifications', which prescribed design loadings and permissible unit strains (stresses), represented a leap forward in rational bridge design.

> " … The most perfect system of rules to insure success must be interpreted upon the broad ground of professional intelligence and common sense …"
>
> *...Theodore Cooper*

Cooper designed a two-span simply supported, bowstring truss bridge to span the Allegheny. To meet the objective of maintaining continuous street-car traffic, the following novel construction approach was followed.

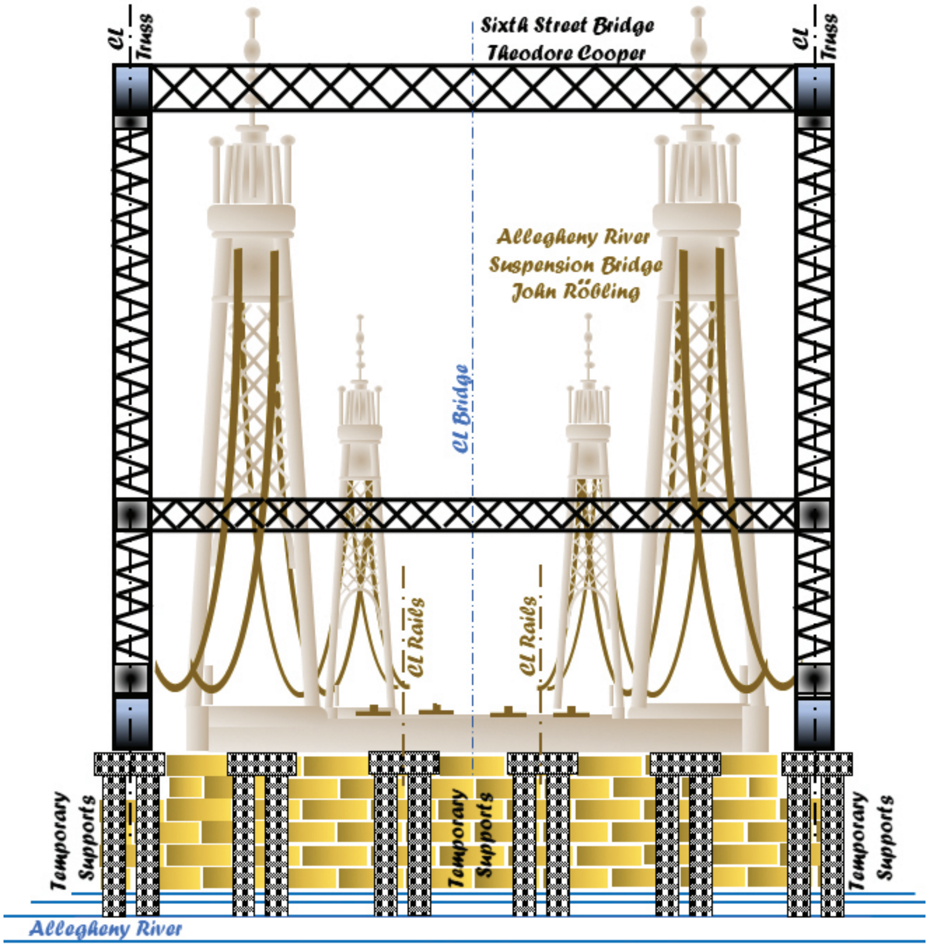
- The mid-stream river pier was aligned with the existing piers on the Union Bridge, at the Point, and Lindenthal's Seventh Street Bridge. Survey work, to determine a precise pier location of the pier, was conducted at 4:00 in the morning so as not to interfere with the street-cars.
- The stone river pier was built on a heavy timber grillage founded on a thick stratum of glacial gravel within the river bed – a common construction method of the day.
- Eight hundred piles were driven to erect a temporary wooden trestle extending across the entire width of the river (except for one small location to allow steamboat passage).
- The deck of the old suspension bridge was placed on blocks and fully supported by the timber trestle.
- Two additional wooded pile trestles were built on either side of the suspension bridge to support a large erection gantry which would hoist and temporarily support each new steel truss, each extending over 70 feet above the bridge deck at mid-span.
- The large erection gantries - taller than the highest point on the bowstring truss – erected the new, two span truss bridge, one span at a time. Remarkably, it only took 8 days to fully erect one complete truss span. The plan was successful – the total lost time to street-cars over the course of erection of the new bridge was three hours.

After Cooper's new bridge was opened to traffic, the old

Allegheny Suspension Bridge, Roebling's third and last bridge treasure in Pittsburgh, was dismantled. Then the street-car tracks were raised to final elevation by hydraulic jacks and blocked into position.

The elegant bowstring truss remained a toll bridge until 1911 when the County of Allegheny obtained ownership. In 1927, the two bowstring truss spans were 'recycled' – to make way for a new river crossing. The truss spans were floated four miles downstream to a new home and became the bridge to Coraopolis over the back channel of the Ohio River.

Theodore Cooper developed and published the first General Specifications for Iron Railroad Bridges and Viaducts in 1884. Engineering News Record, a major industry publication, call it the "first authoritative specification on bridge construction that had been published and circulated." Cooper then published the Specifications for Highway Bridges in 1890, and re-issued it with updates in 1896, 1901, and 1906.



Construction Illustration, c. 1891

These specifications were the basis of many more editions to come, leading up to present day bridge codes. Railroad bridge codes show Cooper's legacy best, as train loads are still referred to as "Cooper-E" loading with numeric designations for weight. When Theodore Cooper passed away in 1919, he had spent over 40 years as a bridge engineer. The obituary in the New York Times referred to him as a "Builder of Great Bridges".

Pittsburgh's 6th Street Bridge over the Allegheny River was one of them – the editors

About the authors...

Tom Leech and Linda Kaplan are co-authors of the book: "Bridges ... Pittsburgh at the Point ... A Journey through History", Word Association Publishers, see facebook.com/BridgesPittsburgh. This article is based on some of the many interesting historical anecdotes presented in their book. Tom is the retired Chief Engineer, Bridges and Structures of Gannett Fleming, Inc. and presently instructor of Civil Engineering at Carnegie Mellon University. Linda is a bridge engineer working in Pittsburgh. She serves on the ASCE & SEI National committees for Aesthetics in Design and Steel Bridges.

Allegheny River Suspension Bridge (1859)
Photo Courtesy of Carnegie Library

Allegheny River Suspension Bridge (1892)
Photo Courtesy of Carnegie Library

The Governor Mario M. Cuomo Bridge:

A Photographic Essay

By Ken Wright

The Governor Mario M. Cuomo Bridge replaces the former Tappan Zee Bridge over the Hudson River (New York State) with two parallel bridges. The project was delivered under a design-build contract. The challenges of building a long structure over the water, as well as the contractor's (Tappan Zee Constructors, LLC) access to large equipment, led to significant innovation in using multiple precast elements.

Additionally, many of the steel components were assembled off-site. The amount of pre-casting and preassembly shifted a significant portion of the fabrication onto land, improving both schedule and safety of the construction. The innovations incorporated into the project are a testament to the benefits of designer-contractor interaction during design development, as well as conceiving details that push the envelope past conventional construction methods.

Photo 1: Lowering of the suspended span portion of the old truss over the navigation span via strand jacks.

Photo 2: Cable stayed towers with blue jump forms providing a protected work area for each concrete lift in the tower legs.

Photo 3: Westbound balanced cantilever cable-stayed construction with WB towers complete.

Photo 4: Westbound structure immediately prior to installation of the closure placement.

Photo 5: Bottom Slab for cable-stayed tower pile cap with first wall form in place on the left side.

Photo 6: Pier precast pile tub with rebars placed to anchor piles into the pile cap.

Photo 7: Placement of the first of multiple lifts of pier concrete, placed to avoid mass concrete/thermal issues.

Photo 8: View looking west; approach piers are completed and awaiting erection of the steel girders.

Photo 9: Approach pier precast pile tub being set in place over previously driven pipe piles.

Photo 10: Lifting precast pier cap into place, with access catwalks attached to the side of the cap.

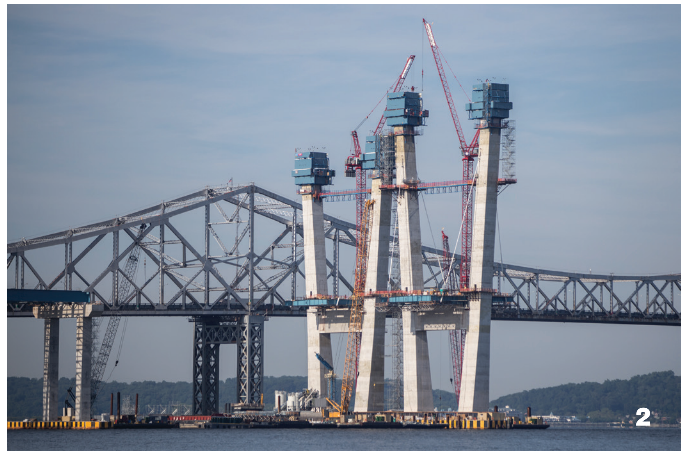
Photo 11: Large crane, with spreader frame, placing 350-foot, 3-girder frame onto the piers.

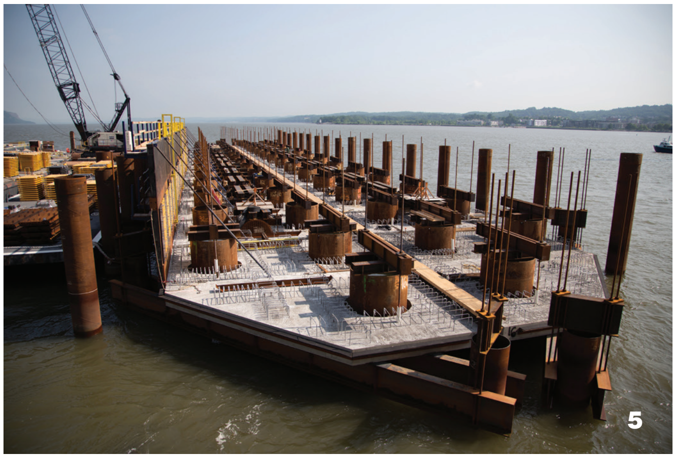
Photo 12: Eight-point lift, lowering half width precast deck panel into position on approach span.

Photo 13: Explosive demolition of the existing piers to drop the east anchor span into the river.

About the author...
Kenneth J. Wright, P.E. was the Design Manager for the Governor Mario M. Cuomo Bridge. He is a Principal Bridge Engineer with HDR, Inc., and a member of the IBC Executive Committee.

All photographs are courtesy of the New York State Thruway Authority

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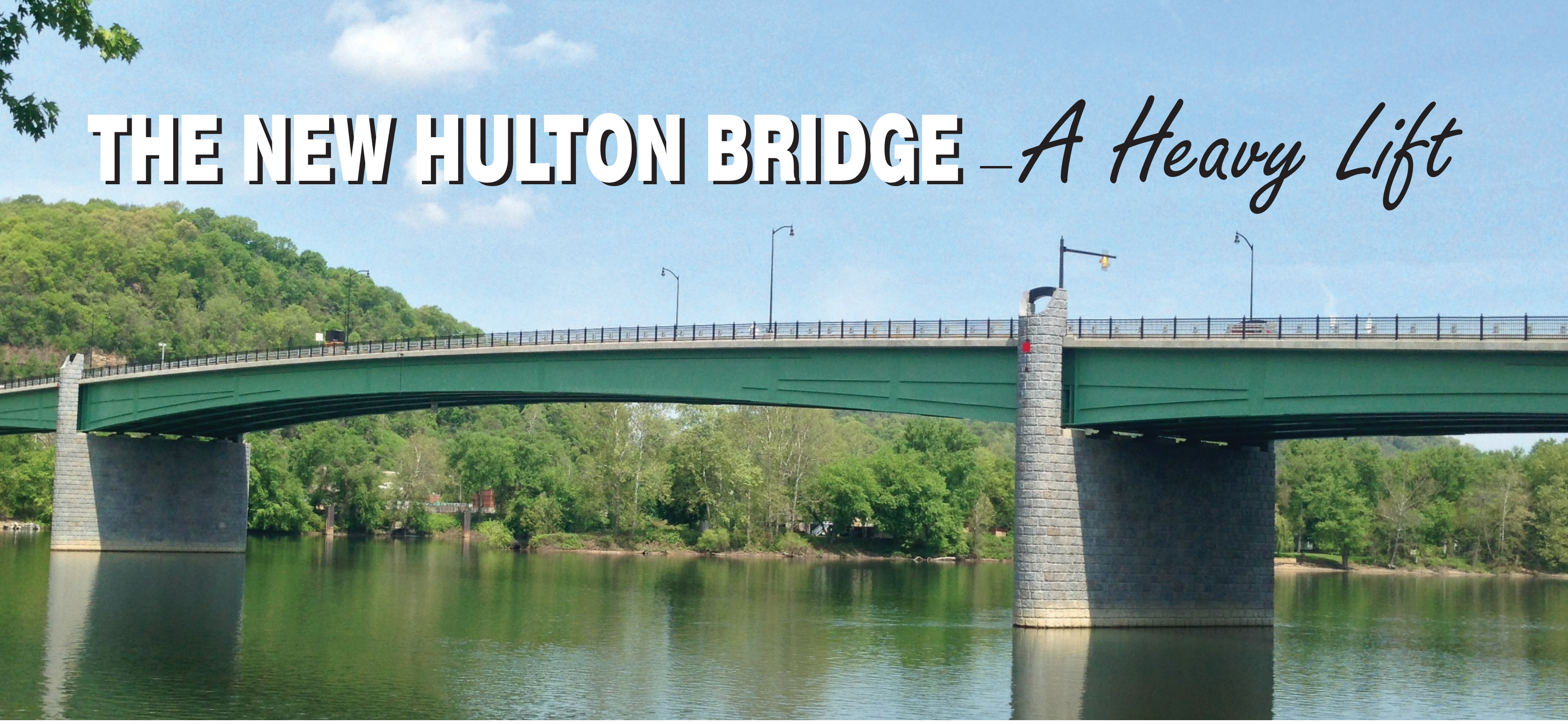


THE NEW HULTON BRIDGE – *A Heavy Lift*

By: Christopher Vollmer

The new Hulton Bridge, which replaces the original 1908 Jonathon Hulton Parker through truss, is owned by the Pennsylvania Department of Transportation (PennDOT), Engineering District 11. The four-lane main structure consists of a 4-span continuous steel haunched plate girder spanning the Allegheny River with spans of 274-ft., 479-ft. (Back Channel), 500-ft. (Navigational Channel) and 275-ft and girder depths that vary from 10-feet at midspan to 20-feet at the interior supports. The 1,633-ft long structure, located 14 miles upstream from the Point at Pittsburgh, was completed in the fall of 2016 to improve traffic flow across the river and upgrade the deteriorating structure with a bridge that will last at least another 100 years.

Challenges regarding constructability of such a large structure spanning navigable waters were inevitable

Challenges regarding constructability of such a large structure spanning navigable waters were inevitable and many of these challenges focused around accommodating multiple modes of transportation within the work site. In addition to the typical roadway traffic concerns it was equally as important that the navigational channel remain open for the duration of construction with only minor exceptions. The exceptions included restrictions such as the following:

- No temporary towers were permitted within the navigational channel at any time
- A 375-ft. channel had to be maintained during construction to accommodate commercial river traffic except for short-term closures
- An 18-hour maximum closure window was permitted for erection of the main channel superstructure.

With these restrictions in mind, the design team developed a detailed Conceptual Erection Plan which proposed the use of strand jacks to erect the 1200-ton, 280-ft. field section over the navigational channel, the last and most critical stage of erection. In designing for the constructability of this section the steel details accommodated this technique by purposely locating the field splices, coinciding with the ends of the lift span, at precisely the steel dead load contraflexure points. With the splices so positioned, the cantilevered ends of the girders, during the lift, rotate to the same orientation as the cambered ends of the lift span. This minimized the need for external adjustments during the most critical stage of erection with only the remaining adjustment for fit being a compensating effect for the weight of the lift apparatus, not otherwise included in the conceptual design. Additionally, oversize holes were detailed at the lift span closure splice locations for fit-up flexibility. This purposeful location of the field splices, consistent with the planned erection technique, resulted in a non-uniform cross frame layout, which is generally not preferred; however, the benefits of a fluid erection outweighed simplicity of cross frame detailing.

Strand Jacking Apparatus

The construction team further refined the conceptual approach by engineering details which included temporary jacking stiffeners under the reaction beams, Skid Track systems to facilitate lateral adjustments and a longitudinal jacking system for accommodating contraction of the structural steel due to the extremely cold erection temperatures (10° F).

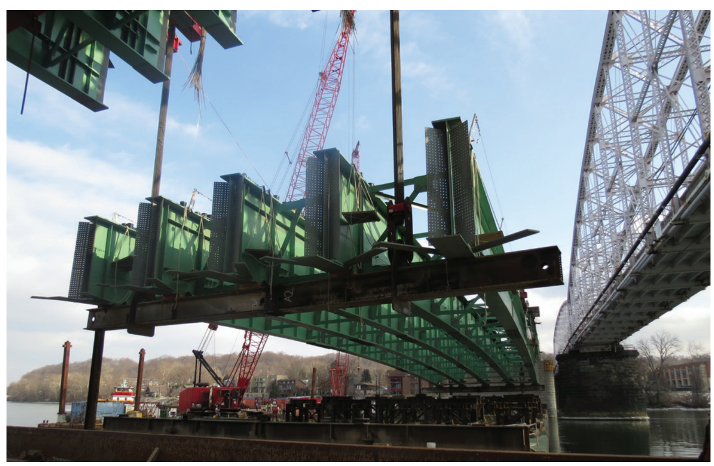
Over several weeks prior to the closure of the navigational channel the contractor was able to fully erect the lift span on barges in the back channel. In addition, the lift apparatus was installed on the erected superstructure which included the reaction beams and the four 600-ton capacity hydraulic jacks with 36 strand wires per jack. Once the closure was implemented, the lift span was floated into position the evening prior and strands were connected to the W40x362 lift beams.

Lift Span Elevation

The lift began early the next day and proceeded systematically over the next 12 hours with intermittent survey to verify the opening and alignment. Once the lift was in position the requirement was to secure the connections with a minimum of 25% of the required 10,000 bolts, in order to support the dead load, remove the barge within the navigational channel and leave unattended. The jacks were then removed once 50% of the bolts were in place.

This innovative strand jacking approach, the first ever for a steel girder bridge in Pennsylvania, allowed the erection of the main span to be completed within the allotted timeframe.

Lift Span Moving into Position



Lift Span going up

The New Hulton Bridge
Owner: PennDOT, District 11
Designer: Gannett Fleming, Inc.
General Contractor: Brayman Construction
Specialty Lift Contractor: Mammoet
Construction Engineer: HDR

About the author...
Christopher Vollmer, P.E., PMP is the Bridge Department Manager for Gannett Fleming, Inc. in Pittsburgh, PA. Chris graduated from Youngstown State University in 1997 and has 22 years of experience in the design, rehabilitation, inspection, and construction of complex bridges and other structures across the country.

Utah's ABC Program

By Carmen Swanwick

INTRODUCTION

Moving innovation into practice takes commitment, patience, passion and motivation. With any new innovation or technology, it is important to understand the benefits and challenges, commit to a direction and strategize a plan toward implementation. The Utah Department of Transportation (Department) established an Accelerated Bridge Construction (ABC) Program through committing to a strong program direction, implementing technologies, developing a strategy and tools, employing technologies into practice, establishing public outreach activities, documenting lessons learned and performing evaluations. This commitment starts in planning, moves to design and construction and finally into bridge asset management.

WHY ABC WAS IMPLEMENTED IN UTAH

In the past, construction strategies have largely been evaluated based on the costs of materials and labor. However, Utah's highway users no longer prefer lowest cost construction strategies, and therefore the way in which projects were evaluated and selected had to change to respond to the public needs. Since Utah's highway users highly value their time, and since user costs are real costs incurred to the public, project cost evaluations must also consider the time of the highway users. The Department aggressively pursued bridge construction strategies that limit impacts to Utah's roadway users. ABC advantages include improved work zone and worker safety along with public safety, reduced on-site construction time, minimized traffic disruption, reduced environmental impacts, and improved product quality from working within a controlled environment and ease of access.

PROGRAM OF ABC WORK

The Department evaluated the ABC components as defined by the Federal Highway Administration (FHWA) and selected specific ABC components within each area to move into implementation. The ABC components and technologies moved to implementation include:

- Foundation and wall elements: geosynthetic reinforced soil (GRS) and integrated bridge system (IBS).
- Rapid Embankment Construction: geofoam.
- Prefabricated Bridge Elements and Systems: prefabricated superstructure and substructure elements; prefabricated superstructure and substructure systems.
- Structural Placement Methods: self-propelled modular transporters (SPMTs); longitudinal launching; horizontal sliding; heavy lifting equipment.
- Fast Track Contracting: innovative contracting; best value; construction manager/general contractor (CMGC); design-build, price plus time bidding.

During the initial implementation the Department started with a pilot project that was very prescriptive on the requirements. Then a program of projects was created based on both prescriptive and performance-based requirements. The prescriptive projects typically used the design bid build or construction manager/general contractor (CMGC) contracting methods which enabled the Department to gain experience with ABC because goals of the projects were clearly defined.

Performance based projects employed the design build contracting method. These projects accelerated the ABC program because contractors initiated the innovations to meet the required limitations of the contract.

All projects that consist of structure work are required to consider ABC as an option. For ABC projects designers need to verify that there is a viable construction approach to the project but the contract specifications place responsibility for means and methods on the contractor. As such the contractor typically involves the construction engineer early on in the project.

PROJECTS

Hoytsville Road over I-80, Wanship, Utah; Prefabricated Elements; Design Bid Build

The Hoytsville Road over I-80 project was a deck replacement project that used full depth precast prefabricated deck panels with cast-in-place closure joints and was also the pilot project for Utah. The design was completed internally in 2002 with construction in 2003. The limitations of operations required the contractor to have the bridge open to traffic in seven days and the contractor did receive the full incentive on the project. Areas of improvement for design included placement of lifting devices, demolition limitations and closure joint layout and sealing above the girders. Areas of improvement for construction included understanding the limitation of operations and staffing requirements for a rapid project.

I-215 over 3760 South, Salt Lake City, Utah; Prefabricated Systems; Design Bid Build

The I-215 over 3760 South project was a bridge replacement that incorporated prefabricated superstructure systems and was also the second ABC project completed. The design was completed internally in 2002 with construction in 2003. The substructure was constructed under the existing bridge and the prefabricated superstructure elements were placed and post-tensioned transversely. Areas of improvement for design include managing tolerances for match cast sections and alignment for post-tensioning ducts. Areas of improvement for construction include planning the staging area and crane placement within the lifting area.

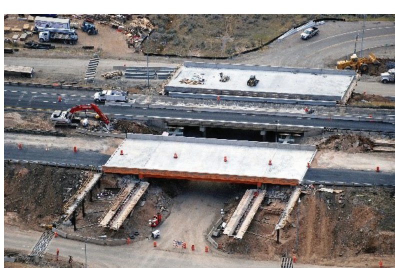
4500 South over I-215, Salt Lake City, Utah; SPMT; CMGC

The 4500 South over I-215 Bridge was the first bridge moved into place using self-propelled modular transporters (SPMTs). The existing spans were removed and the new span placed in one weekend. Removing the existing spans took seven hours and the placement of the new span took eight hours. The Department was strategic in its messaging plan and communication to the public. Extensive animation was prepared and presented to describe the project. Over 10,000 people attended the bridge move event along with numerous state and Federal Highway officials. Areas of improvement include defining roles and responsibilities clearly in the contracting process, plan for more time in design, and schedule adequate time for construction activities.

I-80 at Lambs Canyon and Mountain Dell, Salt Lake City, Utah; SPMT; Design Build

I-80 is a heavily travelled interstate with over 30,000 vehicles per day and mountain grades of approximately 6%. The project contracting method was design build and the project scope was to replace four bridge decks. Road closures were limited to 16 hours for a full directional closure but two – 24- hour closures were negotiated as the contractor proposed full superstructure replacements rather than deck replacements. The contractor was able to complete the initial bridge superstructure moves in 22 hours while the second set of bridge moves took 16 hours. Areas of improvement include verifying survey at all stages of the project and planning for tolerances within construction.

I-80; Two Bridges near Echo Junction, Echo, Utah; I-80 over 2300 East, Salt Lake City, Utah; Bridge Slide; Design Build (Low Bid)



This project consisted of replacing four three-span bridges on I-80. The decision was made to use the design build contracting method to benefit from contractor innovation. The permitted closure time per bridge was 16 hours. The Department imposed incentives and disincentives of $7,500 per 15 minutes with a maximum incentive of $150,000. The first set of bridges replaced two bridges near Echo Junction on I-80. The second set of bridges replaced two bridges on I-80 in Salt Lake City. The contractor constructed the substructure elements within the existing bridge footprint and the superstructures were built on the side. Teflon pads and a hydraulic system were used to slide the bridges into place. This project was the first in which the approach slabs were slid in along with the main span. The project took five months total – from award to completion.

I-80; State Street to 1300 East, Salt Lake City, Utah; SPMT; CMGC

This project is on I-80 in one of the busiest areas of Salt Lake City. Seven bridges were transported from the "bridge farm" to their permanent location. Due to the proximity and the schedule of bridge placements, bridges were driven over bridges. The first bridge-move and placement took 30 hours and its location was closest to the "bridge farm". The last bridge took 6 hours to place and was furthest from the staging area. This shows the learning curve for the contractor and their improvement with each bridge move.

I-70 over Eagle Canyon, San Rafael Swell, Utah; Prefabricated Elements; CMGC

The Eagle Canyon Bridge is a signature structure for the Department and was in need of a deck replacement. The bridge is approximately 500 feet long. A contractor was brought on board using the CMGC contracting method to provide innovation for the deck replacement along with a maintenance of traffic plan through the area. During the bridge analysis, it was determined that a crane could not be placed on the bridge. The contractor had to use a 600-ton crawler with a 335 foot boom section with a one million pound counter weight. The longest panel set, 275 feet in length, weighed 66,000 pounds. The construction project was completed in five months with only 30 days of traffic closure to place the panels.

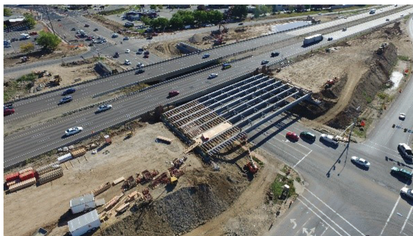
Sam White Lane over I-15, Provo, Utah; Self-propelled Modular Transporter (SPMT); Design Build

The bridge is a two-span steel plate girder structure with a lightweight concrete deck. This is the second two span bridge moved into place with SPMTs. The total length of the bridge along the control line is 354 feet and due the high skew of the bridge the length of the bridge from acute corner to acute corner is approximately 440 feet. The bridge was constructed approximately 300 feet from the final location. The SPMT system used a gravity connection to the bridge. Four lines of SPMT supports were used (two lines per span). Stability was provided by large pipe braces. Monitoring and contingency plans were developed prior to the bridge move and were observed throughout the move.

South Layton Interchange, South Layton, Utah; Longitudinal Launch; Design Build

The South Layton Interchange design build project was originally scoped to move the bridge spans into place using SPMTs but the geometry was too complicated. The contractor then decided to launch the superstructures out over I-15. The two main spans were constructed over the embankment fill, lowered and then launched out to the center bent of the interstate. This required only two directional full closures of I-15.

I-15 over Hillfield Road, Layton, Utah; Bridge Slide; Design Build



The Hillfield Road interchange modification project was advertised as a design build to promote innovative methods of bridge replacement and optimization of structure type. The design build team proposed a 180-ft single span steel bridge using the ABC method of sliding the bridges into place. Three lanes of I-15 traffic were maintained in each direction throughout the replacement by using the southbound bridge as a shoofly structure during the intermediate phase. Each bridge was constructed offline and slid into place using prestressing stands and climbing jacks.

LESSONS LEARNED

The Department continually performs program reviews along with technical project reviews. Program deficiencies and successes are documented and corrective measures are initiated to address deficiencies. Ultimately, the Department reviews decisions and measures initial assumptions against reality. Refer to the Department website for programmatic and project specific lessons learned reports.

CONCLUSION

In the pursuit to improve safety, reduce on-site construction time, minimize impacts to the public and improve quality, the Department, design consultants, fabricators and contractors work closely together to deliver a large program of projects as part of the ABC program. Through open communication and striving for improvement through innovation and advancing technologies and materials the Department continually evolves business practices. The Department increases public support, minimizes societal costs and gains political capital through this approach.

About the author...

Carmen Swanwick is the UDOT Region 2 Deputy Director and served as the Department's Chief Structural Engineer for 10 years and has over 15 years of experience as a consultant. Carmen has been involved in several Department initiatives through the years.

INTERSTATE 78 BRIDGE UNDERCLEARANCE PROJECT

By Chistopher Kufro and Brian Brawand

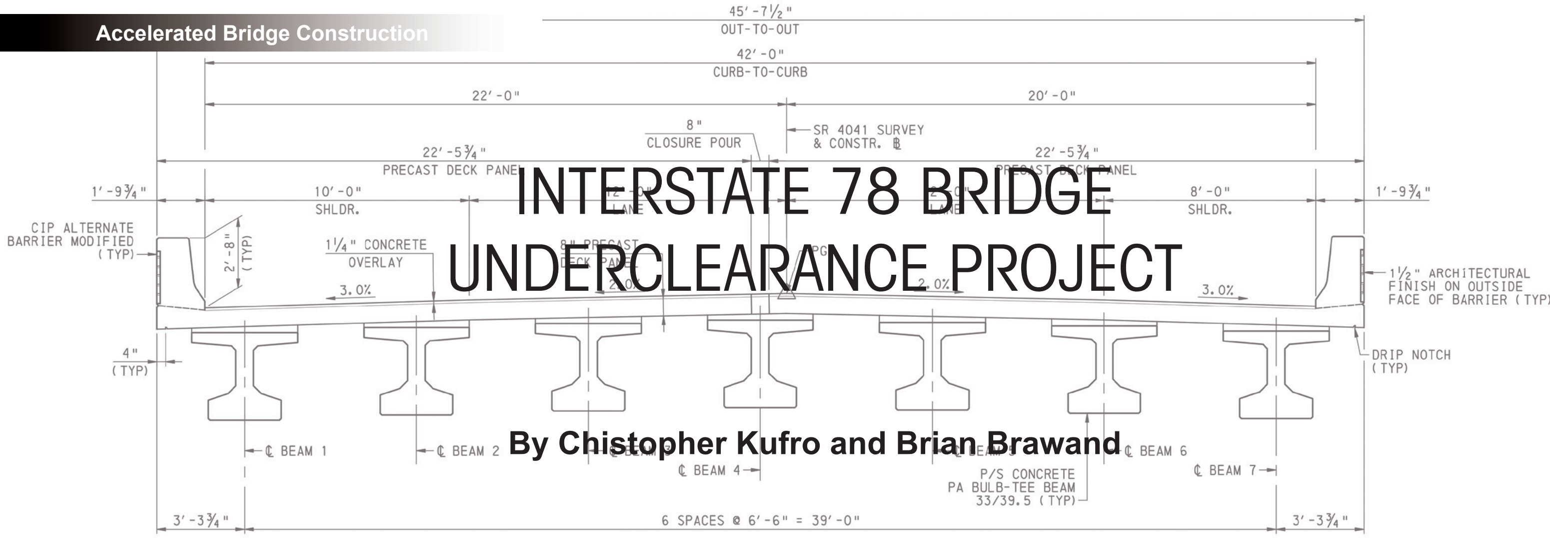


Figure 1: SR 4041 Superstructure Typical Section

PROJECT BACKGROUND

The Pennsylvania Department of Transportation (PennDOT) District 5-0 recently replaced six overhead bridges, located consecutively along an eight mile stretch of Interstate 78 in western Berks County, Pennsylvania. This project utilized accelerated bridge construction (ABC) techniques featuring the first implementation of full height precast concrete cantilever abutments for PennDOT. The project's bridge design team was comprised of Alfred Benesch & Company, Allentown, PA (engineer of record for two bridges), Johnson Mirmiran & Thompson, Allentown, PA (engineer of record for two bridges), Erdman Anthony, Mechanicsburg, PA (engineer of record for one bridge) and AECOM, Conshohocken, PA (engineer of record for one bridge). The bridges were replaced to increase the minimum vertical clearance over Interstate 78 from approximately 14'-0" to 16'-6" and to accommodate future Interstate 78 widening. As part of the project, the approach roadways and ramps (where applicable) were reconstructed to accommodate roadway profile and width modifications.

All six replacement bridges consisted of single span precast, prestressed concrete bulb-tee beam bridges that included aesthetic features such as an architectural finish and color scheme. The substructure typically consisted of full height cantilever abutments supported on spread footings (one structure was supported on pile foundations). The use of ABC techniques under roadway closures reduced the average construction duration for each structure from a year to 45 calendar days. ABC techniques utilized on the project included time-based bidding techniques and prefabricated bridge elements. Prefabricated bridge elements utilized included precast concrete footings, stems, pedestals, back walls, deck panels, approach slabs, sleeper slabs and moment slabs.

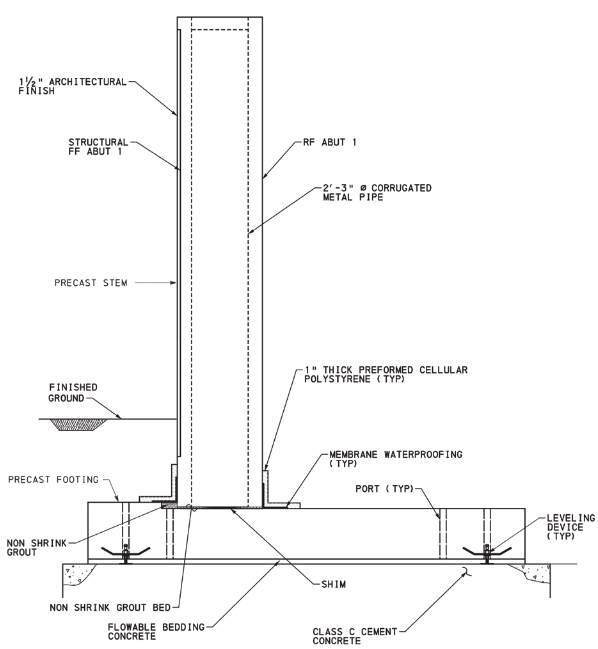


Figure 2: SR 183 Precast Abutment Typical Section

HRI, Inc. (State College, PA) was the winning contractor on the project and constructed three bridges sequentially in both the 2016 and 2017 construction season. Table 1 provides an overview of the six replacement bridges highlighting the span lengths, widths, skews, number of precast pieces and number of days for construction at each bridge location, as well as, noting if the bridge was located at an interchange.

Table 1

Bridge	Span Length	Width	Skew	Interchange Location	Number of Precast Pieces	No. of Days for Construction
SR 0183	121'	53'	17°	Yes	126	40
SR 0419	133'	50'	30°	Yes	146	58
SR 4011	111'	58'	15°	Yes	88	40
SR 4041	115'	46'	None	Yes	86	44
SR 4043	103'	32'	None	No	54	37
SR 4045	104'	32'	None	No	40	40

TIME BASED BIDDING APPROACH

After considering the available options, the project team elected to apply an A+Bx time based bidding approach to this project. There were six separate A+Bx bidding items as part of the project, one for each bridge. The A component was the dollar amount proposed by the bidder for construction of a structure. The Bx component was the number of days for roadway closure proposed by the bidder multiplied by a Road User Liquidated Damages (RULD's) value calculated by the project team for a given location. The RULD's value was based on the Average Daily Traffic at each structure and the associated detour length. The time based bidding approach allowed a significant value to be placed on the time component of the bid, as well as, dictate the sequential order required for construction of the bridges.

PREFABRICATED BRIDGE ELEMENTS

PennSTRESS (Roaring Spring, PA) was the pre-casting fabricator utilized on the project which included the use of over 500 prefabricated bridge elements. The precast concrete footing and stem pieces were the largest prefabricated bridge elements utilized on the project. The precast concrete footing pieces were up to 2'-9"' thick, 18'-6" long and 14'-6" wide. The precast concrete stem pieces were up to 3'-6" thick, 30'-0" tall and 12'-0" wide. The weight of all precast concrete pieces were limited to 50 tons. On two of the bridges, corrugated metal pipes were used to form voids within the stem piece to reduce the piece weight and meet the 50-ton requirement. After erection, concrete was placed to fill the voids. Some of the substructure prefabricated element connections or concepts utilized included overlapping or staggering of the precast concrete stem and footing joints, grouted splice couplers for the precast footing to stem connections and grouted shear keys between adjacent precast footing and stem pieces.

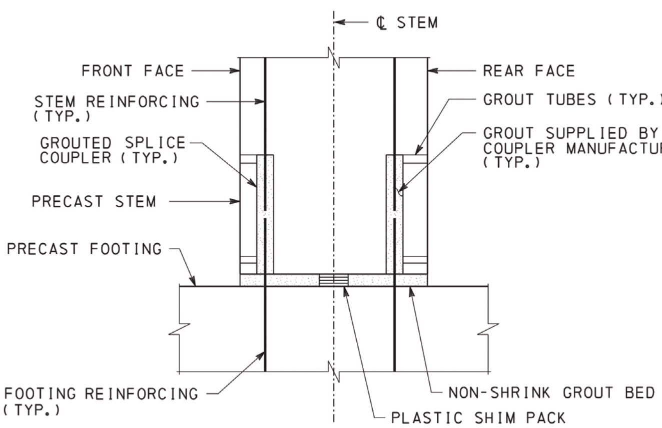


Figure 3: Grouted Splice Coupler Connection Detail

The precast concrete deck panel pieces were typically 8" thick and kept to less than 14' wide to facilitate shipping. The six bridges had significantly different bridge widths; therefore some bridges utilized precast concrete deck panel pieces that extended across the full bridge width while others utilized two or three precast concrete deck panel pieces to extend across the full bridge width. Some of the superstructure prefabricated element connections or concepts utilized included precast concrete deck panel block-outs for the panel to beam connection, longitudinal closure pours with ultra-high performance concrete (UHPC), transverse joints with shear keys and longitudinal post-tensioning of the precast concrete deck panels.

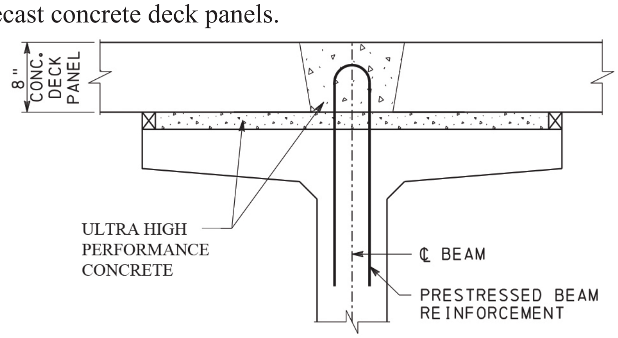


Figure 4: Precast Concrete Deck Panel to Beam Connection Detail

DRY FIT PROCEDURE

The fabrication of the prefabricated bridge elements required tight tolerances so there would not be any fit up issues between elements during construction. Therefore, a dry fit procedure completed at the fabricator's storage yard was required for the project, given the accelerated nature of the project and minimal tolerances permitted by some of the prefabricated bridge element connections. These connections included the grouted splice coupler connections between the precast concrete footing and stem pieces and the connection between the precast concrete beams and deck panels.

The substructure dry fit was completed by initially placing all of the precast concrete footing pieces for one abutment in place.

SR 183 Substructure Dry Fit

Individual precast concrete stem pieces were lifted horizontally to a sand bed staging area to allow for the stem piece tilt up procedure. The precast concrete stem piece was lifted vertically, brought to the footing area and lowered into place ensuring proper fit up. The stem piece was removed and each additional stem piece subsequently checked for fit up. The superstructure dry fit was completed by initially placing all, or a portion of, the precast concrete beams for a structure into place. The precast concrete deck panel pieces were lifted and placed onto the beams ensuring proper fit up.

SR 4045 Precast Stem Erection

DEMOLITION AND CONSTRUCTION

The demolition of the existing three span bridge end spans and abutments was completed during normal work hours. The demolition of the center span over Interstate 78 was completed at night protecting the roadway below with timber mats. Traffic on Interstate 78 was maintained, depending on the specific bridge location, with the use of a ramp around or detour route. The piers, adjacent to the Interstate 78 shoulders, were removed with the use of protective shielding.

The major construction activities required for substructure construction included:

1. Precast Concrete Footings:
    a. Placement of subfoundation concrete
    b. Placement of shims to the proper elevation
    c. Erection of the precast concrete footing pieces
    d. Placement of flowable concrete underneath the footing
    e. Placement of grout in the transverse joints between adjacent footing pieces
2. Precast Concrete Stems:
    a. Placement of shims to the proper elevation
    b. Placement of grout on top of the footing
    c. Erection of the precast concrete stem pieces
    d. Installation of temporary bracing
    e. Injection of grout in the splice couplers
    f. Placement of grout in the transverse joints between adjacent stem pieces

Precast concrete beam and deck panel erection was completed at night and Interstate 78 traffic was maintained, depending on the specific bridge location, with the use of a ramp around or temporary 15 minute closures of Interstate 78.

The major construction activities required for precast concrete deck panel construction included:

1. Erection of the precast concrete deck panels
2. Placement UHPC in the transverse joints
3. Tensioning and grouting of longitudinal post-tensioning
4. Placement of UHPC in the composite reinforcement block outs, haunches, post- tensioning anchor block outs and longitudinal closure pours

The following major construction activities typically completed bridge construction:

1. Precast concrete sleeper slab and approach slab construction
2. Cast in place concrete parapet construction
3. Milling and placement of the latex modified concrete overlay

SR 4011 Constructed Bridge/Interchange Aerial View

CONCLUSION

The Interstate 78 Bridge Underclearance Project was a successful PennDOT District 5-0 ABC project, featuring the first implementation of precast concrete full height cantilever abutments for PennDOT, which replaced six bridges over two construction seasons with an average construction duration of 45 calendar days per bridge. The use of prefabricated bridge elements and time-based bidding techniques were both critical aspects of this PennDOT District 5-0 ABC project.

SR 4045 Constructed Bridge Elevation View

About the authors...

Chistopher Kufro, PE, is the Assistant District Executive – Design, Pennsylvania Department of Transportation, District 5-0, Allentown, Pennsylvania.

Brian Brawand, PE, is a Project Manager with the Alfred Benesch & Company in Allentown, Pennsylvania.

Figure Credit
Figure 1 Alfred Benesch & Company and Erdman Anthony
Figure 2: Alfred Benesch & Company
Figure 3 & 4: Alfred Benesch & Company and Johnson, Mirmiran & Thompson

Photograph Credit
Photographs 1, 2, 4: Alfred Benesch & Company
Photograph 3: Johnson Mirmiran & Thompson

BRIDGE CONSTRUCTION

Quality Through Constructability Considerations In Design

By M. Myint Lwin

Bridge Construction Quality implies the successful completion of a bridge construction project, meeting the requirements of the contract with no delays or cost overruns. The Owner plays the most important role in the quality and success of a project. The owner must clearly establish the requirements and expectations of a project. These requirements and expectations must be communicated and understood by the Designer and the Contractor. The Owner, the Designer and the Contractor must then work together to clearly establish and meet the requirements through plans, specifications and special provisions.

> " ... constructability of a bridge project demands diligent constructability considerations, especially during the design phase ... "

Constructability simply means that a construction project that can be built easily and efficiently with the knowledge, experience and skills of the successful bidder. However, constructability of a bridge project demands diligent constructability considerations, especially during the design phase. The Designer has the most influence on the quality and performance of a constructed bridge project. The Designer controls the key ingredients, such as, workmanship, materials, equipment, labor, that are required in the recipe for successful completion of a bridge project.

Constructability Considerations involve dedicated and committed efforts in the study of many factors that impact the outcome of a construction project. These efforts should be expended throughout the planning, design and construction phases of the project. In the following paragraphs, focus will be on constructability considerations by the Designer during the design phase.

The Designer may enlist the support of peers, fabricators, contractors, inspectors, and maintenance personnel in the review and incorporation of constructability in the project. Below are some important factors that should be considered by the Designer during the design phase to check that constructability is adequately addressed and reflected in the contract provisions:

1. Workmanship Standards – requirements for quality and acceptability, including tolerances, which should be reasonable to meet fitness for purpose.
2. Materials, equipment and labor availability – it is more efficient and cost effective to use locally available materials, equipment and labor.
3. Site accessibility – check that the construction site is accessible to the constructor and Equipment.
4. Environmental requirements – check that the requirements are met, and permits received.
5. Sustainability considerations – consider ways to conserve energy, preserve or enhance the environment, and minimize disruption to the habitats.
6. Geometry, size and weight – perform site and route studies to check that the components can be transported on existing roadways and readily erected at the job site,
7. Stability – provide guidance for addressing stability of the components during handling, shipping and erection.
8. Corrosion and degradation protections – provide adequate protections to keep the structure from corrosion or deterioration for their design life.
9. Construction sequences – this is an important part of constructability; check that the structure can be erected successfully,
10. Inspection requirements and acceptance criteria – inspection, testing and sampling requirements together with acceptance criteria must be clearly specified.

Two important factors that have not been covered above will be addressed below:

1. Errors and Omissions: Errors and Omissions have ruined many otherwise very successful projects. One of the many benefits of constructability considerations in design is an effort to reduce or avoid errors and omissions to minimize waste, delays and cost overrun. The Designer must pay attention to design calculations, structural details, and design drawings or plans to check that they are prepared in accordance with the Owner's formal office practices, and governing design specifications and standards.
2. Quality Control and Quality Assurance (QC/QA) Programs: QC/QA programs are formal office procedures for checking that the Owner's requirements and expectations are fully met. A QC/QA program provides checks and balances within an office to meet quality in the constructed projects. A good QC/QA program is a deliberate and systematic approach to reduce the risk of introducing errors and omissions into a design.

For major bridge projects involving unusual, complex, and/or innovative features, a peer review may be desirable to raise the level of confidence in the quality of design and construction. A peer review is generally a high-level review by a special panel of professionals specifically appointed by the Owner to meet the needs of the project. Peer review is an effective way to improve quality and to reduce the risk of errors and omissions.

A Competent Bridge Designer is key to achieve bridge construction quality as described in this article. A newly graduated Civil Engineering student, who has a fundamental grasp of the principles of engineering mechanics, and who aspires to be a bridge designer, may join a structural engineering firm to put his schooling to work, and gain the practical aspects of bridge engineering and other related fields. With continuing education and training, and working alongside with experienced bridge designers, the student will grow from an entry level bridge designer to a competent bridge designer in due course.

Construction of a Segmental Concrete Bridge
Photo Courtesy of FIGG Bridge Engineers, Inc.

A competent bridge designer has the knowledge and experience in structural engineering, with special interest in bridge engineering, constant application of the principles of engineering mechanics, and other related disciplines to contribute to constructability considerations that will result in a successful project with no waste, on time and within budget. Below is a suggested checklist showing the desirable characteristics of a competent bridge designer with self-assessment ratings of current knowledge and experience. A self-assessment rating of 1 is considered as low or entry level, and a 10 is considered an expert. The self-assessment ratings may be used to set annual goals to work with supervisor and management for continuous education and training to set and meet the goals for professional growth, and upward mobility in the organization.

A COMPETENT BRIDGE DESIGNER IS ONE WHO:									
• Has special knowledge and experience in the design, analysis and preservation of all types of bridge structures.									
ENTRY									EXPERT
1	2	3	4	5	6	7	8	9	10
• Has a good working knowledge in foundation engineering, hydraulic engineering, surveying, material science and other supporting fields of science and engineering.									
1	2	3	4	5	6	7	8	9	10
• Pays due attention to structural details, tolerances, safety, durability, cost effectiveness, esthetics and sustainability.									
1	2	3	4	5	6	7	8	9	10
• Is always conscious of the economy and feasibility in design, construction, inspection, operation and maintenance									
1	2	3	4	5	6	7	8	9	10
• Is able to prepare clear, concise and correct contract plans, specifications and cost estimates.									
1	2	3	4	5	6	7	8	9	10
• Studies existing designs and structures to determine their good aspects and weaknesses; and evaluates innovations and advanced technologies for improvement in future projects.									
1	2	3	4	5	6	7	8	9	10
• Has a good working knowledge of the work in the rolling mills, fabrication shops, field erection, and construction.									
1	2	3	4	5	6	7	8	9	10
• Has a good understanding of inspection, testing, sampling and acceptance of materials and workmanship.									
1	2	3	4	5	6	7	8	9	10
• Has some knowledge in contract laws and contract administration, Federal policies, rules, and regulations.									
1	2	3	4	5	6	7	8	9	10
• Practices good time management, project management and human relations.									
1	2	3	4	5	6	7	8	9	10

The Bridge Designer plays a very key and important role in the Design Phase to implement diligent constructability considerations in design for quality construction that avoids waste, project delays and cost increase. Quality design and construction also lead to ease in inspection, maintenance and preservation, which are so essential for long-term trouble-free performance of bridges. The Bridge Designer is in the best position to determine the extent of needs to engage the cooperative and collaborative efforts of the fabricators, constructors, inspectors and maintenance personnel in constructability considerations and review in design to achieve quality in the constructed project.

About the author...

M. Myint Lwin is currently an independent consultant with special interest and services in engineering education and training, QC/QA assessment, constructability and peer reviews of bridge projects. He is the former Director of the Office of Bridge Technology, Federal Highway Administration (FHWA). He was the State Bridge and Structures Engineer with the Washington State Department of Transportation (WSDOT). He was an adjunct lecturer in Civil Engineering Department, St. Martin University, Lacey, WA. He is a Guest Professor of Chang'An University, Sichuan, China.

He conducts training internationally in LRFD Bridge Design, Construction, Inspection, Maintenance and Preservation.

He holds a BSCE degree from the University of Yangon, Myanmar, and holds an MSCE degree from the University of Washington, Seattle, WA. He is a registered Professor Engineer in Civil and Structural Engineering, the 2013 IBC John A. Roebling Medal recipient, and a Life Member of ASCE. He has authored/coauthored numerous papers and books in structural and bridge engineering

Figure 1: Steel Girder Erection of the Koppel Bridge in Southwestern Pennsylvania. The four span bridge had a maximum span length of 327 ft and full-length lateral bracing in the middle girder bay. The use of full-length lateral bracing helped control girder deflections and girder buckling during erection.

Lateral Bracing Concerns

for Long Span Steel Girder Bridges

By Peter L. Quinn, Shawn E. Tunstall, and Calvin Boring

As structural engineers are becoming more efficient in their designs and utilizing more refined analysis models, steel girder bridge spans are getting longer and girder sections are getting lighter. This results in much less steel, fewer substructure units and therefore lower costs to the owner. A hidden cost that's been increasing has been the erection of these long span, sleek bridges resulting in added difficulties in erection and greater risk for steel erectors.

When developing erection plans, two important steps include examining girder stresses and lateral deflections. When checking stresses, both single girder and system global buckling must be considered. Single girder buckling, the typical AASHTO buckling case, checks a single girder buckling between cross-frames assuming the cross-frames are rigid brace points. System global buckling checks buckling of the entire bridge cross section within the given span length and is just recently being added into the AASHTO code checks. Lateral deflections due to wind load and lateral deflections due dead load of curved and skewed girder bridges, must be examined so that the bridge can be safely built.

For girder stress checks, the single girder condition is examined for buckling using AASHTO guidelines. The two-or-more girder condition is examined for both single girder buckling and system global buckling. With robust girders the global buckling condition does not typically control and was typically not given much attention in girder erection. With slender girders, and limited lateral bracing, system buckling is becoming an increased concern during erection. System buckling can be controlled through the use of lateral bracing. As discussed next, the amount of lateral bracing on long span bridges is being minimized which will also raise the concern for system buckling (See Figure 2).

With slender girders and limited lateral bracing, lateral deflections are a significant concern prior to the deck being poured. Design engineers typically only examine the final fully erected girder condition, leaving the intermediate stages to the contractor. Lateral deflection limits are often allowed to be in the order of L/150 (or 2' for a 300' span) in some instances which allows for significant lateral deflection. The high deflection limit often results in lateral bracing only being required in the end few cross-frame bays for spans in excess of 300', and often no lateral bracing near the abutments. To compound the issue, the deflection resulting from the condition of having only the end span erected is significantly greater than having the full unit erected due to the loss of continuity. So, a deflection that was 2' in design may

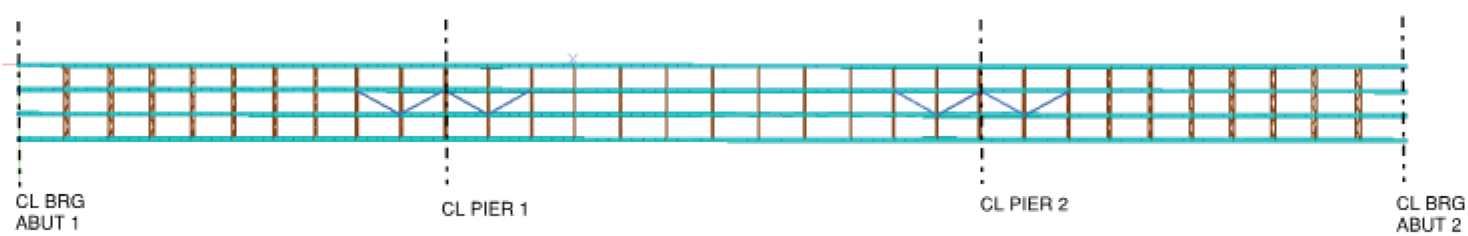


Figure 2 - Steel Framing Plan Showing Limited Lateral Bracing Near the Piers and No Lateral Bracing at the Abutments. This bridge has a high probability of girder deflection and buckling issues during erection.

now become significantly larger during erection. See Figure 2 for an example bridge that may meet all design requirements but be very difficult to erect.

With the minimal amount of lateral bracing on these long span bridges, additional stability measures (wind tie-downs, dead-men, temporary lateral bracing) must be installed by steel erectors to get the bridges erected because of the global buckling or lateral deflection issues. The most effective method to control lateral deflection and global buckling is permanent lateral bracing. But it is often too late to add permanent lateral bracing once a bridge is in construction due to scheduling issues. Without the option for permanent lateral bracing, temporary options that are less desirable must be used to stabilize the structure. Therefore, it is preferable to address the lateral deflection concerns during design rather than construction.

As mentioned above, in some states a lateral deflection of L/150 has been accepted as the upper limit. Is this really a deflection that is feasible in the field for these long span bridges? In particular, locations over water or flat terrain where wind speeds reach higher levels frequently may be problematic. For example, a 300' long bridge would be permitted to deflect 2 feet. Even with a reduced wind speed that may occur on a normal working day, the bridge may still be deflecting several inches. A lateral deflection of several inches makes things such as final connections of cross frames or placing deck pans all that more difficult or potentially not possible.

Adjusting the approach taken during design could help minimize the concerns during erection. Fairly reasonable steps could be put in place to make erecting the bridge much easier on the contractor. Consider requiring a check for lateral deflections for each individual span so that loss of continuity is not a concern. Checking each span alone would ensure adequate lateral bracing is present no matter which span erection starts. With these larger bridges, 3D models often have already been created so breaking it down to check wind between field splices doesn't add much work to the designer. This will most likely add lateral bracing to the design. Adding lateral bracing will increase the steel weight but savings during erection will offset this additional cost. In addition, having adequate permanent lateral bracing will make erection safer.

To this point, this discussion has been focused on the erection of the steel girders. Once the girders are erected, the final designer will have checked the stresses for the deck pour, etc. Global buckling and lateral deflection issues can also present themselves in staged construction where the full cross section of girders will not have been erected at one time, especially with 3 or fewer girders. This temporary condition can present problems because the span-to-width ratio may double if only a few of the girders are erected. The stability may be impacted during the girder erection with the full wind speed or during the deck pour because of the addition of the wet concrete and eccentric loading due to uneven overhangs. This again would be a good cause to install lateral bracing to prevent any lateral deflection or global buckling issues.

This issue is of increased concern because of the longer spans and more flexible girders, with guidance provided in the new AASHTO Guide Specification for Wind Loads on Bridges During Construction, 1st Edition 2017. The main difference with this Guide Spec is that it considers wind on the full cross section of girders. Previously, it was assumed that the fascia girder would shield the other girders from wind. With this new Spec, only Girder 2 does not have wind applied. This has the potential to double, triple, or even quadruple the amount of wind applied to the bridge which will cause more lateral deflection or global stability problems from a design perspective.

Our recommendation is for designers to check individual spans in their simple span configuration for lateral wind loads to provide a more constructible bridge. Adding lateral bracing for at least 20% of the span length at each end also provides a more constructible bridge, especially for global buckling (See Figure 3). In addition, steel erectors need to be aware of the potential lateral deflection and stability concerns associated with slender long span bridges with minimal lateral bracing. All parties need to be aware of the importance of lateral bracing in the stability of the structure.

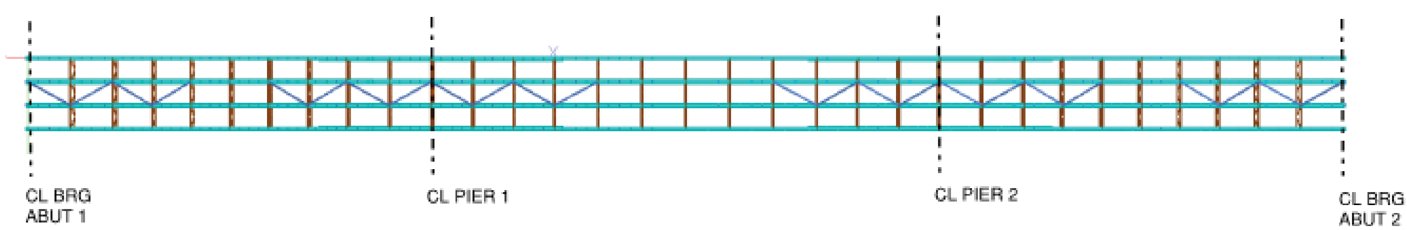


Figure 3 - Steel Framing Plan with Additional Lateral Bracing to Assist in Girder Erection

About the authors...

Peter L. Quinn, P.E. is a Senior Structural Engineer with 14 years of experience in bridge design. His focus is on providing design assistance to contractors during construction.

Shawn E. Tunstall, P.E. is a Senior Structural Engineer and President of Tunstall Engineering Group with 22 years of bridge design experience. His recent focus is on providing engineering design to contractors during construction and design build applications.

Calvin Boring is the Operations Manager at Advantage Steel and Construction with 37 years of experience in steel girder bridge erection. Calvin is a member of the IBC Executive Committee.

STANDING TALL

COLLABORATION OVERCOMES CONSTRUCTION COMPLEXITIES ON OHIO'S LONGEST AND TALLEST BRIDGE

By: Tony Shkurti

When the new Jeremiah Morrow Bridge opened in 2016, its twin structures were among Ohio's longest at 2,252 feet and its tallest at 239 feet above ground. Situated above the picturesque Little Miami River and Gorge, the bridge carries more than 40,000 vehicles daily between Cincinnati and Columbus.

The cast-in-place segmental concrete bridge replaced existing twin truss structures that were built in the mid-1960s. Constructed with 440-feet main spans, single-cell boxes on the new bridges carry a 55-foot wide roadway.

Balanced-cantilever construction of the southbound bridge, constructed within the median of the existing north and southbound trusses.

HNTB provided ongoing construction services to the Ohio Department of Transportation and served as design engineer of record for the six-year, $88 million project.

"Investment was needed on the existing bridges …The question was whether spending it on maintenance would be a good investment. Painting is expensive and re-decking is complicated. This structure moves a lot of traffic; we needed a shoulder and a third lane. We knew the bridge couldn't expand to accommodate that, so we decided to replace both bridges rather than rehabilitate the old one."

…Tim Keller, ODOT State Bridge Engineer

Segmental construction was chosen for its low construction cost, aesthetics and minimal environmental impact. Using the balanced cantilever cast-in-place segmental approach meant no large cranes would be required below the bridge and framework.

CHALLENGES REQUIRED BIG EXPERTISE

Though doable, the Jeremiah Morrow bridge was not a regular, everyday project.

"We've done these types of bridges before, but we needed expertise in several specialties for this," said Dan Mendel, ODOT resident engineer. "From the beginning, we assembled a hybrid team of consultants and ODOT personnel. Each consultant had a specialty. Omni Pro Services, for example, specialized in concrete bridge post-tensioning. This type of construction is segmental box post-tensioned, and the way we construct it is a cast-in-place balanced cantilever construction approach, which is similar to a balanced scale. When you use cantilever construction, there has to be geometry control or a balanced scale. We have to ensure finished pieces follow the profile of the road so that as sections are built out, you can accurately connect the tips.

"Another specialty we needed was a concrete provider with thermal control experience," he added. "Some of our footings were large. Thermal control ensures that the internal and external temperatures of poured concrete stay within limits during the curing process to prevent cracking, which would affect long-term durability."

Ryan Cocco, then project manager with Kokosing Construction Company, Inc., prime contractor for the bridge, said projects of this scale come with built-in, tough situations. Now an area manager, he recalled new construction and demolition of the older structure required finesse as well as expertise.

"Height is always a challenge, but with this bridge being the highest in Ohio, it was noteworthy," he said. "Getting access at that height can be tough. We had to maintain all four lanes of traffic on I-71. The cast-in-place cantilever construction has its natural challenges.

"In addition, the project was lengthy as winter temperatures limited our ability to pour concrete," Cocco added. "Demolition required great expertise, especially because of the height of the structure and the reality that the bridge crosses a scenic river area where no debris could fall."

CONTROLLED COMPLEXITY

Challenges and complexities inspired teams to employ models and drawings to verify effective processes from start to finish, including using 2D for elevation and side views and integrated 3D drawings of piers.

Adding to this complexity was the elevation of the superstructure and range of pier heights. Stiffness varied between the center and ends of the structure. It was important to minimize the self-weight, or the load on the structure created by its own weight, so that the piers could be kept as slender as possible. Another challenge was the density and size of reinforcement. The large-diameter, heavy reinforcement bars were hard to manipulate compared to standard rebar. Post-tensioning elements and components are required to be cast into the concrete with unforgivingly tight tolerances.

To ensure these elements came together appropriately, this construction model was maintained

Deck Finishing on the Northbound Bridge

Balanced-cantilever construction lessens the demand of heavy erection equipment, which would have damaged the environmentally-sensitive area of the Little Miami River.

The finished Jeremiah Morrow Bridge carrying I-71 over the Little Miami River.

throughout the project. Keller said this allowed ODOT to verify construction engineers' assumptions. To ensure the greatest accuracy, construction teams used two independent models and agreed to a reasonable degree of precision before work proceeded.

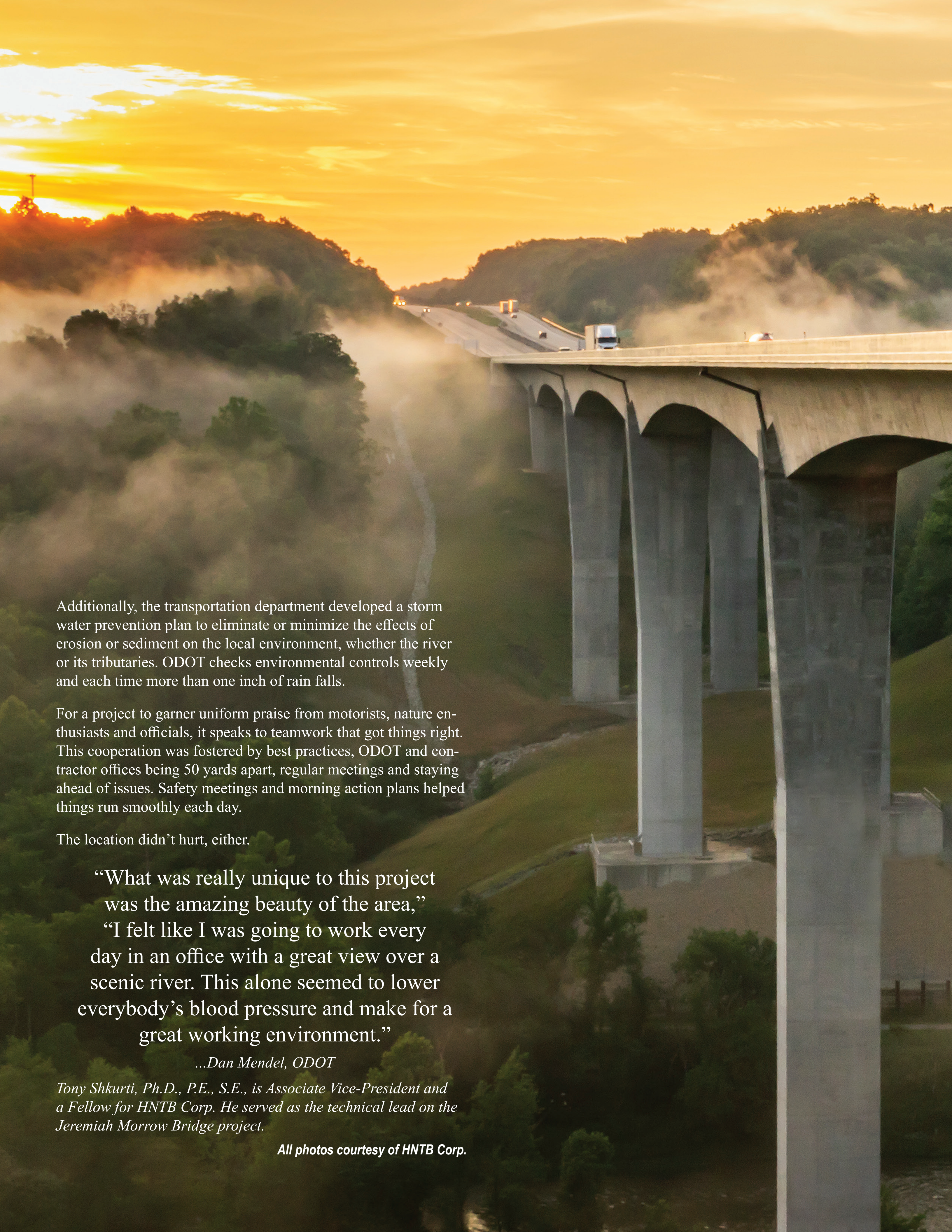
NATURAL BEAUTY PRESERVED

The bridge is situated in one of Ohio's most beautiful natural settings. Sycamores, rocky cliffs and wildlife fill the landscape that is part of the Little Miami Scenic Trail, a 78-mile paved trail that runs along the river banks. Most days, the area hosts nature enthusiasts, cyclists and hikers.

Mendel went on "Equipment and material were kept clear of the river's 100-year flood plain, and no debris fell into the river. As we built the new bridges and began removal of the old ones, ODOT, the construction and consultant teams used a plan that made certain we followed regulations."

The bridge construction was designed so that it did not negatively impact the environment. In fact, the completed project complements the environment – another reason the cast-in-place method was chosen. The project team did not want huge cranes on the valley floor, nor did it want to build access roads to get equipment in place.

Within the project limits are two wetlands locations and an Indiana bat habitat that required complete protection from construction. Erosion control was critical, too; all water runoff is piped to the ground where outflow is controlled to minimize the effects of potential erosion.



Additionally, the transportation department developed a storm water prevention plan to eliminate or minimize the effects of erosion or sediment on the local environment, whether the river or its tributaries. ODOT checks environmental controls weekly and each time more than one inch of rain falls.

For a project to garner uniform praise from motorists, nature enthusiasts and officials, it speaks to teamwork that got things right. This cooperation was fostered by best practices, ODOT and contractor offices being 50 yards apart, regular meetings and staying ahead of issues. Safety meetings and morning action plans helped things run smoothly each day.

The location didn't hurt, either.

> "What was really unique to this project was the amazing beauty of the area," "I felt like I was going to work every day in an office with a great view over a scenic river. This alone seemed to lower everybody's blood pressure and make for a great working environment."
>
> *...Dan Mendel, ODOT*

Tony Shkurti, Ph.D., P.E., S.E., is Associate Vice-President and a Fellow for HNTB Corp. He served as the technical lead on the Jeremiah Morrow Bridge project.

All photos courtesy of HNTB Corp.

Protecting the Little Miami River and its surroundings was a great concern as the river is a state and scenic waterway.

IBC 2019 Awards Program

By M. Patrick Kane

Roebling Medal

“Throughout his distinguished career, Dr. Frank has shaped the way steel bridges are designed in the United States and throughout the world … His extensive influences over the years on the AASHTO Bridge Design Specifications can be seen throughout the steel design guidelines ”

Richardson Medal – Sichuan Hejiang Yiqiao Bridge over Yangtze River

“This impressive concrete filled steel tubular truss bridge is currently the longest main span of its type in the world and incorporates several innovate design features that contribute to its landmark nature”

Lindenthal Medal – Xingkang Bridge on Luding Dadu River

“This suspension bridge in a high seismic zone innovatively addresses earthquake design with corrugated steel web composite struts between the main cable towers and articulated energy-dissipating central buckles at the sag point of the main cables … The impressive 1100-m single span perched part-way up the mountains on each side of the river provides a beautiful addition to the surrounding area”

Figg Medal – Greenfield Bridge

“The Greenfield Bridge incorporated many aspects of public involvement in real design decisions that led to a new iconic bridge spanning over the main route from the east to Pittsburgh PA ... This bridge is located in historic Schenley Park and incorporates several architectural features from the original bridge”

Hayden Medal - Frances Appleton Pedestrian Bridge

“This tubular steel arch bridge incorporates visually appealing curvature around existing trees in the parkland next to the Charles River and provides a multi-use walkway along the river and over a parkway in Boston, Massachusetts”

Lichtenstein Medal – Rehabilitation of the Frankford Avenue Bridge

“The rehabilitation of the oldest continuously-used roadway bridge in the United States over Pennypack Creek in Philadelphia provided a finished product of cut stone masonry that embodies the spirit of preservation that this award represents”

Award of Merit Railroad Bridges – Portageville Bridge Replacement

“This new steel deck arch provides an improvement to a vital link for Norfolk Southern Railroad, while providing an iconic structure that is visually appealing and in harmony with the Genesee River flowing through Letchworth State Park”

Award of Merit for Bridge Research – SR 99 Tunnel South Access

“This special award of merit recognizes research incorporated into this new bridge resulting in the development of innovative Shape Memory Alloy and Engineered Cementitious Composite materials ... These materials provide resistance to earthquakes by providing a truly resilient bridge”

These are some of the many comments of the International Bridge Conference Award’s Committee who viewed, voted and selected this year’s winners and in many cases reflect the thoughts of the public who strongly support local bridge projects.

The International Bridge Conference in conjunction with, Roads and Bridges Magazine, bridge design and engineering Magazine, Covestro and TranSystems, annually awards six medals plus other awards of distinction to recognize individuals and projects of distinction. The medals are named in honor of the distinguished engineers who have significantly impacted the bridge engineering profession worldwide.

Interest in the IBC awards program is quite robust nationwide and internationally. This year the Awards Committee reviewed more than forty nominations for the various bridge metal categories alone, many of which were projects nominated beyond the borders of the United States. After lengthy deliberations, the following individual and projects were deemed worthy of this year’s awards.

JOHN A. ROEBLING MEDAL

Dr. Karl Frank

The John A. Roebling Medal honors an individual for lifetime achievement in bridge engineering. The International Bridge Conference® is pleased to recognize Dr. Karl Frank, who has made substantial contribution towards improving the design and behavior of steel bridges, as the 2019 recipient. Dr. Frank, an emeritus professor of Civil Engineering, University of Texas, Austin, USA, is a recognized expert in steel bridge issues such as fatigue, fracture, welding, bolting, fabrication and erection. Over the course of his career, he has uniquely identified fundamental conceptual problems in design and/or fabrication and then developed simple solutions and specifications that improve both the economy and behavior of steel bridges. Dr. Frank has served and provided leadership on a number of diverse technical committees for AASHTO, AREMA and AISC. His leadership in AASHTO and some of his most significant contributions to the bridge community are evidenced by his long participation and commitment to subcommittee T-14, where his expert opinion has guided the committee to implement LRFD Bridge Design specification changes which are sound, practical and easy to implement.

Sichuan Heijang Yiqiao Bridge over the Yangtze River, Sichuan Province, P. R. of China

GEORGE S. RICHARDSON MEDAL

The George S. Richardson Medal, recognizing a single, recent outstanding achievement in bridge engineering, is presented to the Luzhou Southeast Expressway Development Co. Ltd., the owner of the Sichuan Heijang Yiqiao Bridge over the Yangtze River, Sichuan Province, Peoples Republic of China. This magnificent fixed arch bridge spans the Yangtze River with a 1,740-foot, concrete filled steel tube arch. Innovative features of design include cross bracing between the doubled arched elements s well as a steel beam plus steel-concrete composite bridge deck. The most challenging aspect of design and construction was the placement of concrete within the steel tube. This was accomplished by pumping a low shrinkage, high performance concrete with a dispersant admixture assisted by a vacuum aided delivery system. The bridge's design has led to the first Chinese design code for concrete filled steel tube arch bridges and the bridge serves as a model of economical, environmentally friendly bridge. The bridge is truly a landmark structure in the history of concrete filled steel tube arch bridges.

GUSTAV LINDENTHAL MEDAL

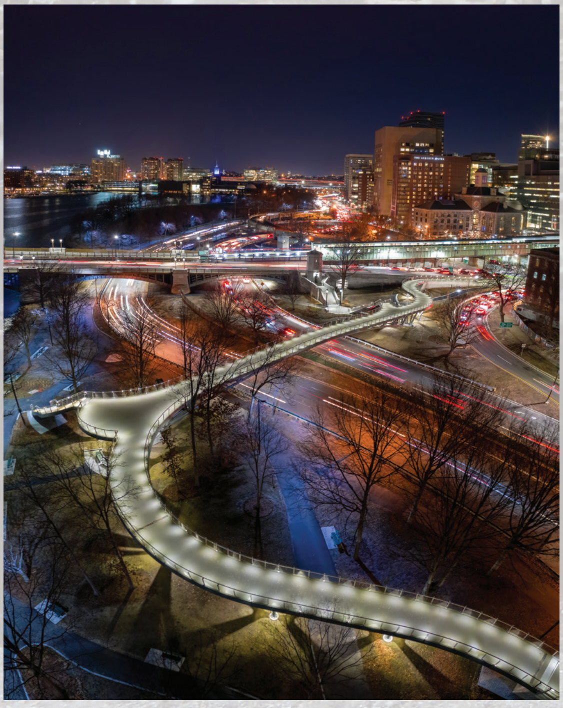
The Gustav Lindentahl Medal, recognizing an outstanding structure that is also aesthetically and environmental pleasing, is presented, to the Sichuan Yakang Expressway Co. Ltd., the owner of the Xingkang Bridge over the Luding Dadu River, Sichuan Province, Peoples Republic of China. This artistic suspension bridge, with a main span of 3,600 feet, spans a deep gorge in high seismically active region of China. A series of highly imaginative and innovating engineering features have been developed for the design and construction of this structure. These features include firstly, composite box girder cross beams laterally supporting the suspension towers with composition consisting of concrete flanges and corrugated steel webs, and secondly, a mid-span "central buckle system", intended to dissipate seismic energy during an earthquake event. The scale of the towers, cables and deck truss, spanning the rugged gorge, as well as the sheer beauty of the mountain setting, provide a most aesthetically pleasing and environmentally sensitive structure.

Xingkang Bridge over the Luding Dadu River, Sichuan Province, P. R. of China

Greenfield Bridge over I-376, Pittsburgh, PA.

EUGENE C. FIGG, JR. MEDAL

The Eugene C. Figg, Jr. Medal for Signature Bridges, recognizing a single recent outstanding achievement for bridge engineering, which is considered an icon to the community for which it is designed, is presented to the City of Pittsburgh, the owner of the Greenfield Bridge over I-376, Pittsburgh, Pennsylvania, USA. The new steel arch bridge replaced a deteriorating but locally sentimental concrete arch structure at the entrance to Schenley Park, one of Pittsburgh's most historic public parks. The result was a context sensitive, community driven design, which included reuse of many of the architectural elements of the former bridge such as decorative entry pylons and other barrier ornamentation and monuments. Special attention to steel detailing, such as Vierendeel arch bracing and sub-assembly of floor system facilitated erection over the interstate highway in a single weekend. Public participation guided the determination of structure type and bridge color; and, the local community welcomed the opening of the new bridge with a gala celebration.



Frances Appleton Pedestrian Bridge, Boston, MA

ARTHUR C. HAYDEN MEDAL

The Arthur C. Hayden Medal, recognizing a single recent outstanding achievement in bridge engineering demonstrating vision and innovation in special use bridges, is presented to the Department of Conservation and Recreation, the owner of the Frances Appleton Pedestrian Bridge, Boston, Massachusetts, USA. This pedestrian bridge includes, as a feature element, a contemporary tubular steel arch with a main span of 222 feet across a parkway. The structure, curvilinear in two directions and 550 feet in overall length, is a continuous structure without joints. The bridge placement and overall geometry was carefully selected to comply with ADA accessibility slope requirements and avoidance of impact to mature trees within the parkland adjacent to the Charles River. The arch and approach spans follow a distinct architectural theme of slender steel piers and struts for visual consistency and aesthetic appeal. The iconic bridge incudes the use of signature color, special aesthetic lighting and elegant detailing. The sinuous crossing is perfectly integrated into the landscape due to its transparency and lightness. The bridge's name pays homage to Frances Elizabeth Appleton Longfellow, beloved wife of New England poet, Henry Wadsworth Longfellow.

Frankford Avenue Bridge, Philadelphia, PA

ABBA G. LICHTENSTEIN MEDAL

The Abba G. Lichtenstein Medal, recognizing a recent outstanding achievement in bridge engineering demonstrating artistic merit and innovation in the restoration and rehabilitation of bridges of historic or engineering significance, is presented to the Pennsylvania Department of Transportation, District 6-0, the owner of the Frankford Avenue Bridge, Philadelphia, Pennsylvania, USA. The Frankfort Avenue Bridge, a three-span stone masonry arch bridge, built in 1697, is the oldest continuously-used roadway bridge in the USA. The presently, rehabilitated bridge, remains true to its original form, even after undergoing many construction and repair campaigns during the last three centuries. The present rehabilitation included in-kind restoration of deteriorated masonry elements, continued reuse of all original architectural details, removal of existing earth fill and use of a flowable fill to eliminate the build-up of hydrostatic pressures and water infiltration. The design and construction process included extensive involvement with Section 106 consulting parties, including ten local officials, four schools and representatives of the local commercial and residential districts. The rehabilitation is truly a sensitive restoration of the oldest bridge in America, true to the craftsmanship of the original, 1697, construction.

Portageville Bridge Replacement, Portageville, PA

AWARDS OF DISTINCTION

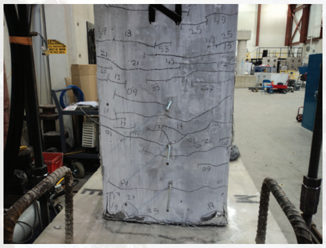
The first Award of Distinction, recognizing a recent outstanding achievement in railroad engineering, is presented to the Norfolk Southern Corporation, the owner of the Portageville Bridge Replacement, Portageville, Pennsylvania, USA. The replacement steel arch structure replaced an 820-foot long viaduct, originally constructed in 1875 as the largest timber bridge in America and later in 1903 reconstructed as a steel trestle. The structure crosses a deep river gorge, commonly referred to as the Grand Canyon of the East, and subsequently spans the Genesee River, in Letchworth State Park, immediately upstream of the beautiful falls of the Genesee. The 1903 bridge, an iconic structure within the state park, was famous for its scenic view and historic heritage, and had become the love of the people. With extensive community involvement, the steel arch design developed as a structure sensitive to the environment, and the bridge is truly iconic in its own right.

The second Award of Distinction, recognizing a recent outstanding achievement in bridge research is presented to the Washington State, Department of Transportation for the SR99 Tunnel South Access Bridge, Seattle, Washington, USA, for its use of shape memory alloys constructed within the bridge piers. This represents the first bridge in the USA to utilize such technology. In a region of high seismic activity, the bridge columns were constructed with an engineered cementitious composite, termed ECC, utilizing shape memory alloys of nickel and titanium for reinforcement. Use of shape memory alloys are intended to improve the resilience of bridge columns at the expected locations of plastic hinges during significant seismic events, with further expectation that return to serviceability can be accomplished with a minimum of repair.

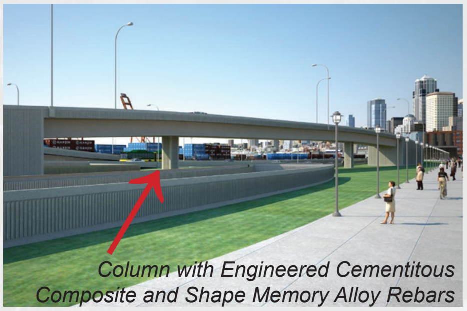
The IBC Awards Committee includes Lisle Williams, Michael Cuddy, Myint Lwin, Stephen Shanley, Liji Huang, Gary Runco, Ken Wright, Jay Rohleder, Matthew Bunner, Tom Vena, Rachael Stiffler, Enrico Bruschi, Tyson Hicks, Pat Kane and Tom Leech.

About the Author...
M. Patrick Kane is the Director of Business Development for GPI, in Pittsburgh, Pennsylvania and a member of the IBC Awards and Executive Committees.

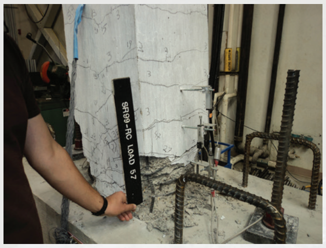
SR99 Tunnel South Access Bridge, Seattle, WA



SMA Reinforced ECC Column Before and After Testing. Numerous Cracks but no Spalling at the end of Testing (12% Drift).



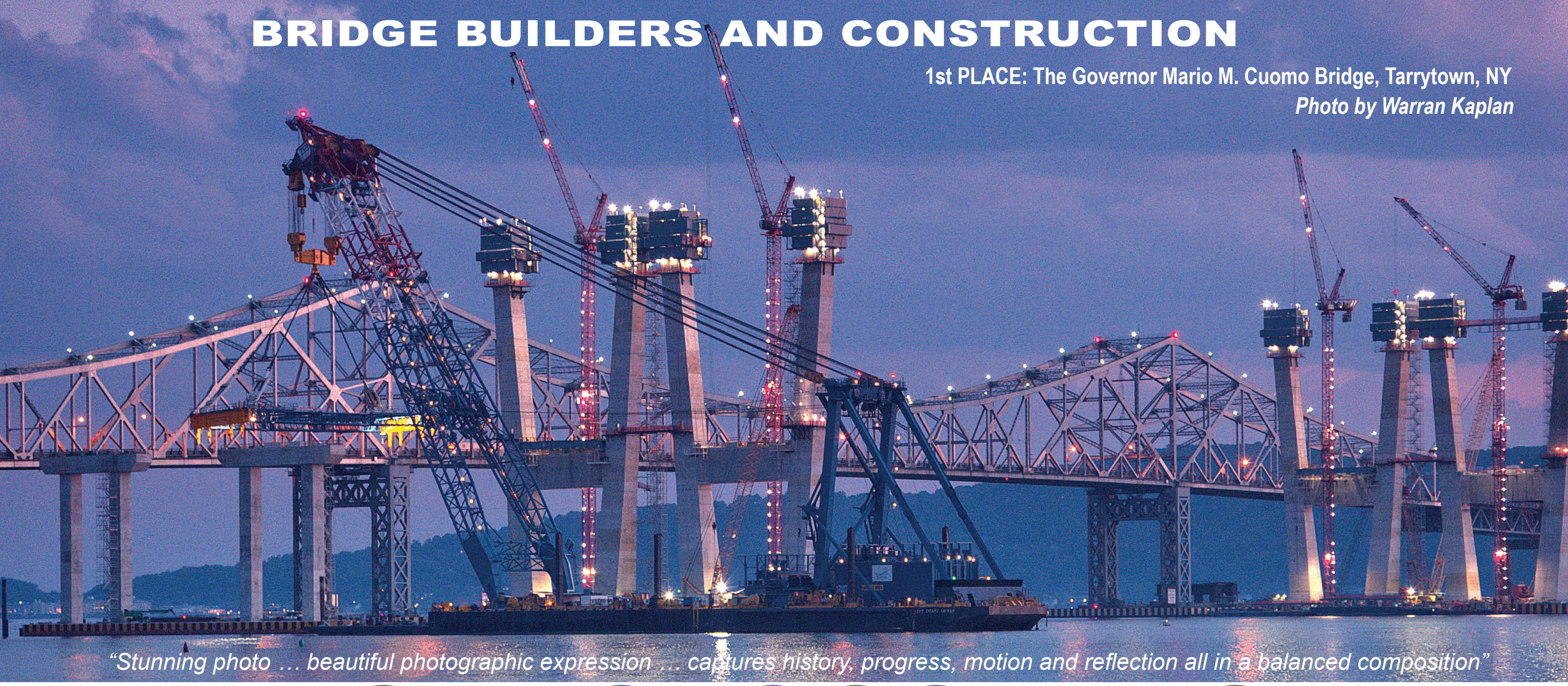
Column with Engineered Cementitous Composite and Shape Memory Alloy Rebars



Normal Reinforced Concrete Column Before and After Testing. Major Cracking and Spalling at the end of Testing (8% Drift).

Testing photos courtesy of Prof. Saiid/UNR

BRIDGE BUILDERS AND CONSTRUCTION



1st PLACE: The Governor Mario M. Cuomo Bridge, Tarrytown, NY
Photo by Warran Kaplan

“Stunning photo … beautiful photographic expression … captures history, progress, motion and reflection all in a balanced composition”

IBCPHOTOCONTEST

The 2019 IBC Photo Contest accepted entries on bridges and their builders. We received a wide variety of perspectives and locations. These photographs are a good reminder of all the people and technology that are a part of bridge construction and the important role bridges play in providing transportation across the world. Enjoy our “Top 10” photographs, and read some of the comments from our panel of judges!!

2nd PLACE: Queensboro Bridge, New York City, NY
Photo by Damian Silverstrim

“Well composed … shows the majestic nature of the structure and skyline ... a bright sunny day on the job”

3rd PLACE: Tappan Zee Bridge Demolition, Tarrytown, NY
Photo by David Nagy

“The old making way for the new … great contrast … somber funeral for an old bridge”

4th PLACE: Goldstar Bridge South Bound, New London, CT
Photo by Damian Silverstrim

“Good contrast ... great scale”

5th PLACE: Osmangazi Bridge, Altinova/Yalova/Turkey
Photo by Riza Kayan

“Engineering beauty matched only by nature’s beauty … fantastic photo”

BRIDGE BUILDERS AND CONSTRUCTION

6th: SR 1003 Wall Street Bridge, Leesport Borough, Berks County, PA
Photo by Derek Dick

"Captivating view of bridge erection … good photo of an active construction site"

7th: Spuyten Duyvil Bridge Rehabilitation, Manhattan, NY
Photo by Huriel Ginzalez

"Good depiction of work … great view"

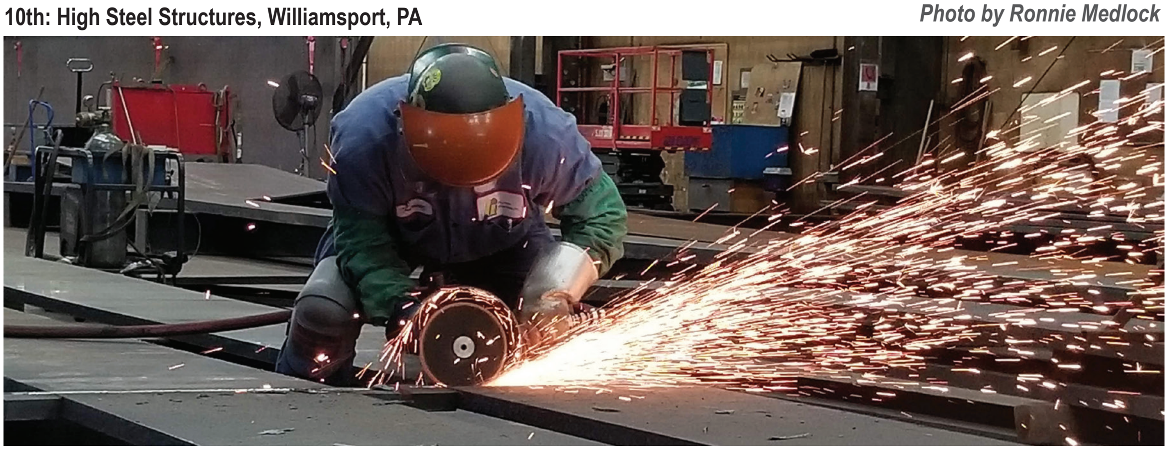
8th: SR 679 Bayway Bridge (Structure E) Replacement, Pinellas County, St. Petersburg, FL
Photo by Ian Foe

"Captivating colors … interesting perspective"

9th: Hulton Bridge, Oakmont, PA
Photo by James Radion

"Heavy lifting effort with scale … interesting photo"

10th: High Steel Structures, Williamsport, PA
Photo by Ronnie Medlock



"Man and machine at work … great "behind the scenes" photo"

ESWP Member News

More than 75 firms are represented in the Corporate Member program of the Engineers' Society of Western Pennsylvania (ESWP). Corporate Memberships are available at 3 levels: Gold, Silver and Bronze. Gold members are entitled to 14 memberships that can be exchanged by employees; Silver, 9; and Bronze, 5 — annual dues are $2400, $1700, and $1000 respectively. In addition, ESWP Corporate Member Firms may add 2 additional individuals in our Under-35 age category at no additional cost!

We also offer Individual Memberships, including a new "Under-35" category, which allows for full member privileges at annual dues of $25 and a Government rate (full-time), with for $50.00! Also, our new Dining Membership allows use of the Executive Dining Room for conducting client entertaining in a great private club setting, all for only $50 annual dues, plus regular entry fee. More information can be found at eswp.com. Please contact the ESWP Office (412-261-0710) for additional details.

Membership in ESWP comes with a long list of benefits! From our continuing education opportunities earning you Professional Development Hours (PDHs), to the business networking events in our Executive Dining Room, there is something for everyone in your organization. Also, ESWP is helping the next generation of engineers with student outreach programs, giving you the opportunity to participate in many rewarding programs.

ESWP Gold Corporate Member Firms

AECOM

gai consultants

MATRIX NAC

ARCADIS

Michael Baker INTERNATIONAL

Gannett Fleming

CDM Smith

PARSONS

HATCH

TeleTracking Workflow Automation for Healthcare.™

DIGIOIAGRAY CONSULTING ENGINEERS & SCIENTISTS

HDR

ESWP Silver Corporate Member Firms

CEC Civil & Environmental Consultants, Inc.

CANNONDESIGN

Lennon, Smith, Souleret Engineering, Inc. Civil Engineers and Surveyors

GATEWAY On Call. On Time. On Target.

WADE TRIM

KU Resources, Inc.

PJ DICK TRUMBULL LINDY PAVING

ESWP Bronze Corporate Member Firms

AIST Association for Iron & Steel Technology

think ALEM

Aquatech

AVALOTIS

awk Consulting Engineers

BRG Berkeley Research Group

Bureau Veritas 1828

CDR Maguire

Carnegie Mellon University College of Engineering

Collective Efforts, LLC Civil and Environmental Engineers

covestro

CSD Carnegie Strategic Design Engineers LLC

DEI DeSalvo Enterprises, Inc.

DQE Communications

Elevator Management Services

ESS NexTier Insurance Group

FIGG

GPI Greenman-Pedersen, Inc. Engineering and Construction Services

H.F. Lenz Company

i+icon USA Infrastructure & Industrial Constructors USA

Hill International

HH Houston Harbaugh Attorneys at Law

JACOBS

JNE Consulting

KCI Technologies

kokosing Industrial

KORYAK

LDG Larson Design Group

LOCHNER

mascaro construction ... build with the best

McKim & Creed Engineers Surveyors Planners

MOC, Inc.

menard Ground Improvement Specialists

Mott MacDonald

ms consultants, inc. engineers, architects, planners

nicholson

NGE Environmental & Geotechnical Engineering Solutions

orbital Engineering, Inc. Strategic Partner to the World's Smartest Businesses

Point Park University

RTP R. T. Patterson Co., Inc. Engineers & Consultants

Rizzo International, Inc.

RDA Romualdi Davidson & Associates Consulting Engineers

RMU Robert Morris

SAI Consulting Engineers

Schnader Attorneys at Law

Sci-Tek Consultants, Inc.

SMS group

Stantec

Tetra Tech

thyssenkrupp

Turner Building the Future

Pitt Swanson Engineering

Veolia

WRA Established 1915

wsp

Wyatt Incorporated Interior Construction

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