NATIONAL STEEL BRIDGE ALLIANCE

Steel Bridge NEWS

Vol. 6, No. 3
July 2005

New Central Viaduct for downtown San Francisco

uses steel girders with integral concrete bent caps for vertical clearance

By Yong-Pil Kim, Senior Bridge Engineer, Caltrans

A new Central Viaduct will soon direct traffic into San Francisco from the Bay Bridge in the east and from Highway 101 in the south. The new steel viaduct replaces a previously retrofitted viaduct whose structural integrity came into question after the 7.1 magnitude Loma Prieta earthquake in 1989. After the earthquake, Caltrans removed the upper deck portion of the viaduct in the interest of safety.

Figure 1 *Tight vertical clearance requirements and the curvature in the horizontal alignment tipped the decision for a steel, rather than precast concrete, superstructure for the Central Viaduct in San Francisco. Standard V-shaped cross frames connect the girders laterally.*

The new steel viaduct replaces the lower elevated deck, and touches down on Market Street, a main thoroughfare within the city. The viaduct provides two lanes in each direction plus shoulders. The steel superstructure has a hybrid girder design, combining high performance grade 70 ksi steel with standard 50 ksi steel. The steel girders are integral with the concrete bent cap to maximize vertical clearance. The contractor post-tensioned the partially built bent cap to eliminate need for falsework during the deck pour. After the deck concrete reaches its strength, additional post-tensioning will be applied to each bentcap for final service loads.

Various factors for this project dictated steel for the viaduct's superstructure. The streets below run parallel to a major portion of the viaduct and had to remain open during construction. One intersection below the viaduct in particular required a long span with a limited area for falsework. Space was sufficient only for falsework to construct the bentcap beam. Vertical clearance requirements, a curvature in the horizontal alignment, and one particularly long span where falsework was prohibited virtually ruled out either cast-in-place or precast concrete design. Oregon Iron Works fabricated the steel for the project.

Viaduct configuration

The new portion of the Central Viaduct consists of ten spans that achieve a total length of 434 m (1424 ft). The longest span stretches to 58 m (190 ft). The design follows LFD specifications. Contractors bolted underlying girders end to end via field splices to create a set of continuous parallel girders that matched the entire length of the viaduct.

Figure 2 *Workers for Adams and Smith, Inc. begin splicing two steel girders to make them continuous. This operation required partial closing of the street below.*

San Francisco Central Viaduct superstructure

Number of continuous steel girders	7
Weight of steel girders	2,362 tons
Number of crossframes	376
Weight of crossframes	392 tons
Number of spans	10
Longest span	190 ft
Viaduct length	1423 ft

Three concrete columns topped by a transverse concrete bent cap support the viaduct's superstructure. The columns extend from concrete pile shafts that run as deep as 94 ft below the surface. Columns are supported by cast-in-place drilled concrete pileshafts, 6 ft and 7 ft in diameter.

Some interruption of traffic could not be avoided. The contractor set up falsework adjacent to bents to set the girders in their final configuration and to bolt-splice the steel girders together, making them continuous. This required closing a portion of the street below. A minimum set number of hours were allowed for this operation.

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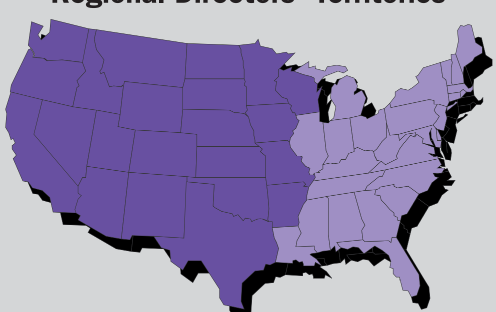
Regional Directors' Territories



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NATIONAL STEEL BRIDGE ALLIANCE

Subscription requests, address changes should and correspondence regarding newsletter content should be sent to the attention of Mike Moffitt.

Message from the Executive Director: Conn Abnee

I would like to take a moment to provide an update on the National Steel Bridge Alliance federal government relations' agenda. We have had many accomplishments that I would like to share.

As you are aware, the National Steel Bridge Alliance has been working closely with several members of Congress to push for an amendment to the Transportation Equity Act (TEA bill) for a dedicated high performing steel research program. Our request would direct research at developing new, longer lasting coatings and low cost, corrosion resistant steels. This program would have benefits to the steel industry that would extend beyond the bridge industry and would contribute to the development of a new generation of steel that will combine strength and reasonable cost. In short, there is no single development that will contribute more to the life cycle of steel benefits or reduce the need to replace current infrastructures than the advancements that will be supported through this program.

After many long hours and a number of meetings with key Senators and their staffs, I am pleased to inform you that Senators John Thune (R-SD) and Barrack Obama (D-IL) agreed to sponsor the NSBA amendment. Soon thereafter, the Senate passed their version of the TEA bill that included our amendment at a funding level of $5 million per year for the next five years. This is excellent news for not only steel bridges, but for the entire steel industry.

As the Senate and House now meet in conference to resolve the differences in the TEA bill, we will need to continue working together to ensure that the NSBA amendment is kept in the final language of the legislation. With this amendment we can propel the steel industry into an age of lower costs and higher quality. Best wishes.

We're on the Move

On July 5th, the Chicago Office of the National Steel Bridge Alliance moved from the 31st floor at One East Wacker Drive to the 7th floor. Please note the new suite number and zip for your records:

National Steel Bridge Alliance
One East Wacker Drive, **Suite 700**
Chicago, Illinois **60601-1802**

Breeding Bridges at Michigan

Michigan Architecture students are breeding – breeding bridges! And some of the children produced in the Structural Framing class, have grown up to span rivers. Asst. Prof. Peter von Buelow has given his students the task to breed efficient structural forms using a program he has written based on Genetic Algorithms. Students select parent structures displayed on the computer monitor that reflect their own design criteria. These parent forms are then breed to produce a generation of children. Mutation can also come into the mix with surprising suggestions. By continually selecting and breeding forms that meet their design criteria, the students are able to explore families of structurally efficient forms. Part of the program performs an optimization of each child to ensure it represents a good solution. All of this requires some substantial computing power. The program runs on Hydra, the schools own Linux cluster that focuses 32 processors and 12 Gig of RAM on the problem at one time. Using parallel processing the program is able to breed a generation of solutions every 10 minutes. This gives students plenty of children to choose from. With a little care and nurturing, the proud parents are able to raise their offspring into full-grown bridges by the end to the semester.

Figure 1 *Michigan Architecture students Jinauh Jeon and Xuezhen Jchen use the Hydra to breed their bridge design.*

Figure 2 *Rendering of a bridge designed by Michigan Architecture students: Jennifer Perlove Siegel, William Marquez, Faye Whittemore and Lauren Bostic*

South Carolina DOT hosts Steel Bridge Collaboration workshop

A workshop of the Steel Bridge Collaboration, a joint effort of the American Association of State Highway and Transportation Officials (AASHTO) and the National Steel Bridge Alliance (NSBA), was held April 28 in Columbia, South Carolina.

The workshop, Current Technology for Design and Construction of Steel Bridges, was held to familiarize staff and consultants from state Departments of Transportation with Collaboration standards and guides, and to encourage their use. Hosted by the South Carolina DOT, the workshop drew approximately 70 attendees.

An orientation to Collaboration standards documents was presented by Ronnie Medlock, Texas DOT. These documents are available for free download through the Collaboration's web site at www.steelbridge.org. Additional presentations by representatives of Texas, Illinois, and Maine DOTs, Trinity Industries, D.S. Brown Company, and NSBA focused on current topics in steel bridge specifications, fabrication technology, erection, quality control, and constructability.

The Collaboration was formed to bring AASHTO and NSBA together with representatives from state DOTs, the Federal Highway Administration, academia, and various industries involved in steel bridge design, fabrication, and inspection. Its mission is to achieve quality and value in steel bridges through shared resources and the standardization of design, fabrication, and erection.

The next meeting of the Collaboration will be held in Orlando, FL in conjunction with the World Steel Bridge Symposium, November 29 through December 2, 2005. For more information, please visit www.steelbridge.org.

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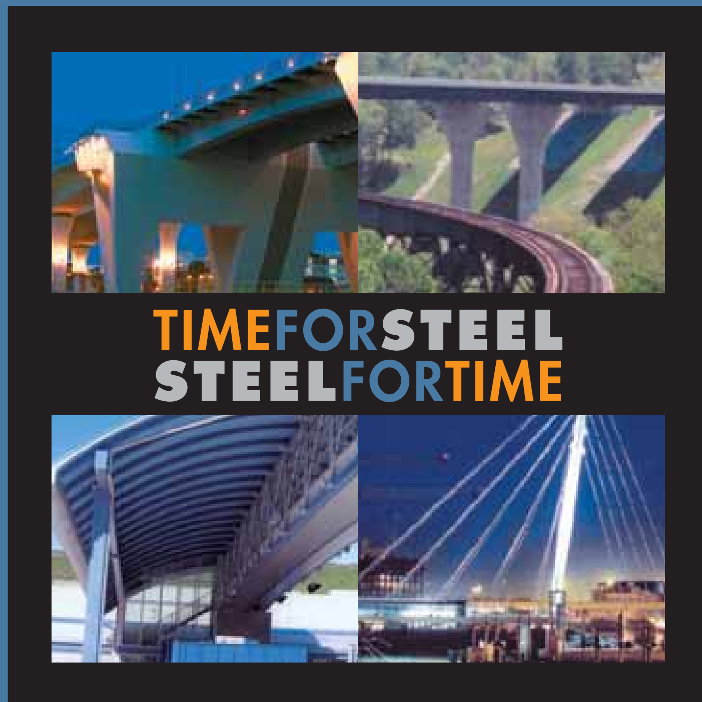

2005 WORLD STEEL BRIDGE
Symposium & Workshops

NOVEMBER 29 - DECEMBER 2 | 2005

Pre-Symposium Program Includes:

Half-day workshops

- PreFabricated Bridge Elements and Systems
- Accelerated Bridge Construction Technology

Symposium Program Focus Areas will include, but are not limited to the following:

- Short Span Bridges
- Intermediate Span Bridges
- Case Studies Featuring the Use of High Performance Steel
- Restoration, Rehabilitation or Reuse
- Fabrication, Construction and Erection
- Innovative Bridge Designs
- Inspection and Maintenance

2005 Prize Bridge Awards will be presented at the Symposium banquet.

Sponsored by:

National Steel Bridge Alliance
www.nsbaweb.org

Federal Highway Administration
www.fhwa.dot.gov/bridge

National Steel Bridge Alliance
A Division of American Institute of Steel Construction, Inc.

More information coming soon! Watch our website:
www.nsbaweb.org

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For **GENERAL INFORMATION**, contact Kristin LaPlaca at LaPlaca@aisc.org

New Central Viaduct

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Seven continuous steel plate girders support the concrete deck. The spacing between the girders varies, as does the width of the viaduct, but averages about 12 ft. The depth of the girders varies from 1.3 m (4.26 ft) to 1.9 m (6.23 ft), depending primarily on span length. Standard V-shaped crossframes connect the girders laterally.

The girder top and bottom flanges consist of both high performance and standard steel, depending on loads. Flange widths range from 450 to 950 mm (about 1.5 to 3 ft), while flange thicknesses range from 32 to 75 mm (about 1.2 to 3 inches). Web thickness is sufficient to require stiffeners only near the support columns. To accommodate expansion, CalTrans specified PTFE bearings on top of the columns at two bents adjacent to the beginning and the end of the structure. Lateral movement of the superstructure is restrained by internal shear keys embedded on top of these columns.

The curves in the plate girders made normal trial assembly nearly impossible. The fabricator fully assembled bridge sections and bunked them to elevation to replicate field conditions, minimizing the possibility of fabrication and erection errors. Adams and Smith, Inc. (Lindon, Utah), erected the viaduct superstructure.

The contractor elected to use stay-in-place metal forms for casting the deck. Installation of wooden forms can compromise safety with traffic underneath. The standard deck thickness is 240 mm (about 9.5 inches). Thickness ranges up to 250 mm where wider girder spacing prevails.

Attaining vertical clearance

The conventional system of erecting steel girders over dropped cap bents was not acceptable due to vertical clearance requirements. As a solution, integral concrete bentcap construction was chosen, where the steel girders are embedded within the concrete bent cap—a relatively unusual configuration. The bottom of the bent cap is just six to nine inches below the girder bottom flanges. This system achieved a final vertical clearance of nearly 17 ft above the street traffic below, and 14.5 ft during construction.

Figure 3 *The continuous steel girders are integral with the concrete bent cap to provide vertical clearance near 17 ft at the lowest point.*

For this system to work the contractor had to post-tension the integral bent cap. Four steel tendons for the post-tensioning run transversely through the concrete bent cap, and they are placed through holes in the web of the steel girders. The path of the tendons follows a parabolic curve, a shape that is opposite to the natural sag of the concrete beam.

Post-tensioning of the bent cap takes place in two stages. The first stage stresses the tendons for a structure that consists of plate girders and partially built bent caps. This permits the viaduct to carry the load during the wet concrete deck pour plus the live load from construction crew and machines. With this technique no falsework is required.

After deck concrete achieves its specified strength, the contractor stresses the tendons in the bent cap a second time. This additional post-tensioning permits the structure to support the dead load of the viaduct plus the live traffic load. Caltrans expects to complete the Central Viaduct in July of 2005.

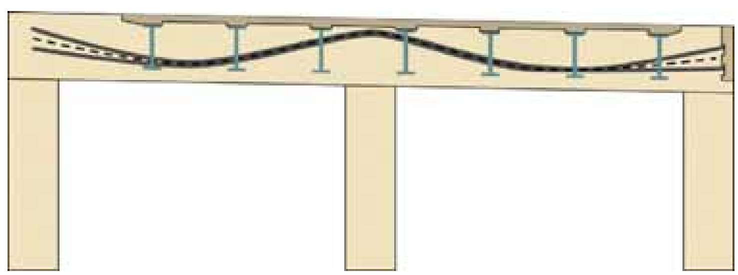
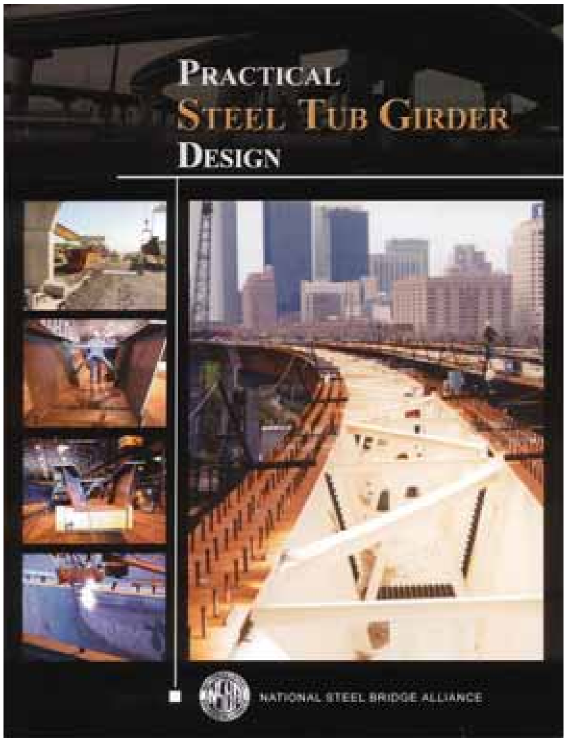


Figure 4 *Steel tendons weave through the steel girders in a parabolic curve within the bent cap. The contractor post-tensions the partially built bent cap prior to the deck pour to eliminate the need for additional falsework for deck weight and construction live load.*

Figure 5 *The deck pan varies from about 9.5 to 10 inches thick, depending on the girder spacing. The contractor chose stay-in-place metal forms for the deck pour.*

New free book offers practical information on design of steel tub girder bridges



Fifty-page, full color, 8½" x 11" book published by the National Steel Bridge Alliance (NSBA) addresses the design of steel tub girder bridges. The book represents a single, comprehensive source of information on steel tub girders. It addresses the entire design process, including layout, design, and detailing, and also offers guidance on construction loading stages.

The book begins with a chapter on the rationale for choosing tub girders as well as application issues. Additional chapters discuss such topics as tub geometries, analysis techniques, diaphragms and bracing, and miscellaneous details. The book concludes with discussions of three example projects. Also included are a comprehensive list of references, an appendix of computer design tools, and an appendix with suggested design details.

Entitled, "Practical Steel Tub Girder Design," the book is available free for download as an Adobe Acrobat file (pdf) from the NSBA website. The entire book (7.3 Mbyte) or individual chapters may be downloaded at: http://www.nsbaweb.org

For a limited time, professionally printed, bound hardcopies of the book can be obtained by contacting Mike Moffitt at moffitt@nsbaweb.org

Steel To Lighten Load of Bronx Whitestone Bridge

Opened to traffic April 29, 1939 and after more than 65 years of additions, it's time for the Bronx Whitestone Bridge in New York to shed some pounds.

The Metropolitan Transportation Authority began replacing the decks of the bridge in June. The decision comes after engineers determined the bridge had grown too heavy from reinforcements added over the years to make it more stable.

The new steel decks will replace the current concrete ones, reducing the bridge's weight by 6,000 tons or about a quarter of its total suspended weight.

The project is expected to take just under a year to complete.

Photo by Robert Cortright, courtesy of http://en.structurae.de/

Upcoming Events

july 2005 - december 2005

July 17-20	**6th International Bridge Engineering Conference** Boston, MA	http://www.trb.org/conferences/ibec
Aug 6-9	**1st International Conference on Fatigue and Fracture in Infrastructure** Bethlehem, PA	http://ffconf.atlss.lehigh.edu/
Sept 15-17	**AISC Annual Meeting** Dana Point, CA	
Sept 25-28	**Western Bridge Engineers Conference** Portland, OR	Jean Canfield (360) 943-7732
Oct 27-28	**Ohio Transportation Engineers Conference** Columbus, OH	www.otecohio.org/otec.htm
Nov 13-16	**Fabtech & AWS Welding Show** Chicago, IL	Joe Krall (800) 443-9353
Nov 29-Dec 2	**World Steel Bridge Symposium** Orlando, FL	www.nsbaweb.org

Steel—Standing the Test of Time

Rip Van Winkle Bridge

Catskill and Hudson, New York

Construction of the Rip Van Winkle Bridge in April 1933. The approved 13-span cantilever bridge design was to be 5,040 feet long, and 145 feet above the river to allow passage of freighters to and from Albany. The Frederick Snare Construction Corporation of New York City won the bid for construction of the new bridge. Despite the fact that the Bridge Authority was financing it, supervisory responsibility remained with the New York State Department of Public Works.

To haul materials to the construction site, roads were constructed on the western shore; a temporary narrow-gauge railroad was built on the eastern shore. In addition, cranes were used to hoist steel and other materials from barges in the Hudson River. Two cranes moved back and forth, putting steel girders in place, followed by men who would bolt and rivet them into place.

Eleven sections of the bridge had been built by November 1934. At the end of December, 60 men were busy closing the last 100-foot gap over the main channel. The last link was put in place on January 18, 1935, the two cantilever arms of the main span being jointed by the use of 16 300-ton hydraulic jacks.

During the spring of 1935, workers installed the two-lane roadway, and completed the Dutch-colonial-style toll plaza and administration building. The Rip Van Winkle Bridge opened to traffic on July 2, 1935, at a cost of $2.4 million and three lives. When the bridge opened, a toll of 80 cents per passenger car, plus 10 cents for each passenger (up to a maximum total of $1.00) was charged.

To accommodate more than one lane of traffic at a time and toll in only one direction, the tollbooths at the Rip were rebuilt in the late 1960's. The new plaza, which was constructed in the same style as the original plaza, also allows larger vehicles to pass through.

During the 1990's, construction crews replaced the deck of the Rip Van Winkle Bridge. In addition, a new maintenance facility was built behind the administration building with the same Dutch-colonial architecture as the main building.

According to the New York State Department of Transportation (NYSDOT), about 15,000 vehicles cross the Rip Van Winkle Bridge each day (AADT). The bridge, which carries NY 23, connects to the west with US 9W and NY 385 in Catskill, and to the east with NY 9G in Hudson. While bicyclists are permitted on the bridge, they must share the two-lane roadway with motor vehicles. Along the outboard of the superstructure, the bridge has narrow sidewalks reserved exclusively for pedestrian use.

Steel Bridge Bearing Guidelines Published

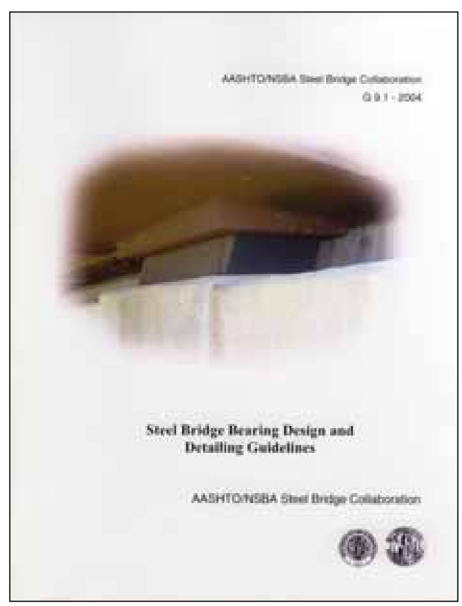
Ronnie Medlock, chairman of the AASHTO/NSBA Steel Bridge Collaboration, announced that the group's latest standard has just been published:

G9.1, Steel Bridge Bearing Design and Detailing Guidelines

This standard presents steel bridge bearing details that are cost effective, functional, and durable. The standard addresses elastomeric bearings, high load multi-rotational (HLMR) bearings, and steel bearings. Two appendices that are included that may be especially useful addressing thermal movement and beam rotation calculation recommendations.

The document may be downloaded for free at the AASHTO Bookstore. To become an AASHTO E-Affiliate go to https://bookstore.transportation.org/ or download the pdf files from the Collaboration homepage at http://www.steelbridge.org.

In making the announcement, Medlock acknowledged the work and leadership of Michael P. Culmo of CME Associates, Inc. As chairman of the Collaboration Bearing Task Group, Culmo can be reached at the following email address for questions or for providing input for future consideration: culmo@cmeengineering.com



nsba Steel Bridge NEWS

A Division of the American Institute of Steel Construction, Inc.

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Montana offers bridge for adoption

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Montana offers bridge for adoption

The Montana DOT is offering up an historic, 79-ton bridge built in 1894 for adoption. It's free and the state will even chip more than $50,000 to help pay the moving expenses. The 500-ft Old Steel Bridge east of Kalispell was the first steel bridge to cross the upper Flathead River and was a major economic development tool at the time.

The bridge includes two 140-foot spans and a main 220-foot span. The vertical clearance is 15 feet 6 inches and the maximum truss height is 30 feet. It's said to be a good example of the pin-connected-through-truss construction technique.

Prospects may take individual spans or the whole bridge, but must make some use of the spans other than scrap. Possible uses include bicycle/pedestrian paths or farmland crossings.

Montana has had about 16 successful bridge adoptions in the past.

Based on an article by William Spence of the The Daily Inter Lake.