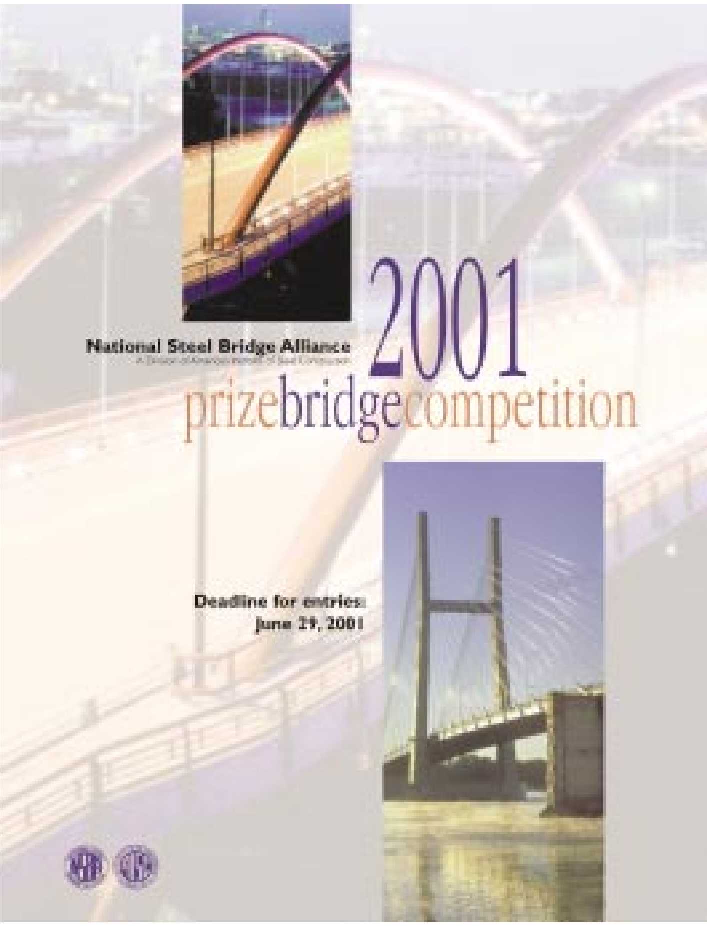
NATIONAL STEEL BRIDGE ALLIANCE

2001 Prize Bridge Competition



Eligibility
All award-winning bridges are built of fabricated structural steel and are found within the United States (defined as the 50 states, the District of Columbia, and all U.S. territories). The bridges were all completed and opened to traffic between May1, 1995 and April 30, 2001.

Judging Criteria
An independent panel judged entries on the following criteria: innovation, aesthetics, design and engineering solutions. Quality of submitted presentations, though not a criterion, was important.

Award Categories
Entries may have been judged in more than one category, but an entry could receive only one award. Awards were presented in the following categories this year:

- Long Span
- Medium Long Span
- Medium Span
- Short Span
- Movable Span
- Railroad
- Grade Separation
- Special Purpose
- Reconstructed
- Special Project

2001 Prize Bridge Competition Jury

Mr. Bill Crawford, P.E.
Chief Bridge Engineer
Nevada Department of Transportation

Mr. William M. Dowd, P.E.
Executive Vice President
HDR Engineering, Inc

Mr. Niels J. Gimsing
Professor
Technical University of Denmark

Mr. Malcolm T. Kerley, P.E.
State Structure and Bridge Engineer
Virginia Department of Transportation

Dr. Dennis Mertz
Associate Professor
University of Delaware

NSBA Prize Bridge Awards Jury (l to r): Gimsing, Mertz, Kerley, Crawford, Dowd.

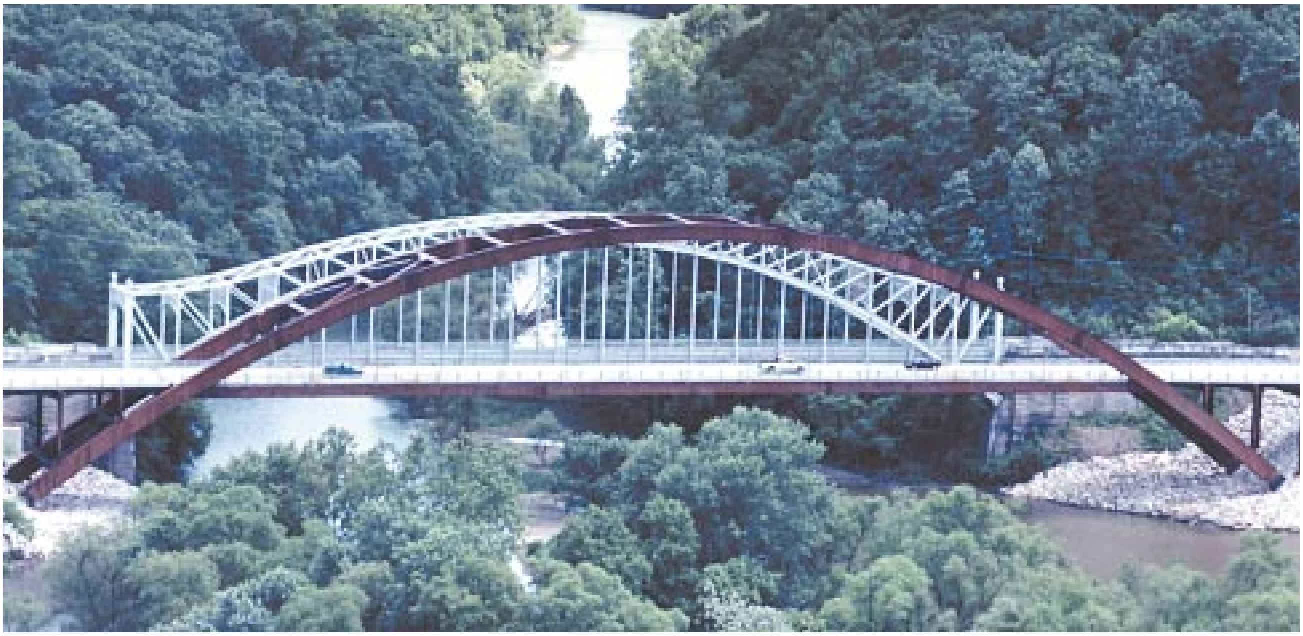
NATIONAL STEEL BRIDGE ALLIANCE

2001 Prize Bridge Award

WINNER: LONG SPAN

Paper Mill Road Bridge

Baltimore County, MD

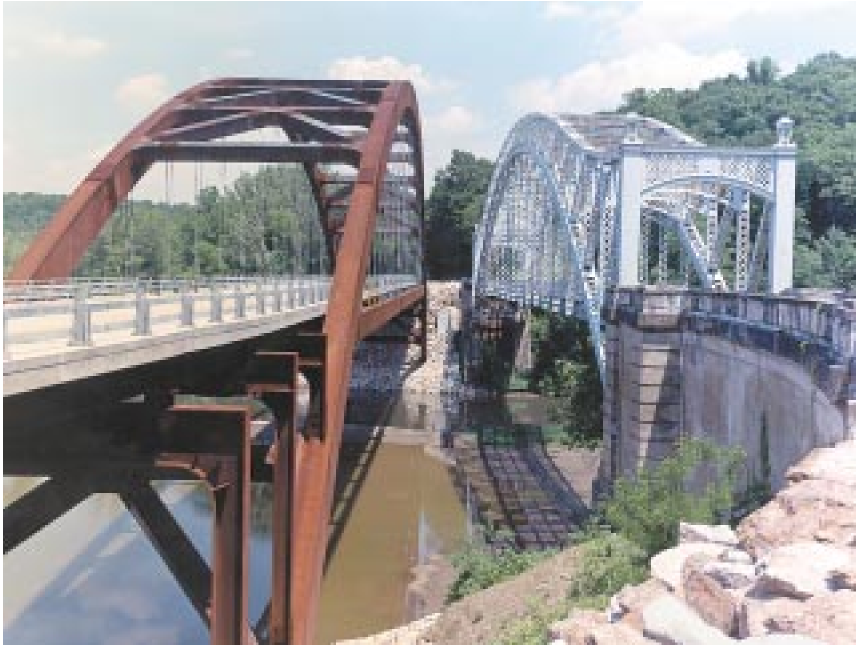


A new Paper Mill Road (MD Route 145) bridge crossing of Gunpowder Falls and Loch Raven Reservoir opened to traffic in December 2000. Travelers using the new bridge enjoy an improved alignment that eliminates the sharp curves of the earlier bridge approach roadways but maintains the serene nature of this area. This $12.1 million project, which complements the existing structure, relies on 3.9 million pounds of structural steel to cross a vital water supply for the Baltimore Metropolitan region with minimal permanent impacts to the watershed.

Design

As the bridge began to require increased maintenance, Baltimore City began to investigate replacing the bridge with a new structure. A new bridge would be able to carry the greater loads required by present day traffic conditions and also provide better-aligned approach roadways. The final recommendation was to replace the arch truss bridge with a new structure next the existing one, which was to remain intact as a river crossing for a future hiker-biker trail. An arch structure was chosen to accommodate the long center span necessary to avoid impacts to the waterway and to be aesthetically compatible with the historic bridge.

The structure consists of a steel box arch with a span of 495 feet that rises to a height of 99 feet above the Gunpowder Falls. The steel arch supports the center span above the reservoir, elimi-



nating piers. The parabolic arch is a 6'-8" high by 3'-0" wide steel box with smaller box sections with end flares providing lateral bracing between arches. The approaches include seven steel stringer spans supported on steel bents for an overall structure length of 670 feet. Two strands are used at each hanger location with each strand able to carry the full dead and live load. An innovative detail was developed at the upper end of the strands that equalizes the load between strands when both are in place but also allows the removal and replacement of one strand if necessary in the future. This rocker bearing type detail is located within the arch box to protect it from the elements.

The new bridge, approximately 25 feet north of the older structure, provides two 12-foot lanes with shoulders and provisions for a sidewalk on the north side. The structure will require minimal maintenance in the future due to the use of high-strength weathering steel and epoxy coated reinforcing steel in all concrete that would be exposed to water and/or salt.

Fabrication

One of the challenges of the project was the fabrication of the structural steel for the arch and the other bridge members. The size of the arches, 99 feet high and 495 feet long, made it impossible to completely erect the arches at the fabrication site prior to shipment to the job site. The fabricator decided to test-assemble the seven sections for each arch in sequence, with no more than three sections of each arch assembled together at one time until all the sections had been assembled together. At all times the fabricator kept strict control of the arch geometry to facilitate erection later at the site.

Construction

In order to construct the bridge quickly and, the contractor proposed an innovative method of construction. This method required the use of a causeway across the reservoir as a staging platform, but designed to protect any submerged Native American artifacts and paper mill ruins.

Each arch was consisted of seven sections. The three sections on each end of each arch were spliced together horizontally and supported from the causeway. One end was attached to the arch support using a pinned bearing, while the other end was raised by cranes and supported on temporary shoring towers. Each of these 275-ton lifts required two 300-ton cranes. After the four arch sections were set in place, the center sections were erected to complete the arches.

Prior to the erection of the arches, the entire deck system, including floor beams, stringers, edge girder, stay-in-place deck forms and reinforcing steel, was erected on the causeway directly under its final position.

When the arch was complete, the 388 foot long, 454-ton deck system was raised to its final position.. Twelve 100-ton hydraulic lifts raised the deck eight inches at a time, a task that required three days to complete. Once in place, the permanent strands were attached and the deck was poured.

Owner
City of Baltimore, Department of Public Works, Baltimore, MD

Structural Engineer
Johnson, Mirmiran & Thompson, Baltimore, MD

Steel Fabricator
Williams Bridge Company, Manassas, VA (AISC member)

Steel Detailer
Alabama Structural Detailers, Inc., Trussville, AL (NISD member)

Steel Erector
Kiewit Construction Company, Elkridge, MD (NEA member)

General Contractor
Kiewit Construction Company, Elkridge, MD

Software
STAADPro

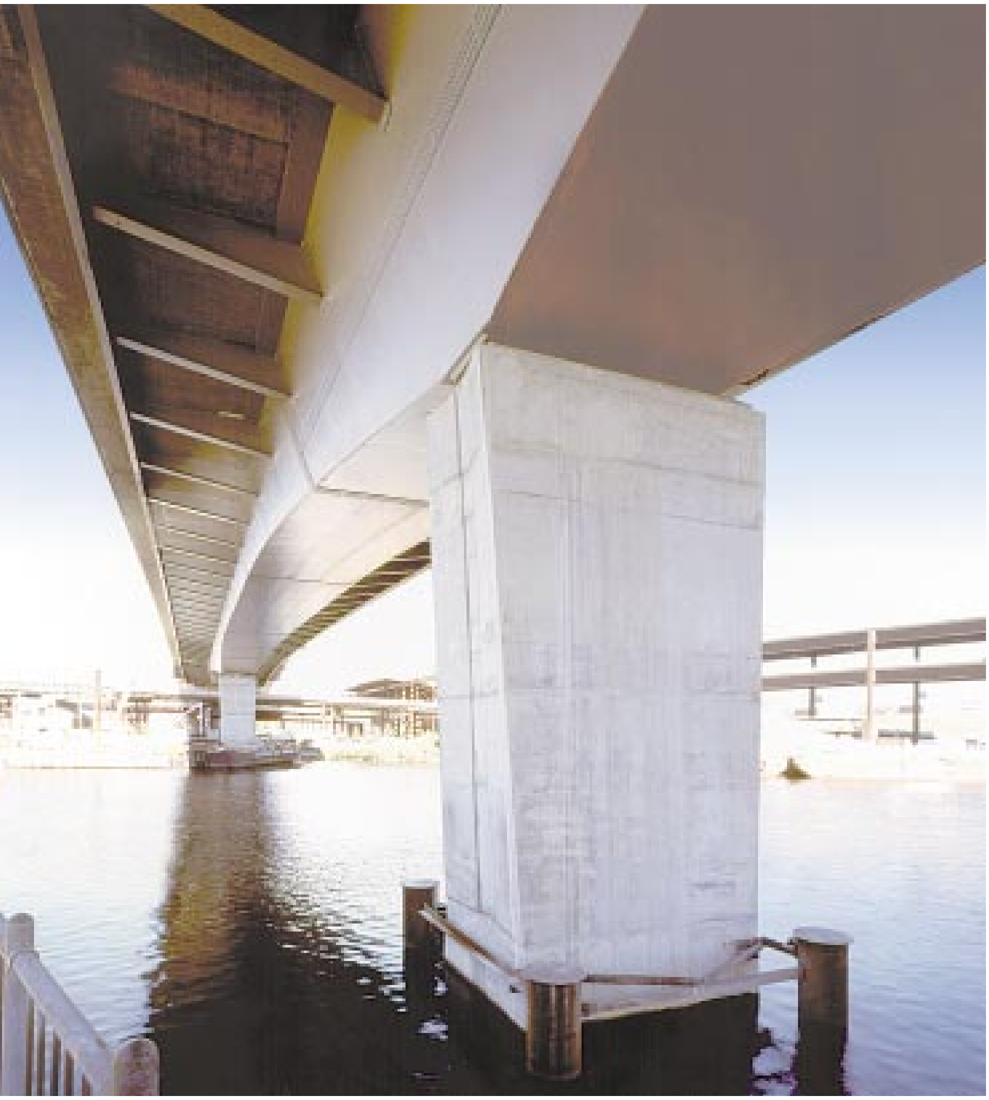
NATIONAL STEEL BRIDGE ALLIANCE

2001 Prize Bridge Award

WINNER: MEDIUM LONG SPAN

Storrow Drive Connector Bridge

Boston, MA



Part of the Central Artery/ Tunnel (CA/T) project in Boston, the Storrow Drive Connector Bridge is the largest steel box girder bridge in the United States. The single-cell trapezoidal steel box girder supports a 76-foot wide roadway, which carries four lanes of traffic connecting Boston's Storrow Drive and Leverett Circle with I-93. The steel alternate was selected over a segmental concrete type structure.

Early in the design process a survey was conducted to gather industry capabilities and preferences for fabrication, handling, transport and erection of large box girder sections. This survey formed the basis for evaluating different choices during the type-study and the preliminary design phases.

The main steel box girder of the Storrow Drive Connector Bridge measures 34′-6″ out-to-out of top flanges and is 31′-0″ wide (c/c webs) at the top flange level. It varies in depth from 8 feet at the end piers to 18 feet at the main piers and to 10 feet at the center of the main span. The constant web slope and the variable depth results in a bottom flange width of 18 feet at the main piers to a maximum of 25 feet at the end piers.

To ensure proper fit-up at the site, the 830-foot box girder was shop-assembled in sections from end to end, including cantilever outriggers and fascia girders, and surveyed to verify the cambered geometry. After the shop fit-up, the sections were disassembled and shipped to Boston.

Field splices were provided to section the 830-foot girder into nine separate field sections. Optional longitudinal splices could be used by the fabricator if required to subdivide these sections for transportation or erection concerns. The 350-ton main pier segments were provided with three longitudinal splices. Two splices were located halfway down on each web and a third at the center of the 18-foot-wide bottom flange, separating it into four sections. For the end sections, the 26-foot-wide bottom flange was provided with two longitudinal splices at third points.

The superstructure required 1,860 tons of structural steel. Over the main piers, the box section consists of 4-inch by 54-inch top flanges, 2-inch-thick bottom flanges and 1¼-inch web plates. Over the negative moment regions near the main piers, the box girder bottom flange was stiffened with WT 16.5 x 100.5 welded in the transverse direction and six lines of WT 10.5 x 36.5 in the longitudinal direction. Longitudinal stiffeners were detailed to pass through web openings of the transverse stiffeners. Over the positive moment areas, the longitudinal stiffeners were changed to ¾-inch by 8-inch plates with MC 6 x 11.5 used in the transverse direction connected to the longitudinal stiffeners at the top with clip angles. The box girder field splices were made with ASTM A325 1" diameter bolts. All other bolted connections used ⅞-inch diameter bolts, including the optional longitudinal splices.

The 10-inch-thick 4500 psi concrete deck slab was designed to act compositely with not only the main box girder but also with transverse floor beams (including the cantilever out riggers) and the longitudinal fascia girders. The resulting span proportions of the deck slab leads to a fairly high level of two-way action, except for the six-foot cantilever overhang section beyond the fascia girders.

The soil conditions indicated the presence of liquefiable layers at the riverbanks near end piers. As an alternate to soil remediation, the designer

proposed to design the drilled shafts against the forces developed by lateral spreading of the post-liquefied soils. At most locations, the liquefaction considerations did not govern the design of the drilled shafts. At the south end pier where this problem was more significant, a 1$^{1}/_{2}$-inch-thick permanent steel outer casing and additional reinforcing steel was provided in the drilled shafts.

The exceptional size and weight of the single-cell box girder sections is an innovative demonstration that, with proper planning, steel box girders of these dimensions can be designed to yield an elegant and economical solution for today's marketplace.

Owner
Massachusetts Turnpike Authority, Boston, MA

Structural Engineer
HNTB Corporation, Boston, MA

Steel Fabricator
Tampa Steel Erecting Co., Tampa, FL (AISC member)

Steel Detailer
Tensor Engineering Co., Indian Harbor Beach, FL (AISC & NISD members)

Steel Erector
Saugus Construction Corp., Georgetown, MA (AISC member)

General Contractor
Daniel O'Connell & Sons, Boston, MA

Software
GT Strudl and in-house software

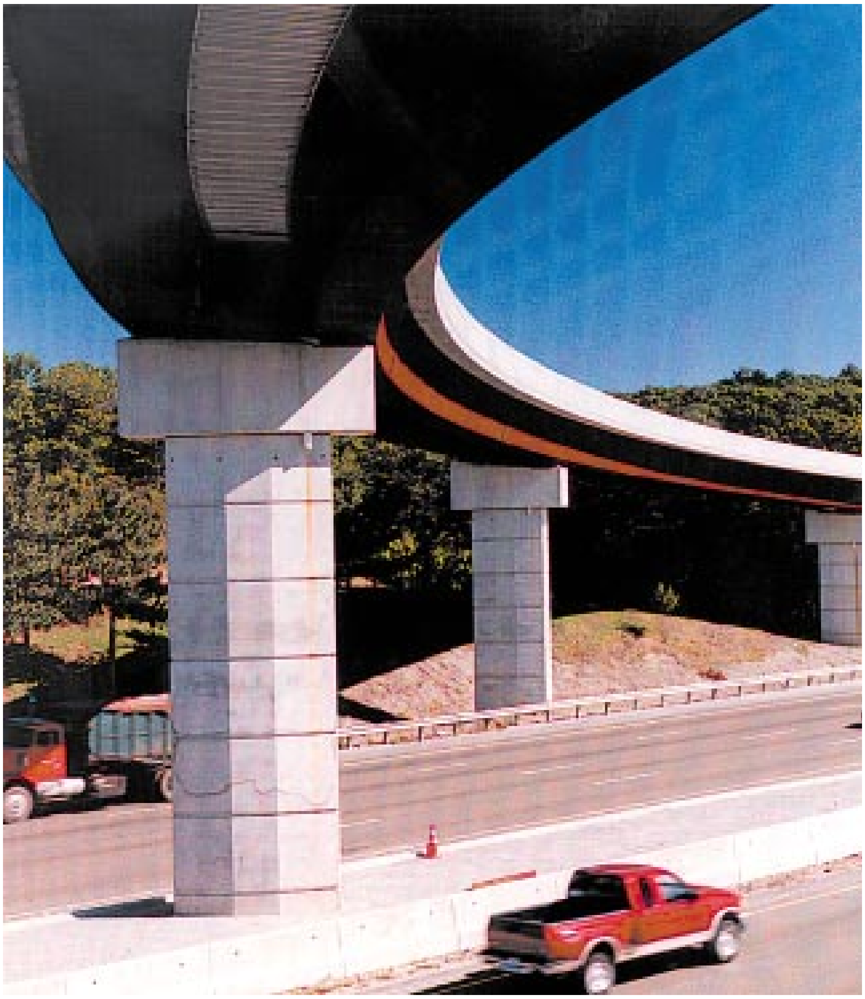
NATIONAL STEEL BRIDGE ALLIANCE

2001 Prize Bridge Award

WINNER: MEDIUM SPAN

Industriplex Interchange Flyovers

Woburn, MA



The I-93 Industriplex interchange project was the first fully directional T-interchange in Massachusetts. Based on type studies, VHB chose curved twin steel trapezoidal boxes to meet tight curvature and minimize structure depths. VHB partnered with the contractor for development of erection procedures. Erection over the Interstate (vpd = 120,000) incorporated southbound closure and northbound crossover. Erection of the girders was completed in less than 36 hours over the weekend.

The interchange directly connects I-93 with a 245-acre area once containing the majority of industry in the city of Woburn, MA, which has been significantly reconfigured to incorporate a 30-acre intermodal center including a MassHighway carpool parking/congregating area, Massachusetts Bay Transportation Authority (MBTA) commuter rail station with parking, and Massachusetts Port Authority (Massport)-Logan International Airport off-airport parking/express bus service, over 1 million square feet planned of "corporate center" space, a 200,000 sq. ft. retail center and hotel/conference space.

I-93 is a major commuter route between Boston and New Hampshire, with substantial buildup along the entire corridor. Additionally, it interchanges with two equally highly traveled routes (I-95/Route 128 and I-495) within one mile and 8 miles, respectively, of the Industriplex interchange. It is also a primary route to vacation and recreational destinations. Maintaining traffic flow during construction was paramount. Construction was scheduled such that erection of the girders occurred in 36 hours over one weekend, during which time the northbound barrel was closed and traffic was diverted to the southbound barrel.

Some design highlights are:

- Both multiple long spans (8 spans = 1,157′ and 11 spans = 1,574′) are jointless, all expansion is allowed at the abutments.
- VHB design eliminated use of intermediate diaphragms and cross frames between girders and used only pier diaphragms, which sped the erection process.
- VHB used complex three-dimensional finite element modeling for analysis of gravity, centrifugal, thermal, seismic and wind load combinations.

Steel was an important element in the design enabling short depths to twin steel trapezoidal box girders of 5′ 6″ for clearance over the Interstate.

The area development enhances the City's economic base and construction of the interchange. It also results in significant improvement to congestion on I-93 and at the interchange with I-95/Route 128 one mile southeast of I-93. For maintenance freedom, ramps were designed of Grade 50 weathering steel with full depth silica fume concrete (high performance concrete) for decks and parapet. They were designed for a 50-year life.

Owner
Massachusetts Highway Department, Boston, MA

Structural Engineer
Vanasse Hangen Brustlin, Inc., Watertown, MA

Steel Fabricator
High Steel Structures, Lancaster, PA (AISC member)

Steel Detailer
ABS Structural Corporation, Melbourne, FL (AISC & NISD members)

General Contractor
SPS New England, Inc., Salisbury, MA

Software
BSTI, STAAD

NATIONAL STEEL BRIDGE ALLIANCE

2001 Prize Bridge Award

WINNER: MOVABLE SPAN

Ninth Street Bridge

over the Gowanus Canal
New York, NY

The Ninth Street Bridge is a new tower-drive vertical lift span with a main span length of 82′. The span was designed to provide a channel width of 60′ and a vertical clearance of 60′ above mean high water when open. The bridge provides three lanes of traffic and two 7′-6″ sidewalks connecting to the area city street grid. The lift span has steel multi-girder framing connected to a welded box lifting girder at each end. The box girders as well as the longitudinal girders are shaped to conform to the unsymmetrical street profile and cross-slope. The roadway deck is a half-filled steel grid. The sidewalk decks consist of a stiffened steel plate with an epoxy grit wearing-surface.

The two steel towers at each end of the bridge consist of four columns each connected at the top with cross girders supporting the machinery rooms. The counterweight sheaves were made larger in diameter than normal to provide adequate space between the counterweight and the lift span for machinery room access stairs. This arrangement optimized the use of space and thereby minimized the tower size. The lift span length was maximized and the structure was visually streamlined by use of compact steel towers. The operator's room is cantilevered from the southwest tower out over the roadway for optimal sight lines through the congested bracing system of the elevated subway.

Additional features included traffic control equipment and gates, highway and utility work, as well as construction of bulkheads and a pier protection system. The pier protection system consisted of stone-filled sheet pile cells along with greenheart timber dolphins and wales. Greenheart timber was used to maximize the life of the system and thereby eliminate the need to drive piles in the area for a long time to come.

Height of Lift Maximized within Site Constraints

Maximizing the height of lift was necessary in order to allow passage of vessels with tall masts and meet Coast Guard permit requirements. A 5′ clearance between the top of the new bridge and the bottom of the overhead bridge

was deemed the minimum acceptable for maintenance purposes. Since height of lift is the same as the distance the counterweight travels, counterweights located over the roadway, as is conventionally done, would limit the height of lift. In the conventional configuration, the counterweight reaches a point close to the roadway level when the span is fully raised. By using four independent counterweights consisting of compact steel boxes containing cast iron and lead located at the corners of the bridge outside of the roadway, the counterweight travel was increased. A further limiting factor to the height of lift is the splay of the counterweight ropes at the sheave. By arranging the ropes in a single row on a widened counterweight sheave without lateral splaying of the ropes, the distance between the lifting girder and the sheave in the fully raised position was minimized. With these two innovative features, the channel vertical clearance was increased to 60′ with the span open.

Constructability

The overhead structure and needs of navigation limited erection procedures for structural steel and machinery components. The tower cross girders provided a work platform which was used to erect the machinery room framing. Provisions for installation of the 20-ton sheaves 5′ below the TA structure were incorporated in the steel framing of the towers. Temporary steel roof extensions were added to lift the sheaves and move them into position at the top of the towers. The framing system designed allowed the contractor the option of either floating in the span or erecting it in the open position while continuing to allow navigation to pass below. Due to geometric constraints of the adjacent bridges, the float in option was not chosen. The lifting girders were hung from the counterweight ropes and longitudinal girders were erected sequentially. Access for the grating installation and completion of the lift span was readily available via the permanent stairways in the towers. Temporary weights were added to balance the span when lowering it for the first time to place the grating infill with the span down.

Owner
New York City Department of Transportation, New York, NY

Structural Engineer
Hardesty & Hanover, LLP, New York, NY

Steel Detailer
John Metcalfe Company, Monroeville, PA (AISC & NISD members)

Steel Erector
American Bridge, Pearl River, NY (NEA member)

Joint Venture General Contractor
Schiavone Construction Co./August C. Lozano P.E., Inc., Secaucus, NJ

Software
M Strudl

NATIONAL STEEL BRIDGE ALLIANCE

2001 Prize Bridge Award

WINNER:

GRADE SEPARATION

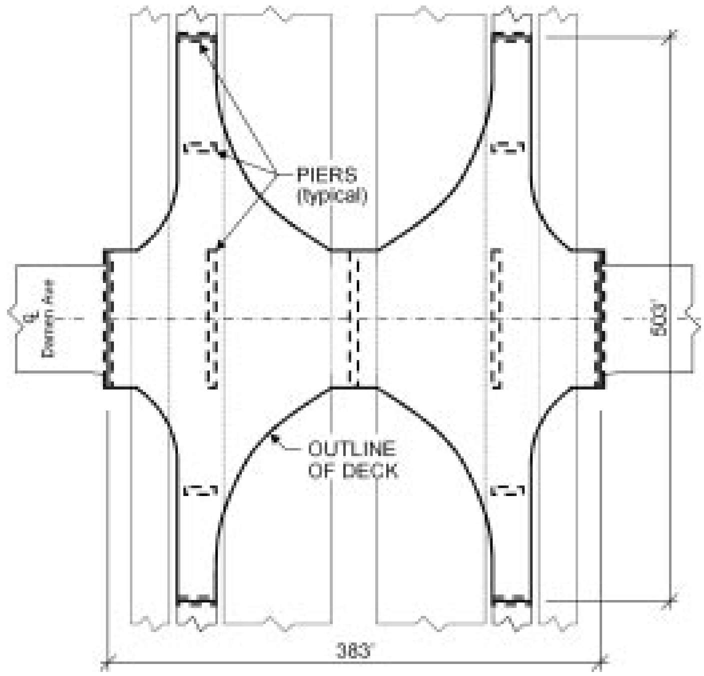
I-55 / Damen Avenue Interchange

Chicago, IL

Limited-access highways have been a boon to travelers but the interchanges needed for access to and from them consume enormous amounts of land—an acute problem in urban areas where land resources are limited. One solution to this problem is the Single Point Urban Diamond Interchange (SPUDI), which can be contained almost entirely within the normal rights of way of the intersecting highways and requires little additional land.

A feature of the SPUDI that has important structural consequences is the large flare at the top of each ramp. The flares are needed to permit two simultaneous left turns onto and off the ramps. Uniquely among SPUDI structures, the I-55 / Damen Avenue design conforms closely to the “minimum” structure needed to accommodate the functional requirements of a SPUDI, minimizing the amount of superstructure required and maximizing the natural light available to the expressway below the interchange.

These benefits of the SPUDI concept (compared to the conventional design) come at the cost of much greater structural design complexity. This design complexity, however, is transparent to the owner, operator and user of the structure.



Basic Superstructure Design Concept

The basic superstructure design consists of a reinforced concrete deck supported on straight steel girders parallel to the Damen Avenue centerline and straight and curved steel girders for the ramps. The upper, flared ends of the ramp structures are framed into the fascia girders of the Damen Avenue bridge structure; these are welded plate girders about 6’-0” deep. The other girders at Damen Avenue and at the ramps are also welded plate girders, about 4’-0” deep.

Piers and Foundations

The typical piers are concrete hammerhead-type units supported on drilled caissons. A steel crosshead within the depth of the girders was required to support the overhanging superstructure at locations where vertical clearance above the expressway was insufficient to accommodate a hammerhead below the girders.

Expansion Joints and Bearings

There are no expansion joints in the 383’ x 503’ H-shaped structure indicated in the figure. The concrete deck and steel framing are continuous over this large area. This eliminates the maintenance and durability problems associated with expansion joints, but it created complications in the design of the bridge bearings, which had to be designed for movement.

Special Condition at Damen Fascia Girders

The steel structure and the concrete deck are continuous across the Damen Avenue fascia girders. There is no expansion joint between the ramp structure on one side of the girder and the Damen Avenue bridge structure on the other side. The cross frames and diaphragms are configured to permit the fascia girder to rotate about its top to accommodate rotations caused by the deflection of the ramp spans. The deck slab has sufficient flexibility to accommodate this rotation without cracking.

Owner
Illinois Department of Transportation, Schaumburg, IL

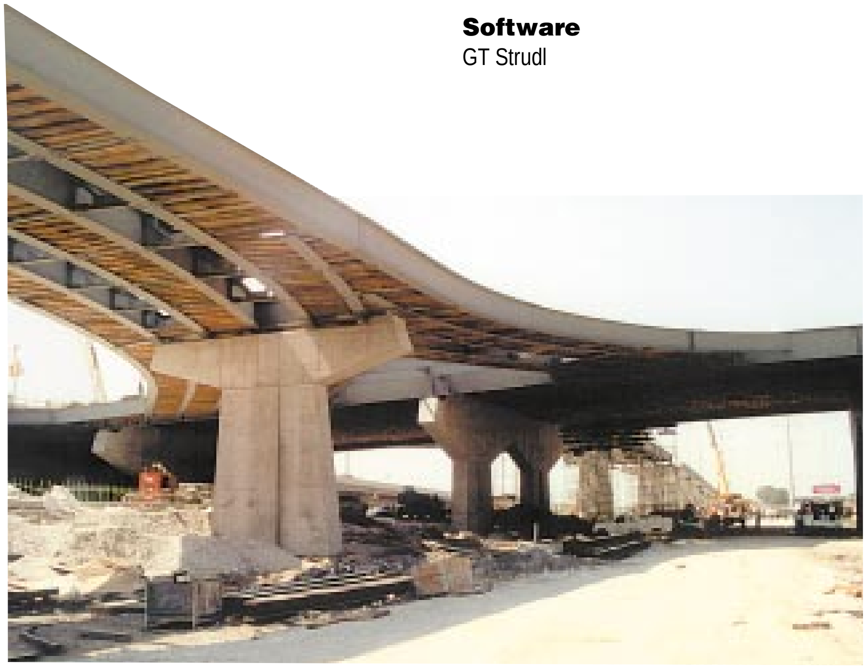
Structural Engineer
Teng & Associates, Inc., Chicago, IL

Steel Fabricator
PDM Bridge, Wausau, WI
(AISC member)

Steel Detailer
Tensor Engineering Company, Indian Harbor Beach, FL (AISC & NISD members)

General Contractor
Walsh Construction Company, Chicago, IL

Software
GT Strudl



NATIONAL STEEL BRIDGE ALLIANCE

2001 Prize Bridge Award

WINNER:

RECONSTRUCTED

I-440 Ramp over I-24

Nashville, TN

The original structure, a four span continuous steel twin tub girder bridge with composite deck, was constructed in 1983 as a one-lane ramp bridge. Its intermediate supports are composed of integral steel box girder bent caps resting on single reinforced concrete filled steel shell composite columns. This substructure configuration was chosen because of a lack of room for pier placement within the interchange, as well as the desire to keep the substructures oriented radially for its curved alignment over a highly skewed crossing. Due to increasing traffic volumes in the intervening years, it became necessary to widen the bridge from its original 30′ roadway to provide a 42′ wide two-lane facility.

Because of the tight, highly skewed configuration of the lanes beneath, choices of how to widen the bridge were limited. If widened to one side only, the substructure for the new portion would have had to be skewed for column placement, and the new integral caps would not have aligned with those existing. Otherwise, the columns and caps of the widened portion would have had to be staggered. In either case, differential deflections between the existing and new girders would have been a substantial problem.

Widening symmetrically and forgoing additional columns solved the aforementioned problems. This choice, however, created several difficulties for the designer. The first problem was how to add extensions to the presently constructed integral bent caps. Second, while the columns had adequate reserve capacity, the existing bearing pins and pin plates as configured could not support additional dead and live loads required. The third problem was the need to control the non-composite new girders during the slab pouring phase to assure a smooth continuation of the existing superelevated cross slope. Fourth, could the resulting four-girder system equally share in the distribution of dead and live loads? Finally, could the construction work be accomplished with minimal traffic disruption?

Innovations

To create the integral cap extension, holes were drilled in the outside half of the existing top flange of the longitudinal tub girders at each intermediate support. The bottom flange was similarly drilled. The cap beam extensions were designed as cubes with one side open. Opposite the open face, the side in contact with the existing girder web was fabricated with a porthole. The completed extensions were first bolted to the flanges and exterior web of the existing longitudinal girders. After connection, a porthole was then cut in the existing web of the tub girders, providing access during construction and for future inspections.

In order to increase the bearing capacity of the existing bearing pins, the retaining nuts were removed from the pins and replaced with machined caps internally threaded and turned to the approximate diameter of the existing pins. Next, new pin plates fitting the cap extensions were installed and welded to the bottom of the cap beam and the outside of the steel shell of the composite column.

New stiffener/connection angles were bolted to the outside of the external webs of the existing tub girders collinear with the existing transverse stiffeners. To these new angles, narrow connection plates were bolted to the outstanding legs. Subsequently, diagonal high strength rods, in pairs, were installed. These rods eventually would pass through the top flanges of the new box girders. The leading edge of the narrow connection plates contained a line of drilled holes matching the external stiffener/connection plates of the new girders. The top-and-bottom most holes in the narrow connection plates were slotted. During the erection of the new longitudinal box girders, bolts were only installed in the two slotted

holes finger-tight, and the diagonal high strength rods tensioned so that the new box beams were lowered while the adjacent tub girders were raised to obtain equal elevations. The hand tight bolts in the slotted holes of the connection plates guided the new girders during the jacking process to prevent transverse rotation of the new box girders. This process of pre-loading the new girders decreased the load on the existing girders so that future loadings would be equally shared by the total system.

Owner
Tennessee Department of Transportation, Nashville, TN

Structural Engineer
Tennessee Department of Transportation, Nashville, TN

Steel Fabricator
Carolina Steel Corporation, Greensboro, NC (AISC member)

Steel Detailer
ABS Structural Corporation, Melbourne, FL (AISC & NISD members)

General Contractor
Ray Bell Construction Company, Inc., Brentwood, TN

Software
In-house

NATIONAL STEEL BRIDGE ALLIANCE

2001 Prize Bridge Award

WINNER:

SPECIAL PROJECT

I-15 Design/Build Reconstruction Project

Salt Lake City, Utah

The success of the I-15 project mandated that all construction disciplines act as a team. Utah Pacific Bridge and Steel led the team effort by creating a joint venture of four fabricators, an erector and a detailer, called I-15 Steel Structures. The I-15 Design/Build Project involved the design and construction of over 125 bridges in approximately four years to have this major roadway open in time for the 2002 Winter Olympics in Salt Lake City.

The girders for the project were all I-girders, but their similarities ended there: they were haunched, straight, curved, simple and multiple span, medium and long span, tapered, skewed, splayed, Y shaped and located over rail yards, roads, interstate highway and a river. They varied from 2.5' deep to 14' deep. For the steel bridges, all the designers agreed to limit the use of transverse stiffeners, to avoid the use of longitudinal stiffeners and to limit the use of haunched girders

The decision was made early in the project that all work on the design would be completed in Salt Lake City. All companies working on the project would have staff located in one design office near the SLC airport. Over 400 engineers, architects, contractors and

UDOT staff moved into the facility, and at the peak of the project over 140 bridge engineers were in Salt Lake City. The use of one office made it very easy to make quick and effective decisions

Throughout the process, the bridge designers, detailers, fabricators and construction personnel worked closely together to provide a design that is the most cost-effective for everyone in the process. After about six months of design, the designers, detailer, and fabricators met to review the designs to date and readjust the design criteria to the demands of design in a high seismic region.

For each submission in the process, plans were shared with the contractor, fabricator, UDOT, and other design disciplines for a constructibility review. This allowed all others in the process to tender comments to improve constructibility, reduce cost, coordinate disciplines and standardize presentation throughout the project.

Input from the detailer, fabricator and erector was received by the designer on every bridge. Fabricators have long known that simply reducing steel weight will not necessarily result in less overall cost. If an engineer replaces a thicker, unstiffened web with a thin web stiffened by numerous intermediate stiffeners, he will reduce weight but actually increase cost because of the high cost of labor. The design for I-15 included many cost saving measures as follows

- Thicker webs resulting in elimination of intermediate stiffeners. Only two intermediate web stiffeners were allowed adjacent to the pier bearing stiffeners.
- Consistent flange thickness from girder line to girder line reduced waste from plate nesting and purchasing from the steel mill.
- Greater cross-frame spacing resulting in fewer cross-frames to fabricate.
- The use of 1″ diameter bolts at the field bolted splices verses $^{7}/_{8}$″ diameter bolts resulted in fewer bolts and fewer holes.
- The elimination of stiffener tab plates that attach to the flanges resulting in a $30.00 savings at every stiffener location.
- A standardized "K"- type cross-frame was used for intermediate

bracing resulting in more economical fabrication and material purchase. A welded full depth plate type diaphragm was used at the pier and abutments.
- Wider girder spacing averaging 14'-0" resulting in less girder lines to fabricate, ship and erect. The heavier, stiffer girders were more cost effective to fabricate, holding their curve and camber well, and having minimal weld distortions.

Detailing

The I-15 Design Build project in Salt Lake City presented the steel detailer with a completely new set of challenges. Detailing challenges included the following:
- Establishing a common detailing system that would work for four different fabricators each with its own standards and detailing systems.
- Establishing a common design presentation and typical details that would be used on all of the bridges.
- Establishing the method to transfer all of the design data and drawing files electronically to and from the design engineers and fabricators.

This project is a great example of what can be accomplished when the detailer is engaged prior to the award of a contract and works closely with the designer and fabricator during the preparation of the design plans.

Owner
Utah Department of Transportation,
Salt Lake City, UT

Structural Engineers
Sargent Engineers Inc., Logan, UT

H.W.Lochner Inc., Murray, UT

T.Y. Lin International, San Francisco, CA

Washington Infrastructure Services Inc.,
Salt Lake City, UT

URS Greiner Inc., Tampa, FL

Parsons Transportation Group, Littleton, CO

Sverdrup Civil, Inc., Bellevue, WA

Steel Fabricators
Roscoe Steel & Culvert Co., Billings, MT
(AISC member)

Fought & Company, Tigard, OR
(AISC member)

Universal Structural, Inc., Vancouver, WA
(AISC member)

Utah Pacific Bridge & Steel,
Pleasant Grove, UT (AISC member)

Steel Detailer
Tensor Engineering Co., Indian Harbor Beach,
FL (AISC & NISD members)

Steel Erector
OLSENBEAL, Lindon, UT (NEA member)

Design Build Contractor
Wasatch Construtors, Salt Lake City, UT

Software
DESCUS, Merlin DASH

NATIONAL STEEL BRIDGE ALLIANCE

2001 Prize Bridge Award

merit award: LONG SPAN

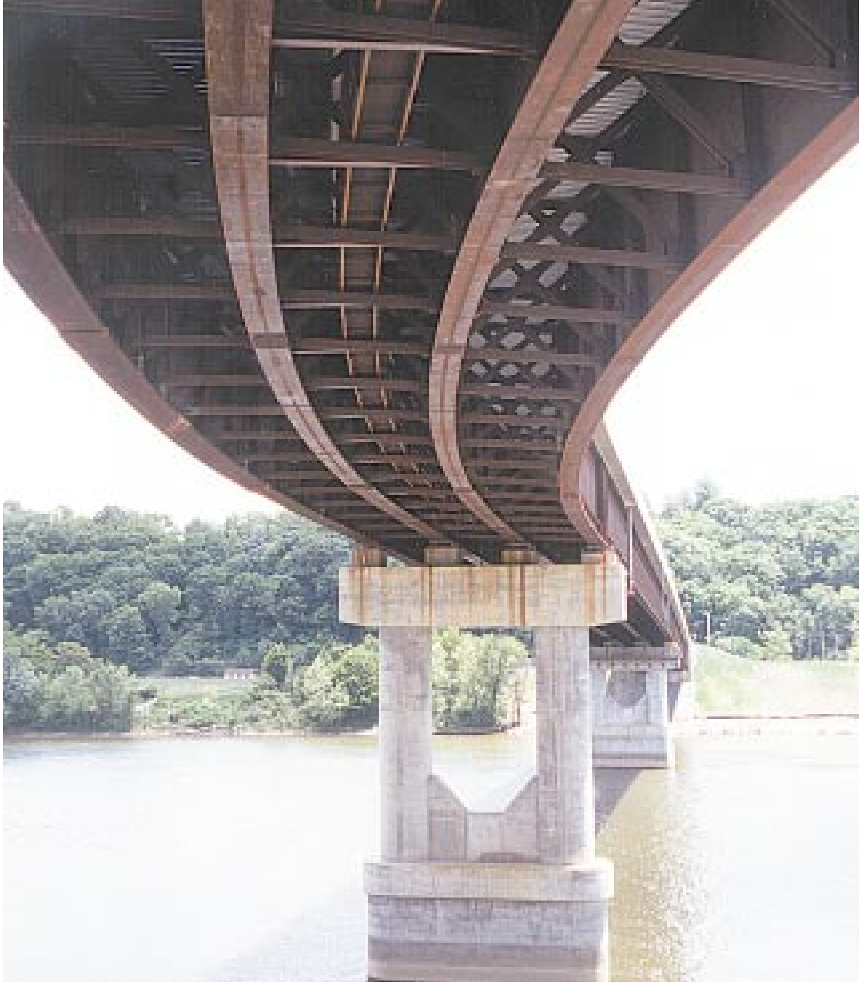
Ford City Veterans Bridge

Ford City, PA

The Ford City Veterans Bridge in Armstrong County at Ford City, PA is a three-span continuous curved steel plate girder bridge with a total length of 323m (1060'), carrying S.R. 0128 over the Allegheny River and the Pittsburgh and Shawmut Railroad . The structure showcases Pennsylvania's longest curved girder to date and PennDOT's first use of grade 485W (70 ksi) high performance steel.

Construction

The project was awarded on April 15, 1998, and traffic was placed on the new bridge on July 31, 2000. The bridge was completed in time for the dedication and naming ceremony on July 28, 2000, but many unique construction challenges had to be overcome in order to accomplish this.



The first significant challenge was the transportation of the 4.3m (14′) deep girders to the project site by water and train. The girders were fabricated by PDM Bridge, of Eau Claire, WI. It took an enormous amount of manpower, equipment and coordination to accomplish this task. Another difficult challenge was the fabrication and erection of these same large girders. This task was also difficult because of the tight radius of 155m (509′) in the curved section of the bridge.

Project Success

The completion of the project marked two very significant accomplishments for the industry. First, by using one of the largest applications of curved high performance weathering steel in the nation to date, the project has paved-the-way for the construction industry to utilize this new material. Eventually, this will greatly reduce construction costs as the new steel becomes increasingly more popular and available. Second, this project was one of the first projects in Pennsylvania to use "partnering" in the design phase to provide local input directly into the design of the new bridge. By implementing partnering during the design phase and working with the local community, PennDOT and its "stakeholders" were able to expedite the design schedule and deliver the best project possible to meet the community's needs.

Significant Project Features

- 3-span, steel curved girder bridge with a main span length of 127.0m (416.67′).
- Total bridge length of 323.0m (1059.71′).
- The structure stands 29.2m (95.8′) above water at the west pier.
- First use of high performance steel in Pennsylvania and one of the largest applications in the nation.
- Currently, Pennsylvania's longest curved girder with a length of 102.0m (334.87′).
- The curved girder had an extremely tight radius of 155m (509′).
- Construction of the new bridge used 9531 cubic meters (12,466 cubic yards) of concrete, 5 million pounds of structural steel and 1 million pounds of reinforcing bars.
- Built in 1914, the existing bridge was demolished in August of 2000.

Owner
Pennsylvania Department of Transportation, Indiana, PA

Structural Engineer
Michael Baker Jr., Inc., Coraopolis, PA

Steel Fabricator
PDM Bridge, Eau Claire, WI (AISC member)

Steel Detailer
Candraft Detailing, Inc., Port Coquitlam, BC Canada (NISD member)

Steel Erector
Abate Irwin, Inc., Eighty Four, PA (NEA member)

General Contractor
Trumbull Corporation, Pittsburgh, PA

Software
Some in-house

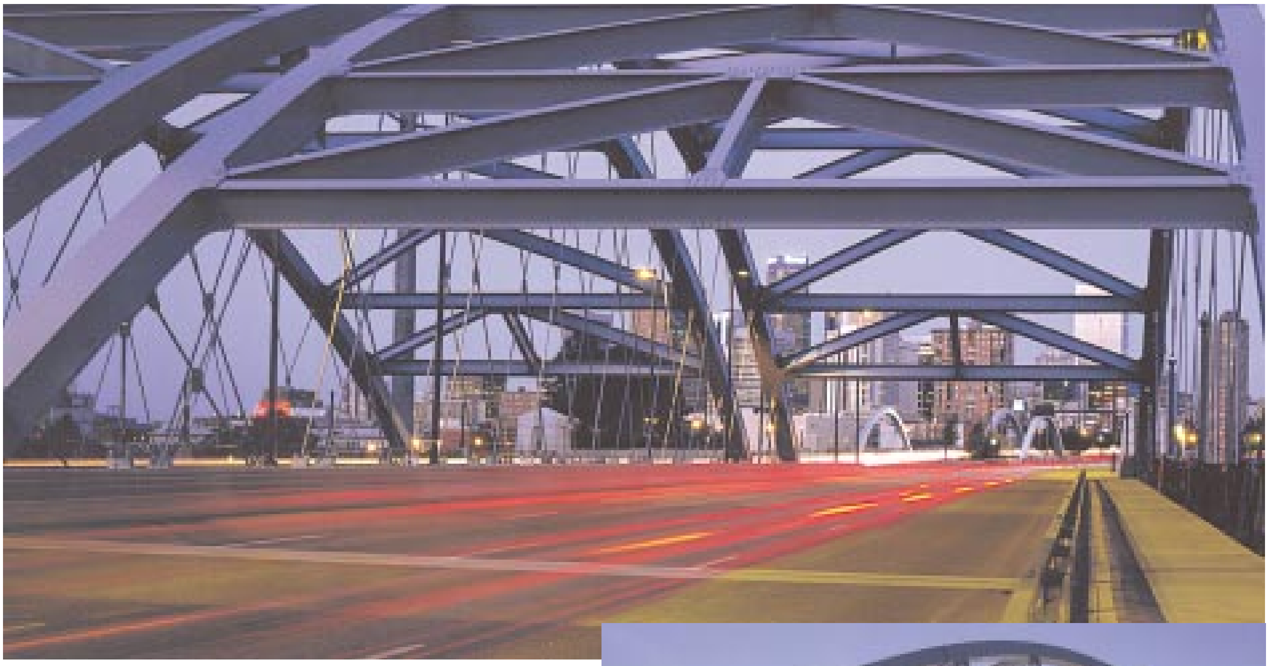
NATIONAL STEEL BRIDGE ALLIANCE

2001 Prize Bridge Award

merit award: MEDIUM LONG SPAN

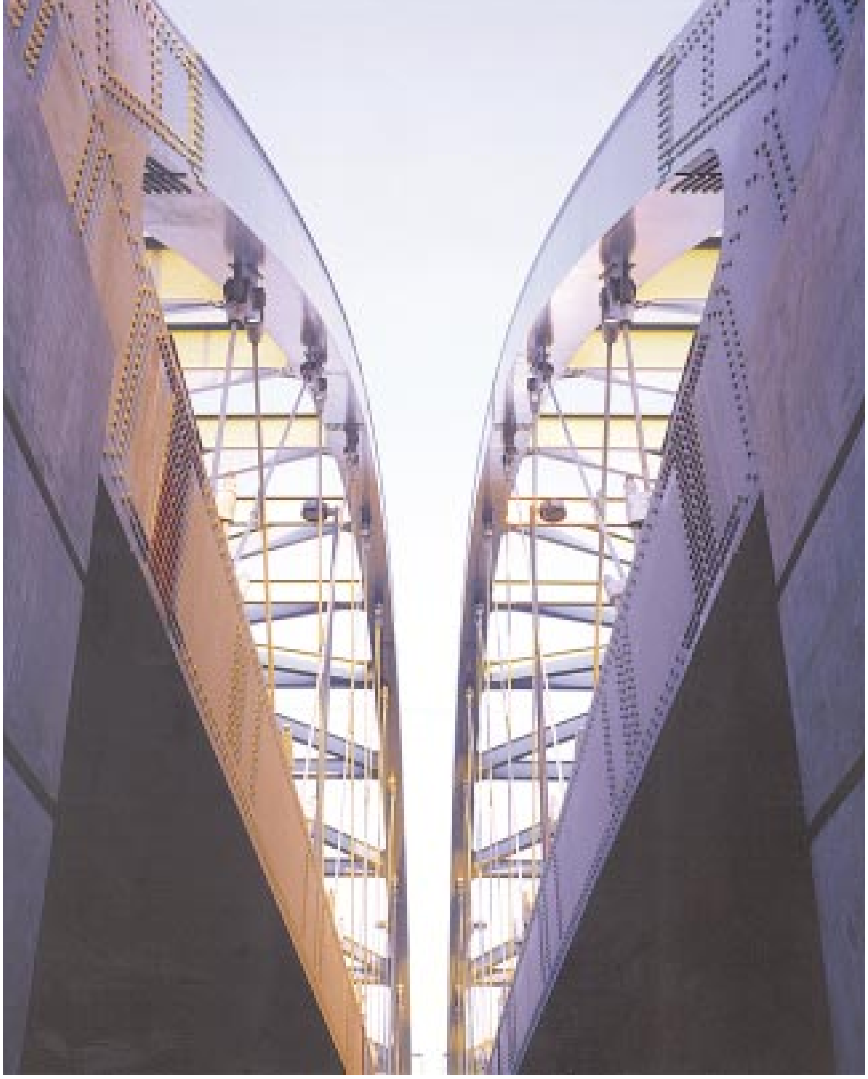
Speer Boulevard Bridge

Over the South Platte River,
Denver, CO



In the 1980s, the City of Denver undertook to revitalize the "Central Platte Valley," an area of former railroad and industrial uses, which have separated the City's downtown from the South Platte River, Interstate Highway 25, and its northwest neighborhoods. A key component of the Central Platte Valley Plan was the reconstruction of the "Valley's" aging transportation infrastructure. Speer Boulevard is a major arterial roadway within the Central Platte Valley and the primary entrance to Denver from the Northwest.

A key element of Speer Boulevard reconstruction was the replacement of twin 400′ long multiple-span steel beam bridges over the South Platte River. The twin replacement structures include 253′- 6″ steel tied-arch main spans in a unique configuration with flanking beam approach spans. The project posed challenges unique to its urban setting, which included limited working space at a site surrounded by city parks, the need to maintain highway, pedestrian, river and trolley traffic at the site during construction, the



Owner
City and County of Denver, Denver, CO

Structural Engineer
BRW, Inc., Denver, CO

Steel Fabricator
Central Denver Ironworks, Inc., Denver, CO (AISC member)

General Contractor
Edward Kraemer & Sons, Inc., Castle Rock, CO

Consultant
Zimmer Gunsul Frasca Partnership, Portland, OR

Software
SAP2000 Plus, STAAD

need to accommodate utilities, work with very limited structure depth, minimize the clutter of multiple substructures and create a downtown "gateway" architectural design within a limited budget.

Concept Design and Structure Type Selection Process

The selection of the tied-arch bridge type was made following a thorough evaluation of a range of feasible alternative bridge types which included beam bridges, through and deck arches, trusses, and a cable stayed option. The tied-arch design was judged to best satisfy the adopted project goals and selection criteria, which included:

• Having a shallow structure depth, similar to that of the existing bridges, to minimize approach roadway reconstruction and to maintain required minimum vertical clearances over a street and historic trolley tracks;

• Being constructable under heavy traffic conditions within a constricted site surrounded by parkland;

• Eliminating piers within the riverway and minimizing the overall number of substructures.

• Being constructable within the available budget;

• Providing a gateway architectural statement in harmony with the site.

NATIONAL STEEL BRIDGE ALLIANCE

2001 Prize Bridge Award

merit award: MEDIUM SPAN

Avery-Muirfield Drive Bridge

Over US33/SR 161, City of Dublin, OH

The existing 36′ wide, four-span structure was a conventional highway steel beam bridge with capped column piers and stub type abutments. All three existing piers were situated less than 30′ from edge of pavement and were shielded by guardrail to mitigate their hazard. The vertical clearance provided by the existing bridge over US33/SR161 (designated on the National Highway System) was substandard at less than 15′.

The new bridge needed to meet current design standards for minimum horizontal clear zone to eliminate guardrail and increase the vertical clearance to a preferred 17′ minimum, while minimizing any

raise in profile grade on Avery-Muirfield Drive so as to avoid re-grading of interchange ramps that flank the bridge. It also needed to be easily constructed while safely maintaining all lanes of traffic both on and under the bridge throughout construction.

Anchored End Span Design

An anchored end span type bridge met all of the above design requirements the best and provided an elegant bridge form from which to develop other architectural features. Furthermore, it allowed the City of Dublin the distinction of having the first bridge of its type in the State of Ohio.

The three-span, continuous, steel girder bridge appears to motorists as a single clear span of 191′ over the six-lane highway with no center support. Limestone faced solid wall piers support the main span and hide the 33′ end spans and abutment anchorage. The deck is 105′ 6″ wide and carries six lanes of traffic and two combination bikeway/walkways. The superstructure framing is comprised of twelve girders having 72″ webs in the end spans and parabolic haunches with 48″ minimum web depth in the center span. The ends of the girders are anchored to the abutments using four post-tensioned galvanized threaded anchor rods extending from a top flange mounted load plate down into grease-packed ducts in the abutment breastwalls. The abutments, designed to preclude pile uplift, have massive footings that serve as counterweights to offset uplift from the unbalanced end spans. Buried pile struts braced off the rigid pier foundations serve to increase the lateral stability of the abutments. Moveable deck joints are avoided by utilizing a semi-integral abutment design that includes a moveable backwall, elastomeric expansion bearings and 12′ long flexible anchor rods to accommodate superstructure thermal movements. Recesses are provided in the abutment for future inspection of the anchor rods. Access to the enclosed spans for inspection and future maintenance is provided via removable fence panels between the girders atop the piers.

The continuity provided by the enclosed short end spans enables the use of gracefully-thin haunched girders in the center span that facilitate obtaining the increased vertical clearance with minimal raise in the overpass profile. It allows the structure to dramatically vault over the entire divided highway without a center pier or any other support within a 30′ clear zone from the edge of traveled lanes. This not only significantly improves the safety of the site by removing hazards within the clear zone; it also greatly increases the aesthetic value of the structure.

Owner
City of Dublin, Dublin, OH

Structural Engineer
Burgess & Niple, Limited, Columbus, OH

Steel Fabricator
Vincennes Steel, Vincennes, IN
(AISC member)

Steel Detailer
Tensor Engineering Company, Indian Harbor Beach, FL (AISC & NISD member)

General Contractor
Complete General Construction Company, Columbus, OH

Consultant
Lisle Architecture & Design, Inc., Wilmington, NC

Software
MDX Software (Curved and Straight Steel Bridge Design and Rating), Bridgesoft, Inc. (STLBRIGE)

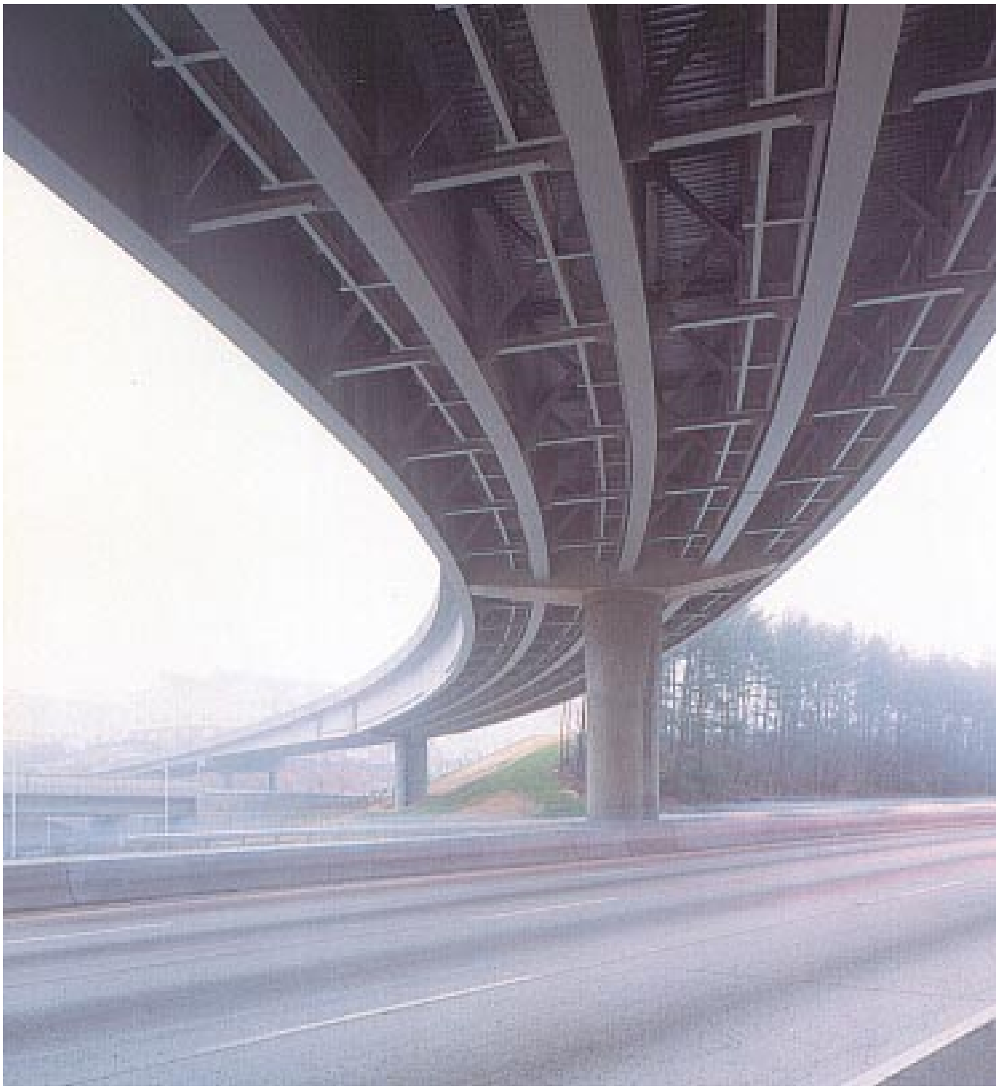
NATIONAL STEEL BRIDGE ALLIANCE

2001 Prize Bridge Award

merit award: MEDIUM SPAN

GA 400 Flyover Ramp

MARTA North Springs Station, Atlanta, GA



Opened to traffic in late 2000, the new North Springs Station Flyover Ramp provides direct access to MARTA's North Line for Atlanta area commuters living in the northern suburbs. This direct connectivity between transit and highway modes of transportation is an essential component in the Atlanta area's long-range plan to encourage utilization of transit and increase air quality. With this in mind, the design of the dedicated station access facility focused on creating an efficient, aesthetic, convenient and safe roadway and bridge system that would draw users to the transit linkage.

Dimensionally, the first 1,648.95′ (502.6m) of the access ramp is constructed on retained fill using mechanically stabilized earth wall units perched on a 2:1 embankment. The finish of the precast panels facing the residential areas was made to resemble cobblestone walls at the request of a local citizens group. In addition, extensive sound walls were constructed on the ramp to mitigate the noise of buses that frequent the MARTA facility.

Near the flyover section, the ramp transitions from a single deceleration lane to two lanes on the curved steel portion of the bridge, providing separation of bus and parking deck vehicular traffic. The bridge was designed to not only span the current GA 400 traffic and MARTA trackway but also allow for the construction of future collector-distributor (CD) lanes as well. The 6% maximum, super-elevated roadway cross section allows a smooth ride around the 468.17′ (142.7m) radius curved bridge.

The bridge superstructure is comprised of five parallel steel girders with web depths transitioning from 5′ to 9′ to 3.28′, (1.524m, 2.743m, 0.838m) based on span requirements and economy. A single girder hinge location inconspicuously dissipates super-structure stresses of the otherwise continuous bridge. Due to roadway clearance concerns, pier caps were cast integrally within the depth of the girders and post-tensioned through the webs for support. Structural rotation at the piers is provided for at the top of the lozenge shaped columns using a key and hinge connection. All steel was painted to match the color of the concrete to increase the transparency of the design and enhance the fluidity of the structure from end to end. The foundations consist of both pile and drilled shaft depending on the localized soil conditions.

In addition to the structural continuity and elimination of all but one deck joint, the serviceability of the bridge is enhanced by the use of a corrosion inhibiting admixture in the deck slab, galvanized reinforcing in the barrier rail and inspection platforms along each girder spanning over the highway portion of the bridge.

Owner
Metropolitan Atlanta Rapid Transit Authority (MARTA), Atlanta, GA

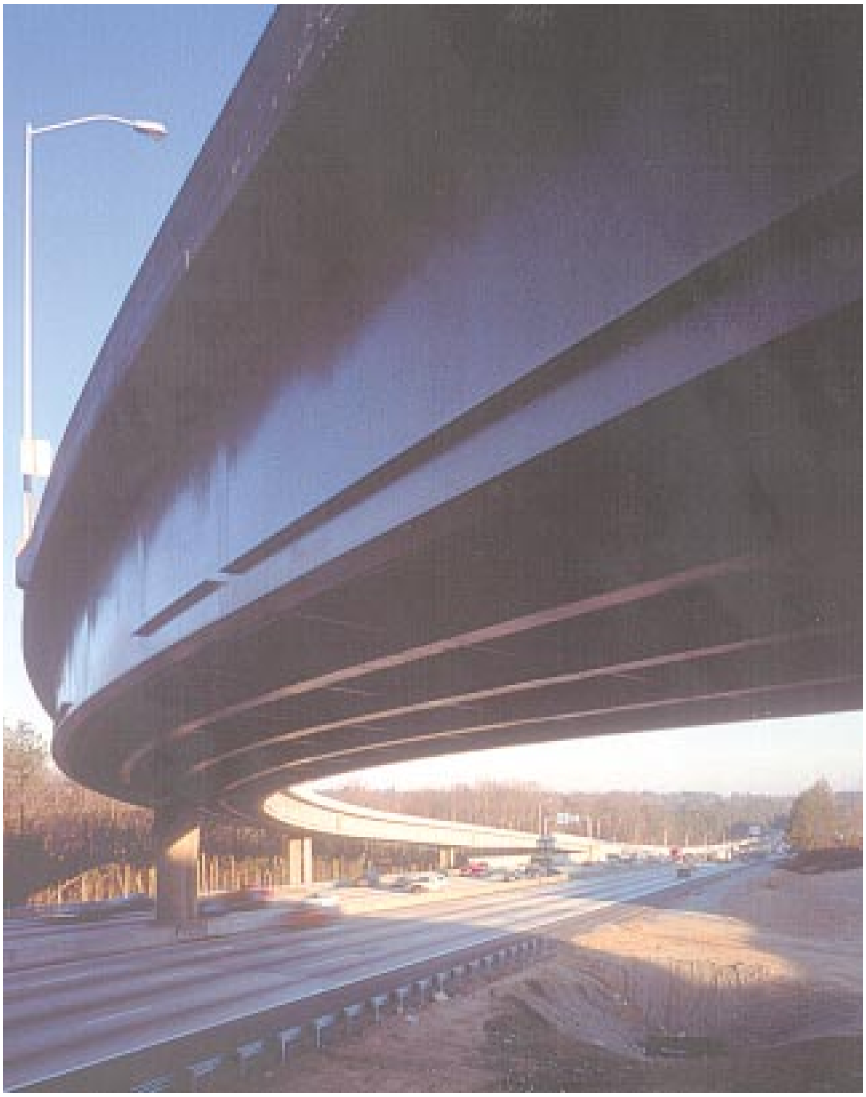
Structural Engineer
HNTB Corporation, Atlanta, GA

Steel Fabricator
Carolina Steel Corporation, Montgomery, AL (AISC member)

Steel Detailer
Carolina Steel Corporation, Montgomery, AL (AISC member)

General Contractor
PCL Civil Constructors, Marietta, GA

Software
Descus 2



NATIONAL STEEL BRIDGE ALLIANCE

2001 Prize Bridge Award

merit award: SHORT SPAN

Bristol Road Bridge

Bucks County, PA

Bristol Road, an important arterial road that connects central and lower Bucks County, PA, carries over 10,400 vehicles per day. The existing site consisted of a mix of environmental concerns, substandard hydraulic conditions, a severely deteriorated concrete bridge and dangerously sharp curves on the approaches to the structure. Bristol Road is a relatively straight roadway for its entire length through Bucks County except for this site. The sharp curves at the bridge had been the scene of numerous accidents through the years, some of which involved fatalities.

Design Problems and Innovative Solutions

The challenge for this project was to replace the bridge with a hydraulically efficient structure and to improve the poor approach alignment to the bridge, while minimizing impact to the environment. To achieve the desired result, a slender three-span continuous steel multi-girder bridge (with span lengths of 84′-8″, 112′-8″ & 84′-8″) with a severe 19º30′ skew to the stream was designed and constructed. Steel was chosen over prestressed concrete for two main reasons. First, a shallow girder was requisite to fit the required roadway profile while providing the waterway opening for hydraulic considerations. Second, the owner's criteria will not allow the use of prestressed concrete for the skew of this bridge.

The severe skew was necessary to improve the poor approach alignment, but it made this design more difficult than a typical straight steel girder bridge. In order to accurately predict the behavior of the bridge both during construction and after completion, a finite element analysis was used. Some important aspects of the structure design included:

- Evaluation of lateral girder rotation during the deck pouring sequence due to the severe skew.
- Analysis of the intermediate and end diaphragms as main load carrying members to provide greater stiffness to better resist girder rotation.
- Checking of girder uplift during the entire deck pouring sequence to determine if the bridge would behave differently than a typical straight bridge.
- Determination of temperature forces transmitted to the bearings and the substructure.
- Evaluation of differential deflection of adjacent girders during the pouring sequence.

These various analyses led to innovative solutions to minimize the forces on the structure. Our temperature analysis indicated that large, almost unmanageable horizontal forces at the bearings would result if the bearings were oriented to allow movement parallel to the girder, as is the typical practice. The designer opted to use pot bearings and to orient them all toward a fixed point in the middle of the bridge. Through an iterative process, the designer was able to almost completely eliminate the effects of temperature to this structure.

Another innovative technique utilized was to require the contractor to leave the end diaphragm bolted connection to the girders loose until the deck was poured. Therefore, the structure was modeled so that no dead load was transmitted to the end diaphragm. Minimizing the load was necessary because the diaphragms were very long due to the severe skew. A cost effective design was not possible without this resourceful innovation.

Owner
Pennsylvania Department of Transportation,
King of Prussia, PA

Structural Engineer
Johnson, Mirmiran & Thompson, York, PA

Steel Fabricator
High Steel Structures, Lancaster, PA
(AISC member)

Steel Erector
High Steel Structures, Inc., Lancaster, PA
(AISC member)

General Contractor
McMinn's Asphalt Company, Inc.,
Lancaster, PA

Software
BSDI-3D
(Bridge Software Development International)

NATIONAL STEEL BRIDGE ALLIANCE

2001 Prize Bridge Award

merit award: SHORT SPAN

James P. Kirkwood Bridge

West Argonne and Clay Avenue, Kirkwood, MO

In 1996, the City of Kirkwood, MO, was faced with the challenge of replacing the deteriorating James P. Kirkwood bridge, (formerly Clay Avenue bridge), which spans the Union Pacific Railroad and is located in a historic (pre-Civil War) downtown business district.

The engineering firm, in coordination with the City Steering committee, selected a steel pony truss bridge as the replacement structure. A pony truss bridge presents a unique structural design challenge since the top chord is not directly braced as it would be in a through truss bridge.

Although the pony truss bridge was popular before World War II, they are rarely used today and there is little guidance in AASHTO or other current references about their design. The design team's innovative solution included treating the top chord as a beam-column supported by an elastic foundation (the truss verticals). The truss verticals are connected to the floor beams with a fixed moment connection to develop their "spring stiffness" resulting in an unbraced length design that is a function of the floorbeam and truss vertical stiffness, the top chord section properties and length.

Economic Benefit and Cost-Effective Aspects of the Design

The James P. Kirkwood bridge is vital to the economic viability of Kirkwood's downtown business area, carrying over 8,000 vehicles a day and providing a bypass for the frequently blocked Kirkwood Road (State Highway 61) railroad crossing.

Cost-effective aspects of the design included providing the minimum structural depth solution, resulting in a minimal impact to the current grade. Most economic bridge types currently in use would have required raising the grade substantially to provide adequate vertical clearance.

The pony truss bridge provides greater horizontal and vertical clearances for the railroad tracks below without causing costly reconstruction of the intersections on each end.

Design Problems and Solutions

Vertical clearance requirements of the Union Pacific Railroad and State Department of Transportation, Bridge Safety Division and the grade of the approach roadway presented design challenges.

The James P. Kirkwood bridge provides a grade separation at the Union Pacific Railroad crossing. The span was lengthened from the original 64' to 90' due to the horizontal clearance required by the railroad. To meet the vertical clearance requirement a steep vertical curve is used which caused considerable increase in complexity both in design and fabrication of the steel structure.

The limited right-of-way of the approach roads with structures along the right-of-way lines further increased the complexity of the design. The roadway approaching the bridge has a +10% grade on the north and a -5.75% grade on the south. The bridge trusses were cambered to approximate the roadway camber.

The pedestrian sidewalk also contributed complexity to the connections on the bottom chords. The sidewalk was cantilevered from the bottom chord in line with the floor beams, which meant that continuity had to be maintained in three directions: the truss bottom chord, the floor beam and sidewalk beam and the truss vertical.

Owner
City of Kirkwood, Kirkwood, MO

Structural Engineer
Horner & Shifrin, Inc., St. Louis, MO

Steel Fabricator
Havens Steel Company, Kansas City, MO (AISC member)

Steel Detailer
Havens S.P.I., Kansas City, MO (NISD member)

Steel Erector
Havens Erectors Inc., Kansas City, MO (AISC & NEA members)

General Contractor
The Harlan Company,
St Louis, MO

Software
SAP2000

NATIONAL STEEL BRIDGE ALLIANCE

2001 Prize Bridge Award

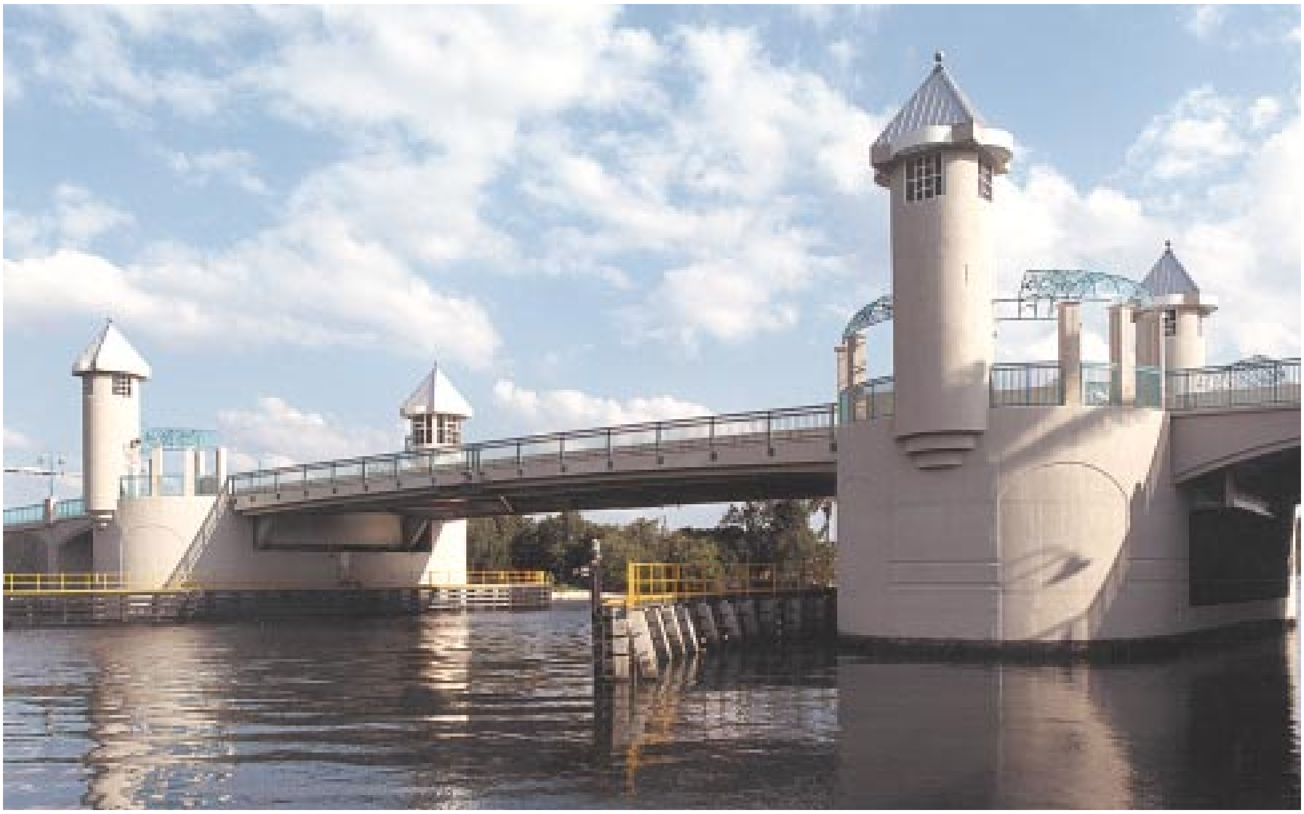
merit award: MOVABLE SPAN

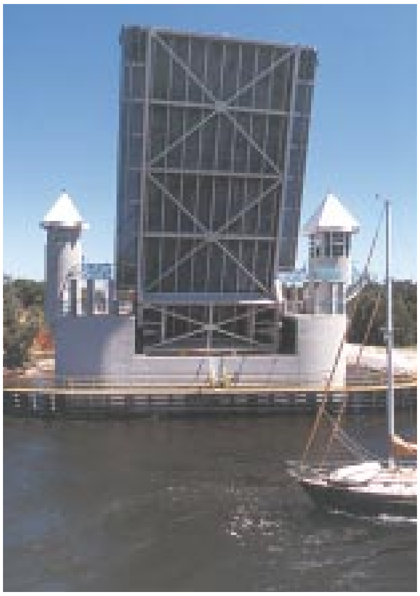
Boynton Beach Bascule Bridge

S.R. 804 over the Intracoastal Waterway,
Palm Beach County, FL

The construction of the Boynton Beach Bascule Bridge presented many challenges to the owner, designer, and the construction team.

The new bridge was constructed on the same alignment as the existing bridge so the first task was removing the existing Bascule Bridge. A 300-ton mobile crane was used to remove each leaf of the old rolling lift bridge in two pieces. Demolition of bascule piers is always a difficult task. The piers were founded on large footings, which were poured on the top of thick concrete





seals. Both engineers and contractors often underestimate the time required for this phase. The Boynton Beach Bridge was no exception. Complete removal of the span, piers, and piling took approximately six months, three months longer than anticipated.

The design specifications required that the bascule span be assembled and aligned in the shop and the parts match marked. This helped to insure proper fit-up and alignment in the field during erection. The racks were attached to the main girders and the trunnions installed in the shop.

After the piers were constructed, the superstructure was shipped by barge to the site from the fabricator's facility in Palatka, FL, along the Intracoastal Waterway. An 800-ton barge mounted, ringer-type crane was used for the erection.

The erection was done to exact tolerances. Since the racks had been installed to the girders with turned bolts, the entire assembly had to be returned to the alignment achieved in the shop to insure proper tooth contact of the gears. After the erection of the first leaf was completed, the leaf was rotated into the open position and erection on the other leaf began. A portion of the concrete counterweight (CTWT) was placed and the concrete deck was poured before rotating the leaf so that the imbalance would be minimal. The typical CTWT framing member was fabricated with 152 mm x 380 mm (6″x15″) flanges and a 152 mm (6″) thick web plate with 50 mm (2″) web doubler plates added to both sides of the web.

Owner
Florida Department of Transportation, Fort Lauderdale, FL

Structural Engineer
Lichtenstein Consulting Engineers, Inc., Fort Lauderdale, FL

Steel Fabricator
PDM Bridge, Palatka, FL (AISC member)

Steel Detailer
Tensor Engineering Company, Indian Harbor Beach, FL (AISC & NISD members)

General Contractor
Walsh Group Ltd (DBA) Archer Western Contractors, Ltd., Fort Lauderdale, FL

Consultant
URS, Fort Lauderdale, FL

Software
Substructure (Florida Peer) and STAAD

NATIONAL STEEL BRIDGE ALLIANCE

2001 Prize Bridge Award

merit award: RAILROAD

Sweetwater Creek Bridge

Austell, GA

Norfolk Southern Railroad, a major Class I railroad, sought the versatility and strength which only structural steel could provide to achieve a solution to a difficult bridge replacement over Sweetwater Creek in Austell, GA, near Atlanta. Norfolk Southern was investing $60 million for construction of a sophisticated new Intermodal Facility at Austell and needed additional track capacity and operating flexibility. To efficiently switch train traffic off the mainline and into the new facility within the constraints of limited space, an existing 109′, single-track, through-girder ballast-deck bridge, fabricated in 1915, was replaced with a longer, 129′ double-track, through-girder, ballast-deck bridge.

The new bridge is the main span in Norfolk Southern Railroad's 589′ crossing of the Sweetwater Creek in Austell, spanning the creek's main channel. The entire structure includes the 129′ steel bridge span, a 29′ pre-stressed concrete box beam approach on the southern end and a 20span, 431′ pre-stressed concrete trestle approach on the northern end. The new Sweetwater Creek Bridge was designed to accommodate

both the existing mainline track and the new siding track with 16′ track centers. The new double-track bridge was assembled adjacent to the existing main-line bridge with the precision needed to roll it into its permanent position with no tolerance for error. In addition to limited room available for construction, the existing mainline railroad track handled as many as 81 trains per day and any construction activities, including girder unloading, bridge assembly and the final span changeout, had to be accomplished with minimal interruption to existing train traffic.

The substructure supporting the new main span was constructed behind the existing stone piers, at an elevation with less than 1″ of clearance beneath the approach spans. This method of substructure construction allowed for continuous, uninterrupted train operations on the existing main line track and bridge. These construction limitations determined the overall length of the new steel main span at 129′, with center-to-center bearings at 126′. The main through-girders were set at 37′, center to center, to accommodate the 16′ track centers, train clearance requirements and girder flange width. The web plates and bottom flange plates were considered fracture critical members and specified to meet the ASTM requirements of S84-F2, S91 and S93. The top flange members of the main girder and floor beams were designated as CVM (Charpy V-Notch Toughness Test) and specified to meet the ASTM requirements of S83-T2 and S91. The main girders were designed using ASTM A709, Grade 50 steel and consisted of 3″ x 32″ flanges and a 1-3/4″ web with an overall depth of 13′. Intermediate web stiffeners were spaced at 5′-3″ center-to-center with the knee braces spaced at 10′ 6″ center-to-center. The floor beams, supporting a 3/4″ steel plate deck, waterproofing, ballast and track, are spaced at 31-1/2″ center-to-center and designed using ASTM A709, Grade 36 steel.

Owner
Norfolk Southern Railroad, Atlanta, GA

Structural Engineer
Carter & Burgess, Inc., Dallas, TX

Steel Fabricator
PDM Bridge, Eau Claire, WI (AISC member)

Steel Detailer
Trevian Projects Ltd., Winnipeg, MB Canada (NISD member)

General Contractor
Scott Bridge Company Inc., Opelika, AL

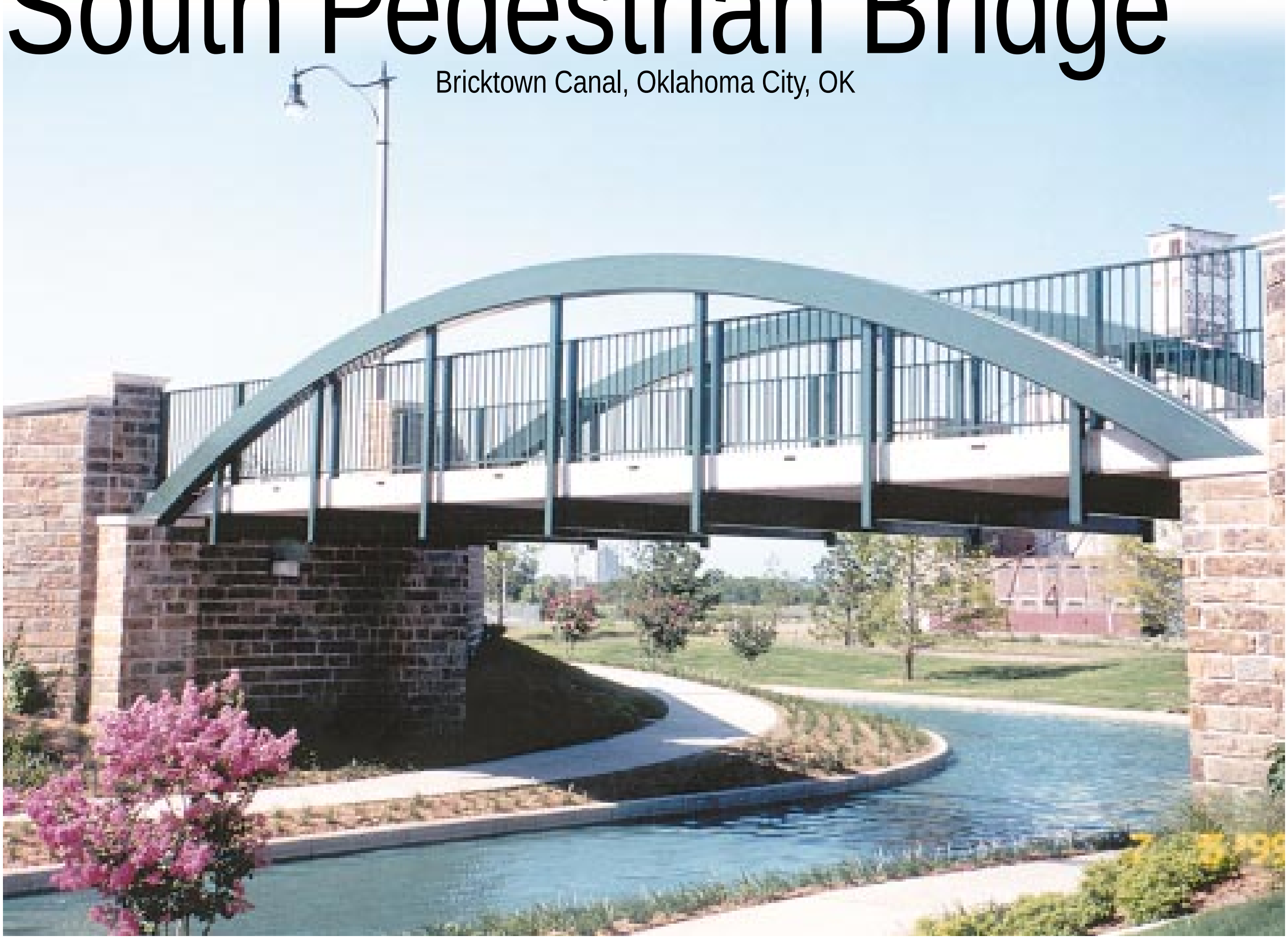
NATIONAL STEEL BRIDGE ALLIANCE

2001 Prize Bridge Award

merit award: SPECIAL PURPOSE

Bricktown Canal South Pedestrian Bridge

Bricktown Canal, Oklahoma City, OK



The Bricktown Canal South Pedestrian Bridge has two main support tubes. They are 14″ x 10″ x $^1/_2$″ wall rectangular tube rolled the hard way to 39′- 6 $^1/_8$″ radius, and two pieces of tube 40′ long were welded near the center of the arch to achieve each of the approximately 55′ long arches. There are seven support hangers: 4 in. sq. by $^3/_8$″ wall tube welded to the main support tubes on each side of the bridge. The support hangers are bolted to W12x14 I-beams that support the concrete deck. The concrete deck is 13′ wide by 50′ long and 8″ thick.

There is a 54” high steel handrail on each side of the deck. All of the steel structure and handrails are painted “Cedar Green.” The concrete abutments and wing walls have a stone veneer.

The bridge crosses the canal near the south end of the project and can be seen from the eastbound lanes of I-40 as one drives through downtown Oklahoma City. It overlooks one of the two waterfalls on the canal, and looking northwest from the bridge is a beautiful view of the downtown skyline.

The walking trails, canal and landscaping combine to enhance the beauty of the bridge and the south end of the canal system. Tourist and locals agree that the South Pedestrian Bridge is the most attractive bridge on the canal system.

Owner
City of Oklahoma City, Oklahoma City, OK

Structural Engineer
Clowers Engineering Company,
Oklahoma City, OK

General Contractor
Wynn Construction, Oklahoma City, OK

Consultant
Zahl-Ford, Inc., Oklahoma City, OK

Software
STAAD 3

NATIONAL STEEL BRIDGE ALLIANCE

2001 Prize Bridge Award

merit award: SPECIAL PURPOSE

East Boise River Footbridge

Boise, ID

As the Park Center region of Boise continued to grow and traffic congestion increased, the city of Boise decided that a bicycle/pedestrian river crossing for the area was necessary. The goal of the city was to provide facilities which would reduce the traffic congestion and assist in the improvement of the air quality by providing an alternate means of transportation and connecting pathways and various business centers on both sides of the river. This resulted in the construction of the East Boise River Footbridge. In the bridge type selection process, various issues played a key role in a steel tied arch structure being chosen.

Since the location of one of the pathways that ran parallel to the river did not allow for a lengthy approach to the bridge, the deck had to remain at the elevation of the riverbank. Additionally, in order to accommodate wheelchairs, the grade could not exceed five percent. These restrictions placed the top of the deck within 10′ of the water surface. Because the river sees extensive use by recreational users (kayakers, rafters), a shallow superstructure was necessary. Additionally, since piers located within the waterway were not an acceptable option, the river had to be crossed using a single span. With these criteria and the desire to create a visually pleasing structure, a tied arch bridge was the obvious choice.

The East Boise River Footbridge is a 195′, single span steel tied arch struc-

ture. The deck is 15′-3″ wide with a widened section at mid-span, affording observation areas on both sides of the bridge. The arches are comprised of a 36″ deep, 7/8″ thick web with 1-1/2″ by 12-1/2″ flanges fabricated along a 150-radius arch. The arches are stabilized laterally with W section X braces. The deck is supported by the bottom chords of the arches, with each chord consisting of two angles back to back. The chords are supported by pairs of 1″ diameter hanger rods spaced at 15′ on center. The structure was designed for the deck to be formed utilizing stay-in-place metal forms; however, the contractor elected to use conventional formwork. The bridge is was constructed utilizing painted M270 Grade 50 steel. The bearing system consists of W section end beams on elastomeric bearing pads, fixed at one abutment and an expansion bearing at the other abutment. To illuminate the deck at night with a minimum impact on the natural surroundings, low intensity sodium vapor downward throw lights were flush mounted in the railing along both sides of the structure.

With the completion of the East Boise River Footbridge, the residents of Boise, ID, have received a functionally beneficial, aesthetically pleasing structure.

Owner
City of Boise, Boise, ID

Structural Engineer
W&H Pacific, Boise, ID

Steel Fabricator
Jesse Engineering Company,
Tacoma, WA (AISC member)

Steel Detailer
N.C. Engineering Company, Burnart, BC
Canada (NISD member)

General Contractor
Universal Construction, Inc.,
Emmett, ID

Software
STAAD 3

NATIONAL STEEL BRIDGE ALLIANCE

2001 Prize Bridge Award

merit award: SPECIAL PURPOSE

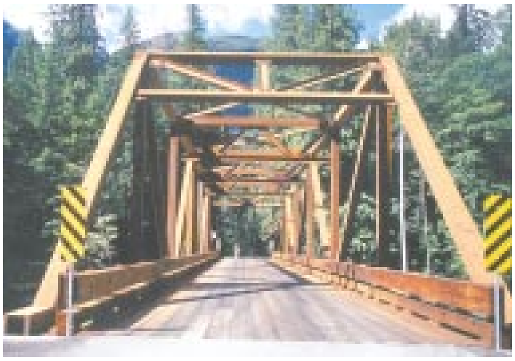
Harlequin Bridge

North Cascades National Park,
Stehekin, WA

In 1997, the Federal Highway Administration (FHWA) identified the existing Harlequin Bridge as a candidate for rehabilitation or reconstruction. This treated timber Baltimore truss bridge was built in 1948. After nearly 50 years in service, the bridge's timbers were severely cracked and splintered, and inspectors noted isolated pockets of decay. An in-depth inspection in August of 1997 revealed that one of the top chord members had failed in compression. Park Service maintenance crews installed an emergency repair, but it was clear that rehabilitation was no longer an option; the bridge would have to be replaced.

The Harlequin Bridge was located in the Stehekin Unit of North Cascades National Park. While there are more than thirty miles of road in Stehekin, this unit can only be accessed by a ferry, barge, boat, or float plane ride 55 miles up-lake from Chelan, WA. All material for construction, including machinery and equipment, would need to be transported by barge, an all day trip for each load, and then wind 4 1/2 miles up a single lane road to the bridge site.

The original 110′ timber truss bridge needed to be lengthened to 165′ to solve scour problems. This fact combined with the remoteness of the site and erection issues resulted in a steel through truss as the ideal choice. Weathered steel was selected to maintain the historical character of the old bridge by replicating the old bridge's timber look. Various structure types were considered including a through girder with the deck suspended between two massive steel girders, but all had some fatal flaw.



An engineering consultant was contracted to assist in preparing design visualization sketches to convey the concept to the park. The replacement bridge was to be a one-lane, six-panel Warren truss bridge made from unpainted weathering steel. Glue laminated timber deck panels and bridge rail were chosen to complement the texture and feel of the truss.

The engineering consultant designed the main truss elements as built-up box sections to resemble the sawn timber members of the existing bridge. Connection details were chosen to minimize areas where dirt and moisture could get trapped on the truss. Steel pipe piles were driven to provide bearing below the scour depth.

Constructing the bridge was truly a team effort, with significant contributions from all parties involved. Strider devised an ingenious method of supporting the truss panel points while the bridge was erected involving a set of tripods resembling giant jackstands. The legs were weighted and adjustable to allow them to be set in the strong flow of the Stehekin River. Universal Structural provided material fabricated to exact dimensional specifications for a perfect fit-up. National Park Service personnel worked closely with WFLHD to provide logistical support. Even the local residents got into the act. Many of them became temporary employees of the contractor, and all of them joined in the dedication ceremony and parade on October 13, 2000.

Owner
National Park Service, North Cascades National Park, Sedro-Wooley, WA

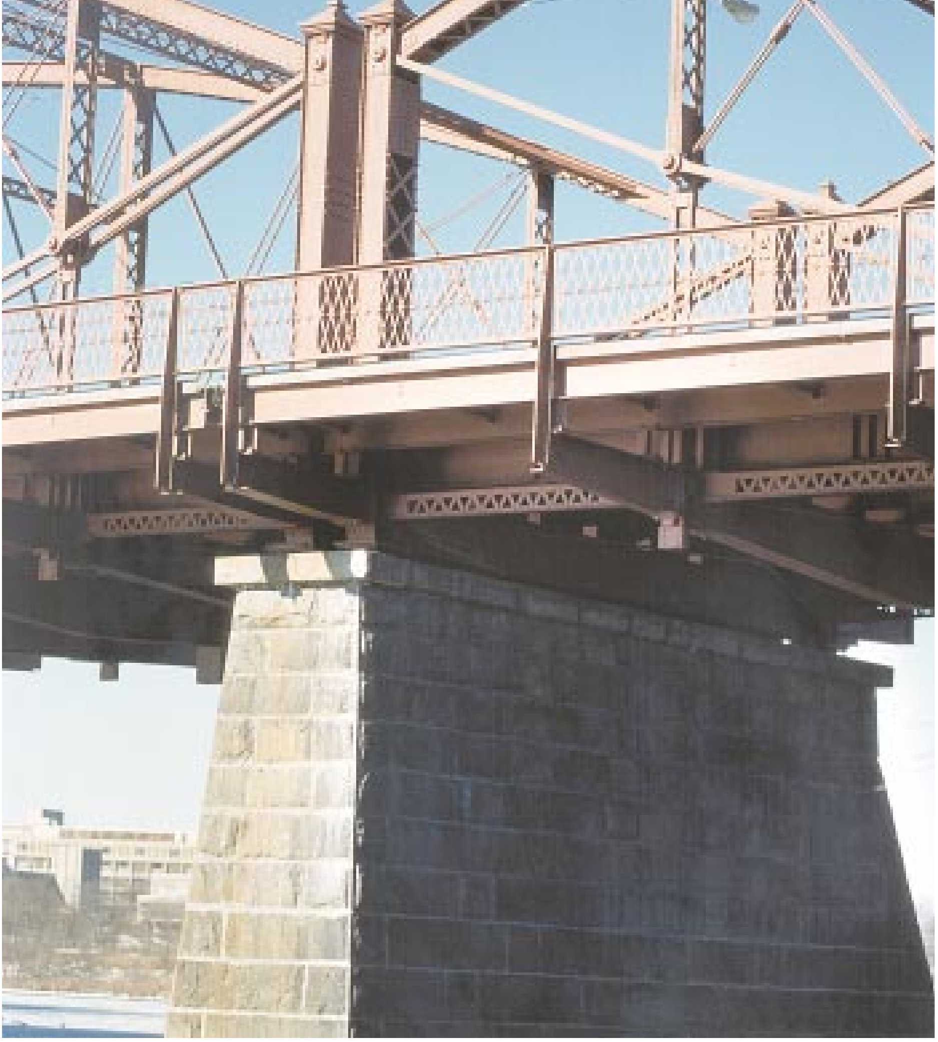
Structural Engineer
Parsons Brinkerhoff Quade and Douglas, Inc., Portland, OR

Steel Fabricator
Universal Structural, Inc., Vancouver, WA (AISC member)

General Contractor
Strider Construction Company, Inc., Bellingham, WA

Consultant
Western Federal Lands Highway Division, Vancouver, WA

Software
GT Strudl



NATIONAL STEEL BRIDGE ALLIANCE

2001 Prize Bridge Award

merit award: RECONSTRUCTED Aiken Street

Over Merrimack River, Lowell, MA

Built in 1883, the Aiken Street Bridge crosses the Merrimack River in the City of Lowell, MA. After more than a century of service, the bridge had deteriorated to the point of having a reduced live load rating and was in need of frequent maintenance and repairs. Rehabilitation was favored over complete bridge replacement based on an evaluation of cost, feasibility and the preference to reuse and preserve the bridge.

Deck Reconstruction

The poor condition of the existing open grid deck, purlins and stringers defined the need for a complete replacement of the roadway and sidewalk deck system. The preliminary design efforts considered both open and closed deck systems.

A closed deck system was favored to improve skid resistance, eliminate runoff on to the structural members and provide a more durable deck structure. A 5-$^1/_2$″ deep steel grid deck half filled with lightweight concrete was selected to provide the desired closed deck benefits with the least amount of additional dead load. A $^3/_8$″ epoxy overlay system placed flush with the grid was specified to provide a durable wearing surface. Galvanized grid was specified for added corrosion resistance.

Floorbeam Strengthening

The floorbeam members, built up with riveted plates and angles, presented the opportunity to repair and strengthen the beams with replacement sections allowing reuse of portions of the existing beams. The final design details called for complete replacement of the bottom flange angles with a slightly larger section and the addition of a bolted top cover plate. High strength bolts were used to replace rivets as required. The construction sequence allowed unloading of the floorbeams, since the entire stringer and deck system was to be removed. Therefore, replacement of beam members was performed in the field considering only the beam self-weight loading condition with minimal effects of existing member stress.

Truss-Reuse

The proposed rehabilitation included reuse of the existing truss members, local repairs to deteriorated or damaged members and replacement of the floorbeam hangers. The development of cost effective bridge rehabilitation schemes was limited to concepts that would allow reuse of the truss without the need for extensive truss member replacement or strengthening. Since the proposed deck reconstruction would significantly increase the dead load, a complete dead plus live load analysis was performed to determine maximum truss member stresses. This analysis was used to define the permissible upper limit of the proposed dead load and indicated that reserve capacity was available for the closed deck reconstruction scheme.

Seismic Retrofit

The preferred retrofit scheme featured improved seismic performance through force reduction with seismic isolation bearings, pier strengthening with internal vertical post-tensioned steel reinforcement and abutment strengthening and stabilization with vertical post-tensioned steel reinforcement and tie back anchors. The preferred scheme, which incorporated force reduction with seismic isolation, offered significant advantages over other retrofit options that considered more costly strengthening methods alone. The preferred scheme also satisfied the important goals of minimizing aesthetic impacts to the existing structures and eliminated the need for retrofit work in the river.

Owner
City of Lowell, Dept. of Public Works, Engineering Division, Lowell, MA

Structural Engineer
HNTB Corporation, Boston, MA

General Contractor
The Middlesex Corporation, Littleton, MA

Software
GT Strudl and in-house software