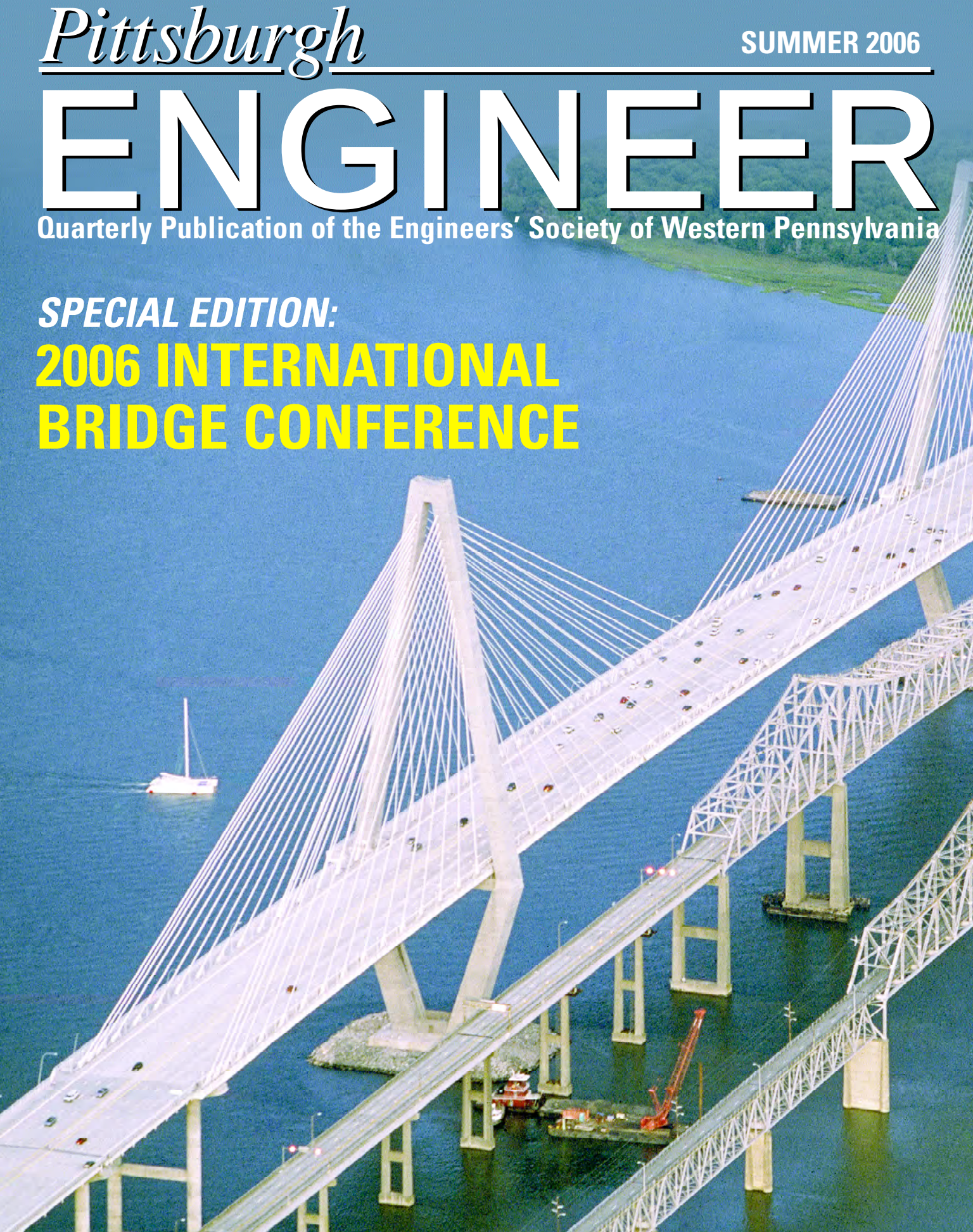
Pittsburgh
SUMMER 2006

ENGINEER

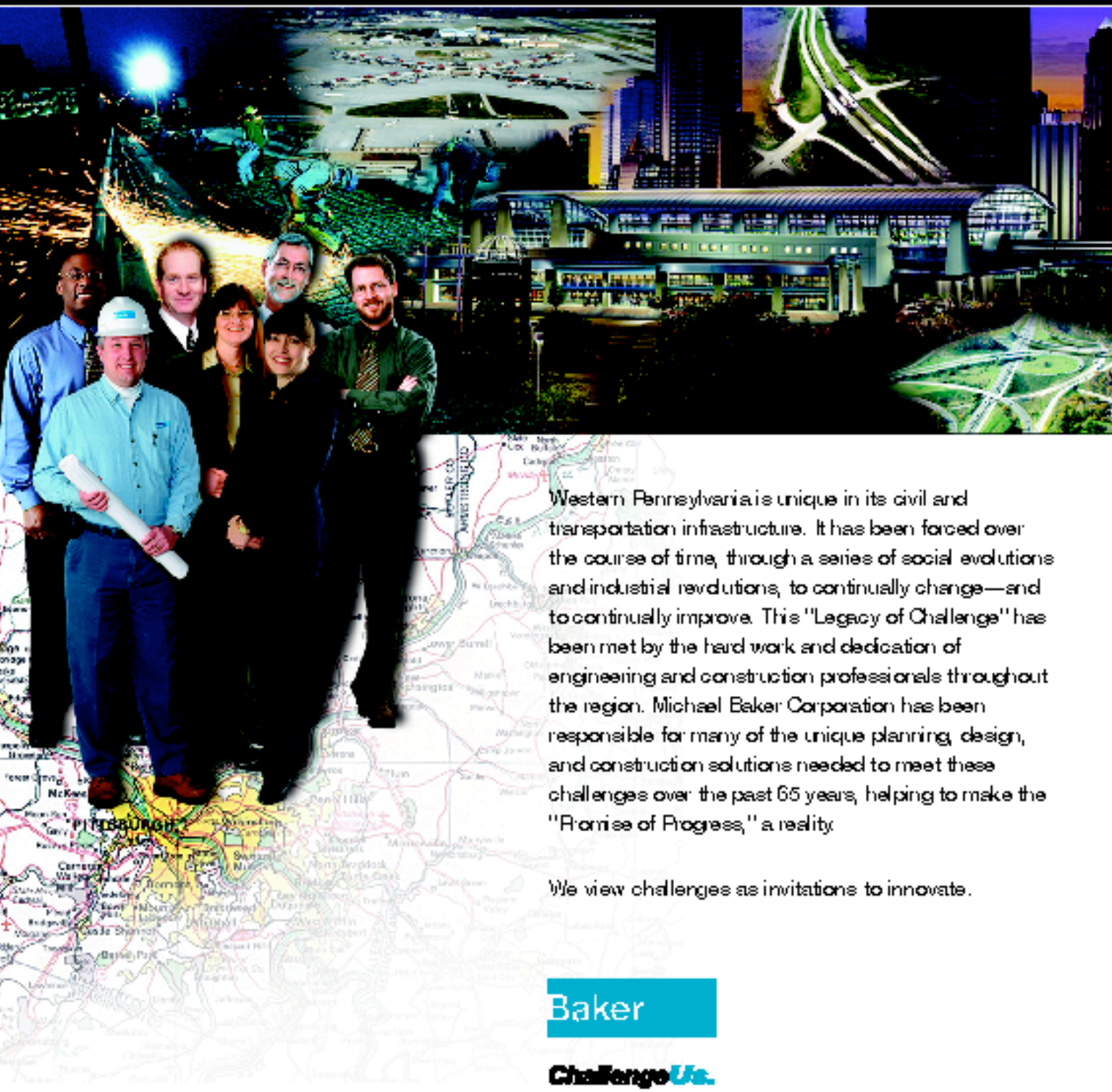
Quarterly Publication of the Engineers' Society of Western Pennsylvania

SPECIAL EDITION:

2006 INTERNATIONAL BRIDGE CONFERENCE



A Legacy of Challenge—The Promise of Progress



Western Pennsylvania is unique in its civil and transportation infrastructure. It has been forced over the course of time, through a series of social evolutions and industrial revolutions, to continually change—and to continually improve. This "Legacy of Challenge" has been met by the hard work and dedication of engineering and construction professionals throughout the region. Michael Baker Corporation has been responsible for many of the unique planning, design, and construction solutions needed to meet these challenges over the past 65 years, helping to make the "Promise of Progress," a reality.

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Cover photo: Anthony Winn

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Bridges Within and Beyond Our Borders

Guest Editor
Thomas G. Leech, PE, SE
Vice-President, Gannett-Fleming

Welcome to the Special Edition of the Pittsburgh Engineer dedicated to bridges and devoted to the International Bridge Conference. The International Bridge Conference, sponsored by the Engineer's Society of Western Pennsylvania, celebrates its 23rd anniversary this June. This conference, conducted annually in Pittsburgh, our city of bridges, celebrates the achievements of bridge owners, bridge contractors and bridge designer's, world wide.

This year, our conference theme is "Advancing Bridge Technology Globally". This rather introspective title, suggests a forward and progressive movement of bride ingenuity and ideas. Indeed, accomplishments in many fields of bridge construction, research and design are moving at rather astonishing rates throughout the world. Bridge types are adapting to an increasing number of modes of transportation. Innovations in materials and construction are pushing the thresholds of speed, reliability and dimension, never contemplated. Codes are increasing in sophistication while providing means for more uniform and reliable margins of safety consistent with applicable means of construction. High speed computers are enabling greater accuracy and speed of computation while providing informative three dimensional visualizations never previously or seriously contemplated. As we consider these achievements, we should look back to study the remarkable achievements of our ancestors, look at the present to see the achievements of our peers and look to the future and beyond as well.

This special edition is devoted to a reflective look of our American past, our global celebration of the present and our view of the immediate horizon. As you read the accompanying articles you will develop a new sense of appreciation of our bridge heritage, illustrated quite well by Mr. Eric DeLony, former Historic American Engineering Record Chief. His summary article asks all bridge enthusiasts "how can we help save our bridge heritage?" Our celebration of the present continues with a tantalizing look at the International Bridge Conference Award's Program for this year which recognizes lifetime achievement, innovation in research, innovation in construction, innovation in design and innovation in imagination. Our celebration of the present follows with a blueprint for relationship building; Lisa Andrus demonstrates how effective community participation and government action can result in structures mindful of our industrial heritage while providing sensitive modern design. As we look to the future, the Asian continent beckons with innovation and promise. Kent Harries takes a small peek into the future reporting on some stellar structural innovations currently underway in Japan and Myint Lwin takes a long look at ever growing bridge program in mainland China, with mega projects competing for complexity.

Our IBC general chairman, Ken Wright will offer a special welcome and share his vision for this year's International Bridge Conference. Our well rounded program includes not only technical sessions from projects scattered through out the globe, but provides the highest of caliber of special interest sessions, proprietary sessions, seminars and workshops.

As you read about our award's program, you may have asked yourself "who really is John Roebling?" for which our lifetime achievement award is named. Look for the special highlight short telling more of the man and his dreams.

Begin your reflective journey – enjoy this year's magazine! See you at the conference. ■

Roebling

"A Vast Legacy of Accomplishments"

"Roebling" is a familiar name within the bridge industry. In fact, even casual observers of the bridge industry know of Roebling, given the vast legacy of accomplishments credited to the name. Cincinnati, Pittsburgh, New York City and other cities boast of their connection to Roebling through one of the lasting structures credited to the name. The accomplishments in and around the bridge industry are well documented and studied. Roebling is also credited as the inventor of wire rope technology which allowed for huge leaps of progress in the bridge industry and in many other applications. However, there is another aspect to the Roebling legacy that warrants attention, but is often overshadowed by these greater accomplishments; it is the lesser noted accomplishment as a settler of American towns.

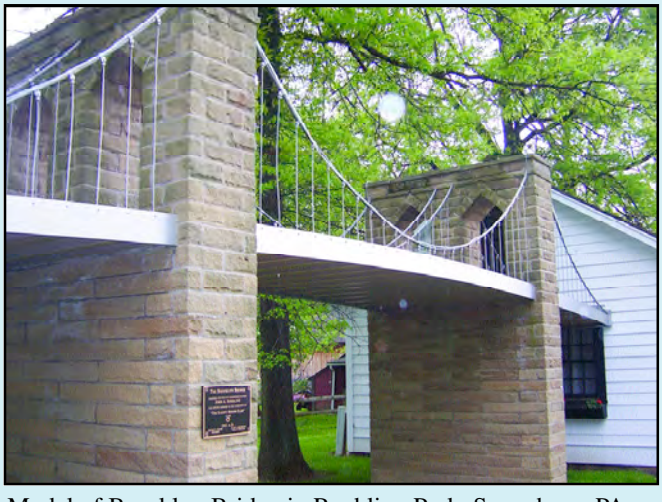
John Roebling and his younger brother, Karl, were greatly impacted by the religious and political limitations they faced while living in Germany in the late 1820's. So much so that they formed an immigration society with several hundred young families in their home town of Muhlhausen to explore the promise of the North America continent. In 1831, their immigration party left Germany aboard two ships consisting of several hundred families, bound for America. Upon their arrival, the Roebling brothers, along with some of the German immigrants accompanying them, settled on an unsettled Butler County land tract about 20 miles northeast of Pittsburgh, Pennsylvania.

Although formally educated in Germany as an engineer, John Roebling began his years in America like his father in Germany, working as a farmer to clear the land and make way for homesites for this new area. After working to establish the town "Germania", now known as Saxonburg, many others who originally did not locate in Saxonburg returned to join the Roeblings. After three years, Roebling returned to work as an engineer in the Pennsylvania canal project. The expensive and unsafe system of using hemp hawsers for lifting transport barges by rail over the Pennsylvania mountains caught the attention of Roebling. This quickly engaged his eager mind to find a better way to assist in the transport. After reading a technical paper discussing the fabrication of rope out of wire, Roebling envisioned a new material to replace the hawsers, and promised cost and safety improvements to the canal's railway sections. To fabricate this new rope, Roebling started a company in 1841 on his Saxonburg farmland, employing many of the same immigrants who traveled from Germany. After some skeptisism, he managed to convince the Pennsylvania State Board of Public Works to experiment with this new technology in the canals, which lived up to the promises set by Roebling.

Soon after, the use of wire rope found its way into many industries causing the Roebling Wire Rope Company to relocate to Trenton, NJ and be closer to the iron works that supplied Roebling to better meet the growing demands for his product.

Despite relocating his family from Saxonburg in 1849, the Roebling family had made and left a profound impact on the town. Many of the early settlement homes are still standing along Main Street, as is the landmark church located at the high end of Main Street on land that was donated by Roebling. Roebling Park is the "town square" of Saxonburg and features a museum recalling the town's early history and a model replica of Roebling's greatest engineering feat, the Brooklyn Bridge.

Roebling Park, Saxonburg PA



Model of Brooklyn Bridge in Roebling Park, Saxonburg, PA

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CHAIRMAN'S MESSAGE

As this year's General Chairman, I am pleased to announce the 2006 International Bridge Conference in Pittsburgh, the "City of Bridges". The theme for the 23rd meeting of what has become the world's premier bridge conference is "Advancing Bridge Technology Globally". We have a strong international program that I trust will be both stimulating and educational.

On behalf of the Executive Committee, I urge you and your colleagues to attend. The conference begins with a Keynote session on Monday morning. We are pleased to have as our keynote speakers Mr. Malcolm Kerley, the Chief Engineer for the Virginia Department of Transportation; Mr. King Gee, from the Federal Highway Administration; and Ms. Caroleann Wicks, the Secretary of Transportation from our featured state of Delaware.

The Keynote session will be followed by our Annual Awards Luncheon. The format for the awards presentation will be similar to that which debuted at the 2005 conference, in which a PowerPoint presentation highlighting the various award winners will be repeated throughout the duration of the luncheon. Please read the article later in this magazine that highlights the various award winners for 2006.

I invite you to take advantage of some of the fine opportunities available during the Conference. There are special interest sessions available in specific areas of interest. We have three half-day seminars that you will find informative: Seismic Engineering; Accelerated Bridge Construction; and an ACI-developed seminar on FRP. We have approximately 120 exhibitors that will present state of the art engineering services and products that may be of use in your daily business. Please take the time to visit with the exhibitors to learn about new technologies that you can apply in your daily design work. We will again sponsor a Tuesday afternoon bus tour that will focus on the ongoing rehabilitation of two major river bridges in the Pittsburgh area – one a large deck truss and the other a steel deck arch structure.

The technical program this year is again very strong and diverse. We offer papers on design, rehabilitation, construction and research. We have a number of papers with a truly international flavor including several from China, which will be the featured country for the 2007 International Bridge Conference. There will be a Chinese delegation attending this year's conference to survey the conference and develop some ideas on what they will present about their country's transportation system in 2007. Please make the delegation feel welcome at the conference as they prepare for 2007.

I would like to offer a sincere thanks to all the IBC Executive Committee members that have given generously of their time and talents over the past year planning this conference. Their dedication and insights have made my job as the General Chairman very easy. Please seek out the committee members during the conference and share your thoughts on what you like about the conference, or what we could improve in the future. We value your input as we plan future conferences.

I hope to see you all at this year's conference on June 12, 13 and 14.

IBC General Chairman

Kenneth J. Wright, PE

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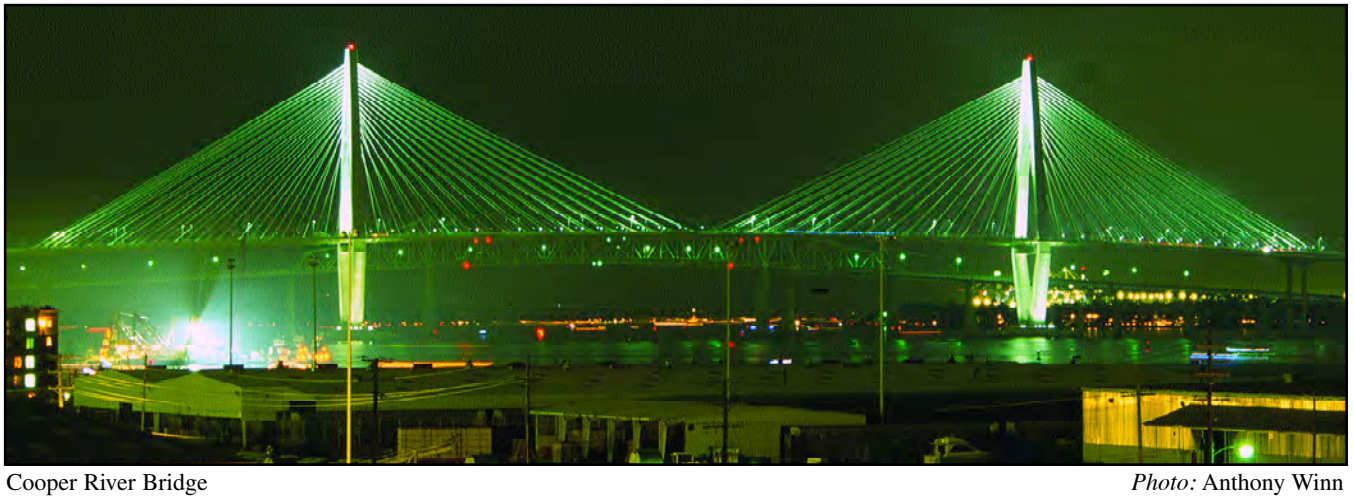
IBC 2006
Bridge Awards Program

by Carl Angeloff, PE
Bayer Materials Science

The International Bridge Conference® in conjunction with Roads and Bridges Magazine, Bayer Corporation and Bridge design and engineering Magazine, annually awards five metals to recognize individuals and projects of distinction. The medals are named in honor of the distinguished engineers who have significantly impacted the bridge engineering profession worldwide.



Cooper River Bridge *Photo:* Anthony Winn

Gustav Lindenthal Medal

The Gustav Lindenthal Medal, awarded for an outstanding engineering structure that is also aesthetically and environmentally pleasing, will be presented to recognize the Arthur Ravenel Bridge. Commonly know as the Cooper River Bridge, this two and one half mile long cable stayed structure spans the mouth of the Charlestown River in South Carolina. This design build project exceeded the owner's expectations for delivery of a major structure project, featuring the longest cable stayed span, currently in the United States. In an unusually earthquake prone setting for the east coast of the United States and in an area frequented by hurricanes, the bridge combines strength and beauty.

Charles Seim

John A. Roebling Medal

The John A. Roebling Medal recognizes an individual for lifetime achievement in bridge engineering. We are pleased to recognize Mr. Charles Seim, P.E., F. ASCE as the 2006 recipient. Mr. Seim's 50 year career with Caltrans and T. Y. Lin International has placed him at the forefront of innovation in engineering and construction. As supervising engineer for Caltrans and later bridge maintenance engineer for California State owned toll bridges, Mr. Seim has supervised an array of repairs and new construction for the major structures in California. His portfolio of projects included the design of many international projects with his later employment with T.Y. Lin. Mr. Seims's considerable publications and presentations spans topics such as elastic stability problems, earthquake considerations, orthotropic steel decks and composites elements in bridge construction. Mr. Seim is an Associate Editor of ASCE Journal of Bridge Engineering.

The George S. Richardson Medal

The George S. Richardson Medal, presented for a single, recent outstanding achievement in bridge engineering, is presented to Dr. William Wright, Mr. Michael Grubb and Dr. Don White for their instrumental work in the development of the LRFD Unified Steel Design Code, which is available for use of the industry, upon release in the 2005 Interims to the third Edition of the LRFD Code. This work is an outgrowth of the NCHRP Project 12-52 which integrates curved and straight girders seamlessly into a unified design specification.

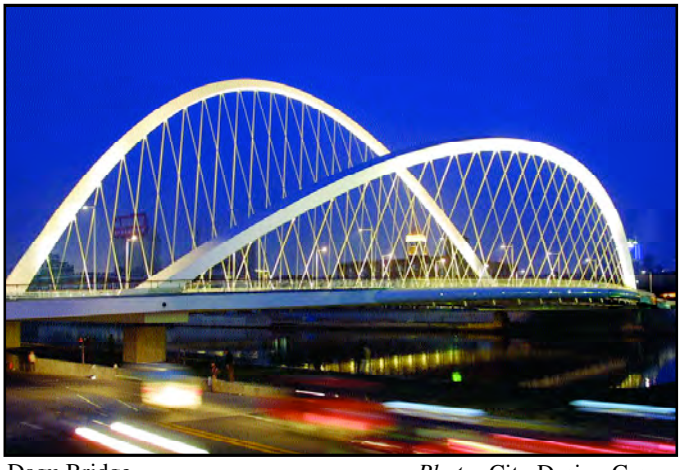
Dr. William Wright

Michael Grubb

Dr. Don White

Eugene C. Figg Jr. Medal

The Eugene C. Figg Jr. Medal for Signature Bridges, recognizing a single recent outstanding achievement in bridge engineering, which is considered an icon to the community for which it is designed, will be presented to recognize the Dagu Bridge, in Tianjin, China. As a new symbol to the City's bold river front revitalization plan, the asymmetric, inclined plane, twin tied arches individually represent the sun and the moon dancing with the golden dragon, the Haihe River, over which the 350 foot bridge spans.



Dagu Bridge *Photo:* City Design Group

Arthur G. Hayden Medal

The Arthur G. Hayden Medal, recognizing a single recent outstanding achievement in bridge engineering demonstrating vision and innovation in special use bridges, will be presented to recognize London's Gatwick Airport taxiway Lima's concourse air bridge. This unusual rigid frame structure provides horizontal and vertical clearances for the largest class of airplanes, while presenting standees and walkers within the structure, an unusual vista of the airport as well as the spine which supports the structure.

Gatwick Pier 6 Bridge *Photo:* BAA/David Hatful

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How Can Engineers Help Save Historic Bridges?

by Eric DeLony

Consultant, Engineering and Industrial Heritage, PC

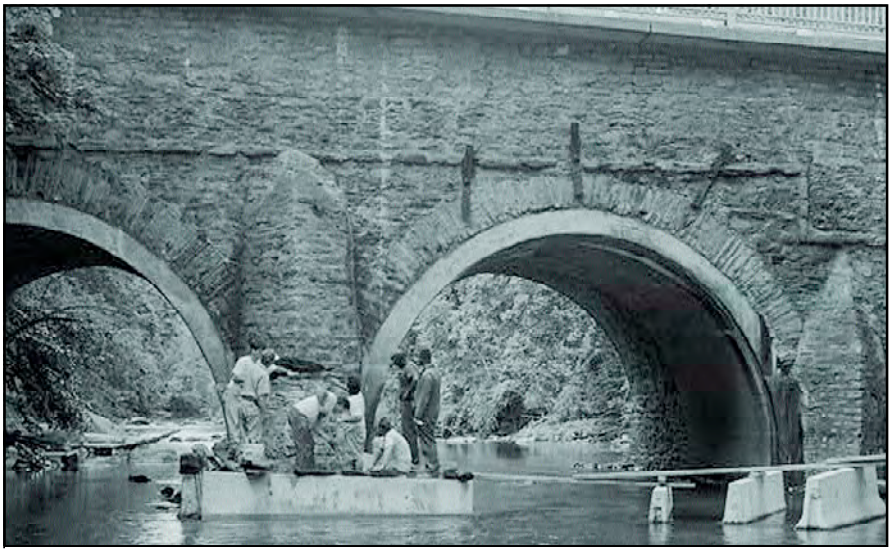

Fig.1: Pennypack Creek Bridge (1697), Philadelphia, PA

Background

America's historic bridges date as far back as the 17th century *(Fig. 1)*, and, extend up to modern suspension bridges, modern concrete structures *(Fig. 2)*, and moveable spans. Historic bridges are the single most visible icon of the civil engineer's art. Bridge building evolved over the last two hundred years in America, driving some of the most important developments in structural design and material technology. Examples from all periods remain, but many have an uncertain future.

About twenty years ago, under direction from the Federal Highway Administration, most states began inventorying and identifying their historic bridges to determine which ones were eligible for listing on the National Register of Historic Places. This major first step is nearing completion. Historic bridges are one of the first structure types to be comprehensively inventoried on a national scale. Significant progress also has been made by increasing the awareness of highway officials and engineers, Congress and the public to the value that bridges hold for the historic built environment and life qualities in our communities.

One only has to look at the number of historic bridges that have been saved to realize the potential that bridges hold for creating a unique sense of place, identity and amenity, for both urban and rural landscapes. Rehabilitating historic bridges not only saves significant historic resources, but can be economically rewarding and a sound engineering practice. Some of the most innovative, cost effective engineering practices are represented by rehabilitated historic bridges. Despite these successes, recent statistics suggest that our historic bridges remain a heritage at risk. *(Fig. 3)*

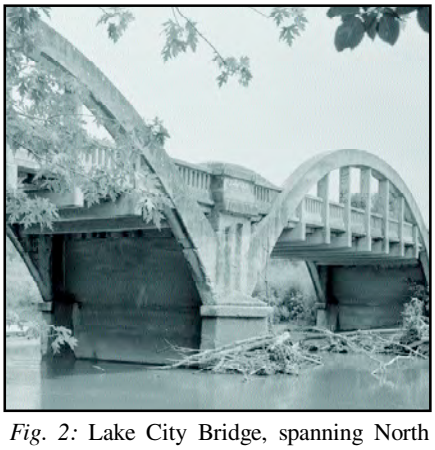

Fig. 2: Lake City Bridge, spanning North Raccoon River, Lake City vicinity, IA. Joseph Elliott, photographer, HAER Collection, Library of Congress.

Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA)

Since 1991, federal legislation has inspired an important transformation within the transportation community, broadening its mission from the traditional task of providing a safe and efficient highway system to acknowledging that these activities play a critical role in preserving our nation's natural and historical heritage. Despite this cultural shift recent statistics suggest that half, if not more, of our Nation's historic bridges have been lost in the last twenty years - two decades in which transportation and preservation consciousness was at a high level. This is an alarming and sobering statistic. To this end, the Federal Highway Administration (FHWA), the Historic American Engineering Record (HAER), and others, organized an invitation-only workshop of experts to articulate and define the issues confronting historic bridges.

The workshop was held in Washington, DC in December, 2003. In the spirit of stewardship, streamlining, and sound environmental and historic bridge management, the goal of the workshop was to provide federal and state transportation agencies, the Congress, and the interested public with recommendations and solutions on how to preserve this heritage at risk. Specifically, the purpose of the workshop was to articulate and define efficient and economical strategies for historic bridge preservation and management. *(Fig. 4)*

HAER and Engineering Heritage Education

In its early years during the 1970s, HAER (Historic American Engineering Record) tried hiring engineering students on its summer teams, but found that engineers had limited skills in producing drawings, photographs, or histories - the main products of HAER documentation projects. While most engineering students understood structural behavior and were familiar with the latest computer programs to analyze modern bridges, rarely did they have the background or experience to analyze historic bridges. *(Fig. 5)*

Beginning about ten years ago (1996), under the leadership of HAER Chief Eric DeLony, HAER began hiring engineering students again to work on its summer surveys along with the architects,

Fig. 3: Gothic Arch (1864), spanning bridle path south of tennis courts at northwest edge of Reservoir, Central Park, New York City, NY, one of five cast and wrought iron bridges designed by Calvert Vaux and Jacob Wrey Mould to separate equestrian from pedestrian traffic in Central Park. Jet Lowe, HAER Photographer, HAER Collection, Library of Congress.

landscape architects and historians, but this time under the guidance of Professor Gasparini, professor of civil engineering, Case Western Reserve University, Cleveland, Ohio. Thus evolved one of the most innovative aspects of the HAER documentation program: to evaluate not only the structural capabilities of historic bridges, but to analyze their performance and behavior enabling assessments of the efficiency of the design, how engineers conceptualized their bridges reconciling structural theory with the practicality of constructing a buildable product in often remote locations. We now are able to compare similar designs types such as iron bowstrings and concrete arches and say something definitive about their efficiency, performance and behavior.

National Historic Covered Bridge Preservation Program (NHCBP)

I was invited to serve on FHWA's NHCBP awards panel in 2001. We allocated $7 million dollars over seven hours, one of the most gratifying days of my federal career. I remember that at the end of the day, Steve Ernst said there was about $900,000 still on the table – did anyone have any ideas on how to spend it? I raised my hand suggesting that this would be an ideal time to document a selection of America's covered bridges. The next morning, Steve called asking that I flesh out the idea in more detail. HAER's senior historian, Rich O'Connor, and I came up with a five-part program: documentation, national historic landmark designation, an exhibit, a national covered bridge web site, and a national conference.

As part of the NHCBP program, the FHWA, in partnership with HAER, proceeded with a project to document a selection of the covered bridges in the United States. The HAER project provided a rich learning laboratory for engineering students. Conducted over a three year period (2001-2003), HAER documented 75 of the nation's estimated 800 covered bridges. A significant component of the project was structural evaluation of selected covered bridges. HAER worked with engineering educators such as Dr. Gasparini and students to analyze a selection of these bridges.

Three of the five objectives have been accomplished. Yet to be done is nomination of a selection of the nation's outstanding covered bridges as National Historic Landmarks. This is the nation's highest form of recognition signifying the bridges value as national treasures, providing a modicum of protection. A national covered bridge data base including a photo, date of construction, builder and location would be extremely helpful to scholars and the traveling public.

Best Practices, Care and Repair of Covered Bridges National Conference, University of Vermont, June 5-7, 2003

In addition to the summer recording projects was the first Best Practices, Care and Repair of Covered Bridges National Conference. This was targeted to attract state and local highway engineers, state and county covered bridge maintenance personnel, volunteers charged with raising funds for the preservation of covered bridges, local and national covered bridge preservation organizations, historic preservationists, general contractors, structural engineers, covered bridge historians, the traveling public and community members. The conference was held at the University of Vermont, June, 2003.

The National Historic Covered Bridge Best Practices Conference was the first of its kind to collect and benchmark the vast array of information that exists on covered bridges by inviting all those concerned with covered bridge preservation to participate. A goal of the conference was to develop a national reference base for evaluating various treatments of historic covered bridges in ways that will maintain their historic integrity as National Register properties. The conference also intended to promote a dialogue of the diverse ideas, experience, techniques and practices for historic covered bridge preservation.

SITES Traveling Exhibit: Spanning Engineering and Culture: America's Historic Covered Bridges

Another benefit of the NHCBP is a

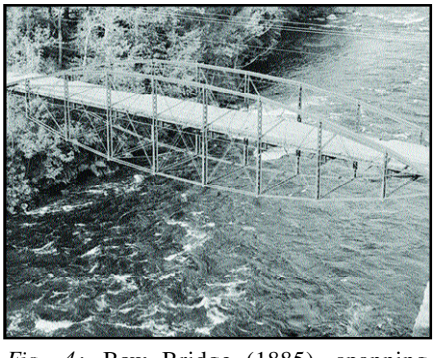

Fig. 4: Bow Bridge (1885), spanning Sacandaga River, Hadley, NY

Fig. 5: Upper Bridge at Slate Run (1890), spanning Pine Creek at State Route 414, Slate Run vicinity, PA, Joseph Elliott, photographer, Library of Congress.

traveling exhibit that displays and interprets HAER documentation for the larger public. Under HAER staff historian Lola Bennett and HAER architect Christopher Marston's fertile imaginations, the exhibit showcases photographs and detailed architectural and engineering drawings from HAER's covered bridge program along with bridge-related artifacts from the Smithsonian Institution's vast collections. The exhibit opened March, 2006, at The State Museum of Pennsylvania, Harrisburg, and will travel to the Montshire Museum of Science, Norwich, VT, the Chico Museum, Chico, CA, and the Bennington Museum, Bennington, VT.

Recent scholarship and best practices on historic bridges, TICCIH-Terni, Italy, September 14-18, 2006

Finally, TICCIH (The International Committee for the Conservation of Industrial heritage) is discussing formation of an historic bridge/infrastructure/public works special interest group. TICCIH is a global organization which has been in existence for 30 years promoting the preservation, conservation, investigation, documentation, research and interpretation of engineering and industrial heritage. To this end TICCIH will sponsor an historic bridge session at the TICCIH congress held in Terni, Italy, September, 2006. Here, not only will there be presentations on current historic bridge scholarship and best practices, but the formation of a special historic bridge/infrastructure/public works special interest group.

Conclusion

Replacement and rehabilitation of old bridges has stimulated interest in their preservation and history in the United States and other parts of the world. In the US, recent statistics suggest that half, if not more, of America's historic bridges have been lost in the last twenty years - two decades during which transportation and preservation consciousness was at the highest level. Engineering and transportation always has had significant impacts on the historic built environment. For over a quarter of a century, consulting engineers, highway officials and federal transportation authorities, industrial archeologists, preservationists, citizen groups and individuals have been grappling over the decision to rehabilitate or replace historic bridges. Certainly, there is no argument that a selection of our most outstanding spans and representative examples of our more common historic bridge types shouldn't be saved for posterity.

I hope those of you in the engineering, transportation and bridge construction industry will find this summary of activities in the historic bridge community of interest. We call ourselves "pontists" and invite you to join our cause–preservation of a selection of the historic bridges of the United States. Come forward if you want to participate in this gratifying yet challenging venture. ■

Author: Eric DeLony, Consultant, Engineering & Industrial Heritage, PC, 21 Cagua Road, Santa Fe, NM 87508, Pontist@Comcast.net, (505)466-1448.

Until his retirement in October 2003, Eric worked with the Historic American Engineering Record (HAER). As Chief, he served as the Departmental and Park Service authority on engineering and industrial heritage, representing the United States at national and international conferences and symposia. Eric has inspired a new generation of engineers in working with the nation's transportation and engineering resources. The author and Portland (OR) graphic designer, Michael Beard, Errol Graphics are endeavoring to publish a book entitled Bridge Cities, which will feature the bridges in some of America's most notable bridge towns. The authors seek support and further suggestions as they launch this project.

Editor's notes: This article was condensed from a longer essay of the same name containing more illustrations and an abundance of related references and web sites. This essay can be found on the ESWP web site; please view at www.eswp.com. All photographs are courtesy of the HAER Collection, Library of Congress. HAER, a program of the National Park Service, documents the nation's engineering and industrial achievements of historic significance. All the illustrations in this article are public domain and may be viewed and downloaded from the HAER Collection,

http://memory.loc.gov/ammem/collections/habs_haer/

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". . . squeezed in between historic buildings . . ."

Building Relationships, Solving Design Challenge

by Lisa Andrus

Marketing Consultant, SAI Consulting Engineers, Inc.

There was a problem in Erie, Pennsylvania. There was no easy access from the City of Erie's east side to Interstate 90, hindering economic development in the region. In 2000, under former Governor Tom Ridge, work began on transportation improvements known as the East Side Access Highway, otherwise referred to as the Erie Bayfront Connector. The $180 million project was to total 6.6 miles extending from the Bayfront Parkway, which runs parallel to the Lake Erie Shore, to Interstate 90. An underutilized railroad corridor was to be used for the new roadway. Sounds like a basic roadway project-not exactly.

One of the greatest challenges for engineers would be the need to design and build a viaduct in Section A60 of the Connector that would cross several sets of railroad tracks, could be squeezed in between historical buildings without damaging the integrity of the structures, and provide unaltered access to the businesses that use both the railroad tracks and historical buildings on a daily basis. Compiled on top of these challenges were the demands of local business owners, community groups, and government agencies to ensure the new structure would be aesthetically pleasing and environmentally friendly. The Zurn Viaduct met those design challenges.

Solutions to the Challenges

Through comprehensive community dialogue and partnerships with private and public businesses, historical groups, and state and local government agencies, the Zurn Viaduct design group was able to use modern day design techniques to solve their design challenges. For example, the following techniques were used to help blend the new viaduct into the historical industrial area:

Multi-column and solid shaft piers were designed with an 18-inch running bond pattern to give the appearance of cut stone foundations. MSE panels of abutments and wingwalls were constructed using a brown, exposed aggregate finish. The exterior face of the bridge parapets were given a brick finish and stained red to blend in with the historical Zurn Industry buildings.

The interior face of the bridge parapets and median were given an ashlar stone appearance to provide a consistent look throughout the whole Bayfront Connector project.

Unpainted weathering steel girders

Exterior Face of Parapet

were used to blend in with the historical site.

Historical Preservation

Zurn Industry was founded in 1900 in Erie, PA. It originally manufactured a patented backwater valve, and it now manufactures and distributes one of the largest plumbing products packages in the world.

To meet the request of local community groups who wanted to preserve and highlight the economic history of the Zurn Industries area, three bronze plaques commemorating the region's history were created and installed facing the sidewalk allowing bicyclists and pedestrians to enjoy them while crossing the viaduct.

Local Business Needs

The designers of the viaduct were required to pay careful attention to the placement of the new piers and abutments. The substructures needed to be spaced in order to not block the existing delivery doors of the warehouses and not interfere with the current flow of truck traffic making deliveries from the railroad tracks to the warehouses. In addition, the viaduct needed to span over the existing and relocated railroad tracks. The designers also had to take into consideration the vertical clearance of the viaduct and future traffic that might occur due to the improved access to the region. Through several meetings of local business owners and railroad representatives, the designers were able to come up with a plan that satisfied everyone's requirements. The goal was to maintain necessary rail access. To accomplish this goal, significant rail work, including general and geometrical upgrades to the track and facilities, rail car track storage, new switches and spur line development, was needed. As a result, adjoining businesses greatly benefited from the new viaduct.

Conclusion

The Zurn Viaduct was met with several challenges beginning at the design inception phase. Through the diligent work of design engineers, local community groups, and government agencies all working together to achieve a common goal, the end result has become a perfect example of modern day design techniques that have met and exceeded the expectations of the community. ■

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Innovative Bridge Engineering in Japan

Viaducts on the Second Tomei Expressway

by Kent A. Harries, Ph.D., P.Eng.

University of Pittsburgh

In June 2005, the author, a University of Pittsburgh Assistant Professor, while leading the annual National Science Foundation's Natural Hazards Mitigation in Japan (NSF NHMJ) summer program for graduate students, had the opportunity to visit three innovative bridge structures being constructed as part of the Second Tomei Expressway linking Tokyo and Nagoya. The three bridges – the Uchimaki Viaduct, the Katsurajima Viaduct and the Sarutagawa Bridge – each take an increasingly innovative approach to the unique design constraints of the project. Each bridge is a variation of the strutted box girder, a bridge form not commonly used in North America. In addition, each bridge is erected using a different method. This article introduces the innovative aspects of the design and construction of these spans in addition to providing some insight into the design and engineering atmosphere which allowed for their innovation.

The Challenge

The Second Tomei Expressway is presently being constructed between Tokyo and Nagoya, Japan. This new dual carriageway road is intended to relieve the overburdened Tomei Expressway and provide additional transportation security for Japan into the 21st century. The Expressway, located along a more scenic route north of the existing expressway, rail and Shinkansen (bullet train) lines, traverses rugged terrain having densely populated valleys. The Expressway, therefore requires many tunnels, bridge and viaduct structures. The high seismicity of the region complicates the design of these, often very tall, viaducts.

Strutted Box Girders

Strutted box girders offered a relatively inexpensive and practical method of providing the large dual carriageway viaducts. Reinforced concrete strutted box girders weigh only about 75% of comparable reinforced concrete box girders. The weight savings translates to reduced materials and launching costs as well as reduced seismic loads. In addition to the box being lighter, often the supporting pier can be made more slender since the box webs are located closer together *(see Fig. 1)*. In North American practice, strutted box girders are not common, proposed primarily to allow future widening of new spans, widening existing spans, or for use in extradosed cable stayed structures (Shushkewich 2003). This article reports on three strutted box girder viaducts; each taking an increasingly innovative approach to address what are essentially similar design and site locations for conditions.

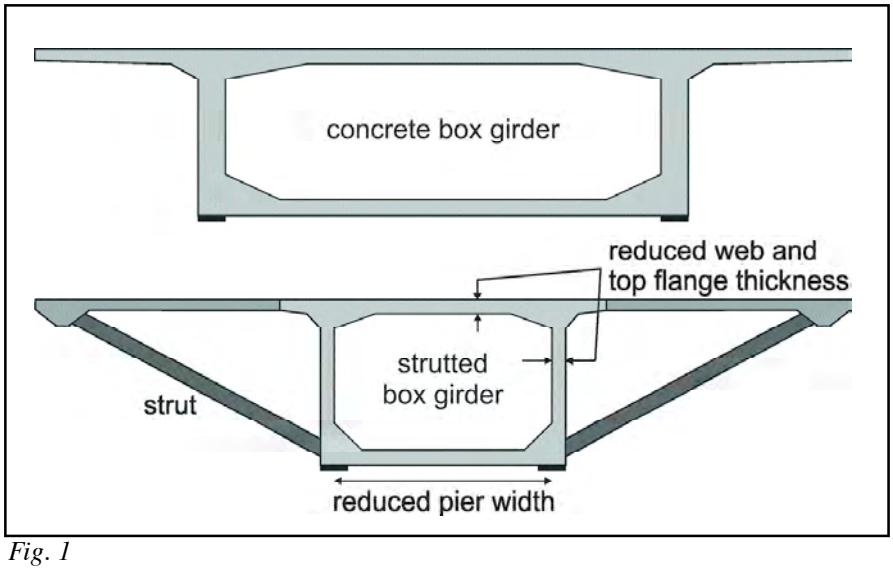

Fig. 1

Uckimaki Viaduct

The westbound Uckimaki Viaduct consists of 17 – 51.5 m (168.8 ft) spans while the eastbound viaduct consists of 8 – 53.0 m (173.8 ft) and 10 – 51.5 m spans. The viaduct, over much of its length, is 37 m (121 ft) above the valley floor. The spans consist of single cell strutted box girders 3.5 m (9.8 ft.) deep with 300 mm (12 in.) webs *(Fig. 2)*. The top flange is 18.05 m (59.2 ft) wide while the bottom flange is only 6.4 m (21.0 ft) wide. A comparable non-strutted box girder would have a 10.31 m (33.8 ft) wide bottom flange, 500 mm (19.7 in.) webs and weigh approximately 33% more than the strutted box. A unique feature of the Uckimaki viaduct is that the precast struts incorporate stay-in-place carbon fiber reinforced polymer (CFRP) forms and CFRP dowel bars to interface with the box sections. This detail results in a more slender strut *(see Fig. 2)* and no corrosion concerns at the junctions between strut and box. The Uckimaki viaduct was erected by the progressive erection

Fig. 2

technique using an overhead launching truss.

Katsurajima Viaduct

The Katsurajima Viaduct consists of twin continuous spans having lengths 52.6-54.0-54.0-52.7 m (172.4-177.0-177.0-172.8 ft). The viaduct is 32 m (105 ft) above the valley floor at its highest pier. The single cell strutted boxes are 3.9 m (12.8 ft) deep, 17.8 m (58.4 ft) wide at the top flange and 6.0 m (19.7 ft) wide at the bottom. While the dimensions of the Katsurajima box are similar to those of the Uckimaki, the former is about 18% lighter due to the use of corrugated steel web elements. As shown in *Fig. 3,* the webs are fabricated as corrugated steel I-girders and cast into the flanges. The webs can also be clearly seen in *Fig. 4*.

The Katsurajima viaduct was incrementally launched from one end of the 216 m (708.2 ft) viaduct using a launching nose. In addition to the weight savings resulting from the strutted arrangement and the steel web, an innovative construction procedure was used to reduce the launching loads to 50% of the overall final weight of the structure. The construction sequence involved launching only the rectangular box and ribs onto which the wings were eventually placed once the girders were set. Steel webs and the use of precast concrete panels as stay-in-place forms to form the entire top flange (the top of the box prior to launching and the wings following launching) resulted in very fast construction time since very little formwork was required.

The reduced launching weight is critical for incrementally launched bridges. In such bridges each section is, at some time during launching, subject to all possible loading conditions as the bridge is pushed out over the piers. This requires complex prestressing and post-tensioning design. In the Katsurajima Viaduct, all post-tensioning was external inside the box *(Fig. 4)*. The tendon arrangement included those that were initially tensioned, those that were tensioned for launching only and later un-tensioned and moved to their final locations to resist final service loads, and those installed only after the spans were set. The apparently unused ducts shown in *Fig. 4* were used for the launching operation after which the same tendons were moved to the locations shown. Figure 4 shows a diaphragm over an interior pier.

Fig. 3

Fig. 4

Sarutagawa Bridge

The Sarutagawa and Tomoegawa Bridges are comprised of spans that range from 57.0 m (186.9 ft) to 119.0 m (390.2 ft). The bridge piers are as high as 72.0 m (236.1 ft). This unique structure may be thought of as a "strutted web box girder" or as a composite truss. The 16.5 m (54.1 ft) wide top flange is connected to the 8.0 m (26.2 ft) wide bottom flange with a three-dimensional steel pipe truss. Complex joint region requirements to allow forces to be transmitted along the

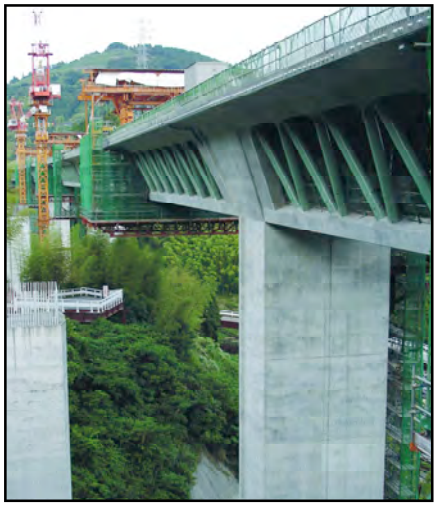

Fig. 5

truss and between flanges and web truss resulted in very large concrete nodal regions *(Fig. 5 and 6)* and relatively steep truss members. Both requirements increased the weight of the bridge; the latter requirement also increased the width of the bottom flange and thus the supporting pier. As a result no savings were realized through use of this innovative structural form – indeed the final structure was heavier than a comparable conventional design. On the other hand, the form is very aesthetically pleasing resulting in a signature structure. Largely due to its weight and the varying site, the Sarutagawa and Tomoegawa Bridges were constructed using conventional cantilever methods.

The Solution

Three incrementally more innovative solutions to a similar design problem are presented. Each design represents considerable development

Fig. 6

efforts on the part of the construction companies involved – Kajima Corporation, Sumitomo Mitsui Construction Company and Obayashi Corporation, respectively. Indeed the systems and, in the case of the Katsurajima Vaiduct, the erection method are proprietary and patented. Such innovation is a hallmark of the Japanese heavy construction industry. Large construction companies maintain active research facilities – often better equipped and supported than government and academic laboratories. Additionally, as evidenced by the site visits described, there is a general openness and willingness to discuss projects with colleagues and the public. The girder section in *Fig. 2,* for example, is part of a visitor's center maintained at the Uckimaki Viaduct site. A fascinating observation to the author was the willingness of the design and construction engineers to openly discuss the engineering challenges and "failures" of each project. These characteristics of the Japanese heavy construction industry help to promote innovation in design and construction.

Personal Observation and Acknowledgments

As the reader can imagine, touring the sites of all three of these structures in a single day (in addition to driving between them on the partially complete expressway, through partially complete (and entirely unlit) tunnels and up (very) steep light gauge access ramps/bridges makes for "the best site visit ever". At each site, the tour was conducted by a senior official of the construction company involved and hosted by Mr. Hideki Notoya, the Japan Highway Public Corporation (JHPC) Project Manager for the Sarutagawa Bridge (Obayashi Corporation is the construction company). All bridges are owned by JHPC. The author would like to acknowledge Mr. Kimio Saito, Senior Engineer with Kajima Corporation (Uckimaki Viaduct) and Dr. Akio Kasuga, Chief Engineer with Sumitomo Mitsui Construction Company (Katsurajima Viaduct). Additionally, the support of the Japan Society for the Promotion of Science and the NSF NHMJ Program (Dr Bill Spencer, University of Illinois Urbana, and Dr. Yahya Kurama, University of Notre Dame). Finally, the participation of Dr. Jerome Lynch (University of Michigan), ten graduate students and three high school teachers funded by the National Science Foundation cannot be overlooked. All photographs were taken by the author. ■

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LEARNING AND SHARING GLOBALLY

by M. Myint Lwin, PE, SE

Director-Office of Bridge Technology, Federal Highway Administration

Nations around the world have invested and are investing significantly in research, development and deployment to apply innovative and advanced bridge technologies to link a network of efficient transportation infrastructure. Learning and sharing bridge technologies and practices globally and rapidly allow nations of the world to adopt and implement advanced technologies and best practices efficiently, effectively and economically to assure safe, reliable and durable bridges and structures for the public. The International Bridge Conference (IBC) has provided the opportunities and forums for the exchange of bridge technologies and practices worldwide for years. This year in June 12-14, managers, planners, engineers, industry representatives, academia, suppliers and manufacturers from around the world will be converging to Pittsburgh, Pennsylvania, to learn and share knowledge, experience, and projects

Fig. 1

on research, bridge design, construction, inspection, management, maintenance, instrumentation, load testing and rating, rehabilitation and replacement of highway and railway bridges.

Over 1,000 bridge professionals from around the world are expected to attend this year's 23rd. Annual International Bridge Conference. In addition to keynote speeches at the Opening Session, and the featured presentations by this year's featured State, Delaware, there will be over 60 technical papers on various topics of bridge engineering to be presented by speakers from North America, Europe, Middle-East, and Asia. In addition to the many fine domestic papers, the foreign speakers will share the technical and financial approaches and solutions to meeting the challenges in seismic design and retrofit; in addressing the corrosion problems by using stainless steel in the construction of pedestrian and short span bridges; in the strengthening of stone arch bridges; in research and testing of wind loads on long span bridges; in the design and load testing of orthotropic plated decks; in overcoming site constraints with an extradosed segmental concrete bridge; in practical and economical applications of corrugated web steel girders; in design-build contracts; and in the design and construction of record-set-

Fig. 2

ting arch bridges, segmental concrete bridges, cable-stayed bridges, and suspension bridges for freeways and high speed rails. This is going to be an exciting and educational conference, where participants can take home lessons and practices for improving their daily engineering activities.

China will be the "Featured Country" in the 2007 International Bridge Conference to be held in June 11-13, 2007 in Pittsburgh, Pennsylvania. The Chinese delegation will be led by Mr. Maorun Feng, Chief Engineer, Ministry of Communications, People's Republic of China (PRC). As "Featured Country" China will have an exhibition room where the Country can showcase outstanding projects and achievements in design and construction of bridges, and a technical session where the Country will make presentations on the technical, financial, social and environmental challenges and opportunities of high-visibility projects. In the past 15 years, China has been investing unprecedented resources.

In the construction of bridges for highways and expressways. By the end of 2004, China has over 321,600 highway bridges as compared to only 220,000 highway bridges in 1998. During this period, 34 major bridges with main span over 1,300 feet have been completed and opened to traffic, 9 major bridges are under construction, and many more are in the planning and design stages. Of these bridges, 16 cable-stayed bridges with main spans over 1,300 feet have been completed, and 5 cable-stayed bridges with spans exceeding 1,960 feet, with the longest span being 2,126 feet, until the completion of the Sutong Bridge (Fig. 1) with a main span of 3570 feet in 2008; and 14 suspension bridges with main spans exceeding 1,480 feet are under construction or being completed. Two of these bridges, the Runyang Suspension Bridge (Fig. 2) and the Jiangyin Suspension Bridge, hold the record for the first and second longest

Fig. 3

main spans in China, and the third and fourth longest main spans in the world respectively. The Runyang Suspension Bridge has a main span of 4,890 feet, and the Jiangyin Suspension Bridge has a main span of 4540 feet.

China has a rich tradition of building stone arch bridges throughout history. In meeting the demands of modern highways, China has revolutionized the design and construction of modern arch bridges by setting a number of world records in various types of arch bridges. For examples, 480-feet span stone arch bridge, 1080-feet span trussed arch bridge, 1,380-feet span concrete arch bridge, and the famous 1,800-feet span Lupu Steel Arch Bridge (Fig. 3), which has won the IBC Eugene C. Figg, Jr. Medal in 2004.

The National Trunk Highway System (NTHS) in China will be completed in 2007, 13 years ahead of schedule. In the next phase of the highway infrastructure expansion, China will focus on the new National Expressway Network, estimated at 53,000 miles in total length. The goals are to reach 34,000 miles of expressway by the year 2010, and 53,000 miles by the year 2020. Highway bridge construction is expected to continue at unprecedented pace and to meet new challenges in bridging valleys, large rivers, bays and straits.

Please join us at the 2006 International Bridge Conference in June 12-14 in Hilton Pittsburgh, Pittsburgh, Pennsylvania to learn and share lessons and best practices on bridge engineering. Please also mark your calendar for attending the 2007 International Bridge Conference in June 4-6, 2007 to communicate with delegates from the "Featured Country: China" and to experience the exciting technological progress in modern highway bridge design and construction in China. ■

SafeLane's Overlay Living Up to its Name, Data Shows

Treated Roads and Bridges Show Fewer Accidents with Less Maintenance

An independent analysis of SafeLane™ Surface Overlay's performance during the 2005-06 winter season concludes that Cargill's patented bridge and pavement treatment is providing safety and mobility benefits where it is being used, while requiring [significantly] less chemical treatment during winter storms.

The report by Asset Insight Technologies, a consulting service for the winter highway maintenance industry, summarizes SafeLane Surface Overlay's performance at all nine test installations across six states, as far north as Wisconsin and as far south as Texas. The report concluded that:

- In nearly all cases, test sections remained clear of snow or ice at times when it was accumulating on untreated (control) sections of roads and bridges.
- When accumulation did occur in heavy snowstorms, the snow and ice did not bond to the surface, resulting in easier plowing.
- Bare pavement could be maintained on test sections with about half the chemical applied to the untreated (control) sections.
- There were no concerns with chemical slickness or slipperiness even when chemical was applied in conditions where such slickness could be expected.
- There were no weather-related accidents at the nine installations sites over the winter season. In many cases this contrasted with several accidents on nearby untreated stretches of road or bridge deck, and in nearly all cases the treated sites themselves had a history of winter weather accidents.

"For statistically significant results, safety studies need to be conducted over a number of years," said Wilfred Nixon, president of Asset Insight Technologies and professor of engineering at the University of Iowa. "But while these data are preliminary, it appears that the improved performance of the SafeLane overlay does indeed translate into safety improvements for the traveling public."

SafeLane Surface Overlay is made up of a patented combination of epoxy and aggregate rock. Liquid de-icer is applied to the overlay before ice or snowstorms hit. The material acts like a rigid sponge, storing the chemicals inside, then automatically releasing them as conditions develop for the formation of ice or snow.

"This proactive approach protects bridge decks and roadways against frost and ice without the need to send work crews out in the midst of icy weather," says Bob Persichetti, general manager for SafeLane Surface Overlay at Cargill Deicing Technology (CDT), which licenses and markets the system and which commissioned Nixon to conduct the study.

Safelane's patented technology is licensed to CDT by Michigan Tech University, where it was invented by Russ Alger, director of MTU's Institute for Snow Research. The university is on Michigan's Upper Peninsula, where the lake effect produces up to 25 feet of snow per year? Obviously an ideal location for such research.

Studies at MTU found that SafeLane Surface Overlay has traction characteristics better than asphalt and equal to concrete. "It also offers economic advantages," notes Persichetti. "It can extend the life of roads and bridges by acting as a sealant to reduce the effects of chloride and water intrusion. There is a diminished need to send trucks out in inclement weather, which means call-outs and overtime can be managed more efficiently. And as total chemical use declines, there is less runoff into the local environment."

For a complete copy of the AIT report, contact Cargill Deicing Technology at 1-866-900-7258 or download it from the web site at:

www.cargillsafelane.com/

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BAKER COMPLETES ACQUISITION OF BUCK ENGINEERING

PITTSBURGH – Michael Baker Corporation announced today that it has completed the acquisition of Buck Engineering, P.C., of Cary, North Carolina. Terms of the transaction were not disclosed.

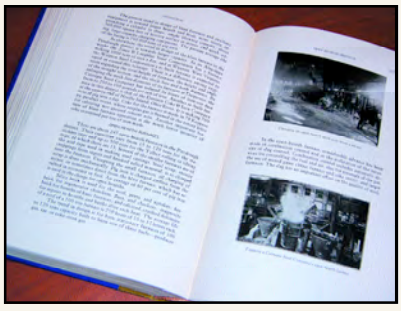
Buck Engineering (www.buckengineering.com) is a planning and environmental engineering firm with a nationally recognized stream and wetland restoration program. The firm is a market leader in stream restoration design and is well respected for its expertise in environmental planning, applied research and extensive training programs.

Founded in 2000, the company currently employs approximately 60 professional, technical and administrative personnel in four principal locations – Cary, Charlotte and Asheville, North Carolina; and Atlanta, Georgia. Its revenues in 2005 were approximately $13 million.

The acquisition of Buck will strengthen and greatly expand Baker's presence in North Carolina, and enable the company to leverage a high-value stream and wetlands restoration service that is of growing importance to many of its customers across the United States. "Context sensitive solutions and greater environmental stewardship are an important consideration to our infrastructure customers today," said Brad Mallory, president of Baker's Engineering segment. "This is Buck's specialty. We will now be able to take this expertise, which has been limited in geographic scope, to our clients in other states – especially Departments of Transportation – that have been requesting such a service."

"All of us at Buck are proud to have gained national recognition for our highly specialized services," said Jim Buck, president of Buck Engineering. "Will Harman and I look forward to joining with Baker to apply our innovative solutions and techniques on a national scale."

Michael Baker Corporation (http://www.mbakercorp.com) provides engineering and operations and maintenance services for its clients' most complex challenges worldwide. The firm's primary practice areas are aviation, environmental, facilities, geospatial information technologies, linear utilities, transportation, water/wastewater, and oil & gas. With more than 4,500 employees in over 40 offices across the United States and internationally, Baker is focused on providing services that span the complete life cycle of infrastructure and managed asset projects.



ESWP Commemorative History Book

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Pitt Trains Budding Engineers to "Think Green"

"University's Mascaro Sustainability Initiative creates Sustainable Engineering Fellowship Program through Department of Education grant"--Dwindling natural resources mean that engineers of the 21st century, more than ever before, must be conscious of environmental constraints. To help train the next generation of engineers to think green, the Mascaro Sustainability Initiative (MSI) in the University of Pittsburgh's School of Engineering has created a Sustainable Engineering Fellowship Program, which will begin in fall 2006.

The interdisciplinary program for Pitt engineering Ph.D. Students will be supported by a three-year, $506,000 grant from the U.S. Department of Education's Graduate Assistance in Areas of National Need program.

"Engineers must understand that the world is a finite place with finite resources, and next generation products and processes must be designed within the framework of this complex system," said Eric Beckman, co-director of MSI and Bayer Professor of Chemical Engineering at Pitt.

"This grant will enable us to engage a diverse and talented group of students to translate the fundamental science of sustainability into real products and processes," added MSI co-director Gena Kovalcik. Pitt engineering students already can travel to the University at Campinas in São Paulo, Brazil, to conduct research in green construction and sustainable water use technology under a University program funded by a $3.2 million Integrative Graduate Education and Research Traineeship grant from the National Science Foundation. Engineering professors at the University also are collaborating on a project called "Research in Sustainable Community Development," which will support an international workshop to generate a research agenda in the areas of green construction and water that is attentive to cross-cultural and ethical issues.

More information on MSI can be found at: www.engr.pitt.edu/msi.

For more information on the Sustainable Engineering Fellowship Program, contact Kovalcik at:

412-624-9698

or

kovalcik@engr.pitt.edu.

PAUL C. RIZZO ASSOCIATES HONORED AS SOUTH CAROLINA'S SALUDA DAM NAMED 2006 OUTSTANDING CIVIL ENGINEERING ACHIEVEMENT

After setting a North American record for the most roller compacted concrete placed in a single day—18,590 cubic yards—Columbia, South Carolina's Saluda Dam Remediation Project has been honored with the American Society of Civil Engineers' (ASCE) 2006 Outstanding Civil Engineering Achievement (OCEA) award. Presented at the seventh annual Outstanding Projects and Leaders (OPAL) awards gala at the International Trade Center in Washington, D.C., the OCEA award recognizes the project's significant contribution to the civil engineering profession and its local community.

"South Carolina Electric & Gas Company (SCE&G) officials were faced with an extraordinary challenge when they realized the impact a repeat of the 1886 Charleston earthquake could have on Columbia's three-quarters-of-a-century-old Saluda Dam," said ASCE President Dennis R. Martenson, P.E., DEE, F.ASCE. "Their proactive approach to protecting the surrounding communities, and the innovative methods they implemented to achieve that goal, make this project the embodiment of everything for which the OCEA award stands. We are proud to honor the Saluda Dam Remediation Project with this year's award."

When SCE&G officials learned that their 1.5-mile-long, 200-foot-high Saluda Hydroelectric Project dam embankment could liquefy during a repeat of the 1886 Charleston earthquake, they knew something had to be done. However, whatever solution they developed had to keep a 78-square-mile reservoir rimmed with homes and businesses nearly full and keep a hydroelectric plant and coal-fired steam plant operational, all the while ensuring the safety of the 120,000 residents living in the floodplain. The result was a 1.3-million-cubic-yard RCC backup dam with zoned earthen abutments.

The project's challenges prompted the patenting of a method of expeditiously placing filter zones and the design of a cooling method to enable concrete production during extremely high temperature. It also required utilization of on-site waste ash and quarried aggregates, as well as the removal of roughly 10 million cubic yards of material. Due to the volume required, finding materials proved challenging, and ultimately, on-site borrow sources proved the best option. A rock quarry was designed to utilize available gneiss rock formations while avoiding schist formations and the on-site coal-fired steam plant served as a source of fly ash. The benefit to the project was the use of 150 pounds of fly ash per cubic yard of RCC, resulting in the use of approximately 200 million pounds of on-site waste ash.

The project faced numerous challenges, including considerations for the local community. Lowering Lake Murray to rebuild the dam would have had unthinkable social and economic impacts, but the backup dam would have to be founded on dense soil or rock and some areas would require extensive excavation—as much as 60 feet below existing grades. Extraordinary measures were required to maintain public and worker safety while retaining the 78 square miles and 750 billion gallons of water that make up Lake Murray. The only practical means to improve excavation slope stability was through intense dewatering efforts. In total, 94 deep wells, 43 shallow wells and 824 eductor wells were installed to lower the ground water and to improve stability of the existing dam during construction.

Due to the array of environmental concerns the project created, full-time environmental engineers were included in the project staff to take a hands-on approach to staying within regulations. Winner of the Engineers' Society of Western Pennsylvania's 2003 Heavy Construction Project of the Year award, the project also, whenever possible, arranged work activities around residents' schedules.

The project, owned by SCE&G, was led by Paul C. Rizzo Associates, Inc., with Barnard Construction Company serving as contractor. Subcontractors included: Kleinfelder, Griffin Dewatering Southeast, H. B. Mellott Estate and Hayward-Baker/Nicholson JV.

Founded in 1852, the American Society of Civil Engineers (ASCE) represents more than 139,000 civil engineers worldwide and is America's oldest national engineering society. For more information on ASCE, please visit www.asce.org

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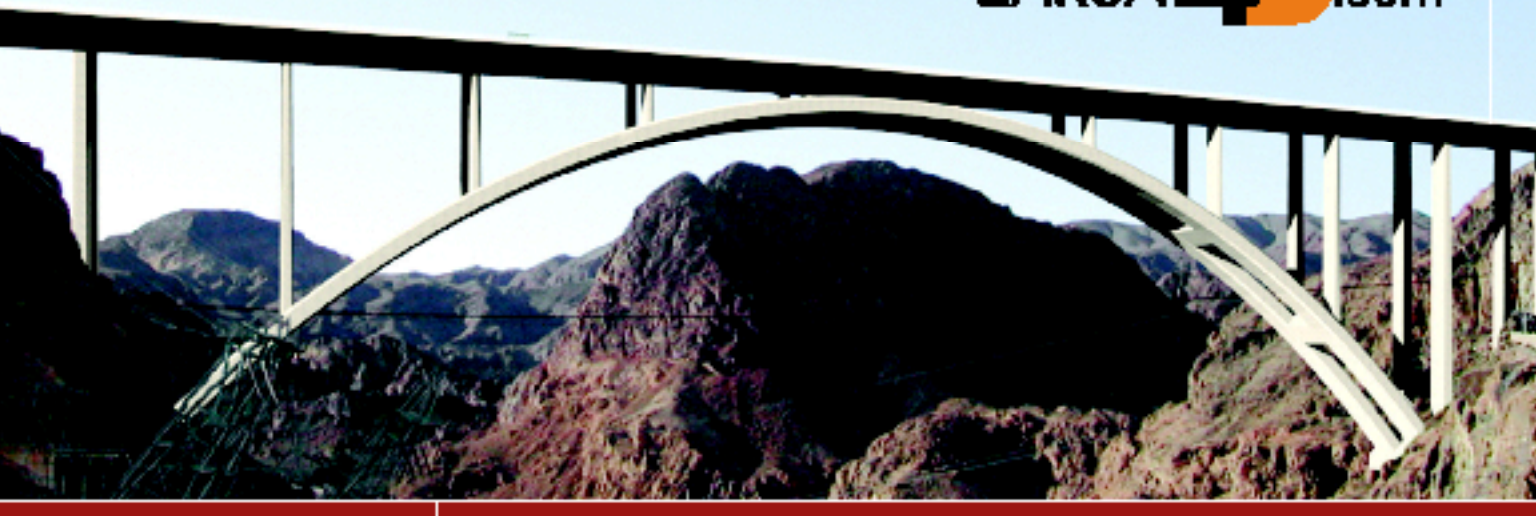

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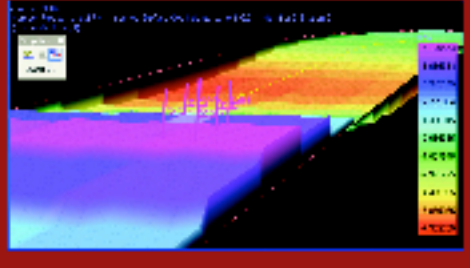

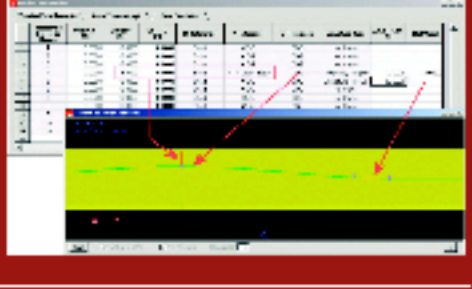

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