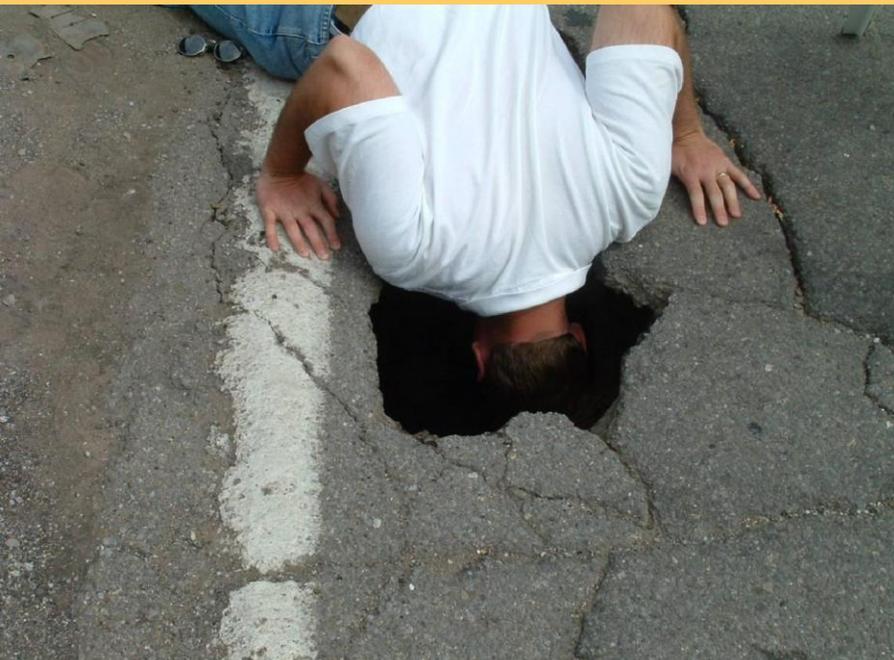




# The Effects of Our Decaying Infrastructure On National Security and Culture

**Roberto Ballarini**  
James L. Record Professor  
Department of Civil Engineering  
University of Minnesota



**APWA Fall Conference**

**2013**

## **Disclaimer:**

**What follows is the perspective of an educator who is also a concerned, proud and ultimately optimistic citizen of a great country.**

## **That said:**

***“Human history becomes more and more a race between education and catastrophe.”***

***H.G. Wells***

# Outline

**What the Nation's infrastructure represents.**

**What it was, what it is, what will it be?**

**What do we do about the existing infrastructure,  
and what do we do about replacing it?**

**We need to take care of a very sick and old patient  
whose parts were not taken care of.**

**We also need to replace the patient.**

**There are solutions; they involve the  
commitment of lots of money for construction/repair,  
education, research, etc., and most importantly, will.**



**National Security; Roman Aqueduct in Pont du Gard, France**  
*The Romans understood the roles of roads, water distribution, etc., in maintaining their empire.*



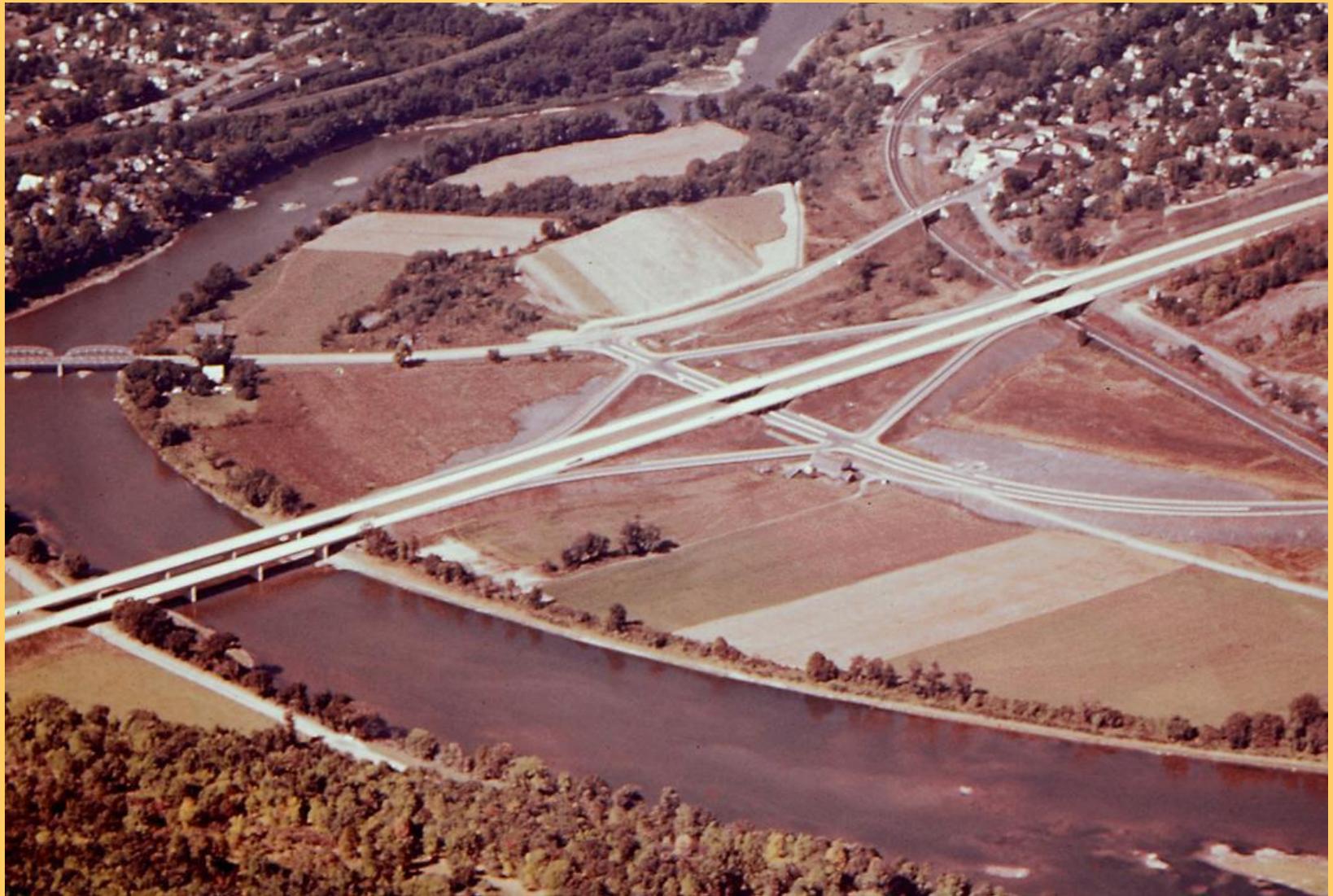
**National pride; Petronas Towers, Kuala Lumpur, Malaysia**



**Our infrastructure was a statement of our vision,  
wealth, capabilities and pride.**







**Interstate system; I-81 Great Bend, PA (1960)**

**We had the most impressive infrastructure, especially  
given our size:**

**Example; Interstate Highways System**

**Carries 20% of traffic but only covers 1% of US land  
Credited with saving ~190,000 lives and preventing ~12 million  
injuries**

**Estimated to have saved \$6 for every \$1 spent on its construction**

**Created good jobs, technical expertise, the economy, ...**



**Infrastructure includes cultural projects!**



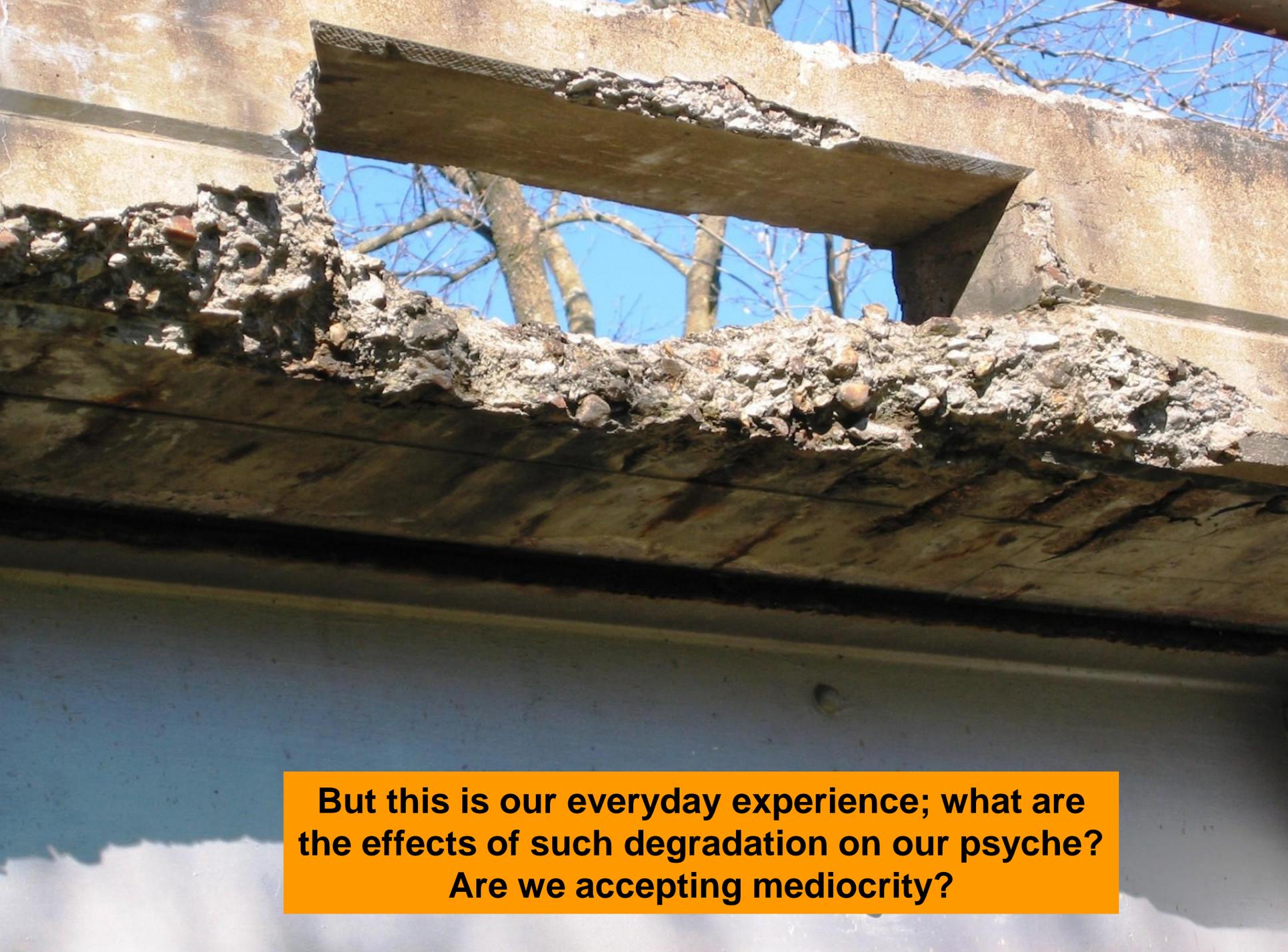
**and Education: Morrill Grant Land College Act of 1862**



# Investment in Infrastructure

- **1950s and 1960s ~4% of GDP**
- **1982 to 2013**
  - **U.S. population – 226 to 314 million**
  - **U.S. GDP - \$3 to \$14 trillion**
  - **current infrastructure investment < 2% of GDP**

**China today ~ 9% of GDP**



**But this is our everyday experience; what are the effects of such degradation on our psyche?  
Are we accepting mediocrity?**





**Rockefeller Road Bridge, Cleveland, Ohio**

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# Sinkhole swallows up SUV in New York street

## Shocked driver escapes serious injury; vehicle rested on gas main



WNBC-TV

**Water main break;  
SUV sitting on gas main.**

The SUV rests in the Brooklyn street sinkhole.

**AP** Associated Press

Updated: 11:32 a.m. CT March 27, 2006

NEW YORK - A city street collapsed under a sport utility vehicle early Monday, leaving the vehicle nose down into a deep sinkhole that officials said was caused by a water main break.

The driver of the SUV escaped without serious injuries but was taken to a hospital for treatment of shock, said Fire Department spokesman Brian Conlon.

### Stand and be counted



[get involved.](#)

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# Aging N.Y. pipes raise concerns of more blasts

## Steam pipes rarely inspected; air tests ease health worries in Manhattan



Timothy A. Clary / AFP - Getty Images

A destroyed tow truck sits in a hole Thursday at the site of an underground steam pipe explosion in New York. The Wednesday explosion tore a crater in Lexington Avenue near Grand Central Terminal, sending residents running for cover amid a towering geyser of steam.

**83 years old steam pipe,  
and part of a system put  
into service in 1882!!!**



NBC video



Launch

N.Y. worries

July 19: The explosion of a weathered steam pipe has more than just New Yorkers pondering the repercussions of an aging infrastructure. NBC's Ron Allen reports.

Nightly News

o: NYC steam explosion



Courtesy of Dennis Martenson

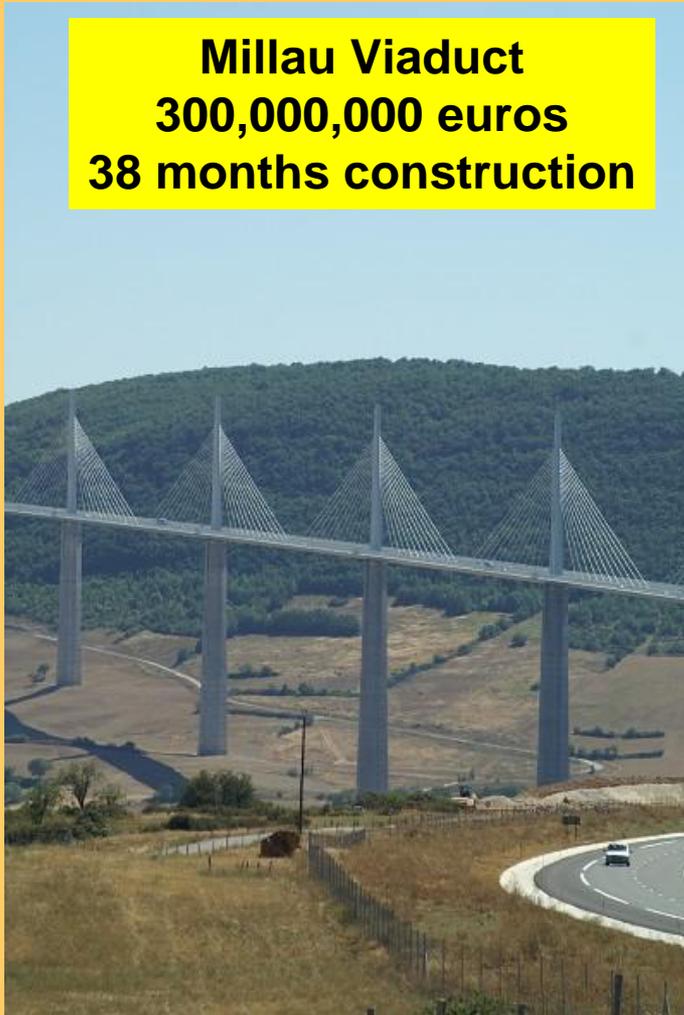
MAR 19 2004

# ASCE Report Card

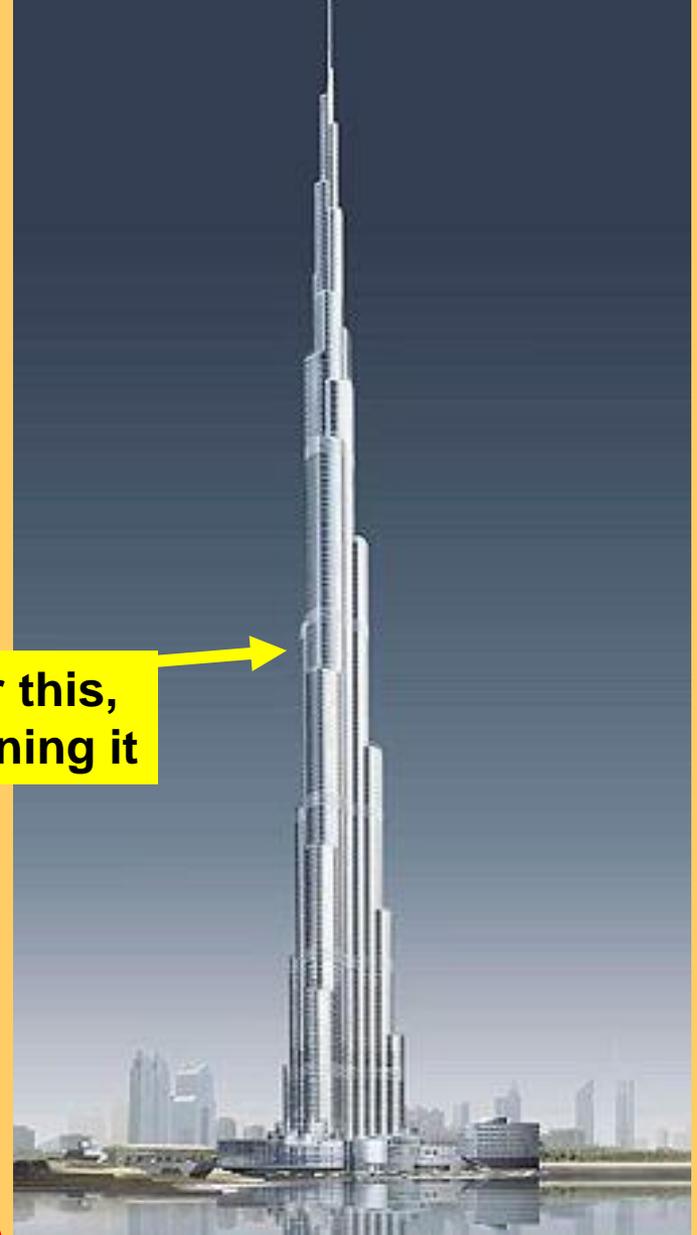
Category	1988*	1998	2001	2005	2009	2013
Aviation	B-	C-	D	D+	D	D
Bridges	-	C-	C	C	C	C+
Dams	-	D	D	D+	D	D
Drinking Water	B-	D	D	D-	D-	D
Energy	-	-	D+	D	D+	D+
Hazardous Waste	D	D-	D+	D	D	D
Inland Waterways	B-	-	D+	D-	D-	D-
Levees	-	-	-	-	D-	D-
Public Parks and Recreation	-	-	-	C-	C-	C-
Rail	-	-	-	C-	C-	C+
Roads	C+	D-	D+	D	D-	D
Schools	D	F	D-	D	D	D
Solid Waste	C-	C-	C+	C+	C+	B-
Transit	C-	C-	C-	D+	D	D
Wastewater	C	D+	D	D-	D-	D
Ports	-	-	-	-	-	C
America's Infrastructure GPA	C	D	D+	D	D	D+
Cost to Improve	-	-	\$1.3 trillion	\$1.6 trillion	\$2.2 trillion	\$3.6 trillion

**Other nations understand the value of infrastructure.**

**Millau Viaduct  
300,000,000 euros  
38 months construction**



**We payed for this,  
and are designing it**

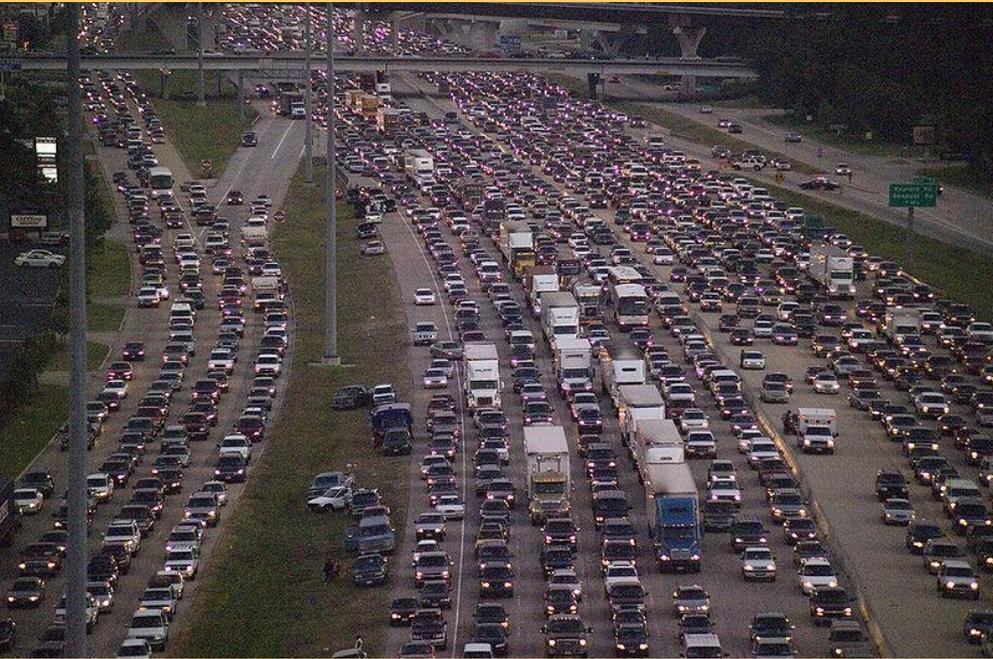


**Burj Dubai  
Completion 2008  
Skidmore, Owings and Merrill**

# Beijing-Shanghai High-Speed Line, China

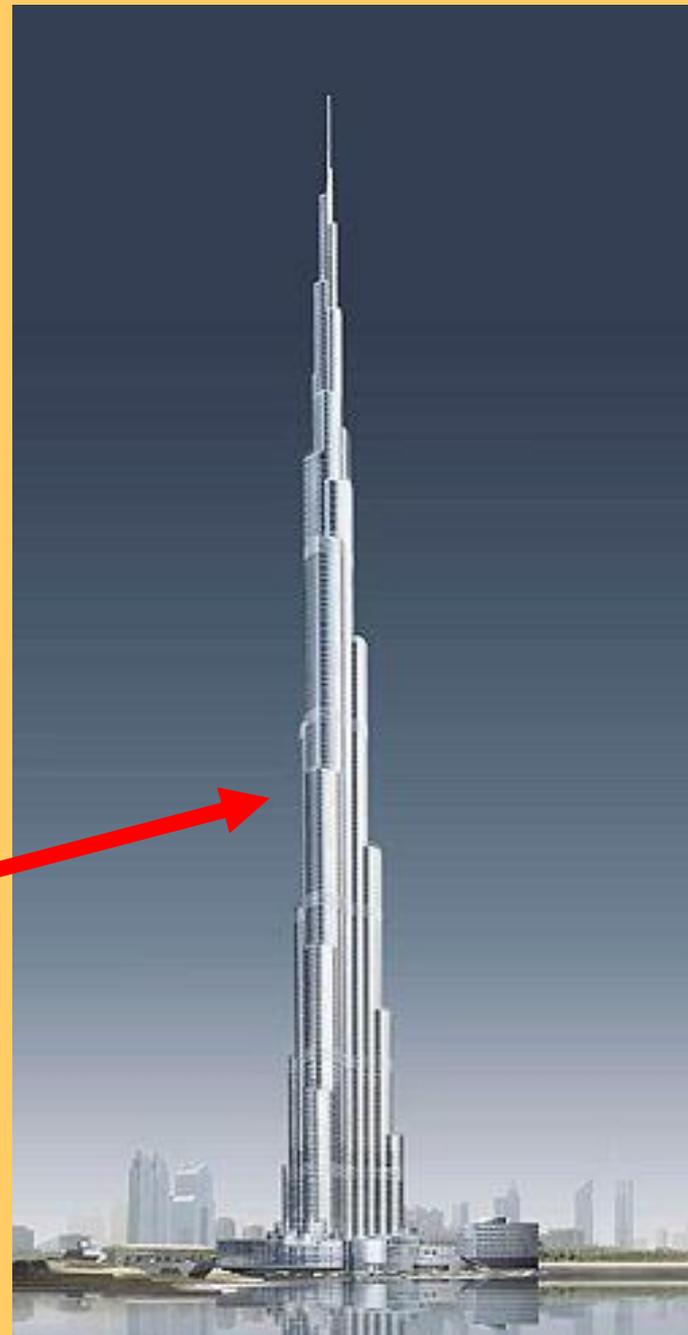
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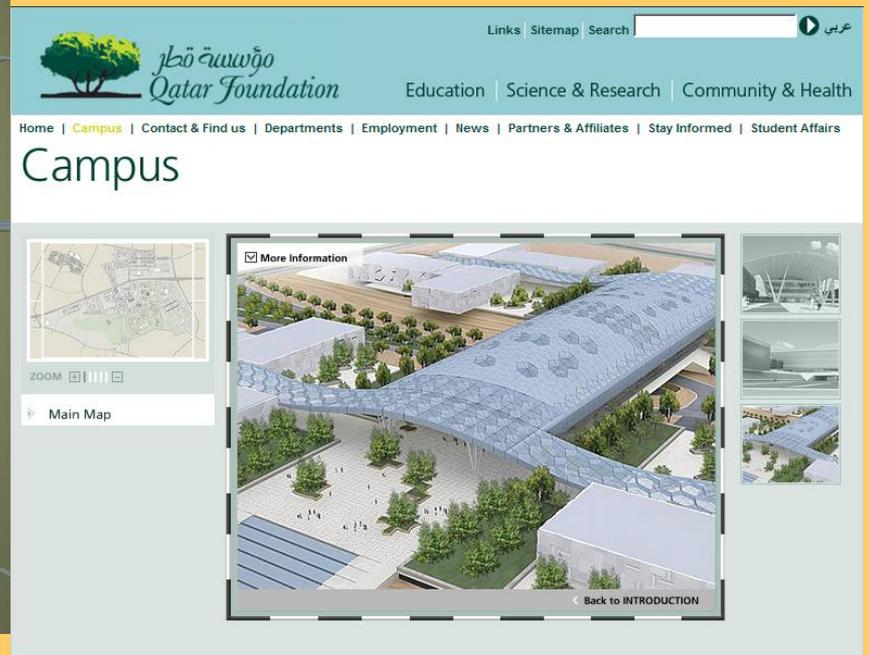
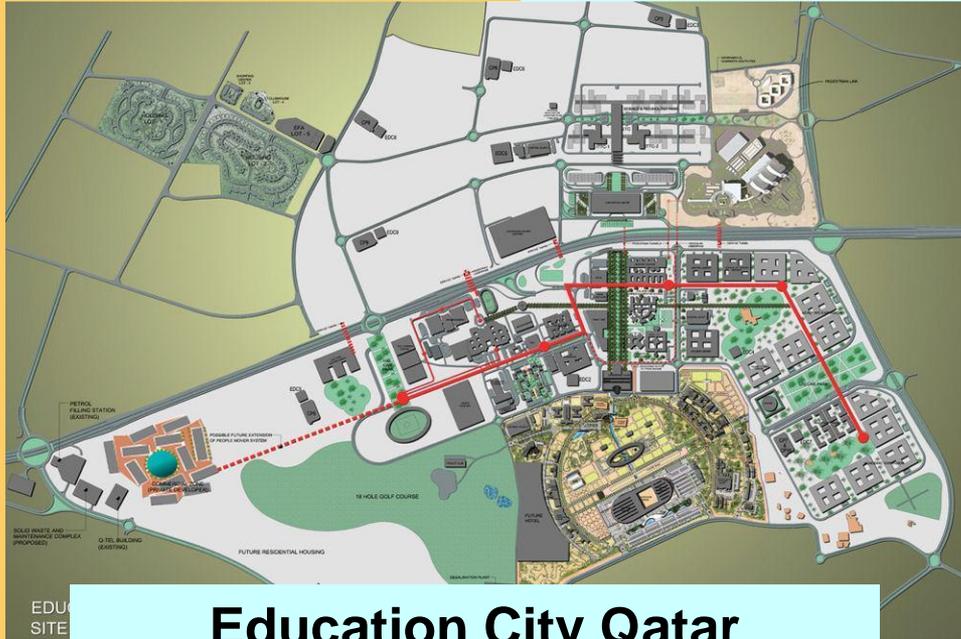


**Double Whammy:**

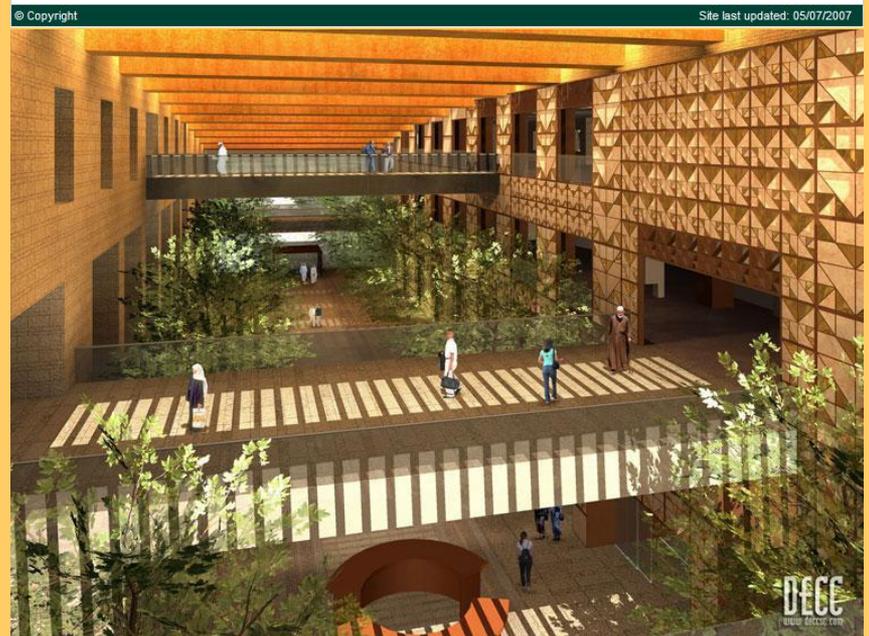
**Congestion caused by  
Evacuees of Hurrigan Rita**



# It's not just about buildings



**Education City Qatar**  
**Carnegie Mellon, Cornell, Texas A&M,**  
**Northwestern**



**The job ahead of us**  
**We need to concurrently maintain and rebuild**

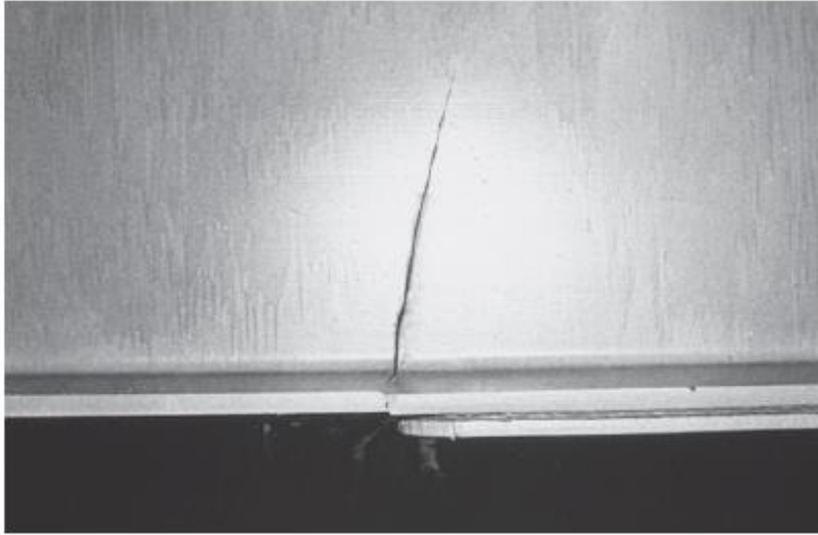


FIGURE 2 Development of fatigue crack at cover plate ends on the multibeam Yellow Mill Pond Bridge in Connecticut in 1976. (Courtesy: John W. Fisher.)

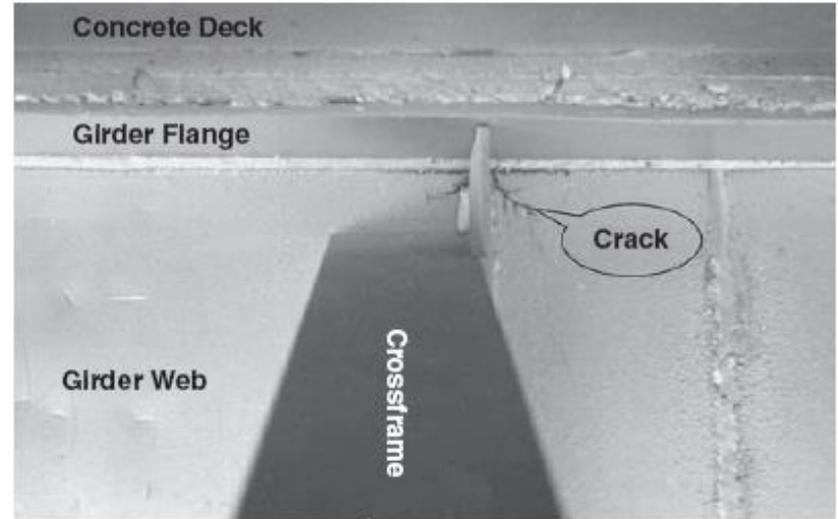


FIGURE 3 Typical web-gap fatigue cracking.

## Cracking can lead to noncatastrophic Damage.



FIGURE 16 View of cracked girder in two-girder span of Lafayette Street Bridge in St. Paul, Minnesota, as an example of a bridge that is sufficiently redundant to avoid collapse despite a fracture of the tension flange and the web of one girder.



FIGURE 9 Example of bridge deck acting as catenary with hinge at fracture location in end span of the approach spans of the Hoan Bridge in Wisconsin—two of the three girders had full-depth fractures in December 2000.

# Effective retrofitting procedures are available; they cost money.

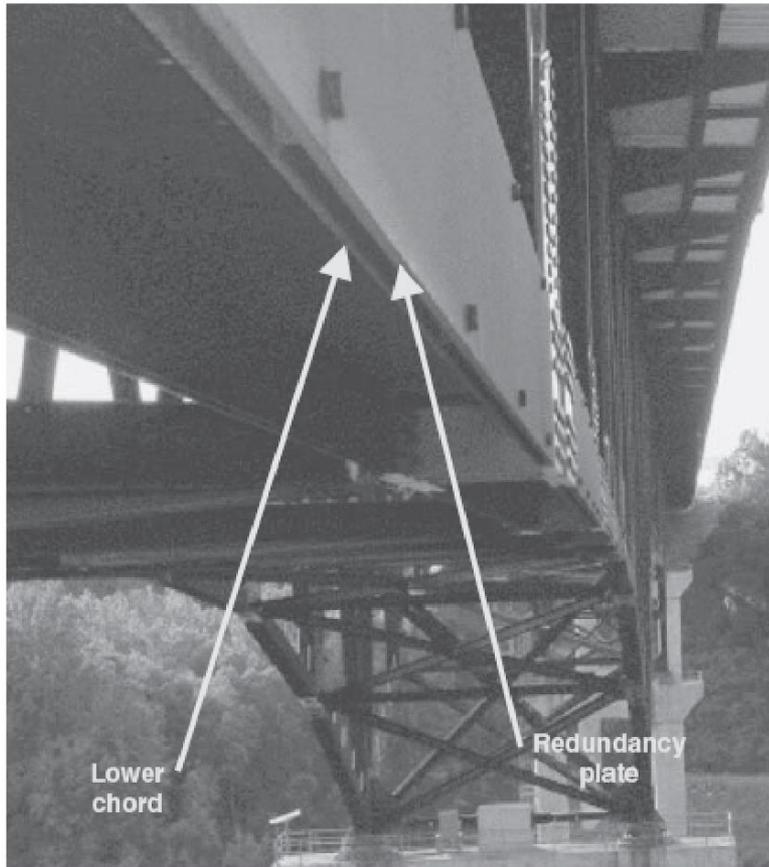


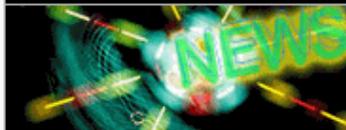
FIGURE 13 Redundancy plate bolted to lower chord of SR-33 bridge near Easton, Pennsylvania. (Courtesy: HNTB.)



FIGURE A10 Bolted doubler plate repair. Dotted line represents crack line beneath doubler plate and circle is the hole drilled at crack tip to intercept further growth.



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## All Images

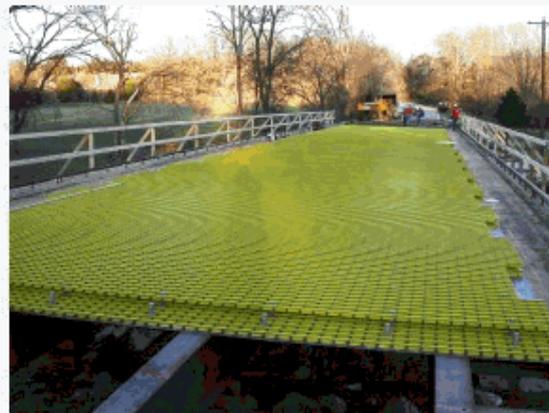
# Effective repair is available

Press Release 06-040

## Easy Up, Not-So-Easy Down

Builders replace bridge in only days using lightweight, corrosion-resistant composites

[Back to article](#) | [Note about images](#)



Fiberglass-polymer composites form the core of a renovated bridge deck in Springfield, Mo. University of Missouri at Rolla researchers at NSF's Buildings and Bridges with Composites Industry-University Cooperative Research Center (RB2C I/UCRC) worked with their industry partners and colleagues at the University of Wisconsin at Madison to develop the pre-fabricated, composite plates and cages.

Credit: *Fabio Matta, UMR*

[Download](#) the high-resolution JPG version of the image. (604 KB)

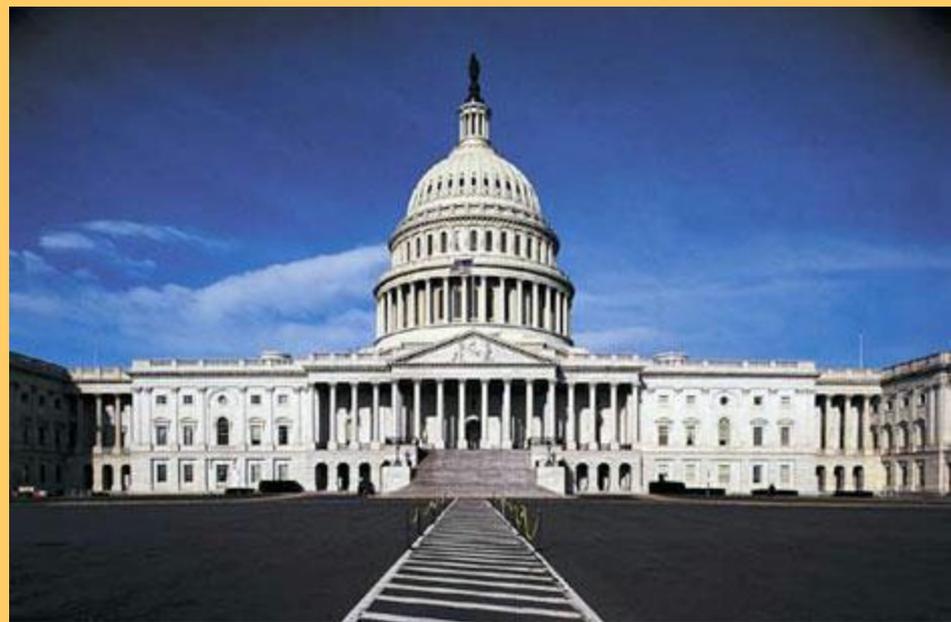
Use your mouse to right-click (or Ctrl-click on a Mac) the link above and choose the option that will save the file or target to your computer.



## Solutions



It comes down to priorities and long-term planning



**Let's put the right people into these positions**

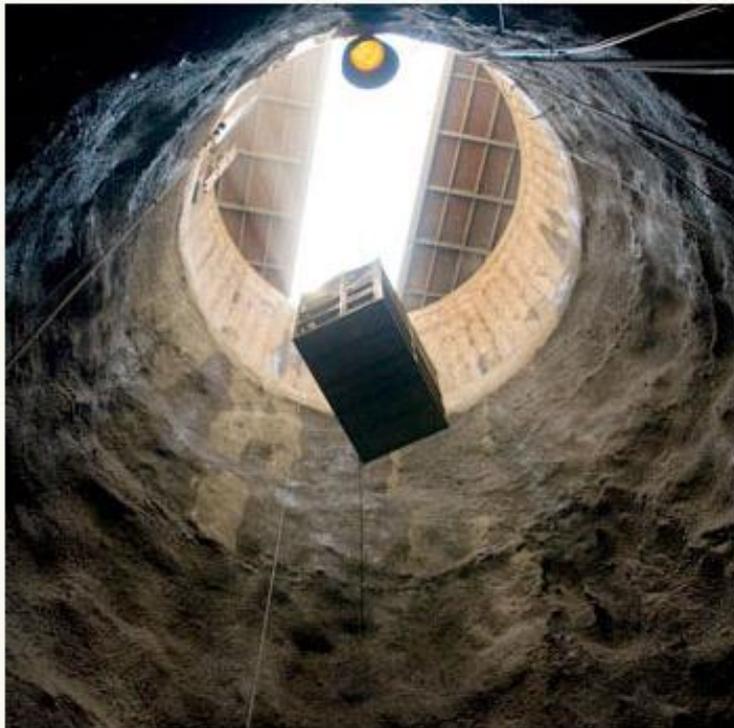
An illuminating look at the vast mega-projects that will bring New York City's underground infrastructure into the 21st Century and beyond.

NEW YORK TRANSIT MUSEUM



The New York Public Library

## The Future Beneath Us



The New York Transit Museum and the New York Public Library's Science, Industry and Business Library present a historic exhibit illuminating the vast underground mega-projects that will bring New York City's underground infrastructure into the 21st Century and beyond.

The exhibition, titled *The Future Beneath Us: 8 Great Projects Under New York*, will be shown in two locations in Midtown Manhattan: the New York Transit Museum Gallery Annex and Store at Grand Central Terminal and the Science, Industry and Business Library's striking Cullman Rotunda and Healy Hall on 34th Street and Madison. The exhibit runs from February 2009 through July 5, 2009.

[The Projects ...](#)

## City Water Tunnel No. 3

It is the largest and longest running capital project in New York City's history and among the largest engineering projects in the world. When it is finished and all the construction shafts have been closed up, it will have completely disappeared from view, up to 800 feet below ground. The only evidence of its existence will be the assurance that when you and many subsequent generations need to bathe, cook, or fight a fire there will be plenty of water to do so. Its name may be prosaic—City Water Tunnel No. 3—but its function is essential to the life of New York.

[Learn more ...](#)



# Raising the Grades Case Study

## Woodrow Wilson Bridge, Northern VA/MD



- **2008 ASCE Outstanding Achievement Award**
- **\$2.4 billion project solved one of the worst bottlenecks on the East Coast.**
- **Replaced a functionally obsolete bridge designed for 75,000 daily trips that was experiencing 200,000 trips and in turn higher accident rates and decreased air quality**
- **New drawbridges are 20 ft higher than the original, thus reducing from 260 to 65 the number of openings per year.**

# Raising the Grades Case Study

## Orange County, California Groundwater Replenishment System



- \$480M first phase and \$160M second phase
- Takes highly treated sewer water and purifies it to drinking standards
- 35-75% cheaper than seawater desalination and one half the energy