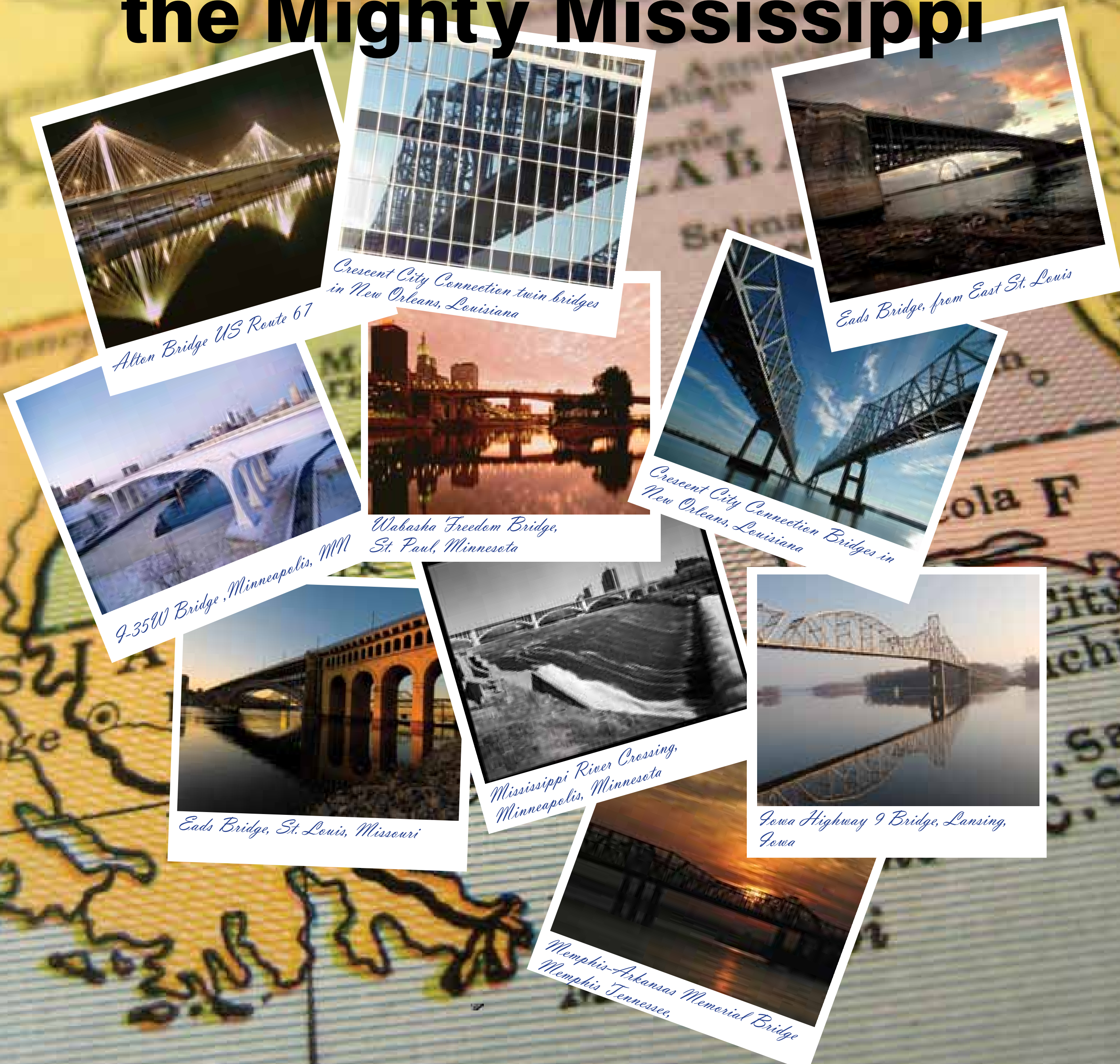
SUMMER 2012
SPECIAL IBC ISSUE

Pittsburgh ENGINEER

Quarterly Publication of the Engineers' Society of Western Pennsylvania

Scenes from a trip down the Mighty Mississippi



Alton Bridge US Route 67

Crescent City Connection twin bridges in New Orleans, Louisiana

Eads Bridge, from East St. Louis

I-35W Bridge, Minneapolis, MN

Wabasha Freedom Bridge, St. Paul, Minnesota

Crescent City Connection Bridges in New Orleans, Louisiana

Eads Bridge, St. Louis, Missouri

Mississippi River Crossing, Minneapolis, Minnesota

Iowa Highway 9 Bridge, Lansing, Iowa

Memphis-Arkansas Memorial Bridge Memphis Tennessee.

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In this issue...

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Guest Editor Column

Thomas G. Leech, P.E., S.E.

THE MIGHTY MISSISSIPPI

By George M. Horas, P.E. and Thomas G. Leech, P.E., S.E.

George M. Horas, P. E.

The Mighty Mississippi has been the subject of many stories and anecdotes throughout the ages. Who doesn't remember reading or hearing about the adventures of Tom Sawyer and Huck Finn as they spent lazy afternoons coming of age on the banks of the Mississippi River? What ends as a mighty and regal river at the mouth of the Gulf of Mexico begins as a not so mighty brook 2,340 miles upstream in Minnesota.

The Mississippi River is the centerpiece of the third largest watershed in the world and is ranked as the World's fourth longest river. It runs through or along 10 States and has almost 125 communities founded along its' banks. Features are commonly indexed to the major regions of the River known as the Upper, Middle and Lower Mississippi.

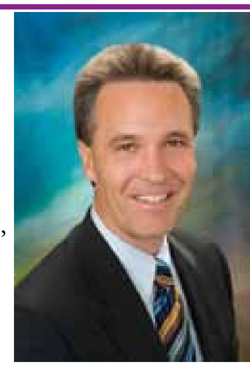
Throughout the history of civilization in North America, the Mississippi River has provided the fertile land, transportation and communication corridor and natural resources necessary for growth and expansion. To facilitate navigation, a series of 29 locks and dams exist on the Upper Mississippi from Minneapolis, Minnesota to St. Louis, Missouri. From there south, the river itself supports navigation. While the River provided a vital function, it also posed a serious impediment to growth and expansion of other types of transportation. The first bridge across the Mississippi was constructed in 1855 in Minnesota. Since then, 38 bridges with engineering or landmark significance have been built.

As the Engineers' Society of Western Pennsylvania prepares for the 29th Annual International Bridge Conference®, we reflect upon the talents and abilities of those who have been tasked to span the Mighty Mississippi. This Special Edition of the Pittsburgh Engineer highlights some of the more significant Mississippi River bridges in the Upper, Middle and Lower reaches. As you read through the articles and view the pictures, it is hoped that you will form an appreciation of the challenges that the River presents and the unique ways in which those challenges were overcome. You will also be entertained by an article that presents a bridge fan's perspective. In addition to the articles, this Special Edition features the results of the inaugural photo contest where you will be captivated by some very special images of Mississippi River bridges.

As we welcome Missouri as the featured State for this year's Conference, note that they are a State which borders the Mississippi River. They have faced everything that the River has to offer. Be sure to check in with them as you tour their exhibit area and treat yourself to a little firsthand knowledge.

Chairman's Welcome

By Matthew P. McTish, P.E.



Matthew P. McTish, P.E.

Welcome to the City of Pittsburgh and the 29th Annual International Bridge Conference® (IBC). This year's theme is entitled "The Sky is the Limit" which respresents the diversity and creativity of the international bridge industry. The Executive Committee of the IBC and the Engineers' Society of Western Pennsylvania have worked diligently over the past year to develop an outstanding program consisting of technical paper sessions, educational seminars, workshops, exhibits, and special events featuring current and state-of-the-art bridge engineering and construction practices throughout the world. The goal of the IBC Executive Committee is to provide the best venue for the presentation and demonstration of new and innovative bridge industry concepts, practices, and products each year.

The David L. Lawrence Convention Center will once again accommodate nearly 1600 attendees, speakers, and exhibitors who plan to attend the IBC. Similar to last year, the concurrent technical paper sessions will be located within the Exhibitor Hall, increasing your opportunity to attend multiple technical sessions, and network with others within the Exhibitor Area. Exhibitor sponsored refreshment breaks, and lunches will also be hosted in the Exhibitor Hall.

On behalf of the Executive Committee, it is my pleasure to welcome the Missouri Department of Transportation (MoDOT) as the featured Agency at the 2012 IBC. Keynote speaker Mr. Don Hillis, assistant Chief Engineer at MoDOT, and Bryan Hartnagel, MoDOT Structural Resource Manager, have prepared an excellent technical session for Monday afternoon, as well as an impressive exhibit.

Monday morning will kick things off with our noteworthy Keynote Session which includes Mr. Hillis as well as the following prestigious speakers:

- Thomas E. Donatelli, P.E., ESWP President, Michael Baker Jr., Inc., Pittsburgh, PA
- Rich Fitzgerald, Allegheny County Chief Executive, County of Allegheny, Pittsburgh, PA
- Don Hillis, Assistant Chief Engineer, Missouri Department of Transportation, Jefferson City, MO
- Malcolm T. Kerley, P.E., Chief Engineer, Virginia Department of Transportation, Richmond, VA
- Timothy G. Galarnyk, CEO, Construction Risk Management, Inc., St. Paul, MN
- Keith Brownlie, RIBA RIAS FRSA, Architect, Toller Porcorum, Dorset, United Kingdom
- Victor M. Mendez, Federal Highway Administrator, FHWA, Washington, DC
- Kirk T. Steudle, P.E., State Transportation Director, Michigan Department of Transportation, Lansing, MI

On Tuesday and Wednesday, the Executive Committee has put together a remarkable technical program which includes the presentation of over 70 technical papers, 4 seminars, 13 workshops, poster displays, and various networking events. Highlights of the 29th IBC will also include:

- Six (6) Bridge Engineering Awards will be presented to internationally recognized Bridge Projects. The IBC will also present the John A. Robeling Medal award to an individual for his/her lifetime achievement in Bridge Engineering.
- The winning photos from the IBC Magazine Photo Contest entitled "Mississippi River Bridges".
- 2012 Bridge Engineering Poster Session – A display of various Bridge Engineering topics including research, testing, design, inspection, and construction.
- Pittsburgh Bridges Bus Tour – Don't miss your chance to visit some of Pittsburgh's Bridges on Tuesday afternoon.
- High School Bridge Explorers Program – Area high school students with an interest in Bridge Engineering will visit the IBC for the opportunity to learn more about the Bridge Industry.
- 2012 James D. Cooper Student Paper Competition Award.

The IBC Executive Committee and the Engineers Society of Western Pennsylvania hope your attendance at the IBC will be a rewarding and enjoyable experience. We also hope you will join us again next year in the "City of Bridges" when the IBC will celebrate its 30th anniversary.

Matthew P. McTish, P.E. is the General Chair of the 2012 International Bridge Conference and President of McTish, Kunkel & Associates

Quiz: How Familiar Are You With the Mississippi River?

By Brian Greene, Ph.D.

Just how familiar are you with the Mississippi River?

Take this 'True or False' test – see the answers and explanations on p. 26.

(Helpful hint: If you answer true to all the questions, you will only have a 50% chance of being right!)

Q1: The Mississippi River was named after a riverboat (of the same name) in 1845 by Mark Twain?

Q2: Henry Schoolcraft (an explorer) documented the true source of the Mississippi River in northern Minnesota in 1832.

Q3: Although a quite wide river, the river is actually very shallow with the deepest section of the Mississippi River only 25 feet in depth near its alluvial fan, barely deep enough for navigation.

Q4: Believe it or not, a raindrop that falls at the source of the river in Lake Itasca (Minnesota) takes only 7 days to reach the Gulf of Mexico.

Q5: The Mississippi River controls approximately 40% of the nation's (i.e. lower 48 States') watershed.

Q6: The Lake Pontchartrain Causeway in New Orleans, Louisiana is the world longest over-water highway bridge.

Q7: Only ten percent of all North American birds use the Mississippi River Basin as their migratory flyway; most bird migration follows either the Pacific or Atlantic coast lines.

Q8: Although at one time abundant with fish, the Mississippi River now is mostly devoid of fish population.

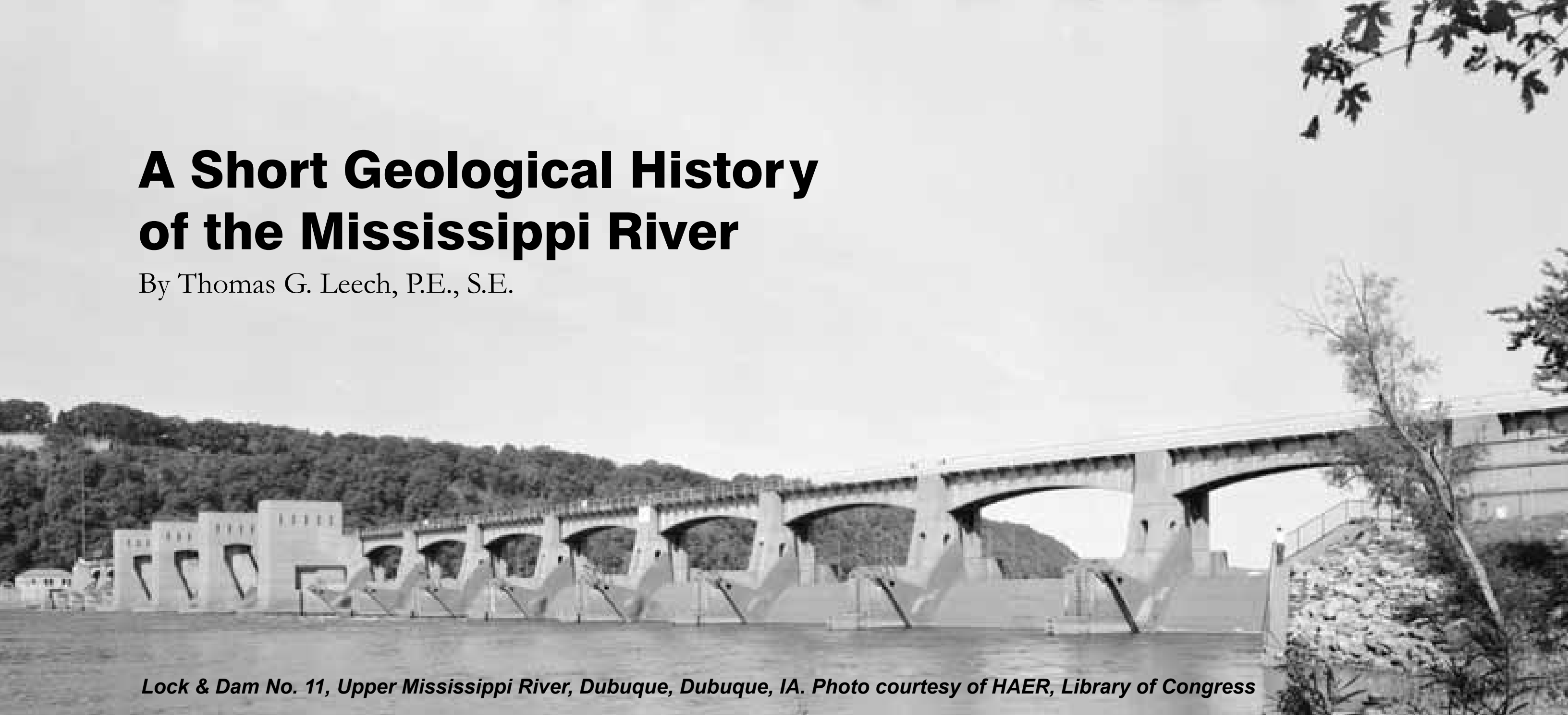
Q9: Water skiing was invented in 1922 on the Mississippi River.

Q10: Crowley's Ridge in eastern Arkansas is the Mississippi River Delta's only "highlands.

Brian Greene, PhD is a Senior Engineering Geologist with Gannett Fleming Inc. in the Pittsburgh Regional Office

A Short Geological History of the Mississippi River

By Thomas G. Leech, P.E., S.E.



Lock & Dam No. 11, Upper Mississippi River, Dubuque, Dubuque, IA. Photo courtesy of HAER, Library of Congress

"Eventually, all things merge into one, and a river runs through it."
Norman Maclean (American Author 1902-1990)

The Mississippi River ("Misiziibi": a river spread over a large area to the Algonquin speaking Indians) is the largest river system in North America. Its headwaters begin in Lake Itasca, in western Minnesota where the river flows southwards eventually reaching the Gulf of Mexico at the Mississippi River Delta. With tributary headwaters extending from the Appalachians to the Rockies, the river drains all or parts of 31 states. With an overall length of 2,340 miles (3,770 km), the Mississippi River is the fourth largest river in the world. But has it always been this way?

"There is something fascinating about science. One gets such wholesale returns of conjecture out of such a trifling investment of fact."
Mark Twain, Life on the Mississippi (Mark Twain was a 19th century newspaper writer and author, who in 1863 began to use a pen name derived from a river navigation term meaning two fathoms or 12 feet, a vertical distance with sufficient depth for safe steamboat passage.)

The Mississippi River's basin originates in Precambrian times (570 Ma) when there was one single continent. At that time the earth's crust, at the present location of the Mississippi River, was locally stretching and small rift zones, insufficient to separate the large continent, developed. With further crustal stretching, faults were created within the rift zones, and within these *failed rift zones*, the early Mississippi River valley was borne. As time passed, other continents did form but, by the end of the Pennsylvania Period (290 Ma), previously separated continental masses (tectonic plates) were colliding. With these collisions the early Appalachian Mountains formed and the landscape was thrust upward in an arching fashion. This arching action led to separation and rapid weathering along the faults within the *failed rift zone* and led to the formation of a distinct proto river valley system that quickly accumulated sediment shed from the Appalachian Mountains.

As time passed, the proto river valley sunk with the weight of accumulated sediment. By the Cretaceous Period (65 Ma), sea level rose more than two hundred feet above present sea level and a large inland bay formed extending from the present Gulf of Mexico to the present confluence of the Ohio and Mississippi Rivers. This bay (also known as the Mississippi Embayment) accumulated sediment at elevated sea levels, and during this time period the embayment became a well defined trough with the rift features plunging with accumulation of sediment load. This embayment retained its basic feature until the more recent Pleistocene Ice Age where at maximum glacial extent (c. 25,000 years ago), sea levels plunged to more than 300 feet below the present sea level, at which time a well defined river valley emerged creating other distinct landforms including scarps and river terraces and creating steepened stream gradients and accompanying rapid erosion of stream beds. With the last glacial retreat (c. 8,000 years ago), sea level rose to approximately its present level and the Mississippi River as we now understand it emerged. Sea levels continue to rise slowly through the present as we now live in an interglacial period. Never the less the Precambrian fault zones, i.e. the *failed rift zones*, are now buried very deeply beneath the Mississippi River, and remain quite active with recurring (weekly) seismic activity. In fact, the 1811-1812 New Madrid Earthquakes (near St. Louis) that are associated with these deeply buried faults remain the largest earthquakes ever recorded in North America and these quakes even caused the Mississippi River to flow backwards for a brief period of time. As recently as February 21, 2012, there was a magnitude 3.9 earthquake in southeastern Missouri having an epicenter located within the New Madrid Seismic Zone. The earthquake shattered windows and cracked walls locally and was felt in 13 states.

"It is strange how little has been written about the Upper Mississippi…there are crowds of odd islands, bluffs, prairies, hills, woods and villages…of course we ignore the finest part of the Mississippi."
Mark Twain in an interview in the Chicago Tribune, July 9, 1886

The official starting point (or headwaters) of the Mississippi River is Lake Itasca, named by explorer Henry Schoolcraft, in 1832, by combining the last four letters and first three letters of the Latin phrase "veritas caput", which he translated as "true head." From these headwaters to the head of navigation at St. Paul, Minnesota, the Mississippi is a clear fresh stream winding through a country side of lakes and marshes. As the river further descends in this reach, it flows past steep limestone bluffs while it ever so slowly increases in size receiving water from tributaries in Minnesota, Wisconsin, Illinois, and Iowa. The Upper Mississippi is defined by a series of limestone, sandstone and dolostone bluffs that were carved by water from melting glaciers at the end of the last ice age. As the glaciers receded, the racing meltwater stretched from bluff to bluff carving in places the dramatic vertical bluff faces we see along the upper river. This upper Mississippi extends to the mouth of the Missouri River, near St. Louis, where for its first 1,150 miles (1,850 km) of descent, it drops approximately 940 feet (287 m) in elevation from its headwaters. At present this reach of the river makes its descent through 43 dams, the largest of which is the site of the St, Anthony Falls in downtown Minneapolis and the location of the only true falls on the Mississippi River.

Crescent City Connection, New Orleans, LA – Lower Mississippi. Photo courtesy of Mike DelGaudio & Modjeska and Masters.

"The river is a strong brown god: sullen, untamed and intractable."
T.S. Eliot, American poet and a native of St. Louis, from The Four Quartets.

Below the Missouri River junction, the middle Mississippi follows a 190-mi (310 km) course and drops 220 feet (67 km) in elevation as it reaches the mouth of the Ohio River. At times the turbulent, and cloudy Missouri River, adds enormous quantities of silt to the otherwise clearer Mississippi. Traveling from north to south, this reach of the river is not dammed and the volume of water is significantly greater due to the contribution of flow from the Missouri River, whose source at 8,000 feet (2,700 m) is Brower's Spring which lies along the Continental Divide in southwestern Montana.

The current form of the Mississippi River basin was largely shaped by the retreat of glaciers during the most recent Ice Age. Glacial meltwaters greatly enlarged the trough along the course that the Mississippi River now flows. Additionally, a buried deep layer of material washed out from the ice sheets accumulating to thicknesses of 100 to 300 ft (30 to 90 m) in this middle section.

"And they talked about how Ohio water didn't like to mix with Mississippi water. Ed said if you take the Mississippi on a rise when the Ohio is low, you'll find a wide band of clear water all the way down the east side of the Mississippi for a hundred mile or more, and the minute you get out a quarter of a mile from shore and pass the line, it is all thick and yaller the rest of the way across."
Mark Twain - Life on the Mississippi (originally written for Adventures of Huckleberry Finn)

The Lower Mississippi River meanders leisurely and descends 315 feet (96 m) from its junction with the Ohio River at Cairo, Illinois to then form the lush delta at the edge of the Gulf of Mexico, for a distance of nearly 1,000 miles (1,600 km). From a transcontinental flight, the sunlight glistening on the twisted ribbon of the one and one half mile wide Mississippi River is a distinctive landmark. What is also quite evident when viewed from the air is the myriad of oxbow lakes and cutoffs, testifying to a geologically active river constantly changing and correcting its course over long periods of time. The study of the river's ever changing patterns falls under the geological term: fluvial geomorphology. As recent as March 1876, a flood moved the river several miles away from a small section of the border of Tennessee and Arkansas. Since this event was an "abandonment", or properly termed an avulsion, the state line remains located in the old

Eads Bridge, St. Louis, MO. – Middle Mississippi, Photo courtesy of HAER, Library of Congress (and now abandoned) channel. At present, there are no dams along this reach of the river, however tall levees and bank stabilization efforts have been constructed to create a highly channelized river.

> "The Mississippi River will always have its own way; no engineering skill can persuade it to do otherwise."
> ...Mark Twain in Eruption

Flood control along the river dates back to the construction of the city of New Orleans in 1717 by the French, who built a small levee to shelter their infant city. While flooding along the river channel is an annual concern and has been the chief agent for change in recent geological history, the year 2012 marks the 85th anniversary of the most devastating flood in recorded history along the Mississippi River. The nation's most destructive flood began with heavy rains in the summer of 1926 which continued throughout the spring of 1927. Three separate flood waves occurred on the lower Mississippi in 1927-in January, February and April, increasing in magnitude each time. In the spring of 1927 many of the levees failed, the worst of which at Mounds Landing, Mississippi, flooding an area 50 miles wide and 100 miles long (the size of the state of Connecticut) with up to 20 feet of water. By July 1, 1927 the waters finally began to recede, but 1.5 million acres of land was still under water, with the disaster leaving behind more than 500 people dead and over 700,000 people displaced from their homes. The catastrophic flood of 1927 fostered a commitment by the federal government to initiate a definite program of flood control by the construction and maintenance of a complex array of riverbank structures rationally designed to contain and divert floods for the entire reach of the lower Mississippi.

> "About fifteen miles above New Orleans the river goes very slowly. It has broadened out there until it is almost a sea and the water is yellow with the mud of half a continent. Where the sun strikes it, it is golden."
> Frank Yerby (American Writer)

Although no glaciers reached the lower Mississippi Delta region, its influences have transformed the surrounding lands and specifically the river Delta. High water flows combined with sediment loads of the glacial melt waters initially created braided stream patterns which developed into existing meandering patterns and the eventual re-depositing of sediment load within the river Delta in layers tens of meters in thickness. In addition to the annual deposition of wind blown and fluvial deposits at the mouth of the river, a natural process known delta switching has historically shifted its final course of the river's mouth to the Gulf of Mexico every thousand years or so. This occurs because the deposits of silt and sediment begin to clog its channel, raising the river's level and causing it to eventually find a steeper, more direct route to the Gulf of Mexico. Geologists consider the next major change in the course of the Lower Mississippi is now overdue; flood control structures and other engineering measures holds the mouth in a tentative state of equilibrium.

> "All rivers, even the most dazzling, those that catch the sun in their course, all rivers go down to the ocean and drown. And life awaits man as the sea awaits the river."
> Simone Schwarz-Bart (American Author)

But does the river end at the Gulf of Mexico? NASA MODIS (Moderate-resolution Imaging Spectroradiometer) images clearly indicate that the fresh river water flowing from the Mississippi into the Gulf of Mexico does not mix into the salt water immediately. The images show a large plume of fresh water which stays intact and flows through the Gulf of Mexico, which then flows into the Straits of Florida, and eventually mixes with the waters of the Gulf Stream off the southeastern coast of Georgia.

Thomas G. Leech, P.E., S.E. is the National Practice Bridge Manager of Gannett Fleming Inc.

A Bridge Fan's View of the Mississippi River

By John A. Weeks III

Over the past 10 years, I have visited every bridge, canal, lock, most of the flood control projects, and all but two dams on the Mississippi River. I have written about these structures on my web site, which has turned out to be surprisingly popular. This has led to a lot of interesting questions over the years. The questions have ranged from school kids working on projects and people doing genealogy research to students at military academies and towboat operators. I started this project out of my own curiosity having no idea that so many other people would find it interesting. Here is a sampling of some of my favorite and most common questions posed from viewers.

Why do you hunt bridges?

Bridge hunting combines many of my interests. This includes photography, writing, doing research, web site publishing, road trips, history, rail fanning, road geek'ing, and a fascination with large civil engineering projects. As a computer engineer who spends so much indoors, bridge hunting is the perfect excuse for me to get outdoors, something that I am badly in need of.

3rd Avenue Bridge, Minneapolis, MN: This is a multi-span concrete arch bridge. It was left in such disrepair that is was close to being condemned. It was rebuilt from the arches up and will hopefully remain a landmark on the upper side of Saint Anthony Falls for another 100 years.

Why do you find the Mississippi River so fascinating?

The Mississippi River is a world-class river, on par with other major rivers in the world such as the Nile, Amazon, Yangtze, and Yellow, and it is right here in my back yard. How could one not be interested in the Mississippi River? I think reading Tom Sawyer, Huck Finn, and Life On The Mississippi in high school added to the mystique.

I did expect that the bridges on the Mississippi River would be the biggest, baddest, most impressive bridges in the US, and thus, in the world. What I hadn't expected is that I have found a number of other rivers that are just as interesting in their own right. This isn't to diminish the importance of the Mississippi River, but rather, to point out that the Mississippi River led me to explore all of these other rivers and discovering a lot more very cool bridges and amazing engineering projects to visit.

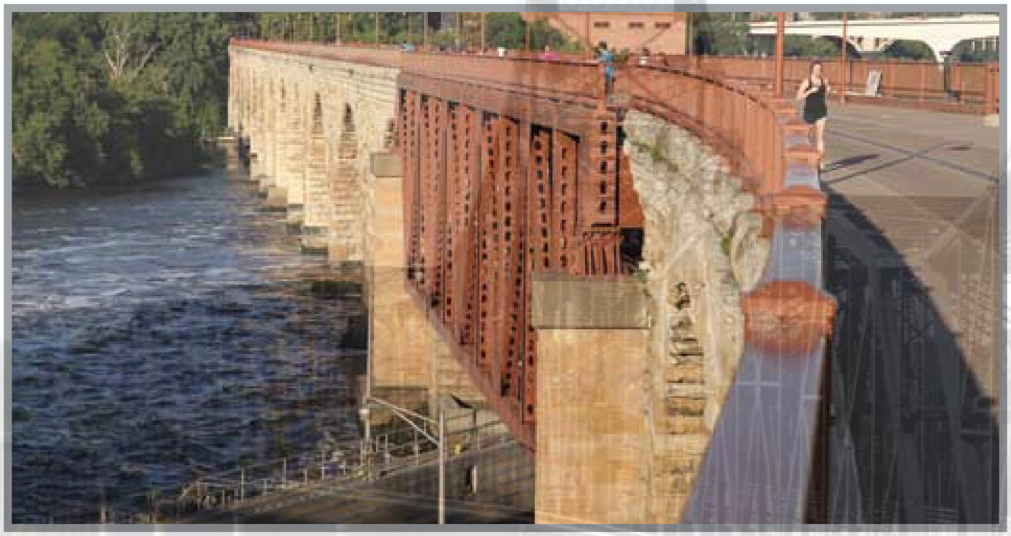
How many bridges are there over the Mississippi River?

There is no easy answer to this question. First off, what is a bridge? Do side channel bridges count, or just main channel spans? Are we limited to highway bridges, or do railroad and pedestrians bridges count? How about bridges that are closed? What about bridges with sections missing, such as the railroad bridge at Keithsburg? What about the pipeline bridge at Grand Tower, or the access bridges that cross the top of the Little Falls Dam and the downstream side of the upper lock at Saint Anthony Falls? Or the snowmobile bridge at Bear Den Landing that is pulled across the river only after it freezes?

Since there is no official sanctioning body for bridges over the Mississippi River, I have my own definition. I track any structure that is in or on the river that I can reasonably call a bridge or dam that goes generally across the river. Put another way, I hunt what I find interesting. I am currently tracking about 300 such structures, of which I would guess about 1/3 are bridges that cross the main river channel.

What is the biggest bridge?

Again, there is no easy answer here because biggest can mean different things to different people. The longest elevated river crossing is the Huey Long Bridge in New Orleans at nearly 5 miles in length. Since the bridge is relatively high above the water (to allow ships to pass under the structure), a very long set of railroad approach trestles are needed to maintain a very slight grade suitable for train traffic. The longest main span is the new John James Audubon Bridge near New Roads, Louisiana. Its 1,583-foot long main span is 8 feet longer than the Crescent City Connection bridges in New Orleans. The widest bridge is the new I-35W Saint Anthony Falls Bridge in Minneapolis at just over 90 feet wide.



Stone Arch Bridge, Minneapolis, MN: this is probably the most iconic bridge over the Mississippi River. It is a very old railroad bridge that was abandoned, and was repurposed as a pedestrian bridge. It is a very popular place for runners, bicyclers, and just for strolling out over the river to see the amazing views of Saint Anthony Falls available from the bridge deck.

What is the tallest bridge?

Tallest can be measured in several different ways. The bridge with the tallest structural element is the John James Audubon Bridge, a cable stayed structure that is supported by 500-foot tall towers. The runner-up is the Greenville Bridge, another world-class cable stayed bridge with 425-foot tall towers. The highest bridge decks belong to the bridges in Louisiana over the section of the river with ocean going ships. The I-10 Horace Wilkinson Bridge in Baton Rouge is slightly taller than other bridges in that category at 175 feet from the mean water level to low steel above the river navigation channel. Interestingly, the Smith Avenue High Bridge in Saint Paul, Minnesota, is almost as high since one end of the structure is perched high on the river bluffs.

What is the oldest bridge?

I do not have perfect data to answer this question. The reason is that some of the older bridges have had sections replaced, and I haven't done enough research to know which bridges are originals and which are replacements. The oldest river crossing is at the site of the Father Louis Hennepin Bridge in downtown Minneapolis, where the first bridge over the Mississippi River was built in 1854. There has been a bridge at this location continuously since that first structure opened. The oldest surviving bridge segment over the Mississippi River is thought to be the Sylvan Island Railroad Bridge in Moline, Illinois. This bridge was originally part of a railroad bridge in Burlington, Iowa, built in 1868. This span was reused in Moline after the bridge in Burlington was replaced in 1891. The oldest complete bridge is the Eads Bridge in Saint Louis, which was built between 1869 and 1874.

What is the busiest bridge?

The bridge with the most highway traffic is the I-94 Dartmouth Bridge in Minneapolis with a reported 157,000 vehicles per day (2002 data). I don't have perfect data on railroad traffic, but the two busiest rail bridges over the Great River are at Little Falls, Minnesota, and Clinton, Iowa, each seeing about 50 trains per day. The BNSF railroad bridge at Little Falls also has the highest train speed limit of any bridge over the Mississippi River. While trains move at very slow speeds across most of the river crossings, at Little Falls, trains hit the bridge at mainline speeds of up to 75 miles per hour. There is a slight downgrade leading to the bridge allowing the locomotives to throttle back. It is impressive to see such a large machine moving so quickly and quietly over such a narrow single-track bridge.

What is the most interesting bridge?

All of them. Every bridge over the Mississippi River is interesting, or has a compelling story associated with it, or is sitting in a scenic location, though you might have to stretch that a little for the series of cookie-cutter pre-stressed concrete girder bridges in central Minnesota. For example, two different bridges over the river were involved in military aircraft incidents. We know about them because one resulted in a broken airplane, and the other in a bent airplane. I know of four bridges over the river that collapsed, one before it was completed, and one on the first day it opened. The first railroad bridge over the river was struck by a riverboat and burned, giving an Illinois attorney national attention which lead him to the White House as our 16th President.

Fort Madison Swing Bridge, Fort Madison, IA: This is another solution to the train and automobile sharing a bridge. In this case, the trains are on the lower deck, and vehicles use the upper deck. While most Mississippi River bridges are high enough to allow river navigation traffic, this swing span sits only a few feet above the water level.

What would happen if the big earthquake hits the New Madrid fault?

The bridges at Memphis, Caruthersville, and possibly Cairo would all fail in a large earthquake despite the seismic retrofit that is ongoing. However, the bridge failures would pale in comparison to the widespread structural damage and human casualties. The bridges would not be the primary concern.

Would terrorists be able to cripple the nation by blowing up a bridge over the Mississippi River?

No. There is relatively modest highway and railroad traffic on the lower Mississippi River. On the upper Mississippi, there are sufficient alternative bridges and available railroad capacity on those alternatives. While a terrorist attack would be a dangerous and dramatic event, there would be relatively little economic impact of the damage and no strategic impact to our security. Any real impact would be on Wall Street and in the hunt for those responsible.

I am scared to death of big bridges. What do I do?

Slow down 5 to 10 miles per hour, get in the middle lane (where available), and focus your attention forward. At highway speeds, you will be across just about any of the river bridges in less than a minute. You can hold your breath that long, so just focus forward and get across safely. Oh, and avoid the two Huey Long bridges. Even I was scared by those devils.

Which bridges have bicycle paths?

Nearly all bridges in the headwaters area (except railroad bridges) accommodate bicycles. In the twin cities, most bridges allow bicycles, even several of the Interstate highway bridges. On the upper river, about half of the highway bridges accommodate bicycles. Below Saint Louis, however, it is very difficult to cross the Mississippi River, with only one bridge that I can think of being open to bicycle and pedestrian traffic. There are, however, some ferry boats that accept walk-ons. As a nation, we should fix this lack of accommodation and we should never again allow a new bridge to be built without making provisions for bicycle and pedestrian users.

What is my favorite bridge?

My top five include the two old railroad bridges in Minneapolis that have been converted to pedestrian use (Stone Arch Bridge and Northern Pacific Bridge #9), the I-90 Dresbach Bridge at La Crosse (due to the amazing scenery), the Ferry Street Bridge in Anoka, Minnesota (due to its Art Deco style concrete arches), and the Harahan Bridge (due to the possibility of the auto lanes being rebuilt for use by bicycles and pedestrians). If I lived a little further south, I might have picked the McKinley Bridge in Saint Louis (for its amazing rebirth), the Greenville Bridge (you have to love a huge cable stayed structure), the I-74 Iowa-Illinois Memorial Bridge (for its gothic look), the Centennial Bridge in Davenport (for its graceful style) and the Huey Long Bridge in New Orleans (for the amusement park-like thrill of the crossing).

Old Vicksburg Bridge, Vicksburg, MS: In the Old Vicksburg Bridge, both the railroad line and the highway ran through the inside of the bridge truss—crossing the bridge in a car was a hair-raising event when a train was on the bridge. The narrow highway was also a challenge for truck drivers, who often smashed mirrors when passing each other. The highway has been closed for years, and although it would an amazing pedestrian bridge, the agency owner has not been willing to do so.

What is the most interesting feature of the Mississippi River?

It is hard to pick just one, so here are a few from different points of view:

Engineering–the most interesting feature is the Old River Control Structure north of Baton Rouge. The US Army Corps of Engineers wages war with Mother Nature every day trying to keep the river from changing course and capturing the Atchafalaya River.

Bridges–the most interesting set of bridges is the collection of huge concrete arch bridges in Minneapolis, most of which were designed by Frederick W. Cappelen, the city engineer for the city of Minneapolis early in the 20th century.

Scenery–the most scenic section of the Mississippi River is the west bank between La Crosse, Wisconsin, and Winona, Minnesota. The river is 5 miles wide, dotted with islands, with high bluffs on each side of the river, and plenty of barge and rail traffic to watch. What makes this section special is that Interstate highway I-90 and US highway 61 hug the riverbank allowing for very close views that are only rarely possible along much of the length of the Great River Road.

History–the largest concentration of history occurs at Saint Anthony Falls in Minneapolis. It was the only true waterfall on the Mississippi, the biggest water power source, featured one of the first hydro-electric plants in the nation, was the world center for flower milling, it played a key role in the lumber boom in the late 1800s, and it was the confluence point for the Grange railroads (such as the Great Northern and the Northern Pacific). Today, the falls area features several history parks and is the site of several historic bridges.

Curiosity–the most curious feature of the Mississippi River is New Orleans. Why would people build a major city next to a flood-prone river, let alone build a city on land that sits a dozen or more feet below the normal river level? Even more curious is how well this city has not only survived, but actually has adapted to its precarious situation, and how it has responded to and recovered from its past setbacks.

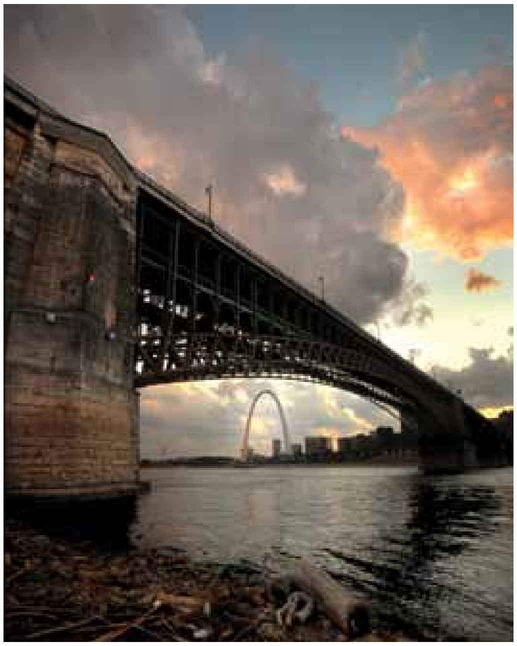
John A Weeks III, bridge hunter and avid amateur photographer, posts and updates a web site which conducts a photo tour detailing the bridges and structures of the Mississippi. In this survey, Mr. Weeks visits the bridges, locks, and dams on the Mississippi from its headwaters at Lake Itasca to the Head Of Passes where the river empties into the Gulf of Mexico. For more great pictures of the many bridges and structures of the Mississippi, visit his web site at: http://www.johnweeks.com/river_mississippi/.

IBC Inaugural Photo Contest

1. Alton Bridge US Route 67, [Middle Mississippi], Photographer: Cathy Morrison-MoDOT, April 2007. Judges' Comments: "*A beautiful nighttime setting … a perfect reflection …*"

In 2012, The International Bridge Conference® (IBC) Executive Committee launched our Inaugural Photo Contest. This year the Executive Committee selected the theme of "Mississippi River Bridges–10 Most Beautiful Bridges" for our inaugural contest. Our request for entries has been outstanding and the Committee has had a difficult time ranking and selecting the photos for publication. Nevertheless, we hope that you, our readers, will find these photographs to be outstanding. Congratulations to Cathy Morrison our first place winner in this, our inaugural contest.

Enjoy – IBC Executive Committee



2. Eads Bridge, taken from East St. Louis, looking west towards the City of St. Louis, Missouri, [Middle Mississippi], Photographer: Gwendolyn Mercer, Troy Illinois, March 2012. Judges' Comments: *"Love the color… Love the Arch, under the Arch…"*

3. Eads Bridge, St. Louis, Missouri, [Middle Mississippi], Photographer: Cathy Morrison-MoDOT, November 2009. Judges' Comments: "*Grace at sunset … great composition and color …*"

4. Iowa Highway 9 bridge over Mississippi River, Lansing, Iowa, [Upper Mississippi], Photographer: Mike LaViolette, March 2009. Judges' Comments: "*From a still moment on the Mississppi River… a clean looking truss … given spectacular treatment …*"

5. Crescent City Connection twin bridges in New Orleans, Louisiana. (Reflective shot in an adjacent building.) [Lower Mississippi],
Photographer: Mark Miller, Hermitage, PA, March 30, 2012.
Judges' Comments: "*A fascinating photo … Imagine the view of the bridges from inside the building ... you can almost see what they are seeing…*"

6. New I-35W Bridge over the Mississippi River ,Minneapolis, Minnesota, [Upper Mississippi],
Photographer: Bryan Lechner, FIGG Engineering, December 2008.
Judges' comments: "*A striking winter scene …colors give this the impact …*"

7. Wabasha Freedom Bridge over the Mississippi River St. Paul, Minnesota, [Upper Mississippi],
Photographer: FIGG Engineering, Fall 1998. Judges' comments: "*What a great effect ... it reminds me of an image from Paris*… "

8. Crescent City Connection Bridges in New Orleans, Louisiana, (showing the twin bridges converging in the early morning sunrise), [Lower Mississippi],
Photographer: Mark Miller, Hermitage, PA, March 30, 2012.
Judges' Comments: "*Majestic … an impressive view of the twin bridges* …"

9. Memphis-Arkansas Memorial Bridge Memphis Tennessee, [Lower Mississippi],
Photographer: Martha Harrell, Nesbit, Mississippi, November 2010.
Judges' Comments: "*Intriguing capture of sunlight and bridge* …"

10. Mississippi River Crossing above fifty foot high St. Anthony's Falls navigation lock, Minneapolis, Minnesota, [Upper Mississippi],
Photographer: Dietrick Floeter Photography, 2005.
Judges' Comments: "*An impressive view of the bridge and the St. Anthony's Falls*..."

I-74 Corridor over the Mississippi River

By Elissa Ship, P.E., S.E.

The Iowa and Illinois Departments of Transportation (Iowa DOT and Illinois DOT) and the Federal Highway Administration (FHWA) have teamed up for improvements to the I-74 corridor in the Quad Cities. Utilizing a variety of technological and design innovations, the I-74 Corridor over the Mississippi River will increase capacity throughout the project corridor by upgrading approximately seven miles of the existing 4-lane interstate including a new Mississippi River crossing, improvements to six existing service interchanges, enhancements to the connecting arterial roadway system, and improved opportunities for transit, bicycle/pedestrian, and intermodal connections.

I-74 is the only interstate facility that crosses the Mississippi River through the central Quad Cities area. As such, the I-74 corridor is the major transportation facility used to move people and goods through the area and across the Mississippi River.

Key Project Benefits

- **Improve connections for workers and goods across the Mississippi River**
- **Improve safety throughout the I-74 Corridor**
- **Reduce traffic delays**
- **Improve infrastructure**

The 2035 Quad Cities Area Long Range Transportation Plan (LRP) predicts an increase in traffic on the I-74 bridges from 77,800 vehicles per day (VPD) in 2002 to 99,800 VPD in 2035. These traffic volumes amount to 45% of the total traffic crossing the Mississippi River in the Quad Cities area. The current traffic volumes already result in significant traffic delays, meaning the projected traffic volumes under the current roadway configuration will result in a detriment to the efficient movement of people and goods throughout the region.

Project Need

The purpose of the I-74 Corridor over the Mississippi River is to improve traffic capacity, infrastructure condition and safety, resulting in more reliable and consistent travel times in the region by meeting the following needs:

Increased traffic demands: Motorists in the I-74 corridor currently experience frequent travel congestion. These conditions are predicted to continue in the future based on a combination of traffic forecasts and current roadway geometry.

Improved transportation connections: Aside from I-74, three other interstate highways, five U.S. highways, ten state highways, three railroads, one commercial airport, 20 barge terminals and one general aviation airport serve the Quad Cities region. The roadway network also provides vehicular and non-motorized access to trails, transit, rail, river, air, and intermodal facilities.

Key Project Needs

- **Increased traffic demands**
- **Improved transportation connections**
- **Improved roadway geometry**
- **Improved infrastructure condition**
- **Improved safety considerations**
- **Support of economic development**

Improved roadway geometry: Since the roadway was constructed, geometric standards developed by the American Association of State Highway and Transportation Officials (AASHTO) have been updated to reflect improved knowledge of how roadway geometry may influence safety and travel performance.

Improved infrastructure condition: The existing 4-lane facility designated as Interstate 74 was constructed and opened to traffic in the early 1970s. The westbound I-74 bridge over the Mississippi River was previously constructed as part of the original NHS route in 1935 while other remaining facilities that comprise the I-74 corridor are close to 40 years old. As such, the Mississippi River bridges are now considered functionally obsolete.

Improved safety considerations: Traffic in sections of the I-74

Corridor over the Mississippi River currently experience higher than average crash rates. The main contributing factors to these rates include current roadway and shoulder widths, ramp and mainline geometry, traffic volumes and congestion.

Support of economic development: Following the passage of the Economic Development Administration Reform Act in 1998, the "Quad Cities" was designated as an Economic Development District and began preparing a plan for economic development. The resulting plan was documented in a report by the Bi-State Regional Commission entitled 2000 Comprehensive Economic Development Strategy and subsequently updated in the 2008 Comprehensive Economic Development Strategy. This report identifies increasing the capacity on the I-74 Mississippi River crossing as critical to enhancing the economic viability of the Quad Cities region.

Dependability of travel: Traffic related delays and congestion on I-74 have a ripple effect on other roadways in the area. Because the existing corridor is operating at capacity, small incidents such as minor traffic accidents, routine maintenance, or inclement weather have a devastating effect on traffic delays and commuter travel times throughout the region. An important project goal of the local governments is to improve dependability of corridor travel times.

Improvements

Project improvements are grouped into three sections: the North, Central and South Sections. (See Figure 1)

South Section

The improvements for the South Section of the I-74 Corridor over the Mississippi River include:

- Reconstructing I-74 and adding capacity with the addition of a third 12-foot lane in each direction and a 12-foot auxiliary lane between Avenue of the Cities (23rd Avenue) and 7th Avenue (westbound I-74).
- Providing 30-foot paved median with barrier to separate opposing traffic.
- Reconstructing the I-74 bridges over the 19th Street collector and 12th Avenue to accommodate proposed roadway improvements and provide adequate vertical clearance.
- Reconstructing the Avenue of the Cities (23rd Avenue) bridge over I-74 to accommodate the proposed roadway improvements and provide adequate vertical clearance.
- Proposing design improvements at entrance and exit ramp terminals and at the ramp intersections along Avenue of the Cities.

Central Section

The improvements for the Central Section of the I-74 Corridor over the Mississippi River include:

- Reconstructing and widening the main line to accommodate three 12-foot through lanes in each direction.
- Reconstructing and widening the I-74 bridges over 19th Street, 7th/6th Avenue, 5th Avenue, 4th Avenue/CRI&P RR, River Drive, the Mississippi River, relocated State St., US 67/Grant Street, Holmes Street/Mississippi Boulevard and the Lincoln Road bridge over I-74.
- Reconfiguring the downtown Moline interchange to improve safety and operation and provide connection to IL 92.
- Removing ramps at State Street and Kimberly Road and constructing an improved diamond interchange at Grant Street (U.S. 67 westbound).
- Converting Grant Street near I-74 to a two-way street with three lanes in each direction.
- Providing pedestrian and bicycle path crossings over the Mississippi River.

North Section

The improvements for the North Section of the I-74 Corridor over the Mississippi River include:

- Reconstructing and widening the mainline to accommodate three 12-foot through lanes in each direction through 53rd Street.
- Constructing twelve-foot auxiliary lanes between Grant Street (in the Central Section) and U.S. 6 in both the eastbound and westbound directions.
- Reconstructing the I-74 bridges over Middle Road, Duck Creek, and U.S. 6/Spruce Hills Drive to provide adequate vertical and lateral clearance and to accommodate design improvements.
- Widening the 53rd Street bridge to accommodate the expansion from a four-lane to a six-lane cross section along 53rd Street.
- Providing thirty-foot median barrier.

Innovation: Design

The main span of the new I-74 crossing over the Mississippi River is a Basket Handle True Arch Bridge. It is one of the first bridges designed with the updated AASHTO seismic design specifications and the new seismic hazard maps and will also be one of the first long-span bridges over water designed using the new AASHTO Guide Specifications for Vessel Collision Design of Highway Bridges.

Another innovative component to this project will be the dedicated bike/pedestrian trail, present on the west side of the eastbound bridge. This is an important enhancement to the regional and national trail network in the Quad Cities.

Innovation: Technology & Investigation

The Iowa and Illinois DOTs have deployed ITS technology in and around the Quad Cities metropolitan area to improve safety and mitigate traffic impacts resulting from daily traffic congestion and the multi-year freeway reconstruction effort. The following ITS technology is planned for the project:

- 11 pan-tilt-zoom cameras
- 10 side-firing radar traffic sensors
- Overhead and side-mounted dynamic message signs

- Video detection system
- 7 automated ramp gates
- 10 side fire microwave detection
- Road Weather Information System (RWIS)

Access and control of the ITS network is being shared with law enforcement, emergency response and 911 Communications Center staffs from the Cities of Bettendorf, Iowa and Moline, Illinois. This access is being provided via the ATMS software in a "virtual" TMC approach using both dedicated Ethernet communications and the public internet bandwidth.

Project-Wise, a web-based project management system, is also being used. It will allow for the Design Team, Iowa and Illinois DOT's and other local agencies to communicate with each other during Final Design. ProjectWise will be used to store all project documentation and through the construction phase.

In addition, the following items will be investigated during final design:

- Bridge Security Monitoring Systems
- Environmental-friendly anti-icing systems
- SMART Bridge Sensors for bridge health monitoring
- Permanent sensors built into the river piers, to monitor water levels, flow velocities and streambed depths for scour evaluation. This will minimize future potentially dangerous underwater inspections.
- Utilization of cool pavements (lighter colored pavements to reduce heat island impact to urban area).
- Use of recycled material for pavement
- Utilization of LED technology to reduce electrical consumption (lights, beacons, and signals)
- Use of alternative energy sources for aesthetic and street lighting, warning signs, and ITS components.

Corridor Redesign Theme

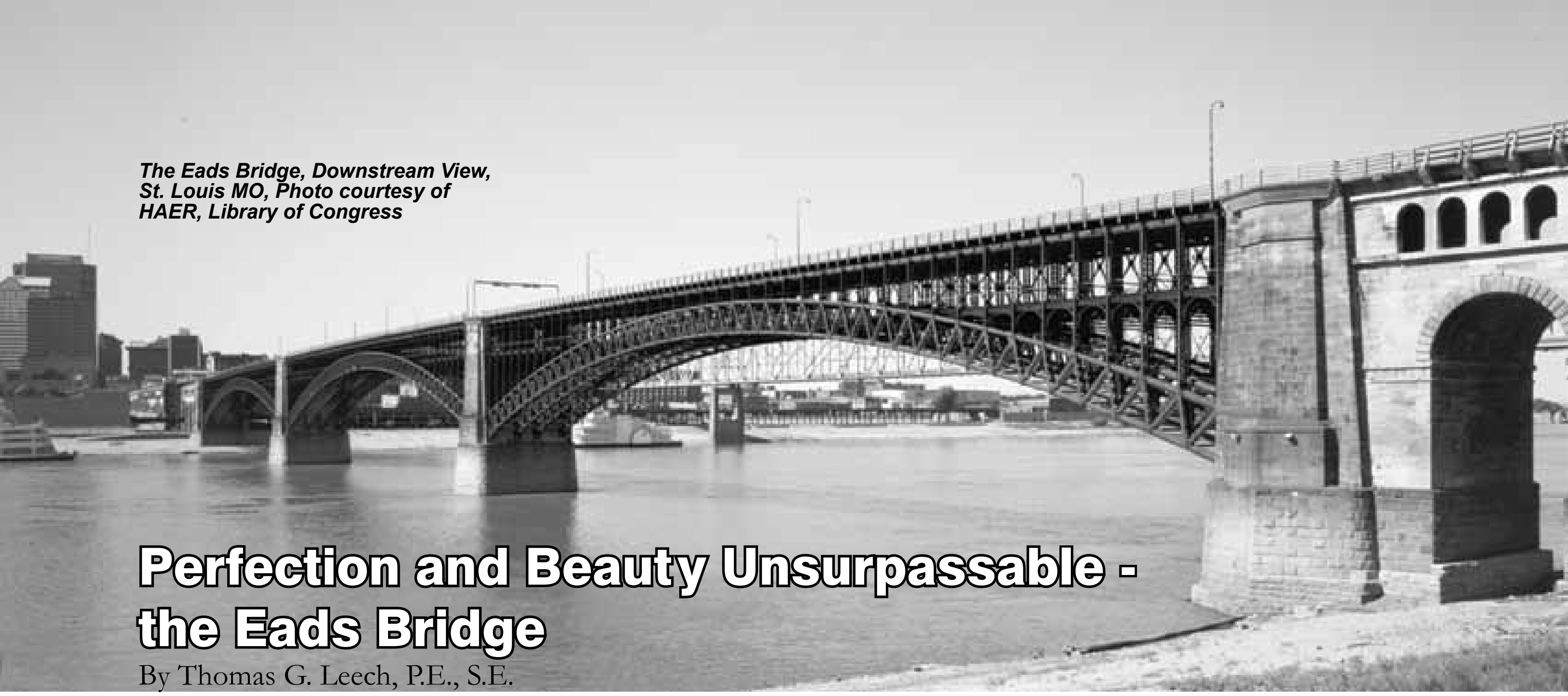
"Reflections." As part of the concept, enhancements to the I-74 project focus on the "mystique of the river" and "thresholds into our states communities, and neighborhoods." The theme will be implemented within elements of the project corridor including:

- **Main Span and Bike/Pedestrian Aesthetic Lighting**
- **Bridge Railings and Fencing**
- **Reflective coatings**
- **Pier shapes**
- **Retaining wall texturing and coating**
- **Landscaping**

Not only will the project increase capacity throughout the project corridor through interstate and interchange upgrades, a new Mississippi River crossing and safety and traffic improvements, but will create new opportunities for transit, bicycle/pedestrian, and intermodal connections in the region.

I-74 is the only interstate facility that crosses the Mississippi River through the central Quad Cities area. As such, the I-74 corridor is the major transportation facility used to move people and goods through the area and across the Mississippi River.

Elissa Ship, PE, SE, is an experienced structural engineer who has managed and contributed to the successful completion of numerous projects, from bridges to buildings. Ms. Ship was responsible for conducting structural designs for several of the complex bridges within the I-74 Corridor over the Mississippi River project.



The Eads Bridge, Downstream View, St. Louis MO, Photo courtesy of HAER, Library of Congress

Perfection and Beauty Unsurpassable - the Eads Bridge

By Thomas G. Leech, P.E., S.E.

"…I have haunted the river every night lately, where I could get a good look at the bridge by moonlight. It is indeed a structure of perfection and beauty unsurpassable, and I never tire of it."

Walt Whitman, 1879 --American poet extraordinaire and brother of an Eads bridge laborer. When Whitman penned these words, the bridge was only five years old, but had already become a world-wide symbol of America's genius and promise.

To the poet, the layman and the engineer, from 1874 to the present, the Eads Bridge captivates the imagination. It has been symbol of daring and beauty from its first construction. As the first symbol for the city of St. Louis as the gateway to the west, it was transfixed into an iconic manifestation with the creation of the St. Louis arch in 1965. What was it that has generated such appeal – an appeal to engineers and artists alike?

"Must we admit that because a thing never has been done, it never can be?"

James B. Eads

In 1797, Captain James Piggott piloted the first ferry across the Mississippi River at St. Louis. Bold plans for a Mississippi River crossing were proposed first in 1839 by Charles Ellet (the father of suspension bridges) who envisioned a 900-1200-900 ft suspension span for pedestrians and carriages, again in 1855 by Josiah Dent who suggested a rail road suspension bridge and once again a year later by Roebling who also envisioned a suspension bridge. And then the civil war intervened.

Enter James Buchanan Eads, hydraulic engineer and a civil war captain who, in1861, at the call of the Federal government, constructed ironclad steamers, gunboats and mortar boats, all of use in opening up the Mississippi and its tributaries throughout the Civil War. In 1879, he designed his last major hydraulic work, system of willow mattresses and stonework at the mouth of the Mississippi River, by which the water was confined to a narrow passage through which it scoured a deep channel to permit the passage of boats. In 1867 Eads proposed a daring river crossing at St. Louis, Missouri. Eads was armed with the knowledge borne of his river experience that in the Mississippi River, the largest threat is scour and if scour could be eliminated, a wonderful work could be accomplished. Having been abroad before the war studying European public works such as the Koblentz Bridge, it no surprise that he envisioned a structure based on a classical style. This style would emphasize imposing pier elements of stone, which would gain their needed support from bedrock, as much as 100 feet below the low water of the Mississippi. The stone pier elements would then be connected by a repetitive and structurally efficient superstructure form.

"[Trussed arches were a] … form which often combines the highest economy with the most elegant and graceful proportions in architecture"

James B. Eads

The true grace of the Eads Bridge is the interplay of strength and delicacy. Strength was achieved though the massive stone river piers and classically styled approach spans balanced by delicacy, which was achieved through the wispy yet handsome superstructure, comprising a series of flat parabolic arches spanning a record (at the time of) 500 feet, each. The arches were trussed in vertical pairs with four pairs per span, intricately braced with interconnecting diagonal elements. (See the accompanying article.) Over objections to the fabricators of the era, the arches were formed from hollow steel tubes, with exacting and demanding metallurgical specification requirements. The result was a marriage of form and function, the grace of a classical architectural form coupled with the efficiency of the parabolic pressure line directing forces into slender tubes, of almost ethereal shape.

In essence, this bridge is visually appealing by applying the modernist creed of less being more. Eads decided to allow the essential beauty of stone and steel and form to carry the load without other aesthetic adornment.

"Here was romance, here was a man, the great adventurer daring to think, daring to have faith daring to do… [The] bridge was to cross a great river, to form the portals of a great city, to be sensational and architectonic."

Louis Sullivan, Chicago Architect, credited with the first modern steel skyscraper changing load resistance paradigm from bearing wall to the emerging skeletal support construction with an outer skin construction. Sullivan credited his inspiration from Eads and was the architect for one of St. Louis architectural treasures, the Wainwright Building at Seventh and Chestnut Streets.

The bridge was completed in 1874; some notable (and not so notable) achievements with the design and construction include:

- First major bridge to cross the Mississippi River (between Illinois and Missouri, although there were a few upper river crossings previously built).
- Designed with capacity to convey both railroad traffic of the day as well as pedestrians and carriages (and presently carries transit and vehicular traffic).
- Originally named the Illinois & St. Louis Bridge, it was later named for its designer.
- First major bridge to make extensive use of steel alloy for the truss and bracing system (including innovations for precision and accuracy of construction and quality control, as well utilization of cast chromium steel components).
- First major bridge with arch spans of 500 ft (longest span is 520 feet).
- First major bridge to use cantilevered construction, avoiding falsework that would hinder river traffic (bowing to the politically influential river industry).
- First major bridge in the U.S. to use the pneumatic caissons for deep underwater pier construction (which sadly led to considerable illness and some deaths from the "bends" – i.e. decompression sickness due to nitrogen in the bloodstream).
- Although an engineering and architectural success, the bridge owners (i.e. the St. Louis Bridge and Iron Company) went bankrupt within the first year of opening.
- Designated as a National Historic Landmark.

"[Eads believed that]… the true, the useful, and the beautiful were equally manifest in the harmony of creation. Machines that worked right looked right because utility and taste were one in the mind of God."

Howard S. Miller, Missouri State Historian and co-author (with Quinta Scott) of the book, "The Eads Bridge".

Postscript

Besides James Buchannan Eads, some industry giants and other historical figures played important and sometimes interesting roles in the Eads Bridge including:

- Eads' Chief inspector was Theodore Cooper (a name well renowned in railroad design, and the name historically and currently affixed to railroad design loadings).
- In 1869, Andrew Carnegie secured bonds from European investors for the construction of the bridge and was subsequently made a member of the board of directors for the bridge.
- William Tecumseh Sherman drove the last spike on June 9, 1874.
- On 14 June 1874, John Robinson led a "test (circus) elephant" across the new Eads Bridge to prove it was safe. (It was believed at that time that elephants had instincts that would keep them from setting foot on unsafe structures.) The bridge was opened, with ceremony, on July 4, 1874.
- Jay Gould (railroad magnate) became the owner of the bridge in 1881 by coercion (as he persuaded Congress to grant a congressional charter for a "new" bridge 45 miles upstream, effectively lowering the selling price of the Eads Bridge; Gould had no intention of building a "new" bridge upstream).

The Eads Bridge, St. Louis MO, Photo courtesy of HAER, Library of Congress

Tonight, I've inherited the soul of James B. Eads.

I am science, civil engineering,

That grand tributary, the Mississippi River,

The forces of nature tamed by his mathematics,

The colossal Eads Bridge itself,

Spanning the rapid currents of my imagination.

From "The Soul of Eads" by Louis Daniel Brodsky, sometimes poet, businessman and proprietor of Time Being Books in St. Louis

Thomas G. Leech, P.E., S.E is the National Practice Bridge Manager of Gannett Fleming, Inc.

The Eads Bridge – A Close-up Look
Photo courtesy of HAER, Library of Congress

The Eads Bridge – A Pittsburgh Connection

By Jim Dwyer, P.E.

"Those were the times when one man, alone, could create a bridge (Eads), or a tower (Gustave Eiffel) or an architectural school (Louis Sullivan)."

Howard S. Miller, Missouri State Historian and co-author (with Quinta Scott) of the book, The Eads Bridge.

"The Eads Bridge of St Louis is of special interest to the steel industry because it was not only the first bridge to make extensive use of steel, but was one of the first significant steel structures of any type."

John K Edmonds, AISC

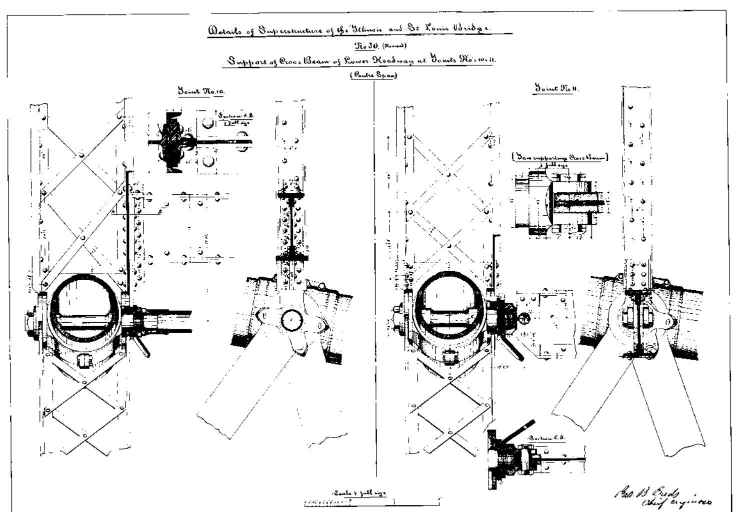
One may not be aware, but the superstructure of the Eads Bridge and the city of Pittsburgh are deeply intertwined.

On April 9, 1865, the Civil War essentially ends with Lee's surrender to Grant at Appomattox Court House, Virginia. In that same year there were two very important milestones in the life of Andrew Carnegie and the construction of the Eads Bridge: (1) Andrew Carnegie "retires" from the railroad; and (2) with a loan of $80,000, Andrew Carnegie and several associates reorganize the Piper and Schiffler Company into the Keystone Bridge Company, as the investors envision building bridges of iron rather than wood. With headquarters in an office building at the corner of 6thAvenue and Grant Streets, downtown Pittsburgh, and their first mill, the Union Mills at 34th Street along the Allegheny River, Andrew Carnegie and his brother, Thomas Carnegie, began their careers in the iron (and eventually steel) industries.

In 1870 the Union Iron Mills were reorganized under the name of the Isabella Furnace Company and a new blast furnace was built, seventeen blocks away, on 51st Street in the Lawrenceville Section of Pittsburgh. The blast furnace, named the Lucy furnace after Thomas Carnegie's wife, was enormous by the standards of the day, standing at 75 feet (23m) in height, and was producing 270 tons per day by 1872. During this time of remarkable tonnage, this furnace was producing all of the steel for superstructure of the Eads Bridge, which included the 100,000 psi structural barrel staves, the hollow tube steel members which uniquely characterize this bridge.

By 1900, Thomas Carnegie had died and Andrew Carnegie sold all steel interests, and the Keystone Bridge Company was one of 28 companies absorbed into the American Bridge Company along with a vast repository of engineering drawings. In 1980, I came in possession of a copy of an 1871 drawing signed by James Buckhannon Eads himself. The drawing (accompanying this article) displays the intricate bracing system nestled within the Eads Bridge's steel superstructure. Not only is the bridge an engineering marvel and aesthetic joy, but the engineering drawings of the day were masterpieces of drafted "art".

Jim Dwyer, P.E. currently serves on the FRA Rail Safety Advisory Committee and a member of the Executive Committee of the International Bridge Conference.



Engineering Drawing: Details of the Superstructure of the Illinois and St. Louis Bridge (later named the Eads Bridge after its designer). This image is a copy is one of many original design drawings of the Eads Bridge transferred from The American Bridge Company Archives to the Washington University (St. Louis) in 1980. Note James Eads' signature on the drawing. Image is courtesy of Jim Dwyer.

The Bill Emerson Memorial Bridge

Cape Girardeau, Missouri

A Historic City with an Instrumented Bridge

By Myint Lwin and Phil Yen

INTRODUCTION

Cape Girardeau, Missouri, was founded more than 200 years ago. It started as a small trading post along the Mississippi River. It was established by the French merchant, Jean Girardot, from Ohio in 1733. Lewis and Clark stopped here on their way to St. Louis, Missouri for their journey into the unknown West.

With the arrival of the steamboat in 1835, Cape Girardeau became a regional trading and distribution center, the largest between St. Louis, Missouri and Memphis, Tennessee. Cape Girardeau experienced significant growth in the mid 1800s with the establishment of public education, the introduction of rail service, and advances in agriculture and industry. A ferry system connected Cape Girardeau in Missouri and East Cape Girardeau in Illinois. The ferry system was replaced with a bridge in 1928. Today, Cape Girardeau is a regional center for education, commerce, and medical care, attracting tens of thousands of visitors daily.

HISTORIC PLACES

There are 39 historic sites in Cape Girardeau that are listed on the National Register of Historic Places. Of these, eight are historic districts. The Red House Interpretive Center located in historic downtown Cape Girardeau commemorates the life of community founder Louis Lorimier, and visit of Lewis and Clark in November 1803. Across the street from the Red House is the Old St. Vincent's Church, built in 1853. The architecture, English Gothic Revival, is awesome and rare. The pews and alters are original! The River Campus of Southeast Missouri State University dates back to 1843, with the construction of St. Vincent's College on the banks of the Mississippi River. The college, listed on the National Register of Historic Places, includes the seminary chapel, which has been converted into a music recital hall.

The Civil War Battle of Cape Girardeau was fought here on April 26, 1863. The Union and Confederate armies collided in a fierce, four-hour artillery barrage on this day. It was the turning point that brought General Marmaduke's second Missouri raid to an end.

Numerous murals commemorate the city's history. The largest is the Mississippi River Tales Mural, located on the city's downtown floodwall. Behind the floodwall lies the Riverfront Park of Cape Girardeau, where riverboats dock and visitors view the Mississippi River. For more stories about the rich history of Cape Girardeau, download the visitor's guide and enjoy a memorable visit!

AN INSTRUMENTED BRIDGE

Prior to 1928 traffic across the Mississippi River from Cape Girardeau to Illinois was handled by a ferry. In the summer of 1928 a bridge was built across the river to replace the ferry. In December 2003, a new four-lane cable-stayed bridge was opened and replaced the old bridge at Cape Girardeau.

Original Cape Girardeau Bridge, built 1928

The original Cape Girardeau Bridge was opened to traffic on September 3, 1928 with a dedication ceremony attended by nearly 15,000 people! The bridge consisted of six concrete deck girder spans, two plate girder spans, a continuous through truss forming two cantilevered channel spans of 671 feet each, and six through truss spans, for a total length of 4,744 feet. This bridge was built for the cars of the time and was only 20 feet wide. Big trucks routinely bumped mirrors when they passed each other. The idea of a continuous through truss bridge was somewhat new and controversial among the engineering community at the time. It was only after Gustav Lindenthal constructed a railroad bridge using the continuous through truss design at Sciotoville, Ohio in 1916, that engineers began to accept the concept. The old Cape Girardeau Bridge was the first Missouri bridge to use the continuous through truss design. Since then the concept has gained acceptance and popularity. The bridge was closed and demolished when the new Cape Girardeau Bridge opened to traffic in December 2003. The portal of the old bridge was left standing after the bridge was demolished. This portal has since been incorporated into a river overlook as part of the new River Campus of the Southeast Missouri State University. This overlook includes a viewing scope that provides a commanding view of the Mississippi River and the new bridge.

In 1987 the Missouri Highway and Transportation Department approved design of a new four lane Mississippi River bridge to replace the old Cape Girardeau Bridge. The new bridge opened to traffic on December 13, 2003. The new bridge was named "The Bill Emerson Memorial Bridge" after the former eighth-term Southeast Missouri U.S. Congressman William Emerson who championed the federal funding for the bridge's construction. Congressman Emerson worked hard to secure Federal Highway Administration money to proceed with the construction. The estimated cost of the bridge was $100 million. Eighty percent of the funding came from the Federal Government. Missouri and Illinois each contributed 10 percent.

The Bill Emerson Memorial Bridge is a 100-foot wide, 4,000-foot long cable stayed bridge with a main span of 1,149 feet. It links Cape Girardeau, Missouri (Routes 34 and 74) and East Cape Girardeau, Illinois (Route 146) and spans the Mississippi River. The Emerson Bridge is illuminated at night by 140 lights. Currently, 11,000 vehicles utilize the structure daily.

The Bill Emerson Memorial Bridge is instrumented to study the response of the structure to extreme events, such as earthquakes and winds. A total of 84 channels (all accelerometers) are used in this project. The sensors are capable of recording (a) free-field motions at the surface and at downhole locations away from the bridge and (b) overall motions of the bridge at the towers, the deck, and at pier locations. This is the most heavily instrumented bridge in the country. The lessons learned from the instrumentation and the data collect are expected to provide better understanding of the response of structures to forces of nature for improving designs of new bridges and retrofits of existing bridges. For more information on the instrumentation of this bridge, please see the article on Seismic Instrumentation of the Bill Emerson Memorial Bridge

The Bill Emerson Memorial Bridge

CLOSING REMARKS

Cape Girardeau has a rich history of educational events in cultures, government, civil wars, education, commerce, medicine, architecture and engineering. There are many valuable lessons, especially in the architecture and engineering of bridges and structures that can be learned from a visit to the City and the surrounding regions.

Frequent Contributor to IBC Magazine, Myint Lwin, P.E., S.E. is the Director, Office of Bridge Technology, FHWA, Washington, D.C, is Secretary of the AASHTO Highway Subcommittee on Bridges and Structures and is a member of the IBC Executive Committee; Phillip Yen, PhD is the Principal Bridge Engineer –Structural Dynamics, Office of Bridge Technology, FHWA, Washington, D.C., is member of Task Committee T3 Seismic Design) of AASHTO's Highway Subcommittee on Bridges an Structures, and is the Chair of the Transportation Committee of the US-Japan Natural Resource Cooperation (UJNR) Panel on Winds and Seismic Effects.

Answers to True & False Test - How Familiar Are You With the Mississippi River

From Page 6

Q1: False: The name "Mississippi" comes from the Anishinabe people (Ojibwe Indians). They called the river "Messipi" or "Mee-zee-see-bee," which means "Big River" or "Father of Waters."

Q2: True: Explorer Henry Schoolcraft was the first non-native settler to locate and document the true source of the Mississippi River at Lake Itasca in northern Minnesota. The year was 1832.

Q3: False: The Mississippi River's depth ranges from less than 3 feet at the headwaters in Minnesota, to the deepest section between Governor Nicholls Wharf and Algiers Point in New Orleans where it is 200 feet deep!

Q4 False: A raindrop falling into Lake Itasca would arrive at the Gulf of Mexico at the mouth of the Mississippi River in about 90 days.

Q5: True: The Mississippi River forms the 3rd largest drainage basin in the world. Its system of 29 locks-and-dams stretches 669 miles between Minneapolis, Minn. and Granite City, Illinois. There are 14 dams above Minneapolis in the non-navigational reach of the river. The entire river system controls approximately 40% of the nation's watershed

Q6: True: At 24 miles long, the Lake Pontchartrain Causeway in New Orleans, Louisiana is the world longest over-water highway bridge.

Q7: False: Sixty percent of all North American birds (which includes 326 distinct species) use the Mississippi River Basin as their migratory flyway!

Q8 False: The Mississippi River is a fishing hot spot! 241 fish species inhabit the Mississippi River and its tributaries!

Q9: True: Water skiing was invented in 1922 on the Mississippi River, in a wide part of the river known as Lake Pepin, between Wisconsin and Minnesota.

Q10: True: Crowley's Ridge in eastern Arkansas is one of the great geologic oddities of the world, and the Mississippi River Delta's only "highlands." The only other similar land form is found in Siberia.

Seismic Instrumentation of the Bill Emerson Memorial Bridge

By Phillip Yen & Myint Lwin

INTRODUCTION

This article describes the seismic instrumentation scheme for the Bill Emerson Memorial Bridge in Cape Girardeau, Missouri. The Mississippi River crossing is a cable-stayed bridge located near the region of the 1811–1812 New Madrid earthquakes.

The acquisition of structural response data during earthquakes is essential to confirm and develop new methodologies for analysis, design, repair and retrofitting of earthquake resistant structural systems, including lifelines, such as highway bridges. This is particularly true in urban environments of seismically active regions. Acquisition of response data is one of the basic requirements for a thorough investigation of the effects of earthquakes on structures. In order to understand structural responses thoroughly, it is necessary to record ground motions at the free-field in the vicinity of the structure to study soil-structure interaction (SSI) effects.

The New Madrid area, where the great earthquakes of 1811–1812 occurred, is a seismically active region requiring earthquake hazard mitigation programs, including those related to investigation of strong shaking of structures and the potential for ground failures in the vicinity of structures. The Bill Emerson Bridge is located approximately 50 miles due north of New Madrid, Missouri. Design of the structure accounted for the possibility of a strong earthquake with magnitude 7.5 or greater during the design life of the bridge. A general location map of the bridge site is provided in Figure 1 and a general schematic and dimensions are shown in Figure 2. This was the first cable-stayed bridge in the New Madrid area earmarked for seismic instrumentation. An older two-span tied arch truss bridge, the I-40 Hernando Desoto Mississippi River Bridge], has been retrofitted by base isolation, and instrumented also (Pezeshk, Steiner and Çelebi, 2004).

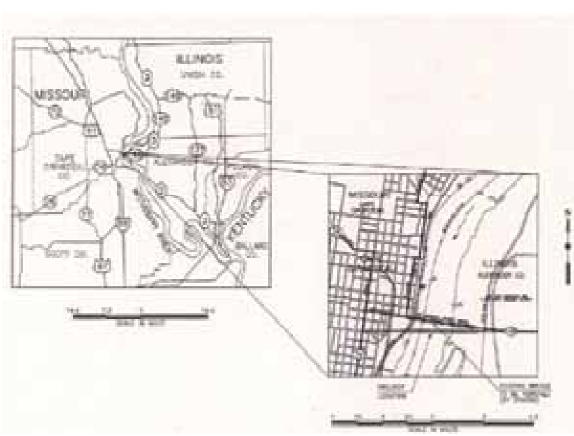


Figure 1. General location map of Bill Emerson Memorial (Cape Girardeau) Bridge

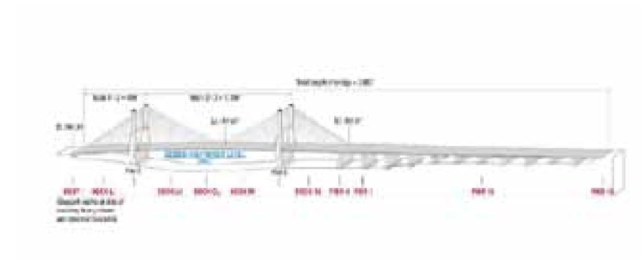


Figure 2. General schematic and dimensions of Bill Emerson Memorial (Cape Girardeau) Bridge.

Leading institutions that collaborated in the financing and development of the seismic instrumentation of the Bill Emerson Bridge are: Federal Highway Administration (FHWA), the United States Geological Survey (USGS), Missouri Department of Transportation (MoDOT),the Multi-disciplinary Center for Earthquake Engineering Research (MCEER) and a selected vendor.

OBJECTIVE OF THE INSTRUMENTATION

The objective of the instrumentation was to establish a state-of-the-art in seismic instrumentation that can be used to record the strong ground motions in the vicinity of the Bill Emerson Bridge and the bridge's structural dynamic responses.

The seismic instrumentation system is now able to work onreal-time streaming, viewing and recording of structural response which provides three additional basic and important advantages:

- record continuous and real-time low-amplitude response data, as needed, with relative ease by manual recording or manually scheduled recording.
- use of the near real-time information can help make informed decisions related to the response and performance of the bridge. This capability maybe construed and configured as "monitoring the health of the structure".
- maintain the system readily and easily as any malfunction of the sensors and related hardware can be detected via the real-time streamed information.

The system can also perform automatic recording after certain threshold of response at a particular location of the instrumented structure is reached.

Although there may be other objectives that may require special purpose instruments and hardware (e.g. sensors tailored for health monitoring such as fiber optics, etc.), for seismic engineering studies, in general, three main categories in recording motions are sought. In planning for the overall instrumentation scheme, it is deemed important to clearly identify these categories:

Figure 3. Completed Bill Emerson Memorial Cable-Stayed Bridge.

- instrumentation of the superstructure and pier foundations.
- instrumentation of the free-field in the vicinity of the structure including those related to downhole measurements and horizontal spatial arrays to assess the differential motions at the piers of the long span structure.
- ground failure arrays in the vicinity of the structure.

ESSENTIAL RESPONSES RECORDED

A total of 84 channels (all accelerometers) are used in this project. The sensors are capable of recording free-field motions at the surface and at downhole locations reaching competent rock, as well as overall motion of the cable-stayed bridge including:

Figure 4. Enlarged three-dimensional view of the Bill Emerson Memorial (Cape Girardeau) Bridge, significant locations identified for seismic instrumentation and distribution and orientation of the accelerometers.

- motions of the two towers to assess their translational and torsional behavior – relative to the caissons and deck levels.
- motions of the deck to assess the fundamental and higher mode translational (longitudinal, transverse and vertical) and torsional components.

The sensors also record the motions of the extreme ends of the bridge and intermediate pier locations, to provide data for studying the torsional, rocking and translational soil structure interaction at the foundation levels. This also provides insight into the horizontal and vertical spatial variation of ground motion.

CONCLUDING REMARKS

It is hoped that the planning and installation of seismic and wind instrumentation of the Bill Emerson Bridge will set an example for future large projects in seismically active regions. By integrating seismic instrumentation into the early design stages of a structure, an owner can save resources by avoiding redundant efforts when making provisions for hardware to monitor and record vibrational responses of such important structural systems during extreme seismic events and weather conditions.

Data from the instrumentation will help with better understanding of the response of structures to extreme events, such as, earthquakes, winds, which is essential to confirm current design practices, and develop new methodologies and criteria for analysis, design, repair and retrofitting of multi-hazard resistant structural systems.

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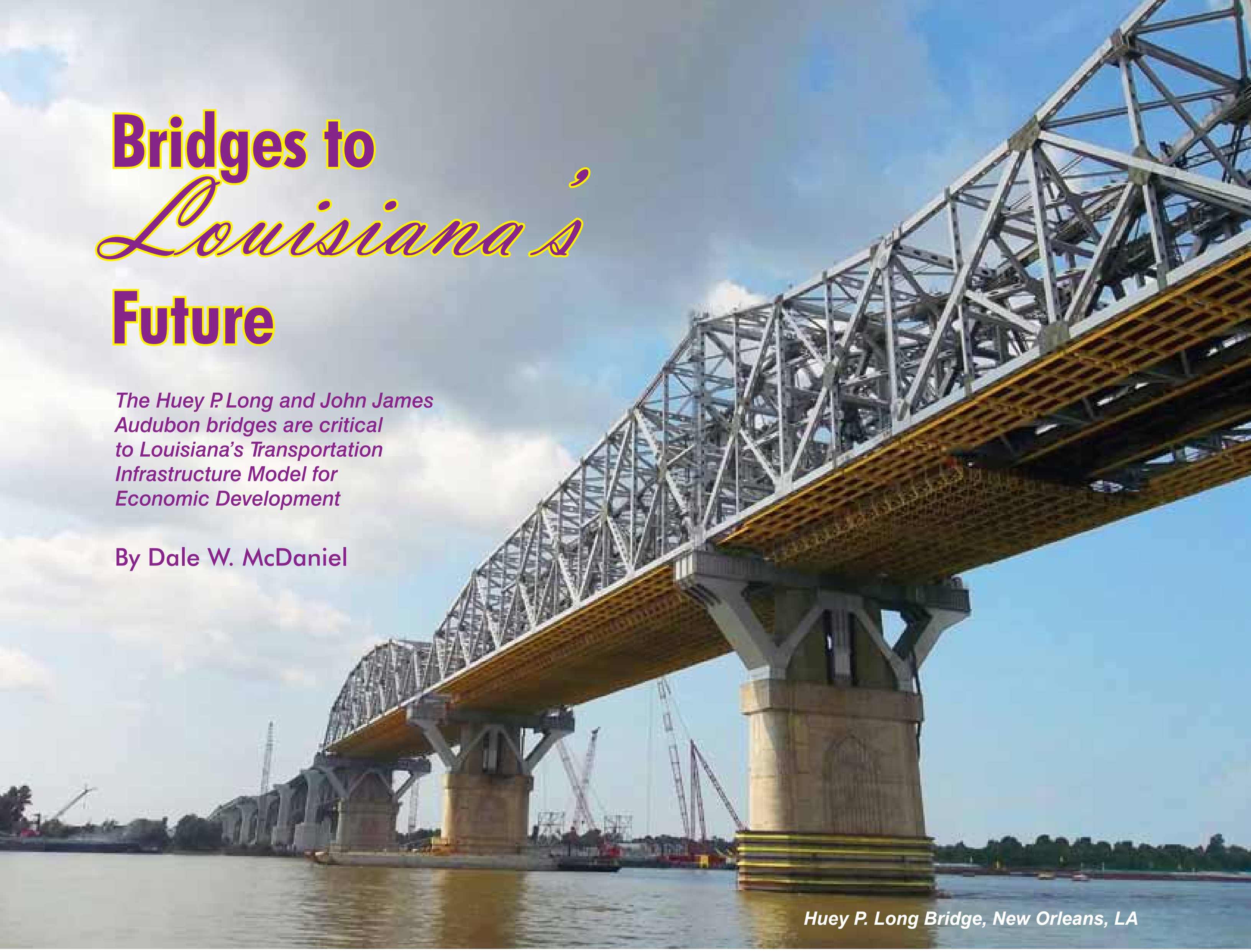
[2] Pezeshk, S., Steiner, G. and Çelebi, M., I-40 Bridge Strong Motion Instrumentation System.

Phillip Yen, Ph.D., is the Principal Bridge Engineer –Structural Dynamics, Office of Bridge Technology, FHWA, Washington, D.C., is member of Task Committee T3 Seismic Design) of AASHTO's Highway Subcommittee on Bridges an Structures, and is the Chair of Transportation Committee of the US-Japan Natural Resource Cooperation (UJNR) Panel on Winds and Seismic Effects. M. Myint Lwin, P.E., S.E. is the Director, Office of Bridge Technology, FHWA, Washington, D.C, is Secretary of the AASHTO Highway Subcommittee on Bridges and Structures and is a member of the IBC Executive Committee.



Bridges to Louisiana's Future

The Huey P. Long and John James Audubon bridges are critical to Louisiana's Transportation Infrastructure Model for Economic Development

By Dale W. McDaniel

Huey P. Long Bridge, New Orleans, LA

Since its inception in 1989, Louisiana's TIMED (Transportation Infrastructure Model for Economic Development) Program—the single largest transportation program in Louisiana's history—has faced many challenges, most notably addressing the immediate and long-term impacts of hurricanes Katrina and Rita in 2005. Nevertheless, the commitment of the Louisiana Department of Transportation & Development (LA DOTD) and its partners in the TIMED program has resulted in remarkable progress, including completion of the John J. Audubon Bridge, the longest cable-stayed bridge in the Western Hemisphere, and the ongoing widening of the 76-year-old Huey P. Long Bridge in Jefferson Parish, La.

Created by an act of the Louisiana legislature and approved by voters, the TIMED program is intended to enhance economic development in Louisiana through an investment in transportation projects. The $5 billion program includes widening 536 miles of state highways on 11 project corridors, widening and/or new construction of three major bridges, and improvements to the Port of New Orleans and Louis Armstrong International Airport. As of 2012, the main project under construction was the Huey P. Long Bridge.

In 2002, LA DOTD engaged Louisiana TIMED Managers (LTM) to manage the TIMED program. A joint venture of Parsons Brinckerhoff of New York City in partnership with the LPA Group of Columbia, South Carolina, and GEC of Baton Rouge, Louisiana, LTM is based in Baton Rouge and at its peak of operations had offices scattered throughout the state.

As of 2010, the TIMED Program was nearly completed, but contracts were extended for the Huey P. Long Bridge and the John James Audubon Bridge due to schedule delays associated with the impacts of the 2005 hurricanes. The John James Audubon Bridge concluded construction in January 2012 and the Huey P. Long Bridge has entered the final construction phase, with completion expected in 2013.

Huey P. Long Bridge

The Huey P. Long Bridge is in the final phase of a $1.2 billion widening project. When the project is completed, the bridge will have three 3.4-meter (11-foot) lanes in each direction with 2.4-meter (8-foot) outside and 0.6 meter (2-foot) inside shoulders, more than doubling the existing driving surface. The project also includes construction of new elevated bridge approaches and ramps. Additionally, new intersections with traffic signals at Bridge City Avenue and Jefferson Highway are being constructed.

Opened to traffic in 1935 and named for Louisiana's legendary governor (1928-1932) and U.S. senator (1932-1935), the Huey P. Long Bridge is a combined railroad/highway bridge that at the time of its opening was the longest railroad bridge in the world. The widening project, which began in April 2006, has been long awaited by local communities and is vital to the recovery of the Greater New Orleans area.

John J. Audubon Bridge

One of three primary crossings of the Mississippi River in the Greater New Orleans area, the Huey P. Long Bridge was designed to carry two railroad tracks and four highway lanes of U.S. 90. The bridge has two 9-foot (2.74-meter) vehicle travel lanes in each direction, with no inside or outside shoulders, and supports both vehicle and rail traffic in the same configuration as when it opened 76 years ago. However, as the Greater New Orleans region has grown, average daily traffic on the bridge increased to approximately 50,000 vehicles per day. The existing bridge does not meet current design standards and contributes to highway capacity problems along this corridor.

The widening project made substantial progress in 2010 with completion of a truss phase that began with an effort that was dubbed "The Big Lift." During a weekend closure in June, a massive bridge segment—larger than an American football field—was the first of three to be lifted in place using barges and strand jacks. The remaining two sections were lifted later that year after hurricane season. Altogether, an estimated 17,500 tons of structural steel and 750,000 new bolts were used during the truss phase of the project.

In 2011, the Huey P. Long Bridge was named a National Historic Civil Engineering Landmark by the American Society of Civil Engineers (ASCE). The designation makes the New Orleans structure one of fewer than 250 ASCE landmarks in the world including the Eiffel Tower, the Panama Canal, and the United States Capitol Building.

John J. Audubon Bridge

The completion of the $408-million John J. Audubon Bridge marked a major milestone in the TIMED Program. The longest cable-stayed bridge in the Western Hemisphere, with a main span of 482 meters (1,583 feet), the Audubon Bridge crosses the Mississippi River between the communities of St. Francisville and New Roads, and is the only bridge over the Mississippi River between Natchez, Mississippi to the north and Baton Rouge to the south, a distance of about 145 kilometers (90 miles).

Major elements of the 23.5-kilometer (14.6-mile) project included the cable-stayed, four-lane main span bridge, high and low approach spans, and low-level bridges both east and west. The project also comprised approximately 19 kilometers (12 miles) of connecting roadways, including seven smaller bridges.

DOTD's TIMED Program Manager Toby Picard, P.E., said the emergency opening of the bridge to traffic on May 5, 2011 allowed continuous river-crossing for traffic affected by the closure of the St. Francisville-New Roads ferry as a result of the flooding that impacted Mississippi River communities from the Midwest to the Gulf of Mexico. Lane closures enabled the bridge to remain in service during the remainder of the construction, until the bridge was fully opened in January 2012.

Public Communications Enhances Projects

The TIMED program is supported with an ongoing public communications effort. Led by staff of Parsons Brinckerhoff, the outreach program includes public meetings, school visits, and interactive events aimed at teaching children about engineering and the state's current projects.

In addition to using traditional tools ranging from leaflets to the TIMED website <http://www.timedla.com/>, the Huey P. Long Bridge project and the LTM team maintains Facebook <http://www.facebook.com/?ref=logo#!/pages/Jefferson-LA/Huey-P-Long-Bridge-Widening-Project/39317547349?ref=ts&__a=6&ajaxpipe=1> and an engaging Twitter feed <www.twitter.com/hueypbridge>. Not only are these tools used to inform the public about planned closures and detours, but these sites are also used for breaking news, and engaging people in conversation.

The TIMED program is a model for state-wide infrastructure development and economic development, demonstrating that commitment and partnership can overcome significant obstacles.

Dale W. McDaniel is a Senior Vice President for Parsons Brinckerhoff in New Orleans, Louisiana

WIDENING the Huey P. Long Bridge

Landmark Mississippi River Bridge Enhancement

By Bruce E. Peterson, P. E.

The Huey P. Long Bridge has been vital to the economy of New Orleans and Louisiana since its completion in 1935. But as significant as this impressive truss bridge has been in the past (the bridge was recently named a National Historic Civil Engineering Landmark by the American Society of Civil Engineers), its most important role lies ahead, as a key component for the facilitation of increased commerce crossing the Mississippi River.

Construction of the US $1.2 billion bridge widening and expansion is expected to come to an end in 2013.

In 1982 the Louisiana Department of Transportation and Development (LADOTD) commissioned a study for a new bridge located in the general area of the existing one. Although several alternative alignments were studied, the public could not agree on a location for a new river crossing.

As a result of the earlier studies, the LADOTD decided to widen the highway portion of the Huey P. Long Bridge to keep highway traffic, and commerce, flowing in the region. Modjeski and Masters was called upon in 1986 to perform conceptual studies of widening alternatives. Modjeski and Masters would oversee the ambitious design project, providing engineering services for the widening of the main bridge, new approaches, and improved interchanges at each end of the crossing. One of the benefits of widening the existing structure as opposed to constructing a new river crossing would be the cost savings of not having to obtain additional right-of-way.

Later phases of work included performing structural services, fatigue studies, preliminary and final design work for new widening trusses, pier widening, pier support brackets, steel and concrete girder highway approaches, and modifications to the railroad approaches. Highway and drainage design was performed for the at-grade connections to the crossing and to improve the existing connecting roadways and interchanges.

The widening of the Huey P. Long Bridge has presented many

Owners

- New Orleans Public Belt Railroad
- Louisiana Dept. of Transportation and Development

Key Challenges

- In order keep rail and highway traffic flowing during construction, the existing main span floorbeam brackets were integrated into the new roadway superstructure design thus allowing existing roadway traffic to continue to use the bridge during the widening construction.
- A 1990 geotechnical investigation indicated that the soils under the caissons could support the increased loads from the widening.
- Deflection of the new widening trusses during erection needed to be taken into consideration in the original contract plans without transferring any load to the existing truss members.

By the Numbers

- **500,000** – Number of field-installed fasteners needed for the main span superstructure widening
- **22,075** – Tons of new steel required for the main span widening alone; roughly double the amount used to build Heinz Field, home of the Pittsburgh Steelers
- **16,000** – Cubic yards of concrete needed to jacket the existing river piers
- **4.4** – length, in miles, between railroad abutments
- **2** – Design codes utilized (AASHTO and AREMA)

unique and interesting design challenges that are not normally encountered in typical bridge design and rehabilitation projects. These challenges – such as keeping the bridge open to both rail and highway traffic during the widening – have been met. Practical, workable solutions were developed to meet the needs of the client, the owner and the travelling public.

Bruce E. Peterson, P.E. is a Senior Associate of Modjeski and Masters, Inc.

Modjeski and Masters, the engineer-of-record for the design, has enjoyed a long history with this combination highway and railroad bridge. They were the bridge design firm chosen for the structure's original design and engineering in 1924, and have since its opening performed yearly bridge inspections for its owner, the New Orleans Public Belt Railroad.

John James Audubon Bridge

By Don Bergman

With a main span of 482 m (1,580 ft.), the John James Audubon Bridge crossing the Mississippi River in south-central Louisiana, is the longest cable-stayed bridge in the United States and Canada. The structure is named after naturalist John James Audubon, who once lived near the bridge site. In recognition of Audubon's legacy, harmony with nature was a guiding principle in the development of the bridge concepts and details.

> "In recognition of Audubon's legacy, harmony with nature was a guiding principle in the development of the bridge concepts and details."

Built to replace an aging and antiquated ferry service, the Audubon Bridge Project consists of 19.3 km (12 miles) of roadway and structure that tie US 61 and Louisiana Route 10. The centerpiece is the 971 m (3,185 ft.) long cable-stayed Main Bridge, which comprises five spans, symmetrically arranged about the navigation channel. The central span is flanked on each side by 189 m (620 ft.) side spans, supported by the stay cables, and 49 m (160 ft.) transition spans. It was the first major design-build project undertaken by the Louisiana Department of Transportation and Development (LADOTD).

The entire project was a joint venture of Flatiron Constructors, Granite Construction Corporation, and Parsons, working under the name of Audubon Bridge Constructors (ABC). Buckland & Taylor Ltd.'s (B&T) scope of work include the detailed design and erection engineering for the cable-stayed Main Bridge.

The Objectives

To achieve the aesthetic objectives of the project, design guidelines with a theme of harmony with nature were developed at the beginning of the project. Objectives were set to approach the project in a similar fashion to the way the project's namesake, John James Audubon, approached aesthetics in his paintings. The structure was to incorporate the use of visual continuity through the use of a palette of common design elements; use horizontal and vertical line features to correspond and contrast with the landscape; and colour of features were to harmonize with the natural setting. The organic reddish color and lines of the weathering steel girders, the burnt umber color of the cables and the lines and soft-white coating of the towers all beautifully support the aesthetic objectives and colour scheme. The result is a striking and harmonious addition to the skyline of the region. The Bridge fits in with it's environment. The aesthetic theme draws on the works of art that it's namesake once produced and reflects the natural beauty of the site on which it is built.

The beauty of this bridge was not only skin deep. Many features were incorporated in the design and construction of the Audubon Bridge in order to enhance the durability of the structure and address the 100 year design life. The features served to improve long term performance, enhance inspectability, minimize maintenance costs and minimize service interruptions. Anchorage of the cable-stays in the two 152.4 m (500 ft.) tall towers provides access for stressing and facilitates the future replacement of the cable-stays, if necessary. The strands are galvanized and individually sheathed with polyethylene.

"The beauty of this bridge was not only skin deep. Many features were incorporated in the design and construction... in order to enhance the durability of the structure and address the 100 year design life"

Significant attention was given to the development of a highly constructible Main Bridge solution. The design was considered compete not when there was nothing left to add, but rather when there was nothing left to take away. The resulting Main Bridge design was a significant factor in the delivery of the lowest cost-adjusted design-build proposal.

The Bridge was also Louisiana's first use of the design-build delivery method, allowing concurrent design and construction, resulting in 1 year saved compared to the traditional design-bid-build method. ABC introduced an ISO 9001-compliant program to ensure successful delivery of a high-quality design and final product. They also helped develop and implement the project's site-specific safety program, and regular safety audits.

The Construction

The foundation conditions for the bridge were extremely challenging. The variation in water level made the foundation design and construction particularly challenging. The difference between high and low water can be in the order of 50 feet. The bridge is founded on drilled shafts installed to a dense sand layer, approximately 61 m (200 ft.) below the river bed. A further increase in depth was not feasible, as the dense sand was underlain by a very thick layer of clay. End-bearing capacity was enhanced using an innovative technique of tip grouting. This process injects cementitious grout at the base of the drilled shaft, after the shaft has been poured, in order to compress the soils at the base of the shaft. This technique has the added benefit of increasing the side shear capacity of the shaft near the tip.

Once the 21 drilled shafts supporting each cable-stay tower were completed, a precast concrete cofferdam was lowered over the shafts in order to provide a form for the concrete pile cap. The cofferdam was then dewatered and the pile cap and pedestal were constructed within it. This giant "hole in the river" provided a dry environment to construct the tower pedestals for river levels up to 15.2 m (50 ft.).

The competed tower pedestals provided a dry base for the construction of the 152 m (500 ft.) tall reinforced concrete towers. Hollow box sections were constructed using jump forms. This allowed the rapid construction of the two legs of each tower at a rate of one 4 m lift every five days, on average. The upper and lower cross-beams were constructed on falsework supported on the tower legs after they were completed to the necessary elevation. The bridge superstructure is not supported on a cross-beam, but simple corbels that were constructed on the inside faces of the tower legs. Vertical and lateral bearings support the superstructure at two locations on each tower.

The form of the towers which utilizes an upper crossbeam was conceived to provide the necessary torsional stiffness to the bridge deck to ensure its aerodynamic stability in strong winds.

The flexible superstructure system is provided by two steel plate girder edge beams supported by the cable-stays. The cable-stay anchorages are spaced 14 m (46 ft.) apart, with floor beams connecting them at 4.6 m (15 ft.) intervals. The deck slab is composed of precast concrete panels that span between floor beams and are connected by cast-insitu concrete joints. The deck panels are high-strength concrete of 8000 psi, necessary to resist the compression forces induced by the inclined stay cables. The deck panels are post-tensioned in three regions of the CSU where the compressive forces are reduced: the middle of the central span and over each of the intermediate piers. Each stay cable is anchored in a sealed anchorage at both the superstructure and the tower. The stays are protected against vibration by friction dampers designed for each stay's length and stiffness. As a contingency, provisions for additional viscous

dampers have been made for the unexpected case that cable vibration is observed.

The stays were installed and stressed one strand at a time. Individual stay stressing allows for the use of a small light weight stressing system that can be easily manipulated inside the tower section. Since the superstructure system is relatively flexible, the stays were stressed to length to achieve the correct final bridge geometry and the stay forces were checked to against the expected construction stage forces.

The stay cables are anchored in structural steel anchor boxes cast inside the hollow tower section. These anchor boxes not only provide the vertical connection of the stay to the tower, but provide the tension tie that resists the opposing horizontal tension force between stays on the main-span and side-span sides. Net horizontal forces are transmitted to the tower through shear studs that are welded to the anchor boxes.

The superstructure is longitudinally connected to the west tower, using steel fixed links for a rigid connection. In order to balance the dynamic wind loads between towers, while not inducing large forces due to temperature variations, lockup devices were utilized to connect the superstructure and the east tower. The devices provide a reliable fixed connection under short-term or dynamic wind loading, spreading loads effectively to two foundations instead of one, while at the same time allowing the structure to "breathe" under slowly applied thermal movements, thereby avoiding the build-up of large internal thermal forces.

"We aimed to blend the bridge in with the environment and have it be a welcome, efficient and practical addition - not a distraction"

Detailed climatological and wind performance analysis and testing were also performed prior to the finalization of the structure design and an innovative analytical climatological study was conducted, whereby wind data from various sites was used to model the anticipated specific wind speeds, turbulence and direction at the project site.

The Environment

The project site was also constructed over and in sensitive wetland areas. As a result, care had to be taken during construction as the wetlands were home to many species of fish, wildlife and animals. For example, the area was habitat for the threatened Louisiana black bear. Incorporating this into final design, 10 bear crossings were constructed, exemplifying the spirit of conservation inspired by John James Audubon. In addition, fly ash was used in place of cement in the concrete, which resulted in a more durable product. This ash is a waste product from coal-fired power plants. The aim was to blend the bridge in with the environment and have it be a welcome, efficient and practical addition - not a distraction. I'd like to think the resulting bridge is a real enhancement to the region.

Don Bergman is a Vice-president of Buckland & Taylor Ltd. He has worked exclusively in bridge engineering since 1981. His experience includes design and construction engineering, seismic retrofit and Design/Build experience on a wide range of bridge forms. Much of his bridge experience has been in the design and construction of cable-stayed bridges.

IBC 2012 Bridge Awards Program

By Fred Graham, P.E.

Roebling Winner: "An Engineer's engineer …. be it by experience or observation … a researcher ... a code writer ... a developer of 3D software ... an educator..."

George S. Richardson Winner: "With six tracks spanning 12,000 feet and speeds up to 186 mph …. the world's first high speed rail bridge ... this bridge is in a class all by itself … nothing else can or needs be said …"

Gustav Lindenthal Winner: "A wonderful river setting … with elegantly shaped substructure with tastefully stained piers … a good neighbor to the adjacent Oakmont Country Club (home of multiple USGA Open Championships) …"

Eugene C. Figg, Jr. Winner: "The terrain, the setting, the harmony ... three beautiful triplets … and at 11,000 feet above sea level, there is nothing like this in Bolivia … in South America …. In the world…"

Arthur C. Hayden Winner: "This bridge is stunningly beautiful … two sides of a river … two curving halves … meeting at the center of the river to make a structural handshake … the symbolic uniting of two communities …"

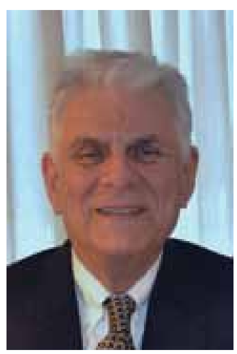
Abba G. Lichtenstein Winner: "From the oldest community in the US … & characterized by the National Trust for History Preservation as one of '11 Most Endangered History Sites' in the Nation ... the bridge with two Marble Medici Lions guarding the bridge ... was rehabilitated and transformed to an icon to the historic city through involvement of the community and engineering innovations …"

These are some of the many comments of the International Bridge Conference® Award's Committee as they viewed, voted and selected this year's winners.

The International Bridge Conference® in conjunction with Roads and Bridges Magazine, Bridge design and engineering Magazine and the Bayer Corporation, annually awards 5 five medals and one student award 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. The student award is named in honor of a former IBC General Chairman, a champion of the student award's program and a friend to the community at large. This year, IBC is pleased to add a sixth award category. The Award's committee has long recognized the need to recognize innovation in the restoration and rehabilitation of bridges of historic or engineering significance. With the sponsorship of TranSystems, IBC is please no recognize a sixth award category, recognizing the preservation of bridges, named after Dr. Abba. G. Lichtenstein

Interest in the IBC awards program is quite robust nationwide and internationally. This year the Awards Committee reviewed more than forty nominations for the various bridge metal categories alone, half of which were projects nominated beyond the borders of the United States. After lengthy deliberations, the following individuals and projects were deemed worthy of this year's awards.

John A. Roebling Medal



Dann H. Hall

The John A. Roebling Medal recognizes an individual for lifetime achievement in bridge engineering. We are pleased to recognize Mr. Dann H. Hall as the 2012 recipient. Mr. Dann H. Hall of Bridge Software Development International, Ltd. (BSDI, Ltd.) has faithfully served the steel-bridge industry for nearly 30 years, and the steel industry as a whole for nearly 50 years. A native of Potsdam, NY, Mr. Hall received his undergraduate degree from Clarkson University and moved from there to the Lehigh Valley in Pennsylvania where he was employed by Bethlehem Steel for nearly 20 years. In the early 1980s, Mr. Hall left Bethlehem Steel to develop an enabling technology for the bridge-design community based on what at the time was the embryonic personal computer. The primary product of these efforts was the development of the 3D System – a suite of software programs that allow the Engineer to interact with the computer to make sound economic decisions regarding a bridge superstructure design. BSDI software has been an industry leader for over two decades and has been employed successfully on well over 1,000 bridges worldwide. Mr. Hall has also been involved in some significant steel-bridge research projects over his career. He developed the unique concept of using a full-scale curved I-girder bridge as a test frame to successfully test curved component specimens as part of the FHWA Curved Steel Bridge Research Project, he was the primary author of the 2003 AASHTO Guide Specification for Horizontally Curved Steel Highway Bridges, and he has been a primary participant and a significant contributor to the development of two successful National Highway Institute (NHI) training courses entitled LRFD for Highway Bridge Superstructures and Analysis and Design of Skewed and Curved Steel Bridges with LRFD. Mr. Hall was also retained by AISI in the late 1980s to undertake the startup of the "Steel Bridge Forum", and a part of this effort, he oversaw the production of the video, "Building Bridges Through Teamwork".

George S. Richardson Medal

The George S. Richardson Medal, presented for a single, recent outstanding achievement in bridge engineering, is presented to recognize the Nanjing Dashengguan Yangtze River Bridge. This impressive 69 span structure spans the Yangtze River in Jiangsu Province, China with an overall span of 12,050 feet (3674 m) and conveys 6 rail lines including four high speed rail lines and two commuter trains. The main feature of the structure is the

Dashengguan Bridge

back to back 1,100 foot (336 m) main arch spans, which were constructed in cantilever fashion. The structure featured many technical and material innovations, the most significant of which include: use of orthotropic deck to support track ballast, hangers with tuned liquid mass dampers, novel expansion device and a unique balanced cantilever erection and truss closure scheme. A new material innovation for the bridge was the development of new steel alloy (Q420qE) for use in the arch ribs combining high strength, toughness and good weldability. The bridge now serves as a rapid transport link between the Circum-Bohai-Sea and Yangtze River delta economic regions, and plays an important role in promoting the economic development of the eastern regions and the central and western regions of China. It is considered one of the remarkable achievements in the history of China's railway bridge construction.

Gustav Lindenthal Medal

The Gustav Lindentahl Medal, awarded for an outstanding structure that is also aesthetically and environmental pleasing, will be presented to recognize the I-76 Allegheny River

I-76 Allegheny River Bridge

Bridge at Oakmont Pennsylvania. The bridge which conveys the Pennsylvania Turnpike, over the Allegheny River, north of Pittsburgh, PA is environmentally friendly with considerations which include a carefully planned bridge layout to keep piers out of the river, construction working from the top down, and context sensitive solutions for a small footprint. With a main span length of 532', the new bridge sets a record for the longest concrete segmental span in the Commonwealth. The piers, up to 100-feet tall, were stained to match the color of the Oakmont Country Club area (home of the US Open). Constructability, repetition, and reuse of formwork were considered during design to deliver an elegant pier shape that could be built economically. A stone texture with earth-toned stain enhances the slender, curved pier shape and blends the piers with surroundings.

Eugene C. Figg, Jr. Medal

The Eugene C. Figg, Jr. Medal for Signature Bridges, recognizing a single recent outstanding achievement for bridge engineering, which is considered an icon to the community for which it is designed, will be presented to recognize the Triplet Bridges in La Paz, Bolivia, a city, located at more than 11,800 ft above the sea level, which has a very complex and steep topography, dominated by numerous ravines of the Choqueyapu River. The Municipality of La Paz has embarked on the construction of a ring new road connecting the eastern and western slopes in the city centre. The communities were connected by

The Triplet Bridges

the construction of three bridges which have similar structural configuration but with slightly different dimensions. The three bridges, with overall lengths of 766 ft (Kantutany), 628ft (Choqueyapu) and 718 ft (Orkojahuira), are extradosed, each with a three-span deck and single central plane of stays. The choice of using extradosed deck allows a modern design, integrated in its environment and technically advanced that gives the bridge a strong personality and at the same time introducing a new and modern structural form in Latin America.

Arthur C. Hayden Medal

The Arthur C. Hayden Medal, recognizing a single recent outstanding achievement in bridge engineering demonstrating vision and innovation in special use bridges, will be presented to recognize the Peace Bridge in Derry-Londonderry, Northern Ireland. The Peace Bridge was conceived as a landmark structure across the River Foyle in Derry~Londonderry linking Ebrington on the east bank to the City Centre on the west bank. The bridge is named for its significance in connecting two historically divided communities and is the centerpiece of a wider regeneration plan, which was conceived to provide an aesthetically pleasing physical expression of the unification of

The Peace Bridge

the city. The bridge is a self-anchored suspension bridge dedicated for the exclusive use of pedestrians and cyclists. The serpentine plan form of the deck is symbolic. The bridge deck is divided into two curved halves, each supported by the suspension system from a single inclined steel pylon. At the centre of the river, the structural systems overlap to form a "structural handshake".

Abba G. Lichtenstein Medal

The Abba G. Lichtenstein Medal, recognizes a recent outstanding achievement in bridge engineering demonstrating artistic merit and innovation in the restoration and rehabilitation of bridges of historic or engineering significance. The Abba G. Lichtenstein Medal celebrates a new category of awards for IBC, specifically devoted to the preservation of our bridge treasures, nationally and internationally. This award will be recognized annually for 2013 and beyond. The 2012 award is presented to recognize the Bridge of Lions Rehabilitation in St. Augustine, Florida. The historic Bridge of Lions has long been one of the most iconic structures in St. Augustine, the Nation's Oldest City. Originally built in 1927 and listed in the National

The Bridge of Lions Rehabilitation

Register of Historic Places, the bridge serves as a critical link between Anastasia Island and St. Augustine's historic downtown area. The striking Mediterranean-Revival style architecture of the bridge is reminiscent of many of the city's oldest buildings. With its iconic arched girders and elephantine bascule towers, the bridge stands majestically over the Matanzas River and is prominent in nearly every skyline image of the city. The goal of the rehabilitation was to preserve as many of the original bridge elements as possible. To preserve the original fascia arched girders and bascule piers and towers, the most iconic of the bridge elements, a new interior steel framework was constructed inside the existing structure and new foundation system was constructed underneath the existing foundations. These "hidden" innovative applications shifted the load from the original girders and strengthened the existing piers, thus allowing these original elements to remain in the rehabilitated bridge.

James D. Cooper Student Award

Zachary B. Haber,

The James D. Cooper Student Award recognizes undergraduate and graduate students who demonstrate an interest and passion for bridge engineering. The award is presented to winners of a student completion for technical writing and engineering insight. The 2012 ward will be presented to Mr. Zachary B. Haber, a PhD Student at the Department of Civil & Environmental Engineering, University of Nevada, Reno, Reno, Nevada for his paper entitled: "Seismic Performance of Emulative Precast Column Elements with Grouted Coupler Connections". The paper is based on Mr. Haber's testing of three half-scale bridge column models to investigate the performance of precast column-to-footing connections for accelerated bridge construction (ABC) in areas of high seismicity. The three models included a benchmark column with conventional cast-in-place (CIP) details and two other precast concrete column models each incorporating emulative grouted coupler connections in the plastic hinge region. The latter two models employed different connection configurations including (1) a precast column connection made directly to the footing and (2) a column connection made to a precast partial pedestal that was used to reduce moment demand on the connection region in order to shift the coupler location away from the footing. The three models were subjected to slow cyclic loading at increasing levels of drift. Results indicate that the precast connections tested are emulative of cast-in-place construction with regards to damage levels, hysteretic behavior, and energy dissipation but had slightly reduced drift capacity.

The IBC Awards Committee includes Carl Angeloff, Lisle Williams, Jim Dwyer, Herb Mandel, Richard Connors, Gary Runco, Myint Lwin, Rachael Stiffler, Ken Wright, George Horas, Helena Russell, Bill Wilson, Fred Graham and Tom Leech.
The IBC Student Paper Awards Committee includes Dr. John Aidoo, Rose-Hulman Institute of Technology, Dr. Dennis Mertz, University of Delaware, Dr. James Garrett, Carnegie Mellon University, and Dr. Kent Harries (Committee Chairman), University of Pittsburgh.

Fred Graham, P.E. (retired) was named Emeritus Member of International Bridge Conference Executive Committee in 2010 and for many years has faithfully served on the IBC Awards Committee. Fred has been an ardent supporter of our newest award category, named in honor of Dr. Abba G. Lichtenstein. Prior to his retirement, Fred dedicated a significant portion of his engineering career to the restoration and rehabilitation of many local major bridges. – Editor

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