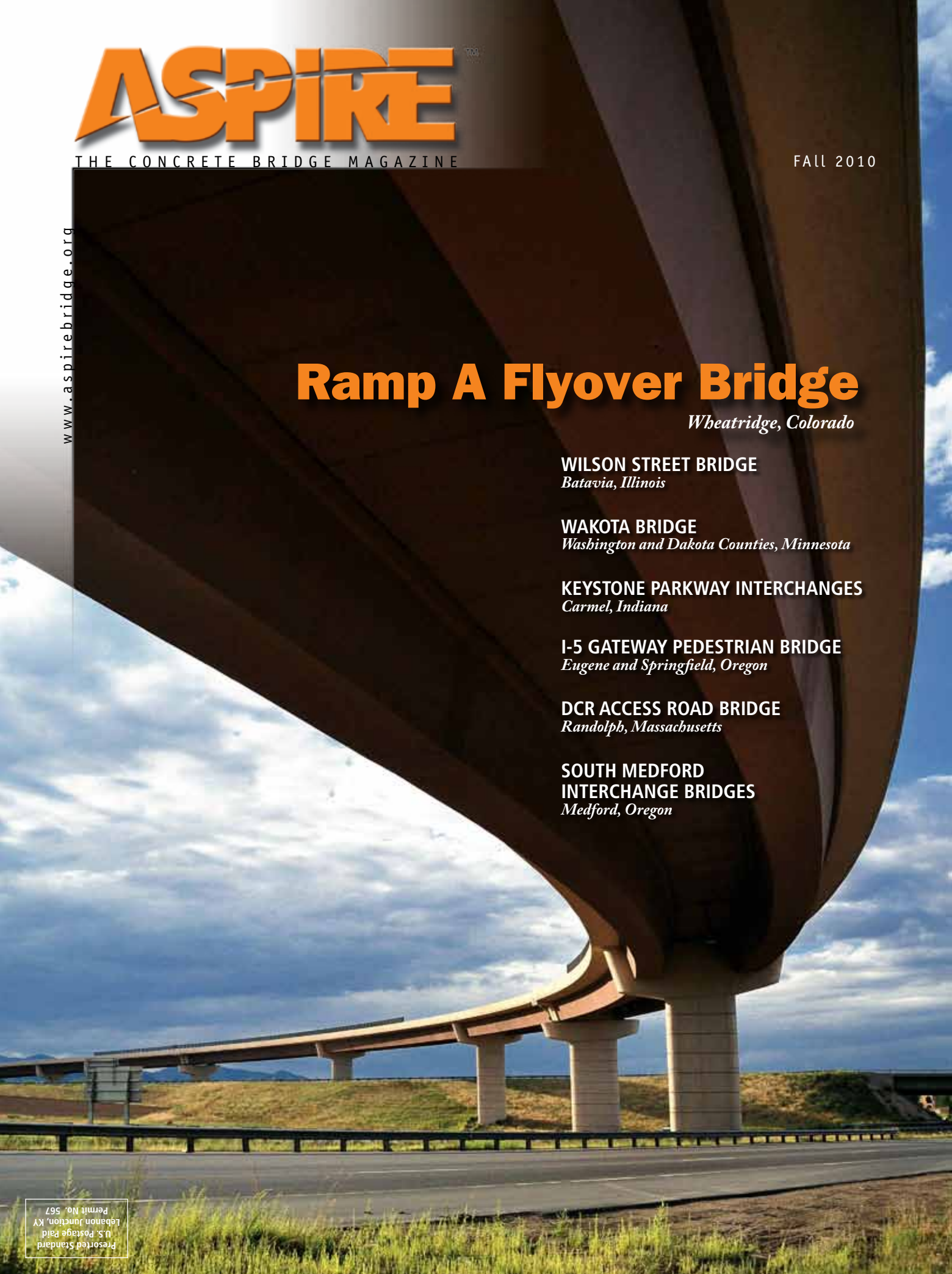
ASPIRE™
THE CONCRETE BRIDGE MAGAZINE
FALL 2010
www.aspirebridge.org



Ramp A Flyover Bridge

Wheatridge, Colorado

WILSON STREET BRIDGE
Batavia, Illinois

WAKOTA BRIDGE
Washington and Dakota Counties, Minnesota

KEYSTONE PARKWAY INTERCHANGES
Carmel, Indiana

I-5 GATEWAY PEDESTRIAN BRIDGE
Eugene and Springfield, Oregon

DCR ACCESS ROAD BRIDGE
Randolph, Massachusetts

SOUTH MEDFORD INTERCHANGE BRIDGES
Medford, Oregon

Presorted Standard
U.S. Postage Paid
Lebanon Junction, KY
Permit No. 567

Modern Concrete Bridge for the Future

June 2010; Pier height is 150' to top of column and 178' to bridge deck. Pier table for spans of 497' and 504'.

CONTEXT SENSITIVE SOLUTION

Mon-Fayette Expressway,
Section 51H
across the Monongahela River,
Brownsville, PA

The Pennsylvania Turnpike Commission's new bridge across the Monongahela River features long, arching spans and tall, slender piers to create an elegant concrete segmental bridge. The 3200 ft long bridge consists of seven spans. The 518 ft main span, built using balanced cantilever segmental construction, crosses the river, two active rail lines, and local roads. The C-shaped piers rise over 200 ft above the mountainous terrain. The concrete segmental structure was bid as an alternate design, saving the Pennsylvania Turnpike Commission more than $8 million over the steel bridge design.

Owner: ***Pennsylvania Turnpike Commission***
Contractor/Designer: ***Walsh Construction Company with FIGG***

FIGG

CREATING BRIDGES AS ART®

1.800.358.3444
www.figgbridge.com

CONTENTS

Social, Economic, and Ecological Benefits of Sustainable Concrete Bridges

Photo: Summit Engineering Group.

Photo: American Structurepoint Inc.

Photo: OBEC Consulting Engineers.

Features

Departments

Photo: Staff Davis, Staff Davis Photography.

Advertisers Index

EDITORIAL

Photo: Ted Lacey Photography.

Innovation

John S. Dick, *Executive Editor*

Innovation is a word we use a lot these days. It describes the result of creativity…of originality… of "thinking out of the box." We shouldn't be surprised; there's a lot of it occurring in the realm of bridge engineering design and construction.

ASPIRE™ magazine was created to share this technology. The dictionary defines aspire as demonstrating "a strong desire for high achievement," to "strive toward an end," to "soar." That definition aptly describes both the ambition of a bridge designer and the objective of this magazine; the ambition to innovate. You'll find it is prevalent in this issue.

Begin with the Wilson Street Bridge article that starts on page 16. This truly elegant design, made possible by post-tensioned, high-performance concrete, shines as the centerpiece of a picturesque river community.

Bridge designers haven't been content with the traditional geometrics of intersection design. This issue reports on two firms at opposite ends of the country that faced challenging constraints and created unique designs. The Keystone Parkway set of interchanges in Indiana, relies on a "double teardrop roundabout" that requires a minimum footprint in the redesign of a busy corridor (see pages 24-26). In Oregon, the South Medford Interchange on I-5 is an example of a well-designed single-point urban interchange (SPUI). SPUIs aren't brand new, but they demonstrate the informed application of a new generation of interchange designs that simplify traffic patterns and reduce driver travel time. This project resulted in 11 bridges requiring 235 concrete girders and 24 precast concrete slabs. The article begins on page 36.

A pedestrian bridge intersecting with I-5 in California, combines the best attributes of concrete with an innovative design. Economics was the winner when a unique deck section was joined with bar stays supported by an "A-shaped" concrete tower. This article begins on page 28.

Accelerated bridge construction (ABC), which satisfies demands by the traveling public to reduce congestion, has been driving creativity and will continue to do so for some time. Many owner agencies are meeting the challenge. The Minnesota Department of Transportation (Mn/DOT) was featured in the Summer 2010 *ASPIRE*. This issue reveals how its state aid bridge office teamed with the FHWA Division bridge office to organize "scanning tours" of other states. Their goal was to develop means and methods for ABC solutions on secondary roads in Minnesota. See pages 50-51.

The Utah Department of Transportation has also embraced ABC methods. *ASPIRE*'s featured state highlights just four of many new bridges using innovative concepts to expedite construction. The Utah feature begins on page 44.

Summit Engineering Group and the Colorado Department of Transportation (CDOT) have gone where none had gone before. Beginning with a project in 1995, CDOT developed concepts for and used curved precast, prestressed concrete trapezoidal box beams on projects in the Denver region. Later, Summit Engineering, together with the precast concrete industry in Denver, took these concepts into the precasting plant. Innovative details and construction methods resulted. Curved precast concrete bridges are common now in eastern Colorado. States in the southeast and Pacific Northwest are beginning to look into similar solutions. Read the FOCUS feature beginning on page 8 for more details.

The Federal Highway Administration fosters innovation through its Highways for LIFE program. In the first of two articles starting on page 42, FHWA discusses how the program operates to identify and share "high-payoff innovations."

And there's more inside. Enjoy—and benefit from these articles from innovators, like you, who are creating new generations of structures across the country. Let us hear about your projects, too. Go to www.asprirebridge.org and select "Contact Us."

PCI Precast/Prestressed Concrete Institute

ASBI American Segmental Bridge Institute

PCA Portland Cement Association

EIG Epoxy Interest Group

SFA Silica Fume Association

ESCSI Expanded Shale Clay and Slate Institute

Log on NOW at
www.aspirebridge.org
and take the *ASPIRE* Reader Survey.

Executive Editor
John S. Dick

Managing Technical Editor
Dr. Henry G. Russell

Managing Editor
Craig A. Shutt

Editorial Administration
James O. Ahtes Inc.

Art Director
Paul Grigonis

Layout Design
Tressa A. Park

Ad Sales
Jim Oestmann
Phone: (847) 838-0500 • Cell: (847) 924-5497
Fax: (847) 838-0555
joestmann@arlpub.com

Reprint Sales
Paul Grigonis
(312) 360-3217
e-mail: pgrigonis@pci.org

Publisher
Precast/Prestressed Concrete Institute
James G. Toscas, President

Editorial Advisory Board
Susan N. Lane, *Portland Cement Association (PCA)*
John S. Dick, *Precast/Prestressed Concrete Institute (PCI)*
William R. Cox, *American Segmental Bridge Institute (ASBI)*
David McDonald, *Epoxy Interest Group (EIG)*
Dr. Henry G. Russell, *Managing Technical Editor*

POSTMASTER
Send address changes to *ASPIRE*
200 W. Adams St., Suite 2100
Chicago, IL 60606.
Standard postage paid at Chicago, IL, and additional mailing offices.

ASPIRE (Vol. 4, No. 4),
ISSN 1935-2093 is published quarterly
by the Precast/Prestressed Concrete Institute
200 W. Adams St., Suite 2100
Chicago, IL 60606.

Copyright 2010, Precast/Prestressed Concrete Institute.

If you have a project to be considered for *ASPIRE*, send information to *ASPIRE*
200 W. Adams St., Suite 2100
Chicago, IL 60606
phone: (312) 786-0300
www.aspirebridge.org
e-mail: info@aspirebridge.org

Cover
Ramp A Flyover Bridge, Wheatridge, Colo.
Photo: Jenna Marie Kusmierek

VSL...Your Bridge Construction Partner

- Fully Committed to Project Success
- Resources and Strength from VSL Worldwide
- Special Bridge Superstructure Construction Techniques
  - Cast-in-Place Cantilever
  - Precast
    - Span-by-Span
    - Cantilever
    - Full Span Segments
  - Incremental Launching Method
  - Stay Cables
- Equipment Custom Designed to Meet Project Requirements
  - Precast Erection Gantries
  - Form Travelers
  - Strand Jacking

To each project, VSL becomes an integral part of the team. With experience on over 130 major projects worldwide, VSL brings resources from proven systems to constant innovation to meet the most challenging requirements.

VSL

www.vsl.net • 888.489.2687

READER RESPONSE

The Edwin C. Moses Boulevard Bridge over Wolf Creek in the City of Dayton, Ohio, designed by RW Armstrong, Indianapolis, Ind.

Editor,

*I happened to meet Henry Russell [*ASPIRE*'s managing technical editor] yesterday while visiting a recently completed bridge we designed for the City of Dayton, Ohio. I wanted to send along a picture of that completed bridge—the Edwin C. Moses Boulevard Bridge. This picture is the realization of the rendering shown in the Fall 2009 issue of* ASPIRE *(page 50).*

We read ASPIRE™ *diligently here. It presents interesting concrete bridge projects and information, thoughtfully described and displayed.*

Seth R. Schickel
RW Armstrong
Indianapolis, Ind.

Editor,

I have received and read every issue of ASPIRE™ *with great enthusiasm since its inception. I must say that it is the best source of information on concrete bridges in the market place. I save all the issues for future reference.* ASPIRE *has very high production values, which makes it easy and desirable to read. Please keep up the great work!*

Ken Shushkewich
KSI Bridge Engineers
San Francisco, Calif.

Editor,

I was trying to find the paper by Larry D. Olson on "Advances in Nondestructive Evaluation and Structural Health Monitoring of Bridges" from the Summer 2010 issue. The article references the "Resources/ Referenced Papers" section on the website for the full article. Can you email me when the paper is posted to your website?

Isaac Canner
Moffatt & Nichol • Blaylock
Long Beach, Calif.

[Editor's Response]
The article is being posted on the web. In the meantime, here's a copy.

Editor,

Thanks for the quick reply. Our company has a large inspection and rehabilitation practice group. Many of the waterfront structures we inspect have deck delamination problems. So, we drag a lot of chain on the decks to map delamination damage manually. It is interesting to read about the advances in nondestructive evaluation.

Isaac Canner
Moffatt & Nichol • Blaylock
Long Beach, Calif.

EDITOR'S NOTE

Additional copies of *ASPIRE* may be purchased for a nominal price by writing to the Editor through "Contact Us" at the *ASPIRE* website, www.aspirebridge.org. A free subscription can be arranged there using the "Subscribe" tab.

We were very distressed to discover an omission in the Summer 2010 issue of *ASPIRE*. In the article on the David Kreitzer Lake Hodges Bridge on page 36, the following important information did not appear: The editors and staff of *ASPIRE* offer our apologies for the omission. The web version of the article has been corrected.

profile

DAVID KREITZER LAKE HODGES BICYCLE PEDESTRIAN BRIDGE / SAN DIEGO, CALIFORNIA

BRIDGE DESIGN AND CONSTRUCTION ENGINEER: T.Y. Lin International, San Francisco, Calif.

INDEPENDENT CHECK ENGINEER: Jill Strasky., Greenbrae, Calif.

ARCHITECT: Safdie Rabines Architects, San Diego, Calif.

PRIME CONTRACTOR: Flatiron, Longmont, Colo.

ANALYSIS AND DESIGN SOFTWARE FOR EARTHQUAKE AND STRUCTURAL ENGINEERING

Our advanced structural analysis and design software specializes in cable-stayed, suspension and segmental bridges. Features like Staged Construction Analysis, AASHTO LRFD steel-girder code check and Macro Integration make LARSA 4D the leader in analysis and design software.

Unlimited technical support and custom training sessions are just a few more reasons why LARSA 4D software is the company standard at FIGG, HDR, Parsons Brinckerhoff, PBS&J, International Bridge Technologies, T.Y. Lin International and many other leading engineering and design firms, around the world.

LARSA4D

To request a free trial of LARSA 4D visit

www.larsa4d.com/trial

LARSA
105 Maxess Road Suite 115N
Melville, NY 11747
1-800-LARSA-01
www.larsa4d.com

CONTRIBUTING AUTHORS

M. Myint Lwin is director of the FHWA Office of Bridge Technology in Washington, D.C. He is responsible for the National Highway Bridge Program direction, policy, and guidance, including bridge technology development, deployment and education, and the National Bridge Inventory and Inspection Standards.

Kathleen Bergeron is the coordinator of technology transfer within the Highways for LIFE program. She has more than 30 years of experience in transportation programs. Among her numerous accomplishments and awards is the FHWA's highest honor, the Administrator's Award for Superior Achievement.

Dr. Dennis R. Mertz is professor of civil engineering at the University of Delaware. Formerly with Modjeski and Masters Inc. when the *LRFD Specifications* were first written, he has continued to be actively involved in their development.

Ken Shushkewich is with KSI Bridge Engineers and for over 35 years has specialized in the design and construction of innovative concrete bridges. He was formerly with Jean Muller International and T. Y. Lin International.

Frederick Gottemoeller is an engineer and architect, who specializes in the aesthetic aspects of bridges and highways. He is the author of Bridgescape, a reference book on aesthetics and was deputy administrator of the Maryland State Highway Administration.

MANAGING TECHNICAL EDITOR

Dr. Henry G. Russell is an engineering consultant, who has been involved with the applications of concrete in bridges for over 35 years and has published many papers on the applications of high-performance concrete.

Photo: Ted Lacey Photography.

CONCRETE CALENDAR 2010/2011

For links to websites, email addresses, or telephone numbers for these events, go to www.aspirebridge.org and select "EVENTS."

October 11-12, 2010
2010 ASBI 22nd Annual Convention
The Westin Bayshore, Vancouver, British Columbia, Canada

October 24-28, 2010
ACI Fall Convention
The Westin Convention Center, Pittsburgh, Pa.

December 1-3, 2010
TRB-FHWA 7th International Bridge Engineering Conference Improving Reliability and Safety
Grand Hyatt, San Antonio, Tex.

January 23-27, 2011
90th Annual Meeting Transportation Research Board
Marriott Wardman Park, Omni Shoreham, and Hilton Washington, Washington, D.C.

April 3-7, 2011
ACI Spring Convention
Marriott Tampa Waterside and Westin Harbor Island, Tampa, Fla.

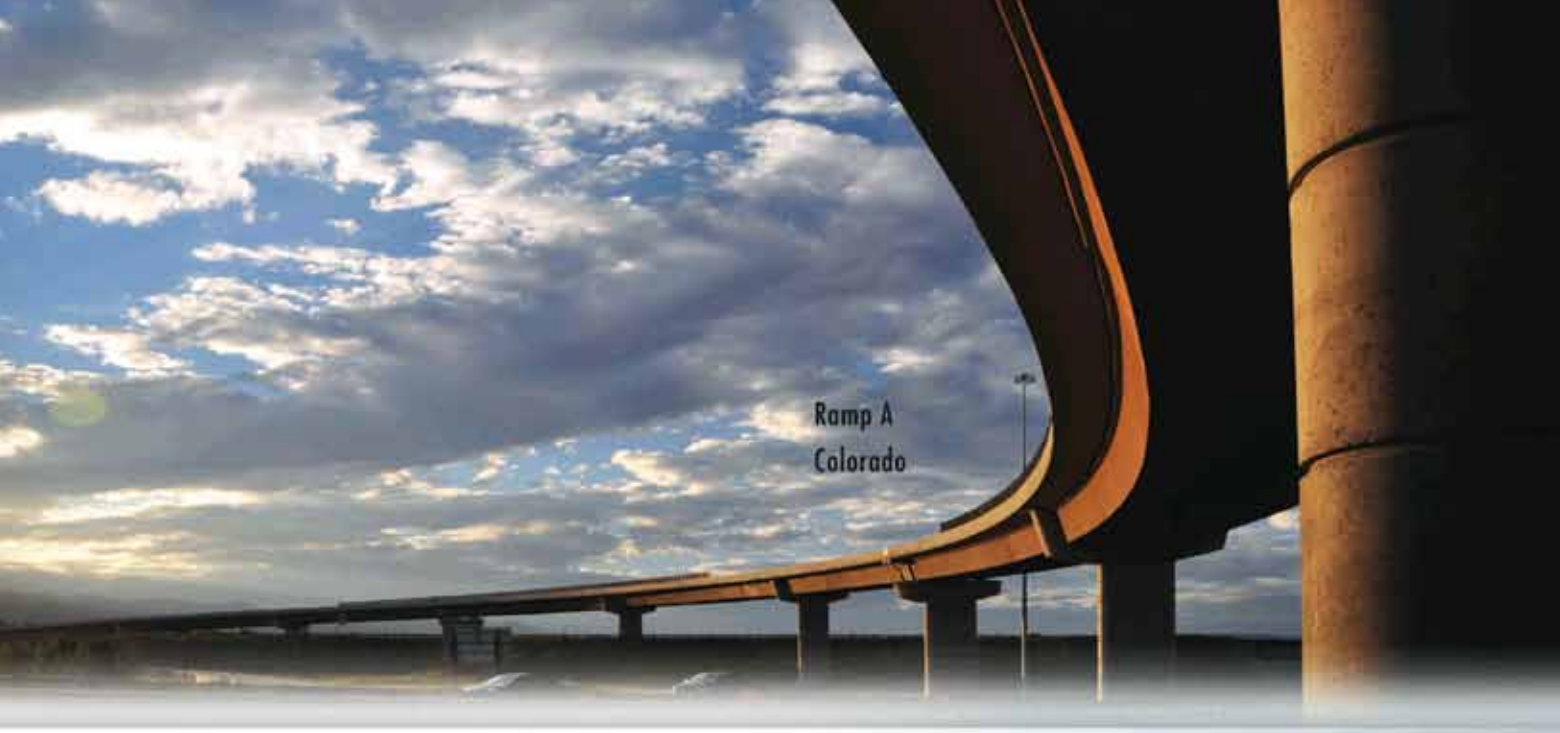
April 18-19, 2011
ASBI 2011 Grouting Certification Training
J.J. Pickle Research Campus, The Commons Center, Austin, Tex.

June 5-8, 2011
International Bridge Conference
David L. Lawrence Convention Center, Pittsburgh, Pa.

October 2-6, 2011
7th World Congress on Joints, Bearings and Seismic Systems for Concrete Structures
Green Valley Ranch Resort, Las Vegas, Nev.

October 16-20, 2011
ACI Fall Convention
Millennium Hotel & Duke Energy Center, Cincinnati, Ohio

October 22-25, 2011
PCI Annual Convention and Exhibition and National Bridge Conference
Salt Lake City Marriott Downtown and Salt Palace Convention Center, Salt Lake City, Utah



INNOVATIVE ENGINEERING SOLUTIONS

FOR DESIGN AND CONSTRUCTION

From project conception to completion, constructability is the focus of our designs.

To learn more about our company and staff please visit us online at
www.summit-eng-group.com

Summit
ENGINEERING GROUP, INCORPORATED
CONSULTING STRUCTURAL ENGINEERS
www.summit-eng-group.com
Phone: 303.933.9114

FOCUS

Summit Engineering Group FOCUSES ON PRECAST INNOVATION

by Craig A. Shutt

Summit Engineering Group was the construction engineer for the Gulf Intracoastal Waterway Bridge at Matagorda, Tex. The bridge was designed by TxDOT and built by Midwest Foundation Corporation. Photo: Dean Van Landuyt, TxDOT.

Segmental, curved U-girders are putting construction engineering firm on growth path

Summit Engineering Group Inc. has made its name on the cutting edge of construction engineering, becoming an expert in the use of precast concrete segmental girders on complex bridge projects. It has gained particular expertise in spliced, post-tensioned U-girders in urban locations. The benefits offered by these components has the firm poised for significant growth.

"The development of the precast concrete spliced-girder and U-girder construction in many states has opened the door for the next big thing in the concrete industry," says Gregg A. Reese, founder of the 15-year-old Littleton, Colo.-based firm. "Precasting U-girders straight or for a curved alignment and splicing them creates extremely cost-effective options for complex bridge structures. This approach moves plant-manufactured precast concrete components into a new arena." The company has done extensive work on a number of successful projects that demonstrate precast concrete's viability for future expansion.

The Ramp A flyover bridge in Wheatridge, Colo., features 11 spans of spliced, precast, post-tensioned concrete U-girders, including seven curved spans. Aesthetics were stressed because of the structure's prominent location for travelers heading to nearby mountain resorts. Photo: Summit Engineering Group.

Reese has been involved with the design concept since its earliest days, having focused much of his career on concrete designs and segmental-bridge construction. He has worked for several bridge-engineering firms, including Figg & Muller Engineers in Tallahassee, Fla.; Austin Bridge & Road Inc. in San Antonio, Tex.; J. Muller International in San Diego, Calif.; Finley McNary Engineers in Denver, Colo.; and Bush Reese & Co. in Denver, Colo.

Intracoastal Bridge is Catalyst

Reese spent 3 years at Bush Reese & Co. working on building projects to pay the bills while developing the bridge engineering business. He started his own firm in 1995 after securing a contract for the intracoastal bridge along Surfside Beach in Angleton, Tex. The three-span structure features precast concrete I-girder approaches and a segmental concrete, balanced-cantilever main span.

Precast concrete spliced-girder construction has opened the door for the next big thing in the concrete industry.

To handle that project, Reese opened an office in Littleton, Colo., and a branch in Arlington, Tex., with a former colleague at Austin Bridge & Road. He eventually moved all operations to Littleton but continues to work in both states, which he notes are both big proponents of precast concrete bridge construction. The firm's "Summit" name references Reese's background in Colorado, which helped him stand out in 1995, he adds. Today, it reflects the company's work in that state and its goals for peak performance.

But many years passed before the firm worked on another segmental project. "We diversified to serve the bridge-construction industry and gain more clients. We took on everything a bridge contractor needed that required engineering work," he explains. The range spanned from designing overhang brackets to cable-stayed bridges. His focus on concrete and Texas contacts led to a string of projects there that continues today. "I've done the construction engineering on every cast-in-place, segmental concrete bridge built in Texas in the last 15 years."

U-Girders Introduced

Summit's involvement with the U-girder concept began in 2000 with Ramp G at the Parker Road Interchange, a third-level connector bridge in Aurora, Colo. As a consultant to the contractor, Summit helped develop a series of innovative value engineering solutions that allowed the contractor to complete the complex flyover structure ahead of schedule and with minimal disruption to existing traffic.

The alternative solution consisted of two lines of curved, trapezoidal box girders spliced and post-tensioned to accommodate a tight 700-ft-radius horizontal curve with spans up to 250 ft. The contractor built the bridge with cast-in-place concrete, but conformed to CDOT's concept that used discrete beam sections to accommodate a complex phasing scheme that was essential to maintain traffic.

"That bridge gave our firm a lot of exposure," he says. "It was an experimental project for the DOT, and it helped launch us in the Colorado market. It was a pretty spectacular-looking project. From that point on, specialty structural work involving precast, prestressed concrete took off for us and has since become most of our work."

In 2004, Summit worked on the Ramp K Bridge in Denver. The contractors were permitted to bid an alternate for the base design of steel trapezoidal box girders. Summit offered a precast concrete option. "It had to use standard CDOT cross sections, because the state wanted to promote concrete. Spliced precast concrete all but eliminates the excessive shoring that can interfere with traffic," he explains.

The project was built using a curved, precast concrete U-girder superstructure that solved a number of challenging site conditions, including four traffic openings. It became the first bridge designed and constructed from its conception using curved, precast concrete U-girders cast in a plant removed from the site. The project won the 2007 PCI Design Award for best long-span bridge.

Following Ramp K's success, the Ramp Y connector was constructed in Denver. The project was the first to be designed, bid, and built using a precast concrete U-girder design. CDOT's design featured a 12-span flyover structure that was value-engineered by Summit Engineering. The bridge has spans varying in length from 100 ft to 230 ft erected on falsework that spanned five traffic crossings during construction while permitting maintenance of traffic.

Summit Engineering Group provided value and construction engineering services for the I-45 Galveston Bay Causeway Bridge over the Gulf Intracoastal Waterway designed by TxDOT and built by Traylor Bros Inc. Photo: Traylor Bros. Inc.

The Parker Road Bridge in Denver, Colo. was one of the first Colorado projects designed with two lines of post-tensioned, curved concrete U-girders and Summit Engineering's first such design. It was built in 2000. Photo: Summit Engineering Group.

The West Bijou Street Bridge, which crosses Monument Creek and the Union Pacific Railroad, features precast, post-tensioned, concrete U-girders. It was built with an erection scheme using strongbacks, without any support from the ground. Photo: Summit Engineering Group.

The Ramp Y connector in Denver, completed in 2003, features curved, precast concrete CDOT U84 standard girders and proved that the design concept could provide a strong precast concrete alternative for complex, long-span bridges. Photo: Summit Engineering Group.

U-Girder Benefits

These projects gave Summit's engineers an appreciation for the benefits that precast concrete U-girders could provide. Previously, many complex bridges used precast concrete or cast-in-place concrete approaches with steel girders for the main span. "Thanks to CDOT's work, the new U-girders, combined with spliced-girder technology, created a new design alternate to complex bridge construction," he says. "We've been fortunate to be involved from the very beginning. We have participated in a number of these projects using a variety of delivery options, including design-build, value-engineering designs, alternative designs, and as engineer of record."

Precast concrete also offers significantly lower fabrication times, which enhance construction speed. "We can take a steel design and value-engineer it into precast concrete after the bid, and then get it approved, delivered, and erected before steel can arrive at the site, even if it's purchased the day after bid approval." Concrete's more consistent pricing also provides a budgeting benefit over the recent high volatility that steel pricing has experienced, he adds.

As more precasters invest in forms, the learning curve flattens and costs drop further, he notes. Experience is also supplying design improvements. "The close proximity of these plants has enabled contractors and engineers to work with them to refine design details to improve constructability. Future projects in Colorado will realize even greater economy as the technology matures without the need for further set-up costs." Summit is actively working to move this technology to other states through its contractor client base.

"One of the huge advantages of this design approach is that aesthetics are improved, in a way that has no economic disadvantage," he adds. "Precast concrete U-girders allow a project to unify the appearance for all conditions with an economical solution. The structural shape is suitable for both long and short spans, with straight and curved alignments. Girders with sloped webs create an attractive structure that has been well received in high-visibility locations."

An example of the strong aesthetics is the $30-million Ramp A flyover of State Highway 58 and I-70 in Wheatridge, Colo. The bridge consists of 11 spans of spliced, precast, post-tensioned concrete U-girders, including seven curved spans. The bridge comprises three continuous and composite superstructure units, with span lengths varying from 147 ft to 235 ft. "We started the project value-engineering parts and portions of the structure. Little by little, we completely redesigned the bridge and became the engineer of record."

Aesthetics were critical, he adds, because of the bridge's prominent position near Golden, Colo., where it is seen by vacationers driving to mountain resorts. "We wanted to make a statement." The project won the 2009 Harry H. Edwards Industry Advancement award from PCI and a Merit Award from the American Council of Engineering Companies.

Aesthetics also came to the fore in the $130-million Colorado Springs Metro Interstate Expansion (COSMIX) project—a design-build effort using precast concrete spliced U-girders. The project, still underway, comprises 16 major precast concrete bridges spanning

The Ramp Y connector in Denver has span lengths up to 230 ft and was erected on falsework that spanned five traffic crossings. Photo: Summit Engineering Group.

floodplains, high scour creeks, railroads, and existing roadways.

The "crown jewel" of the project is the West Bijou Street Bridge, which crosses Monument Creek and the Union Pacific Railroad. The structure consists of precast, post-tensioned, concrete U-girders. Its erection scheme features spliced concrete U-girders supported by strongbacks, without any support from the ground. "This was the signature bridge and really provided a strong thematic look for the project." It won the 2008 PCI Design Award as best bridge with mid-range span lengths.

The $130-million Colorado Springs Metro Interstate Expansion (COSMIX) project features precast concrete spliced U-girders in all 16 major bridges along its route, which spans floodplains, high scour creeks, railroads, and existing roadways. Photo: Summit Engineering Group.

Contractual Methods

Many of Summit's projects use a design-build format. "The growth of design-build, value-engineering, and alternative designs has really opened the door for us to do engineer-of-record work using these concepts," he says. "Contractors are interested in providing cost-effective solutions with aesthetic advantages and are open to new and innovative design alternatives. Spliced precast concrete U-girders represent a win-win situation. They are quickly becoming an attractive option."

Promotion and Awareness

To heighten awareness, Reese speaks at various bridge events and conferences, and has conferred with officials in Florida, Georgia, North and South Carolina, and other states, talking with key highway contractors along the way. "Florida is very open and likely to begin using these girders very soon. I expect Washington State will, too," he says. "More states will become involved over time. Innovation in our business comes very slowly compared to other industries, so you have to be patient."

Certainly, Summit's own work with bridge construction, segmental designs, and precast concrete U-girders shows no signs of slowing. The firm currently is working on a number of segmental projects in the United States, Canada, and the Middle East, plus design-build projects in the Southeast United States, and the design of a precast U-girder bridge for a Denver flyover ramp that will be the company's first using the design-bid-build format.

"The exciting aspect of these projects is that we get to be involved in innovative bridge projects with economical designs that are both technically and aesthetically interesting," he says. "Precast concrete can unify aesthetics and economy in a way that provides a sustainable, cost-effective solution with lower life-cycle costs. There is very little downside to this technology."

The Ramp K Bridge in Denver, completed in 2004, was the first project designed and constructed using curved, precast concrete U-girders in a precast concrete plant removed from the site. Summit provided design engineering on the project.

Design Trends and Growth

The increased popularity of precast concrete is aiding Summit's business, too. "We've gained notoriety over the last decade as a bridge designer with a construction sense, especially for these types of projects. Contractors, consultants, and owners now seek our input on projects that would not have been open to us previously."

As a result, the company anticipates more growth. "We've always been a small, boutique firm, focused on our clients and maintaining long-term relationships. We're not interested in growth for growth's sake. We plan to emphasize our specialties and do good work."

Summit Projects

To learn more about Summit Engineering Group's projects, visit the *ASPIRE*™ website at www.aspirebridge.org and read about their work in these articles:

- State Highway 58 Ramp A Flyover Bridge, Denver: Spring 2010 and the Fall 2009 awards supplement.
- Gulf Intracoastal Waterway Bridge at Matagorda, Texas: Winter 2010.
- Bijou Street Bridge over Monument Creek: Summer 2009 and the Fall 2008 awards supplement.
- I-45 Galveston Causeway: Summer 2009.
- Ramp K Flyover: Fall 2007 awards supplement.

The Story of Eugène Freyssinet

by Ken Shushkewich,
KSI Bridge Engineers

Eugène Freyssinet.

Eugène Freyssinet has been proclaimed one of the most complete engineers of the twentieth century and one of the greatest builders in history. Yet his story is not well known because he was intensely modest and private, and did not write about his work. Only three books have been written about his life and work.

Freyssinet often stated, "I was born a builder." He would go on to build five world-record span length bridges, in addition to being the acknowledged inventor of "prestressed concrete" including pretensioning, the development and use of flat jacks, and post-tensioning.

Freyssinet was born in the countryside near Objat in 1879 and started his career in 1905 in Moulins. He built numerous bridges in the region, including the Praireal-sur-Besbre Bridge in 1907, a three-hinged arch having a span length of 85 ft. This was the first bridge in the world to have the formwork of the arch removed by creating forces using jacks at the crown hinge.

World-Record Span Length Arch Bridges

Freyssinet and the contractor Mercier Limousin designed and built concrete arch bridges, which successively broke his own world record for span length. They are :

- 1912, Veurdre Bridge (238-ft span)
- 1920, Villeneuve-sur-Lot Bridge (315-ft span)
- 1923, Saint-Pierre-du-Vauvray Bridge (430-ft span)
- 1930, Plougastel Bridge (610-ft span)

The main problem during construction of the Veurdre Bridge was the decentering of the three large arches that were subjected to creep and shrinkage. This was mitigated by using jacking thrusts following the procedure first used on the Praireal-sur-Besbre Bridge.

The initial bliss after construction was complete was soon followed by dreadful agony as disconcerting deformations (due to creep and shrinkage) started appearing, first slowly and then more rapidly until there was no possible outcome imaginable other than collapse.

Freyssinet took four reliable men, placed the decentering jacks back in the crown hinge, and began to raise all three arches at once, until the bridge regained its original shape. On future bridges, he eliminated the crown hinge and continued to study the problem of "deferred deformation," a phenomenon that the administrative authorities obstinately denied the existence of, and the official laboratories neglected or refused to measure over sufficiently long periods of time.

Invention of Prestressed Concrete

In 1928, Freyssinet patented the first of his three inventions for applying compression to concrete by "pre-tension and bonded wires," which was the birth of prestressing. His other two methods were his 1938 invention of

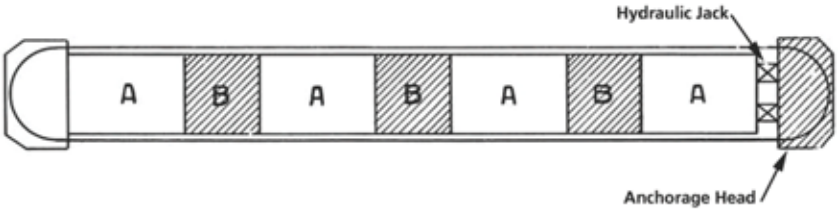
Veurdre Bridge with 238-ft span.

Villeneuve-sur-Lot Bridge with 315-ft span.

Saint-Pierre-du-Vauvray Bridge with 430-ft span.

Plougastel Bridge with 610-ft span.

World-record span length arch bridges designed by Eugène Freyssinet.



Plan view of the footings of the Maritime Station in Le Havre showing the new footings "B" between existing footings "A." Parallel prestressing wires were wrapped around reinforced concrete end anchorages, one of which was jacked away from the others, prestressing the entire composite structure.

the flat jack and his 1939 invention of the concrete anchorage, which was the birth of post-tensioning.

At the time of the October 1928 patent, the scientific community did not believe in prestressing. Freyssinet thus became an industrialist and began producing electricity poles at the Forclum plant at Montargis. The result was a complete technical success, but a commercial failure, due to the depression of 1929.

Freyssinet perfected grinding the fineness of cement, improved on his previous invention for mechanical vibration of concrete, invented steam curing to accelerate the rate of concrete hardening and rate of production, and perfected the industrial precasting process for precast concrete elements. However, over this 5-year period, he willingly spent the entire fortune accumulated during the previous part of his career. Finally, it was his spectacular rescue of the Le Havre Maritime Station in 1934, as described below, that allowed prestressing to become a reality.

Freyssinet next devised the flat jack in 1936 for compressing the raft of the Portes de Fer Dam in Algeria and for raising the height of the Beni Badhel Dam in Algeria by 23 ft to bring it up to 220 ft. The patent for the flat jack was validated in August 1939.

Freyssinet then invented the concrete anchorage. The system consists of twelve 5-mm-diameter parallel steel wires locked in a concrete anchorage cone by a tensioning jack. In August 1939, he applied for the patent that was issued and published in 1947, delayed due to World War II.

Rescue of the Le Havre Maritime Station

The Maritime Station in Le Havre, completed in 1933 for the ocean liner Normandie, was sinking 1 in. per month into a deep layer of clay and collapse seemed to be inevitable. Freyssinet proposed a solution that was immediately adopted.

The solution consisted of adding new footings between the existing footings to make the entire footing unit a monolithic, horizontal element, which was prestressed with parallel wires turned around two reinforced concrete end anchorages. One anchorage was displaced by hydraulic jacks, and the link between the old and new was assured by the general compression of the whole. Then 700 piles were installed through formed sockets of the new footings to sound layers of soil.

The result was both spectacular and convincing, and at once earned Freyssinet a worldwide reputation. This started the collaboration between Eugène Freyssinet and Edme Campenon in 1934 on the entire range of construction projects of the Campenon Bernard group.

Invention of Precast Concrete Segmental Construction

The Luzancy Bridge over the Marne River was started in 1941 and completed after the war in 1946. It was the first precast segmental bridge designed and constructed by Freyssinet. It has a span of 180 ft, a world record at the time. The bridge is a portal frame comprised of three concrete box girders that were precast in segments and assembled on site in sections. It was erected by launching equipment consisting of masts and stay cables.

The bridge was post-tensioned longitudinally and transversely with twelve 5-mm-diameter wires, and pretensioned vertically with tendons consisting of 5-mm-diameter wires. Flat jacks located in the bottom flange at the ends of the bridge allowed for adjustment to compensate for the effects of creep and shrinkage. All three of Freyssinet's inventions for prestressing were used.

The great success of the Luzancy Bridge allowed Freyssinet to build five similar bridges having spans of 243 ft over the Marne River between 1947 and 1951.

On these bridges, a thin layer of dry concrete mortar was placed between segments and compacted. Some 20 years later, his disciple Jean Muller would introduce match-cast epoxy-coated joints on the Choisy-le-Roi Bridge.

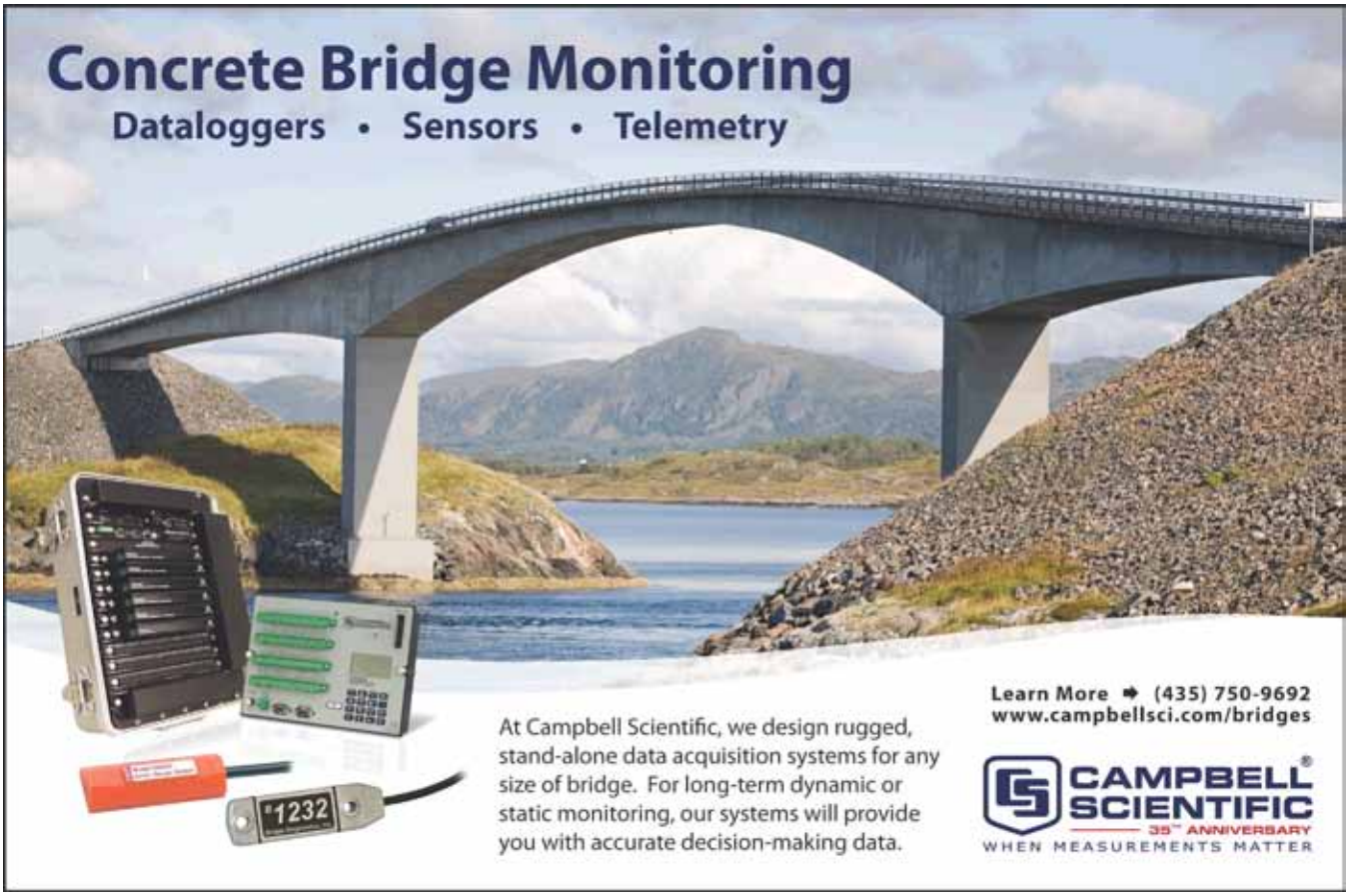
Later Years

Freyssinet continued to design and build until his death. Included in his later structures were the three arch bridges of the Caracas Viaduct from 1951-1953 (with Jean Muller on site), the Underground Basilica at Lourdes from 1956 to 1958, the Orly Airport Bridge from 1957 to 1959, and the Saint-Michel Bridge at Toulouse from 1959 to 1962. The Saint-Michel Bridge opened in 1962, 3 months before Freyssinet's death at the age of 82.

Erection of the partially assembled segments of the Luzancy Bridge in 1946.

EDITOR'S NOTE

Many more details of the life and work of Eugène Freyssinet can be found in a paper presented by the author at the 3rd fib International Congress, June 2010, Washington, D.C. The paper can be downloaded from the ASPIRE™ *website: www.aspirebridge.org, click on "Resources" and select "Referenced Papers."*



Need Help Designing to AASHTO LRFD Specifications?

PCA has the publications you need with extensive design examples

LRFD Design of Cast-in-Place Concrete Bridges

The emphasis on short-span concrete bridges makes it a must-have for county and state bridge engineers.

Understand the design of cast-in-place bridge superstructures according to the AASHTO LRFD Bridge Design Specifications. This book presents step-by-step analysis and design procedures with five detailed bridge design examples.

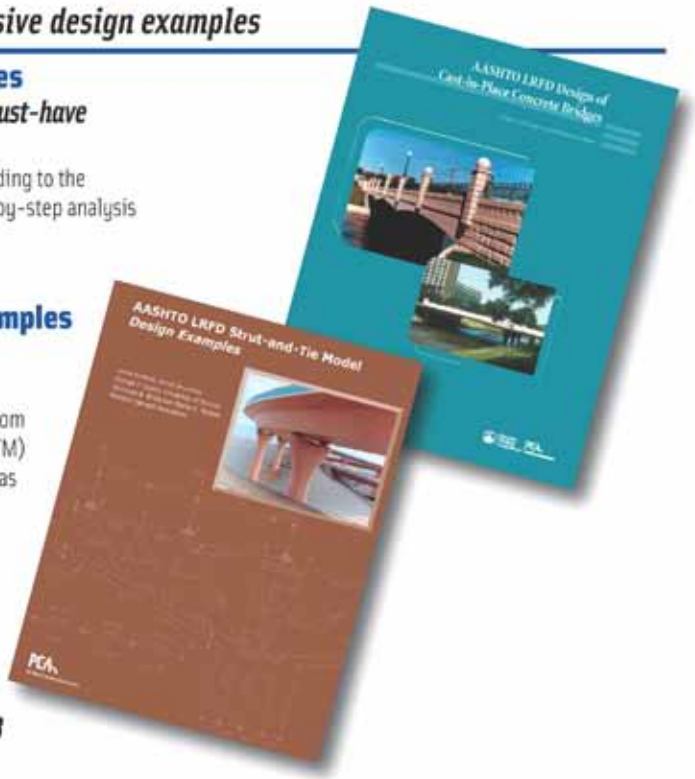
EB232–$75

AASHTO LRFD Strut-and-Tie Model Design Examples

Don't understand the Strut-and-Tie Model? This book is for you.

This publication identifies disturbed regions of structures resulting from geometric or force discontinuities where the Strut-and-Tie Model (STM) must be used. A step-by-step procedure for STM is provided, as well as five detailed design examples.

EB231–$60



Concrete Thinking for a sustainable world | PCA Portland Cement Association

Order at www.cement.org/bookstore or 800.868.6733

Expanded Shale, Clay and Slate Institute Update

ESCSI
Rotary Kiln Produced
Structural Lightweight Aggregate

Because of the significant dead loads present in very large structures, such as the Wakota Bridge or the precast tub girders being designed by Summit Engineering, the use of lightweight concrete for the superstructure can provide significant cost savings for the entire structure. This is especially true for bridges built in seismic zones or where foundation conditions create unique challenges. The Benicia-Martinez Bridge, located just north of San Francisco (highlighted in the Summer 2007 issue of *ASPIRE*™), is an excellent example of a major bridge where lightweight concrete was used to reduce project costs.

While lightweight concrete is generally used to reduce design loads, it is also durable. This has been demonstrated by the lightweight concrete upper deck of the San Francisco-Oakland Bay Bridge which was constructed in 1936 and is still in service. Even bridge decks in northern climates have shown extended service lives, such as, the Lewis and Clark Bridge that connects Washington and Oregon over the Columbia River. The lightweight concrete deck on this large truss span was replaced (with another lightweight concrete deck) in 2005 after 75 years in service.

The Expanded Shale, Clay and Slate Institute (ESCSI) members look forward to assisting owners, designers and concrete producers in using lightweight concrete for bridges.
For more information about ESCSI, visit www.escsi.org.

PROJECT

WILSON STREET BRIDGE REPLACEMENT *Engages Community*

by Daniel Herring, Richard Cholewa, and W. David Shannon, H.W. Lochner Inc.

The Wilson Street Bridge over the Fox River looking toward part of downtown Batavia. Photo: Staff Davis, Staff Davis Photography.

Elegant design expresses both past and future, opening up the river below the roadway

After 10 years of effort, the city of Batavia, Ill. has a new Wilson Street Bridge named the William J. Donovan Bridge, a three-span structure and the only road bridge in Batavia over the Fox River. The structure was designed to complement the surrounding area of downtown Batavia, as well as pay respect to the beloved structure it was replacing.

The project included replacement of the existing structure, a three-span, earth-filled spandrel concrete arch bridge built in 1911 that was showing significant signs of distress. Material testing indicated high levels of chlorides in the concrete leading to corrosion of the reinforcement. The south spandrel wall had cracked and separated from the arch ring. It was determined that the major rehabilitation required for an arch-type structure of this age would be difficult and generally not cost effective.

During the planning phases of the project, the city of Batavia established several key objectives:

- provide an aesthetically pleasing replacement structure
- complement the history and civic pride of Batavia
- provide connections to the Fox River including stairs
- add river observation outlooks
- include pedestrian paths below the bridge
- enhance the area around the bridge including the river walks, bike path, and river viewing area
- enhance the downtown area as a focal point for furthering Batavia's downtown development plans

New Bridge

The replacement structure consists of a post-tensioned concrete deck slab with parabolically shaped haunches. The structure is arranged in three continuous spans of 74 ft, 88 ft, and 74 ft. The bridge is 72 ft 10 in. wide across the deck excluding the sidewalk outlooks. The superstructure depth is 4 ft 0 in. at the piers and 2 ft 0 in. at each midspan.

The existing roadway profile could not be significantly changed due to the proximity of buildings along the bridge approaches. The post-tensioned concrete superstructure provides a thin structure depth to allow clearances

profile

WILLIAM J. DONOVAN (WILSON STREET) BRIDGE / BATAVIA, ILLINOIS

BRIDGE DESIGN ENGINEER: H.W. Lochner Inc., Chicago, Ill.

ARCHITECTURAL CONSULTANTS: Johnson-Lasky Architects, Chicago, Ill., and Lane Allen Architects Inc., Batavia, Ill.

CONSTRUCTION ENGINEERING AND INSPECTION: AECOM, Chicago, Ill.

PRIME CONTRACTOR: Illinois Constructors Corp Inc., Elburn, Ill.

TEMPORARY WORKS ENGINEER: Westbrook Associated Engineers Inc., Spring Green, Wis.

CONCRETE SUPPLIER: Prairie Materials, Batavia, Ill.

PRECASTER: Cary Concrete, West Chicago, Ill.

below the structure to be as large as possible, providing space for the river walks and bike paths. Ultimately, the shallow structure allowed the river walk paths to be placed at a higher elevation, which reduces the potential for the paths to be closed due to high river levels. The shallow structure depth provided proportions of length and width that make the bridge appear open and airy beneath. Two river observation outlooks were placed on both sides of the deck. These outlooks and stairs from the bridge level to the river level satisfied the owner's goals of connecting the bridge with the river.

The post-tensioned slab required a concrete compressive strength of 6000 psi. It was prestressed in the longitudinal direction only, using 34 tendons with nineteen 0.6-in.-diameter strands in each tendon. High-performance concrete, which included ground granulated blast furnace slag and silica fume, was used in the new structure to increase workability during placement and increase the durability of the superstructure.

Numerous aesthetic enhancements were incorporated into elements of the project, including architectural lighting, railings, sidewalk treatments, planters, precast concrete benches with pedestals for public art, river observation patios and outlooks and reveal patterned piers and abutments.

Substructure

The substructure consists of arched piers and full-height abutments. The proportions of the superstructure are further enhanced by the post-tensioned concrete arched piers. The pier foundations are cast-in-place concrete spread footings socketed into rock. The top of the pier was post-tensioned

Demolition of one-half of original structure is nearly complete. A temporary soil retention wall was used to retain the soil in the earth-filled arches. All construction photos: AECOM.

The completed half-pier showing temporary supports under the arch and beam that will be used to support steel stringers that in turn support concrete forms.

Forms shown completed for approximately one-half of the first stage of construction. Note the forming of the soffit of the first of four river outlooks.

With half of the original structure demolished, construction begins on the first half-pier.

Falsework is shown in the river to support stringers and deck formwork.

Concrete placement is ready to proceed during the first stage of construction.

CAST-IN-PLACE CONCRETE, POST-TENSIONED DECK SLAB BRIDGE WITH PARABOLIC HAUNCHES / CITY OF BATAVIA, OWNER

POST-TENSIONING CONTRACTOR: Dywidag Systems International-USA Inc., Bolingbrook, Ill.

BRIDGE DESCRIPTION: Three-span bridge consisting of shallow haunched cast-in-place concrete post-tensioned slab and arched, post-tensioned concrete piers built in staged construction with many aesthetic features such as cantilevered outlooks and with span lengths of 74 ft, 88 ft, and 74 ft.

BRIDGE CONSTRUCTION COST: $9,692,472

AWARDS: *Portland Cement Association, 2010 Bridge Design Award of Excellence; American Consulting Engineers Council, 2010 Engineering Excellence Awards, Structural Systems Category; American Public Works Association (APWA) Fox Valley Branch and the APWA Chicago Metro Chapter, 2009 Public Works Project of the Year for Transportation Structures Between $5 and $25 million; American Institute of Architects, 2009 Illinois Honor Awards and the 2009 Daniel Burnham Award Citation of Merit*

longitudinally with two tendons each consisting of twenty-seven 0.6-in.-diameter strands. The base of the pier was post-tensioned longitudinally with four tendons each consisting of twenty-seven 0.6-in.-diameter strands. Post-tensioning the piers facilitated the arch shape, while minimizing deflections and eliminating tension cracks through precompression.

The abutment wall foundations are supported by vertical and battered 200-ton-capacity micropiles. Micropiles were used to lessen the extent of excavation at each abutment and minimize installation vibrations to protect existing historic buildings adjacent to the site. Temporary cofferdams were utilized in the river to construct the piers and abutments.

Demolition and Staged Construction

The demolition of the earth-filled concrete arch spandrel bridge presented several design challenges. The city required that traffic be maintained on Wilson Street throughout construction. The stability of the existing structure was examined in detail through the use of finite element methods (solid modeling) to determine whether half of the existing structure could be removed lengthwise and continue to safely carry traffic while the first half of the new bridge was constructed. The sequence of the demolition was carefully analyzed to develop criteria for the contractor to safely remove the existing structure.

To accommodate staged construction of the piers, falsework supported the partially constructed arch portion of the caps. A cast-in-place concrete key connected the two halves of the top of the pier prior to post-tensioning.

In a similar way, staging of the deck slab was accomplished through the use of construction joints, spliced reinforcement, and a 1-ft 8-in.-wide closure. A temporary soil retention wall was constructed along the length of the existing bridge to maintain the fill in the spandrel arch during staged construction. Temporary falsework was placed in the river to support the superstructure formwork.

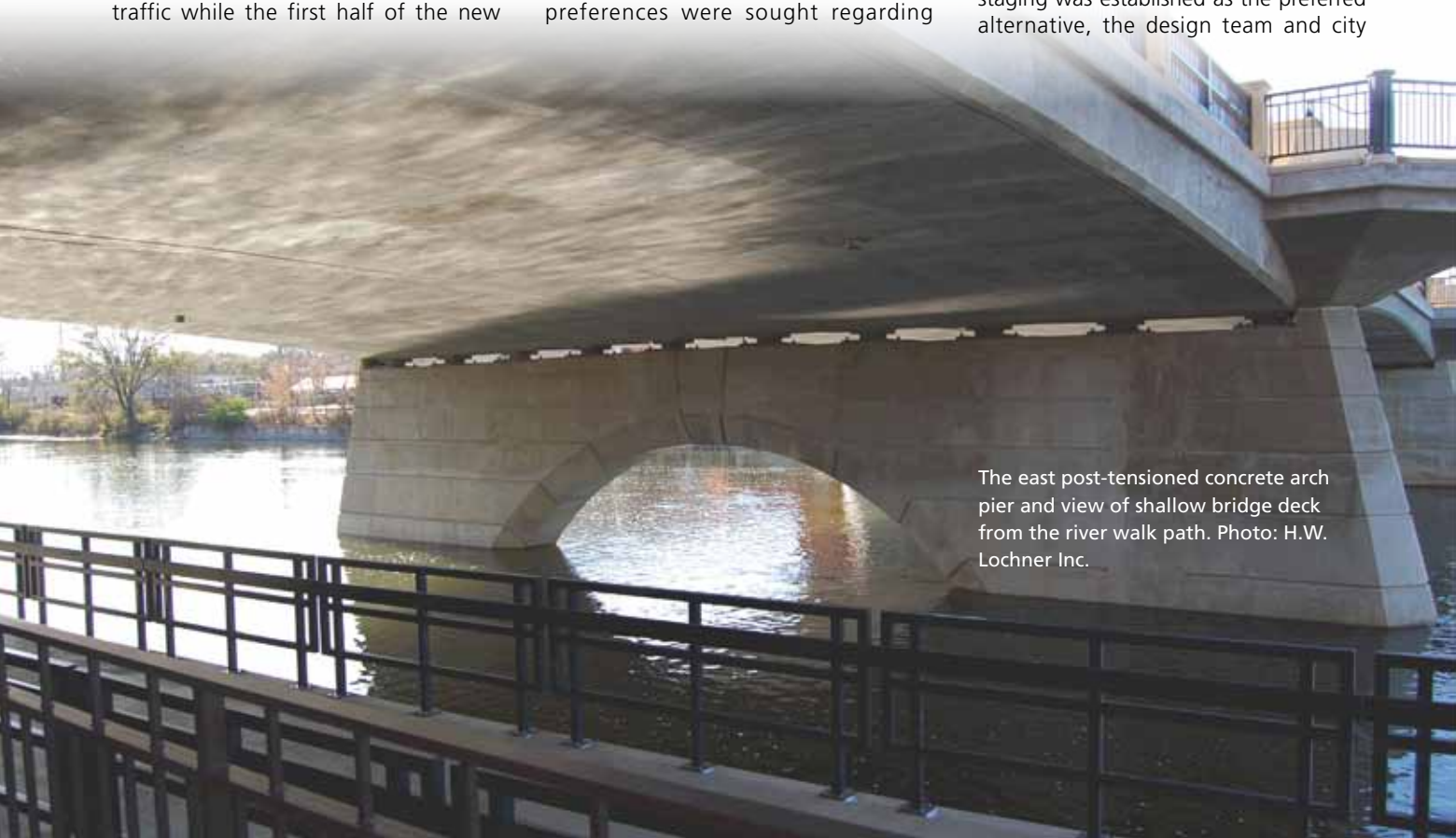
An Involved Community

Public involvement was a key consideration throughout the project. During the planning and design phase, several public information meetings, and design charrettes were held by Batavia city staff and the design team. All stakeholders were invited to the meetings and tours were conducted to allow input on the project. Attendees were encouraged to comment and their preferences were sought regarding all of the design elements, including bridge type, pier detailing, lookouts, sidewalk treatments, railings, lighting, and vertical elements at lookouts. Comments and opinions were submitted to the city engineer for analysis and incorporation into the project.

During the planning and design phase, Batavia formed a citizen's advisory committee to study methods to accommodate construction. Once staging was established as the preferred alternative, the design team and city

Protecting the River

Dewatering operations were closely monitored to minimize sediment released into the river. To reduce sediment, the general contractor employed an ionic polymer dewatering filtration system. The result was that the dewatering effluent had no adverse impact on the river. The United States Army Corps of Engineers was so pleased with the effort that the agency hosted several additional staff members and other agencies to view the system in operation.



The east post-tensioned concrete arch pier and view of shallow bridge deck from the river walk path. Photo: H.W. Lochner Inc.

staff developed a maintenance-of-traffic plan for both vehicles and pedestrians that would protect the public and minimize inconvenience, while allowing traffic to flow through the construction site. Further, a bridge task force steering committee was established that comprised two standing committees: marketing & communications and traffic & parking. Each committee was responsible for knowing the exact status of the project at all times and the impact on the city's logistics.

During the construction phase, the city employed a public liaison person to work with the businesses and impacted citizens—the stakeholders. The city developed a newsletter, bridge information and welcome center at the project site, telephone hotline, and website including a webcam to further keep the public informed. The city staff and construction team also planned a bridge construction coffee event where stakeholders could learn about the progress of the project and discuss any other questions arising as a result of the project.

A direct result of the effort to create these committees and put into place a project liaison was a well-informed public with respect and appreciation for the project. The relations between the city and the public were greatly enhanced.

Conclusion

This project highlights the importance of structural engineering as integrated into the overall project. The availability of the post-tensioned concrete superstructure to provide a thin structure depth, the ability of structural concrete to provide sculptural elements within the structure of the bridge and the flexibility in the form of the concrete structure allowed the structural engineers to succeed in delivering the client's key expectations.

Daniel Herring is a senior structural engineer, Richard Cholewa is a senior project manager and W. David Shannon is a project manager, all with H.W. Lochner Inc. in Chicago, Ill.

For more information on this or other projects, visit www.aspirebridge.org.

AESTHETICS COMMENTARY

by Frederick Gottemoeller

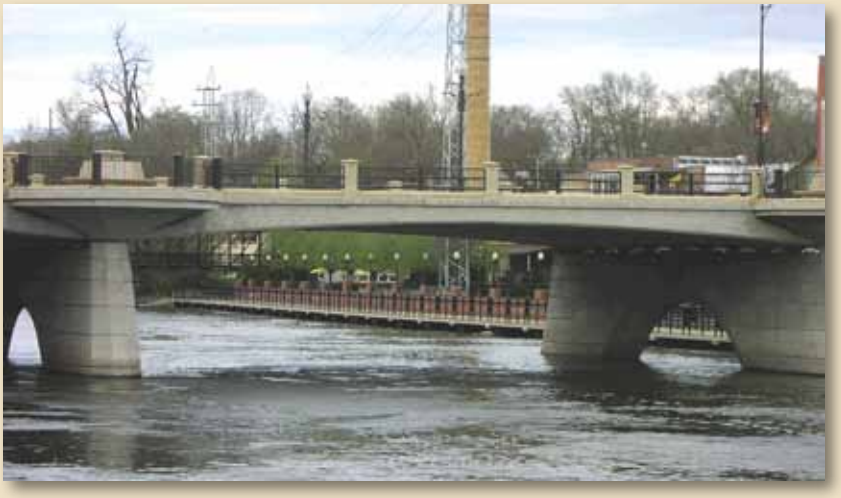
When the renowned architect I.M. Pei was asked to make a major addition to the Louvre Museum in Paris he asked, "How do we make history live and, at the same time, point the way to the future?" Every designer asked to replace a significant bridge in a historic area or town center faces the same question. Pei's answer for the Louvre was a glass pyramid that looks nothing like the Baroque palace behind it, but which nevertheless has become a valued part of the Louvre and a famous landmark in its own right.

The designers of the Wilson Street Bridge have answered the question in a different way. They have combined a structure of amazing thinness, only possible because of modern high-strength concrete and post-tensioning, with traditional details that reflect the nature of its setting. Both the past and the future are expressed.

Because of its thinness, the bridge changes the whole appearance and use of the river. One imagines that the earth-filled arch there before occupied much of the volume below the roadway, blocking views up and down the river and any possible use of the riverbank. Now, almost the whole volume below the roadway is open and empty. The river is visible from bank to bank and into the distance, and the banks are attractive pedestrian amenities.

Most of the traditional details are above the roadway, where they relate to and provide continuity with Wilson Street beyond the bridge. The benches on the generously-sized overlooks are particularly well done. Rather than just pick a standard bench out of a park catalogue, the designers have custom-designed a feature that can stand up to the size and mass of the bridge. In fact, it is big enough to add significantly to the appearance of the overall structure. That, and the way the facets of the overlook soffit extend the facets of the pier nose, are just two examples of how the details reinforce the main lines of the structure.

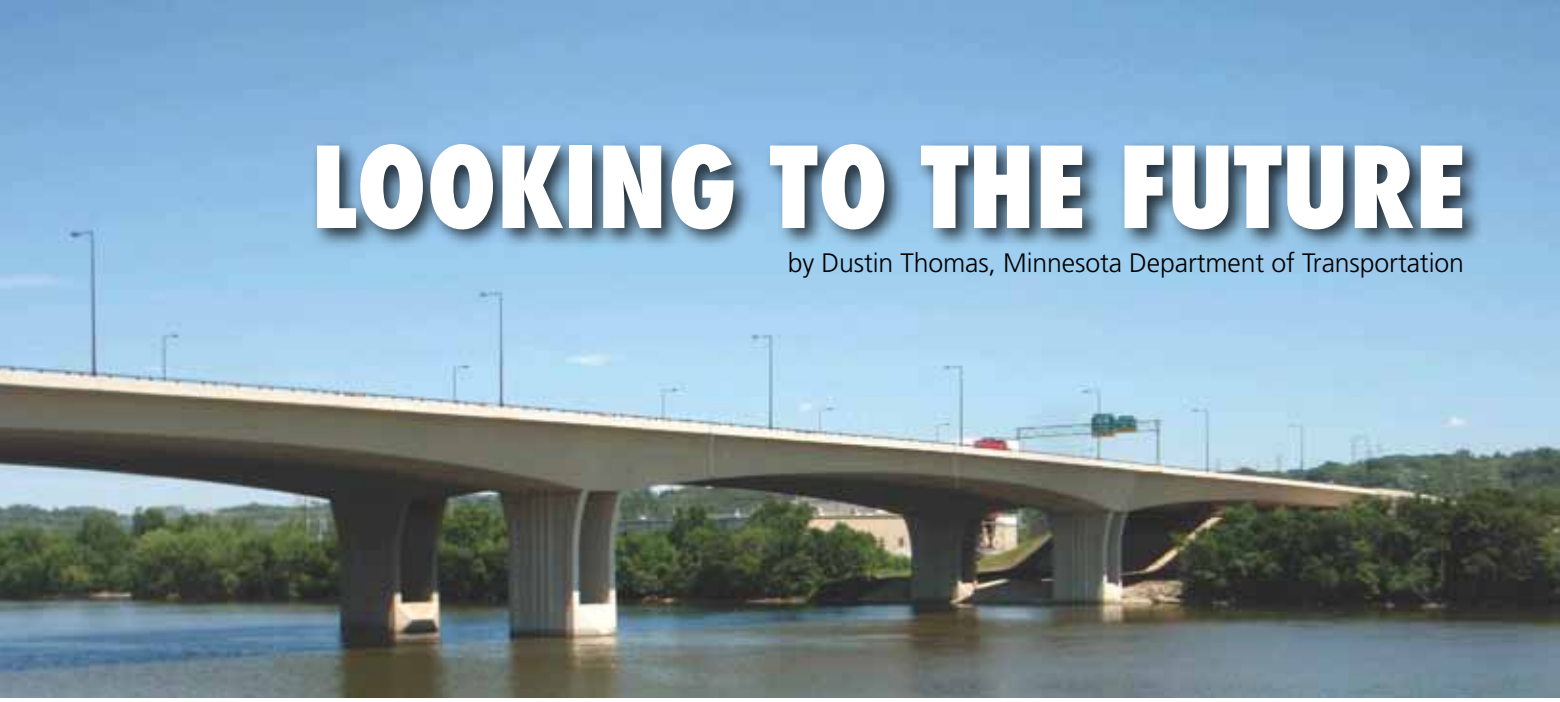
The new Wilson Street Bridge is something the people of Batavia will be proud of for many years.



Shown at high water levels, the bridge opens up the space from bank to bank. Photo: Henry G. Russell Inc.

LOOKING TO THE FUTURE

by Dustin Thomas, Minnesota Department of Transportation



The Wakota Bridge near South St. Paul, Minn., features twin cast-in-place concrete, two-cell, segmental box girders. Completed in July, the bridge is being monitored to evaluate thermal loading in the piers and girders. All photos: Minnesota Department of Transportation.

Segmental design adapts to conditions and includes sensors to assess thermal loading for piers and girders

The new Wakota Bridge that spans the Mississippi River near South St. Paul, Minn., connects Washington and Dakota Counties, giving the bridge its name. To meet a variety of challenges, the twin structures of the bridge were designed as cast-in-place, two-cell, segmental box girders. The bridge will benefit future projects, thanks to the embedment of sensors that will provide information to evaluate thermal loading in the piers and girders.

The new side-by-side structures carry eastbound and westbound I-494 over the Mississippi River, as well as over railroad tracks, a city street, and a bike trail. With widths of 122 ft and 111 ft at the widened end spans, the twin bridges will each carry 5 lanes of traffic and are the widest in the state. The design required variable-width roadway and bridge geometry to accommodate merging entrance and exit ramps at both ends of the structures.

The side-by-side structures replace an existing four-lane, steel, tied-arch structure that no longer could carry steadily increasing traffic volumes. The initial plan was to construct two, four-lane bridges to double the volume, but a fifth lane was added to both structures early in the design process to maximize repeatability and reduce width variations. The westbound bridge, which was constructed first, also includes a pedestrian and bicycle trail with two scenic overlooks.

Each structure features parabolically haunched soffits for efficiency and to gain clearance over the navigation channel. The slope of the outer webs was held constant, creating a dramatic width variation in the bottom slab along the haunched spans.

Segmental Design Minimizes Piers

The span configuration was determined by the Minnesota Department of Transportation (Mn/DOT) bridge office during the preliminary design process. Navigational requirements dictated that the easterly most pier had to remain on the river bank, as the navigation channel along the outer easterly side of the river bends through this stretch. Placing Pier 4 at this location established it at the same spot as a pier from the old bridge. With rock elevations close to the surface on the east bank, placing a new pier here was feasible since spread footings were used for both the old and

profile

WAKOTA BRIDGE / WASHINGTON AND DAKOTA COUNTIES, MINNESOTA

BRIDGE ENGINEER: HNTB, Minneapolis, Minn.

CONSTRUCTION ENGINEER: Janssen & Spaans, Indianapolis, Ind.

CONSTRUCTION ENGINEERING & INSPECTION ASSISTANCE: Parsons Transportation Group, Minneapolis, Minn.

PRIME CONTRACTOR: Lunda Construction Co., Black River Falls, Wis.

POST-TENSIONING SUPPLIER: VSL, Grand Prairie, Tex.

CONCRETE SUPPLIER: Cemstone, Mendota Heights, Minn.

A key cost savings came in selecting twin-wall piers with integral pier tables.

the new pier, so pile interference was not an issue.

The U.S. Coast Guard would not allow a reduction in the width of the main navigation channel, which was 420 ft wide under the old bridge's tied-arch span. The new main navigation-channel span needed to be longer and was set at 466 ft, just clearing the footing and seal from the old bridge. This span length was feasible with cast-in-place concrete segmental construction. The next span was also set at 466 ft to match the main channel and minimize pier conflicts with existing foundations. The westerly spans were incrementally shortened and balanced with the loads from the widening roadway ramps. They were constructed on falsework placed around the in-service railroad tracks.

This efficient and balanced layout created five spans, comprising 266, 328, 466, 466, and 353 ft for each structure. The span lengths were achieved with variable-depth, twin-cell box girders ranging in depth from 24 ft at the pier tables to 12 ft at midspans. Widths vary from 99 ft and 86 ft at typical points to 122 ft and 111 ft at the widened end spans.

The concrete design will reduce long-term maintenance costs for the bridge, which is anticipated to be in service in excess of 75 years. A major factor in increasing durability was the use of a top slab that is biaxially post-tensioned to achieve the established design criteria of zero tension for service-level stresses after all prestress losses. A dense concrete overlay was applied for the wearing surface to increase the corrosion resistance of the deck. All reinforcing bars above ground were epoxy-coated to increase durability and extend service life.

For the substructure, a key cost savings came in designing twin-wall piers with integral pier tables. This approach eliminated the need for shoring during the balanced-cantilever construction and will minimize maintenance needs associated with bearings over the bridge's service life.

Construction Sequencing

The cantilevered spans for the eastbound structure consist of 27 segments ranging in length from 13 ft to 16.5 ft, with 6.5-ft-long closure at midspan. Falsework was used to construct the two end spans. Two sets of form travelers were used for the segmental spans in balanced cantilever construction. The segmental construction began at Pier 4 and Pier 2 at the east and west banks of the river, respectively. When construction at Pier 4 was complete, one set of form travelers was moved to Pier 3 in the middle of the river.

Each cast-in-place segment was cast monolithically. A typical segment placement required approximately 125 yd^3 of concrete and took 4 hours using two concrete pumps. Prior to casting the midspan closures for Spans 3 and 4 (both 466 ft long), they were jacked apart with 400 tons of force to reduce the long-term stresses in the fixed piers.

The westerly span of each structure was constructed on falsework over in-service railroad tracks.

TWO, FIVE-LANE, FIVE-SPAN, CAST-IN-PLACE CONCRETE SEGMENTAL STRUCTURES / MINNESOTA DEPARTMENT OF TRANSPORTATION, OWNER

GROUT SUPPLIER: Sika Corp., Lyndhurst, N.J.

POST-TENSIONING EPOXY GROUT SUPPLIER: Pilgrim Permacoat Inc., Tampa, Fla.

FORM TRAVELER SUPPLIER: Strukturas, Langesund, Norway

INSTRUMENTATION SUPPLIER: Campbell Scientific, Logan, Utah

BRIDGE DESCRIPTION: Two parallel 1892-ft-long, cast-in-place concrete segmental structures consisting of five spans each with lengths up to 466 ft each

BRIDGE CONSTRUCTION COST: $56 million

Segmental, balanced cantilevered construction began at Pier 2 (as well as Pier 4) on the west bank. The piers feature a twin-wall design with integral pier tables.

A key consideration was ensuring the project remained on track while working through the cold Minnesota winter. Heated enclosures were created around the formed wings and leading ends of the cantilevers, with blankets placed on the decks and the top of the bottom slab. Insulated forms were used under the bottom slab. Four 400,000-Btu propane heaters were placed in the box-girder cells and under each wing. Forms were heated 12 hours prior to casting and remained heated until the concrete reached its design strength of 6000 psi.

Monitoring Thermal Loads

After design work was completed, Mn/DOT officials decided to use the eastbound bridge as a test project to monitor the forces generated by thermal effects in the bridge piers and box-girder superstructure. Although such data are readily available for superstructures, much less has been gathered for substructures.

The monitoring effort, conducted by the University of Minnesota, will provide data to aid pier designs in flexible pier-bridge systems of future structures. The instrumentation was designed to isolate and capture behavior of thermal movements of the structure. The concrete components had 84 vibrating wire strain gauges with thermisters embedded in them. These gauges will allow strain changes to be correlated with temperature changes. Two linear string potentiometers also were placed to measure overall length changes.

The monitoring work will provide data to aid pier designs in flexible pier-bridge systems.

Superstructure instrumentation was placed on Spans 3 and 4, which will have the greatest stresses due to temperature variations, since they are fixed at the piers. The twin-wall piers have instrumentation embedded at two elevations, with gauges paired along the width of the wall to maintain consistency.

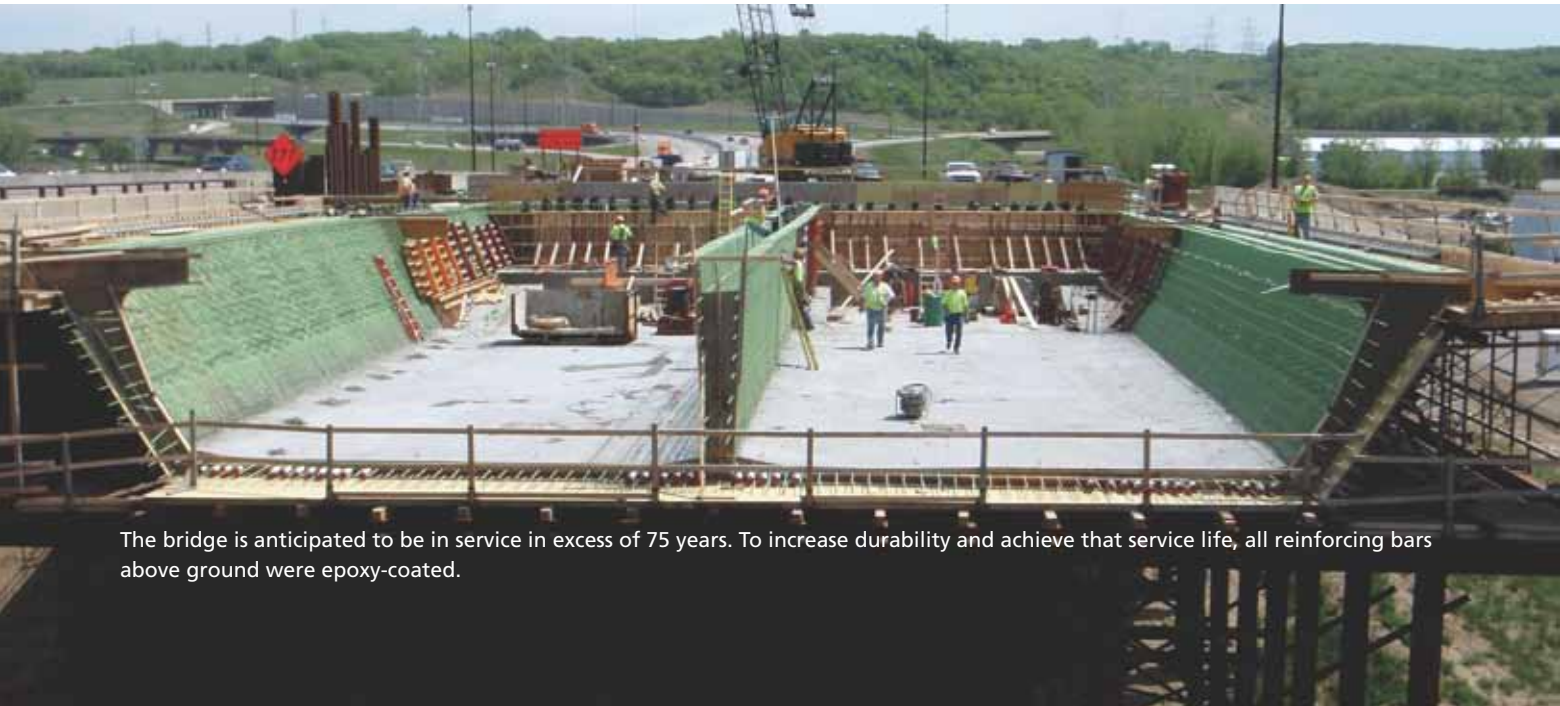
Greatly expanding the capacity of this bridge was sorely needed for both today and tomorrow. The additional benefits provided by monitoring the structure for thermal loading will allow engineers to improve upon design practices for future projects.

Dustin Thomas is the South Region bridge construction engineer with the bridge office of the Minnesota Department of Transportation in Oakdale, Minn.

Navigational requirements dictated that the most easterly pier (Pier 4) had to remain on the river bank. It was established in the same location as the original bridge's pier. Spread footings were used for both the old and the new pier.

Two sets of form travelers were used to construct the segmental spans using balanced cantilever construction. Work began at Piers 2 and 4. After completion of Pier 4 cantilevers, the form travelers were moved to Pier 3 in the middle of the river.

For more information on this or other projects, visit www.aspirebridge.org.



The bridge is anticipated to be in service in excess of 75 years. To increase durability and achieve that service life, all reinforcing bars above ground were epoxy-coated.

Promoting Use and Advancing Quality of Epoxy-Coated Reinforcing Steel.

High Performance at a low cost – Epoxy-Coated Reinforcing

www.epoxyinterestgroup.org

EIG CRSI
EPOXY INTEREST GROUP

For the latest information on EIG, log onto our Web site or become a fan of the Epoxy Interest Group FACEBOOK page.

©Photo courtesy of EIGG, photographer Tim Davis.

Silica Fume Association

The Silica Fume Association (SFA), a not-for-profit corporation based in Delaware, with offices in Virginia and Ohio, was formed in 1998 to assist the producers of silica fume in promoting its usage in concrete. Silica fume, a by-product of silicon and ferro-silicon metal production, is a highly-reactive pozzolan and a key ingredient in high performance concrete, dramatically increasing the service-life of structures.

The SFA advances the use of silica fume in the nation's concrete infrastructure and works to increase the awareness and understanding of silica fume concrete in the private civil engineering sector, among state transportation officials and in the academic community. The SFA's goals are two-fold: to provide a legacy of durable concrete structures and to decrease silica fume volume in the national waste stream.

Some of the recent projects completed by the SFA, under a cooperative agreement with the Federal Highway Administration (FHWA), include:

- The publication of a *Silica Fume User's Manual*—the manual is a comprehensive guide for specifiers, ready mixed and precast concrete producers, and contractors that describes the best practice for the successful use of silica fume in the production of high performance concrete (HPC).
- The introduction of a Standard Reference Material (SRM)® 2696 Silica Fume for checking the accuracy of existing laboratory practices and to provide a tool for instrument calibration. This SRM is available from the National Institute of Standards and Technology (NIST).

A much anticipated research program nearing completion by the SFA is the testing of in-place silica fume concrete under service conditions. At the conclusion of this research the results will demonstrate the benefit of silica fume concrete's unparalleled long-term performance. For more information about SFA, visit www.silicafume.org.

BRIDGING THE GAP

The Nation's Most Compact Double-Teardrop Interchange

by David A. Day and Andrea B. Emerson, American Structurepoint Inc.

Keystone Parkway's teardrop interchange configuration is the tightest in the nation. This is the 106th Street Bridge. All photos: American Structurepoint Inc.

Carmel, Ind., is an affluent community to the north of Indianapolis and contains one of Indiana's largest business districts. It has grown substantially over the past 10 years, adding 50,000 residents. The explosive growth spurred many traffic challenges, with Carmel's most heavily traveled road—Keystone Avenue—growing increasingly sluggish and, as drivers tried to beat traffic lights, more dangerous.

Since the late 1960s, Keystone Avenue, also known as Indiana State Road 431 and controlled by the Indiana Department of Transportation (INDOT), had been a four-lane, divided roadway with seven at-grade signalized intersections—two of which were rated as "failing" at peak travel periods, according to a state-led analysis. The corridor, now renamed Keystone Parkway, averaged 200 accidents each year.

From Planning Gridlock to Fast Track

Seeking a minimally disruptive, long-term solution, City Engineer Michael McBride proposed to introduce grade separations at intersections using teardrop roundabouts. Meanwhile, Carmel Mayor Jim Brainard asked the state to relinquish control of the corridor—a request the city had been making for more than a decade.

Taking their cue from "Major Moves"—an aggressive program by Indiana Governor Mitch Daniels calling for much faster execution of road and bridge projects—the state agreed that Carmel was in a better position to meet the deadlines. Keystone Avenue was turned over to Carmel, which then partnered with American Structurepoint Inc. to refine and implement its plan.

Driven to Teardrops

As the engineers began shaping the design, it was clear roundabouts would be key ingredients to the solution, and with good reason. Studies point to roundabouts as one of the safest, most efficient intersection control techniques. Not only do accidents occur less frequently, but the severity of accidents at roundabouts is far less than stop-controlled or signalized intersections. "Anytime you remove conflict points, you improve safety," McBride explained. "A two-lane, four-way signalized intersection has more than 30 conflict points," he added, "but a typical single-lane roundabout has only eight."

As the design progressed, a unique teardrop interchange configuration—the tightest in the nation—emerged as the silver bullet. When measured center to center of the teardrop, the ramp termini are less than 290 ft apart, with

profile

KEYSTONE PARKWAY INTERCHANGES–106TH AND 126TH STREET BRIDGES / CARMEL, INDIANA

BRIDGE DESIGN ENGINEER: American Structurepoint Inc., Indianapolis, Ind.

PRIME CONTRACTOR: Milestone Contractors LP, Indianapolis, Ind.

CONCRETE SUPPLIER: Irving Materials Inc., Greenfield, Ind.

GIRDER PRECASTER: Prestress Services Industries LLC, Lexington, Ky., a PCI-certified producer

BRIDGE CONSTRUCTION COST: $3,081,160 (without MSE walls and approaches)
Superstructure and deck $76.01/ft^2; Substructure $39.78/ft^2

maximum right-of-way width less than 300 ft. The payback was a much smaller footprint and drastic reduction in the amount of right-of-way that had to be purchased. No residential homes and only one commercial building had to be relocated for the first two interchanges. Had a traditional tight-diamond design been used, dozens of homes would have been relocated.

Bridging the Gap

Part of Keystone Parkway's design hinges on two bridges carrying the roundabout traffic at the 106th and 126th Street intersections, connecting Carmel from east to west. The two-span, continuous, composite bridges feature precast, prestressed concrete AASHTO Type II beams with cast-in-place concrete deck slabs. Span lengths for the 106th and 126th Street bridges are 50 ft 9 in. and 50 ft 6 in., respectively. The 106th Street structure has a 15-degree skew right and the 126th Street structure has no skew. Each of the bridges' framing consists of 15 beam lines, with the 11 interior beams parallel to each other and each outside two rows of beams splayed to fit the copings, which are curved to follow the geometry of the roundabouts. The concrete decks were cast in halves due to the varying width of the deck with the curved overhangs.

Adding to the complexity of the project were specialty items such as stamped concrete, patterned formliners, hand-stained color patterns, ornamental handrail, and custom signage attached to bridge structures. Full-size, mock-up pieces were created for client approval of colors and patterns.

Raised median curbs and outside sidewalks are cast-in-place, colored concrete with pattern stamping. The cast-in-place barrier railing reflects an inset brick pattern on the pedestrian side. The exterior face of the railing has multiple circle shapes canted 2 in. inside the face of the railing at the bottom, and 2 in. outside of the face of the railing at the top. The railings have masonry coatings to accentuate the patterns. An ornamental steel railing was added to the top of the concrete railing to meet pedestrian and bicycle height requirements.

The bridges' end bents are cast-in-place concrete pile caps on driven piles, made integral using INDOT standards. They sit atop a mechanically stabilized earth (MSE) abutment with precast concrete facing panels with a random ashlar finish. The panels were stained to produce a tri-color, earth-toned finish.

The center piers are cast-in-place concrete frame bents on driven piles with architectural effects of circular openings canted 20 degrees to reflect the circular pattern in the outside face of the bridge railings. The piers have masonry coatings with the interior of the circular openings colored to match the circles in the railings.

Despite the intricate, custom design, speed was imperative: In order to expedite construction, specialty forms were fabricated off site and erected on site, enabling the center pier to be completed within 1 week, start to finish. Prefabricated Styrofoam blockouts were used to build the circular cutouts, saving time and avoiding complex forming inside the center pier. Wall panel formliners, barrier rail formliners, a city logo formliner, and ornamental railing materials were all saved to maintain architectural consistency throughout the corridor and reduce costs.

The design of the two interchanges was completed in approximately 4 months, and construction began in April 2008, and opened to traffic in April 2009. The project, dubbed "Carmel Link,"

The double-teardrop interchange resulted in a 78% reduction in personal-injury accidents at these intersections. This is the 126th Street Bridge.

TWO-SPAN, CONTINUOUS, COMPOSITE, PRECAST, PRESTRESSED CONCRETE I-BEAM BRIDGES WITH CAST-IN-PLACE CONCRETE SUBSTRUCTURES SUPPORTING DOUBLE TEAR-DROP INTERCHANGES / CITY OF CARMEL, OWNER

BRIDGE DESCRIPTION: Two concrete bridges with lengths of 103 ft 7 in. and 102 ft 6 in., each with two equal spans that create grade separations and support unique tear-drop interchanges. The bridges vary from approximately 111 ft to 220 ft wide.

STRUCTURAL COMPONENTS: 30 AASHTO Type II I-beams in each bridge, cast-in-place concrete decks, center piers, and end bents with the pile caps made integral with the piles, and precast concrete MSE wall panels

AWARDS: *American Consulting Engineers Council 2010 Engineering Excellence Award; 2010 Portland Cement Association Concrete Bridge Award for excellence in design and construction; American Concrete Institute Award; FHWA Excellence in Highway Design; Indiana Partnership for Transportation Quality Award*

The finished bridges provide ample space for pedestrians and bicyclists.

Update of Progress

There were seven at-grade intersections on Keystone Avenue. Six have been removed and replaced with grade-separated interchanges like the first two featured in this article. All use AASHTO Type II or Type III precast, prestressed concrete beams. Of the other four, two others (136th Street and 131st Street) are completely finished and opened to traffic. The other two (116th Street and Carmel Drive) are still under construction and scheduled to open by the end of 2010.

The seventh intersection (98th Street) has been left as is for the time being. INDOT is in the midst of another major project that may impact 98th Street. The City of Carmel elected to leave the intersection alone until INDOT finishes their plan.

One additional bridge, Keystone Parkway over Cool Creek, was included with the interchange project at 136th Street. The bridge needed major repairs, so the superstructure was removed, the substructure widened, and the superstructure replaced with AASHTO Type II beams as well. It is 148 ft 11 in. long and varies from approximately 126 ft to 145 ft wide.

The grade separations along Keystone Parkway allow traffic to flow smoothly underneath the bridges supporting the roundabout interchanges. From the driver's viewpoint, the new, double-teardrop configuration functions the same as standard roundabouts. (View a video simulation at www.carmellink.org/Keystone.swf.)

Carmel residents followed the bridges' progress through an aggressive public outreach campaign at www.carmellink.org.

included an aggressive public outreach campaign and website (www.carmellink.org) offering detailed information and updates to residents.

Outcomes

Within months of unveiling the new interchange, city officials reported a 78% reduction in personal-injury accidents at these intersections. What's more, motorists are able to navigate the corridor without having to stop at traffic signals; thereby reducing travel times on both sides of the streets. That's good news for the environment, considering less power is required for signals and, without the starting and stopping, emissions are lower. Additionally, the removal of traffic lights along the corridor helped reduce noise levels, electricity consumption, and pollution. In addition to improved safety, "this context-sensitive solution," said Brainard, "has provided a very aesthetically pleasing result for the surrounding neighborhoods."

David A. Day is senior bridge project manager and Andrea B. Emerson is marketing associate with American Structurepoint Inc. in Indianapolis, Ind.

For more information on this or other projects, visit www.aspirebridge.org.

Center piers are cast-in-place concrete frame bents on driven piles.

Hand-stained MSE panels and circular cutouts reflect the bridges' intricate, custom design.

PRESTRESSED

CONCRETE BRIDGES

PHOTO OF ROUTE 70 OVER MANASQUAN RIVER IN NEW JERSEY (PHOTO COURTESY ARORA ASSOCIATES).
ALTERNATE STRUCTURE DESIGN UTILIZES PRECAST CAISSONS, PIERS, PIER CAPS, AND PRESTRESSED BEAMS AND WAS OPENED TO TRAFFIC TWO YEARS AHEAD OF AS-DESIGNED SCHEDULE.

AN OPTIMUM SOLUTION TO BENEFIT:

THE PUBLIC - AESTHETIC, DURABLE, AND SAFE
THE OWNERS - LOW MAINTENANCE AND LIFE CYCLE COSTS
THE DESIGNERS - WELL ESTABLISHED STANDARDS - SIMPLE TO DESIGN
THE CONTRACTORS - FAMILIAR MATERIAL - FAST TO CONSTRUCT
THE ENVIRONMENT - LOW ENERGY CONTENT AND SUSTAINABLE SOLUTION

PCI CERTIFIED PLANTS AT YOUR SERVICE IN THE CENTRAL ATLANTIC REGION

Bayshore Concrete Products
1134 Bayshore Road
Cape Charles, VA 23310
Phone: (757) 331-2300
Fax: (757) 331-2501
www.usacivil.skanska.com
Email: Chad.Saunders@skanska.com

Northeast Prestressed Products, LLC.
121 River Street
Cressona, PA 17929-1133
phone: 570-385-2352
fax: 570-385-5898
www.nppbeams.com
Email: info@nppbeams.com

Jersey Precast Corporation
853 Nottingham Way
Hamilton Township, NJ 08638
phone: 609-689-3700
fax: 609-689-3797
www.jerseyprecast.com
Email: jrzprecast@aol.com

Newcrete Products, Inc.
P.O. Box 34
301 Plum Creek Road
Roaring Spring, PA 16673-0034
phone: 814-224-2121
www.newcrete.com
Email: ggorman@nesl.com

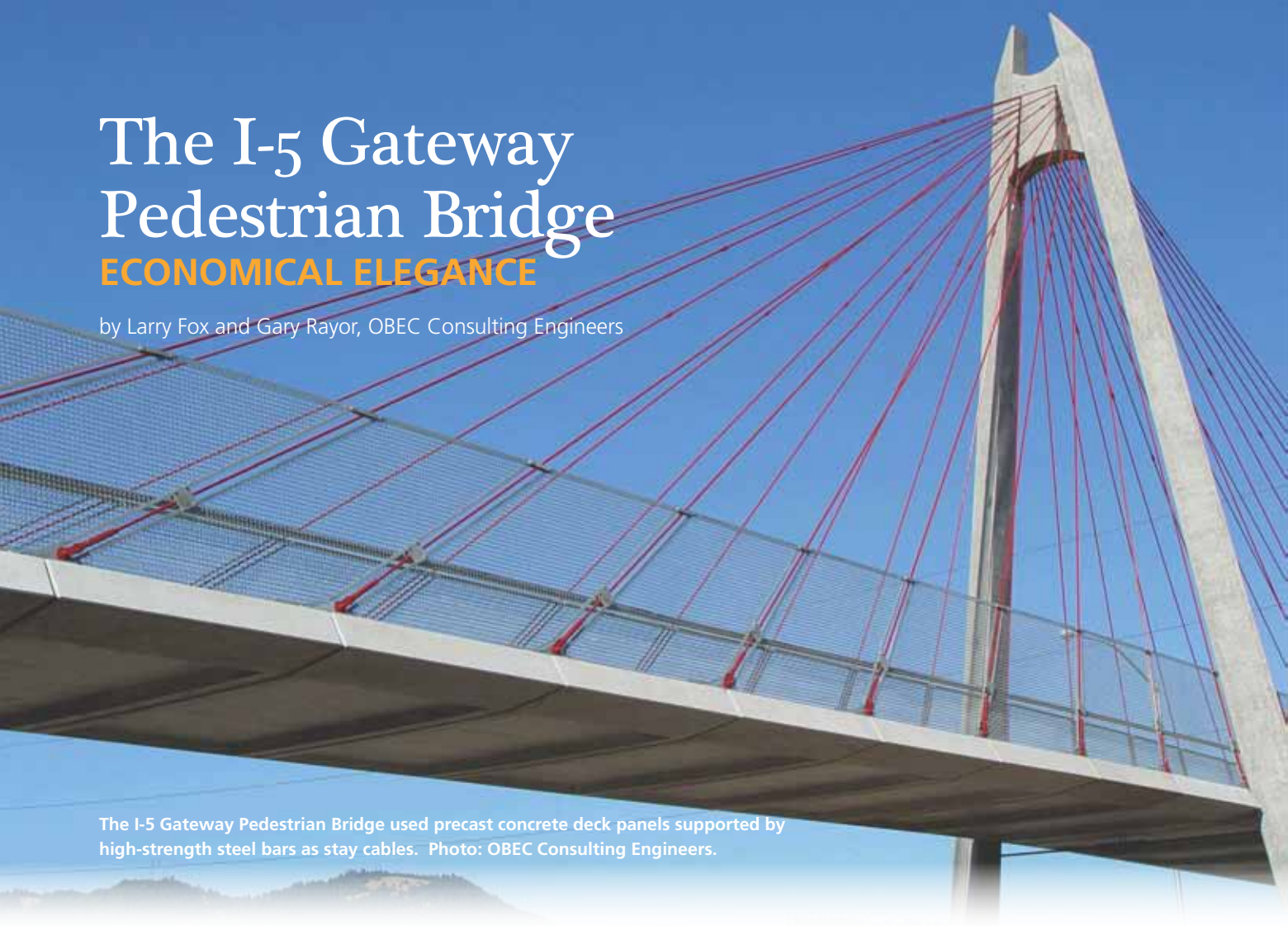
CABA
Central Atlantic Bridge Associates

1042 North Thirty Eighth Street • Allentown, PA 18104
Telephone: (610) 395-2338

The I-5 Gateway Pedestrian Bridge

ECONOMICAL ELEGANCE

by Larry Fox and Gary Rayor, OBEC Consulting Engineers



The I-5 Gateway Pedestrian Bridge used precast concrete deck panels supported by high-strength steel bars as stay cables. Photo: OBEC Consulting Engineers.

When the Oregon Department of Transportation (ODOT) undertook a major interchange improvement at I-5 and Beltline Highway in Lane County, Ore., the project also required pedestrian and bicycle mobility improvements. A number of structure types could have effectively spanned the interstate highway that separates the cities of Eugene and Springfield. However, this major improvement project stood out as an opportunity to provide the communities with a noteworthy landmark structure.

The design team collaborated to develop an iconic cable-stayed pedestrian bridge located immediately south of the improved highway interchange. The cable-stayed bridge type helped the designers deliver a sleek structure that was both rapidly constructable and extremely economical. OBEC Consulting Engineers and Jiri Strasky have successfully demonstrated the feasibility of this cable-supported bridge type on three other signature pedestrian bridges in the area. Adding the highly visible I-5 Gateway Pedestrian Bridge to the local bike and pedestrian system supported a unified theme and extended the area's already unique and inspiring biking and walking experience across the highway.

The minimal and functional design is a direct result of the team's belief that a bridge is a sculpture; that the public appreciates and intrinsically recognizes elegance and simplicity of form as the essence of good design. As such, the bridge itself becomes public art.

The team accomplished the efficient bridge design by drawing upon the experience gained during several long-span cable bridge projects in western Oregon. The team's broad experience

profile

I-5 GATEWAY PEDESTRIAN BRIDGE / EUGENE AND SPRINGFIELD, OREGON

BRIDGE DESIGN ENGINEERS: OBEC Consulting Engineers, Eugene, Ore., and Jiri Strasky, consulting engineer, Greenbrae, Calif.

PRIME CONTRACTOR: Mowat Construction Company, Woodinville, Wash.

CONCRETE SUPPLIER AND PRECASTER: Knife River Corporation, Harrisburg, Ore., a PCI-certified producer

POST-TENSIONING CONTRACTOR: Schwager Davis, San Jose, Calif.

BRIDGE DESCRIPTION: 503-ft-long, 14-ft-wide cable-stayed pedestrian bridge with 103-ft-long main spans using precast concrete deck panels, precast concrete central tower, and 30-ft-long concrete approach spans

with similar bridge concepts improved the design of the I-5 Gateway Pedestrian Bridge and showcased the versatility inherent in the fundamental deck system. The project also demonstrated how precast concrete segmental construction allows for rapid and safe bridge erection over a busy interstate highway without traffic interruption.

Alternative Selection

Three types of bridges were evaluated: a conventional precast, prestressed concrete box girder, strut-stayed, and cable-stayed. The cable-stayed bridge was the most cost-effective solution when considering the intrinsic aesthetic appeal it offered with only a small cost premium over the prestressed concrete girder alternative. As a refinement in the predesign study, the design team also considered both steel and concrete central "A-shaped" tower construction and found that concrete further reduced the cost of the bridge. ODOT ultimately selected the cable-stayed alternative, making it the first cable-stayed bridge in the state's inventory.

Bridge Design

The I-5 Gateway Pedestrian Bridge includes many unique details and innovations. The use of cable-supported precast concrete structural elements has resulted in high levels of cost-efficiency in the final structure. The background and development of the general bridge concepts used in this project demonstrate the versatility of cable-supported segmental precast concrete deck panels.

The bridge is 503 ft long with a pedestrian deck width of 14 ft. The two main spans of the bridge over the highway are 103 ft long. Ninety-two feet of each span comprise precast panels. The panels are typically 10 ft in length except for one panel in each span at the tower that is 12 ft long. The concrete used in the panels had a compressive strength of 5800 psi. The rest of the bridge beyond the area of precast panels consists of approximately 30-ft-long cast-in-place approach spans. Sixty-three feet of the cast-in-place concrete at both ends of the bridge are post-tensioned to the panels to form a 310-ft-long continuous section.

In order to eliminate the need for shoring within the highway clearance area, the deck panels are externally supported on stay cables as the bridge is erected outward from the central tower using a balanced cantilever method. The precast concrete deck panels also serve as the form for a composite cast-in-place concrete topping slab that is placed on the precast panels, making the entire bridge continuous. The topping strength was specified to be 4350 psi. The mix contained silica fume to reduce permeability and improve corrosion protection for the deck reinforcement. The cast-in-place approach spans were cast with the same mix used for the topping and some were cast at the same time the topping was placed.

The topping slab contains continuity reinforcement and full-length longitudinal post-tensioning that accomplishes several goals:

- provides capacity for asymmetrical live load bending
- enhances superstructure stiffness for improved user vibration comfort
- prestresses the panel closure joints
- precompresses the entire deck section against shrinkage and temperature cracking for increased longevity

The bridge contains no deck joints from end to end, further minimizing maintenance.

View of the main spans with spiral stairway. Photo: OBEC Consulting Engineers.

CABLE-STAYED, 503-FT-LONG PEDESTRIAN BRIDGE WITH MAIN SPANS OF PRECAST CONCRETE, END SPANS OF CAST-IN-PLACE CONCRETE, AND A PRECAST CONCRETE CENTRAL TOWER / OREGON DEPARTMENT OF TRANSPORTATION, OWNER

STRUCTURAL COMPONENTS: 18 precast concrete panels, precast concrete tower, cast-in-place concrete deck approach spans, and substructure, galvanized and painted steel stay cables, mechanically stabilized earth (MSE) walls

BRIDGE CONSTRUCTION COST: $2,035,000, including bridge bid items and mobilization ($290/ft^2)

AWARDS: *2010 Portland Cement Association Concrete Bridge Award for excellence in design and construction*

One Deck System, Many Bridge Types

The Eugene and Springfield area of Oregon has a number of long-span, cable-supported pedestrian and special use bridges designed by the OBEC/Strasky team, which is unusual for a community of this size. The design team has delivered innovative bridges using technology similar to the I-5 Gateway Pedestrian Bridge to the City of Eugene, ODOT, and the Wildish Companies. These bridges embody economical elegance by building on the previous work of Dr. Strasky in the Czech Republic prior to the fall of the Iron Curtain, when bridges had to be built with minimal materials.

The stay cables consist of galvanized and painted high-strength steel bars, connected with tapered architectural couplers to achieve the required length. The bar-type stays use simple threaded connections at the tower and deck using standard American Institute of Steel Construction clevises. The use of galvanized and painted bars represents an improvement over the more standard multiple wire bridge rope stay cables, as they vastly reduce the surface area subject to corrosion, simplify connections, and improve stiffness. Each stay cable is also readily adjusted using paired cargo jacks at a structural turnbuckle located on the stay. The turnbuckles are located at the same elevation as the bridge railing to improve aesthetics and provide easy access.

The other major elements of the bridge include cast-in-place concrete approach spans, a spiral stairway, and approach embankments supported by mechanically-stabilized earth retaining walls. The I-5 Gateway Pedestrian Bridge is similar to other economical and elegant bridges designed by this team through its innovative use of precast concrete, cable-supported main spans, slender profiles, pleasing aesthetics, and economy.

The bridge was bid in 2006, and construction was completed in early 2009.

Construction

The plans allowed for either on-site or off-site precasting of the "A-shaped" tower legs and the contractor elected to precast the legs on-site. This was done in the median of the highway with the entire tower laid out horizontally adjacent to the tower foundation to provide direct geometry control of the final assembly. The one-piece central tower was then set with a 350-ton-capacity hydraulic crane into a temporary erection tower to provide stability against overturning during erection of the superstructure. The tower legs are triangular in cross section. They have a width parallel to the bridge of 42 in. and a perpendicular depth of 36 in. at the base of the tower and taper to 28 in. wide by 24 in. deep at the top. The top of the tower stands 73 ft above the roadway and 54 ft above the deck. The concrete strength specified for the tower was 5800 psi.

The temporary tower was designed by the contractor's engineer based on design criteria shown on the plans. The criteria required the tower to resist the imbalance in the main spans during deck panel placement, aerodynamic wind loading from passing trucks, and normal horizontal wind loading. This allowed the main span deck panels to be erected without the use of any stabilizing falsework within the highway clearance envelope. The deck panels were placed during three night shifts with temporary lane closures. Erection required only a light crane to set the panels on alternate sides of the tower and connect them to the stays with easily adjusted connections. Panel erection could be terminated at any location at the end of each night shift. When work was completed each night, a temporary support was placed under the last deck panel for added stability, provided it did not conflict with active freeway lanes. All lanes of traffic on the busy interstate stayed open during daylight hours.

The deck reinforcement and full-length deck post-tensioning were installed after final grading of the panels by adjusting the stay cables to their calculated length prior to adding the remaining dead load. The next step of construction was casting the concrete topping slab within the post-tensioned portion of the bridge, post-tension the deck, and then cast the remainder of the approach spans, spiral stairway, and appurtenances. Finally, the protective fencing and railings were installed to complete the bridge.

Location of the pedestrian bridge in context of the Beltline Interchange Improvement Project. Photo: Oregon Department of Transportation.

Precast concrete tower at high point during erection. Photo: OBEC Consulting Engineers.

Conclusion

The design team's intent was to provide ODOT, the construction contractors, and the communities of Eugene and Springfield with an iconic pedestrian bridge that met all parties' needs by designing a structure that was easy to understand, constructable, economical, easily maintained, and elegant. They achieved these goals with a combination of innovative cable-stay technology and straightforward bridge construction techniques, including the use of precast concrete elements, segmental erection, and simple, effective cable support systems, and erection techniques.

Larry Fox is vice president and chief engineer and Gary Rayor is principal engineer, both with OBEC Consulting Engineers in Eugene, Ore.

For more information on this or other projects, visit www.aspirebridge.org.

THE WESTIN
BAYSHORE
Vancouver

October 11-12
2010 Annual ASBI
CONVENTION
Vancouver, BC, Canada

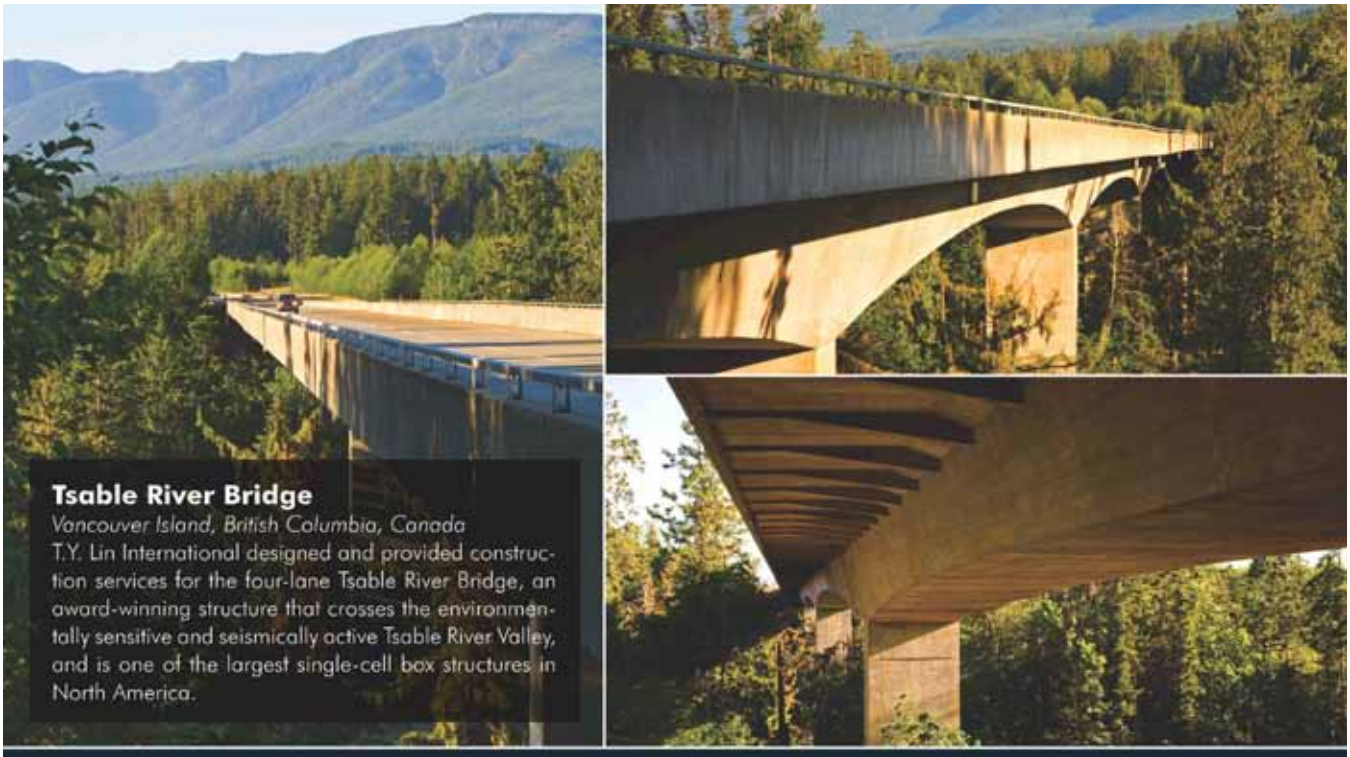
AMERICAN SEGMENTAL BRIDGE INSTITUTE

Construction Practices
SEMINAR
See News & Events on our website for future seminars.

Mark Your Calendar Today!
For these three important ASBI events.

April 18-19
2011 Grouting Certification
TRAINING
J.J. Pickle Research Campus
University of Texas, Austin

For further details visit
www.asbi-assoc.org



Tsable River Bridge
Vancouver Island, British Columbia, Canada
T.Y. Lin International designed and provided construction services for the four-lane Tsable River Bridge, an award-winning structure that crosses the environmentally sensitive and seismically active Tsable River Valley, and is one of the largest single-cell box structures in North America.

T·Y·LIN INTERNATIONAL

Two Harrison Street, Suite 500, San Francisco, California 94105
tel: 415.291.3700 | fax: 415.433.0807 | www.tylin.com

'CHANNEL' BRIDGE IMPROVES CLEARANCE

by Matt Card, Purcell Associates
and Thomas Cyran, International Bridge Technologies

This rendering of the DCR design shows the cross section of the precast concrete segmental "channel" bridge. Rendering: IBT.

Precast segmental concrete design offers thinner cross section

A precast concrete "channel" bridge offers significant opportunities for expanding the capabilities of post-tensioned segmental construction. The potential can be seen in the DCR Access Road Bridge over Route 24 in Randolph, Mass. The project will improve clearance for the heavily traveled road below, complement the scenic areas surrounding it, and reuse existing materials to reduce waste and lower costs.

The project is located in the Blue Hills Reservation area, surrounded by land owned by the state Department of Conservation and Recreation (DCR). The existing bridge, built in 1958, consisted of a 247-ft-long, four-span steel I-girder structure supporting a 7.5-in-thick concrete deck and an asphalt wearing surface. The substructure featured two concrete stub-type abutments supported on steel piles and three reinforced concrete piers supported on spread footings.

Partly due to its low 14 ft 3 in. vertical clearance, the existing bridge had become structurally deficient. In fact, the steel I-girders had repeatedly been hit by trucks driving below on Route 24. Officials at the Massachusetts Department of Transportation (MassDOT) wanted to increase the vertical clearance without having to perform extensive roadway work either underneath the bridge or at the abutments. Raising the profile of the approach roads at the abutments was not an option because of the scenic location, landscaping surrounding the site, and transitions to extensive woods and horse paths used by horse-rental farms on both sides.

MassDOT officials also wanted to create a design that would blend with the scenic surroundings and minimize long-term maintenance needs.

To reach those goals, MassDOT engineers selected the precast concrete "channel" bridge concept with post-tensioned, segmental construction. In addition to meeting the immediate goals, it will provide long-term durability through a minimum service life of 75 years.

Edge Beams Serve Two Roles

The channel cross section features a precast concrete superstructure with an unusual U-shaped design. It consists of two edge beams that function as the main load-carrying elements, with the roadway slab supported between them. The two edge beams serve a second purpose by acting as traffic barriers.

During erection, top flanges on the outside of the edge beams temporarily support the segments on erection beams that span between the abutments and piers. This system eliminates the need for a below-deck support system, minimizing vertical-clearance needs and construction time while reducing life-cycle costs.

The DCR Bridge is 248-ft-long, comprising two 124 ft spans. The two-span continuous precast segmental concrete structure will increase vertical clearance over Route 24 by more than 2 ft to 16 ft 5 in. The substructure consists of two new, reinforced concrete stub-type abutments

profile

DCR ACCESS ROAD BRIDGE OVER ROUTE 24 / RANDOLPH, MASSACHUSETTS

ENGINEER OF RECORD: Purcell Associates, Boston, Mass.

SUPERSTRUCTURE ENGINEER: International Bridge Technologies Inc., San Diego, Calif.

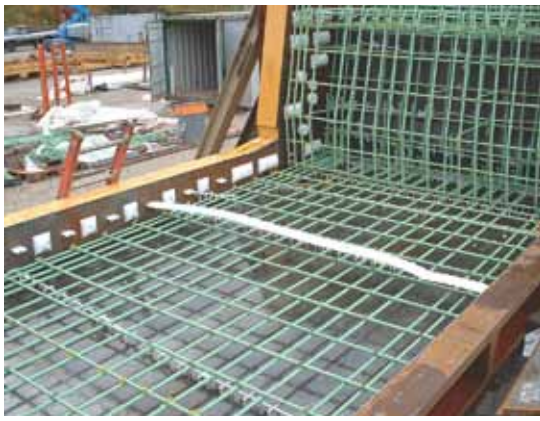
CONSTRUCTION ENGINEER: FINLEY Engineering Group Inc., Tallahassee, Fla.

PRIME CONTRACTOR: R. Zoppo Corp., Sloughton, Mass.

PRECASTER: Unistress Corp., Pittsfield, Mass., a PCI-certified producer

The new precast concrete channel bridge (bottom rendering) and the original steel I-girder bridge (top photo) and are shown for comparison. The new channel bridge provides more than 2 ft of additional clearance. Illustration: IBT.

The original steel bridge's I-girders were removed and then reused as temporary erection beams to support the precast concrete channel segments during erection. Photo: Purcell Associates.



The precaster purchased relatively simple specialized forms to cast the channel segments shown here during set-up for casting the first non-match-cast segment. Photo: IBT.

supported on steel piles and a new center pier consisting of two 59-in.-diameter, reinforced concrete columns supported on a common concrete spread footing. The specified concrete compressive strength for the substructure was 4350 psi. Utilizing only a center pier, the DCR Bridge eliminates the need for side piers at each outside roadway edge. This adds safety for highway users, and also reduces material cost and construction time.

The new superstructure is 29.7 ft wide and 5.38 ft deep. Each edge beam is fully post-tensioned using one 12-strand tendon, one 15-strand tendon, and two 19-strand tendons. All tendons use 0.6-in.-diameter strands. Fourteen additional longitudinal tendons are provided in the deck slab, using flat 4-strand tendons of 0.6-in.-diameter strands. Transversely, the structure is fully post-tensioned before erection using flat 4-strand tendons. All non-prestressed reinforcing steel is epoxy-coated.

Purcell Associates served as the engineer of record on the project and designed the substructure elements. The firm subcontracted the superstructure design to International Bridge Technologies (IBT), which has experience with the channel concept. It was originally created and patented by the innovative bridge engineer Jean Muller, whose firm designed two such bridges in upstate New York in the 1990s and others in Europe. Daniel Tassin, IBT's technical director, worked with Muller for many years.

Superstructure Construction

A total of 31 precast concrete channel segments were match-cast for the project with concrete having a specified compressive strength of 6500 psi. Typical segments were 8.2 ft long, with the two abutment segments being 5.1 ft long.

To avoid deflection issues resulting from unequal weight distribution, all of the segments were placed onto the erection beams prior to their actual assembly. This erection took 4 days. Then, groups of two to four segments were assembled incrementally using epoxy joints and post-tensioning bars, starting from the center of the bridge and moving towards the abutments in a balanced sequence. Each group of segments was assembled in a 1-day shift resulting in a total time of 10 days. Once all of the segments were assembled, the permanent post-tensioning was stressed in the edge beams and deck slab, and the temporary steel erection beams were removed.

When the erection of the superstructure

The channel design eliminates the need for a below-deck support system.

SEGMENTAL, POST-TENSIONED CHANNEL BRIDGE / MASSACHUSETTS DEPARTMENT OF TRANSPORTATION, OWNER

POST-TENSIONING MATERIALS: VStructural LLC, Hanover, Md.

PRECAST CONCRETE FORMWORK: EFCO Corp., Des Moines, Iowa

BRIDGE DESCRIPTION: 248-ft-long, precast concrete, post-tensioned segmental channel bridge, 29.7 ft wide and 5.38 ft deep, comprising 31 segments, typically 8.2 ft long

BRIDGE CONSTRUCTION COST: $3.86 million

The 8.2-ft-long, U-shaped segments feature a top flange on the outside of the edge beams that temporarily support the segments on erection beams. This approach eliminates the need for a below-deck support system. Photo: IBT.

Eliminating piers at the roadway edge increased driver safety while reducing material costs and construction time.

segments was completed, contractors finished casting the abutments and wingwalls and added the riding surface. It consists of a waterproof membrane covered with a binder coat and a final 3-in.-to 4-in.-thick asphalt wearing surface. The bridge's channel shape provides a 4-ft-high concrete parapet railing along both sides of the bridge, to which a Type II Modified Protective Screen was mounted on each of the parapets.

Timber guard railing and posts will be added within the project limits at all four corners of the bridge for traffic safety. The guardrail has a special steel backing for added strength and safety. The final step is to complete all surrounding incidental landscaping.

The bridge is scheduled to open in October 2010. To date, nothing out of the ordinary has arisen in the project, which is notable since the channel concept is being used for the first time in several years.

The channel design results in a sleek, low-profile appearance that provides functional clearance benefits while keeping it unobtrusive in scenic areas. Best of all, it minimizes long-term maintenance needs that will improve safety of construction crews and users while reducing costs over its service life.

Matt Card is a project manager at Purcell Associates in Boston, Mass., and Thomas Cyran is a bridge engineer with International Bridge Technologies in San Diego, Calif.

For more information on this or other projects, visit www.aspirebridge.org.

Segment groups were assembled incrementally in a balanced sequence on each side.

Groups of two to four segments were assembled incrementally, using post-tensioning bars. Once all 31 segments were placed, they were permanently post-tensioned together into one secure unit, and the temporary erection beams were removed. Photo: IBT.

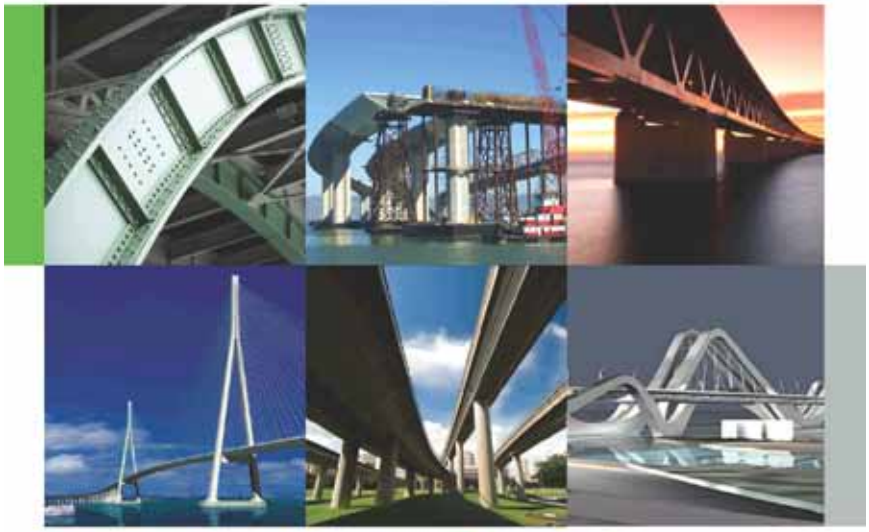
Sustainable Considerations

Minimizing waste and remaining environmentally aware were key goals of the project, and this resulted in an innovative reuse of materials. The steel I-girders of the existing bridge were reused as erection beams, thus serving as the needed temporary shoring while the segments were being erected. Upon completion of segment erection, the steel I-girders were removed and recycled.

The existing bridge piles were retained where possible and interspersed with new ones. To minimize excavation needs along the highway, the center pier's footings were retained. The contractor removed the existing material to the footing and started there with new concrete. The new center pier was designed for additional loads that were needed to support the weight of the concrete components that replaced the lighter steel components of the existing bridge.

Owners, contractors, and engineers are constantly looking for ways to reduce their projects' carbon footprints while ensuring long durability, speed of construction, and maximum aesthetics. The channel design provides a new alternative for achieving these goals. The design encourages the recycling of components from the old structure, which helps reduce construction costs and the impact on the environment.

To avoid deflection issues resulting from unequal weight distribution, all of the precast concrete segments were placed onto the temporary erection beams prior to their actual assembly. Photo: IBT.



Bridge Information Modeling – It's *everything* to do with the bridge.

Bridge Information Modeling (BrIM) is a compelling new methodology for project delivery that dramatically improves bridge quality and reduces risk. Using the Bentley bridge solution for BrIM, engineers develop and employ an unprecedented depth of information about the bridge as they streamline the entire bridge development process, design through construction engineering.

Join the world's top engineering consultancies. Choose the Bentley bridge solution for BrIM – and the satisfaction of delivering safe, sustainable bridges on time and on budget.

Only Bentley can take you there. www.bentley.com/ASPIRE

Bentley
Sustaining Infrastructure

© 2010 Bentley Systems, Incorporated. Bentley, the "B" Bentley logo, and LEAP are either registered or unregistered trademarks or service marks of Bentley Systems, Incorporated or one of its direct or indirect wholly-owned subsidiaries. Other brands and product names are trademarks of their respective owners.

Body of Knowledge

IS YOUR CERTIFICATION PROGRAM PLUGGED-IN?

Specify PCI Certification – There is a Difference!

PCI Certification – is built on, and integrated with the Body of Knowledge for the Precast Concrete Structures Industry.

Certifying Precast/Prestressed Concrete Manufacturers for over 40 years.

Body of Knowledge – The Foundation of Certification

The Body of Knowledge (BOK) refers to the collective knowledge of an industry that is relied upon to design and build with a specific material or system. It is from this BOK that building codes, design guides, education programs, certification, and everything else relied upon is derived.

There are 12 essential elements that an organization must have to develop, maintain and disseminate an industry's Body of Knowledge. All of these elements are typically found in the Industry's technical institute. Effective certification programs must be an integrated and ongoing part of an Industry's BOK and therefore, be developed and managed by an industry's technical institute.

PCI is the technical institute for the precast/prestressed concrete structures industry and as such the PCI Certification program is an integrated and ongoing part of the precast concrete structures industry's body of knowledge. PCI Certification provides owners, designers and specifiers with the highest probability that precast concrete products and systems will be manufactured, and perform in accordance with specifications.

For more information visit www.pci.org/certification or contact Dean Frank, P.E., PCI director of quality programs at dfrank@pci.org or 312-583-6770.

PCI Precast/Prestressed Concrete Institute
200 West Adams Street | Suite 2100 | Chicago, IL 60606-5230
Phone: 312-786-0300 | Fax: 312-621-1114 | www.pci.org

Eleven bridges were required for the project

THE I-5 SOUTH MEDFORD Interchange

by Keith Kaufman, Knife River Corporation—Northwest
and Daniel J. McIntier, formerly with H.W. Lochner Inc.

Interstate 5 is a major transportation corridor that is parallel to the Pacific Ocean coastline and links California, Oregon, and Washington. Motorist traveling north from California cross the Siskiyou Summit in Oregon and descend into the Rogue River Valley and the cities of Ashland, Medford, and Grants Pass. Interstate 5 also parallels Bear Creek from Ashland to just north of Medford where the creek flows into the Rogue River. Medford is the southern gateway to the famous Crater Lake National Park.

The South Medford Interchange (SMI) links I-5 and East Barnett Road and is only one of two freeway interchanges in Medford. The existing interchange did not meet current design standards and was severely congested during peak traffic periods. Projections of future traffic demands showed worsening congestion with levels of service far below reasonable driver expectations.

The Oregon Department of Transportation (ODOT) elected to construct a new South Medford Interchange about 0.4 miles south of East Barnett Road. It eliminated I-5 access at East Barnett Road. Instead, Highland Drive, which runs north-south, would be extended south from East Barnett Road, curve west to I-5, and meet with the eastward extension of Garfield Street. The new interchange would then be at the Garfield Street and Highland Drive intersection with I-5. The South Medford Interchange improves the safe and efficient movement of goods, people, and services to the rapidly growing community.

Design Challenges

The Bear Creek Greenway and pedestrian-bicycle pathway are located just east of the interchange and then pass under I-5 just south of the project. The proximity of Bear Creek limited ramp access to the new interchange. Therefore, all traffic movements on and off I-5 had to be held close to I-5. ODOT selected a single-point urban interchange (SPUI) to minimize the right of way required and impacts to the existing neighborhoods, businesses, and sensitive environmental area. The SPUI improves the primary function of the interchange including safe and efficient travel, accommodating planned land use and growth, improving multimodal connectivity, and improving interchange operations. ODOT has previous experience with this type of interchange. It constructed a SPUI at the intersection of Market Street and I-5 in Salem, Ore., in the late 1990s. That SPUI was under I-5. The SMI SPUI, however, needed to be constructed above the I-5 alignment.

Another unique challenge for the designers was the need for a mechanically stabilized earth (MSE) island on the east edge of the interchange. This island incorporates four abutments: the main bridge over I-5, on and off ramps for I-5 northbound, and the Highland Drive Bridge spanning Bear Creek to the east. The island was sized and located to allow each of the four bridges to remain independent and provide a stable base to obtain maximum vertical bridge clearance with the smallest footprint. The existing bridges carrying I-5 over Bear Creek were replaced. The longest bridge over Bear Creek with a 172-ft-long span, replaced an existing bridge over Bear Creek on East Barnett Road. Other structures were required to span local creeks on the project. A total of 11

This is a view looking south where Highland Drive crosses I-5 at the South Medford Interchange. Four bridges over Bear Creek are shown south of the overpass. All photos: Wildish Construction Co.

profile

SOUTH MEDFORD INTERCHANGE BRIDGES / MEDFORD, OREGON

BRIDGE ENGINEER: H.W. Lochner Inc., Salem, Ore.

GENERAL CONTRACTOR: Wildish Construction Co., Eugene, Ore.

PRECASTER: Knife River Corporation—Northwest, Harrisburg, Ore., a PCI-certified producer

bridges were needed for the interchange and associated realignments.

To meet the 75-year service life requirement with limited maintenance, and to minimize impacts to Bear Creek, precast, prestressed concrete girders with high-performance, cast-in-place concrete decks were chosen. The elevation of Medford is about 1400 ft and the area experiences some snow accumulation. Epoxy-coated reinforcement was used in the bridge decks but uncoated reinforcement was used in the beams and substructures. This solution will require less total maintenance throughout the service life.

The Highland Drive Bridge over Bear Creek is on a horizontal curve with a 700-ft radius. Straight precast, prestressed concrete girders were placed with varying spacings to provide the framework for the cast-in-place concrete horizontally curved and superelevated deck. This is the only curved bridge in the interchange and this girder layout permitted the project to use only concrete girders.

The East Barnett Road Bridge over Bear Creek created special challenges for the design and construction of the final bridge on the project. Originally, the design concept had temporary towers in the creek. That meant the construction schedule was dependent on reduced-work windows allowing for the protection of salmon. The towers were required to splice and post-tension precast, prestressed concrete girder segments to achieve the 172-ft-long simple span. During the advance plan design phase, ODOT adopted and used 90-in.-deep bulb-tee girders on a different project. The spliced girder plan was replaced with single-span BT90 girders that eliminated the need for towers in the creek. These long-span girders reduced the overall construction time to complete the bridge.

Long-span girders reduced the overall construction time to complete the bridge.

Construction

The project was bid in March 2006 with a bid value of $59.7 million and was completed in 2010. The 4-year-long project of 11 bridges included many stages of construction, and intricate traffic staging. Detour structures were constructed using multiple spans of adjacent precast concrete voided slabs. These detour bridges allowed traffic switching while maintaining the two lanes of I-5 traffic in each direction. Nighttime erection and single-lane

Looking toward the southeast shows the roadway structures approaching from the east and the bridge over Bear Creek. That bridge, the bridge over I-5, and the structures of the on and off ramps of northbound I-5 bear on abutments embedded in the MSE island constructed between the Interstate and the creek. The girders spanning over I-5 are not evenly spaced. Two groups of girders are more closely spaced to support the large pedestals and signal posts on the SPUI.

Looking to the north, Bear Creek crosses under I-5 at the location of the construction of the four bridges. The structure for the off ramp of northbound I-5 is nearly complete on the right. Northbound I-5 has been detoured to a temporary bridge. Southbound I-5 is using the finished northbound bridge. Work is ongoing on the bridges for southbound I-5 and the southbound on ramp. A portion of the original Barnett Road interchange can be seen at the top edge of the photo.

The three-span Highland Drive Bridge over Bear Creek is on a 700-ft-radius horizontal curve. Chorded spans with splayed girder lines accommodate the curve. Two additional bridges are shown in the background: the Highland Drive Bridge over Larson Creek and the Bike Path over Larson Creek.

SINGLE-POINT URBAN INTERCHANGE AND 10 ADDITIONAL PRECAST, PRESTRESSED CONCRETE GIRDER BRIDGES
OREGON DEPARTMENT OF TRANSPORTATION, OWNER

PROJECT CONSTRUCTION COST: $59.7 Million.

PRECAST CONCRETE BRIDGE COMPONENTS: $5.25 Million

Another view of the Highland Drive Bridge over Bear Creek. The I-5 off ramp structure is at the upper right. H piles were driven through large concrete pipe sleeves embedded in the island fill for the abutments of the I-5 Bridge.

closures were required at some of the bridge locations.

The interchange covers a large area of varying soil profiles. The foundation types for the bridges include spread footings, driven piles, and large-diameter drilled shafts. Installation of the drilled shafts within Bear Creek required temporary work platforms during short windows providing for protection of fish. The window is from June to September. As a result, installations of foundations within Bear Creek were on the critical path.

Precast Concrete Bridge Components

Bridge engineers in Oregon can select from a smorgasbord of precast concrete alternatives to satisfy their design challenges. These precast products include voided slabs that are 12, 15, 18, 21, 26, and 30 in. deep; box beams 33, 39, 42, and 48 in. deep; deck bulb-tee beams with top flanges up to 8 ft wide and depths of 36, 45, and 60 in.; bulb-I beams 51, 63, and 75 in. deep; and bulb-tee beams 48, 60, 72, 84, and 90 in. deep. Many other options are available for splice-girder construction including 9-ft-deep girders and trapezoidal tub girders.

The SMI project took advantage of many of the precast sections for the 11 bridges on the project. Over 259 pieces consisting of 5.81 miles of precast concrete bridge girders were manufactured and installed on the project. This does not include more than eight spans of voided slabs used for the detour bridges. A large number of voided slab beams were purchased by the contractor to use in temporary bridges. Some were purchased from a contractor on a different project where they had been used for the same purpose. Others were purchased from the precast concrete manufacturer to augment those reused. The voided slab beams for the detour bridges have since been sold and used in other detour bridges throughout the state.

The precast concrete manufacturer was located 190 miles north of the site and was able to supply all the various girder sizes for the bridges. Some of the girders required 9000 psi compressive strength concrete. The typical ODOT standard strength for precast, prestressed concrete girders is 7500 psi. Prestressing strands were ½-in.-diameter except those in the 90-in.-deep bulb-tee girders, which were 0.6 in. diameter. All strands were ASTM A416 Grade 270, low relaxation.

The 90-in.-deep bulb-tee girder was first introduced in Oregon during the summer of 2004 and has the capability to span 184 ft. This product was incorporated into two bridges during the design period between the type, size, and location study and the advanced plans phase. The BT90 allowed wider girder spacing, eliminated girder lines, and eliminated piers in the water.

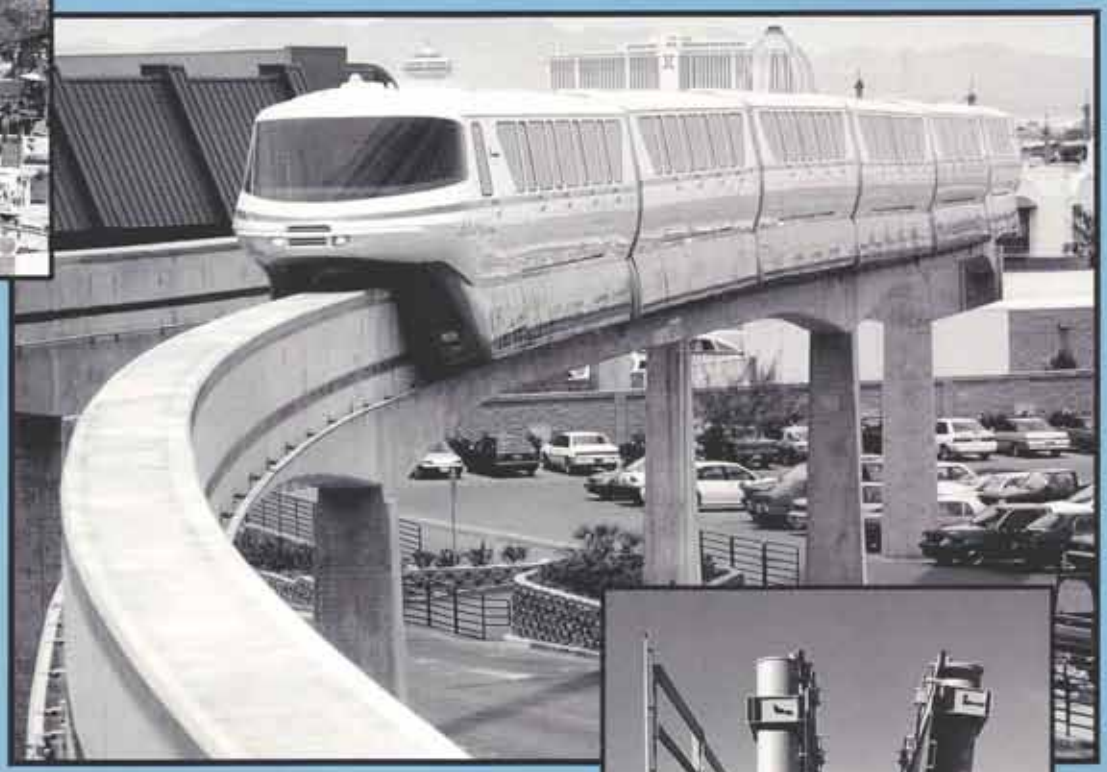
Keith Kaufman is chief engineer with the Knife River Corporation—Northwest in Harrisburg, Ore., and Daniel J. McIntier was the project engineer for H.W. Lochner Inc. in Salem, Ore.

Bridge Name	Bridge Length, ft	Bridge Width, ft	Number of Lanes	No. of Girders and Type	Girder Spacing	Span Lengths, ft
Garfield Street over I-5 (SPUI)	136	262.5	4M & 4T	(40) BT72	6′-11″	136
I-5 NB On Ramp	361	30 to 45	1M to 3T	(23) BT84	7′-10″ to 8′-4″	118, 125, 118
Highland Drive over Bear Creek	419	96.5 to 144	4M & 3T	(12) BT60 & (36) BT90	8′-8″ to 7′-9″	85, 2@167
Highland Drive over Larson Creek	102	107	4M & 3T	(14) BT60	7′-11″	102
I-5 SB On Ramp	416	38 to 31	2M to 1M	(22) BT60	6′-7″ to 6′-6″	85, 2@123, 85
I-5 NB over Bear Creek	350	54.5	2M	(33) BT48	6′-0″	59, 108, 111, 72
I-5 SB over Bear Creek	316	46.6	2M	(24) BT48	5′-11″	92, 2@112
I-5 NB Off Ramp	604	41 to 31.5	2M to 1M	(16) BT60	7′-2″ to 6′-9″	4@151
E. Barnett Road over Bear Creek	172	100	4M	(15) BT90	6′-8″	172
Highland Drive over Lazy Creek	37	80	3M	(20) 15″ Slab	4′-0″	37
Bike Path over Larson Creek	71	16	N/A	(4) 30′ Slab	4′-0″	71

M = Main Through Lanes; T = Left or Right Turn Lanes.

The longest span on the South Medford Interchange project was the 172-ft-long single span of the East Barnett Road Bridge over Bear Creek. It was one of two bridges on the project to use 90-in.-deep bulb-tee girders.

For more information on this or other projects, visit www.aspirebridge.org.

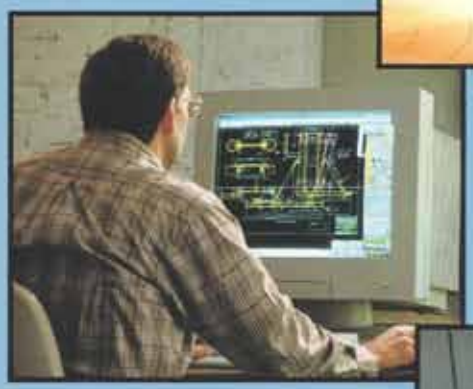


A vision of tomorrow comes to life.

When you combine the latest in design technology with 43 years of experience in manufacturing precast and prestressed concrete forms, you have a capable partner for the future.
Helser Industries,
quality since 1952.

Performance. *From straight to superelevated, Helser delivers forms that exceed customer expectations.*

Precision *forms are ensured with state-of-the-art equipment.*



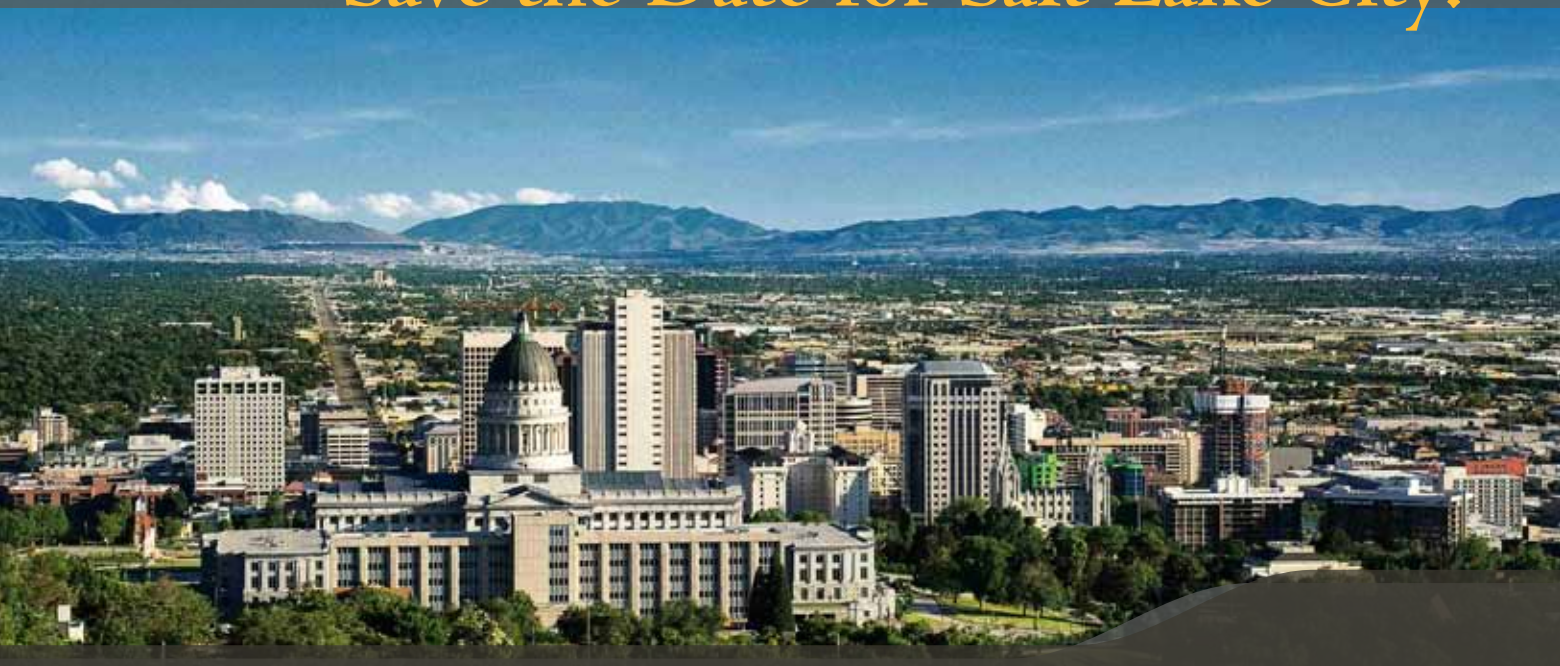
Preparation *and design stages include a detailed analysis of form operation.*

Production *processes are continually upgraded for improved efficiency.*

HELSER INDUSTRIES

10750 SW Tualatin Road
PO Box 1569 Tualatin, OR 97062
(503) 692-6909
Fax: (503) 692-1666
www.helser.com

Save the Date for Salt Lake City!



2011 PCI Annual Convention/Exhibition and National Bridge Conference

October 22–25, 2011

Salt Lake City, UT

Marriott Downtown & Salt Palace Convention Center

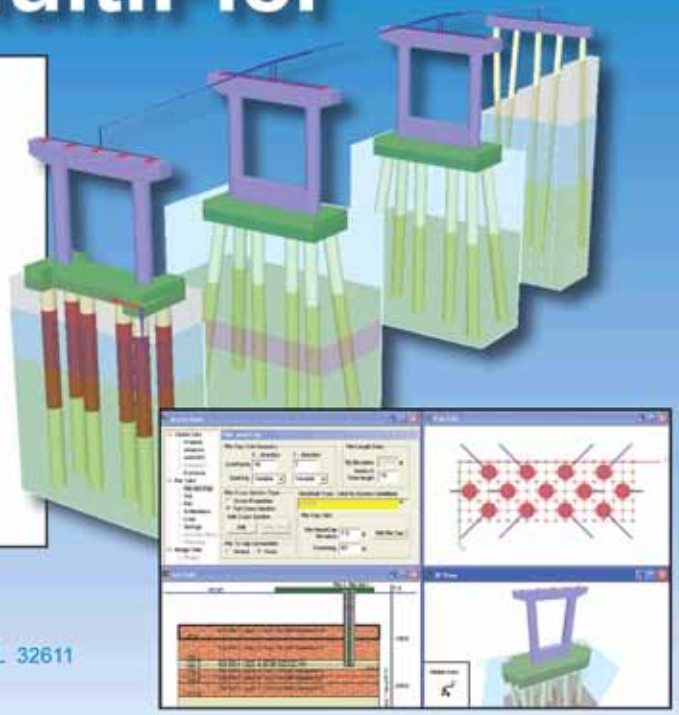
With over 50 technical committee meetings, dozens of education sessions, peer-reviewed technical papers on the latest technologies and innovations, and an expansive tradeshow, the 2011 National Bridge Conference promises to be a must attend event. Join hundreds of your colleagues and peers and get involved with the Body of Knowledge for the precast concrete structures industry! Mark your calendars and plan to join us in Salt Lake City! Call for papers opens in January 2011.

PCI Precast/Prestressed Concrete Institute
200 West Adams Street | Suite 2100 | Chicago, IL 60606-5230
Phone: 312-786-0300 | Fax: 312-621-1114 | www.pci.org

www.pci.org/convention

FB-MultiPier

- Single or Multiple Pier Model
- Static, Dynamic, and Pushover Analysis
- Linear and Nonlinear Analysis (structure and soil)
- Rapid Model and Load Generation Tools:
  - Automated multiple pier generation for bridge model
  - AASHTO load combination generator
- Graphical Force Display (axial, shear and moment)
- Calculation of Equivalent Foundation Stiffness
- Nonlinear Soil Degradation Model
- Modeling of Nonlinear Soil-Structure Interaction
- Bi-Axial Moment Interaction Diagrams
- Cantilever Retaining Wall



BSI
Bridge Software Institute

Bridge Software Institute
http://bsi-web.ce.ufl.edu
365 Weil Hall, Gainesville FL 32611
Support: bsi@ce.ufl.edu

QuikDeck™ Suspended Access System

The Access Advantage for concrete bridges, buildings and other structures

To be successful in today's competitive market, you need an advantage. The versatile **QuikDeck™ Suspended Access System**'s modular platform design can be assembled from just a few basic components and made to fit almost any shape or size.

- Designed for easy installation
- Specially-engineered modular platform to reduce labor costs
- Can be "leapfrogged" to reduce equipment cost
- Professional engineering support and crew training on installation and removal to ensure safety
- Safe to the environment

Bridge Division
Toll-Free: (800) 582-9391
Fax: (518) 381-4613

Out with the new. In with the old.

We're Safway Services. Again.
And even through the name changes,
our standards never swayed.

Find out more at **www.safway.com/aspire**.

SAFWAY.
Scaffolding & Access Solutions

Formerly ThyssenKrupp Safway, Inc.
©2010 Safway Services, LLC

The Highways for LIFE Pilot Program

Identifying and supporting innovative methods and technology


by Kathleen Bergeron and Myint Lwin,
Federal Highway Administration

Congress established the "Highways for LIFE Pilot Program" under the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) in 2005. The purpose of the pilot program is to advance longer-lasting highways using innovative technologies and practices to accomplish the fast construction of efficient and safe highways and bridges.

Objectives

The U.S. Secretary of Transportation (Secretary) is charged with the responsibility to provide leadership and incentives to demonstrate and promote state-of-the-art technologies, elevated performance standards, and new business practices in the highway construction process that result in improved safety, faster construction, reduced congestion from construction, and improved quality and user satisfaction. The program has the following three key elements:

Technology Transfer

Highways for LIFE has developed a more effective way to encourage adoption of high-payoff innovations. Teams of technical and marketing experts identify critical needs and obstacles, develop marketing plans, and create implementation tactics and communication tools to support those plans. The teams make presentations at technical meetings and host workshops, peer exchanges, and demonstration projects for potential users. They partner with organizations throughout the highway community to champion the technologies.

Technology Partnerships

The Technology Partnerships program within Highways for LIFE helps private sector innovations make the leap from promising late-stage prototypes to market-ready products. By providing funds to refine and test the best ideas developed by industry under real-world conditions, the program fills a critical gap in development of innovations. The Federal Highway Administration (FHWA) awarded seven grants totaling $2.3 million in 2008 and 2009. Two concrete-related awards involved fully precast concrete bridge bents for use in seismic regions and full-depth ultra-high-performance concrete waffle bridge deck panels. FHWA expects to announce additional grant awards in 2010.

Highways for LIFE–Funded Projects

Highways for LIFE offers incentive funding for states to try innovative approaches. Between 2005 and October 2009, the program awarded approximately $25 million to 25 projects in 21 states, highlighting more than two dozen innovations, such as wider use of accelerated bridge construction techniques and innovative, performance-based contracting.

To be eligible to participate in this element of the program, a state is to submit an application that contains a description of a proposed project to be carried by the state under the pilot program.

A proposed project must meet the following requirements to be eligible:

1. The project must be eligible for federal highway construction funding under Title 23.
2. The owner agency must commit to achievement of all applicable Highways

A full-depth precast concrete deck panel is installed on the 24th Street bridge over I-29/I-80 in Council Bluffs, Iowa, the first Highways for LIFE project in that state. All Photos: Iowa Department of Transportation.

for LIFE performance standards, including at least one standard for each of the three goal areas (safety, construction-related congestion, and quality).

3. The owner agency must commit to facilitate and support collection of the data required for full and complete evaluation of the project prior to, during, and after construction.
4. The owner agency must be willing to support technology transfer activities to promote innovative practices used on the project and participate in related showcases, workshops, training, etc.
5. The project is or will be ready for construction within 1 year of approval of the project proposal. For the purposes of the Highways for LIFE program, the FHWA considers a project to be "ready for construction" when the FHWA Division Office authorizes the construction project.

A project proposal must contain the following information:

1. An identification and description of the project to be delivered
2. A description of how the projects will result in improved safety, faster construction, reduced congestion due to construction, user satisfaction, and improved quality
3. A description of the innovative technologies, manufacturing, processes, financing, and contracting methods that will be used for the proposed projects
4. Identification of how implementation of the proposed feature will improve the quality as experienced by the driver, both during and after construction
5. A commitment to determine (a) How satisfied the user is with the new facility, compared with its previous condition, and (b) How satisfied the user is with the approach used to construct the new facility in terms of minimizing disruption.

Closing Remarks

The Highways for LIFE Pilot Program provides opportunity for stakeholder input and involvement in the development, implementation, and evaluation of the program. The program encourages working together in learning and sharing information on technology used, developed, or deployed under this program. The information will be made available to the transportation community and the public.

The article in the next issue of *ASPIRE*™ will discuss the successful deployment of innovative technologies through the Highways for LIFE funded projects.

Work on the 24th Street bridge included nighttime installation of precast concrete panels over the traveled lanes in order to minimize traffic interruption.

On the 24th Street bridge, the full-depth precast concrete panels were fabricated in a manufacturing plant using self-consolidating concrete.

Precast concrete panels on the 24th Street bridge were 8 in. thick, 10 ft long, and 52 ft 4 in. wide. Two panels framed the width of the bridge using a center longitudinal joint. Here panels are shown in the precaster's plant following supplemental steam curing. There were a total of 70 panels on the bridge.

A Highways for LIFE project is the Little Cedar Creek Bridge in Wapello County, Iowa. A two-way ribbed deck panel of ultra-high-performance concrete (UHPC) will be grouted to the girders with UHPC. The panel is 8-in. deep with a top flange 2 ½-in. thick. It weighs one-third as much as a typical deck panel. The panels attained a concrete compressive strength of 29,000 psi. They were on display at a FHWA showcase at the Coreslab Structures Inc. plant in Omaha, Neb.

ACCELERATED BRIDGE CONSTRUCTION:

Tradition meets innovation at the Utah Department of Transportation

by Catherine Higgins, Utah Department of Transportation

The Utah Department of Transportation (UDOT) has experienced great success with Accelerated Bridge Construction (ABC) methods in the past 4 years. ABC, which applies traditional design principles in an innovative way, promises a faster approach to building concrete bridges. UDOT's intent is to reduce project duration and save time and money for road users and other stakeholders such as utility companies and railroads.

The transportation community in the United States is familiar with UDOT's recent bridge moving projects–19 bridges have been built off site then moved into place using various new technologies. However, projects using other ABC methods have not received as much national attention.

UDOT's less familiar projects have served as the impetus to develop new standards and specifications for structural elements. "This is new technology," says Fred Doehring, deputy structures engineer at UDOT. "We're doing a lot of research and development not only for Utah but for the rest of the country right now."

UDOT seeks to design and build quickly as soon as project funding is secured. And because concrete is made of readily available materials, components are quick to produce. A bridge deck on I-70 and three bridges on U.S. 6 provide good case studies about how UDOT has partnered with the private sector to pioneer ABC methods that deliver high-quality concrete bridges much faster than traditional means.

I-70 Bridge over Eagle Canyon

A concrete bridge deck replacement project in a remote Utah location proved to be an ideal application for an ABC approach.

The Eagle Canyon Arch Bridge, originally built in 1966, is located on I-70 at Mile Post 118 between Salina and Green River in southern Utah, over 200 miles from Salt Lake City. The bridge crosses a 480-ft-wide canyon and is 289 ft high.

The bridge deck replacement was designed by Horrocks Engineers of Pleasant Grove, Utah, and constructed by Granite Construction Company of Salt Lake City. UDOT used a construction manager/general contractor (CMGC) contracting approach that brings design engineers and construction contractors on board throughout the process.

According to Larry Reash with Horrocks Engineers, the CMGC process intent is to "form a partnership between UDOT, the owner, the designer working for UDOT, and the contractor. This partnership is developed during the design phase to minimize risk, develop a project schedule, identify potential innovations, and develop a project cost model."

During design, the Granite and Horrocks team worked together to analyze construction loading on the bridge. The investigation showed that removing the entire deck at once would potentially lead to instability of the arches so the deck panels would need to be removed and replaced section by section.

The remote location and proximity to sensitive cultural and scenic resources made

During redecking of this arch bridge over Eagle Canyon, sections of the old deck were removed and replaced with groups of five new full-width precast concrete panels until reaching midspan. The work then moved to the opposite end. Photo: Granite Construction Company.

Deck panels being installed on the I-70 Bridge over Eagle Canyon. Photo: Granite Construction Company.

The Emma Park Bridge on U.S. 6 features precast, prestressed concrete girders and full-depth precast concrete deck panels. Photo: Utah Department of Transportation.

Shown during fabrication, deck panels are pretensioned in the plant. GFRP reinforcement is used in both top and bottom mats. Photo: Utah Department of Transportation.

This end panel with integral barrier will connect with the cast-in-place concrete end closure diaphragm. The panels are also connected together with a cast-in-place longitudinal closure strip along the center of the bridge. Photo: Utah Department of Transportation.

the prospect of trucking-in and operating a concrete batch-plant expensive and impractical. In addition, casting the deck in-place was ruled out as an option because curing times of 14 to 28 days would have extended the duration of the project past UDOT's comfort level and road users expectations. Deck panels would need to be precast and trucked to the bridge.

During construction, a newer bridge close by served as an alternate route and allowed crews to work away from live traffic. A 600-ton crane, with one million pounds of counter-weight and a 324-ft-long boom, was used to remove sections of deck and erect new panels. In order to reduce crane loads as well as dead loads, lightweight concrete was used for the new full width deck panels. The panels were 34 ft wide and 13 to 14 ft long. The contractor installed, longitudinally post-tensioned, and grouted five panel sections at one time. This removal and installation process proceeded to the middle of the bridge before switching sides.

The ABC approach was amazing even to a "field guy," said Steven Archuleta, project supervisor for Granite Construction Company. "We removed a bridge deck, built a precast deck in Salt Lake City, and assembled it on site," says Archuleta. Using precast concrete deck panels meant that curing happened at the precasting plant, not on I-70 where the traveling public would have been bothered by a lengthy project.

Emma Park Bridge

Emma Park Bridge, located on U.S. 6 between Spanish Fork and Price in central Utah, is in an area "notorious for wildlife hits," says UDOT structural designer Rebecca Nix. "The new bridge is an effort to reduce those accidents." Over several years, there have been multiple projects in the area to improve safety by widening the road or adding crossings, including the Emma Park Bridge.

Before construction, the area consisted of a piped creek under the roadway. During construction the area was excavated to provide a wildlife crossing in conjunction with the creek crossing. The bridge itself consists of 24 precast concrete deck panels on precast, prestressed concrete girders with cast-in-place concrete abutments. The deck panels were transversely pretensioned and longitudinally post-tensioned.

An important innovative feature of the bridge is the use of glass fiber reinforced polymer (GFRP) bars for the top and bottom reinforcing mats of the precast concrete deck panels. By using GFRP, UDOT engineers hope to extend the service life of the bridge deck beyond 50 years. "The number one cause of degradation of bridges is rusting steel inside concrete," says Doehring. Bridges are designed to last 75 years or longer while decks only last 40 to 45 years.

Building bridges using GFRP is relatively new technology, and more information is needed about how the material functions in bridge decks. UDOT is partnering with the University of Utah, Department of Engineering, to monitor the panels for 2 years in order to evaluate the suitability of GFRP for future use.

Sensors to measure strains, temperatures, and deflections were installed during the precasting process. Monitoring of the sensors began at the precasting plant and continued during transport to the construction site and through the post-tensioning operations. The sensors will continue to be monitored for more than 5 years.

In addition, an on-site camera takes a photo when sensors indicate the deck experiences stresses reaching predefined trigger values. The photos are sent by cell phone connection to the University of Utah researchers and are shared with UDOT.

The work UDOT and the University of Utah are doing will make a significant contribution to future use of GFRP. Nix is helping to evaluate the new information, and believes that by using GFRP data collected in a real-world setting, UDOT will eventually know how to "design based on what's actually happening."

Tucker Bridge

UDOT has built several fully precast "Lego" bridges, including the Tucker Bridge located on U.S. 6 at Mile Post 204 in Spanish Fork Canyon. Precast concrete elements of the Tucker Bridge included girders, abutments, back walls, wing walls, deck panels with parapets attached, approach slabs, and sleeper slabs. Steel elements included intermediate diaphragms.

Accelerated construction allows little time to resolve fit-up issues during construction. Accounting for fabrication and construction tolerances in the design of the connections between precast elements is critical. The Tucker Bridge, with a 120-ft-long span and a 25 degree skew, is "a simple bridge" by design, says Ray Cook, structural designer for UDOT, because precast elements were designed to simplify the fabrication and construction as much as possible.

Though the bridge is on a curved alignment, the deck edges were designed to be straight

The Tucker Bridge on U.S. 6 is shown nearing completion. It is almost totally precast concrete. Formliner finishes were provided on the abutments, wing walls, and parapets. Photo: Utah Department of Transportation.

and parallel to simplify the fabrication and construction of the precast deck and approach slab elements and to minimize the number of unique precast panels. The uniform pieces also saved time and money during fabrication.

The Tucker Bridge is UDOT's second totally precast concrete bridge supported on drilled shafts. Drilled shafts were required to support the wing walls as well as abutments because of the wing wall length. Each abutment consists of four precast concrete segments, which were placed over the reinforcing steel cages extending from the drilled shafts. The first abutment was placed in less than a day and the second abutment placed in less than 4 hours. All cast-in-place concrete closures were made with high early strength concrete.

Fit-up of some precast concrete elements was an issue and lessons learned will be valuable in the future. Overall, it's important to "design construction tolerance into all connections," says Cook. For example, placing the approach slab and sleeper slabs was tricky. UDOT and the contractor resolved constructability issues by placing and leveling the approach slab panels on the sleeper slabs, then grouting between pieces to provide uniform bearing. This process is now part of the standard detail and works well to place the approach slab panels properly.

Mile Post 200 Bridge

The Mile Post 200 Bridge on U.S. 6 in Spanish Fork Canyon was designed by UDOT and emulated traditional design with prefabricated elements for a mostly precast concrete structure.

Mountainous geography and a geometrically complex Union Pacific Railroad (UPRR) crossing made the bridge a challenge to design. The old structure, a three-span steel girder bridge, needed to be replaced on a new alignment. UDOT's new bridge, which resembles a giant box culvert is "definitely different," says in-house structures design engineer Michael Romero. "There are not a lot of structures like this around." Romero liked the complexity of the project which involved "doing things that haven't been done before."

U.S. 6 and the UPRR cross at a sharp 60-degree skew. Transition spirals are used at each approach. Additionally, the roadway superelevation reverses in the middle of the bridge.

Taking all potentially conflicting conditions into account, Romero designed an extra wide, single span bridge with the U.S. 6 traffic alignment running skewed across the deck. The abutments are parallel with the railroad and the girders span on a small skew. Precast deck panels were placed longitudinally on the girders.

The Tucker Bridge also utilizes full-depth precast concrete deck panels with attached parapets. The panels are connected with both transverse and longitudinal closure strips. Photo: Utah Department of Transportation.

The Mile Post 200 Bridge provides a new alignment of U.S. 6 over UPRR tracks. Type VI AASHTO girders bear on an abutment framed with precast concrete blocks stacked 33 ft high. The blocks are keyed and post-tensioned to the footing. Photo: Utah Department of Transportation.

The old Mile Post 200 Bridge is seen in the background. The new alignment will have U.S. 6 traverse a reverse curve diagonally across the new bridge in the foreground. The new concrete girders span nearly up and down in the photo. Granular fill is being placed on the structure to create the reverse superelevation of the new alignment. The roadway will be paved with asphalt. Photo: Utah Department of Transportation.

Granular fill was placed on the structure to achieve the changes in superelevation. Asphalt is used for the riding surface.

Because the structure is large, with a 107-ft-long span and a 303-ft width, more than 480 precast concrete pieces were required. The 33-ft-tall abutments were built with stacked, keyed blocks that were also keyed into the footing. The abutment blocks are held together with post-tensioning rods threaded through corrugated ducts filled with high-strength grout. The project used 35 AASHTO Type VI precast, prestressed concrete girders. Precast concrete deck panels with cast-in-place longitudinal and transverse closures were used.

A combination of deep foundations and spread footings were used to support the structure using traditional cast-in-place concrete construction methods.

Benefits of ABC

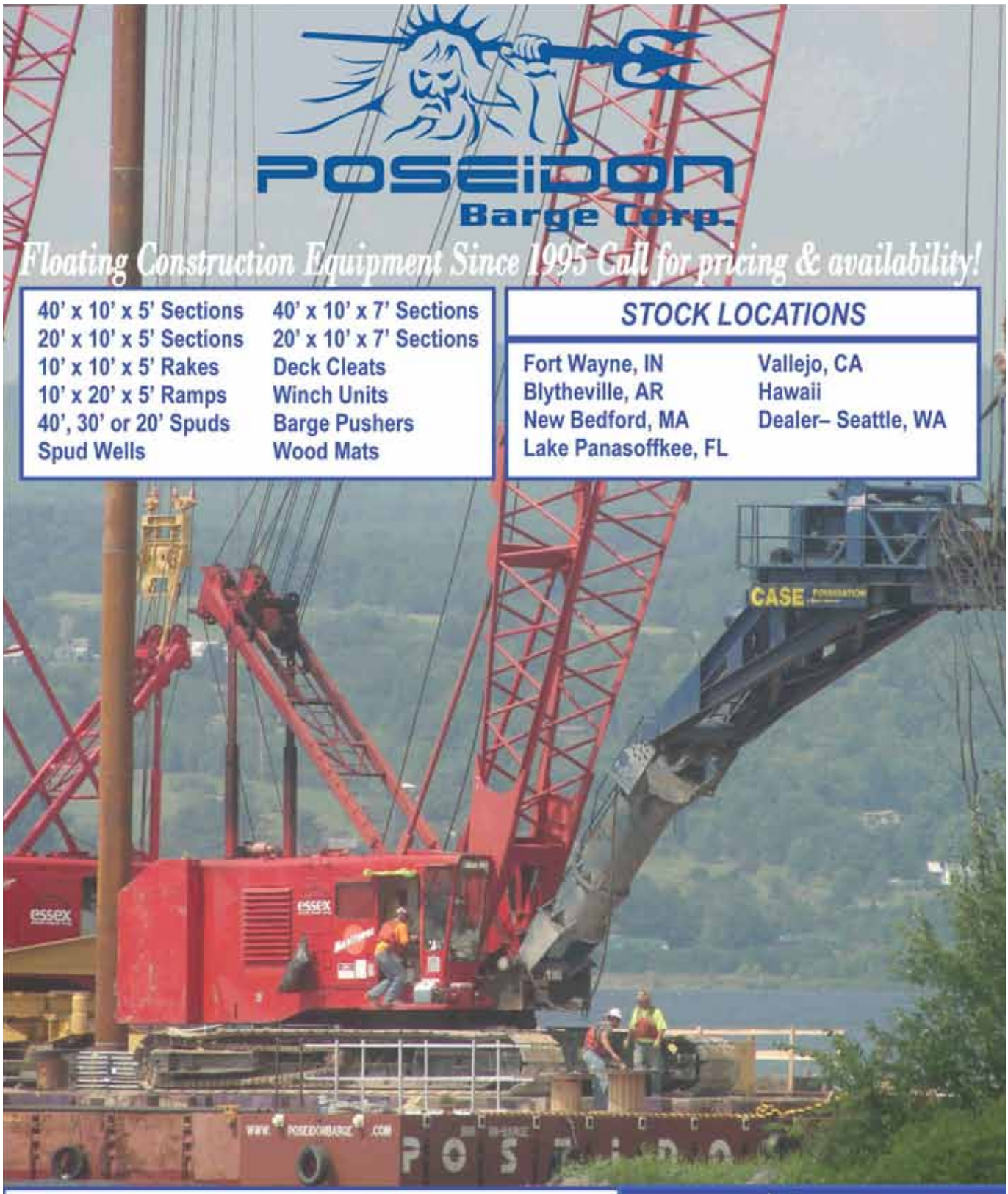
Through using ABC methods, UDOT and road users have benefitted from reduced project duration resulting in:

- Saved user costs—Reducing the duration of construction also reduces the duration of traffic delays, which has a real measurable cost to road users because of increased time spent in traffic.
- Improved safety—Fewer accidents related to construction occur because project duration is reduced and construction is limited to off-peak travel times. Road users and construction crews have less exposure to risk.
- High quality—Construction of substructures or superstructures in a controlled environment off site gives workers "time to build these elements correctly," says Doehring. Better workmanship can happen when construction takes place out of the pressure of working in live traffic.

Catherine Higgins is special projects manager in the communications office at the Utah Department of Transportation in Salt Lake City, Utah.

For more information on Utah's bridges, visit www.dot.state.utah.gov.

The Mile Post 200 Bridge is 303 ft wide, allowing U.S. 6 to traverse the bridge and the railroad tracks below on a sharp skew. Full-depth precast concrete deck panels were placed in a longitudinal configuration on the girders. Photo: Utah Department of Transportation.



POSEIDON BARGE CORPORATION

3101 New Haven Ave, Fort Wayne, IN 46803
PH: 260-422-8767 or 866-992-2743
WEB: www.poseidonbarge.com
Email: info@poseidonbarge.com

POSEIDON
Barge Corp.

For Custom, World-Class Lifting Solutions, CHOOSE THE RIGHT PARTNER.

In the bridge industry, you need more than a lifting-equipment vendor. You need a partner that provides customer-inspired precast lifting solutions. Shuttlelift works closely with you to design a durable, reliable machine that meets your critical engineering requirements and is perfectly suited to your current projects — while offering maximum flexibility for those yet to come. Partner with Shuttlelift, and discover world-class lifting solutions as unique as you are.

SL 15 25 35 50 75 100 150 200 250 300 400 500 600 700 800 1000 Tons and greater.

300 TON

SL 300 – Minnesota, Minneapolis

SHUTTLELIFT®

www.shuttlelift.com • USA Tel: +1 920.743.8650

The MINNESOTA Local Bridge Scanning Tour

by Dave Conkel, Minnesota Department of Transportation

Minnesota has 14,368 bridges on the local highway system. Approximately 13% are classified as structurally deficient or functionally obsolete with an age of 60 years or older. Over the past decade, Minnesota has been replacing its aging local bridge system at a rate of approximately 215 bridge structures annually.

The structure types commonly used for replacement in Minnesota are 25% precast concrete culverts, 33% cast-in-place concrete slab spans, 35% precast, prestressed concrete I-beams, 3% steel beams, 2% timber, and 2% precast concrete arch bridges. Recognizing an opportunity to possibly expand the local bridge inventory with long lasting, economical, and rapidly built bridges, a Minnesota Local Bridge Scanning Tour (LBST) team was formed.

The LBST team was initiated in 2006 by the Minnesota Department of Transportation (Mn/DOT) office of State Aid for Local Transportation and the Minnesota Division Office of the Federal Highway Administration (FHWA). The primary purpose of the LBST team was to visit other states across the nation that owned or contained local bridge types proven to be safe, durable, economical, and that can be rapidly constructed. The team consisted of several local bridge consultants, county engineers, and FHWA and state DOT representatives.

Early in the development of this initiative, it was realized that consultation with industry experts would help the team locate specific areas of the nation to assure a successful scanning tour. The team met with the Precast/Prestressed Concrete Institute, U.S. Forest Service, and conversed with the National Steel Bridge Alliance. After extensive consideration and input from our nation's experts, the team selected the states of New York and Washington to begin the bridge tours.

These states were selected primarily due to their extensive use of precast concrete bridge systems, similar weather and environment to Minnesota, and a good representation of urban and rural roadways. The tour of New York in October 2006 emphasized the west region of the state and included Erie, Cattaraugus, Allegany, and Steuben counties. The team became very interested in their adjacent precast, prestressed concrete box beam system for local bridges.

In Washington State in 2007, the team's focus area was the east and northwestern regions of the state including Spokane, Adams, Whatcom, and Tacoma counties. The team was impressed with their advanced and predominate use of precast, prestressed concrete technology. Notable local bridge types that stimulated the team's interest were the adjacent precast, prestressed concrete bulb-tee beam bridges, and the precast, prestressed concrete spliced bulb-tee girder bridges. The team also scanned timber and steel bridges during these tours.

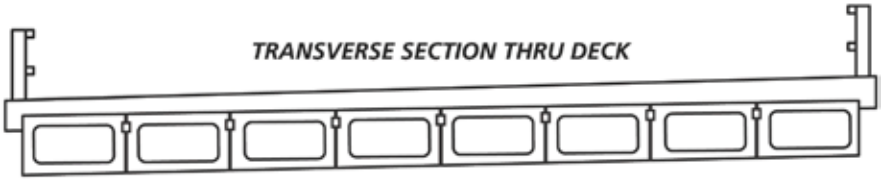
At the conclusion of the New York and Washington visits, the LBST team decided to pursue and implement the adjacent precast, prestressed concrete box beam system as a new Minnesota local bridge type.

In 2008, Blue Earth County, Minn., and the county's local bridge consultant, with support from the FHWA and Mn/DOT, began developing a local bridge project to demonstrate the New York-style adjacent box beam superstructure, metal traffic railing, and steel sheet pile abutments. The bridge superstructure called for adjacent 2-ft 3-in.-deep by 4-ft 0-in.-wide precast, prestressed concrete box beams to achieve a 32-ft 0-in.-wide roadway with a span of approximately 70 ft. The bridge superstructure also incorporated a 6-in.-thick composite cast-in-place concrete slab overlay.

To keep up the momentum and the success of the scanning tours, in 2009, several members of the LBST team took a day trip to Monroe County, Wis., where they visited several bridges that used adjacent precast, prestressed concrete box beams with noncomposite, cast-in-place concrete slabs and bituminous overlays, and side-mounted metal traffic railings. Once again,

The erection of an adjacent precast, prestressed concrete box beam bridge on steel sheet pile abutments. This is a demonstration bridge in Blue Earth County, Minn.

An adjacent precast, prestressed concrete box beam bridge with top-mounted metal traffic railing located in Erie County, N.Y.



The proposed cross section of a demonstration bridge incorporating New York features to be located in Blue Earth County, Minn.

Blue Earth County, Minn., took the lead in developing another set of adjacent concrete box beam bridges that incorporated features from Wisconsin in an effort to further reduce time of construction and lower overall construction costs.

The team continues their dialogue and strong interest in implementing other proven bridge systems and details. These include the adjacent bulb-tee beam bridges as seen in Washington. The team is currently developing plans to visit Iowa and possibly other Midwestern states.

In the end, it will be the many long lasting business relationships developed during these scanning tours that will continue to help us share, learn, and promote proven and viable bridge technologies from across the country.

Dave Conkel is state aid bridge engineer in the Office of State Aid for Local Transportation at the Minnesota Department of Transportation in Oakdale, Minn.

The LBST team visiting an adjacent precast, prestressed concrete bulb-tee beam bridge in Adams County, Wash.

An adjacent precast, prestressed concrete box beam bridge with side-mounted metal traffic rails in Monroe County, Wis.

EDITOR'S NOTE

PDFs of three presentations may be viewed and downloaded from the ASPIRE™ *website, www.aspirebridge.org. They can be found there in the issue's Table of Contents or by clicking on "Resources" and selecting "Referenced Papers." These are presentations of the details and results of the 2006 New York State Tour and the 2007 Washington State tour. The presentations include many interesting photographs.*

The LBST team inspecting precast, prestressed concrete, post-tensioned, spliced bulb-tee girder fabrication at the Central Pre-Mix Prestress Co. plant in Spokane, Wash.

Minnesota Local Bridge Scanning Tour team in Washington State. The photo includes representatives from Adams County, Wash.; Polk County, Minn.; Cattaraugus County, N.Y; the Washington Department of Transportation; the New York and Minnesota offices of the FHWA; and Washington and Minnesota bridge design consultants.

Participants in the Local Bridge Scanning Tours, 2006-2009

Organized by the Minnesota Department of Transportation office of State Aid for Local Transportation and the Minnesota Division Office of the Federal Highway Administration

COUNTY ENGINEERS:
- Alan Forsberg, Blue Earth County, Minn.
- Rich Sanders, Polk County, Minn.
- Gary Bruggeman, Steele County, Minn.
- Bill Fox, Cattaraugus County, N.Y.
- Mark Burr, Cattaraugus County, N.Y.
- Carl Dimmig, Erie County, N.Y.
- Kevin Obrien, Niagara County, N.Y.
- Steve Catherman, Stueben County, N.Y.
- Guy James, Allegany County, N.Y.
- Clint Biggar, Adams County, Wash.
- Public Works, Whatcom County, Wash.

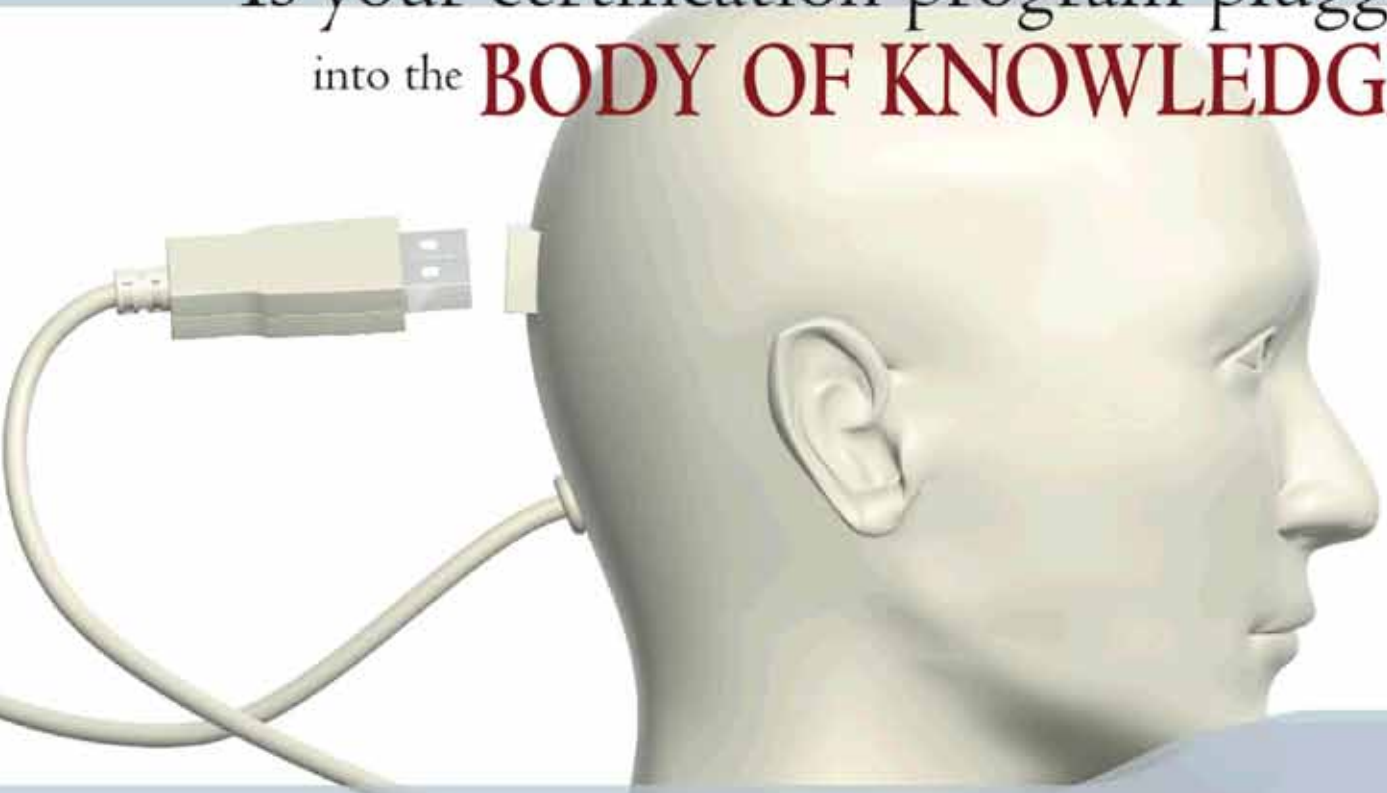
PRECAST CONCRETE MANUFACTURERS:
- Cameron West, Concrete Technology Corporation, Tacoma, Wash.
- Chuck Prussack, Central Pre-Mix Prestress Co., Spokane, Wash.
- Dan Whitford and Bob Skulds, LC Whitford, Wellsville, N.Y.
- Mike J. Kistner, Kistner Concrete Products Inc., Lockport, N.Y.

CONSULTANTS:
- Kent Rohr & Jeff Rensch, WSN Consulting Engineers, Alexandria, Minn.
- Larry Erickson, SRF Consulting Group Inc., Minneapolis, Minn.
- Ron Benson, Erickson Engineering, Minneapolis, Minn.
- Ken Johnson, Wheeler Lumber LCC, Minneapolis, Minn.
- Jerry Nicholls, Nicholls Engineering Inc., Spokane Valley, Wash.

INDUSTRY:
- John Dick, Precast/Prestressed Concrete Institute, Chicago, Ill.
- Jim Wacker, Forest Products Laboratory, Madison, Wis.
- Calvin Schrage, National Steel Bridge Alliance, Lincoln, Neb.

FEDERAL & STATE AGENCIES:
- Romeo Garcia, Minnesota Division Office, FHWA, St. Paul, Minn.
- Earl Dubin, New York Division Office, FHWA, Albany, N.Y.
- Patti Loken, Mn/DOT, Oakdale, Minn.
- Dave Conkel, Mn/DOT, Oakdale, Minn.
- Kevin Marracino, NYSDOT Region 5, Buffalo, N.Y.
- Ron Mauro, NYSDOT Region 6, Hornell, N.Y.
- Grant Griffin, WSDOT, Olympia, Wash.

Is your certification program plugged into the BODY OF KNOWLEDGE?



Certification is more than inspections, paperwork and checklist!

It must be an integrated and ongoing part of the Industry's

Body of Knowledge!

PCI is the Technical Institute for the precast concrete structures industry and as such, PCI Certification is an integrated and ongoing part of precast concrete structures industry's body of knowledge. Specify PCI Certification and be plugged into success!

PCI Precast/Prestressed Concrete Institute
200 West Adams Street | Suite 2100 | Chicago, IL 60606-5230
Phone: 312-786-0300 | Fax: 312-621-1114 | www.pci.org

To learn more visit www/pci.org/certification or contact Dean Frank, P.E. PCI director of quality programs at dfrank@pci.org or 312-333-3333.

Concrete Connections is an annotated list of websites where information is available about concrete bridges. Fast links to the websites are provided at www.aspirebridge.org.

IN THIS ISSUE

www.carmellink.org
This website contains information about the Keystone Avenue reconstruction project described on page 24 The site contains a drive-through simulation, written instructions on how to navigate the new roundabouts, and an instructional video for both drivers and pedestrians.

www.fhwa.dot.gov/hfl
Visit this website for more information about the Highways for LIFE program described on page 42. Separate sites address Innovations, Communications, Technology Partnerships, Demonstration Projects, and Technology Transfer.

www.udot.utah.gov/main/f?p=100:pg:0:::T,V:1991
This Utah Department of Transportation website contains more information about Utah's Accelerated Bridge Construction (ABC) program described on page 44.

Environmental

http://environment.transportation.org/
The Center for Environmental Excellence by AASHTO's Technical Assistance Program offers a team of experts to assist transportation and environmental agency officials in improving environmental performance and program delivery. *The Practitioner's Handbooks* provide practical advice on a range of environmental issues that arise during the planning, development, and operation of transportation projects.

www.environment.transportation.org/teri_database
This website contains the Transportation and Environmental Research Ideas (TERI) database. TERI is the AASHTO Standing Committee on Environment's central storehouse for tracking and sharing new transportation and environmental research ideas. Suggestions for new ideas are welcome from practitioners across the transportation and environmental community.

Bridge Technology

www.aspirebridge.org
Previous issues of *ASPIRE*™ are available as pdf files and may be downloaded as a full issue or individual articles. Information is available about subscriptions, advertising, and sponsors. You may also complete a reader survey to provide us with your impressions about *ASPIRE*. It takes less than 5 minutes to complete.

www.nationalconcretebridge.org
The National Concrete Bridge Council (NCBC) website provides information to promote quality in concrete bridge construction as well as links to the publications of its members.

www.hpcbridgeviews.org
This website contains 62 issues of *HPC Bridge Views*, an electronic newsletter published jointly by the FHWA and the NCBC to provide relevant, reliable information on all aspects of high-performance concrete in bridges. Sign up at this website for a free subscription.

NEW http://international.fhwa.dot.gov/pubs/pl10014/pl10014.pdf
The U.S. Federal Highway Administration's Office of International Programs has released a report titled *Assuring Bridge Safety and Serviceability in Europe*. The report describes a scanning study of Europe that focused on identifying best practices and processes designed to help assure bridge safety and serviceability. The scan team gathered information on safety and serviceability practices and technologies related to design, construction, and operations of bridges. A summary of the study was provided in *ASPIRE* Winter 2010, page 50.

http://onlinepubs.trb.org/onlinepubs/archive/NotesDocs/20-07(229)_FR.pdf
An NCHRP report titled *Bridge Construction Practices Using Incremental Launching* is available at this web address. The report includes a review of current practice, a manual of best practice, and a strategic plan for increasing use of the incremental launching method.

www.tsp2.org/bridge
This website was developed to provide highway agencies and bridge preservation practitioners with on-line resources about bridge preservation, maintenance, and inspection.

Bridge Research

www.trb.org/CRP/NCHRP/NCHRPprojects.asp
This website provides a list of all National Cooperative Highway Research Program (NCHRP) projects since 1989 and their current status. Research Field 12—Bridges generally lists projects related to bridges although projects related to concrete materials performance may be listed in Research Field 18—Concrete Materials.

NEW www.utexas.edu/research/ctr/pdf_reports/0_5706_1.pdf
The Center for Transportation Research of the University of Texas at Austin has released a research report titled "Impact of Overhang Construction on Girder Design." The research included field monitoring, laboratory testing, and parametric analyses. The report includes recommendations for prestressed concrete girder systems.

NEW http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_654.pdf
NCHRP Report 654, *Evaluation and Repair Procedures for Precast/Prestressed Concrete Girders with Longitudinal Cracking in the Web*, explores the acceptance, repair, or rejection of precast/prestressed concrete girders with longitudinal web cracking. The report also includes suggested revisions to the AASHTO LRFD Bridge Design Specifications and improved crack control reinforcement details to use in new girders.

NEW http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_651.pdf
NCHRP Report 651, *LRFD Design and Construction of Shallow Foundations for Highway Bridge Structures* contains recommended changes to Section 10 of the AASHTO LRFD Bridge Design Specifications for the strength limit state design of shallow foundations.

http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_645.pdf
NCHRP Report 645, *Blast-Resistant Highway Bridges: Design and Detailing Guidelines* explores code-ready language containing general design guidance and a simplified design procedure for blast-resistant reinforced concrete bridge columns. The results of experimental blast tests and analytical research on reinforced concrete bridge columns are reported.

BUYERS GUIDE

The companies listed on these pages have supported *ASPIRE*™ magazine during 2010. Each produces a high-quality product or service targeted to the bridge industry and is worthy of your consideration. In choosing *ASPIRE* as the way to communicate with you, they show enormous confidence in us.

These companies shared in the significant success achieved by *ASPIRE*. Advertisers put their money where their mouths are, and they can rightfully be proud of *ASPIRE*'s success and our ambitious plans for 2011. They enable us to move ahead with confidence to better serve our readers.

Just as important, the advertisers create valuable messages for our readers. Their announcements and product information supplement our own presentations to keep readers current with new ideas.

Whenever an opportunity arises, please contact an *ASPIRE* advertiser, ask them for more information, and thank them for their investment in the bridge community. For an easy way to make a contact, go to **www.aspirebridge.org** and select "Advertisers." Clicking on any listing will take you to their home page.

We appreciate their support, and yours, for making *ASPIRE* the most read and talked about bridge magazine!

	Description	Address/Phone
Bentley LEAP SOFTWARE www.bentley.com/BrIM	**Bentley** offers comprehensive bridge software solutions for design, analysis, and construction engineering: LEAP Bridge and RM Bridge.	685 Stockton Dr. Exton, PA 19341 800.BENTLEY
www.bridgescape.net	**Bridgescape, LLC.** Principal, Frederick Gottemoeller, is considered America's most distinguished bridge architect. His award-winning Woodrow Wilson Bridge in DC. has received universal acclaim. His book Bridgescape is a 'bible' for bridge designers.	5425 Vantage Point Road Columbia, MD 21044 301.490.6088
BSI bsi@ce.ufl.edu	**Bridge Software Institute.** FB-MultiPier is a 3-D nonlinear finite element analysis computer program that models soil-structure interactions of bridge piers under AASHTO, static, and dynamic loading conditions.	University of Florida P.O. Box 116580, 457 Weil Hall Gainesville, FL 32611 352.392.9537 x1514
CABA www.caba-bridges.org	**Central Atlantic Bridge Associates.** Promoting the benefits, advantages, and performance of prestressed concrete bridges in the Central Atlantic region.	1042 North Thirty Eighth St. Allentown, PA 18104 610.395.2338
CAMPBELL SCIENTIFIC www.campbellsci.com	**Campbell Scientific, Inc.** Manufacturer of data acquisition systems for long-term, stand-alone monitoring of bridges and other structures: data loggers, software, sensors, telemetry, and power supplies.	815 W 1800 N Logan, UT 84321 435.753.2342
CH2MHILL www.ch2m.com	**CH2M HILL** provides transportation planning, design, and construction services for some of the most complex highway and bridge projects in the world.	9191 S. Jamaica St. Englewood, CO 80112 303.771.0900
CORTEC www.cortecvci.com/index2.php	**Cortec® Corporation** offers VpCI® and MCI® Technologies for packaging, metalworking, construction, electronics, water treatment, oil/gas, and other industries. Cortec® Corporation is ISO9001 and ISO14001:2004 Certified.	4119 White Bear Parkway St. Paul, MN 55110 800.4.CORTEC
CREATIVE FORM LINERS, INC. www.creativeformliners.com	**Creative Form Liners, Inc.** The industry leader in custom and off-the-shelf fiberglass and rubber form liners supplied to DOTs and GCs nationwide for transportation infrastructure projects and urban environments.	3411 Windom Rd. Brentwood, MD 20722 301.864.3676
DSI www.dywidag-systems.com	**DYWIDAG-Systems International** – Experts in the design, manufacture, supply, and installation of THREADBAR®, multistrand, and cable-stay post-tensioning systems.	320 Marmon Dr. Bolingbrook, IL 60440 630.739.1100
ENERPAC www.enerpac.com	**Enerpac** – Manufacturer of integrated systems for bridge building and rehabilitation using high force, hydraulic products and solutions. Enerpac products provide high forces with safety and efficiency.	6100 N. Baker Rd. Milwaukee, WI 53029 262.781.6600
FIGG www.figgbridge.com	**FIGG** specializes exclusively in the design and construction engineering of American bridge landmarks.	424 North Calhoun Street Tallahassee, FL 32301 850.224.7400
FINLEY Engineering Group, Inc. www.finleyengineeringgroup.com	**Finley Engineering Group** is an engineering and construction consulting firm specializing in complex bridge projects.	1589 Metropolitan Blvd. Tallahassee, FL 32308 850.894.1600
FLATIRON www.flatironcorp.com	Founded in 1947, **Flatiron** is one of the leading providers of transportation construction, and civil engineering in North America. Its core competencies include major bridge, highway, and rail projects.	10090 E. I-25 Frontage Rd. Longmont, CO 80504 303.485.4050
FYFE Co. LLC Tyfo Fibrwrap Systems www.fyfeco.com	**FYFE Company** is a global network of certified applicators, are global leaders in the use of externally bonded Fiber Reinforced Polymer (FRP) systems for the strengthening, repair and restoration of masonry, concrete, steel and wooden structures.	8380 Miralani Dr. San Diego, CA 92126 858.642.0694
HDR www.hdrinc.com	**HDR** – an ENR Top 10 Transportation Firm – provides planning, design, program management, environmental, construction and security services through a variety of delivery methods, including design-build.	8404 Indian Hills Drive Omaha, NE 68114 800.366.4411
HEADWATERS RESOURCES www.flyash.com	**Headwaters Resources** manages and markets CCPs, including fly ash. Fly ash use improves concrete performance and creates significant benefits for our environment.	10653 S. River Front Parkway, Ste. 300 South Jordan, UT 84095 888.236.6236

Description		Address/Phone
www.helser.com	**Helser Industries** designs and manufactures steel forms for producing precast and prestressed concrete components for numerous commercial applications.	10750 SW Tualatin Rd, P.O. Box 1569 Tualatin, OR 97062 503.692.6909
www.fhwa.dot.gov/hfl	The purpose of **Highways for LIFE** is to advance longer-lasting highway infrastructure using innovations to accomplish the fast construction of efficient and safe highways and bridges.	1200 New Jersey Ave, SE Washington, DC 20590 202.366.1325
www.holcim.us	**Holcim** is one of the world's leading suppliers of cementitious materials including our eco-efficient Envirocore products delivering innovation and greener building solutions to your customers.	201 Jones Road Waltham, MA 02451 781.647.2501
www.ibtengineers.com	**IBT** specializes in bridge engineering on projects worldwide with offices in the United States, Mexico, United Arab Emirates, and Canada.	9325 Sky Park Court, Suite 320 San Diego, CA 92123 858.566.5008
www.larsa4d.com	other contractors **LARSA Inc.'s** software for bridge analysis and design addresses specialized needs of a variety of bridge structures, including cable, segmental, curved, box, and other types, and is a standard in leading U.S. firms.	Melville Corporate Center 105 Maxess Rd., Ste. 115N Melville, NY 11747 800.LARSA.01
www.mi-jack.com	**Mi-Jack Products Inc.** is recognized as an industry leader and innovator in Travelift® and Translift™ rubber tire gantry crane manufacturing, sales, service and support	3111 W. 167th Street Hazel Crest, IL 60429 708.596.5200
www.olsonengineering.com	**Olson Engineering Inc.** has provided state-of-the-art structural and infrastructure NDT condition assessment services since 1985. The staff of Olson Engineering has been carefully assembled to have world class expertise in NDT&E consulting services.	12401 W. 49th Ave. Wheat Ridge, CO 80033 303.423.1212
www.pbworld.com	**PB** is a leader in infrastructure development around the world, dedicated to meeting the needs of clients and communities.	One Penn Plaza New York, NY 10119 212.465.5000
www.pbsj.com	**PBS&J** is an employee-owned company that provides infrastructure planning, engineering, construction management, architecture, and program management services to public and private clients. PBS&J has nearly 3,000 employees and more than 80 offices across the United States and abroad.	4030 West Boy Scout Boulevard, Suite 700 Tampa, FL 33607 800.477.7275
www.pomeroycorp.com	**Pomeroy** is recognized throughout the industry for providing award winning engineered precast solutions to the most challenging projects since 1947	2020 Goetz Rd. Perris, CA 92570 951.657.5293
www.poseidonbarge.com	**Poseidon Barge Corporation** manufactures, sells, and rents Portable Sectional Barges to the Heavy Highway and Marine Construction Industry. We have distribution in Indiana, Arkansas, Florida, California, and Massachusetts.	3101 New Haven Ave. Fort Wayne, IN 46803 866.992.2743
www.safway.com	**Safway Services LLC** has been an industry leader in scaffold services since 1936 and offers the QuikDeck™ Suspended Access System for easy access under bridges.	Scotia-Glenville Industrial Park, Building 406 Scotia, NY 12302 518.381.6000
www.shuttlelift.com	**Shuttlelift** mobile gantry cranes are designed and manufactured to specification, producing cranes that offer practical, robust, and durable lifting solutions for the bridge construction industry.	49 E. Yew St. Sturgeon Bay, WI 54235 920.743.8650
www.splicesleeve.com	**SPLICE SLEEVE**. The *original* grout-filled mechanical splice for rebar used for moment-resisting connections in precast concrete.	192 Technology Dr., Ste. J Irvine, CA 92618-2409 949.861.8393
www.summit-eng-group.com	**Summit Engineering Group Inc.** is a consulting engineering practice specializing in construction engineering, structural design, analysis, and structural evaluations and investigations.	10394 West Chatfield Ave., Ste. 110 Littleton, CO 80127 303.933.9114
www.transpo.com	**Transpo Industries Inc** is a manufacturer of roadway safety products - breakaway supports and specialty polymer concrete materials for the rehabilitation, maintenance and preservation of bridge and concrete structures - since 1968.	20 Jones Street New Rochelle, NY 10801 914.636.1000
www.tylin.com	**T.Y. Lin International** is a full-service infrastructure consulting firm recognized worldwide for its long-span and signature bridge design services, as well as seismic analysis and retrofit expertise.	Two Harrison St., Ste. 500 New Rochelle, NY 10801 800.321.7870
www.vsl.net	**VSL** provides design support, construction systems, and services for precast segmental, cast-in-place, and stay cable bridges.	7455-T New Ridge Rd. Hanover, MO 21076 888.489.2687

The HL-93 Live Load Model

Dynamic Load Allowance

by Dr. Dennis R. Mertz

Dynamic load allowance is the increment added to the static load to yield force effects assumed equivalent to a dynamic load. Engineers analyze highway bridges by statically placing vehicle or uniform lane loads onto the bridge or its members. To account for the dynamic nature of the moving traffic, the static loads are incremented by an additional percentage in lieu of a true, more complicated dynamic analysis. In the case of the *AASHTO LRFD Bridge Design Specifications*, for the most part the dynamic load allowance for the HL-93 live-load model is specified in Article 3.6.2, as a constant value of 33% for superstructures at the strength or service limit states. In previous AASHTO specifications, the dynamic load allowance was termed "impact," and in the *LRFD Specifications*, dynamic load allowance is abbreviated as IM.

Research conducted during the development of the *LRFD Specifications* suggested that a constant dynamic load allowance of approximately 25% should be applied to vehicular loads. An explanation of the specified value of 33% is in order.

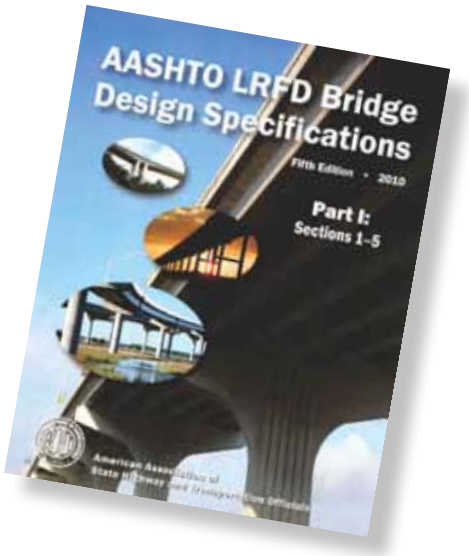
Recall from the previous articles that the HL-93 live load consists of a design truck or design tandem and a design lane load. The dynamic load allowance is only applied to the vehicles of the HL-93 live-load model—the design truck or the design tandem—not the design lane load. Thus, the static axle loads of the design truck or the design tandem are, in effect, multiplied by 1.33 to yield dynamic force effects.

The fact that the design lane load does not get incremented for dynamic effects acknowledges that when a bridge is more fully loaded as in the case of the design lane load, the various vehicle axle loads that the design lane load represents, tend to dampen each other.

From the discussion in the Fall 2009 issue of *ASPIRE*,™ the design lane load is predominate for long-span bridges with the design vehicles becoming more and more insignificant with increasing span length. In this case, the dynamic load allowance has little or no effect.

For medium-span bridges, the design truck is the governing vehicle and it is on this vehicle that the design lane load is superimposed. In this case, the design lane load, as a part of the notional load, amplifies the effects of the 72-kip design truck to super-legal magnitudes, but dynamic load allowance is only applied to the design-truck loads. To account for this, the observed dynamic load allowance of 25% of vehicle loads was increased to the specified value of 33%. This "adjusts" for the fact that the dynamic load allowance is not applied to the design lane load in medium-span bridges yet the design lane load is used to amplify the 72-kip truck to a more realistic truck weight for design. Thus, a dynamic load allowance of 33% works for the HL-93 live-load model since it is a notional load. For actual trucks as opposed to a notional load, a value of 25% is more appropriate for dynamic load allowance.

Finally, short-span bridges are governed by the axle loads of the design tandem with the design lane load applied to loaded lengths so short as to become insignificant with shorter and shorter span lengths. Axle loads are typically more variable or uncertain than complete vehicles. The specified dynamic load allowance of 33% as opposed to the observed value of 25% was deemed appropriate for these span lengths to provide some additional reliability to the more uncertain axle loads.



Delivering Top Quality Concrete Bridges for our Clients around the Globe


I-10 Escambia Bay Bridge, Pensacola, Florida


Minisa Bridge, Wichita, Kansas


Mattaponi River Bridge, West Point, Virginia

I-95/I-295/SR 9A Ramp, Jacksonville, Florida

pbworld.com

SR 9A Ramp Photo Courtesy of Superior Construction Company, Inc.

...Changing tomorrow today...

PB PARSONS BRINCKERHOFF 125 YEARS

With over 125 Years of Engineering Excellence

THE ART FORM OF BEAUTIFUL BRIDGES™

TOP **Heritage Bridge** over **Turner Turnpike** – This award-winning project used our state-of-the-art form liners to create the stunning aesthetic treatments. Our detailed high-relief fiberglass liners were used to cast the central shield and wing walls depicting local ledge stone and the emblem from the Oklahoma state flag. Specialty staining in earthen browns, reds, blues and beiges further enhances the local stone affect. Our durable rubber liners were used to cast the repeating woven band and jewel pattern along the parapets and piers. Even with only a 2" relief, this crisp pattern is visible from a great distance.

BOTTOM **U.S. 77 Bridge** – Our high-quality rubber form liners and stamps created stylized prairie grass patterns across the wing walls, piers, parapets, and slopewalls of this newly constructed bridge. In select locations, Oklahoma's state bird, the Scissor-tailed Flycatcher, appears to soar above the grass blades. Even without specialty stain enhancements and only a 2" relief, the intricate details created by our in-house artists make these patterns appear three-dimensional and lifelike.

CREATIVE FORM LINERS, INC.

GIVING AESTHETICS FORM™

www.CreativeFormLiners.com **301-864-3676** info@CreativeFormLiners.com