17th Street Bridge

Atlanta

David Lawrence, Prime Images, Inc.

The 17th Street Bridge crosses the I-75 and I-85 interchange in Atlanta and provides a vital link between the city's Midtown neighborhood and the site of a future mixed-use development.

The bridge is a three-span structure with span lengths of 205'-336'-289', consisting of variable depth steel box girders. The structure depth varies from 14'-1" over the two intermediate piers to 7'-9" at the bridge ends and at midspan of the center span.

Considering the dimensions of the box girders, the field sections selected for the girders were relatively large to minimize the number of elements that needed to be handled over the busy highways. The longest field section erected was 190' long, while the heaviest field section was 100' in length and weighed 125 tons. Setting of the box girder field sections required only a few temporary traffic detours, and these occurred at night during weekends.

The main span length of 336' is the shortest span length that could be utilized, considering the limitations imposed by the current lanes of traffic and an I-85 bridge planned for construction under the main span. With a center span of 336', the end spans had to be relatively long as well, resulting in the final three span configurations.

A T-intersection located within the limits of the bridge at both ends presented sight-distance issues in regards to above-deck elements such as arch ribs or cable-stayed towers. The use of steel box girders addressed these concerns by eliminating all above-deck elements.

The south sidewalk, at 22'-0" wide, has an undulating shade canopy and continuous missile fencing, both made of a combination of stainless steel and galvanized carbon steel. The north sidewalk, at 30'-0" wide, also has continuous missile fencing, plus intermittently spaced trellises in planter boxes. Both the north and south sidewalks have perch rails at regular intervals along the length of the bridge, which allow pedestrians to rest while enjoying the views of the city. ★

Owner
Georgia Dept. of Transportation

Engineer of Record
URS Corporation, Tampa, FL

Engineering Software
MDX

Detailer
Tensor Engineering, Indian Harbour Beach, FL, NSBA/AISC member, NISD member

Fabricator
Tampa Steel Erecting Company, Tampa, FL, NSBA/AISC member

Erector
V & M Erectors, Pembroke Pines, FL, NSBA member

General Contractor
C.W. Matthews Contracting Company, Marietta, GA

MERIT AWARDS

LONG SPAN

Iowa River Bridge

near Steamboat Rock on U.S. 20 over Iowa River

Designers for the Iowa River Bridge on U.S. 20 near Steamboat Rock over the Iowa River recommended a launched steel I-girder design and erection technique for the 1,630' project. The design featured longer spans to reduce the number of piers needed and to minimize visual obstructions at river level. The launched-girder erection technique would eliminate the need for the temporary erection towers and piece-by-piece "in place" erection of structural steel required by conventional methods.

The incrementally launched erection process consisted of:

- Erection of all structural steel for the first 154 m of the eastbound bridge (including girders, diaphragms, and upper and lower lateral bracing) on temporary pile bents behind the east abutment in a launching pit.
- Attachment of a launching nose (leading end) and tail section (trailing end) to the girder train.
- Jacking of the girder train forward longitudinally 92 m from Pier 6 to Pier 5.
- Removal of the tail section and splicing of additional girder sections to the tail end of the girder train.
- Reinstallation of the tail section.
- Longitudinal jacking of the girder train to Pier 4

This sequence was repeated for a total of five spans. After steel erection was completed on each span in the launching pit, including all diaphragms and lateral bracing, the steel was launched downhill along a 0.64% grade, being pushed by hydraulic pistons towards the west abutment at a pace of approximately one foot per minute.

After adjustments were made to the steering mechanism to ensure the spans were guided in the proper alignment, the launching process moved forward. The temporary launching nose was attached to the front of the leading span to guide its placement and reduce deflection of a 302' cantilever. Temporary roller bearings placed on the bridge piers assisted with the process of rolling the sections across the valley.

Following the launch of the eastbound bridge, the contractors' equipment was moved to initiate an identical launching of the parallel westbound bridge. After the launch of the tenth and final span was completed, the launching skid was removed. The full length of the superstructure was jacked up to remove the rollers and then jacked down onto permanent bearings on the piers.

ASTM A709 Grade 345W weathering steel was selected for the girders for aesthetic reasons and to eliminate the need for costly painting. The project, which required 9.2 million lb of structural steel, was completed approximately seven months ahead of the original contract schedule. ★

Owner
Iowa Dept. of Transportation, Office of Bridges

Engineer of Record
HNTB Corporation, Kansas City, MO

Engineering Software
T187 (HNTB proprietary software)

Fabricator
Capitol Steel and Iron, Inc., Oklahoma City, NSBA/AISC member

General Contractor
Jensen Construction Company, Des Moines

Erection Engineer
Ashton Engineering, Davenport, IA

To read more about the Iowa River Bridge, see "Landmark Launch" in the February 2004 issue of MSC *at www.modernsteel.com.*

Photo courtesy of Iowa Department of Transportation.

Bill Emerson Memorial Bridge

Cape Girardeau, MO

Photos courtesy of HNTB Corporation/Mark McCabe.

The Bill Emerson Memorial Bridge, named after an eight-term Southeast Missouri congressman, is a 3,956'-long, 96'-wide structure linking Cape Girardeau, MO and East Cape Girardeau, IL. The bridge carries a four-lane roadway and includes an 1,870' eastern approach structure and a 2,086' cable-stayed unit with a 1,150' navigation span.

The bridge is located 50 miles from the New Madrid, MO fault zone and was designed for a magnitude 8.5 earthquake. In addition to seismic hazards, other design issues included the potential for liquefaction and lateral spreading at the Illinois river bank, geological issues, the probability of deep scour, and the potential of a barge collision with any of the bridge piers (the bridge was designed to resist the force of a 1,200'-long barge tow).

The bridge features a 1,150' cable-stayed navigation span with conventional steel and an approach structure comprised of eleven 170' conventional composite steel plate girder spans.

The cable-stayed structure is supported on rock-bearing footings and hydraulically dredged caissons. The approach spans are supported on deep, large-diameter drilled shafts socketed into rock.

Built by the balanced-cantilever method, the two halves of the main span were connected without any special jacking or counterweights needed to make the closure. A seamless connection was made at the middle of the river, and the bridge was within 1" of target.

The bridge also includes cable connections and tie-downs at the end of the cable-stayed spans. The cable connections are extensions of the girder webs designed to load the webs directly and to minimize the torsional stresses that could be induced with offset connections. The tie-downs are a combination of a sliding block and rotating pin, which allow the bridge to translate and rotate under both downward and uplift load conditions.

The bridge was fabricated with Grade 50 weathering steel. The cable connections above the deck were painted to match the two-tube bicycle rail atop the barrier curbs. ★

Owner
Missouri Department of Transportation

Engineer of Record
HNTB Corporation

Detailer
Tensor Engineering, Indian Harbour Beach, FL, NSBA/AISC member, NISD member

Fabricator
Vincennes Steel Corporation, Vincennes, IN, NSBA/AISC member

Erector and General Contractor
Traylor Brothers, Inc., Evansville, IN, AISC member

General Contractor
Massman Construction Co., Kansas City, MO

Third Avenue Bridge over the Harlem River

New York

Photo by Raimondo di Egido.

Owner
New York City Department of Transportation

Architect
B. Thayer Associates, New York

Engineer of Record
Hardesty & Hanover, LLP, New York

Engineering Software
GT STRUDL

General Contractor
KiSKA Construction Corp., New York

The new Third Avenue Bridge over New York City's Harlem River consists of 17 steel girder approach spans and a 350'-long, 6 million lb steel through-truss swing span designed to maintain the historic aesthetics of its predecessor and of the surrounding region. An on-line, staged construction scheme employed innovative concepts, including float-in of the fully-assembled swing span and a pivot pier founded on 6'-diameter steel shafts arranged to complement construction staging and to minimize demolition efforts. Other critical design features include a 15'-deep steel box pivot girder and the highest load capacity spherical roller thrust bearing ever used for a swing bridge.

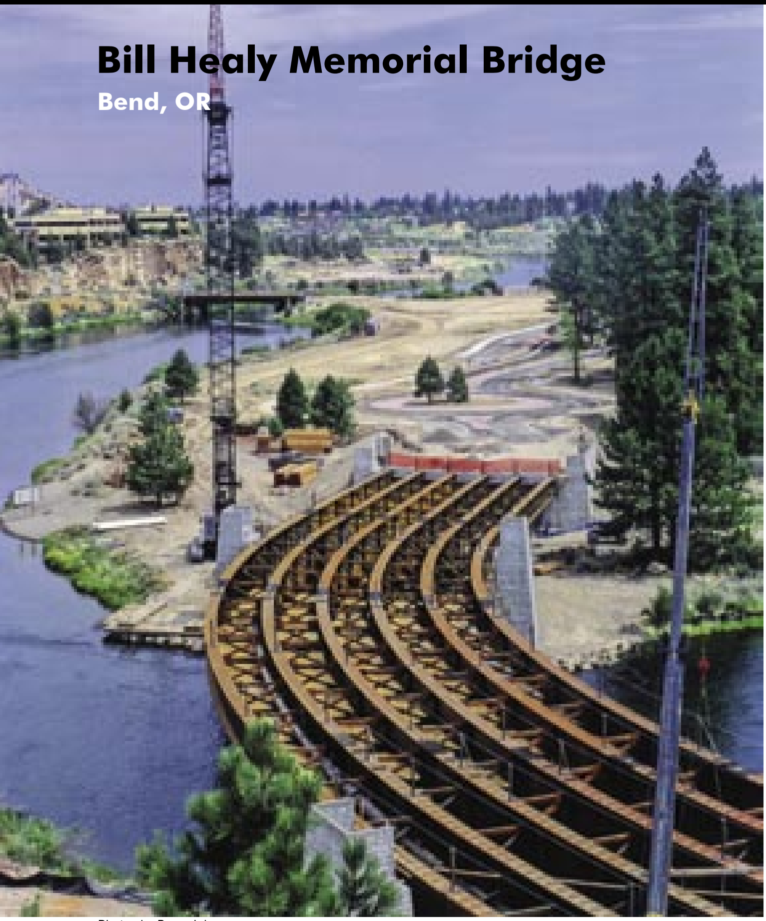
To prepare for the float-in of the new span, the 2000-ton existing swing span was cut in half with torches and saws and removed from the site in three major pieces. Next, the new swing span was transferred from a single barge to two barges to allow clearance with the fender and pivot pier during float-in. Over the next several months, the span remained atop these two barges. The barges were moored about 200 yards south of the bridge where installation of the bridge deck, barriers, and railings, completion of the control house, and installation of the electrical systems took place. During this same time period, the pivot pier was constructed, pier mounted machinery was installed, and the remaining work on the approach spans completed. With the bridge ready to receive its main span, the swing span was floated into position and permanently lowered onto its pivot assembly. ★

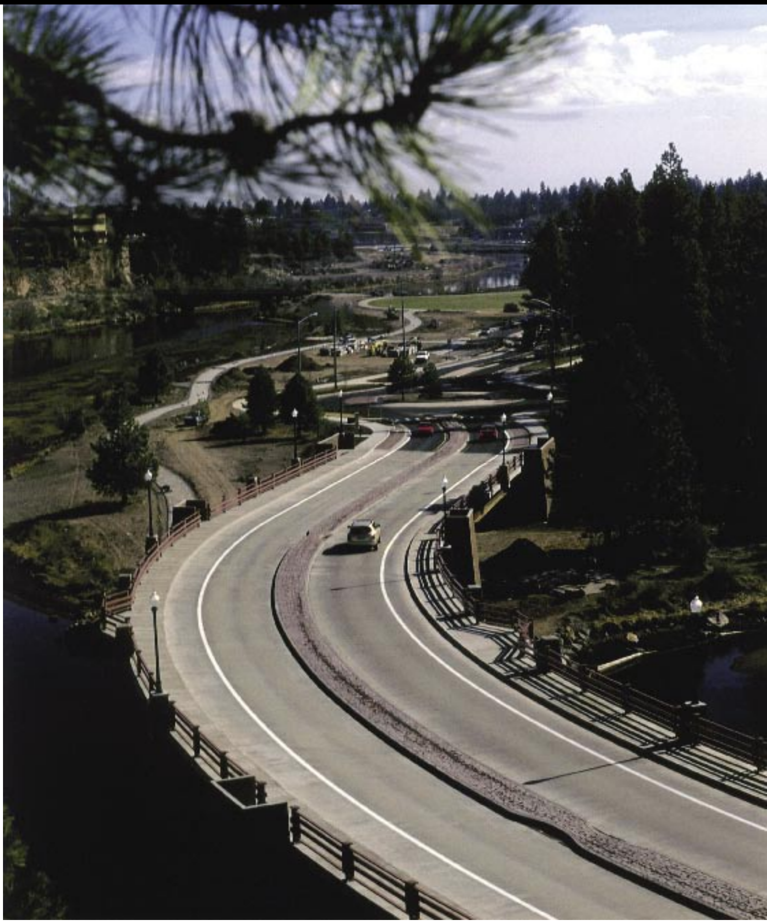
MERIT AWARDS

MEDIUM SPAN

Bill Healy Memorial Bridge

Bend, OR





Photos by Barry Johnson.

Owner
City of Bend, OR

Engineer of Record
W&H Pacific, Bend, OR

Engineering Software
MDX

Detailer
Steelcon, Inc., Cordova, TN, AISC member, NISD member

Detailing Software
AutoCAD

Fabricator
Fought & Company, Inc., Tigard, OR, NSBA member, AISC member

Erector and General Contractor
Hamilton Construction Co., Springfield, OR, NSBA/AISC member

The Bill Healy Memorial Bridge is a 480'-long steel plate girder bridge crossing the Deschutes River and a one-mile extension of Reed Market Road in Bend, OR.

The bridge design incorporates curved, haunched steel plate girders combined with architecturally treated concrete piers that blend with the character of the canyon. The curvature allows the road and bridge to fit the existing constraints of the steep canyon walls and narrow ravines. The haunches create a streamlined, aesthetic appearance and an "open" feeling for people traveling beneath the structure.

The three-span steel girder structure minimizes structure depth, providing ample space for trail users and wildlife to cross under the approach spans, and eliminated the need for piers in the water. Multiple curves were required, which resulted in vertical curves at each end of the bridge with a constant 2% slope between. The horizontal alignment includes a tangent section with reversing curves at either end.

The end spans are typically 60% to 65% as long as the main center span to balance the loads and avoid uplift at the abutments. To keep a balance in the spans, for every foot increase in the length of the main span the bridge, total length would increase close to 2.5', or a special tie-down method at the abutments would be required. A balance between span lengths, individual girder lengths, roadway geometry, overall bridge length, and environmental impact dictated the location of the piers and abutments.

Because of the bridge's curvature, special bearing devices were selected to allow for multi-direction movement. In maintaining a balance between all of the geometric design constraints, the design team decided to allow minor uplift under maximum live load at the end bearings. To account for this, special uplift bearings were incorporated to eliminate any upward movement by the girder.

The faces of all walls slope to create a more visually balanced effect. Three large arched portals are in each pier to allow for more light under the bridge and better views of the river. A natural native rock wall appearance was created at the bridge piers and abutments with stained rock-like concrete shaped by form liners. Multiple arches within the pier structures were incorporated to increase visibility.

Another important feature is the bridge's "raised" bike lanes. By raising the bike lanes next to the travel lane, autos are restricted to a narrower lane that encourages lower speeds. At the same time, the roadway is wide enough to allow emergency vehicle access.

Girder erection was accomplished by erecting the end spans, pier sections, and the final drop in span in the center of the bridge. The contractor was able to use design coordinates for bearing seats and end sections of each girder piece to ensure the final placement of the girders. The girders were placed on temporary supports by cranes to splice the span lengths together. ★

Nebraska Highway 2 over I-80

Grand Island, NE

Photos courtesy Nebraska Department of Roads.

Owner
Nebraska Department of Roads

Engineer of Record
Nebraska Department of Roads, Grand Island, NE

Fabricator and Erector
Capital Contractors, Inc., Lincoln, NE, NSBA/AISC member

The Highway 2 Bridge over I-80 in Grand Island, NE is one of the first bridges in the U.S. to use High Performance Steel (HPS)-100W. It is also among the first to use a new pier connection detail concept, "Simple for Dead Loads, Continuous for Live Loads and Superimposed Dead Loads," which eliminates bolted splices.

The bridge is a two-span steel box bridge, with each span at 139' long. Preliminary designs indicated that use of HPS and steel boxes in conjunction with the new system, which was developed to provide a cost-effective alternative to concrete bridges in short span ranges, would be economical. Use of HPS made it possible to increase the span length for each girder beyond the traditional 120', while keeping the total weight of each girder below 60,000 lb—the crane capacity of local fabricators.

Use of the new system significantly reduced the time required to place the girders over the supports. Elimination of bolted splices was accomplished by joining the girders over the pier using a concrete diaphragm. The detail over the pier allowed the girders to act as simple beams during casting of the concrete deck and to behave continuous after the concrete hardened.

Design of the box girders was based on the assumption that the girders would use a hybrid arrangement, with the bottom flanges of the box sections using 70 ksi HPS and the webs and top flanges using conventional 50 ksi steel. HPS plates permitted the use of thinner plates for bottom flange and reduction in web depth. ★

Photos courtesy HDR Engineering, Inc.

Fort Pitt Bridge and Approaches

Pittsburgh

Built in the 1950s and used by 150,000 vehicles daily, Pittsburgh's Fort Pitt Bridge and Tunnel started showing their age with corrosion, cracking, and dangerous deterioration, the Pennsylvania Department of Transportation (PENNDOT) was faced with the task of rehabilitation. The $84 million Fort Pitt Bridge and Tunnel Rehabilitation was completed in September, 2003.

The project included the rehabilitation of dual 3,600'-long tunnels, a double-deck 750' tied arch river span, and a "spaghetti-bowl" of ramp structures. Innovative design solutions resulted in significant cost savings, enhancing aesthetics and improving the long-term serviceability of the structures, including:

- Simple steel approach spans spliced over the piers to eliminate joints.
- New traffic barrier designs that preserve views from the bridge.

The bridge rehabilitation featured complete deck replacements; strengthening of truss diagonals to meet construction-staging requirements and to provide increased capacity; and replacement of the existing lead based paint with a new three-coat paint system for all of the structural steel. Complete replacement of some steel spans was more economical than rehabilitation.

The original approach spans were primarily simple spans made up of rolled steel shapes and riveted plate girders. Open joints at the piers and years of exposure to de-icing salts caused the greatest deterioration. Where feasible, the existing simple span steel girders were spliced over the piers to eliminate the expansion joints. Fewer joints will enhance the long-term serviceability of the structures by preventing joint leakage and improving the ride quality of the deck. The splices have the added benefit of increasing the capacity of the girders by making them continuous for live load. ★

Owner
Pennsylvania Department of Transportation

Engineer of Record
HDR Engineering, Inc., Pittsburgh

Engineering Software
GT STRUDL, BAR7

Detailers
John Metcalfe Company, Monroeville, PA, AISC member, NISD member

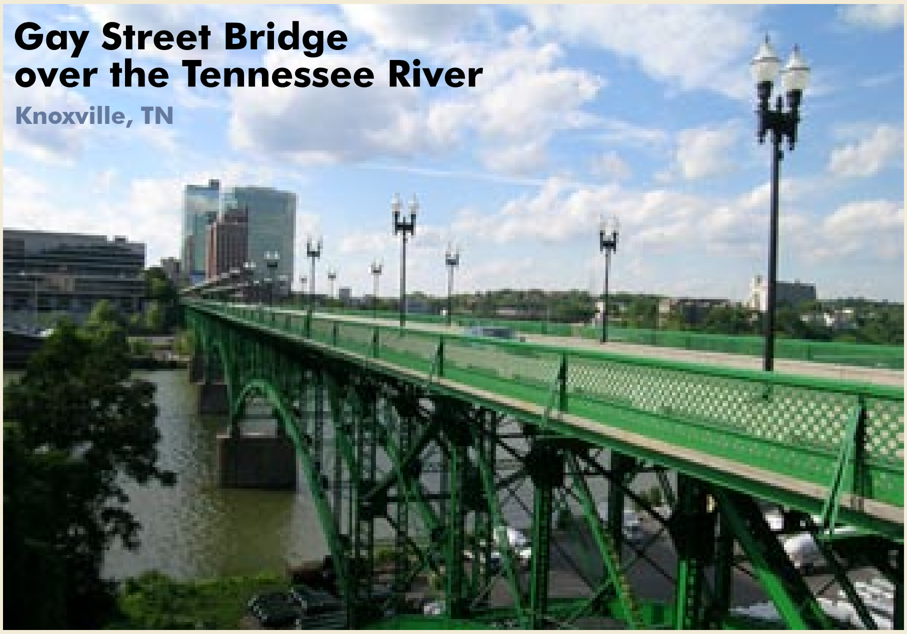
Detailing Software
SteelLogic

Erector
Multi-Phase Inc., Coraopolis, PA, AISC member

General Contractor
Trumbull Corporation, West Mifflin, PA

Gay Street Bridge over the Tennessee River

Knoxville, TN



By George Hornal.

The Gay Street Bridge, constructed in 1897, crosses the Tennessee River in Knoxville. The bridge is composed of seven spans of pin-connected, arched cantilever trusses with a total length of 1,512'. The deck has a 30' roadway with two 6' sidewalks.

By the late 1990s the curbs and deck had deteriorated to the point that they were beyond repair. A study concluded that the Gay Street Bridge could be rehabilitated to modern standards while maintaining its historical character.

The entire floor system, except for the floor trusses, was replaced. A new lightweight concrete roadway and sidewalks, deck joints, drainage, street lighting, curb railings, and approaches were provided.

The centerpiece of the work was reconstruction of truss pin joints at 132 locations. Successful repair of the pin joints was vital to saving the bridge, otherwise total replacement would have been necessary. This entailed partial disassembly of the members meeting at a joint, with new components spliced into the end connections to replace the corroded steel. Pins remained in place and disassembly was only permitted on one side of the joint, either inboard or fascia, at a time. These structural repairs were complicated, as the member ends were stacked in layers on the pin. ★

Owner
City of Knoxville

Engineer of Record
Lichtenstein Consulting Engineers, Paramus, NJ

Engineering Software
GT STRUDL

Detailer and Fabricator
Beverly Steel, Inc., Knoxville, TN, NSBA/AISC member

Detailing Software
AutoCAD, AutoSD

General Contractor
Ray Bell Construction Co., Brentwood, TN

MERIT AWARDS

SHORT SPAN

SR 3008 (Hillsborough Street) over CSX and NS Railroads

Raleigh, NC

Hillsborough Street in Raleigh, NC crosses over a railroad corridor used by two Class A railroads and a future light rail facility. The Hillsborough Street Bridge (SR 3008) provides vehicular and pedestrian passage across this busy railroad corridor. And because the surrounding area is a historic district, construction of the bridge could not damage any of the surrounding buildings.

Urban arterial roadways east, west, and tangent to the new bridge set the transverse bridge configuration with a required typical section width at the west end of 22.664 meters (74.36') and a required east-end typical section width of 27.509 meters (90.25'), producing a width difference of 4.845 meters (15.90'). A rhombus-shaped footprint for the bridge deck was selected in lieu of a rectangular shape to minimize the required square footage of the deck. This configuration required the girders to be splayed instead of parallel and reduced the deck area by 92.33 square meters (994 sq ft).

The proposed bridge depth was governed by two site specific factors: an existing masonry building and the two railroads beneath Hillsborough Street. The result of upper and lower limitations produced a height envelop for the bridge superstructure of 688mm (2.25').

Steel was selected for the bridge due to its span capabilities, and a fixed haunched plate girder bridge type was found to meet the restrictive site requirements. The rigid frame consisted of steel haunched plate girders embedded into a concrete cap creating an integral beam/cap supported by reinforced concrete columns and drilled shafts.

By utilizing a fixed-fixed end condition, the induced dead and live moments were shifted from the center of the girder span to the girder ends. This permitted the girder depth to be minimized. To maintain the fixed-fixed condition necessary and to enable the superstructure to expand and contract freely, one end of rigid frame had to be reconfigured. The revised configuration included an additional short approach span adjacent to the long main span and utilized a two-span continuous girder, thus producing an equivalent single span rigid frame unit. ★

Owner
North Carolina Department of Transportation

Engineer of Record
TranSystems Corporation, Greenville, SC

Engineering Software
Merlin-DASH

Detailer and Fabricator
Carolina Steel Corporation, Greensboro, NC, NSBA/AISC member

MERIT AWARDS

SPECIAL PURPOSE

BP Pedestrian Bridge at Millennium Park

Chicago

Peter Barreras Photography.

The BP Pedestrian Bridge links Chicago's newly opened Millennium Park to the Lake Michigan across Columbus Drive. Overall, the bridge is some 920' long. Both bridge approaches are comprised entirely of reinforced concrete continuous bearing walls, curved in plan and elevation, with reinforced concrete slabs spanning between the bearing walls. The resulting length of the approaches allows for gentle grades (less than 5%), which avoids the requirement for longitudinal handrails and intermediate flat landings to meet accessibility standards.

The termination of the approach structures is formed by reinforced concrete abutments which in turn support a transition structure between the approaches and the Columbus Drive crossing proper. These transition structures are propped three-dimensional cantilever steel trusses spanning between the concrete abutments to single 6'-diameter reinforced concrete pylons, which are constructed atop existing garage structures and located along existing column lines. The trusses cantilever beyond the pylon supports approximately 8' on the west and 28' at the east; each locating longitudinal expansion joints in the structure.

Both cantilever trusses are formed by a four-chord spine composed of large diameter pipes with web members W14×43 throughout. The trusses to the east and west of the Columbus Drive span are significantly different geometrically, with the east truss doubly curved in plan in addition to the longer cantilever. All truss chords are curved in a single plane only and then inclined, with the west chords formed by two tangent arcs of radii varying from 72' to 130' and the east chords formed by three tangent arcs of radii varying from 52' to 130'. All truss pipe chords are 20"-diameter with wall thicknesses of 1.5" at the west and 2.0" at the east. While the top chords of the trusses are spaced to match the width of the walkway (15' apart), the bottom chords are considerably narrower (5') to bear on the pylon support. The central four-chord spine of the cantilevered trusses is further structured with transverse outrigger members, beyond the width of the walkway, which serve as auxiliary supports for the architecturally clad surfaces.

Structurally, the four-chord articulated cantilever trusses narrow as they approach the expansion joints, which then give way to a discrete rectangular steel box girder. The box girder is a two-span arrangement (approximately 80' each) between the ends of the cantilevered trusses and a reinforced concrete pylon. The box girder is 72" wide, 39" deep with 1.5" thick top and bottom flanges, and 0.5" web plates. The box girder is composed of six continuously curved tangent arc segments with radii varying between 92' and 140'. Longitudinal W12 purlins support the edge of the walkway deck. A series of transverse outrigger frames and longitudinal girts support the architectural cladding secondary frames. ★

Owner
City of Chicago

Architect
Gehry Partners LLP, Los Angeles

Engineer of Record
Skidmore, Owings & Merrill LLP, Chicago

Detailer
Mountain Enterprises, Inc., AISC member

General Contractor
Walsh Construction, Chicago

Turtle Bay Sundial Bridge

Redding, CA

Owner
City of Redding, CA

Architect
Santiago Calatrava, SA, Zurich, Switzerland

Engineer of Record
Calatrava Firm, Zurich, Switzerland

Detailer
Tensor Engineering, Indian Harbour Beach, FL, NSBA/AISC member, NISD member

Fabricator
Universal Structural, Inc., Vancouver, WA, NSBA/AISC member

General Contractor
Kiewit Pacific Co., Vancouver, WA

Photo by David Greusel.

The 1,600-ton Turtle Bay Sundial Bridge opened July 2004 over the Sacramento River in Redding, CA. It consists of a 300'-long by 217'-wide single-inclined tapered pylon supporting a 722' truss span. The triangular pylon, inclined at 42 degrees, runs in a true north-south direction. At approximately 110' long by 75' wide, the open base of the pylon forms a plaza at a 36-degree angle between the east and west walls.

The west face, which supports the triangular deck span, inclines two degrees to the west, while the east face is inclined toward the west at 28 degrees. The north wall is a curved, warped surface connecting to the rear edge of the west and east walls. Each wall has both inner and outer faces which are 2'-8" apart at the base and taper to about 6" at the top.

The span is supported by 14 cables connected to transverse bulkheads in the deck truss and to plate brackets cantilevered from the west inclined face of the pylon. Horizontal and vertical stiffener systems, as well as skewed stiffeners, line up with the cable support brackets.

The entire structure is made up of plate material varying in thickness from 1" at the base and reducing to 5/8" at the top.

The 722' pedestrian bridge deck system is a triangular pipe truss with a 14'-diameter bottom chord and two 11'-diameter top chords. The 23' wire translucent deck is framed in glass panels with granite accents. The deck is not symmetrical, and so it had to be cambered vertically, longitudinally, and transversely.

To learn more about the Turtle Bay Sundial Bridge, read "Sun Sculpture" in the October 2004 issue of MSC*, available at www.modernsteel.com.* ★