

Woodrow Wilson Memorial Bridge Replacement

Washington, D.C.

HOOD CANAL BRIDGE

Kitsap and Jefferson Counties, Washington

I-10 BRIDGE REPLACEMENT

Escambia Bay, Florida

SOUTH FORK EEL RIVER BRIDGES

Leggett, California

GARDEN GROVE BOULEVARD WIDENING

Orange County, California

POMEROY-MASON BRIDGE

Ohio to West Virginia

SWINGLEY RIDGE ROAD BRIDGE

Chesterfield, Missouri



Bentley® LEAP® Bridge. It's all in there.

The power of LEAP Software's mature and proven analysis & design applications is now **ONE**.

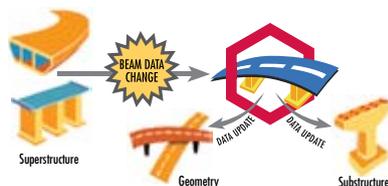
ONE Central Application

LEAP Bridge acts as the central information hub for your projects. Exchange data with AASHTOWare's BRIDGEWare Database. Transfer important data with any LandXML compliant applications (MicroStation®, GEOPAK®, InRoads® and more).



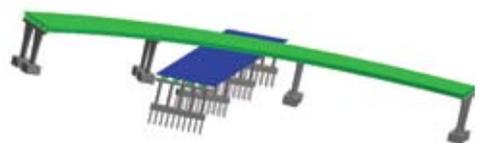
ONE Parametric Design System

All data for bridge components is exchanged and maintained in a single database with design changes from individual modules populated instantaneously. Your bridge is always up to date.



ONE Console

All component design modules are accessed from the single user console. 3D solid or transparent views of your entire bridge project or individual components are available on demand with the capability to print or export views to DXF files. Run full project/bridge reports and individual component reports from a single location.



ONE Powerful Solution

Efficient, logical and accurate. The new fully integrated LEAP Bridge is developed by engineers who have expert knowledge of code specifications, design methodologies and have been leading the industry in new technology development for over twenty-two years. When you work in LEAP Bridge you have the advantage of a virtual bridge engineering brain trust at your fingertips powering a seamless analysis and design workflow.



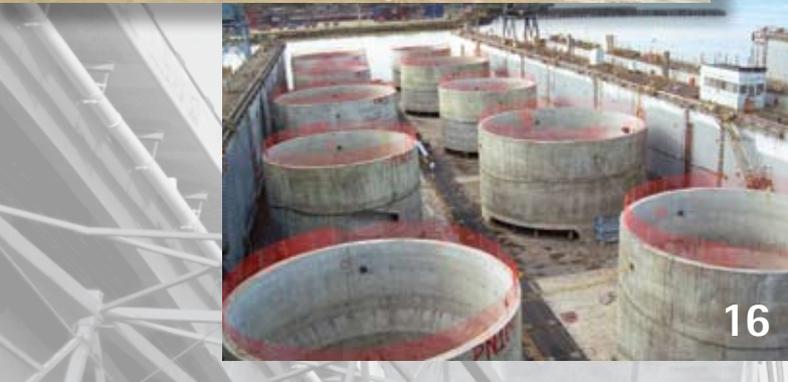
NEW configurations and licenses available to match the way you work!

Please contact us for more information. (888) 793-5490 • sales@leapsoft.com • www.bentley.com/LEAP



Photo: Parsons

8



16



22

Photo: Charles Rudie, P.E.



Photo: Bob Henry, Michael Baker Jr. Inc.

34



40

Woodrow Wilson Memorial Bridge
Photo: Parsons.

Features

| | |
|--------------------------------------------------------------------------------------------------------|-----------|
| Parsons Adapts to the Market | 8 |
| <i>From Tacoma to Abu Dhabi, Parsons uses local expertise to create efficient, attractive designs.</i> | |
| Hood Canal Bridge | 16 |
| <i>One of eleven, but one of a kind.</i> | |
| I-10 Bridge Replacement | 22 |
| <i>Innovative solutions for rapid construction.</i> | |
| South Fork Eel River Bridges | 26 |
| <i>Avoiding landslides.</i> | |
| Garden Grove Boulevard | 30 |
| <i>Economical bridge widening.</i> | |
| Pomeroy-Mason Bridge | 34 |
| <i>State partnership creates cable-stayed bridge.</i> | |
| Swingley Ridge Road Bridge | 40 |
| <i>Cast-in-place concrete provides the answer.</i> | |

Departments

| | |
|-------------------------------------------------------|-----------|
| Editorial | 2 |
| Reader Response | 4 |
| Concrete Calendar | 6 |
| Perspective—Sustainable Concrete Bridge Design | 14 |
| Aesthetics Commentary | 42 |
| Concrete Connections | 44 |
| Safety and Serviceability | 45 |
| STATE—Concrete Bridges in Washington | 46 |
| CITY—St. Paul, Minnesota | 50 |
| AASHTO LRFD Specifications | 52 |



Bridge Sustainability, Part Three: Economic Considerations

John S. Dick, *Executive Editor*

Photo: Ted Lacey Photography

In this issue of *ASPIRE*[™], we continue our year-long effort to define sustainable issues in bridge design and construction. On page 14, Jay Holombo, Vinh Trinh, and Maher Tadros of PBS&J discuss the “economic” aspects of sustainable concrete bridges, particularly as these concepts apply to conditions in California.

This issue’s featured design consultant, Parsons, comments that concrete is Parsons’ choice whether in Texas, Colorado, California, or the United Arab Emirates. Durability and long-term costs are primary considerations. They say the owners are demanding designs that ensure long-term performance—100 years in many cases.

Our featured state, Washington, has been recognized as progressive in its work with the concrete industry and implementation of economical systems and solutions. Consider that the state’s first precast concrete girder bridge was a post-tensioned, spliced-girder solution built 54 years ago. They haven’t stopped innovating since.

Segmental concrete bridges are establishing a significant niche. This issue’s project reports include two such solutions, one in California and another between Ohio and West Virginia. Once again, these bridges are designed for longevity.

The oldest segmental bridges in the United States are now some 35 years old. A study

discussed in our “Safety and Serviceability” feature (page 45) by Brett H. Pielstick of Eisman & Russo Consulting Engineers, reports on the performance of the entire inventory of segmental bridges. You’ll also find a link there to the full, detailed report.

Finally, we want to remind you to return the mail back postcard bound into this issue if you have not yet done so. That helps validate our subscriber list with the post office. Your assistance is appreciated. Soon, we’ll need to remove those who do not respond.

Your opinion is important! Please, communicate your ideas to us!

We invite you to share your impressions about *ASPIRE*[™] magazine with the editors. A simple survey is available by selecting the “Survey” button at www.aspirebridge.org. It offers multiple-choice and fill-in-the-blank questions. It’ll take less than 5 minutes to complete.

Why participate? This is your magazine, by and about bridge practitioners. To remain valuable, it must be relevant to you. Your opinion is crucial to keeping the magazine on target for your needs.

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



Precast/Prestressed
Concrete Institute



American Segmental
Bridge Institute



Portland Cement
Association



Post-Tensioning
Institute



American Coal Ash
Association



Expanded Shale Clay
and Slate Institute



National Ready Mixed
Concrete Association



Silica Fume
Association



Wire Reinforcement
Institute

Executive Editor: John S. Dick

Managing Technical Editor: Dr. Henry G. Russell

Managing Editor: Craig A. Shutt

Editorial Staff: Daniel C. Brown, Roy Diez, Wayne A. Endicott

Editorial Administration: James O. Ahtes Inc.

Art Director: Mark Leader, Leader Graphic Design Inc.

Layout Design: Marcia Bending, Leader Graphic Design Inc.

Electronic Production: Chris Bakker, Jim Henson, Leader Graphic Design Inc.

Ad Sales: Jim Oestmann

Phone: (847) 838-0500 • Cell: (847) 924-5497

Fax: (847) 577-0129

joestmann@arlpub.com

Reprint Sales: Mark Leader

(847) 564-5409

e-mail: sales@leadergraphics.com

Publisher:

Precast/Prestressed Concrete Institute,

James G. Toscas, President

Editorial Advisory Board:

David N. Bilow, *Portland Cement Association (PCA)*

John S. Dick, *Precast/Prestressed Concrete Institute (PCI)*

Clifford L. Freyermuth, *American Segmental Bridge Institute (ASBI)*

Theodore L. Neff, *Post-Tensioning Institute (PTI)*

Dr. Henry G. Russell, *Managing Technical Editor*

POSTMASTER: Send address changes to *ASPIRE*, 209 W. Jackson Blvd., Suite 500, Chicago, IL 60606-9887. Standard postage paid at Chicago, IL, and additional mailing offices.

ASPIRE (Vol. 2, No. 3), ISSN 1935-2093 is published quarterly by the Precast/Prestressed Concrete Institute, 209 W. Jackson Blvd., Suite 500, Chicago, IL 60606-6938.

Copyright 2008, Precast/Prestressed Concrete Institute.

If you have a project to be considered for *ASPIRE*, send information to *ASPIRE*, 209 W. Jackson Blvd., Suite 500, Chicago, IL 60606-9887 phone: (312) 786-0300 www.aspirebridge.org e-mail: info@aspirebridge.org

Cover:

Woodrow Wilson Memorial Bridge, Washington, D.C.

Photo: Parsons

Gaze Into The Future

Of Bridge Design And Construction

...with an exciting career as a member of the FIGG Team, creating Functional Bridge Sculpture™. If you share our passion, then please contact us at 1.800.358.FIGG (3444). We are currently seeking talented Bridge Design Engineers, CADD Designers, Construction Site Engineers and Inspectors to join our Team.

Maine's Penobscot Narrows Bridge & Observatory, open May to October, provides visitors with views from the world's tallest public observatory.

*Owner: Maine Department of Transportation
Contractor: Cianbro/Reed + Reed JV
Designer/Construction Engineering: FIGG*



www.figgbridge.com
CREATING BRIDGES AS ART®

An Equal Opportunity Employer

READER RESPONSE

I am currently working on the preliminary engineering for the rehabilitation of an historic concrete arch bridge in the Pittsburgh area. Part of the scope of the project is a complete re-decking. Due to both difficult access and the benefits of shorter project duration, we believe that a precast deck alternative may be appropriate. Fortunately, I happened to see in the Fall 2007 ASPIRE™ magazine a very similar-looking project, the Monroe Street Bridge. The precast plank subdeck with a CIP topping is pretty much exactly what I had envisioned as the way to go here. I was wondering if it would be possible to get more details from this project, whether it is construction photos or engineering drawings. I'm particularly interested in reinforcement and dowel details at the floor beams and any details with regards to the sidewalk cantilevers. I have proposed details to our client, but not having seen a similar job, I think their mind would be set at ease to see details on a similar job that has been built successfully. Please let me know if it would be possible to get any of this information. I appreciate your assistance.

Gary Gardner
ms consultants inc.

[Editor's Note: Mr. Gardner was put in touch with the participants in the Monroe Street Bridge, Spokane, Wash., and we trust all questions and requests were answered.]

I recently had an opportunity to read the Spring 2008 edition of ASPIRE. I was somewhat disappointed that there were no articles dealing with railroad bridges. As a Rail Bridge Designer, I know that the U.S. railroads use a large volume of prestressed concrete beams and girders for their bridges. There are some amazing things that the railroads do with their bridge designs and construction using these types of beams and girders. One of the most amazing is that they can change out bridge superstructures in hours, not days or weeks. I believe your readers would be fascinated with what railroads can do with prestressed concrete elements.

Jeffrey Teig
HDR Engineering Inc.
Omaha, Neb.



Indiana LIAP is a research/technology transfer program funded by INDOT and FHWA. We publish a quarterly newsletter and are interested in requesting permission to reprint an article from your Winter 2008 issue "Structurally Deficient Bridges are SAFE." How might I go about requesting that permission?

Lisa Weicker Calvert
West Lafayette, Ind.

I work at the University of Arkansas at Little Rock in the department of Urban Studies & Design. We are seeking your permission to print the article titled "Fifth Street Pedestrian Plaza Bridge" from

the Winter 2008 edition of ASPIRE, in a report we are producing for the City of Little Rock.

Kim Simmons
University of Arkansas
Little Rock, Ark.

The "Loop 340 Bridges" article in the Spring 2008 ASPIRE is great! I was very pleased we were able to get that project to letting in August 2004, the month before I retired. I'm now equally pleased to see it in ASPIRE.

Mary Lou Ralls
Ralls Newman LLC
Austin, Tex.

ZBAR™ HIGH PERFORMANCE CORROSION PROTECTION

REINFORCING STEEL BAR... Steel scrap is the primary raw material used in the production of Gerdau Ameristeel reinforcing steel. Our mills re-use more than nine million metric tons of steel each year, making **Gerdau Ameristeel the Second Largest Recycler in the Americas.**

THERMALLY APPLIED ZINC INNER COATING... Durable; providing cathodic protection for the steel as needed.

ELECTROSTATICALLY APPLIED POWDER OUTER COATING... ZBAR's first line of defense against water and chlorides which lead to corrosion.

ASTM A1055 COMPLIANT
Standard Specification for Zinc and Epoxy
Dual Coated Steel Reinforcing Bars.

MEETS FHWA HIGHWAY FOR L.I.F.E. REQUIREMENTS

GERDAU AMERISTEEL

CALL 888-637-9950
FOR SALES & ORDERING INFORMATION
www.gerdauameristeel.com/zbar

MEMBER OF
CRSI



AMERICAN SEGMENTAL BRIDGE INSTITUTE

FIRST ASBI INTERNATIONAL SYMPOSIUM

2008

"Future Technology for Concrete Segmental Bridges"

NOVEMBER 17-19, 2008

Fairmont Hotel, San Francisco, CA

NOW AVAILABLE: Online Symposium Registration, Brochure, and Exhibit and Hotel Reservations Information.

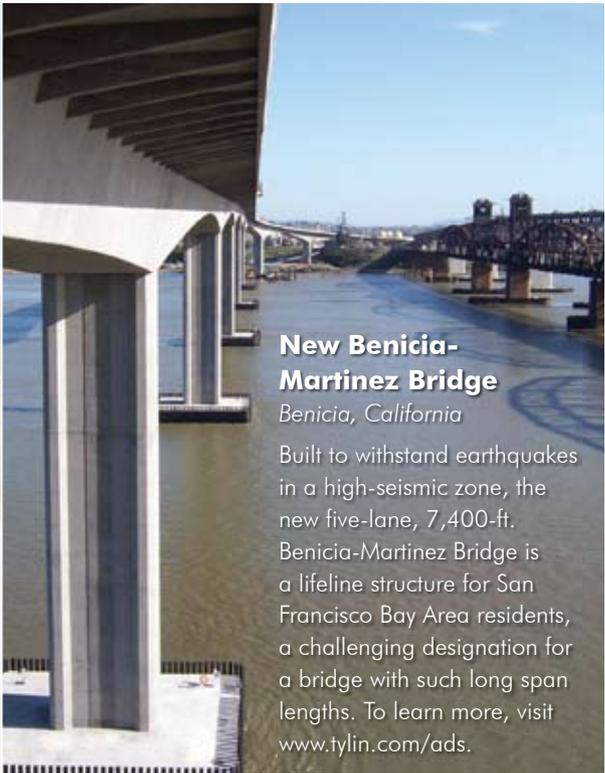
www.asbi-assoc.org/news/symposium/



photo courtesy of Kiewit Pacific Company



Photos courtesy of Caltrans



New Benicia-Martinez Bridge *Benicia, California*

Built to withstand earthquakes in a high-seismic zone, the new five-lane, 7,400-ft. Benicia-Martinez Bridge is a lifeline structure for San Francisco Bay Area residents, a challenging designation for a bridge with such long span lengths. To learn more, visit www.tylin.com/ads.

TYLIN INTERNATIONAL

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

CONTRIBUTING AUTHORS



Jay Holombo is leader, Transportation Structures Group, PBS&J, San Diego, Calif.



Vinh Trinh is group manager responsible for the Structures Group, PBS&J, Orange, Calif.



Maher K. Tadros is principal technical professional, Structures, PBS&J, Tampa, Fla., and the Leslie D. Martin professor of civil engineering, University of Nebraska-Lincoln, Neb.



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.



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.

Brett H. Pielstick is senior vice president/partner with Eisman & Russo Inc. and chair, ASBI Bridge Condition Advisory Committee.

MANAGING TECHNICAL EDITOR



Photo: Ted Lacey Photography

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.

CONCRETE CALENDAR 2008/2009

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

July 27-30

Sixth National Seismic Conference on Bridges & Highways

Organized by the Federal Highway Administration (FHWA), the Transportation Research Board (TRB), the South Carolina Department of Transportation (SCDOT) and MCEER, University at Buffalo, N.Y. Francis Marion Hotel, Charleston, S.C.

July 28-29

ASBI Seminar on Construction Practices for Concrete Segmental and Cable-Supported Bridges

Hilton Sacramento Arden West, Sacramento, Calif.

August 4-6

PCI Quality Control & Assurance Personnel Training & Certification Schools

Embassy Suites Hotel - Nashville Airport, Nashville, Tenn.

October 5-7

PCI-FHWA National Bridge Conference

Rosen Shingle Creek Resort, Orlando, Fla.

November 2-6

ACI Fall Convention

Renaissance Grand & America's Center, St. Louis, Mo.

November 3-8

PCI Quality Control & Assurance Personnel Training & Certification Schools

Embassy Suites Hotel - Nashville Airport, Nashville, Tenn.

November 10-12

Third North American Conference on the Design and Use of Self-Consolidating Concrete

"SCC 2008: Challenges and Barriers to Application"

Marriott O'Hare Hotel, Chicago, Ill.

November 17-19

ASBI 20th Anniversary International Symposium on Concrete Segmental Bridges

Fairmont Hotel atop Nob Hill, San Francisco, Calif.

January 11-15, 2009

Transportation Research Board Annual Meeting

Washington, D.C.

March 15-19, 2009

ACI Spring Convention

Marriott Rivercenter, San Antonio, Tex.

April 20-21, 2009

2009 ASBI Grouting Certification Training

J.J. Pickle Research Campus, The Commons Center, Austin, Tex.

April 22-26, 2009

PCI Committee Days

Westin Hotel, Chicago, Ill.

July 5-9, 2009

AASHTO Subcommittee on Bridges and Structures Annual Meeting

Hilton Riverside Hotel, New Orleans, La.

September 12-15, 2009

PCI National Bridge Conference

Marriott Rivercenter Hotel and Henry B. Gonzales Convention Center, San Antonio, Tex.

October 25-27, 2009

2009 ASBI 21st Annual Convention

Hilton Hotel, Minneapolis, Minn.



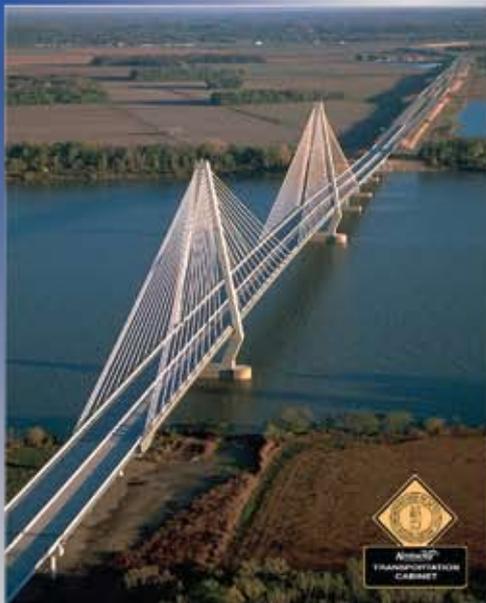
*Ocean City - Longport Bridge
Cape May, New Jersey*



*SOBRR Chao Phraya River Bridge
Bangkok, Thailand*



*East End Bridge
Louisville, Kentucky*



*William Natcher Bridge
Owensboro, Kentucky*



*I-10 Escambia Bay Bridge
Pensacola, Florida*

Bridges
for the 21st Century
www.pbworld.com

**PB PARSONS
BRINCKERHOFF**
100 YEARS



PARSONS adapts to the **MARKET**

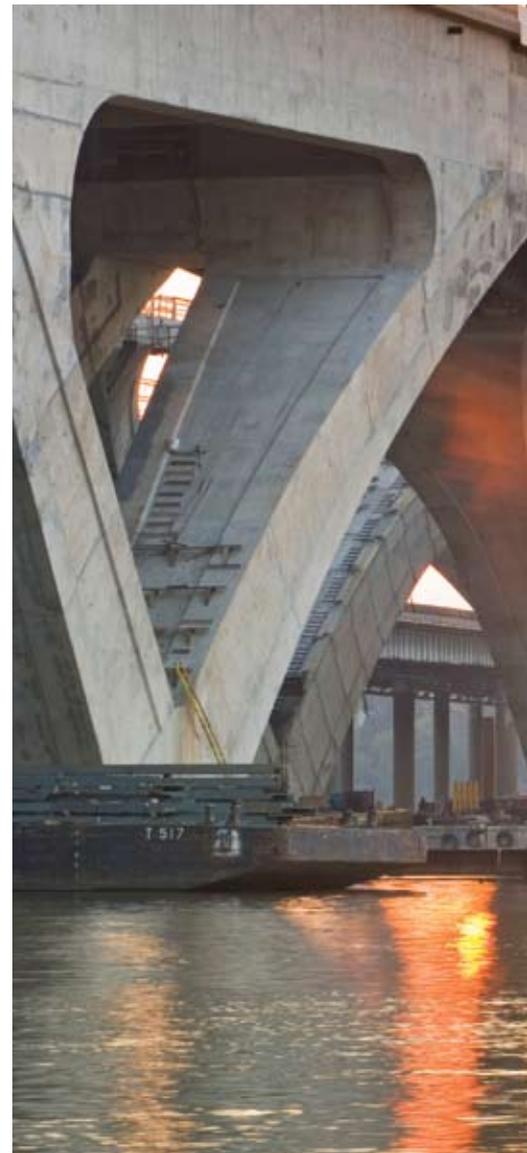
by Craig A. Shutt

**From Tacoma
to Abu Dhabi,
Parsons uses
local expertise
to create efficient,
attractive designs**

Parsons operates around the world, conquering tough logistical challenges and delivering landmark projects in many countries and climates. But while it works globally, it designs locally. Designers take advantage of the expertise available in each area to ensure that they create the most efficient, durable, and aesthetically pleasing structure.

“Parsons is a diverse company, with diverse capabilities,” says Greg Shafer, southeast subsector manager in the Baltimore office. The company’s services include bridge planning, design, and construction of all types, including design-build programs. It provides construction engineering and inspection, bridge rehabilitation and retrofit, and condition inspection and seismic analysis. That combination keeps the company involved in bridges at all stages of their life cycle, providing a good perspective on the industry.

“We work pretty hard to investigate all types of construction when we begin a project, including precast concrete, cast-in-place concrete, segmental precast girders, and structural steel. We always consider alternatives, and our choice usually depends on the region and conditions. If the contractors are familiar and comfortable with a specific technology, it is more attractive to design that way.”



That expertise is often driven by how the Departments of Transportation (DOTs) operate, notes Paul Goryl, construction services manager in the San Francisco, Calif., office. "DOTs often become comfortable with certain bridge types, which leads to standards being developed around a certain construction approach. As a result, local contractors become very cost competitive, and the DOTs gain a lot of price history for cost estimates."

Parsons can adapt to the local contractors' expertise, which ensures the most efficient design for that area, even though the same challenges in another area may result in a different structure. For instance, California only has a few designs incorporating precast concrete I-beams or segmental construction, Goryl notes, whereas states such as Texas use mostly precast I-beams. "Concrete I-beam bridges are the most competitive approach in Texas, so we design to that unless special circumstances dictate otherwise."

Concrete designs have become more popular with owners.

Most Designs Feature Concrete

Despite the adaptability, a large percentage of Parsons' designs feature concrete today, Goryl estimates. The reasons for that include economics, constructability, aesthetic capabilities, durability, and speed of construction.

"Constructability has become a key concern, and it's growing, especially in urban areas," he says. "Maintaining traffic while construction is underway has become a top priority. As urban areas become more congested, you have more to contend with, and you have to look at alternatives for minimizing the disruption to traffic, such as night work and detours."

Concrete designs also have become more popular with owners as they change their approach to economics. "There's more focus on the hard dollars being spent on each individual project as opposed to larger program budgets," he says. "Now, they're looking closer at the costs on a project-by-project basis and looking at the risks associated with different factors—such as what the cost will be if the design is late, how many contractors will bid the project, or will it take longer to build than expected."

Owners also are changing their calculations to consider the long term, says Shafer. "They want more durable structures. It's not uncommon for owners to ask for a 100-year service life. They are thinking more about life-cycle costs."



To blend the new Woodrow Wilson Memorial Bridge with other Potomac River crossings, Parsons' designers used V-shaped precast concrete piers with curved legs. Photos: Parsons.

The 5400-ft-long Tacoma Narrows Bridge is one of only two suspension bridges built in the United States in the past 40 years. It features 510-ft-tall cast-in-place concrete towers and was completed in only 14 months. Photos: Parsons.

And when you compare concrete and steel, concrete is more competitive when you look at life-cycle costs. You don't have the costs for maintenance and repainting."

Those needs recently came into play for Parsons' designers on the John James Audubon Bridge in Louisiana, which will be the longest cable-stayed bridge to be built in the western hemisphere, when completed in 2010. The design-build project, with a main span of 1583 ft, was planned to withstand barge impacts and hurricanes. In total, 80% of the bridge length of all of the bridges in the project feature precast concrete girder components.

"One of the key requirements for the proposal was to demonstrate that the cable-stayed bridge could achieve a 100-year service life and that the

precast concrete bridges could achieve a 75-year service life," explains Shafer. The company performed a life-cycle cost analysis for all of the bridges to show how its design would reach those goals. As part of that plan, the cable-stayed bridge will include polyethylene-sheathed, galvanized-steel stay cables encased in polyethylene pipes to achieve a three-way protection system.

Durability Gains Attention

Durability has also gained attention from contractors, especially those involved with design-build-operate-maintain projects, Goryl notes. In these projects, the contractor constructs the bridge and then is responsible for its maintenance, typically for 25 to 30 years. "In those instances, contractors are more concerned with creating a design that minimizes maintenance, so they're looking at concrete options."

That also was a driving factor in specifying concrete for parts of the \$2.4-billion Woodrow Wilson Memorial Bridge, a replacement project that serves as the only Potomac River crossing in the southern half of the Washington, D.C., Metropolitan area. Approximately 6000 ft long, the new 234-ft-wide bridge contains 34 fixed spans, divided between two structures, and a 260-ft-long, eight-leaf bascule span.

State-of-the-art concrete mixtures, including high-range water-reducing admixtures, were used to allow the concrete to flow around the dense reinforcement without creating voids. A zero-bleed grout also was used for extensive amounts of the post-tensioning cable-duct grouting. The anchorage-protection grout also featured special epoxy grout.

In addition, the owners set a goal of never having to replace the bridge deck on the movable segment, Shafer says. To achieve that, designers used stainless-steel strand. "It added only 1% or 2% to the overall bridge cost, but it will make a big difference in long-term durability for that element."

A key goal was to design the bridge to blend with other Potomac River crossings, which typically have arch designs. But the site was not well suited to a conventional arch design.



To replicate that appearance, V-shaped precast concrete piers with curved legs were created to form an arch-like appearance that met the owners' requirements," Shafer says.

On Time, On Budget

The project was honored by the American Segmental Bridge Institute (ASBI) with a 2007 Bridge Award of Excellence for its design and construction and by the American Society of Civil Engineers (ASCE) with its 2008 Outstanding Civil Engineering Achievement Award. "It really was a success," says Shafer. "All the decisions proved to be good ones. The best part was that it was completed on time and on budget."

The bridge was not the only one Parsons has designed that combined steel and concrete components—nor the only one to win awards for that combination. The company's expertise and design-build capabilities were key factors in its selection as the joint-venture lead on the Tacoma Narrows Bridge scheduled for fast-track completion in 55 months. The new bridge was constructed adjacent to the structure that had replaced "Gallop-ing Gertie," the well-known 5939-ft-long bridge that was torn apart in November 1940 as a 42-mph windstorm caused it to undulate until it broke apart.

The new bridge, with dramatic concrete towers, is only the second suspension bridge to be built in the United States in the last 40 years. The other is California's Carquinez Bridge, for which Parsons provided design services and engineering support. The concrete caissons are some of the largest ever built, equivalent to an underwater 20-story building supporting the 510-ft cast-in-place concrete towers. The caissons were constructed under environmentally extreme conditions that comprise 150-ft-deep water, currents up to 7 knots, and 50-mph winds.

The client challenged Parsons to deliver parts of the caisson design within 1 month after notice to proceed and to deliver the complete caisson design before completing the superstructure design. The designers worked closely with both the design-build client and the Washington State Department of Transportation, to make accurate



Parsons' work on the Dallas High Five project was driven by the need for fast construction and to minimize traffic impact. Two of the five concrete segmental ramps, with span lengths up to 300 ft, opened early, with the other three completed on schedule.

Photos: Texas Department of Transportation and Parsons.



assumptions regarding the design loads, mitigate risk, and deliver the design early.

The entire design was completed within 12 months of notice to proceed. The finished project was recognized by ASCE as a finalist for the 2008 Outstanding Civil Engineering Achievement Award and by American Council of Engineering Companies (ACEC) as a Grand Award winner.

The 5400-ft-long bridge features a 2800-ft main span and includes four eastbound lanes of traffic. The design also can accommodate a second deck for future light-rail use or additional highway lanes.

Both the Carquinez and Tacoma Narrows suspension bridges feature cast-in-place concrete towers constructed with jump forms, notes Goryl. "Cost was a key factor, along with the schedule," he says. "The concrete towers could be constructed at the site while the steel deck sections were being fabricated overseas, shipped directly by ocean-going vessels to the project site, and lifted from below."

'Contractors are more concerned with creating a design that minimizes maintenance, so they're looking at concrete options.'

'We always look at what local concrete producers are accustomed to providing.'

Design-Build Grows Popular

Parsons' adaptive ability works especially well on design-build projects, and that project-delivery method is one of the company's strengths, Goryl adds. "An owner might have a preference or past history with a bridge type that may not provide the most cost-efficient design. But when we're working directly with a contractor on a design-build project, especially with a lump-sum contract, a good starting point is to have a clear understanding of the contractor's most competitive capabilities."

Design-build methods are being used more today, he notes. "Some DOTs are further ahead on the curve than others, for different reasons." Speed is one benefit that design-build methods can provide. "Shorter schedules have become more important to all owners, which leads many to the design-build project-delivery method."

Faster construction and the ability to minimize impact to traffic were key goals for Parsons' work on concrete segmental ramps on the Dallas High Five project, which consisted of five ramps with span lengths up to 300 ft. Two of the five ramps were opened to traffic early, with the other three completed on schedule. Beating the planned schedule reduces concerns about worker safety and minimizes user costs by reducing congestion or eliminating detours earlier.

Overseas Mindset Differs

The ability to shorten project-completion schedules is a key consideration in much of the work the company does in the Middle East, especially the United Arab Emirates and Qatar, Goryl notes. He recently completed the design and bid for the Saadiyat Bridge in Abu Dhabi, United Arab Emirates. The Middle East's single largest natural-island development lies almost 1 mile off the shore of the capital city. Called the Island of Happiness, it will include downtown and marina districts with single- and multi-family golf-course communities, 12 resort hotels, and world-class museums.

Parsons is designing and managing construction for an estimated \$2.2-billion infrastructure project including earthwork, roads, water and wastewater infrastructure, and multiple bridges linking Saadiyat Island to Abu Dhabi. The Saadiyat Bridge, currently under construction, will be the first concrete segmental roadway bridge ever built in the United Arab Emirates. The bridge will be open to traffic in mid 2009, and the Saadiyat Island project is expected to be fully developed by 2018.

The segmental design was used due to its long-span capability and low maintenance, explains Goryl. "It's a new construction technology for this country. They're very capable with conventional cast-in-place concrete, post-tensioned box-girder bridges that are used in most of their highway systems," he says. "They've made amazing progress in the past 20 years with conventional designs, and the local contractors produce good quality cast-in-place box-girder bridges."

In the United States, he explains, a lot of focus is placed on long-term permanence, and that's increasing with the emphasis on life-cycle costs. Whereas, in parts of the Middle East that are experiencing a construction boom, owners want value and are more focused on the next two to three years and opening bridges to traffic quickly.

"They are building the infrastructure for their major cities, and they have a difficult time attracting investors and residents to the development projects until the infrastructure is underway," he explains. "So they are more concerned that the project be constructed and usable in a shorter time frame. As these projects are built, they learn more about the capabilities of concrete and expand their own expertise."

Parsons also has worked on several innovative U.S. highway projects. The firm served as part of a joint-venture team to design and build the Southeast Corridor Transportation Expansion Project (T-REX), the largest transportation contract in Colorado history. The design-



build project includes highway, light-rail transit, pedestrian, and bicycle facilities along the I-25 and I-225 corridors in Denver. The firm was responsible for approximately 50% of the total project design.

The designers' plan reconfigured the interchange to move light-rail trains from the highest level to the lowest, resulting in significant cost savings, aesthetic improvements, and enhanced temporary traffic control. Parsons acted as the primary designer of 19 miles of double-track light-rail transit, including 13 new transit stations, park-and-ride lots, three parking structures, 25 light rail bridges, a new operations control tower, power and signal systems, and supervisory control and data-acquisition systems for the existing transit lines. T-REX also included 17 miles of highway construction, with 33 new bridge structures, 13 bridge widenings, and six pedestrian bridges. The \$1.6-billion project was completed in 2006.



Designers on the Southeast Corridor Transportation Expansion Project (T-REX), the largest transportation contract in Colorado history, reconfigured the interchange to move light-rail trains from the highest level to the lowest. The changes resulted in significant cost savings, aesthetic improvements, and enhanced temporary traffic control. Photo: Parsons and Colorado Department of Transportation.

New Techniques Continue

Designers expect the dominance of concrete in their projects to continue, especially as new engineering techniques are unveiled. The Woodrow Wilson Bridge, for instance, used lightweight concrete on the deck slabs for its movable span. "When moving a big mass like that, it makes a lot of sense to use lightweight materials wherever possible," says Shafer. "We used lightweight concrete combined with normal weight mixtures to create an efficient system that took advantage of the best properties of both." Weight also becomes a concern for large components that must be transported and lifted under challenging conditions, he notes.

Low water-cementitious materials ratios also are being used more often, he says. "We can achieve a nice, low permeability mix by using a lower ratio and improved curing techniques. These help provide better durability, which is in demand today." High-performance concrete (HPC) also helps meet challenging goals, he adds. "We're using HPC more and more,

because it provides strength that can create longer spans and eliminate piers. But it's also being used more often for its durability, which helps when the client wants a 100-year service life."

The designers also are intrigued by the advancements being made in reinforcing steel. Stainless-steel strand, such as used on the Woodrow Wilson Bridge, is becoming more popular, along with galvanized and epoxy-coated options. "The idea of stainless-steel reinforcement, both in solid forms and as a cladding over a carbon steel core, creates real possibilities," says Shafer. "They are relatively new technologies that are still not readily available or always cost-effective, but we expect to see them more and more."

As their volume increases, the prices will come down, adding more demand—which will increase volume and help drop the price further. Adds Goryl, "There is a lot of research going on with reinforcement in concrete. We sometimes

get into complex designs that push the limits, and we like to see new techniques come out."

As those techniques arrive, Parsons will work with local contractors and concrete suppliers to find the most efficient solution. "We always look at what local concrete producers are accustomed to providing," says Shafer. "We ask if they have experience with certain techniques to ensure we are specifying something that can be built in the local business climate."

That approach ensures the design creates the most efficient approach possible, says Shafer. "New techniques and growing familiarity with them in new areas go a long way toward giving owners what they want, which is something that will last a long time and save them money in the long run."

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

SUSTAINABLE

Concrete Bridge Design by Jay Holombo, Vinh Trinh, and Maher K. Tadros, PBS&J



As with many states, California is faced with diminishing open space to improve congested transportation networks. Therefore, most of these improvements involve heavily-congested urban interchanges, where traffic disruption is not acceptable. Efforts are further hampered with construction cost increases in recent years that have largely outpaced inflation; thus delays in project delivery effectively diminish available budgets. All of this underscores the importance of delivering sustainable concrete bridges both cost-effectively and in an accelerated schedule. Bridge construction is often in the critical path of larger transportation improvement projects and is a significant portion of the overall project cost.

When owner agencies and industry collaborate, the cost benefits of sustainable concrete bridge delivery are maximized, as demonstrated by the recently completed widening of the State Route 22 freeway in Southern California. Twenty-two bridges were widened, nine bridges were replaced, and three new bridges were added in an aggressive design-build schedule. These bridge improvements were part of an overall project to eliminate bottlenecks, reduce congestion, and improve safety on a 12-mile stretch of Route 22, located in Orange County, California, extending from Valley View Boulevard



Formwork is placed around precast girders in the construction of a seismic-resistant integral connection with the columns. Photo: Jay Holombo, PBS&J.



Completed low-profile precast concrete girder undercrossing on SR 22. Photo: Vinh Trinh, PBS&J.

to its terminus at State Route 55. This project added a high-occupancy vehicle (HOV) lane, auxiliary lanes, shoulders along with ramp replacement, and interchange reconfiguration.

The \$670 million project was funded by the Orange County Transportation Authority (OCTA), and delivered using design-build, led by the Granite-Myers-Rados (GMR) joint venture. The GMR team hired PBS&J as the lead structural engineer in design and construction support. A collaborative environment facilitated by innovative project delivery methods was crucial in not only meeting the aggressive design-build schedule but also maximizing economy.

A significant challenge on the project was maintaining acceptable vertical clearance of the undercrossing and separation widening because widened bridge structures had to match the existing cross-slope and profile. Further,

the widened structures had to match the structural seismic and gravity response characteristics of the existing cast-in-place box girder bridges that are both continuous longitudinally and monolithic with the substructure. And finally, disruptions to traffic had to be minimal during construction.



Agency-Industry Collaboration Maximizes Economic Benefits in California

To meet this challenge, the design-build team worked with OCTA and the California Department of Transportation (Caltrans) to select a system of precast, prestressed concrete bridge beams and stay-in-place (SIP) precast concrete deck panels with a composite concrete topping. Depending on the span range, bulb tees, California I-beams, and rectangular-shaped girders were utilized. The latter were used for shorter spans, where vertical clearance necessitated the use of bridge-specific girder depths, and exterior bridge beams to match the aesthetics of the existing cast-in-place bridges. Continuity for gravity and seismic loading was created with longitudinal reinforcement in the cast-in-place deck topping and bottom-flange continuity reinforcement mechanically coupled through the cap-beam making an integral connection with the columns. This system allowed the design-build team to expedite delivery economically while meeting the structural performance and aesthetic requirements.

One of the biggest challenges was widening the State Route 22/I-5 separation structure. This bridge spans 17 lanes of I-5 traffic on a curved alignment with a variable superelevation up to 6%, and on a 45-degree skew. The longest span is 170 ft, has an inside radius-of-curvature of 1300 ft and spans five lanes of mainline northbound

I-5 traffic that had to remain open throughout the duration of the project. The design-build team elected to use curved precast, prestressed concrete tub girders to span over these lanes of traffic. These girders, measuring over 100 ft in length and weighing over 250 kips, were spliced with box girders cast on falsework using continuous post-tensioning. The contractor site-cast the curved tub girders using a cast-in-place concrete slab that was graded so the soffit would match deck contours including the variable super-elevation and camber. Vertical stems were used to simplify the interface with the cast-in-place sections. After casting, these girders were transported from the casting site, and lifted into place using a single crane. Although not necessarily new, the curved tub girder system allowed for an innovative structure that was economical, fit the aesthetic requirements of the site, and met the aggressive design-build schedule with minimum traffic interruptions. Savings amounted to approximately 10% of the overall bridge cost; however, this method had an added benefit of minimizing risk and providing a safer choice.

The challenges faced by agencies and industry, as more and more of our transportation improvements in California include highly congested urban interchanges, require innovative and cost-effective solutions to meet



Curved precast, prestressed concrete spliced girders span I-5 at the interchange with State Route 22.

Photo: Rick Sharp, PBS&J.

diminishing budgets. Construction materials and reduced cost escalation has largely outpaced inflation. To meet these challenges, agency-industry collaboration is essential in the delivery of sustainable concrete bridges, and the benefits of this collaboration have been demonstrated with successful delivery of the State Route 22 HOV widening.

Aerial view of State Route 22 passing over I-5 during construction.

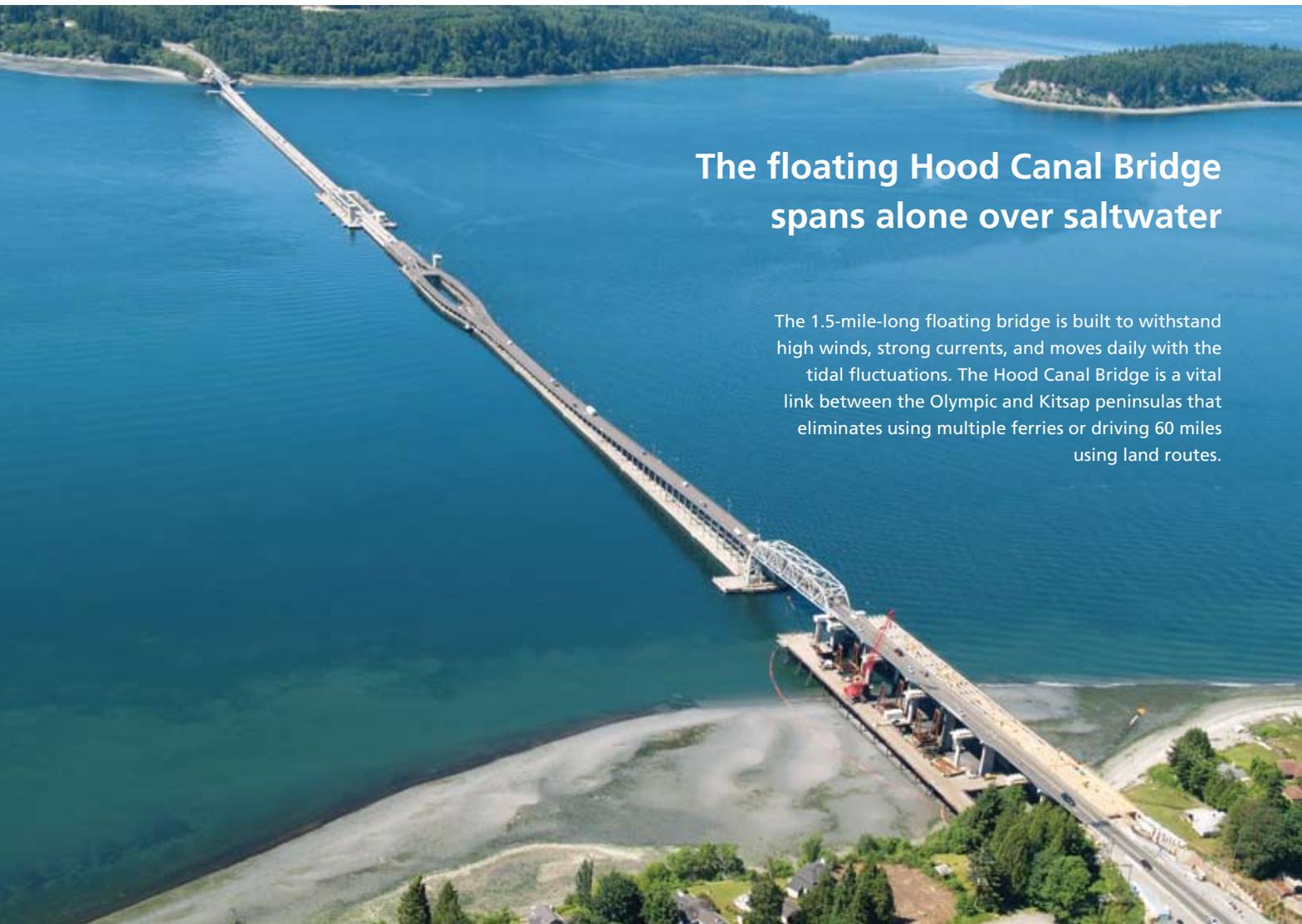
Photo: © James A. Gallego.



PROJECT

ONE OF ELEVEN, BUT ONE OF A KIND

by Mark A. Gaines and Joseph M. Irwin, Washington State Department of Transportation and Michelle L. Tragesser, Parametrix



The floating Hood Canal Bridge spans alone over saltwater

The 1.5-mile-long floating bridge is built to withstand high winds, strong currents, and moves daily with the tidal fluctuations. The Hood Canal Bridge is a vital link between the Olympic and Kitsap peninsulas that eliminates using multiple ferries or driving 60 miles using land routes.

profile

HOOD CANAL BRIDGE / KITSAP AND JEFFERSON COUNTIES, WASH.

ENGINEER: Washington State Department of Transportation, Olympia, Wash.

PRIME CONTRACTOR: Kiewit-General (a joint venture), Poulsbo, Wash.

CONCRETE SUPPLIER: Glacier Northwest Inc., Seattle, Wash.

POST-TENSIONING SUPPLIER FOR STRAND TENDONS: AVAR Inc., Campbell, Calif.

POST-TENSIONING SUPPLIER FOR BAR TENDONS: Williams Form Engineering Corp., Portland, Ore.

PRECASTER FOR PRESTRESSED GIRDERS, STAY-IN-PLACE DECK PANELS, AND VOIDED SLABS: Concrete Technology Corporation Inc., Tacoma, Wash., a PCI-certified producer



The pontoons are heavily reinforced and post-tensioned in all three principle directions. Tight tolerances on placement of formwork and reinforcement are required to maintain the design height of the pontoon deck above the water surface.

The scene is the epitome of the Pacific Northwest: evergreen trees, dark blue water, and majestic mountains. But the natural beauty of the Hood Canal hides a beast's heart. As winter descends on the region, it brings icy rains, gale force winds, and white-capped waves that blow and crash through the area almost unimpeded.

At the northern end of the waterway, the Hood Canal Bridge spans across the divide to connect the Kitsap and Olympic peninsulas, fluctuating in elevation daily with tidal shifts up to 16.5 ft. Its elevated roadway, like bridges everywhere, allows drivers a more direct route to their destinations. Yet, the bridge is one of only 11 floating bridges in the world. With a length of 7869 ft—approximately 1.5 miles—the bridge is the longest of its kind over saltwater. It hasn't been an easy existence, either.

The 1979 Storm

The original Hood Canal Bridge's west half sank in 1979 after less than 18 years of service. With the wind blowing from the south and a very strong current flowing from the north, the west-half floating structure overturned at the most exposed part of the canal. That half was replaced in 1982, but now the east half, completed in 1961, is reaching the end of its service life.



A total of 14 floating pontoons are being constructed in four separate cycles in approximately 2-1/2 years in the graving dock.

Why Build a Floating Bridge?

At the bridge site, the canal is up to 340 ft deep. A concrete floating bridge provides a cost-effective solution for crossing a channel with very deep, soft soils in a high seismic region. While a high-level structure was evaluated during design, the exorbitant costs for the site conditions could not be justified.

Not only must the bridge float in a harsh marine environment, it must also permit marine vessels to navigate the canal. Essential hydraulic, electrical, and mechanical components housed in key pontoons allow the bridge to open its 600-ft-wide draw span for marine traffic. With a naval submarine base to the south of the structure and the mouth of the canal to the north, this function is critical for national security.



Two pontoons incorporated precast segments and closure pours to facilitate placement of large, heavy embedded mechanical components of the draw span that required maximum tolerances of 1/16 in. in 500 ft.

Construction Progress

The Hood Canal Bridge West-Half Retrofit and East-Half Replacement Project was started in June 2003 and will be completed by the end of 2010. The new east half is expected to be operational until 2084. To ensure this 75-year lifespan, high-performance

PRECAST CONCRETE FLOATING BRIDGE / WASHINGTON STATE DEPARTMENT OF TRANSPORTATION, OLYMPIA, WASH., OWNER

EPOXY-COATED STRAND SUPPLIER: Sumiden Wire Products Corp., Stockton, Calif.

BRIDGE DESCRIPTION: 1.5-mile-long floating bridge with fixed approach spans and movable transition spans between fixed piers on land and structures floating on tidal saltwater

CONCRETE STRUCTURAL COMPONENTS: Prestressed concrete pontoons; reinforced concrete anchors; two-column reinforced concrete piers; 32-in.-deep and 42-in.-deep, precast, prestressed concrete I-girders; and precast, prestressed concrete stay-in-place deck panels topped with a cast-in-place concrete roadway

BRIDGE COST: \$471 million

WSDOT Moving Towards Performance-Based Concrete Specifications

Although the concrete has performed well overall, future projects similar to this will use performance-based concrete specifications. This will allow WSDOT to include additional performance requirements such as shrinkage and scaling resistance. Some potential improvements that could be made to this mix include reducing cementitious materials content, adding shrinkage-reducing or corrosion-inhibiting admixtures, or perhaps moving to self-consolidating concrete. Shifting to performance specifications will allow contractors to develop mixes that meet performance requirements yet are tailored to the forming, placement, consolidation, and the form removal methods they prefer.

The WSDOT is currently considering use of the performance-based specifications for the next floating bridge project, which will likely be the State Route 520 floating bridge replacement across Lake Washington. This project is currently in the design phase, with pontoon construction expected to start late 2009. Pontoon construction on this project shares many similarities with the Hood Canal project. The WSDOT is incorporating valuable experiences from Hood Canal into the design of the State Route 520 Bridge to further improve performance and constructability, and reduce construction costs.

materials and tight construction tolerances are required. Widening and improving the bridge's west half was completed in 2005. Since then, the Washington State Department of Transportation (WSDOT) has been constructing a new east half, which will be moved into place in May-June 2009, and further upgrading the west half.

The work is underway at multiple construction sites in western Washington. Since early 2006, construction progress includes successfully building and floating 12 of the 14 new east-half pontoons, joining the draw span pontoons together, and rehabilitating three 1980 pontoons. The original elevated roadways were removed from these pontoons, and wider roadways with a new profile grade were constructed in their place. Also, 20 gravity anchors have been constructed and were placed on the canal floor in summer 2007. Other large operations in various stages of construction include fabrication of the transition spans and specialized supports, lift spans, large spherical and cylindrical bearings, major mechanical components, and outfitting of the draw span assembly with buildings, access ramps, and the hydraulic, mechanical, and electrical systems.

All of these elements of work set the stage for the closure of the bridge in May-June 2009, when the east half of the bridge and the west transition span will be replaced. The bridge will be open to traffic while new anchor cables are installed and west half mechanical and electrical upgrades are made.

Pontoon Construction

The prestressed high-performance concrete (HPC) pontoons are being constructed in four separate cycles at Concrete Technology Corporation's graving dock in Tacoma, Wash. The largest of the cellular box structures is 60 ft wide, 18 ft tall and 360 ft long. The pontoons are heavily reinforced with both conventional epoxy-coated reinforcing steel and longitudinal, transverse, and vertical post-tensioning tendons.

The HPC used for the pontoons was originally developed in the 1990s for the I-90 Lacey V. Murrow (LVM) floating bridge across Lake Washington and includes the following components:

Type I/II cement: 625 lb/yd³

Class F fly ash: 100 lb/yd³

Silica fume: 50 lb/yd³

Aggregates: 1/2-in. maximum size

The approximately 31,000 yd³ of pontoon concrete have a minimum specified 28-day compressive strength of 6500 psi, and a maximum 56-day chloride permeability of 1000 coulombs. The actual 28-day compressive strengths have been approximately 11,000 psi and the 56-day permeability less than 800 coulombs. Early in the project, the contractor realized that the LVM concrete placement in the pontoon walls would be challenging because the walls are up to 21 ft tall; 6 in., 8 in., and 10 in. thick; and heavily congested with reinforcing steel and post-tensioning ducts. To improve concrete placement and consolidation, the contractor requested approval to exceed the maximum 9-in. slump that was allowed by the contract. This was achieved by using additional high-range water-reducing admixture within manufacturer's allowances. After

The elevated roadway was constructed at Terminal 91 at the Port of Seattle on three existing pontoons. These three pontoons were used temporarily in the west draw span until 1982 to open the Hood Canal Bridge quickly after the 1979 storm sunk the west half. These pontoons were successfully rehabilitated in 2007 after 25 years of storage in the Puget Sound and are used in the new east half.



The final set of 10 anchors was towed to the Hood Canal and set accurately on the channel floor using GPS, tilt meters, and gyroscopes. The anchor cables will be attached between the anchors and pontoons in 2009.



Pontoons are assembled together with spliced post-tensioning tendons before being towed to the Hood Canal Bridge to replace the old pontoons.

conducting a series of qualification tests and constructing a mock-up pontoon wall, the contractor successfully demonstrated that this "new" mix could be placed without segregation. Testing and acceptance of this concrete was accomplished using the flow test that is common with self-consolidating concrete (SCC).

Another innovation implemented was to precast portions of two pontoons that make up the moveable draw pontoons. These pontoons have heavy mechanical components cast into the walls 21 ft overhead. The precasting operation improved overall safety in supporting these massive guides and facilitated the tight alignment tolerances needed for the mechanical draw span operations. The precast elements consisted of

portions of the exterior walls with all necessary reinforcement and post-tensioning to tie into the top and bottom slabs. Once the precast pieces were set into place, reinforcement and post-tensioning was tied into the base slab and the wall closure regions. The base slab, wall closures, and top slab were then constructed with cast-in-place concrete. By precasting portions of these pontoons, construction time was reduced. Precasting also allowed much of the work to be shifted off-site and away from the heavily congested graving dock facility.

Elevated Roadway Construction

To withstand the regular pounding of saltwater waves that crash over the bridge during the storm season from October through April, the elevated roadway built atop the pontoons is constructed primarily of reinforced and precast, prestressed concrete. With project activities since early 2006 focusing on constructing pontoons and anchors and assembling the draw span section, the elevated roadway remains a main element of work to be accomplished.

A concrete floating bridge provides a cost-effective solution.

The elevated roadway on a floating structure compels the designer to select an optimal span length to minimize the dead loads and to evenly distribute column loads to the pontoon structure, which behaves like a beam on elastic foundation from water buoyancy. For the Hood Canal Bridge, this equates to shallow I-girders with 60-ft span lengths. Built on two-column piers, the two-span continuous units have a hinge diaphragm at the center pier. The floating structure is isolated from seismic events with special connections to the fixed structures, so the floating bridge is governed by dynamic loads from wind, waves, and currents instead of seismic loads.

The prestressed concrete I-girders are typical WSDOT 32-in.- and 42-in.-deep sections, but all reinforcement and 0.5-in.-diameter prestressing strands are epoxy coated and the bottom flange concrete clear cover is 1-1/4 in. The 7-1/2-in.-thick roadway deck consists of 4 in. of reinforced concrete cast on 3-1/2 in.-thick, stay-in-place precast, prestressed concrete deck panels. Using stay-in-place panels significantly decreased the time required to construct the deck and increased safety when working over water.

Girders on the draw pontoons, where the profile grade drops to the lowest point, use dapped ends and end blocks—with some cantilevering over piers. To open the navigation channel, three lift spans are raised to allow the draw pontoons to retract underneath. The draw span necessitates minimizing the deck elevation while maintaining sufficient vertical clearance for maintenance vehicles underneath and to clear most storm waves.

Temporary ballast water is used in the pontoon's internal cells to balance the pontoons as the superstructure loads are added. Regular monitoring of the pontoon freeboard (distance from top of the deck to water line) is needed to maintain a level and stable structure at dockside. Specialized survey equipment tracks the top plane of the deck as it moves with the wind, waves, and the addition of new loads. Construction measurements are then referenced to this fluctuating theoretical plane. Permanent rock ballast is used to make final adjustments.

Gravity Anchor Construction

From the public's perspective, the reinforced concrete gravity anchors were said to look like giant "tea cups," measuring 29 ft tall and ranging in diameter from 46 ft to 60 ft. The anchors are massive, stout vessels that must float initially. Built in Seattle, the large bowl-like structures were towed 50 miles to Hood Canal, then lowered to the canal floor and filled with crushed rock ballast.



The draw spans open for large vessels and submarines in the Hood Canal.

The ballasting is required to attain the final submerged anchor weight, keeping the pontoons in alignment during storms without shifting the anchors on the soft soil slopes. While the geometry of the anchors is complex, the general design details are straightforward. The anchors have 3 in. of concrete clear cover to all reinforcement and a low-permeability, 4000 psi concrete mix made with pea gravel. Vertical post-tensioned bar tendons are used in the walls at the picking eye locations to distribute the shear forces from the setting operations.

After the new east half of the bridge is floated into place, 3-in.-diameter anchor cables will be threaded through the 27-in.-diameter pipe cast inside 4.5-ft-thick, heavily reinforced walls and attached to the pontoons to complete the anchorage connections for the floating bridge. Some of the gravity anchors are offset nearly 2000 ft from the bridge alignment and rest in water as deep as 340 ft below mean tide. Cathodic protection systems are used to protect the anchor cables, thereby protecting the pontoons and the anchors.

The elevated roadway uses precast, prestressed concrete I-girders, and stay-in-place deck panels. This construction method reduced formwork efforts and improved safety for the over-water construction activities.

Floating into the Future

From the anchors 340 ft below the waterway's surface to the pontoons and elevated roadway, the concrete of the new Hood Canal Bridge will be tested regularly by the elements. High-performance concrete and the extensive use of pretensioning and post-tensioning will ensure that it passes its daily trials. The WSDOT has been able to learn from its past experience to create a new structure that has set the standard for floating bridges in the Washington state highway system and beyond. The new Hood Canal Bridge is a balance of form and function, putting innovative ideas into action and paving the way for improved transportation well into the future.

Mark A. Gaines is assistant state construction engineer and Joseph M. Irwin is communications consultant for the project with the Washington State Department of Transportation, Olympia, Wash. Michelle L. Tragesser is with Parametrix, Tacoma, Wash., and is technical services manager for the project

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

BRIDGES FOR LIFE[®] MARK YOUR CALENDAR

FEATURING HIGH-PERFORMANCE BRIDGES



U.S. Department of Transportation
Federal Highway Administration
 Cosponsored by the Federal Highway Administration



The PCI National Bridge Conference (NBC) is the premier national venue for the exchange of ideas and state-of-the-art information on concrete bridge design, fabrication, and construction—particularly precast, prestressed concrete bridges. Public agencies and industry have joined forces and are committed to bringing together the nation's most experienced, expert practitioners. More than 90 papers will be presented in 23 individual sessions. The NBC will be held in conjunction with the PCI Annual Convention and Exhibition, which offers additional opportunities.

Sunday afternoon, October 5

Opening Session featuring the 2008 PCI Bridge Design Award Presentations

Spotlight State Plenary Session – The Washington State Department of Transportation

Monday, October 6

Technical Education Sessions

Tuesday, October 7

Technical Education Sessions

Social Events and Gatherings

Throughout the event, you'll have ample time to network with colleagues and establish or renew acquaintances. Social events include an opening reception gala, sumptuous buffet luncheons sponsored by our exhibitors, and a banquet. Above all, you'll have the opportunity to immerse yourself in the state of the art of concrete bridges. An exciting program of tours and activities for accompanying guests is also available.

Special Bonus

Those registering for the National Bridge Conference also have the opportunity to participate in all the exciting committee meetings and educational sessions of the PCI Annual Convention and Exhibition.

For a listing of papers and presenters, and to view registration details as they develop, visit the conference website at www.pci.org/news/bridge_conference/index.cfm.

For more information, contact John Dick;
 Tel.: (312) 360-3205; Fax (312) 786-0353; or
 Email: jdick@pci.org.

OCTOBER 5-7, 2008, ROSEN SHINGLE CREEK RESORT, ORLANDO, FLA. PLAN NOW TO ATTEND!

SCP BRIDGES THE GAP

HIGHWAYS • BRIDGES • GIRDERS • PILES • HEAVY STRUCTURAL HIGHWAYS



SCP STANDARD CONCRETE PRODUCTS

Offices in: Columbus • Atlanta
 Mobile • Savannah • Tampa

Corporate Office:

PO Box 1360
 Columbus, GA 31902-1360
 Phone: (706) 322-3274
 Fax: (706) 576-2669

www.standardconcrete.net

Replacement of the I-10 Bridges across Escambia Bay

INNOVATIVE SOLUTIONS FOR **RAPID CONSTRUCTION**

by Charles Rudie, John Poulson, Victor Ryzhikov, and Theodore Molas, PB Americas



Following Hurricane Ivan, emergency repairs were made to the westbound bridge using spans from the eastbound bridge. All Photos: Charles Rudie, PB.

Hurricane Ivan struck Florida's coast in September 2004 near Pensacola with devastating results. More than 50 spans of the existing 3-mile-long, I-10 bridges across Escambia Bay were washed into the bay and another 60 were permanently dislocated. In order to reopen I-10 to the public as quickly as possible, missing spans on the westbound bridge were replaced with entire spans from the more heavily damaged eastbound bridge. With the westbound bridge reopened, work shifted to the eastbound bridge. By replacing the missing spans of the superstructure with a temporary metal structure, the eastbound bridge was brought back into service, but for only one lane of traffic.

The Florida Department of Transportation (FDOT) quickly released a request for proposals (RFP) for the design-build replacement of the I-10 bridges. The request mandated that all traffic be moved onto the new structure by the end of 2006, and that the bridges be brought to their final condition consisting of three 12-ft-wide lanes of traffic with two 10-ft-wide shoulders no later than the end of 2007. The width of this typical section allowed for one bridge to temporarily carry four 12-ft-wide lanes and a center barrier until the second structure was finished.

Design-Build Approach

With notice to proceed given on April

profile

I-10 BRIDGE REPLACEMENT / ESCAMBIA BAY, FLA.

ENGINEER: PB Americas, Tampa, Fla.

PRIME CONTRACTOR: Tidewater Skanska Flatiron, Milton, Fla.

PRECASTERS: Standard Concrete Products Inc., Tampa, Fla., a PCI-certified producer; Gulf Coast Pre-Stress Inc., Pass Christian, Miss., a PCI-certified producer

POST-TENSIONING CONTRACTOR: VSL, Hanover, Md.

AWARDS: 2007 PCI Bridge Design Award for the Best Bridge with Spans Greater than 150 ft.

25, 2005, the design-build team had less than 21 months to design and build the first new bridge. Both bridges would need to be completed in just 33 months. These milestones forced the design schedule to be very aggressive and to be split into several submittals. This allowed the precaster and the prime contractor to begin operations earlier than a traditional process would have allowed. The first submittal was delivered on May 20, 2005, clearing the way for pile fabrication and driving. The entire plan set was completed in September, just 5 months after notice to proceed.

Substructure

Several options were considered for the foundation, but 36-in.-square precast concrete piles were determined to be the most efficient and economical. The typical span could incorporate five piles located directly under five girders, allowing for a more efficient pile cap design.

The use of precast elements was instrumental in achieving the project's milestones. Precast elements not only eliminated time-consuming cast-in-place (CIP) construction on the water, but also allowed the contractor to utilize two precasters. The majority of the substructures consisted of precast pile caps resting on five piles. The other substructures were piers with waterline footings, which increased in size as they approached the channel. For a large number of the piers, two precast footings resting on three piles were used. This arrangement kept the weight of the footings to 80 tons, allowing the contractor to use the same equipment to erect precast piles, caps, footings, and girders.

The 36-in.-square piles have a 22.5-in.-diameter void throughout the length of the pile, except for a 4-ft solid section at the tip. This was done primarily for reduction in material and weight, but it

also presented the opportunity to utilize precast pile caps and footings. The connection between the substructure element and the pile was made by inserting a rebar cage into the top 10 ft of the pile that extends into the pile cap, or footing. With a plug that extends 6 in. below the cage, the void was then filled with concrete. The length of connection was controlled by the stress transfer between the precast concrete of the pile and the CIP concrete of the plug.

Production piles were completed for the channel piers first. This was done because the spliced girders required substantially more time to erect than the rest of the superstructure. The footings for these piers needed to be cast-in-place, and the contractor employed a very clever method to accomplish this. First, a concrete seal slab was cast in the yard to create the bottom form. Next, a prefabricated rebar cage was placed on the seal slab. Steel side forms were then connected to the seal slab. The tops of the side forms were connected to each other with a series of steel girders.

These girders were then connected to the seal slab with four steel tie rods. These rods were placed inside PVC pipes to accommodate removal after casting. This entire system was then lifted into place and set on top of the piles. The steel girders rested on top of steel pipes, which were placed on the piles. This process eliminated the need for friction collars on the piles and transferred the entire load down to the pile through compression. After the concrete was cast and given time to set, the steel pipes and tie rods were removed and the remaining holes filled.

After the footings were finished, work proceeded on the remainder of the substructure. Except for the previously mentioned precast pile caps, the remainder of the substructure was cast-in-place. The majority of the reinforcement in the columns, caps, and struts was pre-tied in the yard, or on a barge. As the formwork was erected, these pre-tied cages were set into place, making the elements ready for concrete quickly.



Spliced post-tensioned haunched girders with a drop-in span were used for the 250-ft-long main spans.

PRECAST, PRESTRESSED CONCRETE / FLORIDA DEPARTMENT OF TRANSPORTATION, TALLAHASSEE, FLA., OWNER

BRIDGE DESCRIPTION: Two 2.6-mile-long parallel bridges with precast, prestressed concrete beams and cast-in-place concrete deck with the first bridge completed in 20 months

STRUCTURAL COMPONENTS: 1024 78-in.-deep Florida bulb tees, 71 AASHTO Type II girders, 6 AASHTO Type I girders, 130 pile caps, 64 pile footings, 1346 3-ft-square piles, and 8 2-ft-square piles

DESIGN AND CONSTRUCTION COST: \$245.6 million

Precast, prestressed concrete girders with a cast-in-place deck were the obvious choice.

Superstructure

The superstructure selection was heavily influenced by the RFP's requirement that the typical span length of the bridge had to be a minimum of 130 ft and the channel span length had to be a minimum of 250 ft. This span arrangement, and the aggressive environment created by the saltwater in Escambia Bay, made precast, prestressed concrete girders with a cast-in-place deck the obvious choice for the superstructure. For the typical span, five 78-in.-deep Florida bulb tees at a 12 ft 6 in. spacing and a length of 136 ft were the most economical. A three-span post-tensioned spliced girder based on the 78-in.-deep Florida bulb tee was chosen for the channel span.

The spliced girder is comprised of five sections: two haunched sections over the center piers, two end sections, and a drop-in girder between the haunched sections. The haunched sections over the center piers increase to a maximum depth of 112 in. The system contains four draped post-tensioning ducts to house twelve 0.6-in.-diameter Grade 270 low-relaxation strands. To handle the bursting stresses associated with these strands, the end beams contain an approximate 2-1/2-ft-wide by 10-ft-long anchor block over the full depth of the beam.



A deck stripper was used to remove the steel formwork from the underside of the deck.

Before erection of the segments could occur, two temporary shoring towers were constructed to support the system between the end girders and the haunched girders. After the haunched and end girders were erected, the drop-in section was set into place between the haunched girders. The drop-in segment rested on two strongbacks supported from the tops of the haunched girders. Once all the segments were in place, the strands in the first two post-tensioning ducts were stressed. At this point, the deck was placed. After the deck achieved sufficient strength, the strands in the last two ducts were tensioned. This erection sequence afforded minimum disturbance to the barge traffic in the channel.

Deck Construction

After the girders were set and diaphragms cast, work shifted to the CIP deck. Two methods were employed for the placement of formwork utilized in the deck construction. The first was a removable steel formwork system, which was installed with a track-driven formwork placer. The tracks for the placer were temporarily placed on the girders. The placer used a system of winches to lift formwork, drive it into position, and hold it in place as workers tightened a series of turnbuckles to allow the formwork to rest on the bottom flange of the girders. After casting the deck, the formwork was removed by a formwork stripper. The stripper drove over the deck on rubber tires and employed an under-slung arm to access the formwork from below the deck. The stripper used a system of hydraulic jacks, winches, and a sliding platform to remove the formwork and transport the sections to the top of the deck for future use. At the peak of construction, this method allowed the contractor to place over 10,000 ft² of bridge deck per day.

The second formwork method utilized was corrosion resistant stay-in-place (SIP) forms. The use of SIP was approved for the approaches and over the channel to allow deck construction from multiple fronts.



A track-driven placer was used to install the steel formwork for the deck.

Working on multiple fronts was not unique to deck construction. The extremely aggressive schedule associated with the project required the contractor to utilize this philosophy on all aspects of construction. At the peak of construction, over 20 cranes were on site with a work force of over 350 people working day and night to complete the first bridge.

Conclusion

Interstate 10 provides the traveling public with a vital link between Florida and the southeastern United States. I-10 functions as a major corridor for the delivery of goods and services, and also as an essential evacuation route. The importance of reestablishing this link could not be said more simplistically and truthfully than as stated by the former governor of Florida, Jeb Bush, at the ribbon cutting ceremony for the eastbound bridge, "This was a big damn deal!" These bridges will stand as a testament to what can be accomplished when a crisis challenges the tenacity and perseverance of the bridge building community.

Charles Rudie, senior structural engineer; John Poulson, vice president; Victor Ryzhikov, senior supervising engineer; and Theodore Molas, senior structural engineer are all with PB Americas, Tampa, Fla.

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

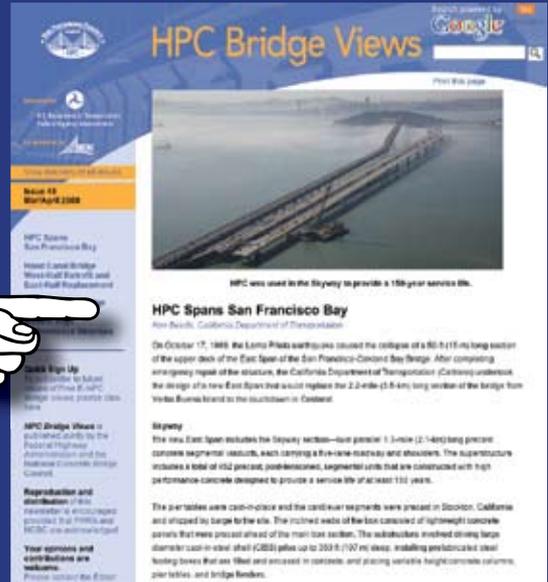
HPC Bridge Views Is Now Electronic Only

Starting in 2008
HPC Bridge Views
will be distributed
electronically.

To continue to receive
HPC Bridge Views
you must subscribe
online at:

www.hpcbridgeviews.org

Don't miss any more issues.
Subscribe today.



U.S. Department of Transportation
Federal Highway Administration



LEHIGH™ WHITE CEMENT

Architectural Concrete.

The versatile building product for:

- DURABILITY AND LONGEVITY
- ENERGY EFFICIENCY
- REFLECTIVE SURFACES
- BETTER INDOOR AIR QUALITY
- BEAUTIFUL & FUNCTIONAL STRUCTURES



LEHIGH CEMENT COMPANY
WHITE CEMENT DIVISION
7660 Imperial Way
Allentown, PA 18195-1040

Toll Free 1 800 523 5488
Phone 610 366 4600
Fax 610 366 4638

www.lehighwhitecement.com

SUSTAINABLE

AVOIDING

LANDSLIDES

by Kevin Harper, California Department of Transportation



The emergency project relocates a portion of U.S. Route 101 away from a large landslide requiring two large bridges over the South Fork Eel River.

The large landslide extends over 1000 ft above the river enveloping the current highway. The slide is approximately 3000 ft wide.
Photos: © Caltrans.

The relocation of U.S. Route 101 required two high-level bridges over the Eel River

An emergency project to relocate a portion of the Pacific Coast Highway (U.S. Route 101) away from a large landslide in northern California required two large bridges to span the South Fork Eel River. Although the bridges are within a quarter mile of each other, they are dramatically different structures. The difference in the bridge types resulted from the vastly different terrains at the two crossings of the South Fork Eel River that snaked along in the shape of a giant "U" with a bridge over each leg. The southern leg of the river, with its wide banks, required a 1355-ft-long, three-span, segmental concrete bridge that was 275 ft above the river. The northern leg of the river, which passed through a narrow rock walled canyon, required a 581-ft-long, three-span, cast-on-falsework concrete arch bridge that sits 150 ft above the river.

Route 101 is the primary route that provides direct access to California's north coast for commercial trucking and recreational traffic. North of the San Francisco Bay area, this highway is considered the "lifeline of the California's north coast." There has been a recurring problem of landslides around Confusion Hill over the last decade, resulting in frequent road closures and high maintenance costs. When a major landslide occurs that closes both lanes, the traffic south of Confusion Hill may have to backtrack and detour an additional distance of 250 miles. During the past 10 years, over \$33 million has been spent on slide repairs.

The project involves relocating approximately 1.5 miles of U.S. Route 101 away from the active landslide. The large ancient rockslide complex extends

profile

SOUTH FORK EEL RIVER BRIDGES (CONFUSION HILL BRIDGES) / LEGGETT, CALIF.

ENGINEER: California Department of Transportation, Sacramento, Calif.

PRIME CONTRACTOR: MCM Construction Inc., North Highlands, Calif.

CONTRACTOR'S SEGMENTAL ENGINEER: Finley Engineering Group Inc., Tallahassee, Fla.

CONCRETE SUPPLIER: Mercer-Fraser Company, Eureka, Calif.

FORM TRAVELER SUPPLIER: AVAR Construction Systems Inc., Campbell, Calif.

POST-TENSIONING SUPPLIER: Schwager Davis Inc., San Jose, Calif.

REINFORCING STEEL SUPPLIER: Fontana Steel, Stockton, Calif.

upwards from the river for more than 1000 ft, enveloping the current highway that is benched into the mountain about 240 ft above the river. The landslide area is approximately 3000 ft wide. Geotechnical studies have concluded that the slide is progressively losing strength and there is a high probability that the complex will continue to move in the future. This highway relocation project is an emergency project that is fully financed with federal emergency relief funds. The expedited delivery of this \$65.7 million dollar project only took 28 months from the initial planning study phase until award of the construction contract.

The complete project includes two bridges, two tieback retaining walls, and a large cut between the two bridges. The bid for the structures work was \$49.4 million. The contractor started work in June of 2006 and is expected to complete the project in 2009.

North Bridge

The smaller north bridge is a concrete inclined leg frame arch with a 229-ft center span and 175-ft end spans. This bridge type fits this particular site well by meeting the requirement to keep the piers out of the ordinary high water limits of the river while still maintaining balanced span ratios. This configuration actually kept the piers out of the higher 100-year water level, which simplified the environmental process even more. The river at this site was contained within a relatively narrow canyon with steep rock walls, which provided suitable foundation material to anchor the inclined piers. The superstructure of the bridge is a cast-in-place, post-tensioned, two-cell box girder with sloping exterior webs. The box varies in depth from 13.8 ft at the piers to 5.9 ft at the ends and midspan. The deck width is 42.8 ft and the bottom slab

width varies from 16.8 ft at the piers to 24.7 ft at the ends and midspan. The bridge was cast on falsework that was up to 140 ft tall. The solid concrete tapered piers are anchored into the mountain in 17.5-ft-wide by 6.9-ft-high by 80-ft-deep mined shafts to develop the full probable plastic moment of the piers during a seismic event. The shafts were excavated through very hard rock that required blasting, as well as weathered and fractured rock regions that required rock bolting for stability.

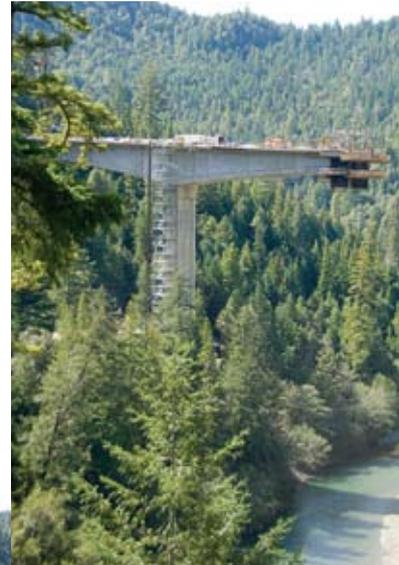
Concrete compressive strength was specified as 6100 psi for the superstructure and 5100 psi for the piers. The concrete strength required at time of post-tensioning was 3600 psi.

The total post-tensioning jacking force applied at abutment 1 for the full-length tendons was 8776 kips. The tendons consisted of 0.6-in.-diameter, 270 ksi, low relaxation strands.

South Bridge

The larger south bridge uses a cast-in-place, segmental concrete box girder with normal weight concrete. Like the north bridge, the piers were not only outside the required ordinary high water limits of the river, but also the 100-year flood levels. The south bridge was selected to be segmental because its height above the river was too high for economical construction using falsework. The span lengths of the bridge are 348 ft, 571 ft, and 436 ft.

The south bridge, which is 275 ft above the river is a cast-in-place concrete segmental box girder constructed by the balanced cantilever method. Photos: © Jon Hirtz, Caltrans.



The north bridge, which is approximately 150 ft above the river, was built as a cast-on-falsework post-tensioned concrete box girder. The lower portion of the falsework (table top) can still be seen below the bridge as well as the temporary access trestle behind the bridge.



SEGMENTAL CAST-IN-PLACE CONCRETE / CALIFORNIA DEPARTMENT OF TRANSPORTATION, OWNER

DRILLING SUBCONTRACTOR: Pacific Coast Drilling, Petaluma, Calif.

EARTH WORK AND MINED SHAFTS: Ladd & Associates, Redding, Calif.

BRIDGE DESCRIPTIONS: Three-span, segmental cast-in-place concrete single cell box girder constructed by the balanced cantilever method and three-span, cast-on-falsework post-tensioned concrete two cell box girder with inclined piers

STRUCTURAL COMPONENTS: South Bridge: 68 concrete segments in spans of 348 ft, 571 ft, and 436 ft. North Bridge: Cast-in-place on falsework with spans lengths of 175 ft, 229 ft, and 175 ft

BRIDGE CONSTRUCTION COST: South Bridge—\$37 million; North Bridge—\$9 million



Looking south at segmental construction of the south bridge pier 2 cantilever with form travelers. Abutment 1 can be seen in the background. Photo: © Jon Hirtz, Caltrans.

The superstructure varies in depth from 31.5 ft at the piers to 11.5 ft at the ends and midspan. The single cell, box girder cross section has vertical webs and is post-tensioned longitudinally and transversely. The box girder has a deck width of 42.8 ft and a bottom slab width of 23.8 ft. The bridge is being built by the balanced cantilever

For both bridges, the piers were located outside the 100-year flood levels.

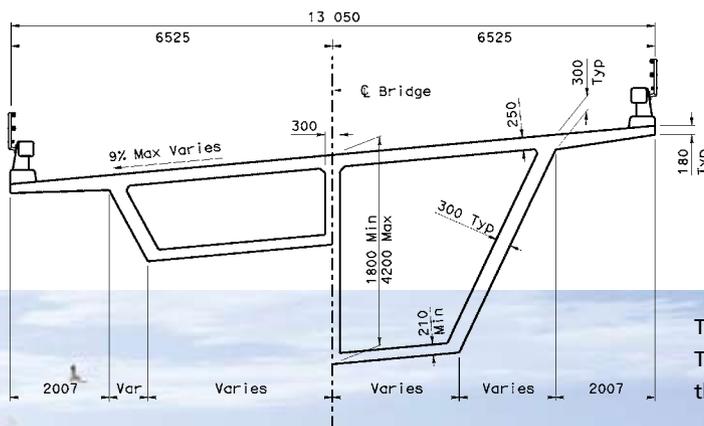
construction method from each pier and casting on falsework near the abutments. The contractor is utilizing one set of conventional form travelers, constructing the pier 2 cantilever first and then moving the travelers over to pier 3 to construct the final cantilever. The cantilevers on each side of the piers consist of 17 segments. The first four heavier segments are 13.1 ft long while the remaining 13 segments of each cantilever are 15.4 ft long. The closure segments are 12.5 ft long. The heaviest segment weighs 200 tons. The pier table length is 45 ft and is 7.5 ft out of balance toward the center span side of the pier so that during segment production the cantilever will not be more than one-half of a segment out of balance. The first segment cast is on the end span side of the piers.

The heights of the piers from top of the footing to the top of the bridge deck are 200 ft. Because of this height, it was determined that it was more economical to use a hollow pier section. The hollow piers have heavily confined corner elements using welded No. 10 reinforcing hoops spaced at 4-3/8 in. on centers

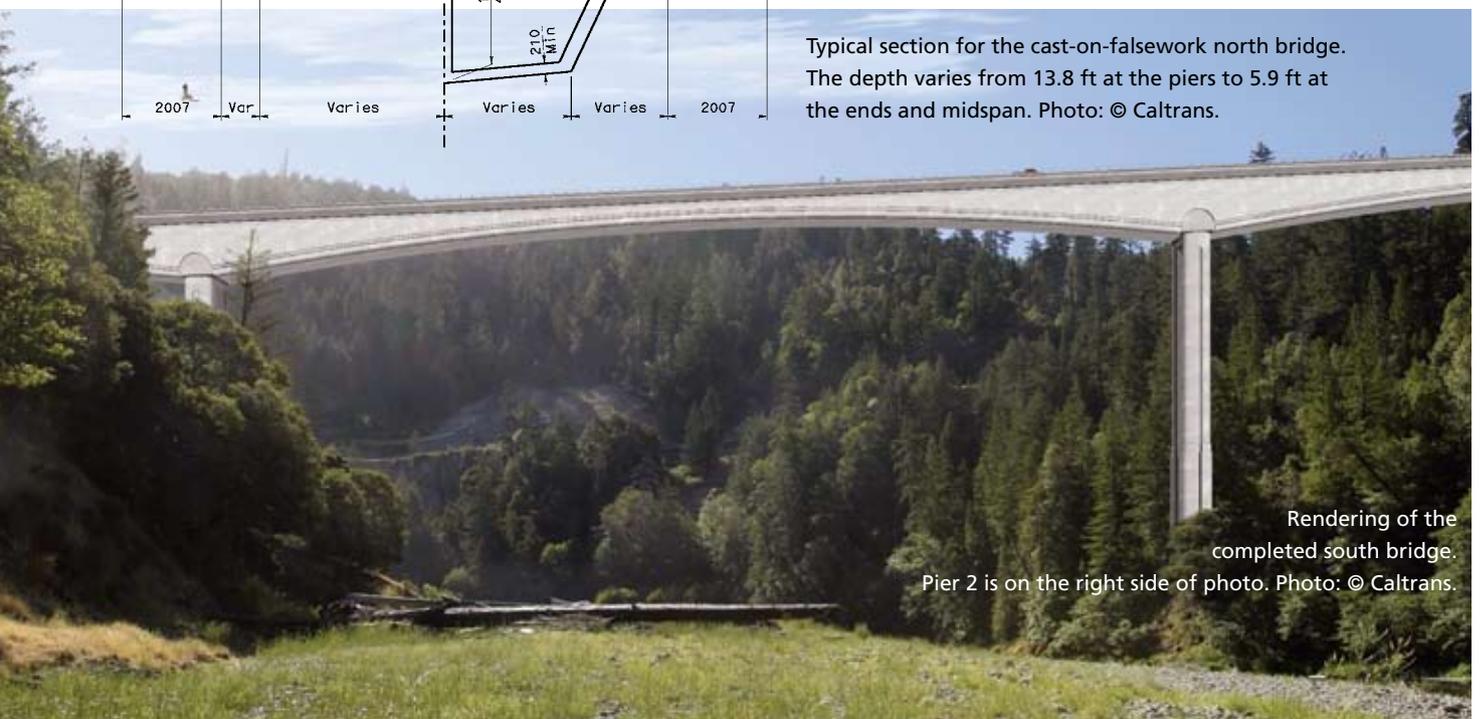
to get the necessary ductility to meet the California Seismic Design Criteria. The solid pier footings and caps were classified as mass concrete and required chilled water to be pumped through the elements to keep the heat of hydration below specified limits. The footings incorporated eleven 5-ft-diameter cast-in-drilled hole piles. The piles are up to 136 ft deep and have a nominal compression resistance of 4382 tons per pile. The footing dimensions are 36 ft long by 49 ft wide by 10.5 ft deep.

Construction of the superstructure began at the pier 2 table in October 2007. Early on, the contractor was able to achieve two segments per week per pair of travelers on the first cantilever. The contractor has plans to increase segment production to three segments per week prior to completing this first cantilever. The bridge deck incorporates an integral overlay in which an additional 1 in. of cover has been provided to the deck reinforcement for profile grinding. The bridge has also been designed to carry a future wearing surface.

The design of the bridge utilized the 1990 CEB-FIP Model Code for Concrete Structures to model the time-dependent creep and shrinkage characteristics of the bridge. Testing of the contractors mix surprisingly showed that the actual shrinkage was twice that predicted in the



Typical section for the cast-on-falsework north bridge. The depth varies from 13.8 ft at the piers to 5.9 ft at the ends and midspan. Photo: © Caltrans.



Rendering of the completed south bridge. Pier 2 is on the right side of photo. Photo: © Caltrans.

Protecting the Environment

The project is located at the north end of Mendocino County. It is within the majestic redwood forests near Standish-Hickey State Recreation Area, approximately 10 miles north of the town of Leggett where State Route 1 terminates and joins U.S. Route 101. Several tourist attractions are nearby including the adjacent Confusion Hill Mystery Spot from which the landslide gets its name.

The South Fork Eel River is federally designated as a "Wild and Scenic River." Because of this designation, all bridge piers were required to be outside of the "ordinary high water" level of the river in order to expedite the environmental process on this emergency project. This requirement caused the bridges to have relatively large center spans over the river. Both bridges are three-span structures that carry two lanes of traffic and have see-through concrete barriers along each edge of the deck.

CEB model. Consequently, a shrinkage-reducing admixture was added to the mix to cut the concrete drying shrinkage in half. The shrinkage results of the mix at the Devil's Slide segmental bridges were similar (see article in Winter 2008 *ASPIRE*[™]), and a shrinkage-reducing admixture had to be incorporated into that mix as well.

The project is progressing on schedule and within budget. The north bridge was completed in January 2008. The contractor is currently trucking excavated material from the large cuts between the two bridges over the north bridge. The south bridge pier 2 cantilever is expected to be completed in July, at which time the form travelers will be moved over to pier 3. The closure between the cantilever tips is scheduled to be placed in early 2009.

Kevin Harper is a senior bridge engineer with the California Department of Transportation, Sacramento, Calif.

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

Advertisers Index

| | | | |
|---------------------------------------|----|----------------------------------|-------------------|
| AVAR | 39 | Lehigh Cement | 25 |
| Bentley/LEAP ... Inside Front Cover | | PB | 7 |
| Campbell Scientific | 51 | PCAP—CABA | Inside Back Cover |
| DSI | 43 | Splice Sleeve | 33 |
| Eriksson Technologies Back Cover | | Stalite | 49 |
| Finley Engineering | 29 | Standard Concrete Products | 21 |
| FIGG | 3 | T.Y. Lin International | 5 |
| Gerdau Ameristeel | 4 | VSL | 38 |
| Hatch Mott MacDonald | 33 | | |

Imagine the Possibilities

At FINLEY Engineering Group, we pride ourselves on exceptional design, innovative techniques and superb client satisfaction.

Imagine a firm that does this on bridges all around the world.

We are seeking qualified applicants for Bridge Engineers and CADD Technicians.

Call: 850-894-1600



1539 Metropolitan Boulevard
Tallahassee, Florida 32312
850.894.1600



Bridging Challenges With SolutionsSM
www.finleyengineeringgroup.com

Natchez Trace Bridge, Tennessee



ECONOMICAL BRIDGE

WIDENING

by Craig A. Shutt

Two types of concrete girders were combined to create an economical design that complements surrounding structures

Designers faced several key challenges in planning the widening of State Route 22 over the Garden Grove Boulevard in Orange County, Calif. A key concern was complementing other bridges along the highway, which were constructed with cast-in-place concrete box girders, while remaining within a tight budget. The solution was found in using two types of precast concrete girders, which also helped overcome other obstacles.

The \$500-million project was part of an extensive revamping of State Route 22, which serves as a key regional route through some of the most densely populated areas of the county. The bridges accommodate local vehicular and pedestrian cross-traffic within the communities bisected by the freeway. In all, 34 bridges and more than 100 retaining walls and soundwalls were included in the project, which

profile

GARDEN GROVE BOULEVARD WIDENING / ORANGE COUNTY, CALIF.

ENGINEER: URS Corporation, Roseville, Calif.

PRIME CONTRACTOR: GMR (a joint venture of Granite Construction, C.C. Myers, and Rados), Orange, Calif.

PRECASTER: Pomeroy Corp, Perris, Calif., a PCI-certified producer

AWARDS: *Best Rehabilitated Bridge in the Precast/Prestressed Concrete Institute's 2007 Design Awards competition*

The bridge was widened from three lanes to five in each direction.

The project involved several key challenges that required innovative thinking.

constructed, reconstructed, widened, or modified the infrastructure along 12 miles of highway. The overall project was undertaken on a design-build basis and bid as a lump sum contract.

Widened by One-Third

The existing bridge, built in 1960, was constructed of cast-in-place, reinforced concrete box beams, as were many of the bridges along the route. The construction widened the six-lane bridge by one-third to accommodate a total of 10 lanes of traffic. Each side along the bridge's 340-ft length was widened by 28.75 ft, creating a total width of 170 ft. The deck's total area expanded by 19,500 ft² to 57,800 ft². The bridge features two 61-ft-long end spans and two 108.75-ft-long main spans. The structure also includes a high skew angle of 59 degrees and a tangent-horizontal alignment, with a 1% grade.

The project involved several key challenges that required innovative thinking, says Syed Mohsin Kazmi, senior project manager for URS Corp. in Roseville, Calif., the bridge designer. These went beyond aesthetics to include both logistical and safety issues that required close teamwork among the design and construction partners. Specifically, the city and Orange County Transportation Authority officials wanted to ensure traffic was not disrupted throughout the project, build the project quickly, blend it with other cast-in-place bridges along the highway, and keep it within tight budgetary restraints.

The exterior beam is a rectangular section to match other bridges, whereas, more economical bulb-tees are used for the interior beams.

To resolve these issues, the designers specified two types of precast concrete girders for each of the four spans on each side of the original bridge. The outside girder on each side is a 5-ft-deep rectangular, hollow, precast, prestressed concrete girder. The three interior girders on each side are 5-ft-deep precast, prestressed concrete bulb-tee girders. Approximately 250 precast concrete panels were used for the deck, with four precast domes used for decorative pilasters.

The girders were erected on cast-in-place bent caps, which sit on cast-in-place columns and footings. They, in turn, are supported by 366 precast, prestressed concrete, driven piles that

were 14 in. square. "The soil in this area required the addition of piles to provide the necessary support for the additional loads of the columns for the widened bridge," Kazmi explains.

"It was a huge challenge to design and construct this project, because of the variety of concerns involved," he adds. "The selection process for these projects is very rigorous in any event, but we looked at many alternatives before we found the one that provided the best combination of benefits. The challenge was especially to come up with a structure type that could be constructed quickly and without significant impact to the existing traffic."



PRECAST, PRESTRESSED CONCRETE GIRDERS AND DECK PANELS / CALIFORNIA DEPARTMENT OF TRANSPORTATION (CALTRANS), OWNER

BRIDGE DESCRIPTION: Widening of a four-span cast-in-place concrete bridge with precast, prestressed concrete rectangular box beams, bulb-tee girders, and deck panels

STRUCTURAL COMPONENTS: Twenty-four, 5-ft-deep precast, prestressed concrete bulb-tee girders; eight, 5-ft-deep rectangular hollow precast, prestressed concrete girders; 250 precast, prestressed concrete deck panels, 366 14-in.-square precast, prestressed concrete driven piles; and four precast domes for decorative pilasters

Precast, prestressed concrete beams were used because of a lack of clearance for falsework and to speed construction.



Limited Vertical Clearance

One of the significant logistical concerns was the inadequate vertical clearance available for using falsework. Using cast-in-place box girders to replicate the look of the existing bridge and surrounding structures would have required falsework spanning three traffic lanes in each direction, he explains. "The available vertical clearance was not adequate to accommodate falsework deep enough to span three lanes of traffic. This was the key factor in choosing precast concrete."

The girders and deck panels also offered a shortened construction time, as they could be fabricated off-site and erected quickly upon arrival. "The precast girders

significantly reduced the timeframe for impacting on-going traffic," he says. The project was designed in six months, with construction taking about 1 year. But the actual road closure to erect the precast girders amounted to only 2 days during this period.

Although cast-in-place girders could not be used due to falsework requirements, the concern was that the use of precast, prestressed concrete bulb-tee girders would not blend with the appearance of the rest of the bridge, or with other bridges in the area. "We usually see cast-in-place box girders being used in California, and the agencies involved in this project wanted to match their design," Kazmi explains.

To replicate that look, precast, prestressed concrete rectangular box girders were used as the exterior girder on each side of the bridge. The girders were deeper than they were wide and featured a rounded outside fascia corner to replicate the look of cast-in-place box girders. The design provided the box shape that all the bridges offered to drivers nearing the structures, he says. Inside girders, which are viewed only when cars are directly beneath them, are bulb-tee sections. "Motorists see the look of a concrete box-girder bridge as they approach, and the structure blends well with the adjacent structures." This combination of girders kept the cost of the project in line by using less expensive bulb-tee girders in the less visible area, he notes.

Aesthetics

The existing structure and several structures along the corridor are cast-in-place box girder bridges with vertical webs for the exterior girders. The use of more typical precast, prestressed concrete girders at this location would not have matched the aesthetic character of the bridges. The problem was addressed by the use of precast, prestressed concrete rectangular box girders with a rounded outside corner for the exterior girders. This gives the motorist the look of a concrete box girder bridge and the structure blends well with the adjacent structures.

Speed of Construction and Public Safety

Another challenge on this project was the need for a structure type that could be built quickly and would significantly reduce the duration of the inconvenience to the on-going traffic. This was largely achieved by the efficient use of precast, prestressed concrete girders as well as permanent precast concrete deck panels.

While preparation work was underway at the site, the girders were cast at the precaster's Perris, Calif., plant. Once they arrived at the site, all 32 girders were erected in 2 days, while the road under the bridge was closed and traffic rerouted. Traffic could flow under the bridge while the precast concrete deck panels were being installed. "Being able to keep traffic open while the deck panels were installed provided a considerable advantage."

The project achieved all the goals set for it, by combining several types of girders and maximizing the benefits offered by the precast concrete design. "There were a number of factors that created key challenges on this project," says Kazmi. "But solutions for all of them were made possible because of the use of precast concrete members."

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

Economical, Efficient & Elegant Solutions

Bridge Services

- Planning
- Design
- Inspection
- Rehabilitation
- Program Management
- Construction Management

Worldwide Expertise & Local Experience

Millburn, NJ 973.379.3400
 Pleasanton, CA 925.469.8010
 Pensacola, FL 850.484.6011
 Mississauga, ON 905.855.2010

Hatch Mott MacDonald
www.hatchmott.com

Robert Shulock
 Practice Leader, Highways & Bridges
 206-855-0968

How to do it in Precast...

Q How do you connect the rebar?

A Use the... **NMB Splice-Sleeve System.**

Q How is the moment connection made?

A All you need is an emulative detail, reconnect the concrete and rebar.

Edison Bridge, Fort Myers, Florida

cross-section

Mill Street Bridge, Epping, New Hampshire

NMB SPLICE SLEEVE

SPLICE SLEEVE NORTH AMERICA, INC.
 192 Technology Drive, Suite J • Irvine, CA 92618-2409
 PHONE: 949-861-8393 • FAX: 949-861-8419 • e-mail: info@splicesleeve.com
WWW.SPICESLEEVE.COM

An artist's rendering shows the bridge from the West Virginia side.



State Partnership Creates Cable-Stayed

Ohio DOT builds bridge connecting states, then turns over operation to West Virginia

When the steel cantilever through-truss steel bridge over the Ohio River between Pomeroy, Ohio, and Mason, W.Va., was judged functionally and structurally deficient by the Departments of Transportation of Ohio (ODOT) and West Virginia (WVDOT), deciding to replace it was an easy decision. But how best to design and construct it was far from an obvious choice, says Dave Jeakle, lead engineer from the Tampa office of URS Corporation. Because it

spanned the Ohio River between the two states, both states were involved in the decisions—and created a unique partnership.

The Ohio River at the bridge location lies within West Virginia's boundaries. Since the bridge's construction and traffic affect both states, both the ODOT and WVDOT were involved. But rather than divide the construction responsibility between the two states, a unique

profile

POMEROY-MASON BRIDGE / POMEROY, OHIO TO MASON, W.VA.

ENGINEER OF RECORD: URS Corporation, Tampa, Fla.

CONSTRUCTION ENGINEERING: Janssen & Spaans Engineering Inc., Indianapolis, Ind.

CONSTRUCTION INSPECTION: Michael Baker Jr. Inc., Pittsburgh, Pa.

PRIME CONTRACTOR: C.J. Mahan/National Engineering (a joint venture of C.J. Mahan Construction Co., Grove City, Ohio, and National Engineering & Contracting Co., Westerville, Ohio)



A major consideration, especially for West Virginia, was to minimize long-term maintenance.

“We evaluated several systems to determine the best choice, with plenty of input from both states,” says Jeakle. “A major consideration, especially for West Virginia, was to minimize long-term maintenance.”

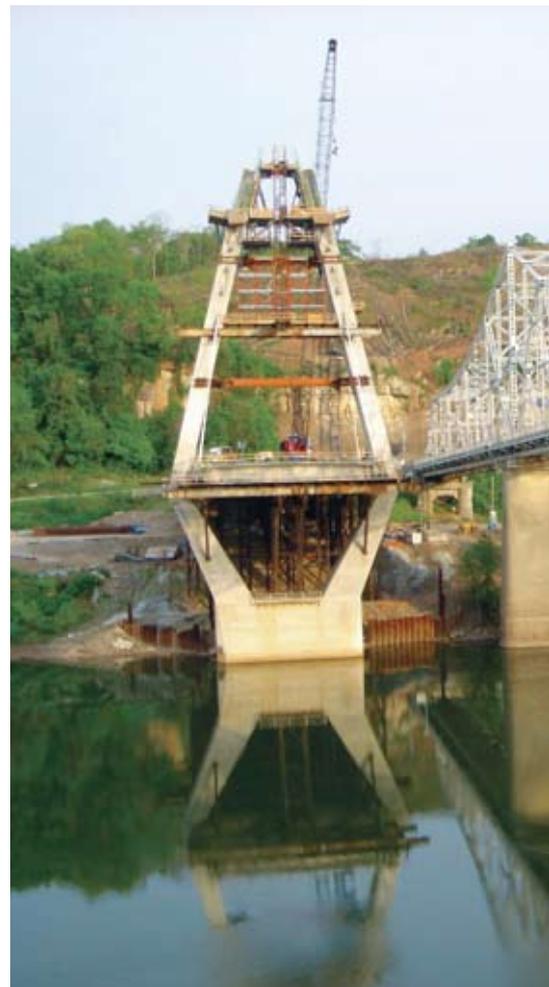
Among the systems discussed were a simple tied arch; a three-span, continuous, parallel-chord steel truss; and a three-span, cast-in-place concrete cable-stayed bridge. The cable-stayed option was chosen, primarily because of the design’s aesthetics. “Although construction cost was definitely a factor in the decision-making process, when we compared all of the various options, none stood out as being more cost efficient than another.” The final design represents a consensus from both departments, including a variety of officials, adds Michael Zwick, a senior project manager in URS’s Cincinnati office, who shepherded the project.

75-Year Service Life

Longevity was another key factor in choosing the concrete, cable-stayed design, says Zwick. “We project a minimum 75-year service life, provided that certain routine maintenance tasks are performed. In that time, we would expect that the stay cables will need to be replaced once and expansion joints and bearings will need to be changed twice. Also, the silica fume concrete overlay will need to be redone approximately every 20 years.”

Officials at the two highway departments asked designers to study three different types of cable-stayed bridges. The first type featured a single-tower, unsymmetrical design

The new Pomeroy-Mason Bridge begins to take shape alongside its predecessor at the right. The new bridge, over the Ohio River between Pomeroy, Ohio and Mason, W.Va., is just 110 ft upstream from the functionally obsolete steel structure it replaces to carry Ohio Route 33 over the Ohio River. All photos: Bob Henry, Michael Baker Jr. Inc.



Bridge

by Wayne A. Endicott

arrangement for its construction was reached.

In this arrangement, the bridge is being built by the ODOT. On completion, ownership and responsibility for maintenance of the bridge will pass to the WVDOT. Virtually all decisions on the bridge, such as its location and design, were hammered out between the two departments. The bridge is expected to be completed this fall.

CAST-IN-PLACE SEGMENTAL CABLE-STAYED BRIDGE / WEST VIRGINIA DEPARTMENT OF HIGHWAYS, CHARLESTON, W.VA., OWNER

STAY-CABLE SUPPLIER: Dywidag-Systems International, Bolingbrook, Ill.

BRIDGE DESCRIPTION: 1163-ft-long, three-span, symmetrical cable-stayed concrete bridge with a 675-ft-long center span and two 244-ft-long side spans

POST-TENSIONING SUPPLIER: Dywidag-Systems International, Bolingbrook, Ill.

BRIDGE CONSTRUCTION COST: \$45.8 million (including approach spans)

The 675-ft-long main span uses cast-in-place concrete edge girders with concrete transverse floor beams, constructed using form travelers.



The cast-in-place segmental concrete bridge progresses outward from the delta-shaped towers.

with span lengths of 566 ft and 671 ft. The second type called for a three-span, unsymmetrical design with spans of 340 ft, 671 ft, and 244 ft long. If this type had been selected, the West

Virginia tower would have been taller than the one on Ohio's end. The third type provided a three-span, symmetrical design, and this design was eventually chosen.



Concrete for the main span was delivered over the side spans and pumped into place.

The design required a superstructure consisting of concrete edge girders, 5-ft 6-in. deep by 5 ft wide, with 1-ft 9-in.-wide transverse floor beams in each segment. The transverse beams each contain two 19-strand post-tensioning tendons. The 244-ft-long side spans and the first 40 ft of the main span were cast on falsework. Typical segment lengths are 26-ft 6-in. long in the main span and 17-ft 10-in. long in the side spans.

Because the side spans are shorter than desired for a cable-stayed bridge, it was necessary to add a significant amount of ballast in each side span to eliminate uplift and balance the long main span, Zwick says. For this reason, the transverse floor beams in the side spans are 9 ft thick to balance the main span's weight.



Construction proceeds simultaneously from both sides of the Ohio River.

Two Identical Towers

The two delta-shaped towers are geometrically identical. Tower foundations consist of a waterline footing supported by six 8-ft-diameter drilled shafts. Ohio River water levels at the bridge's location can fluctuate significantly, Jeakle notes, with variations from normal pool to 100-year flood stage varying by as much as 38 ft. For this reason, the footing caps were shaped to create snag-free elements for vessels plying the river. The footing cap tapers from 30 ft wide at the top of the shafts to 16 ft wide at the bottom of the tower legs.

Possible barge collisions are a concern, especially at the two towers. To address this, the tower legs below the bridge deck are solid concrete, while the tower legs above the deck are hollow and contain the stay-cable dead-end anchorages. A fully post-tensioned cross strut at deck level of each tower resists the tension force created through the angle change in the tower legs.



The stay cables consist of 0.6-in.-diameter greased and sheathed strands within an ungrouted HDPE casing. Non-linear viscous dampers are connected to all cables at deck level to minimize cable vibrations from wind and rain.

The bridge provides an undivided roadway consisting of four 12-ft-wide lanes. Also included are two 4-ft-wide shoulders and a 6-ft-wide sidewalk, creating a total width of approximately 74 ft. The roadway alignment is on a tangent for the bridge's full length, except for a J-hook on the Ohio side of the river. This 180-degree turn in the roadway, beginning approximately 150 ft inland from the river bank, is made necessary by the steep rocky hillside that parallels the Ohio shoreline.

The navigational channel of the river, on the Ohio side, provides a minimum of 645 ft of horizontal clearance and 55 ft of vertical clearance, which is consistent with the clearances provided at other Ohio River bridges, Jeakle says.

High Performance Concrete

The cast-in-place concrete specification for the bridge's superstructure called for a concrete mixture with a compressive strength of 6000 psi and a low permeability of 1000 coulombs. The mix contains fly ash and a high-range water-reducing admixture. The 11-in.-thick deck will be permanently protected by an overlay consisting of a silica fume concrete that meets the standard ODOT specifications.

When completed this fall, the bridge will have white stay cables and all white concrete surfaces, except the roadway deck, which will be painted with an off-white epoxy urethane.

The bridge represents a spirit of cooperation between governmental bodies, which frequently can have their own agendas, says Jeakle. "Probably the biggest challenge in completing this project was whether the two states could come to a consensus on a design concept agreeable to both. When it opens to traffic this fall, I believe that that question will be answered positively."

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



The new bridge takes shape upstream from the existing bridge, which remains open to traffic.



BRIDGE POST-TENSIONING SYSTEMS:

Innovative, Proven and Durable.

SYSTEMS

- BONDED MULTISTRAND
- VSLAB+® BONDED SLABS
- STAY CABLES
- VIBRATION DAMPING

SERVICES

- SYSTEM INSTALLATION
- DESIGN SUPPORT
- HEAVY LIFTING
- REPAIR & STRENGTHENING
- EQUIPMENT RENTAL

Owners and design teams rely on VSL to provide innovative technology and proven systems to maximize the durability of transportation structures. A world leader in post-tensioning, VSL has evolved into a multi-disciplined bridge partner capable of providing contractors and engineers with design support, as well as construction systems and services for precast segmental, cast-in-place and stay cable bridges.



www.vsl.net • 888.489.2687



post-tensioning for segmental bridges

Precast Span-by-Span

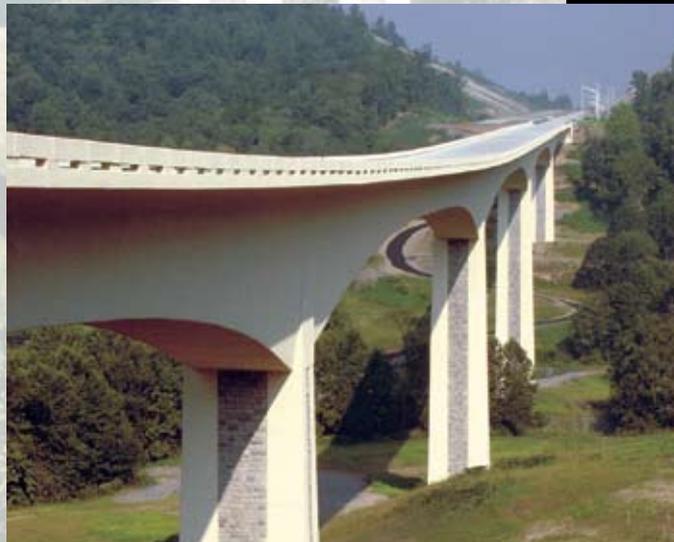
Precast Balanced Cantilever

Cast-in-Place Balanced Cantilever

Incremental Launching

providing

- Tendons from 4 to 37-0.6" strands
- Form Travelers
- Equipment
- Installation Labor
- Value Engineering



SMART HIGHWAY BRIDGE

owner Virginia DOT

contractor PCL Civil Constructors

*post-tensioning
and form travelers* AVAR Construction Systems, Inc.



Construction Systems, Inc.

504-F Vandell Way

Campbell, CA 95008

408.370.2100

info@avarconstruction.com



BRIDGE OVER **SWINGLEY RIDGE ROAD**

by Kevin Eisenbeis, Harrington & Cortelyou Inc.

The bridge spans Swingley Ridge Road and provides access to the parking garage.

**Cast-in-place
concrete provides
the answer**

A cast-in-place concrete bridge provided the aesthetic solution when Sachs Properties Inc., owners of the Chesterfield Ridge Center office development complex in Chesterfield, Mo., needed a bridge for access to their new parking structure and six-story building. The complex site geometrics called for a bridge to span Swingley Ridge Road, while also providing access to the rooftop level of a new parking structure.

A new, 322-ft-long bridge spanning Swingley Ridge Road was desired to allow easy access to Chesterfield Ridge Center from the nearby North Outer 40 parallel connector road and I-64. A 100-ft-long upper level drive extension, projecting from the bridge, was also needed for access to a new parking structure. A cast-in-place, reinforced concrete bridge, T-shaped in plan view, provided the elegant solution desired. The monolithic concrete structure,

profile

SWINGLEY RIDGE ROAD BRIDGE / CHESTERFIELD, MO.

BRIDGE DESIGNER: Harrington & Cortelyou Inc., Kansas City, Mo.

CIVIL ENGINEER: Volz Inc., St. Louis, Mo.

GEOTECHNICAL ENGINEER: Geotechnology Inc., St. Louis, Mo.

BUILDING ARCHITECT: Mackey Mitchell Associates, St. Louis, Mo.



A cast-in-place reinforced concrete bridge provided the elegant solution needed.

the main structure. Use of a monolithic concrete slab bridge eliminated structural discontinuities and complex superstructure framing details where the elevated structure arms converged. Pier caps supporting girders were no longer needed. Expansion joints on the structure could also be eliminated, with joints being used only at abutments and where the entrance drive joined the parking structure.

Eric Neprud, project engineer for Harrington & Cortelyou, summarized the choice: "Selection of the voided slab bridge drastically simplified the detailing requirements where the access drive meets the main bridge." The use of 16-in.-diameter voids embedded within the 2-ft 3-in.-thick slab reduced weight and material requirements, allowing the thin superstructure to span up to 60 ft between pier support points. Drop panels

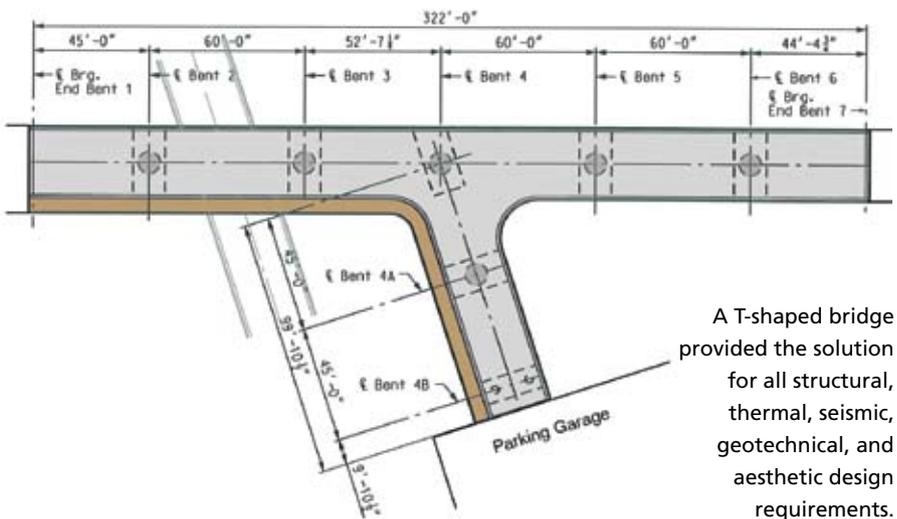
varying from 6-in. to 10-in.-thick were required to distribute loads to the narrow concrete columns. A 28-day concrete compressive strength of 4000 psi was used with the Missouri Class B2 mix design, allowing the bridge to carry AASHTO HS-20 live loading. A 5-ft-wide sidewalk was also cantilevered from the bridge.

Chesterfield, located just west of St. Louis, Mo., is subject to Category B seismic requirements. The complex T-shape of the structure dictated that a three-dimensional analysis would be required for seismic considerations with a ground acceleration of 0.12g. Structural analysis utilizing a response spectrum analysis with mTAB Stress (SAP 386) software indicated displacements and loadings would be acceptable. The tall, slender piers supported on single drilled shafts performed well when analyzed for seismic loading. Conventional analysis of the bridge was made utilizing the Brass program.

Field exploration consisted of four borings extending through the 41-ft to 46-ft-thick overburden and 25 ft into the rock below. Due to the geology of the site, a potential for slope instability in the earth fill required special analysis.

supported on single-column, "golf tee" concrete piers, provided the ideal solution to meet all structural, thermal, seismic, geotechnical, and aesthetic design requirements.

Several structural options were initially considered for the bridge. Framing issues and thermal movement requirements for steel and concrete girder spans proved to be undesirable where the upper level drive entrance connected to



A T-shaped bridge provided the solution for all structural, thermal, seismic, geotechnical, and aesthetic design requirements.

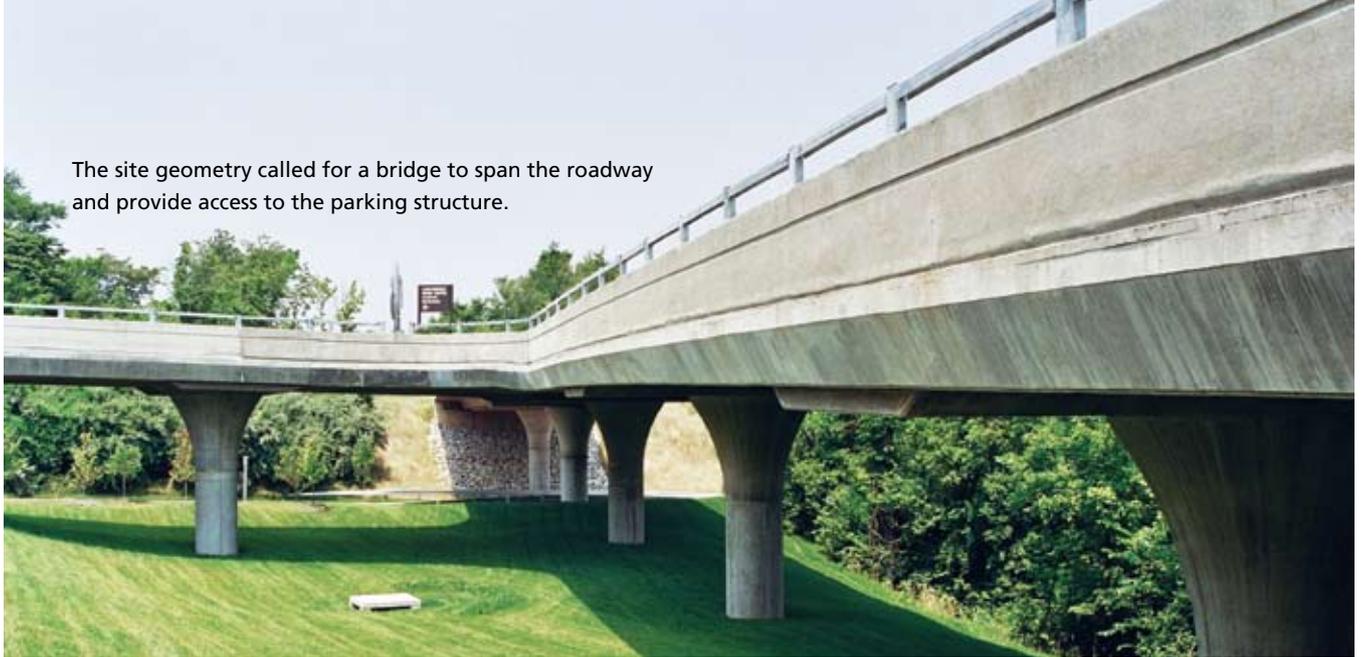
CAST-IN-PLACE REINFORCED CONCRETE / SACHS PROPERTIES INC., ST. LOUIS, MO., OWNER

BRIDGE CONTRACTOR: St. Louis Bridge, St. Louis, Mo.

FIELD OBSERVATION: Alper-Ladd, St. Louis, Mo.

BRIDGE DESCRIPTION: A cast-in-place reinforced concrete bridge, T-shaped in plan view consisting of eight spans supported on six columns and three end bents

The site geometry called for a bridge to span the roadway and provide access to the parking structure.



The tall, slender piers supported on single drilled shafts performed well when analyzed for seismic loading.

Any change in natural conditions of the highly plastic shaley clays could lead to instability. Drilled shaft foundations were designed for an additional 40 kips of lateral load, in addition to other lateral loads on the piers, as a result of potential slope creep in the 45-ft-thick soil mass overlying the limestone bedrock. Drilled shafts were socketed 2.5 diameters into the limestone below the fill to provide additional lateral

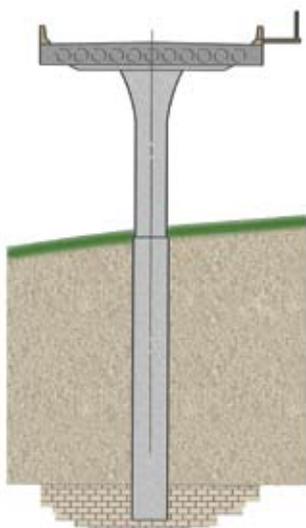
resistance. Since falsework and shoring were used to build the new structure, recommendations were also provided for allowable bearing pressures for falsework support footings.

The bridge was built over a 10-month period. Following installation of the drilled shafts and pier columns, the voided slab superstructure was constructed on falsework with concrete placed in a sequential manner. Positive moment sections were placed first, followed by 30-ft-long segments over the pier supports. Forms were cambered to account for dead load deflections and removed when the concrete strength reached 3000 psi.

The cast-in-place concrete bridge provided an economical and attractive solution in this combined commercial and residential setting while the complex geometry of the site and shallow structure requirements made the cast-in-place option ideally suited for this application.

Kevin Eisenbeis is a principal with Harrington & Cortelyou Inc., Kansas City, Mo.

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



The substructure consists of single piers on single drilled shafts.



AESTHETICS COMMENTARY

by Frederick Gottemoeller

This structure is an excellent resolution of a complicated structural and aesthetic problem: the bridge with a branch. Designing a bridge like this with typical steel or concrete I-beams always results in a confusion of beam layouts and awkward connections. The cast-in-place voided slab, on the other hand, adapts readily. All of the connections and points of force transfer are inside the slab. The exterior shows only a smooth continuous surface along the main lines of the structure. The bridge seems to be all one piece. The eye effortlessly follows its edges from abutment to abutment.

The cross section of the superstructure also has enough torsional stiffness to allow single column supports. This minimizes the number of columns and allows streets, planting areas, and views to flow through under the bridge. The space under the bridge remains a pleasant place to be. Finally, the flares at the top of the columns make clear the flow of forces from the superstructure to the ground. They make this small but complex structure memorable.

Spikes in Worldwide Steel Prices Impact Bridge Construction

Worldwide demand and the weak dollar have led to unprecedented price increases and volatility for all types of steel products. According to data published by American Metal Market (AMM), steel plate prices increased 63% between January and May 2008; high-strength wire rod used in the production of prestressing strand increased 34%, and steel reinforcement increased 48%.

These increases pose major challenges for owners, contractors, and industry suppliers. Out-of-date estimates can result in funding shortfalls. Fixed price bids, which have not anticipated these sky-rocketing prices, threaten the financial viability of contractors and suppliers alike. Owners, contractors, and suppliers are urged to work together to meet this challenge and reasonably manage risk for all involved in bridge construction.

On a positive note, as material prices continue to rise, the use of high-strength materials generally becomes more cost competitive. Prestressed concrete bridges that proportionally

use less steel are even more economical when compared to other structural systems.

Post-tensioning is being utilized on bridges in increasingly varied ways, including cable stays for long-span applications, segmental construction, on bridge decks, strengthening, and on spliced girders to extend the capabilities of precast elements. Post-tensioning offers some unique advantages, which can reduce material usage and improve overall economy and performance.

PTI has training programs to improve the quality of post-tensioned construction. The Bonded Post-Tensioning Certification program is a comprehensive course on all aspects of **bonded post-tensioning installation**. The 3-day training workshop is intended for construction personnel, inspectors, and construction managers. Attendees are certified following successful completion of the training and the subsequent examination.

For more information about post-tensioned bridges and training programs, contact PTI or visit our website at: www.post-tensioning.org.

DYWIDAG-SYSTEMS INTERNATIONAL



DYWIDAG Post-Tensioning Systems

- ▶ Multistrand Post-Tensioning Systems
- ▶ Bar Post-Tensioning Systems
- ▶ DYNA Bond® Stay Cable Systems
- ▶ DYNA Grip® Stay Cable Systems
- ▶ Engineering
- ▶ Construction Methods
- ▶ Stay Cable Testing
- ▶ Supply and Installation

DYWIDAG-SYSTEMS INTERNATIONAL

HQ America

DYWIDAG-SYSTEMS
INTERNATIONAL USA INC.
320 Marmon Drive
Bolingbrook, IL 60440, USA
Phone (630) 739-1100
Fax (630) 972-9604
E-mail: dsiamerica@dsiamerica.com

Business Unit Post-Tensioning & Reinforcement

320 Marmon Drive
Bolingbrook, IL 60440, USA
Phone (630) 739-1100

525 Wanaque Avenue
Pompton Lakes, NJ 07042, USA
Phone (973) 831-6560

1801 N. Peyco Drive
Arlington, TX 76001-6704, USA
Phone (817) 465-3333

4732 Stone Drive, Suite B
Tucker, GA 30084, USA
Phone (770) 491-3790

2154 South Street
Long Beach, CA 90805, USA
Phone (562) 531-6161

www.dsiamerica.com

CONCRETE CONNECTIONS

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

<http://www.hoodcanalbridge.com>

This WSDOT site provides information about the Hood Canal Bridge Project on State Route 104. Click on "Construction cameras" to see work at the two off-site construction locations, or visit the photo gallery for still photographs and the computer animation for time-lapse videos and computer simulations.

<http://dot.ca.gov/dist1/d1projects/confusionhill/index.htm>

Visit this website for information about the South Fork Eel River Bridges, also known as the Confusion Hill Bridges.

www.fhwa.dot.gov/bridge/britab.htm

This FHWA website lists tables of frequently requested National Bridge Inventory (NBI) information. Data are available for several years as Excel or html files and in some cases as pdf files.

<http://www.wsdot.wa.gov/eesc/bridge/software>

Go to this website for a list of WSDOT Bridge Engineering Software including PGSuper™ for the design and analysis of prestressed concrete superstructures.

<http://bridges.ci.stpaul.mn.us>

This website provides information about bridges in the city of St. Paul, Minn. including bridge facts, construction projects, bridge maintenance, bridge clearance, and truck routes.

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.

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 49 issues of *HPC Bridge Views*, a newsletter published jointly by the FHWA and the NCBC to provide relevant, reliable information on all aspects of high performance concrete in bridges.

Bridge Research

www.trb.org/news/blurb_detail.asp?id=8815

The U.S. FHWA's Turner-Fairbank Highway Research Center (TFHRC) has released a report that provides a brief overview of individual TFHRC laboratories, their current activities, and laboratory managers.

<http://ntlsearch.bts.gov/tris/index.do>

The National Research Information System provides a bibliographic database of over 640,000 records of published research for all modes of disciplines and transportation.

www.trb.org/CRP/NCHRP/NCHRPprojects.asp

This website provides a list of all National Cooperative Highway Research Projects (NCHRP) 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. Some completed projects are described below:

<http://trb.org/TRBNet/ProjectDisplay.asp?ProjectID=349>

NCHRP Report 549, Simplified Shear Design of Structural Concrete Members, contains the findings of research performed to develop practical equations for design of shear reinforcement in reinforced and prestressed concrete bridge girders. Recommended specifications and commentary plus examples illustrating application of the specifications were also developed. The results of this research have been incorporated into the AASHTO LRFD Bridge Design Specifications.

http://trb.org/news/blurb_detail.asp?id=7443

NCHRP Report 579, Application of LRFD Bridge Design Specifications to High-Strength Structural Concrete: Shear Provisions, examines research performed to extend the applicability of shear design provisions for reinforced and prestressed concrete structures in the AASHTO LRFD Bridge Design Specifications to concrete compressive strengths greater than 10 ksi.

www.trb.org/news/blurb_detail.asp?id=8693

NCHRP Report 584 Full-Depth Precast Concrete Bridge Deck Panel Systems examines recommended guidelines and the AASHTO LRFD specifications language for design, fabrication, and construction of full-depth precast concrete bridge deck panel systems. Recommended guidelines and proposed revisions to LRFD specifications language are available as online appendices.

Durability of Concrete Segmental Bridges

by Brett H. Pielstick, Eisman & Russo Consulting Engineers

With the collapse of the I-35W bridge in Minneapolis last year, the durability of bridges has become a national issue. In a report¹ sponsored by the American Segmental Bridge Institute (ASBI), the durability of segmental bridges is addressed in comparison to all structure types listed on the National Bridge Inventory (NBI). This article provides a summary of the ASBI report.

The information was based on the December 2006 Federal Highway Administration (FHWA) NBI data base, which documented the condition of 597,479 bridges in the United States. The majority of these bridges were constructed during two bridge-building booms—one during the post-depression era and the second during the interstate construction boom. Many of these bridges are, therefore, 40 to 70 years old and are beginning to show their age, with 73,798 bridges (12.4%) rated as structurally deficient. An additional 80,317 bridges are listed as functionally obsolete. The discussion in this article focuses exclusively on structurally deficient bridges.

Figure 1 shows the proportion of bridges by material type compared to Figure 2, which shows the proportion, by type, for structurally deficient bridges. A discussion of structurally deficient bridges was provided in *ASPIRE*,TM Winter 2008. The purpose of the ASBI durability report is to assess the condition of concrete segmental bridges, with service lives approaching 40 years in the United States, along with their ability to provide long-lasting structures.

In Figure 1, the categories of steel bridges represent about 32% of the overall bridges in the FHWA survey,² but they are responsible for

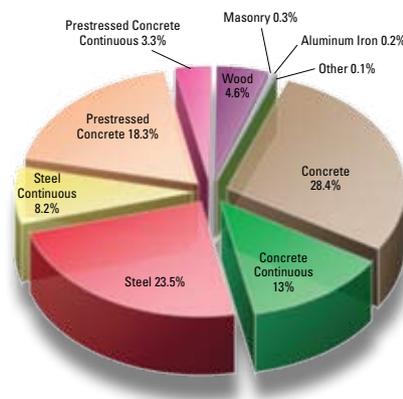


FIGURE 1
Proportion of bridges by material type.

about 54% of the structurally deficient bridges as shown in Figure 2. Reinforced, prestressed, and post-tensioned concrete bridges represent 63% of the overall bridges but only represent 32% of the structurally deficient bridges, with 6% of the prestressed concrete bridges and 0% of the segmental bridges classified as structurally deficient. This means that the ratio of structurally deficient bridges to the total number of bridges is 5.8 times greater for steel bridges than for prestressed concrete bridges and 2.7 times greater for concrete bridges. Timber bridges, while representing only 4% of the entire number of structures, represent 14% of the structurally deficient bridges.

The most frequent reason that steel and timber bridges are classified as structurally deficient is a low structural adequacy rating. This means the bridge has a lower load-carrying capacity.

The information for the ASBI survey identified over 400 segmental bridges with 275 inspection reports and condition ratings obtained. All segmental bridges were rated as “fair” or better. Of the 273 bridges, over 97% had superstructure

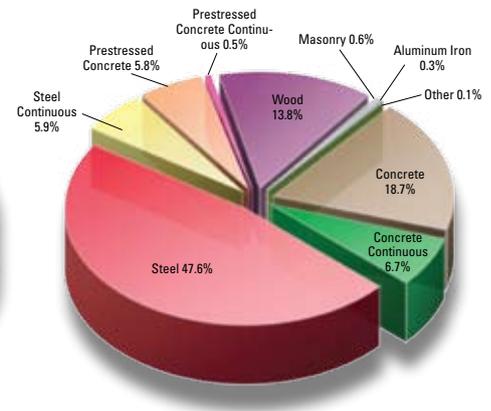


FIGURE 2
Proportion of structurally deficient bridges by material type.

ratings of “satisfactory” or better, 85% had superstructure ratings of “good” or better and 25% had superstructure ratings of “very good” or better. On average, the 275 segmental bridges, built over the last 35 years, with inspection data gathered averaged a superstructure rating of “good.”

The NBI inspection data² summarized in the ASBI report shows that concrete bridges continue to perform well. No structural deficiencies in segmental concrete bridges were noted. Other bridges constructed during the past 35 years using other materials have experienced varying levels of structural deficiency.

REFERENCES

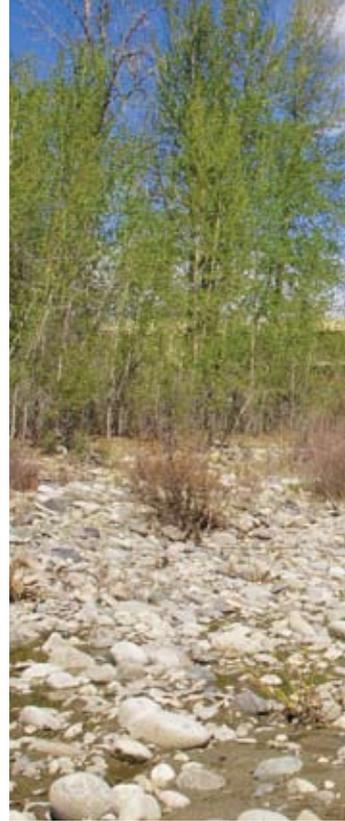
1. Pielstick, Brett, *Durability Survey of Segmental Concrete Bridges*, Third Edition, September 2007, available from ASBI.
2. Ann Shemaka, FHWA Bridge Technology “Tables of Frequently Requested NBI Information,” updated May 1, 2007, at <http://www.fhwa.dot.gov/bridge/britab.htm>.

Concrete Bridges in

Washington State



by Jugesh Kapur and DeWayne Wilson, Washington State Department of Transportation



The Selah Creek Fred G. Redmond Bridges on I-82 near Yakima opened in 1971.

Concrete is the material of choice for the majority of bridges in the State of Washington. Approximately 2600 out of 3000 bridges maintained by the Washington State Department of Transportation (WSDOT) have a main span type that consists of concrete. The oldest of these bridges dates back to the early 1900s.

The first known use of a precast, prestressed concrete girder bridge in Washington was in 1954 for a bridge over the Klickitat River on State Route 142. The center span of this three-span bridge is 90 ft and consists of four precast segments about 22 ft in length that were supported on falsework in place and then post-tensioned together. The contractor chose to install the girder in units, based on the lifting capacity of his crane. Technology and equipment have advanced since then to allow current bridges with spliced girders to have lengths in excess of 200 ft.

There are two major statewide transportation improvement programs underway. The first, known as the “Nickel” funding package, began in

2003 with a total budget of \$3.9 billion to address primarily congestion and safety on 158 projects. The second, known as the “Transportation Partnership Account” began in 2005 with a total budget of \$7.1 billion to address preservation and mobility on 274 projects. Concrete bridges will play a big part in these new programs.

Selah Creek Arches

The twin Selah Creek Fred G. Redmond Bridges on I-82 provide a connection south from Ellensburg to Yakima. They were the largest arch span bridges in the United States at 549.5 ft when they opened to traffic in 1971. The top of the arch span is 325 ft above the canyon and required falsework to be built from the valley below. The superstructure on each bridge consists of 17 spans of prestressed concrete girders that are 78.5 ft long. These two bridges are examples of the use of concrete for nearly 780 interstate bridges built between 1955 and 1975 that are now 30 to over 50 years old.

South 317th St HOV Access

In 2006, a bridge was opened over I-5 near Federal Way to provide direct access for buses and high occupancy vehicles from I-5. Bridge engineers decided to use precast, prestressed concrete trapezoidal tub girders 5 ft wide and 6 ft deep that were spliced together with post-tensioning. The bridge span is curved at the intersection with the access ramps to accommodate turning buses. The structure is 128 ft long with four spliced precast, trapezoidal tub girders, each consisting of 35-ft- and 88-ft-long segments. The segments were temporarily supported on falsework and then post-tensioned together. The bridge has 50-ft radius curves connecting to the ramp side. Curved edge beams frame into the diaphragm at a splice location and are supported on an abutment wall at the pier. This configuration of straight precast girders with curved edge beams is typically achieved with cast-in-place box girders. Trapezoidal girders were added to the WSDOT standards in 2004.



Precast trapezoidal tub girder.



The Methow River Bridge uses WSDOT's "Super Girder."

These girders have span lengths up to 140 ft, are considered for special bridge projects that need a low profile, and have been used in nine WSDOT bridges to date.



Transporting WSDOT's "Super Girder."

Methow River

The Methow River Bridge on State Route 20 in Okanogan County replaced a seven-span concrete T-beam bridge built in 1931. The old bridge had span lengths of 53 ft with several piers in the river. The new bridge, completed in September 2003, has two 180.5-ft-long spans that are 35 ft wide curb-to-curb with a total length of 360.8 ft. The bridge uses seven lines of 82.7-in.-deep precast, prestressed concrete WSDOT W83G "Super Girders" on 6.1 ft centers supporting a 7.9-in.-thick cast-in-place concrete deck. WSDOT introduced these deeper girders, commonly called "Super Girders" in 1999. The Methow River Bridge was their first application. There are three sizes of these girders designated WF74G, W83G, and W95G with the number equating to the approximate girder depth in inches. These "Super Girders" are capable of

achieving span lengths up to 185 ft, based on a 200,000 lb weight limit for transporting the girders to the construction site. To date, WSDOT has used the W83G girders for eight bridges with the longest girder length being 180.75 ft.

The length and weight of the girders installed at Methow River required special planning for the 250-mile trip from the precasting plant in Tacoma. This trip took 9 to 13 hours. The introduction of new high performance concrete (HPC) mix designs allowed WSDOT bridge designers to develop these new "Super Girder" sizes. The Methow River girders used a specified 28-day concrete compressive strength of 10,000 psi with actual strengths ranging from 10,600 psi to 15,200 psi. The concrete mix proportions included 752 pcy of Type III cement and 50 pcy of silica fume, placed with a water-cementitious materials ratio of 0.27.



The SR 502 bridge over I-5 near Vancouver uses W83Gs with a girder length of 176 ft.

Twisp River

The Twisp River Bridge is also on State Route 20 less than 1 mile from the Methow River Bridge and is located in the town of Twisp. The new bridge was completed in 2001 and replaced a four-span, cast-in-place concrete T-beam bridge built in 1935. The Twisp and Methow Rivers are home to several endangered fish species. Environmental permit conditions limited the amount of time for construction below the normal high water mark during the months of July and August. WSDOT bridge engineers decided to use a new precast, prestressed concrete W95PTMG single-span

girder that would be fabricated and delivered in three units, erected on temporary falsework bents, and post-tensioned together once the deck was placed. The span length is 197 ft and the girders are 7.9 ft deep. The girders used HPC with a 28-day compressive strength of 8000 psi. All post-tensioned anchorages were placed in a cast-in-place concrete end diaphragm. At the time, this was the longest precast, spliced concrete girder in WSDOT's inventory. This type of "Super Girder" was developed in 1996 through a joint effort between WSDOT and the Washington state precast, prestressed concrete industry.



The Twisp River Bridge spliced "Super Girder."

Hood Canal Floating Bridge

The Hood Canal Bridge is the longest concrete floating bridge in the world over a saltwater tidal basin. The basin is up to 340 ft deep with a maximum tidal swing of 16.5 ft. On average, 15,000 cars per day use this bridge, which provides a vital link to the northern part of the Olympic Peninsula. The bridge was originally built in 1961. The west half during a storm in 1979 and was replaced in 1982. WSDOT is currently in the middle of a \$478 million rehabilitation project to replace the east half floating section along with both approaches, install new concrete floating anchors, and widen the west half superstructure. The project began in 2003 and is now about 73% complete. Further details of the bridge are provided in the article beginning on Page 16.

WSDOT also owns and maintains three other concrete floating bridges, the Evergreen Point Bridge on State Route 520, which is the world's longest, and the Homer Hadley and Lacey V. Murrow Bridges on I-90.

PGSuper™ Computer Program

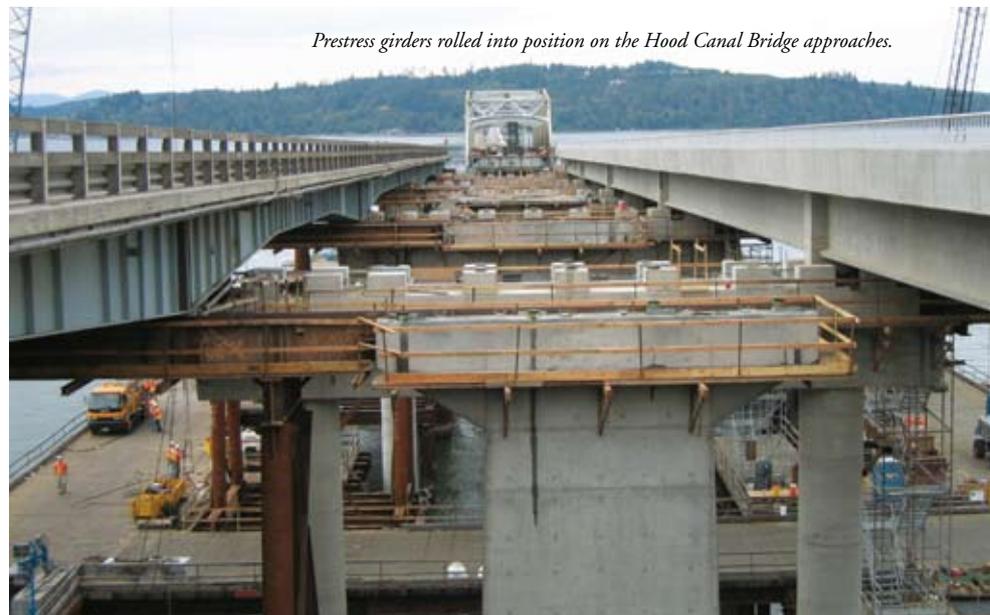
WSDOT has developed an in-house computer program for engineers to design precast, prestressed concrete girders. It is available through a free download. (See Concrete Connections on Page 44 for details.) PGSuper is our precast, prestressed concrete girder design and analysis software. It can be used to design and to check designs in accordance with the AASHTO LRFD Bridge Design Specification and WSDOT criteria. The flexural design feature computes the number and configuration of prestressing strands and the minimum required concrete release strength. The shear design feature determines the number, size, and spacing of transverse reinforcement for vertical shear, horizontal shear, bursting, and strand confinement. Specification checking evaluates girders for compliance with strength, serviceability, and detailing criteria. Girders are evaluated for stresses and stability during handling and transportation. Temporary prestressing to control camber, improve stability, and reduce concrete release strengths may also be input. The program has been designed to allow for future expansion and updating as design criteria and user expectations change.

Jugesh Kapur is bridge and structures engineer and DeWayne Wilson is bridge management engineer with the Washington State Department of Transportation.

For more information on Washington State bridges, visit www.wsdot.wa.gov/eesc/bridge.



Hood Canal floating bridge.



Prestress girders rolled into position on the Hood Canal Bridge approaches.



ACAA American Coal Ash Association

The Romans used volcanic ash to build structures that we admire over 2000 years later. Engineers today can achieve the same high-strength endurance using coal combustion products (CCPs)—materials produced when we burn coal to generate electricity.

Though the material properties vary according to coal composition and power plant operating conditions, experts can advise on quality and determine the best mix design for almost any condition and project. Mix designs exceeding 40% fly ash have proven successful in many projects. Experts with first-hand experience may be located by contacting the American Coal Ash Association, an industry association devoted to educating designers, engineers, concrete professionals, regulatory officials, and others about CCPs' technical, environmental, and commercial advantages.

Fly ash concrete has been specified because of its high strength and durability for the John James Audubon Bridge near Baton Rouge, La. When complete, it will be longest cable-stayed bridge in North America.

The California Department of Transportation (Caltrans), a leader in fly ash concrete projects, required high volume fly ash mixes for the largest bridge project in its history—the San Francisco-Oakland Bay Bridge. Using innovative specifications and blending techniques, Caltrans was able to improve the workability, hardening, and permeability properties of the bridge's concrete. A number of engineering standards and specifications define CCP applications, thus ensuring high quality performance and products.

In addition to a myriad of core performance attributes in construction and industry, CCPs use can conserve natural resources, reduce greenhouse gas emissions, and eliminate the need for additional landfill space. For more information, contact ACAA at info@aca-usa.org or call 720-870-7897.



TAKING THE LOAD OFF... Bridges Around the World



George P. Coleman Memorial Bridge - Virginia
Lightweight concrete deck on widened replacement trusses.



Mattaponi River Bridge - Virginia
Lightweight concrete deck and long-span spliced girders.

Economical Solutions for Rehabilitating Bridges

- Proven Enhanced Durability
- Reduced Deck Weight Increases Rating
- Use Wider Deck on Same Structure
- Reduced Weight for Precast Elements
- Reduced Seismic and Foundation Loads
- Consistent Quality and Properties
- Easy Pumping and Placement
- Shipped anywhere in the US and World!

STALITE

HIGH PERFORMANCE LIGHTWEIGHT AGGREGATE
800.898.3772 704.637.1515
www.stalite.com

*In the wake of tragedy,
more funding helps expand bridge program*

St. Paul Creates Replacement Plan

by Kevin L. Nelson, City of St. Paul, Minn.

The collapse of the I-35W bridge in the Twin Cities region brought increased attention to the condition of Minnesota's bridge infrastructure, beginning a process to increase the available funding for replacement projects and rehabilitation. Most of our recent bridge and retaining wall projects have been concrete structures, and we expect that will continue for the future.

The additional funding, especially through the state matching-funds program, is a welcome addition. It is being financed by a bond fund supported by an increase in the gasoline tax—the first such increase in 25 years. Minnesota had fallen behind other states in increasing this funding as there was no way to include an inflation factor in our budgeting. This caused us to fall behind in our construction. This program will help us to catch up and update bridges more quickly.

In all, the city has 331 bridges within the right-of-way of the city, county, and state with 110 of those being concrete. The City of St. Paul has 12 structurally deficient bridges,

according to our current bridge inventory. All are programmed for replacement in the next 5 years, with three to be replaced in 2008. The city also has nine Mississippi River crossings, including three concrete arch bridges and a segmental box girder bridge. All have been rebuilt or constructed new within the past 15 years.

When we replace or build a new bridge, most often, we use the standard Minnesota Department of Transportation precast, prestressed concrete I-girders, although the state recently developed new standards that include a solid box beam design and an inverted T-beam. We have not yet designed with those components, but we will be using them once we see how best to apply them. Cast-in-place concrete decks are used on most of the bridges.

We use concrete on our new bridges today because it fits our needs. It is a versatile material, providing a variety of ways that we can mold it and color it. It is economical and readily available. It also offers high durability and strength that will provide a service life of 50 to 100 years.



The Raspberry Island Bridge features five spans of cast-in-place concrete slab girders. The bridge ties in with the nearby Harriett Island trail system and the River Walk, and features "St. Paul Rail" designed hand rails.

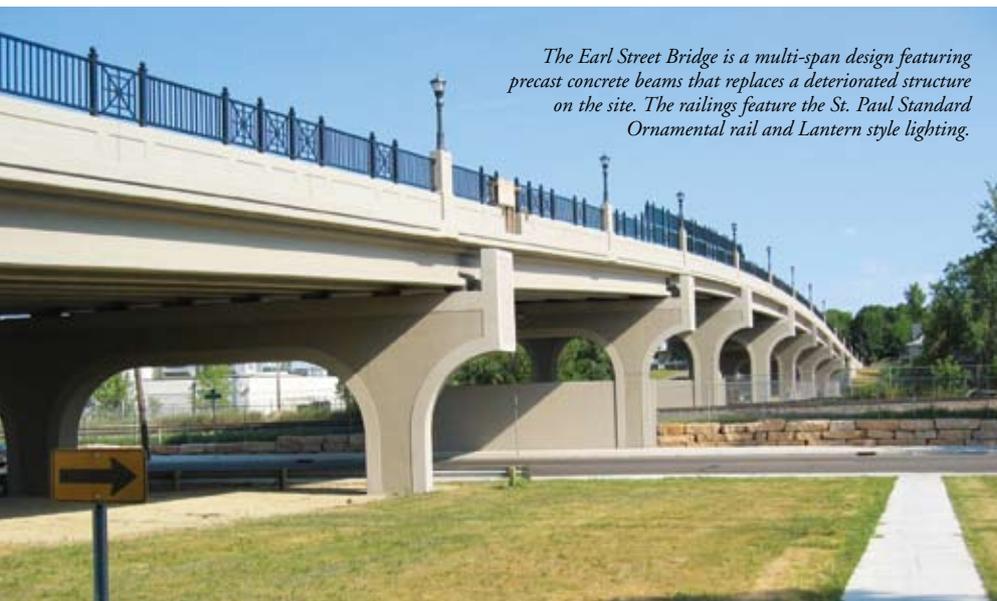
Two of the three bridges being replaced this year will be replaced with concrete bridges. We anticipate replacing the remaining deficient bridges at a rate of two bridges per year. Most of these are local roads crossing railroads, and some of them are as much as 100 years old. The bridges being replaced this year were constructed in the 1950s.

One of our most notable recent bridges was the Raspberry Island Bridge, which is the only land link to the island for vehicles and pedestrians. The five-span, cast-in-place concrete slab bridge was built during a difficult spring flood, which slowed falsework and forming procedures. The bridge features two 50-ft-long end spans and three 75-ft-long center spans. Ornamental steel railings and a colored concrete overlay on the deck panels were used to add visual appeal to the bridge.

City engineers work closely with the state on achieving design goals and coordinating work so that designs are complementary, efficient, and cost-effective. Concrete designs ensure that those goals are met for us.

Kevin L. Nelson, P.E., is the bridge division manager for the Public Works Department of the City of St. Paul, Minn.

The Earl Street Bridge is a multi-span design featuring precast concrete beams that replaces a deteriorated structure on the site. The railings feature the St. Paul Standard Ornamental rail and Lantern style lighting.



EDITOR'S NOTE

If your city has a high percentage of concrete bridges or some interesting and innovative concrete bridges and would like to be featured in ASPIRE™ please let us know at info@aspirebridge.org.

The Secret is Out: Structural WWR Is A Superior Choice for Reinforced Concrete

Many say that structural welded wire reinforcement (WWR) is the best-kept, time-saving, high-quality, cost-cutting secret in the concrete reinforcement industry today -- for virtually any application that calls for traditional reinforcement products.

WWR is a highly controlled, cold-worked structural product, produced in standard and custom prefabricated sheets, with higher yield strength than Grade 60 reinforcement. High-quality welds and computer-controlled spacing eliminate the time-consuming and less precise job-site layout and tying that is typical of traditional reinforced concrete construction. The higher yield strength of the steel means less weight and less handling -- often resulting in a reduction of as much as 50% in labor costs and less material.



WIRE REINFORCEMENT INSTITUTE®

Call (800) 552-4WRI [4974] or write:

WRI

942 Main Street, Suite 300
Hartford, CT 06103

www.wirereinforcementinstitute.org

Excellence Set in Concrete®

WWR is used in standard beams and girders. For example, Daniel Kolb of Pre-Stress Engineering Corp., Prairie Grove, IL, stands beside precast, prestressed concrete, 190-ft.-long I girders with WWR shear reinforcement here. WWR is also used in bridge decks, bridge rails, median barriers, sound walls and more. Welded wire can also be epoxy-coated to meet special requirements in coastal or snowbelt environments.



Bridge Monitoring

Know more about your bridges.

At Campbell Scientific, we design rugged, stand-alone data acquisition systems for any size of bridge. From short-term testing to long-term monitoring, our systems can provide you with valuable decision-making data.



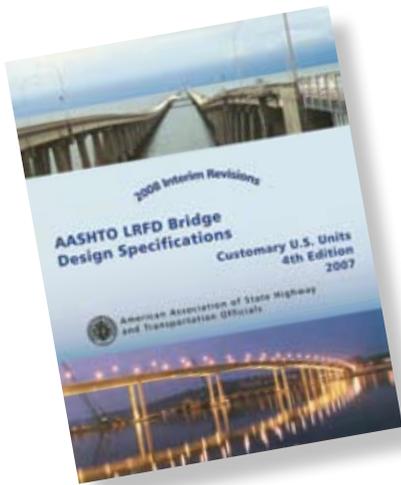
(435) 750-9692
www.campbellsci.com/bridges

**CAMPBELL®
SCIENTIFIC**
WHEN MEASUREMENTS MATTER

2008 Interim Changes Part 2



by Dr. Dennis R. Mertz



Agenda Item 35 is a relatively straightforward item addressing issues regarding combined shear and torsion. It corrects errors in equation numbering in Articles 5.8.6.5 and C5.8.6.5, Nominal Shear Resistance, and adds commentary on the use of Equation 5. This equation is only used to establish concrete section dimensions for sections subjected to combined shear and torsion.

Agenda Item 36 is a companion to a 2007 agenda item moved forward by Technical Committee T-5, Loads and Load Distribution, which simplified the determination of effective flange width in Article 4.6.2.6 in Section 4, Structural Analysis and Evaluation. The revision to the effective flange width determination is applicable to sections of all materials and thus is included in the general section on analysis. The revision of Article 4.6.2.6 states that in general “the effective flange width of a concrete deck slab in composite or monolithic construction may be taken as the tributary width perpendicular to the axis of the member for determining cross-section stiffnesses for analysis and for determining flexural resistances.” There are exceptions to this simplification specified in Article 4.6.2.6 including girders with large skew angles. Agenda Item 36 standardizes the definition of “*b*” in Articles 5.3, 5.7.3.1.1, and 5.7.3.2.2, by defining it as the width of the compression face of the member, or for a member with a flange in compression, effective width of the flange as specified in Article 4.6.2.6.

Six agenda items related to concrete structures were adopted by the AASHTO Subcommittee on Bridges and Structures (SCOBS) in Wilmington, Delaware, in July 2007. Agenda Items 32 through 37 were developed by Technical Committee T-10, Concrete Design, over the past several years and moved to the full subcommittee ballot last year. The agenda items represent revisions and additions to the AASHTO LRFD Bridge Design Specifications or the AASHTO LRFD Bridge Construction Specifications and appeared as the 2008 Interim Revisions published earlier this year. Agenda items 32 through 34 were discussed in the Winter 2008 issue of ASPIRE.™ The other three 2007 concrete-structures agenda items are reviewed in this article.

Agenda Item 37 clarifies Article 5.10.6.3 with regard to column ties for bundled bars. This clarification is made by modifying every reference to “bars” in the fourth paragraph of Article 5.10.6.3 to “bars or bundle.” The existing specification language was not fully clear and required interpretation as to how bundled bars should be treated. Making the requirements explicit eliminates the need for designer interpretation, and provides more consistent application of the specifications to columns with bundled bars.

The SCOBS met in Omaha during May and adopted changes for publication in 2009. These additions and revisions will be reviewed and discussed in future articles.

PRESTRESSED CONCRETE BRIDGES

serving the public's best interest

LONG LASTING INNOVATIVE FAST TO CONSTRUCT ECONOMIC



Prestressed Concrete Association of Pennsylvania
www.pcap.org



Central Atlantic Bridge Associates
www.caba-bridges.org

Advantages of Prestressed Concrete Bridges:

Simple Design

A variety of components can accommodate various load-carrying capabilities and span potentials. Connections between elements are simple – carefully planned details result in economy.

Low Initial Costs

Prestressed concrete bridges are economical as well as provide for minimum downtime for construction. Carefully planned details speed the total construction process and result in overall economy.

Fast, Easy Construction

Construction is fast with prestressed concrete. As the beams are factory produced, site preparations can proceed. Prestressed concrete is ideal for limited access locations and where speed of erection is crucial.

Widely Used and Accepted

While prestressed concrete is a relatively new product – the first use of prestressed concrete in the United States was in a bridge, built in the early 1950s in Philadelphia, Pennsylvania – today, about a third of all bridges built use prestressed concrete beams.

Assured Quality

The quality of prestressed concrete bridges is controlled under factory conditions. Because of such protected conditions, weather can't affect the result of casting. Unlike cast-in-place concrete, precast concrete offers greater consistency and more options for high quality finish.

For more information, call us or any of our member companies:



Bayshore Concrete Products
P.O. Box 230
Cape Charles, VA 23310
Phone: (757) 331-2300
Fax: (757) 331-2501
www.usacivil.skanska.com
Email: joe.rose@skanska.com



Schuylkill Products, Inc.
121 River Street
Cressona, PA 17929-1133
phone: 570-385-2352
fax: 570-385-5898
www.spibeams.com
Email: info@spibeams.com

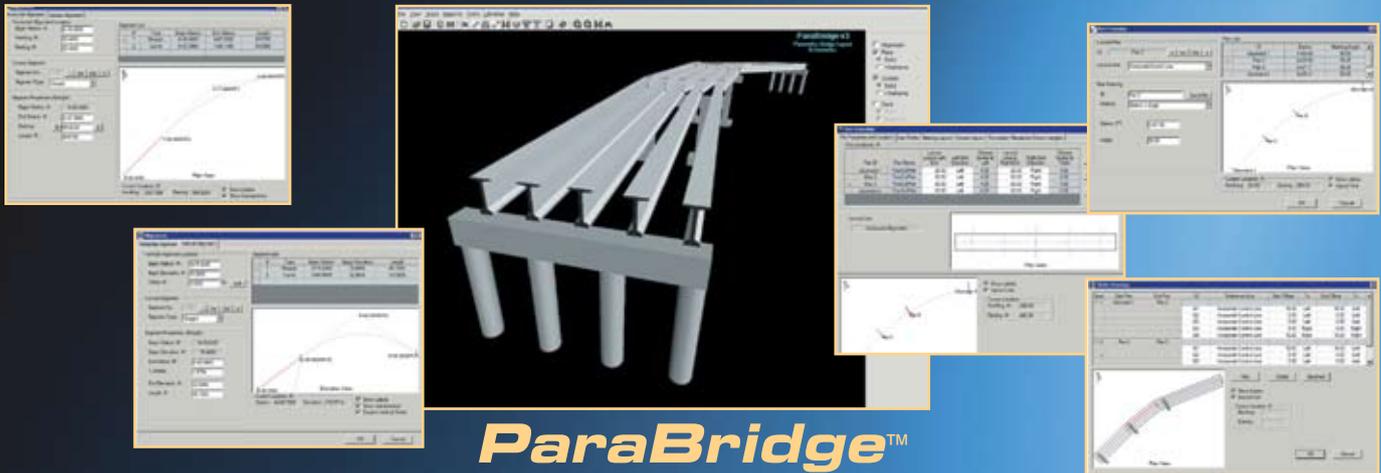


Jersey Precast Corporation
1000 Somerset Street
New Brunswick, NJ 08901
phone: 732-249-8973
fax: 732-249-9720
www.jerseyprecast.com
Email: jrzprecast@aol.com



Newcrete Products, Inc.
P.O. Box 34
301 Plum Creek Road
Roaring Spring, PA 16673-0034
phone: 484-902-0256
www.newcrete.com
Email: romani@nesl.com

Integrated 3D Design



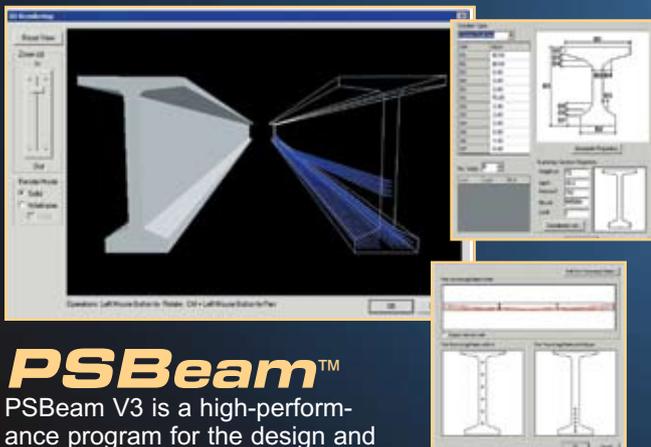
ParaBridge™

ParaBridge is a parametric 3D bridge modeling and design system that puts powerful and flexible bridge generation, geometry, and design tools at your fingertips. Designed and created within the state-of-the-art Microsoft .NET Framework, it represents the future of integrated 3D bridge engineering.

Laying out a bridge has never been easier. Powerful modeling wizards help you rapidly import or enter bridge alignment and roadway data. Girder and pier framing tools give you a highly-leverage means of describing the bridge layout. Piers and girders of multiple types can then be inserted into the project—all parametrically.

All pertinent bridge geometry is solved by ParaBridge: deck elevations, girder lengths, bearing data, quantities, etc. Element design is smooth and seamless. Both PSBeam and ETPier are tightly integrated with ParaBridge.

The main view is a true 3D object-oriented model of your bridge. Zoom, rotate, and pan the model in real time. ParaBridge utilizes technically advanced OpenGL graphics with no third party add-ins. The result: a high-performance system with no need to purchase an expensive CAD system to run it. Yet the model can be seamlessly passed to CAD software as needed.

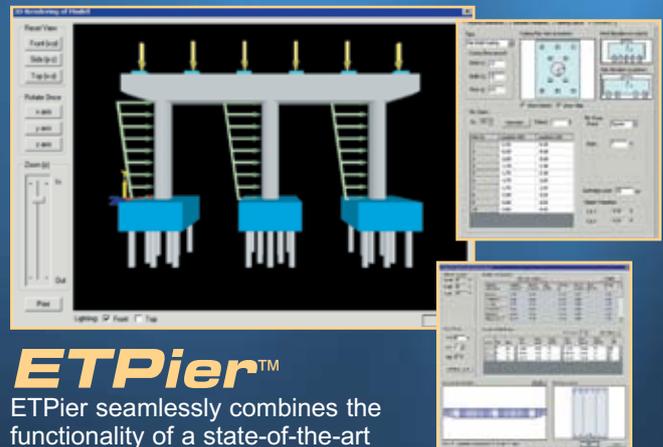


PSBeam™

PSBeam V3 is a high-performance program for the design and analysis of simple-span or continuous precast, pretensioned or post-tensioned concrete bridge girders. PSBeam is the software of choice for many bridge engineers who demand flexibility, high performance, and rock-solid reliability.

Virtually any precast beam type and pretensioning pattern can be handled by PSBeam. You can even extend spans using spliced girder technology.

PSBeam can accommodate the needs of all stakeholders in the life of a girder—from design to fabrication, through to load rating.



ETPier™

ETPier seamlessly combines the functionality of a state-of-the-art structural analysis engine with concrete column, beam, and footing design. Integration of these critical design tasks into one system means you get superior productivity and flexibility with improved quality control.

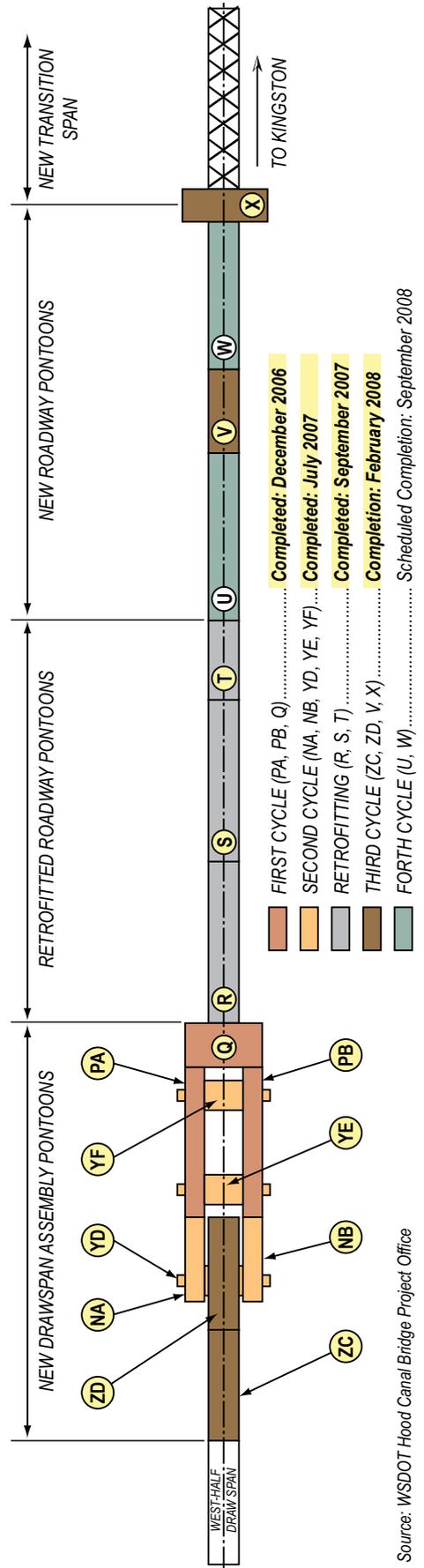
ETPier is specifically designed for bridge substructures. Powerful parametric modeling wizards are included to facilitate rapid structure layout and generation. Specify which load combinations to investigate and ETPier will automatically process them and quickly identify the governing case for each component of the structure.



The 20 anchors built for the East half are 29 ft tall and range in diameter from 46 ft to 60 ft.

Hood Canal Bridge pontoon construction cycles.

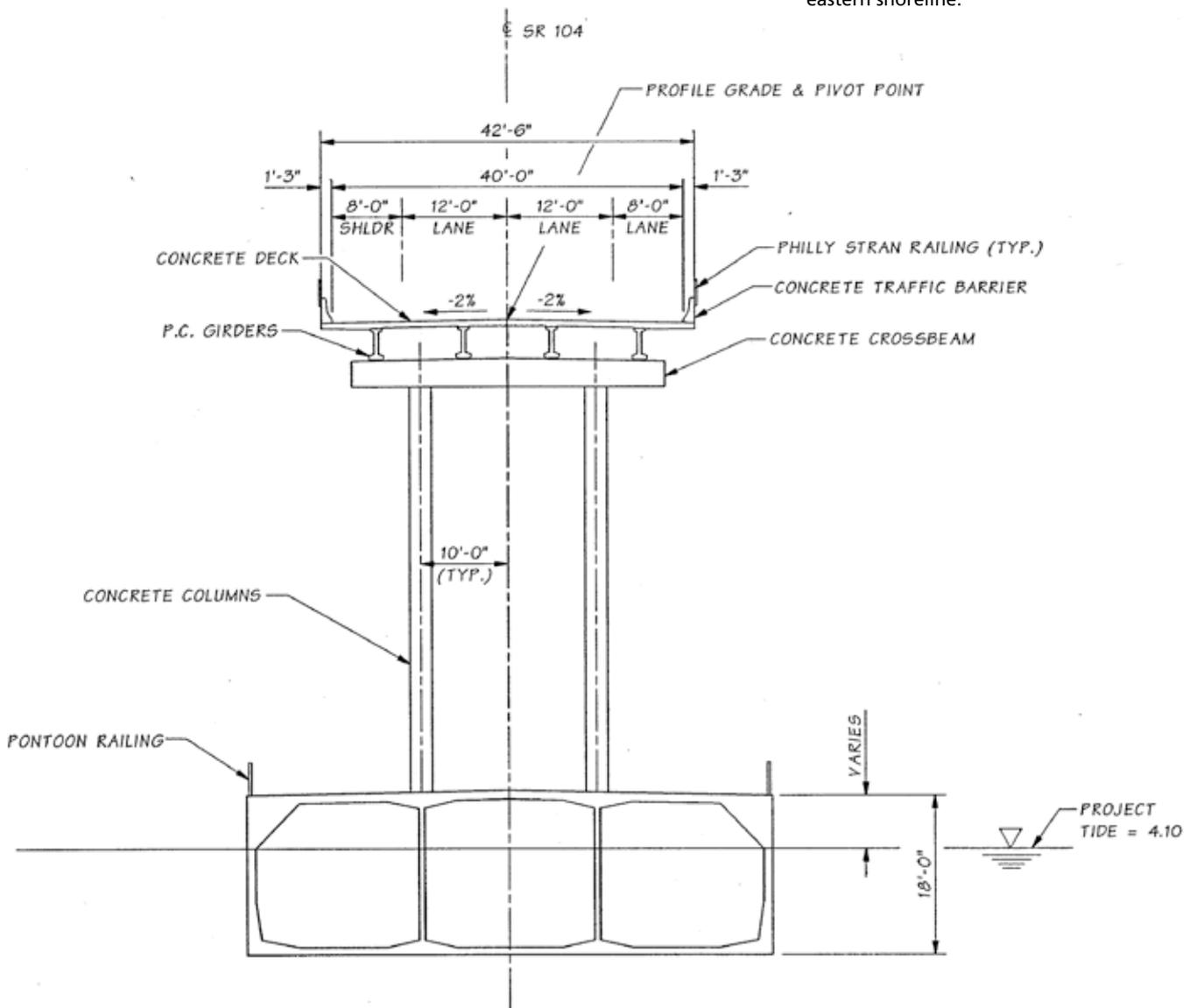
Hood Canal Bridge Pontoon Construction Cycles



Source: WSDOT Hood Canal Bridge Project Office

HOOD CANAL BRIDGE / WASHINGTON

Once the pontoons are joined into subassemblies of multiple pontoons, the elevated roadway is constructed on top of the floating pontoon foundations. The roadway deck towers over the top of the pontoon decks as high as 52 ft near the eastern shoreline.



TYPICAL SECTION @ PONTOONS U & W

Precast concrete seal slab with side forms for the channel pier footings



Photo: Charles Rudie, PB.

I-10 BRIDGE REPLACEMENT / FLORIDA

Precast pile footings with reinforcement cages in the piles reduced the amount of cast-in-place concrete construction over water.



Photo: Charles Rudie, PB.

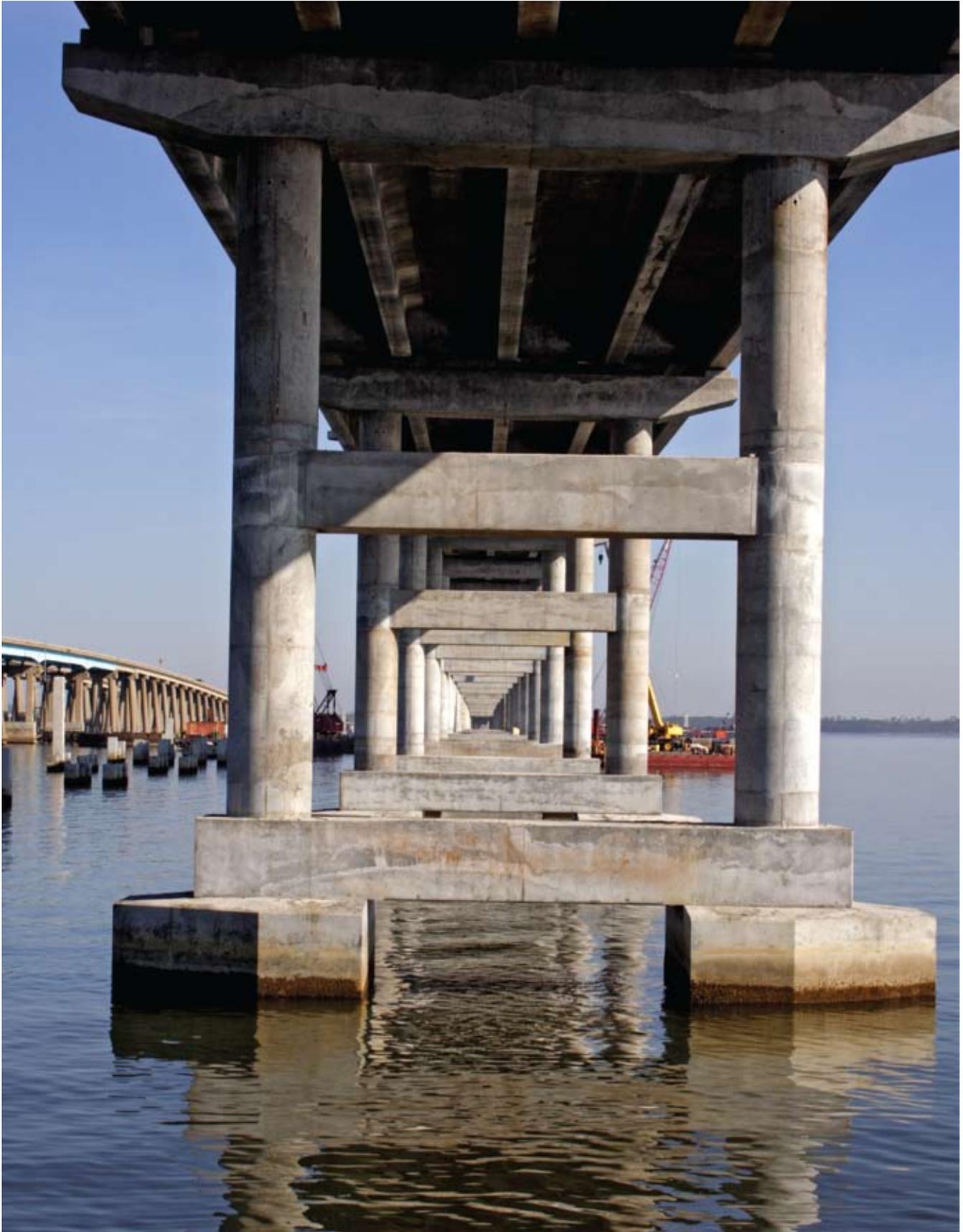
ASPIRE, Summer 2008 | Web

Precast concrete pile caps were used with a cast-in-place connections.



Photo: Charles Rudie, PB.

I-10 BRIDGE REPLACEMENT / FLORIDA



Typical pier configuration.

Photo: Charles Rudie, PB.

The first of the twin bridges was completed in 20 months.



Photo: Charles Rudie, PB.

I-10 BRIDGE REPLACEMENT / FLORIDA

Low-level pile bents.



Photo: Charles Rudie, PB.

ASPIRE, Summer 2008 | Web

SOUTH FORK EEL RIVER BRIDGES / CALIFORNIA



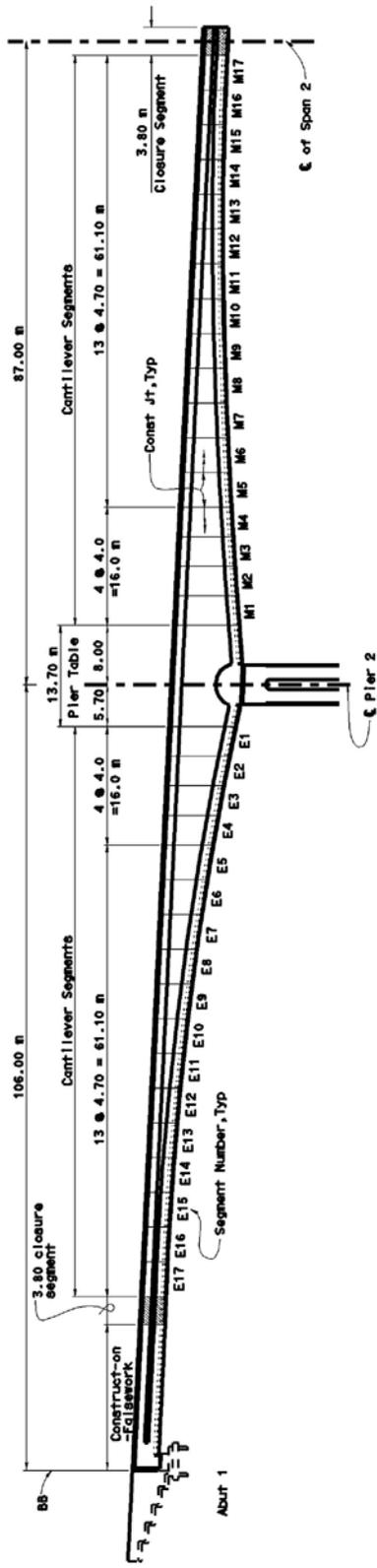


Photo: ©Caltrans.

POMEROY-MASON BRIDGE / WEST VIRGINIA



Photo: Michael Baker Jr. Inc.

POMEROY-MASON BRIDGE / WEST VIRGINIA



Photo: Michael Baker Jr. Inc.

POMEROY-MASON BRIDGE / WEST VIRGINIA



Photo: Michael Baker Jr. Inc.

POMEROY-MASON BRIDGE / WEST VIRGINIA



Photo: Michael Baker Jr. Inc.

ASPIRE, Summer 2008 | Web