NATIONAL STEEL BRIDGE ALLIANCE 2009 PRIZE BRIDGE COMPETITION

THE NSBA PRIZE BRIDGE COMPETITION honors significant and innovative steel bridges constructed in the United States. Awards are presented in a variety of categories, including long span, medium span, short span, movable span, major span, reconstructed, and special purpose.

The National Steel Bridge Alliance thanks the submitters of all of the outstanding entries for their participation in the 2009 Prize Bridge Competition. The projects were judged on:

- ➜ Innovation
- ➜ Aesthetics
- ➜ Design and engineering solutions

Designers of the winning Prize Bridge projects will receive award plaques during an award reception at the 2009 World Steel Bridge Symposium in San Antonio, Texas, on November 19, 2009. Owners of winning bridges will receive award plaques at a dinner banquet during the 2010 AASHTO Bridge Subcommittee meeting.

Jurors for this year's competition:

Ralph Anderson
Chief of Bridges & Structures, Illinois Department of Transportation, Springfield, Ill.

Nancy Kennedy
Principal Bridge Engineer, Nevada Department of Transportation, Reno, Nev.

John Elwell
Senior Supervising Engineer, Senior Project Manager, Parsons Brinkerhoff, Minneapolis

Bill Wilson
Editor, Roads & Bridges Magazine, Arlington Heights, Ill.

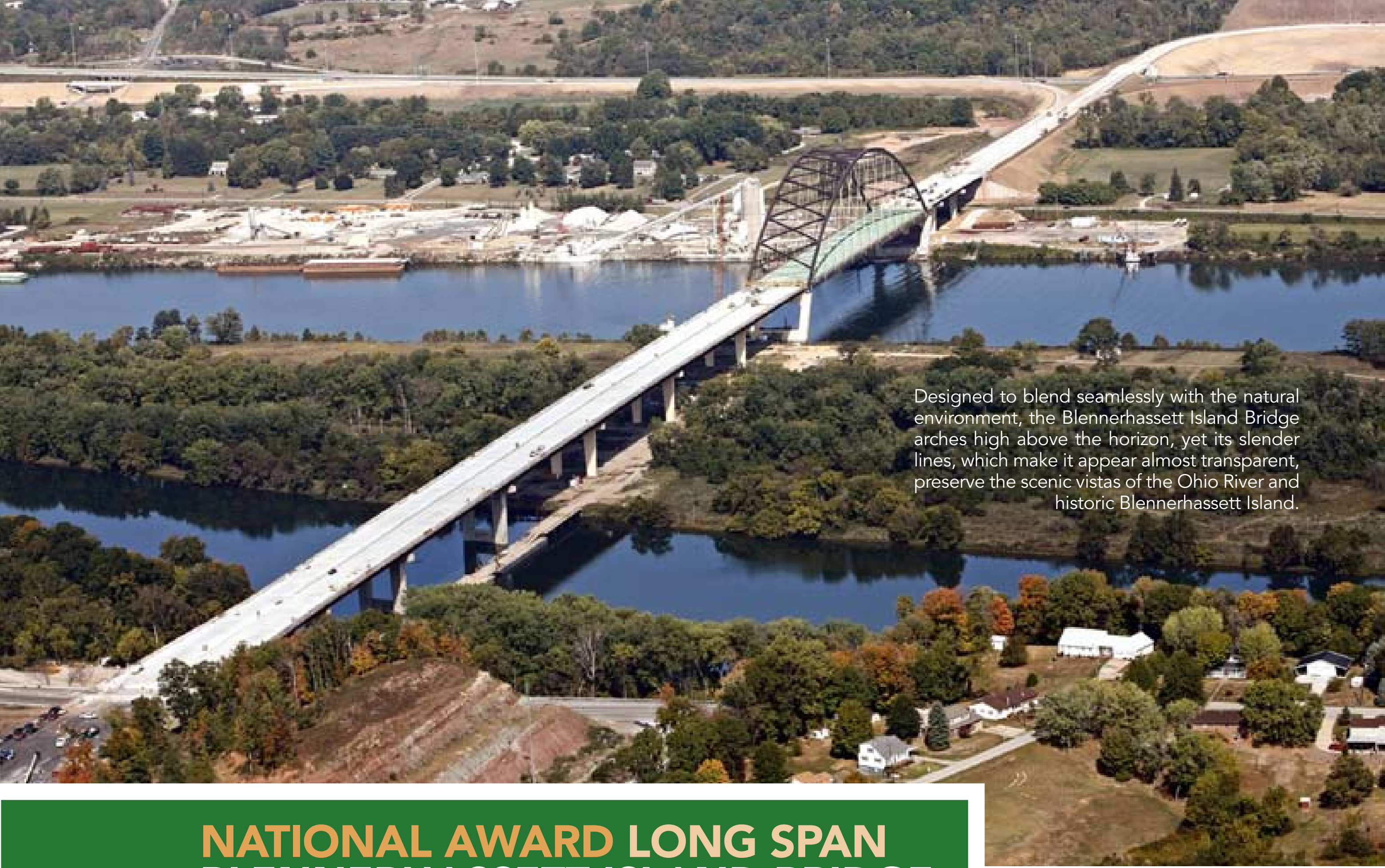
2009 Prize Bridge Awards

National Awards

Long Span	Blennerhassett Island Bridge Wood County, W.Va. and Washington County, Ohio
Major Span	Tempe Town Lake Light Rail Bridge Tempe, Ariz.
Medium Span	Mount Si Bridge Replacement King County, Wash.
Short Span	Roslyn Road Grade Crossing Elimination Mineola, N.Y.
Special Award	Woodrow Wilson Memorial Bridge Washington D.C.
Special Purpose	Bob Kerrey Pedestrian Bridge Omaha, Neb.
Movable Span	Hamilton Avenue Bridge Brooklyn, N.Y.
Reconstructed	Thurston Avenue Bridge over Fall Creek Ithaca, N.Y.

Merit Awards

Long Span	Route 151 over the Salmon River East Haddam, Conn.
Medium Span	Sauk River Bridge Darrington, Wash.
Medium Span	Three Springs Drive Bridge Weirton, W.Va.
Special Purpose	Dr. Martin Luther King, Jr. Memorial Bridge Roanoke, Va.
Reconstructed	MacArthur Maze Ramp Reconstruction Oakland, Calif.



Designed to blend seamlessly with the natural environment, the Blennerhassett Island Bridge arches high above the horizon, yet its slender lines, which make it appear almost transparent, preserve the scenic vistas of the Ohio River and historic Blennerhassett Island.

NATIONAL AWARD LONG SPAN
BLENNERHASSETT ISLAND BRIDGE
WOOD COUNTY, W.VA. AND WASHINGTON COUNTY, OHIO

The Blennerhassett Island Bridge, which spans the Ohio River between West Virginia and Ohio, was the critical remaining "missing link" of the final segment of Appalachian Highway Corridor D. This major economic development highway traverses approximately 240 miles along U.S. 50 from Cincinnati, Ohio, to Clarksburg, W.Va.

The 4,008-ft bridge includes an 878-ft-long, tied-arch main span with a rise of 175 ft and approach spans that consist of variably spaced steel-plate girders with spans up to 401 ft in length. To minimize the size and weight of the approach span superstructure, the design uses hybrid girders and high-strength steel. Post-tensioned concrete pier caps support the main tied-arch span and contribute to the structure's cost efficiency.

The bridge's tied arch ranks as the longest networked tied-arch structure in the United States and is among the longest in the world. The bridge spans historic Blennerhassett Island, an environmentally sensitive area and designated Historic District, and the main and back channels of the Ohio River.

Numerous innovative approaches were employed during the planning, design, and construction of the Blennerhassett Island Bridge. A total of 16 alternatives were studied to arrive at the alternative with the least environmental impact.

Archaelogical concerns led to the use of trench shields during project excavation to protect investigators as they searched for prehistoric deposits as much as 40 ft under ground. Coincidentally that reduced the amount of excavation required, compared to benching, saving both time and money.

Another example of the efforts undertaken to protect the environment throughout construction, the team performed tree-topping as an alternative to tree removal. Removing the trees within the bridge alignment would have been a quicker and more easily implemented solution, but the tree-topping technique saved more than 200 trees that are an integral part of a valuable forested wetland complex.

From the earliest planning stages, accommodating the massive size of the Blennerhassett Island Bridge posed a significant design challenge. Engineers sought to develop a design that would optimize structural integrity and user safety, but that would also control costs by minimizing the size and weight of the approach span superstructure. They departed from traditional bridge design methodology by designing a tied-arch structure that integrates a key truss-type element—post-tensioned steel networked cables that improve structural strength and flexibility and enhance safety. This hybrid "arch-truss" design approach made it possible to leverage the benefits of both bridge types.

The bridge's arch span is strengthened by post-tensioned, seven-wire-strand steel cables configured in a unique X-shaped network, which enhances stiffness and redundancy in the bridge's superstructure. These cables allow the structure to redistribute some of the arch rib horizontal load, so that the members function similarly to those in a truss structure.

To evaluate stress distribution within the structure under normal conditions, as well as during catastrophic events such as cable loss, a 3D finite element model of the bridge was created. The 3D model was used to refine the construction sequence. Each time the survey points on the arch were measured, the 3D model was updated to obtain data on the actual stresses to the members. The networked cables were carefully adjusted to optimize deck elevations and stress distribution for the structure, based on the results of the 3D model.

The arch tie itself, normally a fracture-critical member, is a box-shaped tension tie that was specially designed to withstand cracking and not collapse. The tension tie was mechanically fastened together with bolts for redundancy, rather than welded together, which enables it to withstand loads, even if one of the four plates that comprise the box fractures.

Plans specified the use of the stringent mill-to-bear method for fabrication of the steel for the arch ribs. The intent was to use the most precise fabrication process available to reduce construction cost. It succeeded in reducing the number of bolts required at the arch rib splices by 50%.

The design also included hybrid steel members of high-strength, high-performance 70 ksi weathering steel, for maximum durability and improved ductility. This also helped to minimize the size and weight of the approach span superstructure, reduce material quantities and construction cost, and defray long-term maintenance costs.

The bridge deck is longitudinally post-tensioned to prevent cracking caused by the lengthening of the tied arch under load. The piers are also post-tensioned to resist cracking.

Construction

Innovative construction methods and techniques were required to account for the challenges presented by the extraordinary weight and size of the structural members, the mountainous terrain, and the riverine environment. In preparation for construction of the tie girders and arch, the contractor constructed eight temporary drilled caissons in the river. The tie girders and arch were constructed in segments, from each main river pier, halfway across the channel. The most efficient method was to construct a significant portion of the tie girders and use this as a base for building out the arch ribs until the cantilevers reached the center of the span.

The construction of the arch was the most complicated task of the entire project because of its size and the need to ensure that the arch segments fit together perfectly. Temporary adjustable stays were used to brace the arch segments during erection, prior to installation of the cable hangers. As each cable hanger was installed, the supporting temporary stay was removed.

The position of the arch was monitored very closely. Elevations were taken after every segment was erected, and the position of the structure was adjusted through the use of the temporary falsework stays provided by the contractor.

The Ohio side of the arch was constructed six inches out of position longitudinally, and then jacked into place during installation of the arch's keystone section. The ends of the arch were temporarily post tensioned to the pier caps to ensure the stability of the cantilevered sections during jacking. Sand jacks with steel shims and polytetrafluorethylene sliders were mounted on top of the river caissons and served as temporary supports. The jacks and sliders also could be quickly and easily removed after the arch was constructed. Large, barge-mounted cranes were used to install the heavy steel segments (which weighed up to 60 tons) for the arch and the West Virginia approach.

The contractor designed a temporary bridge and used a "barge bridge" to cross the back channel of the Ohio River to access the island from the West Virginia shore. On the island, 70-ft-high falsework towers, designed to withstand a 75-mph wind load, supported the girder segments. The towers were anchored by guy wires connected to concrete deadmen embedded in the island soil.

> The use of network cables was very innovative. This bridge showcases complexity on a grand scale and should make a lasting impression over the Ohio River. *—Jury Comments*

The original plans called for the design of a suspension bridge with no piers on the island. To reduce construction costs, the client decided instead to proceed with the design alternative that included piers on the island. Pier placement required extensive archaeological and environmental investigation.

The innovative approach to the design of this project, including the hybrid design of the arch and the efficiencies in material quantities, resulted in significant cost savings to the client and taxpayers, and will also deliver long-term benefits by reducing maintenance costs and extending service life.

The client realized significant cost savings from the design of a networked tied-arch structure. Employing this bridge type further demonstrates its application in the engineering field as a viable, cost-effective alternative to the more commonly used design options. The use of the networked cables enabled engineers to reduce the arch rib size by approximately half and thereby significantly reduce overall construction cost. Also, the use of inclined hangers with stay cables will facilitate future cable replacement.

Owner
West Virginia Department of Transportation, Charleston, W.Va.

Designers
Michael Baker, Jr., Inc., Charleston, W.Va.; HNTB, New York

General Contractor
Walsh Construction Company, Canonsburg, Pa.

Steel Fabricator (approaches)
Hirshfeld Group, Greensboro, N.C. (AISC/NSBA Member)

Detailer
CanDraft, Coquitlam, B.C. (AISC/NSBA Member)

NATIONAL AWARD MAJOR SPAN
TEMPE TOWN LAKE LIGHT RAIL BRIDGE TEMPE, ARIZ.

An advanced fiber-optic lighting system vividly illuminates the Tempe Town Lake Light Rail Bridge.

Built to withstand a 500-year flood, the Tempe Town Lake Light Rail Bridge spans 1,535 ft and consists of two abutments, 10 Y-shaped piers and 42 steel trusses that feature diagonal pipe bracing connecting top and bottom pipe chords. It was built to provide the Valley Metro Light Rail project, a high-capacity transit system, with a crossing over Tempe Town Lake to connect Phoenix with Tempe and its neighboring communities.

This bridge represents true design innovation because it combines the past with the present. During the day, one can see that the superstructure mimics the truss design of the adjacent historic Union Pacific Railroad Bridge. At night, modern technology emerges for a visual spectacle. Below the 30-ft-wide cast-in-place concrete deck is an advanced fiber-optic lighting system that vividly illuminates the structure with various colors.

During construction, the unique bridge design created several technical challenges, one of which dealt with the complexity of the site conditions. The location of the south approach and abutment had obstacles above and below. The high-voltage power lines overhead presented a significant hazard during construction. Because the large drill rigs on the barge could not fit under the power lines and the power lines could not be de-energized, the abutment design was switched from the original plan of using drilled shafts to a single spread footing. In addition to solving the constructability challenge, this redesign also reduced costs.

Below the abutment, a major water line that supplies downtown Phoenix with 60% of its potable water posed a potential challenge. It was crucial to not disrupt the underground 72-in. diameter pipeline. The project team solved this challenge by carefully excavating and encasing the waterline with concrete reinforcement to withstand the mass of the south approach structures.

Throughout the project, the project team worked closely with local historical and transportation commissions to ensure that the bridge did not detract from the adjacent historical railroad bridges built in 1912. Valley Metro Rail worked with the State Historic Preservation Office through several design concepts from a cable-stayed bridge to the constructed concept where the design consultant borrowed from the old rail bridge design while adding modern touches. Despite the unpredictable issues that came up during construction, the team was

> Its innovative use of steel pipes creates a powerful and efficient structural system. It is "beauty over water," and the lighting makes it a piece of art. *—Jury Comments*

able to overcome the challenges with the development and implementation of innovative solutions. Detailed and strategic coordination among design and construction teams enabled the delivery of an on-time and on-budget project.

The bridge follows AASHTO Load Factor Design guidelines, using 50 ksi yield strength steel pipe. A 24-in. diameter steel pipe with a 1-in. wall thickness forms the bottom apex of each triangular truss. Two 18-in. diameter steel pipes about 5 ft apart lie at the top vertices of each truss, directly under a track rail. Wall thicknesses of the pipes vary, depending on whether the truss is in a positive or negative loading configuration. A series of 880 10-in. diameter steel pipe braces in sets of four run diagonally upward from a steel saddle on the bottom pipe to a saddle on the two pipes above, creating the truss. Spacing of the bottom saddles ranges from about 10 ft to 15 ft between longitudinal centers. Truss segments between piers range from about 75 ft to 160 ft long.

The lighting system hangs from horizontal 8-in. pipes, positioned directly above the bottom chord and connecting the two upper pipe chords. Tubular cross-diaphragms connect the parallel trusses at both abutments and at the nine piers. Disc bearings, two on each abutment and two atop each pier, control bridge movement.

The cylindrical piers have the look of being "wood chopped" at the top center, where they form a Y. The bottom pipe of each truss rests on one arm of the Y. All but the center pier accommodate expansion. Total movement for expansion at each abutment is about 5 in. A 46,000-sq.-ft continuous concrete deck placed on stay-in-place decking forms the tops of the two trusses, providing a 30-ft width for the two tracks and emergency walkways. Depth of the truss is 9.25 ft and the overall depth is 11 ft at the top of the rail.

Fabrication was a critical challenge. The main obstacles were weld configurations, open-root welds, rework and material.

Open-root welds, which were required by code, had to be made out-of-position without backing bars. Welders first had to be qualified to make these welds. The welding fabricator's testing left only six qualified for the job. Usually this type of project would require backing strips, but in this case, backing strips would not have made the structure sturdier. They also would have added 20% to 30% more time and cost to the project. Additionally, any necessary rework was limited to two reworks on each weld joint.

The original design specified ASTM A618 pipe in various diameters and wall thicknesses, and because Federal Transit Administration funding was involved, domestic materials were required. By contract, the bridge was to be fabricated in six months—including material procurement. However, the lead time for A618 for several of the size and wall thickness combinations was at least one year. Sources often would not quote some sizes at all or would require a huge mill purchase for each size and wall thickness. Eventually the Federal Transit Administration approved the use of imported materials for two size combinations, which before purchase, were subject to on-site inspection by the fabricator to verify dimensions, form, and traceability.

Another aspect of this construction that at first might have been considered a hindrance, actually was a benefit: segmented fabrication. To optimize structural strength versus weight, meet budget, enable transportation to the work site, and enable a modular erection, the fabricator constructed the bridge in segments. The design consultant decided on the segmented fabrication method as a way to help ensure the bridge would be fabricated on time.

The design consultant also invited the fabricator for an interview and to provide comments and recommendations that eventually helped write the welding specifications. Because Arizona generally uses concrete more than steel, the fabricator helped educate others on the team about welding and developed the majority of the weld design.

Owner
Valley Metro Rail, Phoenix

Designer
T.Y. Lin International, Tempe, Ariz.

General Contractor
PCL Civil Engineering, Inc.

Fabricator/Detailer
Stinger Welding, Inc., Coolidge, Ariz.
(AISC/NSBA Member)

Architect
Buster Simpson, Seattle

Electrical/Lighting
R.A. Alcala & Associates, Inc., Tucson, Ariz.

Using built-up box members and HSS sections created a neat and clean appearance for the new Mount Si Bridge. Built-up members in the top and bottom chords are connected with minimally-obstructive, slender hollow structural section tube web members.

NATIONAL AWARD MEDIUM SPAN
MOUNT SI BRIDGE REPLACEMENT
KING COUNTY, WASH.

The Mount Si Bridge serves as a vital link across the Snoqualmie River for local residents and as a gateway to regional outdoor activities within the Mount Si Natural Resources Conservation Area, southwest of Seattle.

For more than half a century, the original bridge provided the only access to the community and recreation areas north of the Snoqualmie River. As the second-oldest bridge in King County, and one of its few remaining steel Pratt truss bridges, the Mount Si bridge symbolized the rural community and was designated a county landmark. It also was on the National Register of Historic Places for its engineering and architectural significance.

The structure had severely deteriorated over the years and was listed as a high priority for replacement in the county's 2001 annual bridge report. The structural design team presented eight bridge alternatives for evaluation. Ultimately, another steel Pratt truss bridge was chosen based on cost, ease of construction, and maintenance requirements.

Located in one of the state's most popular outdoor recreation areas, the new bridge had to blend with the natural environment and not be an eyesore, while keeping the scenic attraction of Mount Si in the background. To accomplish this, the design had to be as open as possible.

The design team used built-up box members and HSS sections to create a neat and clean appearance. These built-up members, with top and bottom chords, are connected with minimally-obstructive, slender hollow structural section tube web members.

Other innovations included using rigid moment sway frames with slip-critical type bolt connections and optimizing panel spans at 30 ft, rather than the usual 20 ft to 25 ft, which resulted in using less steel and reducing fabrication requirements.

The new Mount Si Bridge also incorporates art in many bridge elements, including:

- ➜ Ornamental in-fill panels on the approach span railings
- ➜ Landscaping elements surrounding the bridge
- ➜ Decorative bronze plates attached to the bridge structure
- ➜ Bridge and railing paint colors
- ➜ Special finish and color applied to the bridge's sidewalk

Owner
King County Department of Transportation, Seattle

Designer
Andersen Bjornstad Kane Jacobs (ABKJ), Seattle

General Contractor
Mowat Construction Company, Woodinville, Wash. (IMPACT Member)

Fabricator
Jesse Engineering Company, Tacoma, Wash. (AISC Member)

Detailer
MKE Detailing Service, Seattle (AISC Member)

Consulting Firm
3 Ring Services, Seattle

Art elements, such as the decorative bronze plates attached to the bridge structure, combine with the bolt connections to make the Mount Si Bridge a distinctive and aesthetically pleasing structure.

> The construction staging to accommodate working with a busy railroad was impressive. Aesthetically, it fits into the neighborhood while providing a unique solution to a unique situation. *—Jury Comments*

NATIONAL AWARD SHORT SPAN
ROSLYN ROAD GRADE CROSSING ELIMINATION
MINEOLA, N.Y.

The tragic death of nine teenagers in 1982, when they drove their van around a properly functioning crossing gate onto the Long Island Rail Road (LIRR) main line tracks and into the path of an oncoming train, gave the village of Mineola, N.Y., the impetus to reinvigorate a 24-year-old desire to eliminate several at-grade LIRR crossings in the community. Today, almost 50 years after the village's initial petition to eliminate the grade crossings, the final chapter of the $180 million plus grade crossing elimination project—the Roslyn Road Grade Crossing Elimination—is complete. The project, including designing and constructing both a new steel structure for the LIRR main line and a depressed Roslyn Road beneath the tracks, has enhanced safety and traffic operations as well as improved the quality of life for village residents.

The LIRR is the most active commuter rail line in the country, and so included challenging design issues. A number of alternatives were investigated that involved raising or lowering either the LIRR tracks or the roadway. Because nearby residents were concerned that raising the railroad would increase noise levels, the railroad was kept at grade and Roslyn Road was depressed to pass below. That decision made designing and constructing the structure for the steel bridge that supports the tracks, as well as the depressed roadway, extremely complex.

The 73-ft steel through-girder bridge, which carries the tracks over Roslyn Road, was extremely challenging to construct, especially because the longest period allowed for a track outage was a long weekend. Three steel through-girders support the two existing main line tracks and allow for a future third track. These girders govern the critical vertical clearance, which is 14½ ft for the bridge.

A unique construction phasing solution was developed that allowed the new bridge and substructures to be built with only four weekend single track outages and two weekend double track outages. After each outage, the tracks were returned to service.

During the first weekend double track outage, large diameter steel casings were augered into the ground, then filled with concrete to act as foundation piles. At a much later time, during

Rolling this new bridge into place eliminated the most dangerous at-grade crossing on a busy commuter line and completed the effort begun 50 years earlier.

four weekend single track outages, four temporary steel trestles were installed atop the concrete piles. These temporary trestles provided support for the tracks while excavation and construction of the abutments occurred below the trestles.

After the substructures were completed, the second weekend double track outage was implemented. The new bridge had been constructed adjacent to the tracks while the substructure work was progressing. During this weekend, the new bridge was rolled into position and placed onto the new abutments. After the final weekend outage, the tracks were returned to service.

The public's safety, welfare and quality of life all have been improved, either as primary or secondary benefits of this project. The project's most significant benefit is its elimination of the very serious safety issue of rail and vehicle conflicts, particularly important given more than 200 trains per day running through the village—some at speeds exceeding 80 mph.

Prior to the project, peak hour gate closures caused major traffic backups, which, in turn, resulted in a breakdown of function at the adjacent intersections. This traffic congestion, with cars idling, caused pollution, excessive energy consumption, aggravation for those caught in the backup, and a temptation for some to avert the gates. Additionally, the at-grade crossing caused noise pollution, with train horns blasting each time a train approached the crossing. Had the project not been undertaken, anticipated expansion of LIRR operations would only have exacerbated these problems. Instead, the project completion has eliminated them. With gasoline prices at today's levels, the removal of traffic congestion and idling makes the project even more cost-effective, bringing economic as well as environmental benefits to the community.

Prior to the grade separation both traffic and safety were serious issues at this crossing.

Owners

Long Island Rail Road and New York State Department of Transportation

Structural Engineer

Stantec Consulting Services Inc., New York

General Contractor

Posillico Civil Inc., Farmingdale, N.Y.

Fabricator

Francis A. Lee Company, Syosset, N.Y. (AISC/NSBA Member)


courtesy of Top Shots

The monumental $680 million Woodrow Wilson Memorial Bridge project, under construction on the Capital Beltway (I-495) for more than a decade, was undertaken to eliminate one of the nation's worst traffic bottlenecks.

NATIONAL AWARD SPECIAL AWARD
WOODROW WILSON MEMORIAL BRIDGE
WASHINGTON D.C.

The Woodrow Wilson Memorial Bridge is truly a new icon in a city of monuments. The $680 million project replaces an outdated bridge carrying I-95 across the Potomac River connecting Maryland and Virginia at the southern tip of the District of Columbia. It is a vital link on I-95 and the Capital Beltway (I-495), the circumferential freeway surrounding the core of the Washington metropolitan area. The new state-of-the-art structure eliminates one of the nation's worst traffic bottlenecks. The 12-lane bridge has separate local and express lanes, and capacity for future mass transit expansion. It also contains America's largest movable span.

The previous bridge had a vertical clearance of only 50 ft, but its drawspan over the Potomac River's navigational channel allowed larger marine vessels access to Washington, Alexandria, and other points north of the bridge. The decision was made to build new drawbridges rather than a higher fixed-span structure because many commercial, Navy, Coast Guard and recreational vessels on the river require high clearances. A fixed bridge would have required a vertical clearance of 135 ft.

The previous double-leaf bascule span bridge opened an average of five times per week. The new drawbridge is about 20 ft higher than its predecessor, reducing the number of bridge openings each year from approximately 260 to less than 60.

> This monumental bridge is packed full of innovation and is a trailblazer in the land of leaders. The engineering elements are amazing. This was a stimulus package before there was a need. The number of jobs created was incredible. It is an elegant, visually stunning bridge with good lines that enhances the surrounding architecture.
>
> *—Jury Comments*

The project includes two parallel bridges, each consisting of eight plate girders and three to four substringers to accommodate widths of up to 148 ft. Each bridge consists of two parallel double-leaf bascule spans for a total of eight leaves, which keeps the floor system and mechanical and electrical systems economical. By not connecting adjacent leaves, and providing separate machinery with the ability to operate each leaf independently, any one of the leaves can be taken out of service, if required, while maintaining a minimum of three lanes of traffic in each direction.

Each of eight drawspan leaves weighs approximately 2,000 tons and is designed to close within a ⅛-inch tolerance. Thirty-four million pounds of structure will move to clear a ship through the channel, representing the largest moving mass of any bridge in America and possibly the world. With 270 ft between trunnions, this span is among the longest in the world. It also is extremely wide: 249 ft from fascia to fascia.

The bascule span is a simple trunnion Chicago-type bascule. The front transverse beams of the piers serve as supports for the forward live load bearings at each bascule girder. The fixed deck beam of the bascule pier also serves as the rear live load anchor. Other design features of the bascule include a fully-composite lightweight concrete deck, fully counterweighted leaves, shear and moment-transferring span locks, and tail locks.

The span lock arrangement for the new Woodrow Wilson Bridge is unique in that the locks transfer moment as well as shear between the leaves of each double-leaf span. The tail locks work in conjunction with the span locks and relieve the operating machinery of live load transferred through rack into the main pinions. This will significantly reduce wear on the operating machinery.

The design of the bridge was decided by competition. The signature bridge that resulted from this process is an elegant, curving, haunched plate girder bridge supported by V-shaped piers. The combination of the curved V-piers and the girder haunches highlights the architectural motif of arches desired by the public. The steel plate girder/diaphragm/substringer framing system was used for overall economy, aesthetics and compatibility with the V-pier configuration.

The floor system framing and detailing were kept as simple as possible. Each bascule leaf consists of two bascule girders that support floor beams and stringers. Girder-to-

Thirty-four million pounds of structure move to clear a ship through the eight-leaf bascule arrangement on the Woodrow Wilson Memorial Bridge over the Potomac River.

girder distances vary for different leaves, ranging from 35 ft to 40 ft, 6 in. The typical floor beam spacing is 20 ft, 9 in. and stringer spacing is kept under 6 ft. Girders and floor beams are welded I-shaped members, and the stringers are rolled sections. Bolted connections are used throughout the span.

In all, 16 bascule girders are required. These girders are very large, with webs varying in depth from nearly 12 ft at the toes to 20 ft in the vicinity of the trunnions, and with 28-in.-wide flanges that range between 1½ in. and 4 in. thick. The overall length of each girder is 215 ft. To keep girder segments within sizes and weights that could be fabricated and to provide shipping and erection options, the girder design included two field splices. Each bascule girder weighs between 350 tons and 400 tons.

Approach Spans

The approaches on each end of the bridge consist of two continuous units, with 13 individual spans on the Virginia side and 19 spans on the Maryland side. They use haunched plate girders having a depth of 11 ft, 9 in. at the support points and 6 ft, 10 in. at midspan. The parabolic shape was developed to provide the continuous curved line of the V-pier and the superstructure varies with the span length.

The variable-depth girders in conjunction with the V-shaped piers provide the arch-like appearance that was desired in order to be visually similar to the other great bridges in the capital city. The plate girder spans vary from 100 ft to 209 ft. This variation in span length is due, in part, to the height of the structure above the ground surface. Plate diaphragms support the substringers and provide a clean appearance from the historic park below the bridge.

The plate girders were designed as hybrid girders. They were primarily fabricated from ASTM A709 Grade 50 steel, but some flanges used Grade 70 HPS steel to minimize the plate sizes, reduce girder weight and minimize constructed cost.

Co-Owners

Maryland State Highway Administration, Baltimore

Virginia Department of Transportation, Chantilly, Va.

Designer

Parsons, Baltimore

courtesy of Potomic Crossing Consultants

General Contractor (bascule)

American Bridge (AISC/NSBA, IMPACT and TAUC Member)/Edward Kraemer & Sons (IMPACT Member) Joint Venture, Coraopolis, Pa.

Detailer (bascule)

Tensor Engineering, Indian Harbour Beach, Fla. (AISC/NSBA and NISD Member)

Consulting Engineer (bascule superstructure design)

Hardesty & Hanover LLP, Annapolis, Md.

General Engineering Consultants

Potomac Crossing Consultants, Alexandria, Va.

Fabricator – Virginia Approach

Williams Bridge Company, Manassas, Va. (AISC/NSBA Member)

Fabricator/Detailer – Maryland Approach

High Steel Structures Inc., Lancaster, Pa. (AISC/NSBA and IMPACT Member)

It's a unique structure, a graceful and attractive bridge, created with a one-of-a-kind approach. The construction of a curved bridge with straight members added an interesting element. *—Jury Comments*


© Mark McCabe, 2009, courtesy HNTB

The Bob Kerrey Pedestrian Bridge provides 53 ft of clearance for Missouri River traffic and serves as a landmark for riverfront development in both Omaha, Neb., and Cedar Bluffs, Iowa.

NATIONAL AWARD SPECIAL PURPOSE
BOB KERREY PEDESTRIAN BRIDGE
OMAHA, NEB.

The Bob Kerrey Pedestrian Bridge spans the Missouri River connecting the cities of Omaha, Neb., and Council Bluffs, Iowa. At more than 2,300 ft, the structure is one of the longest pedestrian-only bridges in the U.S. Visually transparent but dynamic and innovative, its curvilinear design gives it a signature look and makes it a visual icon for the area.

The bridge's length made design and construction a complex matter, with wind-induced vibrations a particular concern. By keeping the girders relatively shallow and allowing a 4-ft gap between the edge girders and deck, designers provided for aerodynamic stability and kept wind-induced vibrations to a minimum. The girders are approximately 23 in. deep on a 24-ft-wide steel frame, and the 16-ft-wide deck is 12 in. deep at the curbs and 3 in. elsewhere. Had the girders been deeper, they would have been stiffer and stronger, but they also would have increased the potential for wind-induced problems.

The shallow girders reduce the wind load, but require closely-spaced cables to further support the deck. Because the cables are more steeply angled than traditional cable-stayed bridges, the axial load on the girders is reduced.

Another innovation used by the design-build team was the foundation design, with each pylon supported by a single drilled shaft. Minimizing the use of temporary works, the team drilled shafts that are 13 ft in diameter and extend roughly 85 ft into the riverbed. And because the foundations were constructed within the steel casing that forms the shaft, no cofferdams were required.

With a strict $22 million budget, the design-build team made each of its decisions within the context of economic feasibility. That started, quite literally, from the foundation up: Rather than take additional borings, the team chose to place the foundations in locations where subsurface investigations had already been completed. Other cost-saving measures included the use of the balanced-cantilever method, which reduced the need for falsework, and foregoing traditional cofferdam construction in the river.

But no decision was more important than the decision to use steel. The design-build team needed an efficient and lightweight structure to stay within budget and determined that choosing steel over concrete was the answer for many reasons, including a reduction in:

- ➜ The size of the foundation
- ➜ The size of the cables
- ➜ The magnitude of the windload
- ➜ The amount of falsework

The bridge's signature look is its curvilinear design, which is complemented by a pair of three-sided pylons that pierce 203 ft into the air and transform the area's skyline. Two planes of cables are connected to those pylons, and those 80 cables—40 per pylon—range in diameter from 1.25 in. to 2.3 in. Spacing the cables closely together—roughly 23 ft apart—and increasing the height of the pylons to decrease the cable angles provided enough clearance along the curved deck for a wide variety of users as well as a maintenance vehicle.

The LED lights at the top of each pylon make the bridge an aesthetic marvel. The lighting is dramatic, with different colors and effects at different times of the night.

The first bids on the project, in 2004, came in at more than twice the budget. City officials later re-issued the RFP, specifically asking for a design-build contract and a bridge that was "architecturally significant." However, the team had less than six months to design it.

The first step was choosing Grade 50 fracture-critical steel to create the superstructure. The final design consists of a horizontally curved bridge with a 506-ft main span and two 253-ft back spans. The superstructure bends from one side of the first pylon to the opposite side of the second pylon, spanning a total of about 2,300 ft.

The bridge's innovative design enabled builders to use straight steel segments instead of curved segments. The bridge is set on a radius, and all dimensions are based on that radius. Although the bridge alignment is curved, the superstructure segments and pre-cast deck panels are not. Instead, steel sections are straight-edged and identical in size and shape—with one side slightly longer than the other—and arranged to create the "S" curve.

Each section of the bridge is fairly short—approximately 23 ft—and its concrete deck is skewed slightly to create the curves along the bridge length. The long superstructure segment consists of a 24-ft-wide steel frame and a 16-ft, 4-in. precast concrete deck panel.

In effect, the main span of the bridge is really a series of short spans. Even the railings, piecewise, are straight. The use of straight-piece sections is one of the most innovative features of the bridge, and it couldn't have been done with any material other than rolled steel. Foregoing the heat-curving process that would have been necessary with shaped steel segments, the design-build team saved time and money with the straight sections, assuring an on-time and on-budget delivery.

Construction of the bridge through a design-build contract began in October 2006. The bridge opened to the public in September 2008, two months ahead of schedule and within its strict $22 million budget.

Owner
City of Omaha, Neb.

Architect and Designer
HNTB Corporation, Kansas City, Mo.

General Contractor
APAC-Kansas, Inc., Kansas City, Kan.

Fabricator/Detailer
DeLong's Inc., Jefferson City, Mo. (AISC/NSBA Member)

The two replacement skewed bascule spans include all new steel superstructures and mechanical and electrical systems.

NATIONAL AWARD MOVABLE SPAN
HAMILTON AVENUE BRIDGE BROOKLYN, N.Y.

The rarely seen Hanover skew bascule, also known as a knee-girder bascule bridge, is a unique and complex movable structure in terms of both design and construction. The replacement of a movable bridge during an accelerated construction period is also an incredibly difficult task to engineer and construct. Either one of these constraints would make a project difficult to execute. For the Hamilton Avenue Bridge project in New York City, however, these two levels of complexity combined to create a one-of-a-kind project that would challenge the owner, designers and constructor to achieve a near impossible goal: to replace a skewed bascule bridge with a new, fully operational span in 64 days.

The existing Hamilton Avenue Bridge was constructed in 1945 based on the novel knee-girder bascule design. The bridge comprises two separate single-leaf bascule bridges with each leaf carrying four lanes of Hamilton Avenue over the Gowanus Canal, a fixed span at the north pier which carries the roadway over the bascule pit, and a fixed arch span at the south end. The approaches have steep grades to meet the existing local street network of Brooklyn before and after the canal crossing. The East Span carries traffic northbound to the Brooklyn Battery Tunnel and lower Manhattan and the West Span traffic southbound to lower Brooklyn. The bridge carries approximately 55,000 vehicles per day with a high percentage of truck traffic.

As part of its ongoing bridge evaluation and maintenance program, the New York City Department of Transportation (NYCDOT) conducted an in-depth evaluation of the existing bridge in 1998. The bridge superstructure possessed a number of nonconforming roadway features (lane widths, bridge railings, etc.) making it functionally obsolete, so NYCDOT decided to replace the two skewed bascule spans with new steel superstructures and mechanical and electrical systems.

One of the key unique aspects of this project is the structure type itself. Only four knee-girder bascule spans were constructed in the U.S. based on the patented design of Clinton D. Hanover. The Hamilton Avenue Bridge was the first and is one of only two remaining in existence. The knee-girder framing provides an efficient means to span a skewed waterway with a single-span bascule bridge and alleviates a number of the disadvantages of this type of bridge, such as large differential loads in the supports and a non-uniform counterweight.

The project included tight time and work zone constraints. During two closure periods in July and August of consecutive years, the existing bascule span and approach superstructure of each span was demolished and replaced with the new structure.

To meet the schedule requirements, the contractor used an innovative temporary operating system for the bascule spans. The use of hydraulic cylinders and a hydraulic power unit enabled the contractor to decommission the existing bridge's electrical control system and machinery in advance of the roadway closure period, permitting many components to be partially or completely disassembled in advance. Much of the wiring and electrical components contained asbestos, so the contractor used this initial phase for the abatement of these hazardous materials. Their removal at this early and non-critical-path phase permitted the critical path tasks to proceed without delays due to worker safety or environmental issues.

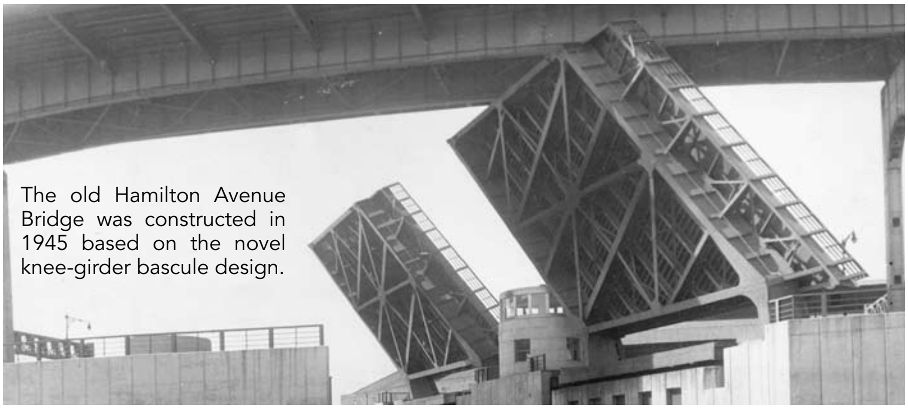
The temporary hydraulic drive system was also used for the new bridges to ensure span operation at the end of the closure period while allowing the time-intensive gear and machinery alignment to be performed outside of the two-month closure period.

Owner
New York City Department of Transportation

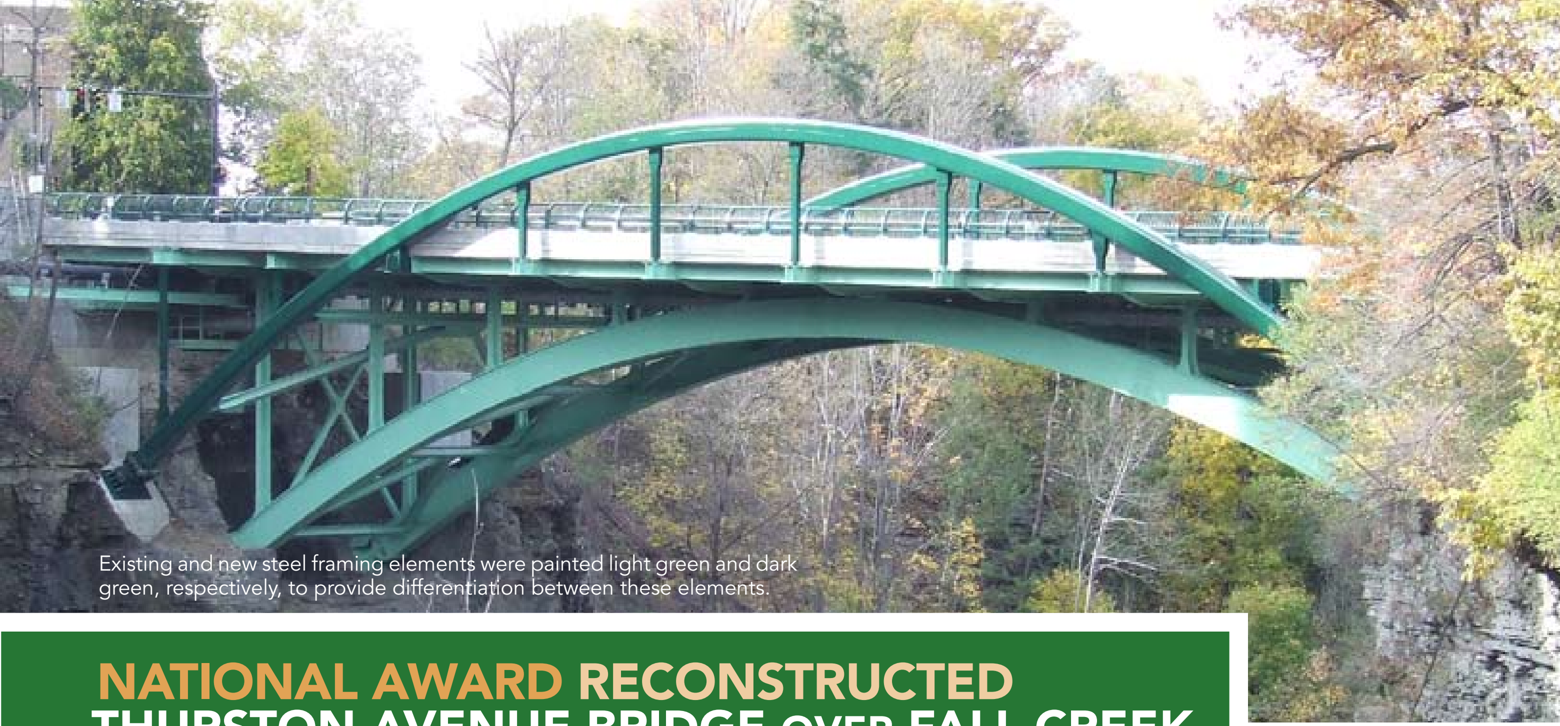
Designer
Hardesty & Hanover, LLP, New York

Consultant
Greenman-Pedersen, Inc., Babylon, N.Y.

General Contractor
Kiewit Constructors, Inc., Park Ridge, N.J. (IMPACT and TAUC Member)



The old Hamilton Avenue Bridge was constructed in 1945 based on the novel knee-girder bascule design.



Existing and new steel framing elements were painted light green and dark green, respectively, to provide differentiation between these elements.

LaBella Associates

NATIONAL AWARD RECONSTRUCTED
THURSTON AVENUE BRIDGE OVER FALL CREEK ITHACA, N.Y.

The Thurston Avenue Bridge over Fall Creek in Ithaca, N.Y., is built over scenic gorges and has a long and interesting history dating to the late 1800s. Ezra Cornell and his associate Andrew Dickson White capitalized on the famous "Ithaca is Gorges" slogan to bring students to their new university in 1868. Recognizing the significance of the setting and reputation of Cornell University, the City of Ithaca and the New York State Department of Transportation (NYSDOT) implemented a first-of-its-kind design to retain a bit of history in combination with a bit of invention for the rehabilitation of Cornell's primary link.

Originally a trolley bridge, the 215-ft long crossing now serves more than 34,000 students, faculty, and staff as the "gateway" between the residential and academic campuses of the university. However, severe congestion was causing pedestrians to walk in the travel lanes as well as vehicle delays at the approach intersection. The bridge's capacity had to be increased, but with due respect to its heritage.

The solution was to widen the bridge by 12 ft by adding new induction bent tubular arches at each fascia to provide for 10-ft-wide sidewalks and 5-ft-wide bicycle lanes. The new arches were elevated so that the existing arches remained visible.

The final parabolic curvature of the new arches was designed to meet constraints posed by a number of factors. The location of existing floor beams for column and hanger connections helped determine the locations where the arches rise above the deck. The height of the crown was determined by the owner's desire to allow views to the gorge and to discourage climbing.

The 32-in. by 30-in., 1-in.-thick tubular shape the designer arrived at was larger than any standard tube section produced in the U.S. and so had to be custom fabricated. The tubes also had to be bent into a parabolic curve, incorporating field-welded splices to maintain a continuously smooth appearance for the entire length of the arch rib.

Fabrication began by cold bending two 50 ksi, 1-in.-thick flat plates into U shapes that were then welded together with complete joint penetration seam welds. The 20-ft tube sections were fed through an induction bending machine that heated the steel to 1,850 °F. The curvature was introduced as it was pushed through at 1.5 in. per minute.

Each arch was erected by first setting the end pieces followed by the center piece. The splice ends were fabricated with a backing tube that allowed the crown section to be dropped in without springing the two sections.

Three cranes held the arch sections in place for approximately 16 hours until temporary stand-offs and new bracing struts were connected and complete joint penetration butt welds at the splices were finished and tested.

The new arches are filled with nitrogen gas to provide an internal corrosion protection system. The gas was pumped into the arch replacing all of the air inside and sealed with a slightly positive pressure. Permanent pressure gages ensure pressure loss does not occur.

The great lengths that were taken to mesh a new structure with the historic one should be considered legendary. The bent tubular arches are a graceful element and used an innovative fabrication solution. The color treatments were exceptional. *—Jury Comments*

Owner
City of Ithaca, N.Y., Department of Public Works

Designer
LaBella Associates PC, Rochester, N.Y.

General Contractor
Economy Paving, Inc., Cortland, N.Y.

Fabricator
BendTech, Inc., Duluth, Minn. (AISC/NSBA Member)

Reducing the skew and increasing the span for the new Salmon River Bridge reduced ice jamming potential but also required innovative design features.

MERIT AWARD LONG SPAN
ROUTE 151 OVER THE SALMON RIVER
EAST HADDAM, CONN.

The original three-span through-girder steel bridge at this challenging river crossing had served well for many years but was the site of frequent ice jams. However, the more serious problem was that riverbed scour had undermined its spread footings. Rather than disturb the sensitive environment with scour countermeasures, the decision was made to replace the bridge with a new structure that would span the entire river channel, thus preventing ice jams and reducing scour potential. Even so, the new foundations were designed to accommodate an anticipated 26 ft of scour and included end-bearing steel H-piles driven to bedrock.

Although the original bridge alignment spanned a total of 219 ft and was skewed 60 degrees to the channel, the new span was set at 250 ft with a 20 degree skew. Reducing the skew angle meant the cross frames could be laid out on the skew, which would greatly decrease the potential for skew-induced torsion. It also enabled the use of skewed deck reinforcement, which simplified construction.

Weathering steel was selected for the corrosion protection system, which at the time required and received public approval.

The new bridge girders were the first in Connecticut to be designed according to LRFD bridge design specifications. The girders had a large span-to-depth ratio, which would have required very thick bottom flanges. However, designing them as hybrid sections using Grade 70 steel for the bottom flange reduced the size of the flanges to a maximum thickness of 2.25 in. The web design was optimized so that transverse stiffeners were required only in the first 25 ft of the span.

Many of the design's key features were based on NSBA Steel Bridge Collaboration documents, including the following details:

- Inverted K-type cross frames, used without top horizontals
- Skewed cross frame connection plates
- Weathering steel drip bars
- Bolted splice plates
- Elastomeric bearings

The result of the design and detailing was that the cost for the structural steel was very reasonable. The bid price for the steel, fabricated and erected, was $1.28 per pound, which was very reasonable for bridges in Connecticut.

The innovative design did not stop at the girders. Large-scale round elastomeric bearings were designed to accommodate potential torsional rotation brought on by the large deflections and skew. Anchor bolts were only used at the fixed bearings. The expansion bearings are connected to the girders, but simply rest on the abutment seats. Lateral restraint is provided by concrete keeper blocks between two of the girder flanges. The 25-in.-diameter bearings were most likely the largest elastomeric bearings ever used in the state. The bid price for the bearings was much less than an equivalent high load multi-rotational bearing.

Another innovation was the use of the empirical design method for the composite deck design. The LRFD design greatly reduces the amount of deck reinforcing, which was run along the skew of the bridge.

The overall cost of the bridge portion of the project was approximately $3.9 million for a deck area of 9,159 sq. ft. This results in a unit bridge cost of $425 per sq. ft—a very high value, even for bridges in Connecticut.

Based on the strict scour criteria, the cost of the substructure and foundations was significant. The unit cost of the superstructure alone was $133 per sq. ft, approximately 25% less than typical superstructure costs in Connecticut. This is especially significant considering the size of the girders in the bridge section.

The original steel bridge lasted more than 73 years, serving well with virtually no maintenance, and was replaced only because of scour issues. The new Salmon River Bridge is the next generation of steel bridges that have the potential to serve the department for the next 100 years with minimal maintenance.

Owner
Connecticut Department of Transportation, Newington, Conn.

Designer
CME Associates, Inc., East Hartford, Conn.

General Contractor
Baier Construction Company, Inc., Bloomfield, Conn.

MERIT AWARD MEDIUM SPAN
SAUK RIVER BRIDGE
DARRINGTON, WASH.

Replacing the Sauk River Bridge near Darrington, Wash., required protecting one of the most wild and scenic rivers in the country.

Spanning a federally designated "wild and scenic" river, the Sauk River Bridge fords one of the most spectacular white-water rafting and fishing stretches in the country. Built in 1930, the existing two-truss steel bridge served as the only access to Darrington, Wash., and its main employer, the Hampton Logging Mill, from the Sauk Prairie area east of the river.

But the bridge was extremely narrow and dangerous, especially for truck traffic. Determined to be both functionally obsolete and structurally deficient, its overhead clearance, bridge curb-to-curb width, and structural load carrying capacity did not meet current standards. In addition, the west pier of the bridge was scour critical and was considered extremely vulnerable to one of the most energetic hydraulic environments in the state.

Carrying two lanes of traffic and providing a wide pedestrian shoulder, the new two-span steel truss bridge is the county's longest at nearly 479 ft and is composed of a continuous truss with a main span of 266 ft. Built on a new alignment just downstream from the existing bridge, it features drilled-shaft, scour-proof foundations as deep as 125 ft to ensure survival during extreme spring and winter floods. It now handles an average daily traffic of 750 vehicles, 25% of which are heavy logging trucks. It also provides a dramatic stopping point for tourists on the Mountain Loop Highway, viewed against a backdrop of snowcapped Whitehorse Mountain and other nearby Cascade peaks.

Numerous challenges faced the project team. Rugged, cramped conditions, raging water, an adjacent lumber mill, and river migration patterns severely limited placement and construction options for a new bridge. Environmental regulations required that the bridge be built without any temporary supports in the river, and within an unusually tight fish window for in-water work. Road traffic would have to be maintained at all times because the bridge provided sole access to and from Sauk Prairie. Additionally, the existing bridge was eligible for being listed on the National Register of Historic Places (NRHP), complicating the removal process.

Many original solutions make this project both successful and noteworthy. Designing the bridge to be continuous for the structure self-weight (dead loads) and the forces imparted by traffic and the environment (live loads) allowed longer spans to be achieved and improved material efficiency. Advanced 3D modeling techniques incorporated into both design and construction allowed members to be optimized for cost reduction and resulted in greater geometrical precision during fabrication, which greatly reduced the potential for erection and launching difficulties.

Careful siting and design minimized right-of-way issues, yet will also accommodate future river movement. An innovative launch technique allowed the bridge to be constructed on shore and cantilevered into place, which minimized environmental impacts. Other environmental considerations included hot-dip galvanizing and powder coating the bridge, a first for the region; temporary erosion control measures during construction; longer pier spans to accommodate river migration; and a suspended access work platform and protective system to keep debris from entering the river during new bridge construction and as the old bridge was demolished.

An interpretive kiosk at the bridge site mitigates loss of the previous bridge, increases historic awareness, and enhances the town's status as a destination on the Mountain Loop Highway.

Design innovations incorporated into the launching scheme saved approximately $1 million in construction costs and about five months in construction time.

Owner
Snohomish County Public Works, Everett, Wash.

Designer
Berger/ABAM, Federal Way, Wash.

General Contractor
Mowat Construction Company, Woodinville, Wash. (IMPACT Member)

Fabricator
Rainier Welding, Inc., Redmond, Wash. (AISC Member)

Detailer
Pro Draft, Inc., Surrey, B.C. (AISC, NISD Member)

Having the girder continuity splices for the Three Springs Drive Bridge on the intermediate support simplified bearing details and removed making the splices from the critical path.

MERIT AWARD MEDIUM SPAN
THREE SPRINGS DRIVE BRIDGE
WEIRTON, W.VA.

The Three Springs Drive Bridge over U.S. Route 22 in Weirton, W.Va. was designed using simple for dead load, continuous for live load (SDCL) steel girder construction. The project involved replacing the existing structure with one carrying five 12-ft traffic lanes, two 3-ft-wide shoulders and a 5-ft-wide, raised sidewalk with an 8-in. concrete deck for a total width of 73 ft, 4 in. The deck is supported by seven 54-in.-deep weathering steel plate girders spaced at 11 ft, 2-in. with spans of 125 ft, 6 in. and 95 ft. Span lengths were dictated by the configuration of U.S. Route 22. The girder depth was based on preliminary depth studies. K-type cross frames were provided at intermediate locations and temporary X-type cross frames were used at the supports until the deck was cured.

The steel girders were placed as simple spans to resist non-composite forces. After placement of the deck in both spans, flange splices and a concrete continuity diaphragm at the pier were constructed to provide continuity for composite dead and live loads. The structure is supported at the ends by jointless, integral abutments founded on steel H-piles.

SDCL construction was accomplished by splicing the top and bottom flanges of the simple span girders at the interior support location after placement and curing of the deck. The deck was placed to within 5 ft of the centerline of bearing at the abutments and centerline of the pier, which minimized non-composite forces on the continuity splice.

Constructing the new bridge using staged construction adjacent to and overlapping the existing bridge was determined to be the most practical and economical option to maintain traffic for this on-alignment replacement. This option reduced traffic congestion during construction and eliminated the need to construct a temporary bridge, thereby reducing time and cost.

Due to simplified and expedited fabrication, erection, simplified traffic control, and cost effective design and detailing, both schedule and cost were minimized. The SDCL detailing in conjunction with the pier continuity splice, weathering steel and fully integral abutments will help minimize maintenance and extend the life over conventional fully-continuous steel plate girder structures of similar size.

Owner
West Virginia Department of Transportation, Division of Highways, Charleston, W.Va.

Designer
HDR Engineering, Inc., Pittsburgh

General Contractor
Ohio-West Virginia Excavating Company, Shadyside, Ohio

Fabricator/Detailer
Ohio Structures, Inc., Canfield, Ohio (AISC/NSBA Member)

MERIT AWARD SPECIAL PURPOSE
DR. MARTIN LUTHER KING, JR. MEMORIAL BRIDGE
ROANOKE, VA.

Roanoke's historic First Street Bridge was removed, refurbished, reinstalled and rechristened as a memorial to Dr. Martin Luther King, Jr.

The City of Roanoke, Va., wanted to preserve a historic but deteriorating 19th century steel truss bridge that spans the Norfolk Southern rail lines by renovating the existing vehicular structure for pedestrian use only and enhancing its approaches to create a memorial to civil rights leader Dr. Martin Luther King, Jr.

Formerly known as the First Street Bridge, the structure consists of three 53 ft, 10-in. approach spans on the south, a 100-ft main truss span, and a single 53-ft, 3-in. approach span on the north. The deck surface was an asphaltic concrete overlay of 3-in. timber decking supported on 6-in. by 14-in. timber stringers and built-up steel floor beams. The main load-carrying superstructure members of the approach spans consist of built-up steel through-girder sections while the main span is a steel Warren pony truss.

After bridge ownership was transferred from the railroad to the city in the 1990s, the city decided to replace the existing First Street crossing with a new bridge at Second Street and convert the existing bridge to pedestrian use only.

The built-up floor beams were the critical members, so they were replaced with new rolled W-sections. All other components retained more than the necessary capacity for the pedestrian live load.

In-place rehabilitation was impractical because of the active railway below the main span. Engineers developed a plan for removing the deck and stringers, carefully dismantling the steel members, and repairing, then strengthening and painting them off-site. This also kept the removal of lead-based paint in a completely controlled and monitored environment.

Owner
City of Roanoke, Va.

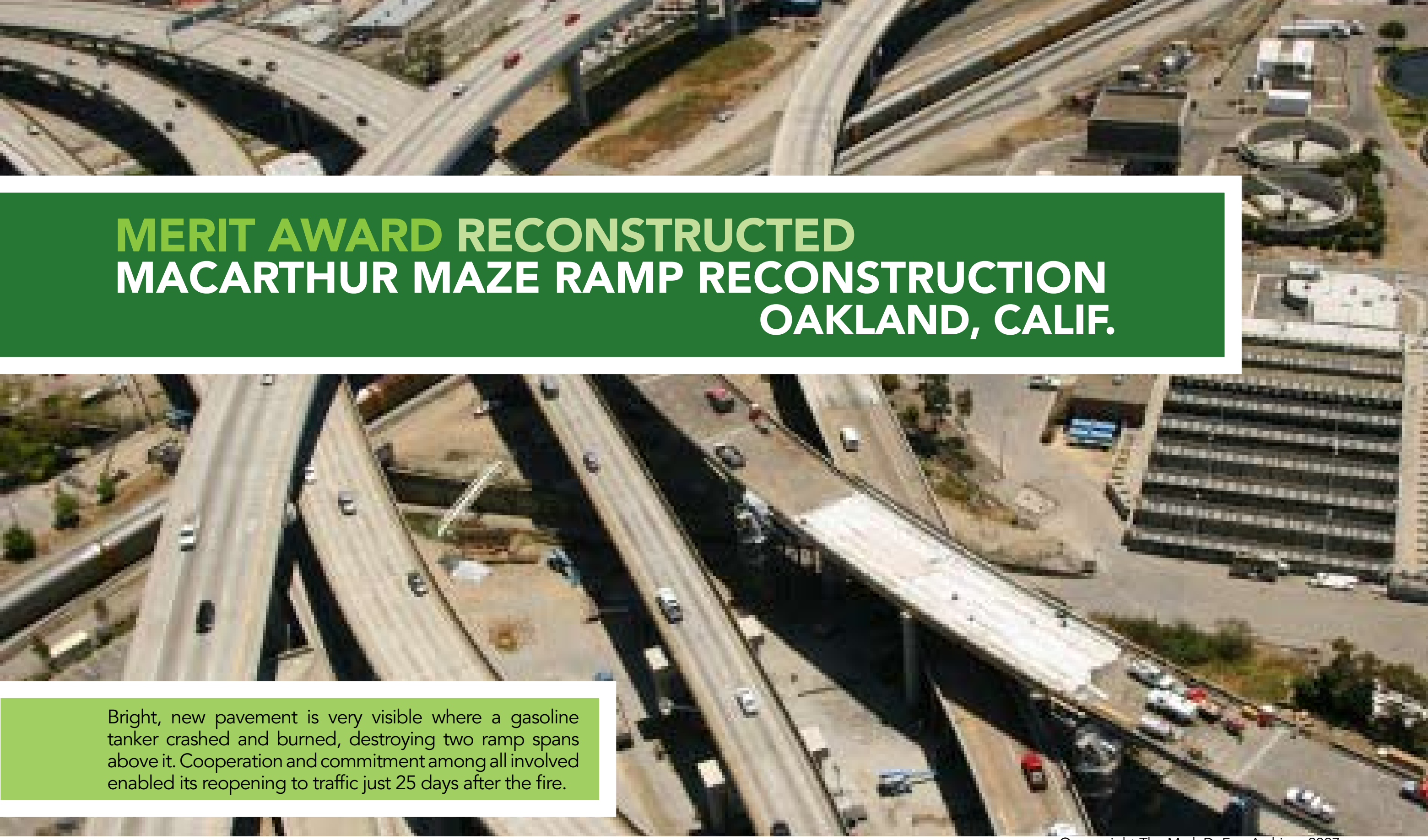
Designer
AECOM, Roanoke, Va.

General Contractor
Allegheny Construction Company, Roanoke, Va.

Fabricator/Detailer
Structural Steel Products Corporation, Clayton, N.C. (AISC/NSBA Member)

Consulting Firm
Hill Studio, Roanoke, Va.

MERIT AWARD RECONSTRUCTED
MACARTHUR MAZE RAMP RECONSTRUCTION
OAKLAND, CALIF.



Bright, new pavement is very visible where a gasoline tanker crashed and burned, destroying two ramp spans above it. Cooperation and commitment among all involved enabled its reopening to traffic just 25 days after the fire.

The I-80/I-580 MacArthur Maze Ramp is a vital link between Oakland, Calif., and San Francisco. At 3:41 a.m., on April 29, 2007, a tanker truck, carrying 8,600 gallons of fuel and traveling southbound on the lower ramp, overturned on the bridge deck and skidded directly beneath the upper level connector ramp.

The 1,500+ °F heat from the free-burning gas fire caused the steel box bent cap as well as adjacent spans to collapse onto the lower level connector ramps directly below. The collapsed portion, a total of 160 ft long and 45 ft wide, included the six steel girders in both spans and the steel bent cap.

Within hours, bridge officials were meeting to set priorities and engineers were on site assessing the damage. Steel plate girders and a precast prestressed concrete bent cap were designed to replace the collapsed portion of the structure. Heat straightening would be used to repair the lower ramp.

The reconstruction plans, specifications, and engineer's estimate ($5,140,070) were completed by the design team within three days. Caltrans was motivated to complete the project as safely and quickly as possible, so the project was advertised with a $200,000 per day incentive/disincentive clause capped at $5 million to reward contractor innovation. In addition, the contractor would be fined $200,000 for every 10 minutes that lane closures were picked up late.

Bids were opened May 7, nine days after the accident. The contract was awarded on the same day to general contractor C.C. Myers, who had arranged to work with Stinger Welding, for the bid price of $867,075.

Within two hours Caltrans began discussions with the steel fabricator on its first critical path item. Within 24 hours, Caltrans had a senior reviewer full-time at the fabricator's shop to provide immediate guidance for welding and shop plans.

Three days later, representatives from Caltrans, C.C. Myers, and Stinger, the AISC/NSBA fabricator, conducted a pre-welding meeting to discuss steel welding and fabrication quality. By the end of the meeting, Caltrans was satisfied with the fabricator's plan and fabrication began.

Stinger fabricated the 12 girders in eight days. Six truckloads took the girders and diaphragms to Oakland for construction. The concrete deck was designated for a 96-hour compressive strength of 3,600 psi prior to directly supporting construction loads, allowing fast track deck placement and a bridge re-opening earlier than originally scheduled.

Caltrans' contract set a construction completion deadline of re-opening on June 27. The work was completed on May 24, 2007, after a mere 15 days on site, earning the contractor the maximum incentive of $5 million.

Innovative concepts incorporated into this project include:

- ➜ The girder web thicknesses were increased to reduce the number of stiffeners required for local buckling checks and the amount of welding required on the built-up girders.
- ➜ The web depth was adjusted to ensure that the overall depth would not require adjustment of the existing bearings that were to be reused.
- ➜ The flange plates were kept to one size to simplify the fabrication.

A professionally made 29-minute documentary on the reconstruction is available at **www.amazingmaze.org**. MSC

Owner and Designer
California Department of Transportation, Sacramento, Calif.

General Contractor
C.C. Myers, Inc., Rancho Cordova, Calif.

Fabricator/Detailer
Stinger Welding Inc., Coolidge, Ariz. (AISC/NSBA Member)