# Construction of the Eads Bridge

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*“Science can do anything, however tremendous, if it has enough money."*

- James B. Eads

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# Purpose

To provide the class with an overview of the Eads Bridge to include its history, design, and construction.

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# Outline

- Bridge Information
- Engineering Innovations
- James B. Eads
- The Problem
- The Solution
- Bridge Design
- Bridge Supports
- Building the Piers
- Caissons
- Superstructure
- Problems with Iron and Steel
- Erecting the Superstructure
- Completion and Opening
- History of Use

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# Bridge Information

- Engineered and constructed by James B. Eads
- Built from 1867 to 1874 at a cost of $6 million ($12 million including land, tunnels, debt, and approaches)
- Oldest standing bridge across the Mississippi and one of the first
- Spans: 502, 520, and 502 feet
- Materials:
    - Steel: 2,390 tons
    - Wrought Iron: 3,156 tons
    - Timber Decking: 806 tons
    - Stone Masonry (limestone): 97,571 cubic yards

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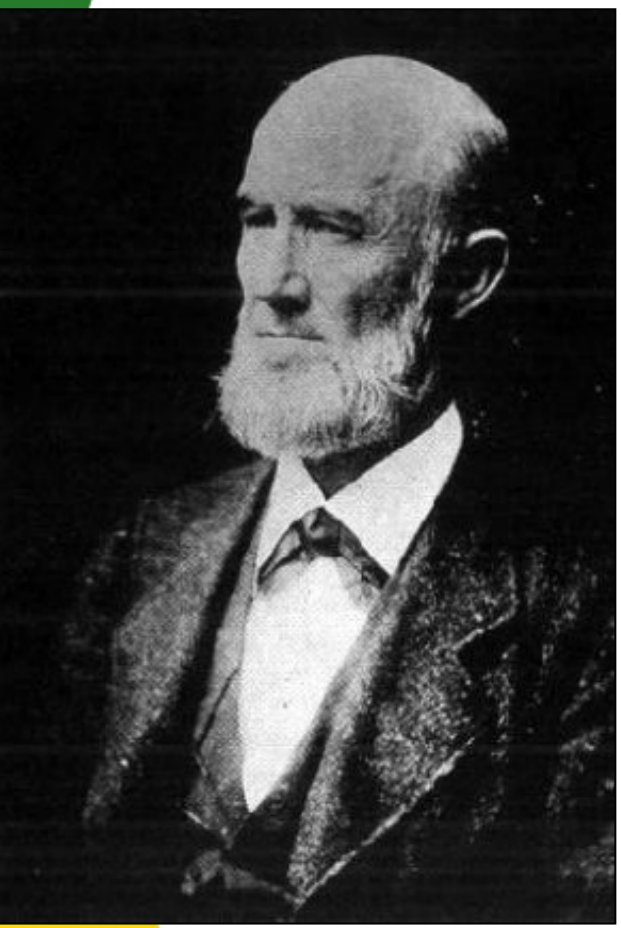
# Engineering Innovations

- Largest bridge constructed at the time
- First major use of structural steel
- Use of cantilever support for superstructure
- First significant underwater use of compressed air in the United States
- Largest and deepest caissons used to date
- A variety of new mechanical inventions including the sand pump

# James B. Eads



- Born on 23 May 1820 in Indiana
- Family moved to St. Louis in 1833
- In 1844, Eads began his own Mississippi River salvage business
- He taught himself engineering and designed his own salvage ships and diving bell
- Built ironclads for the Union during the Civil War
- Suffered from ill health, probably from his diving excursions, and took convalescent trips to Europe
- Engineered jetties for the Mississippi River Delta
- Proposed a huge ship-railway system across the Isthmus of Tehauntepec, Mexico
- Married twice with one daughter and three stepdaughters
- Died 08 March 1889 in the Bahamas

# The Problem (1 of 2)

Saint Louis - 1859

- Railroads began to overtake rivers and canals as the preferred transportation of commerce
- Rapid expansion of Illinois and Chicago railroad lines

# The Problem (2 of 2)

- Chicago railroads bridged the Mississippi at Rock Island with plans to bridge at Dubuque, Burlington, and Quincy
- Chicago rail moved deep into Saint Louis' Trade Region
- Chicago's population soared while Saint Louis' stalemated


1870 Railroad Map

# The Solution (1 of 2)

- By 1866, civic and financial leaders of Saint Louis demanded a bridge to connect the five eastern and three western railroads near the city
- The St. Louis and Illinois Bridge Company secured state and federal authorization to bridge the river
- Early designs included:
  - A suspension-arch from John Roebling
  - A tunnel from the Mississippi Submerged Tubular Bridge Company
  - A lattice-girder truss with six piers from the Illinois and St. Louis Bridge Company
- The Illinois and St. Louis Bridge Company, led by Chicago capitalist Lucius Boomer, received the exclusive rights to build from Illinois side

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# The Solution (2 of 2)

- Railroad financiers did not share the city's enthusiasm because many were from Chicago
- Steamboat men objected because it would cut into their commerce and add an obstruction to the river
- Political opponents passed a Congressional Bill in 1865 which would require the bridge to have 500 ft spans and have a clearance of 50 ft above the City Directrix, the local survey base line
- James B. Eads originally was not interested, but did not want the bridge's control to fall into Chicago's hands
- Eads teamed up with the St. Louis and Illinois Bridge Company
- Eads began circulating designs and became the company's director by May 1867

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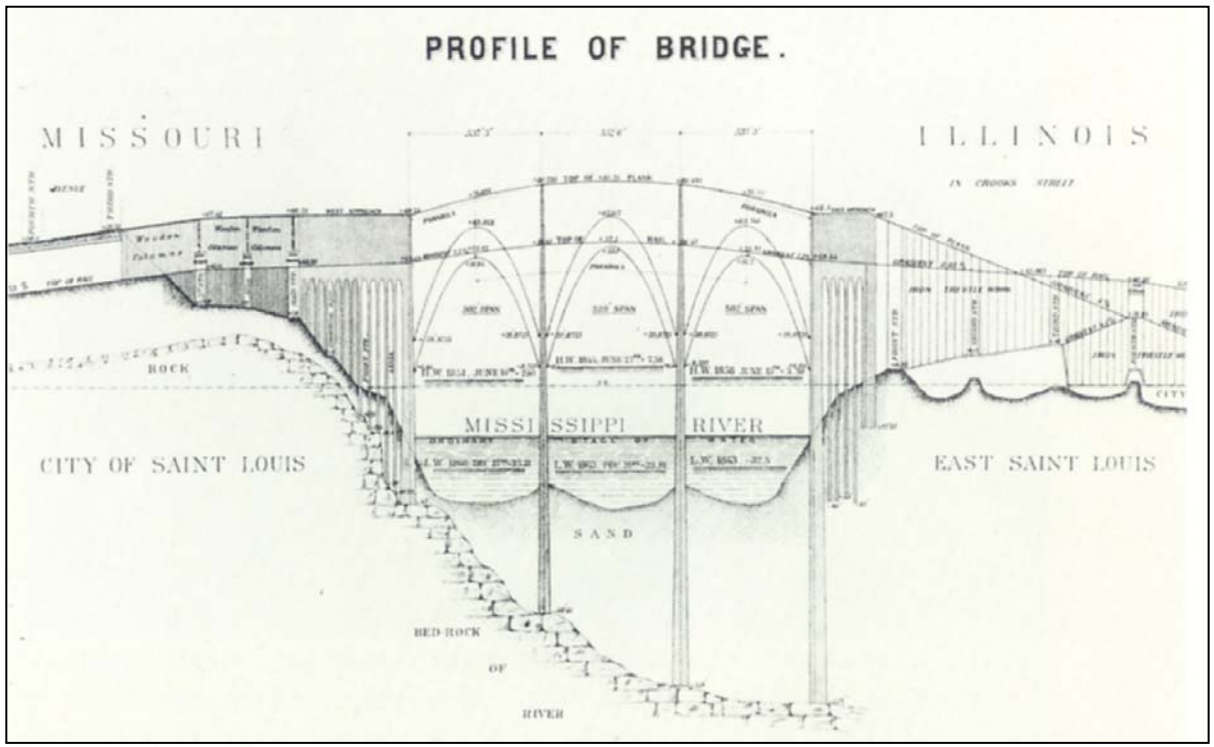
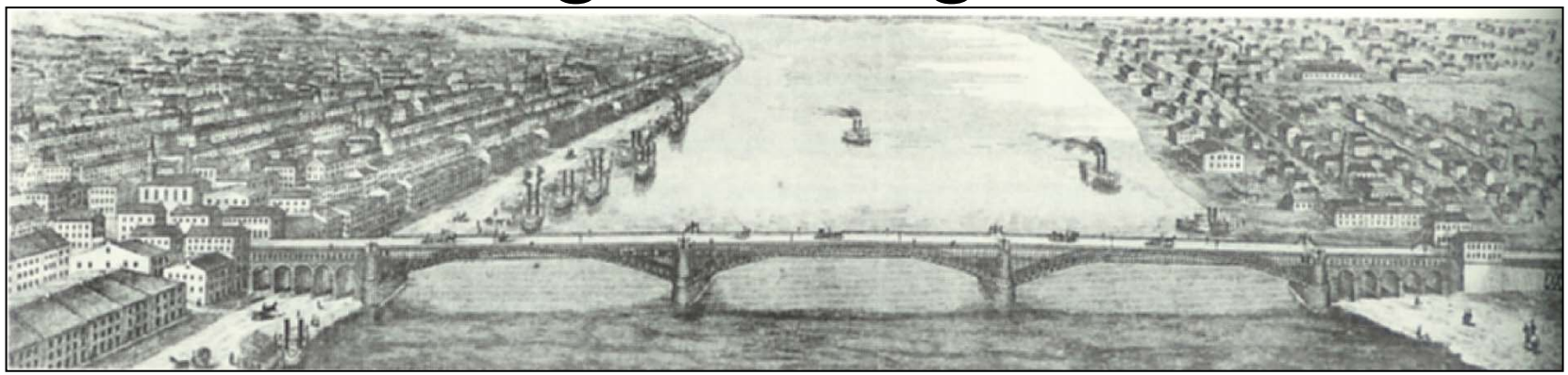
# Bridge Design (1 of 2)

Eads was inspired by the Koblenz Bridge in Germany

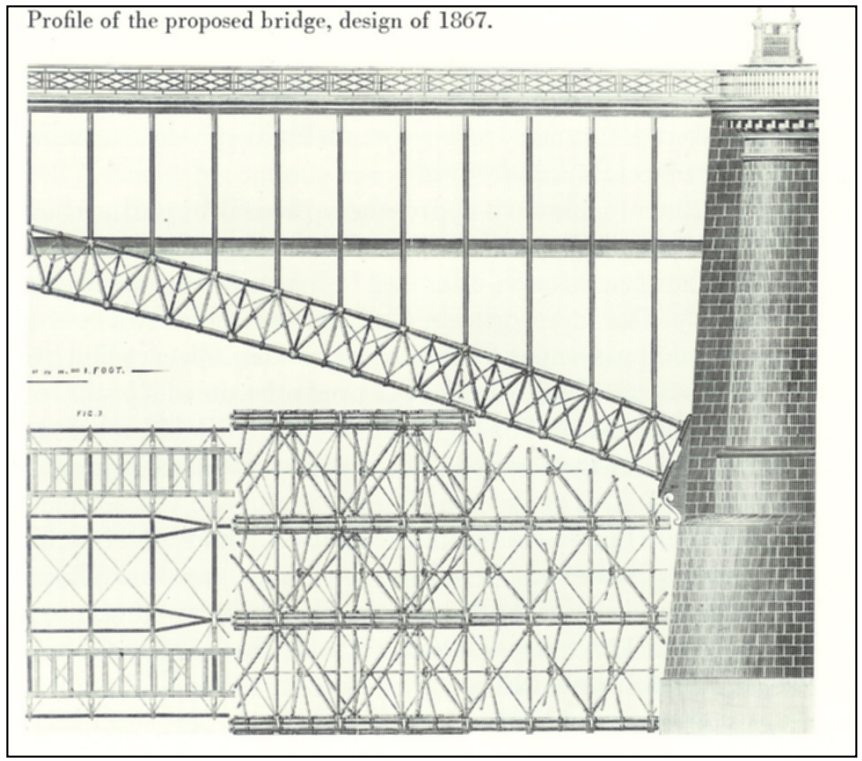
- Eads design called for 3 steel arches supported by masonry abutments and piers
- Supports extend to bedrock for stability



# Bridge Design (2 of 2)

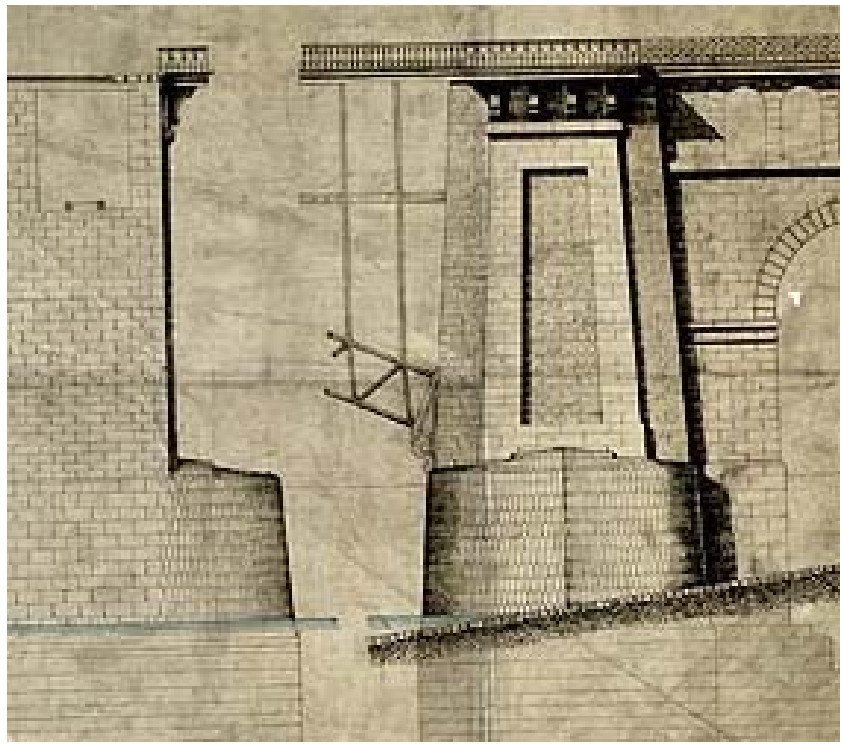


Original design placed rail deck below the arches and included architectural accents.

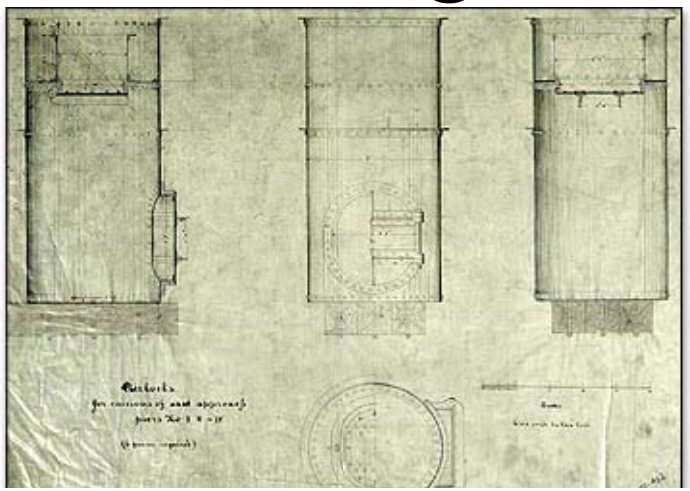


# Bridge Supports (1 of 2)

- Constructed of  limestone masonry
- The original plan called for the use of coffer dams to place all the supports
- Coffer dam for west abutment started in August 1867; cornerstone laid on 25 February 1868
- Masonry from bedrock: 113ft

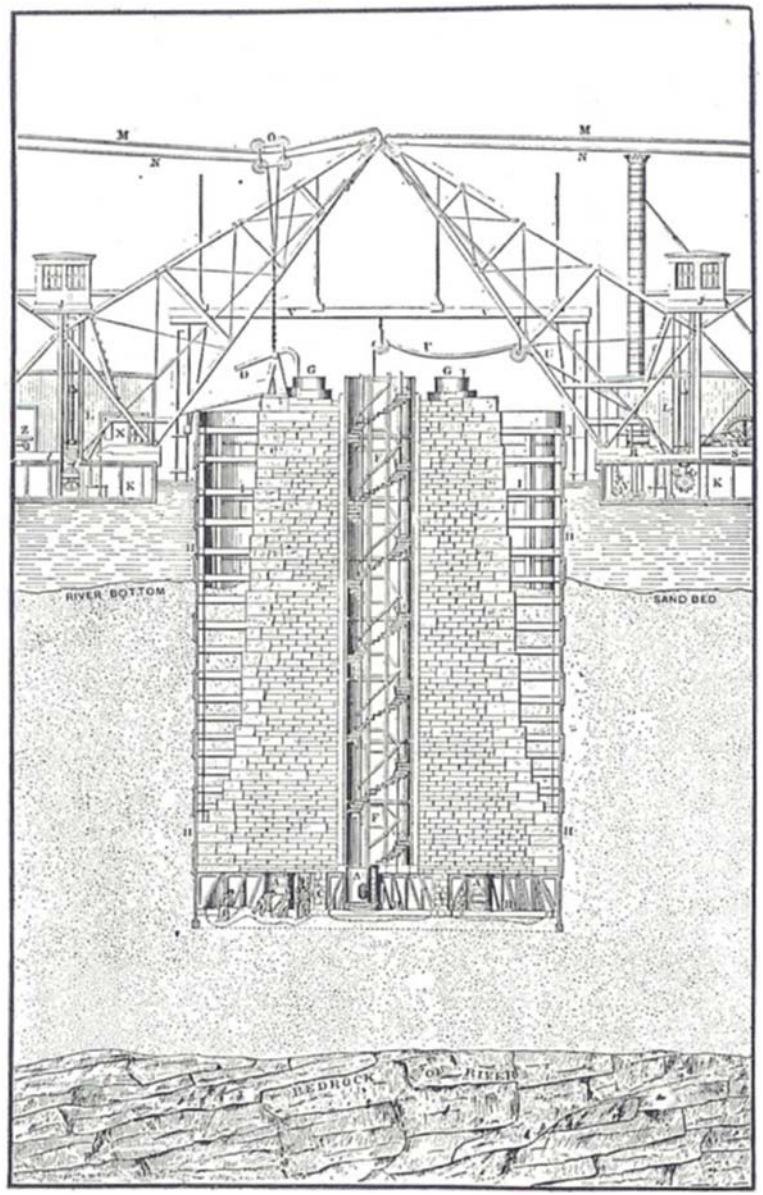


# Bridge Supports (1 of 2)

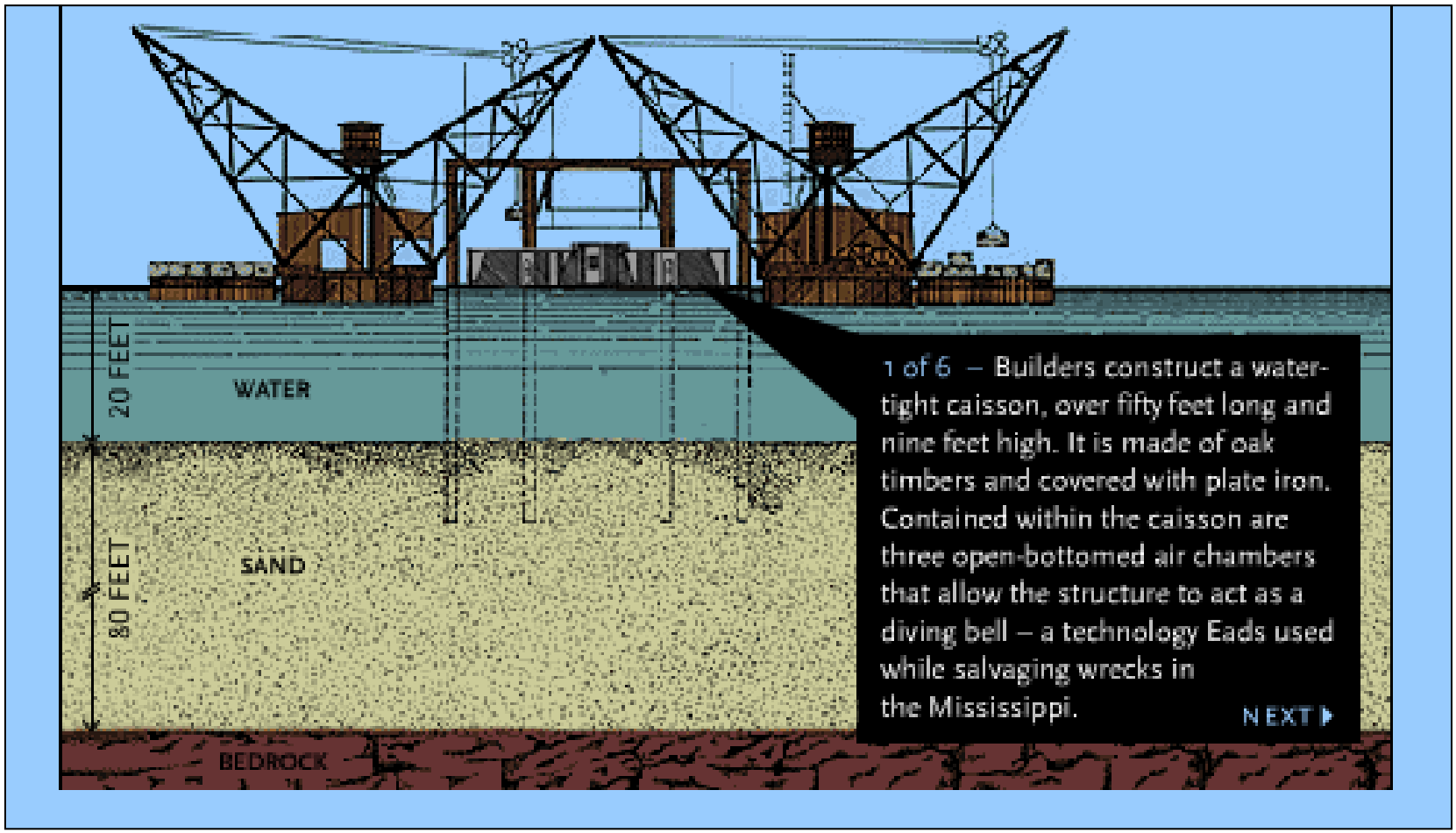


Air Lock

- In 1869, Eads discovered the *plenum pneumatic* method, excavating in caissons, while convalescing in Europe
- He brought it to Saint Louis to use on the remaining abutment and piers

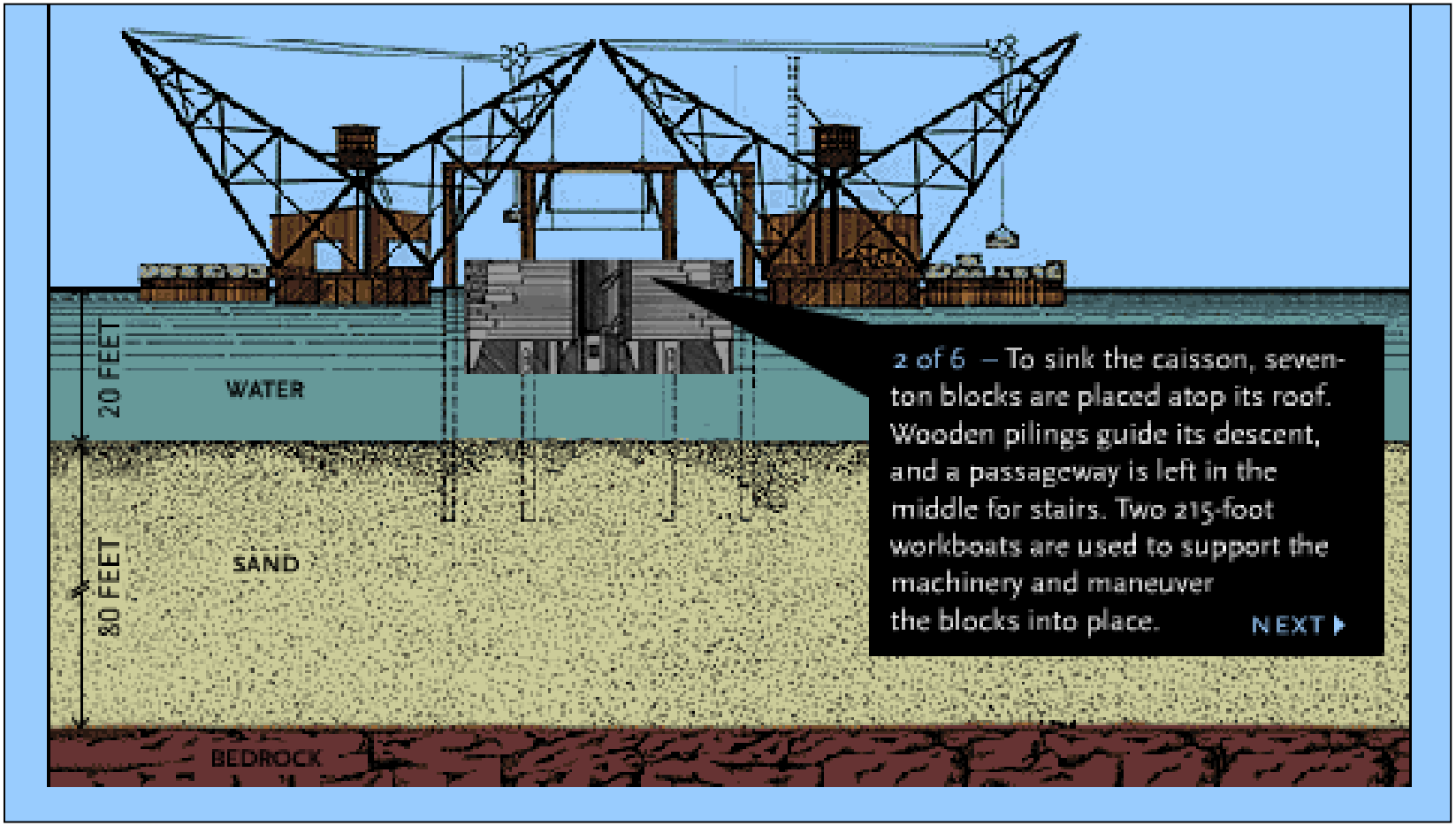


# Building the Piers * (1 of 6)

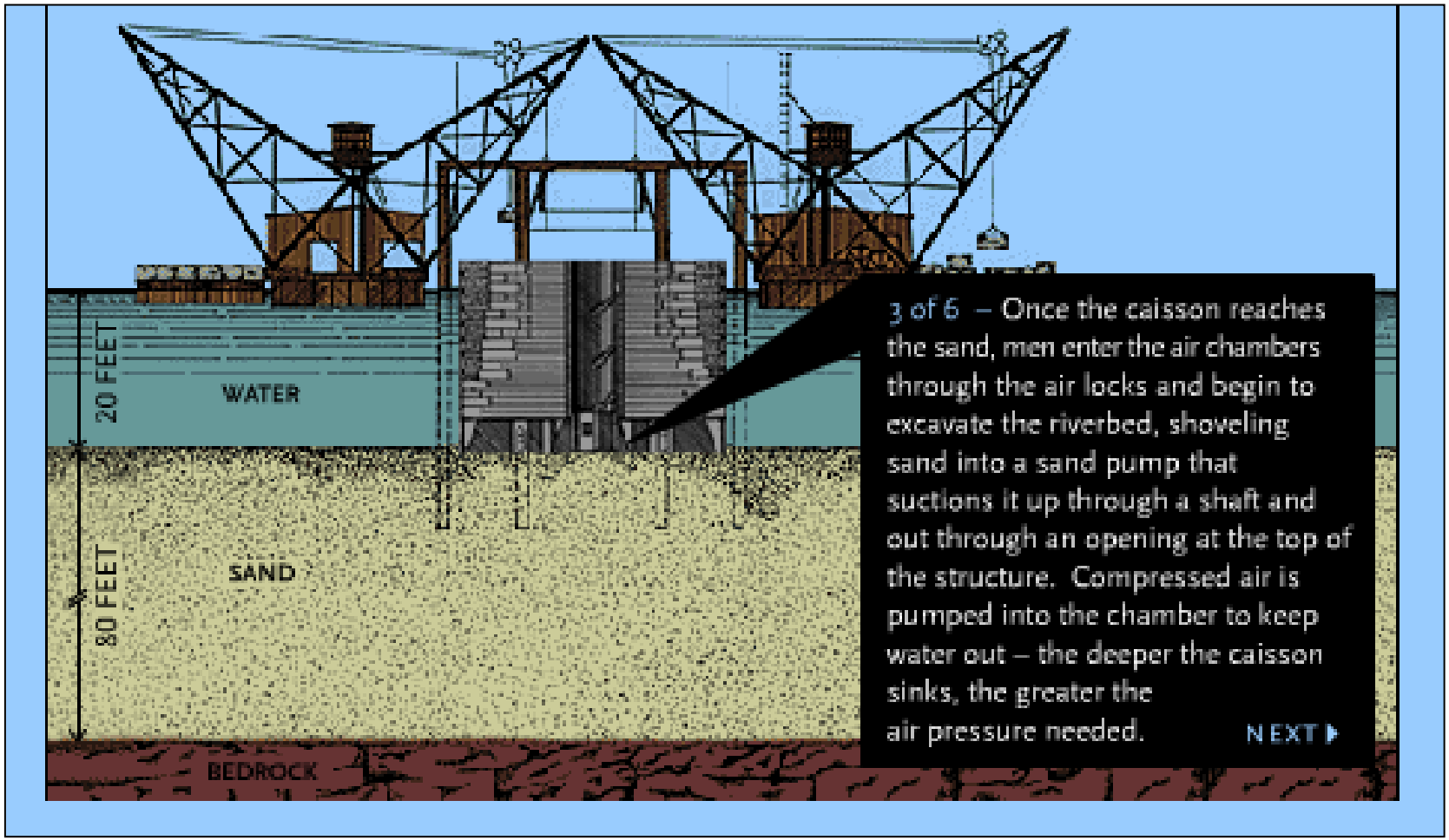



* Taken from PBS American Experience, “Secrets of a Master Builder”

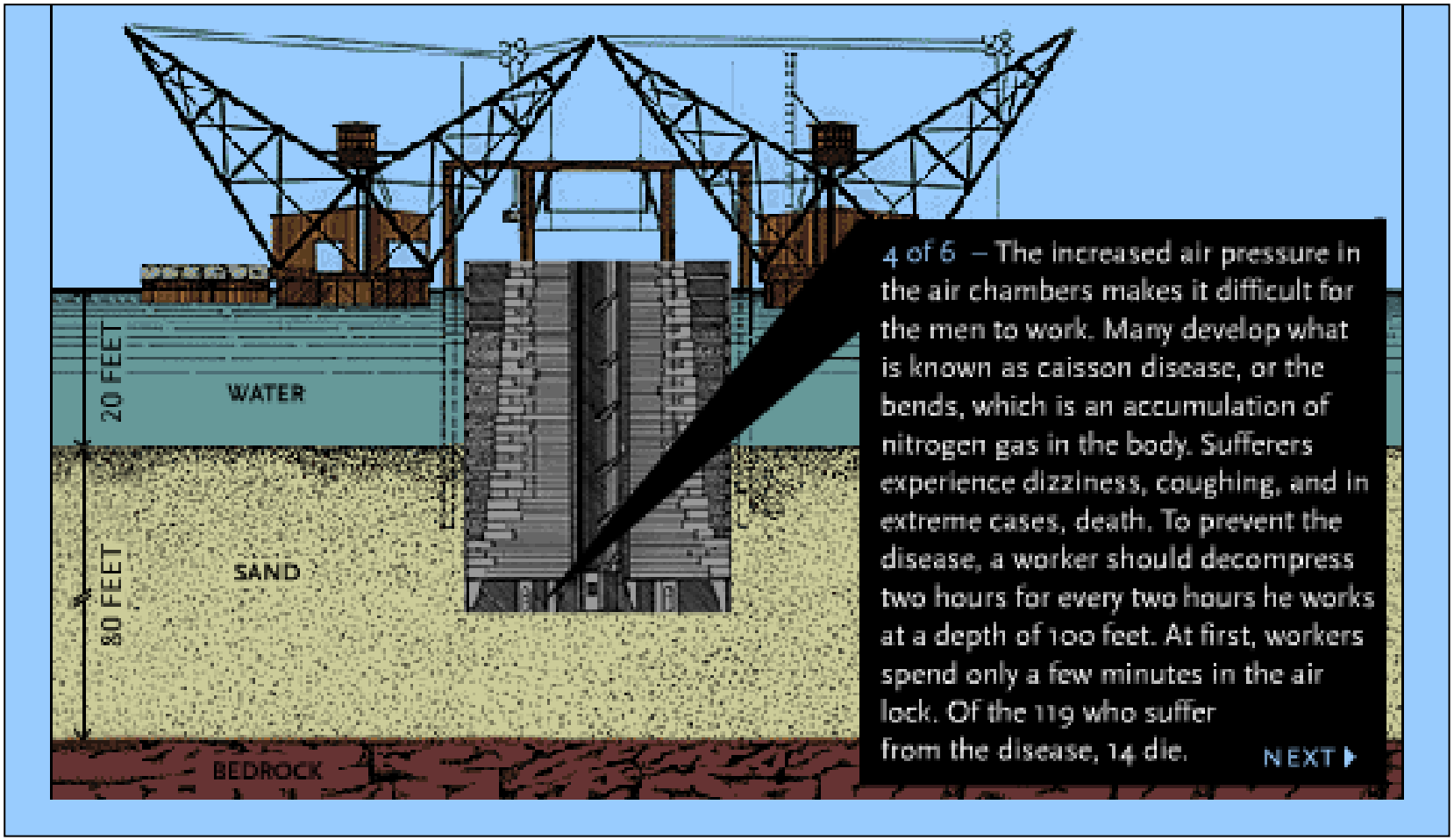
# Building the Piers (2 of 6)



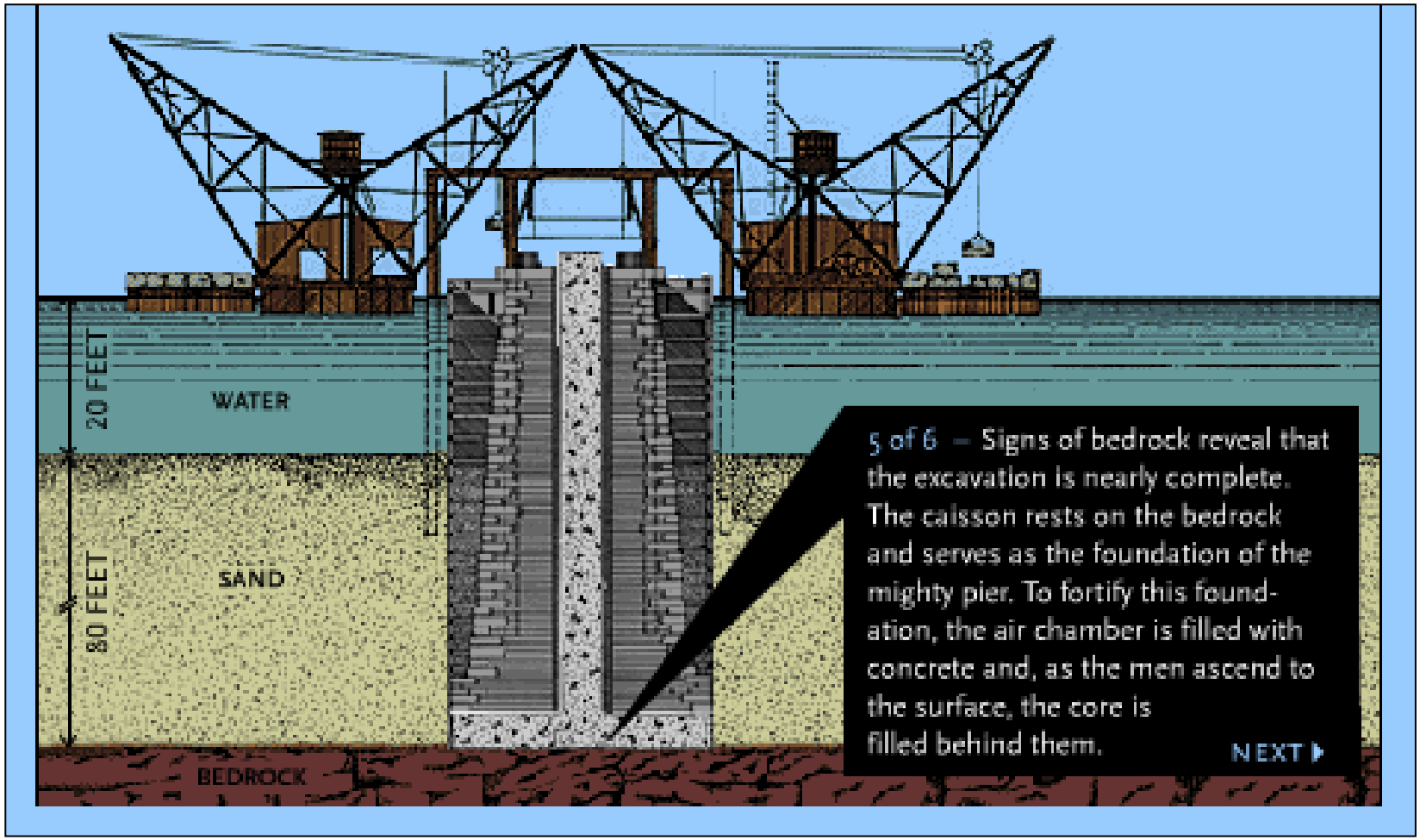
# Building the Piers (3 of 6)



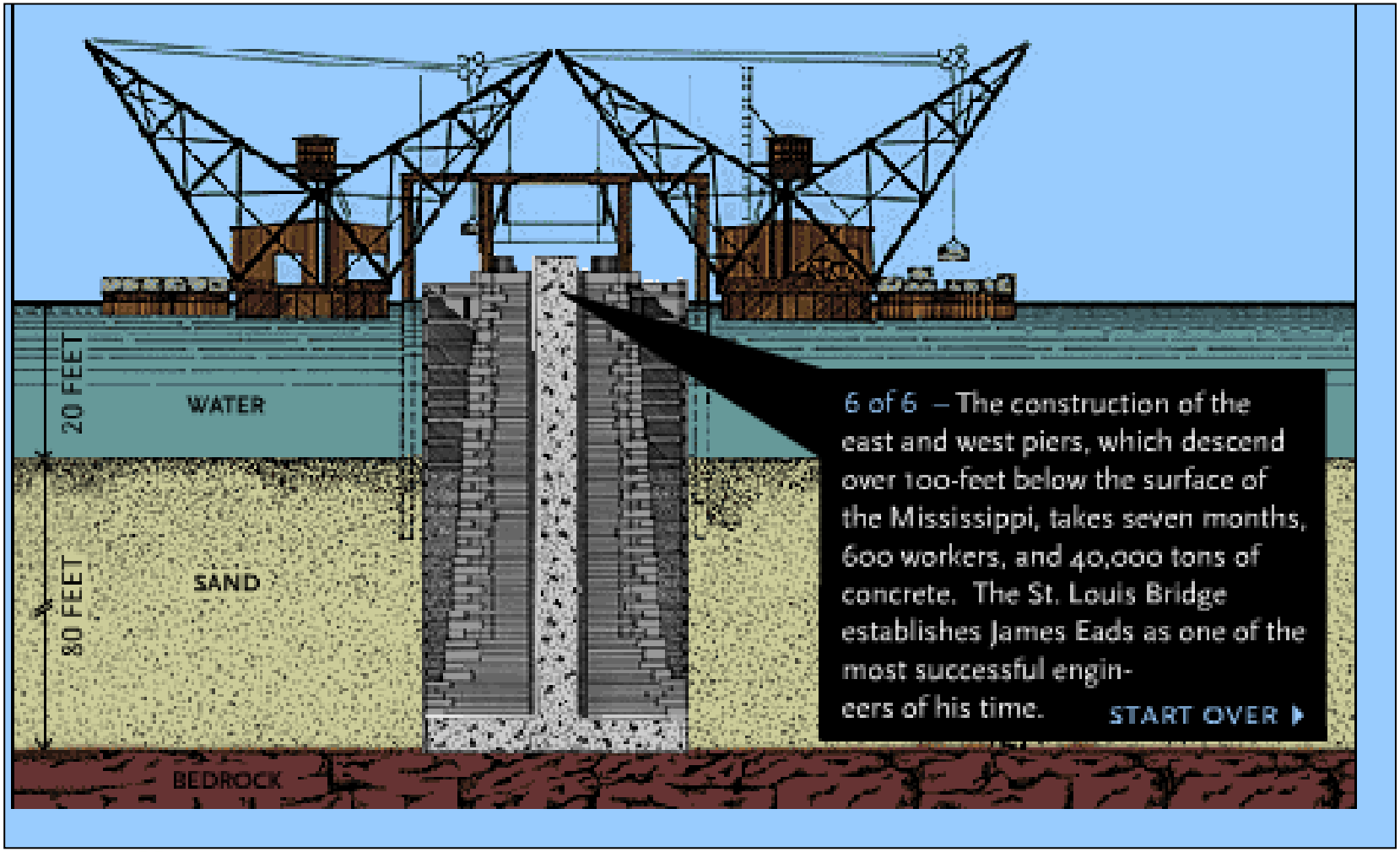
# Building the Piers (4 of 6)



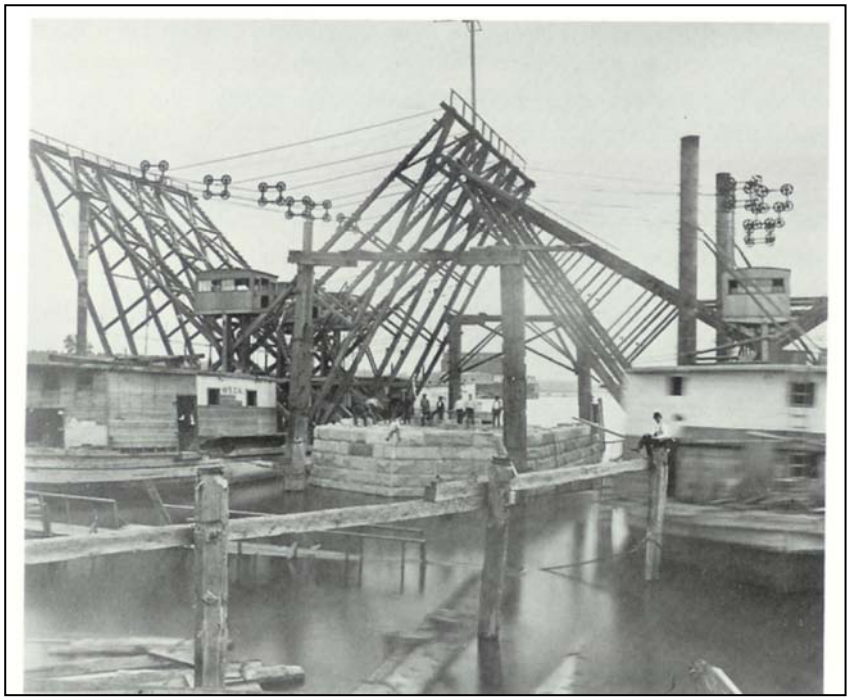
# Building the Piers (5 of 6)



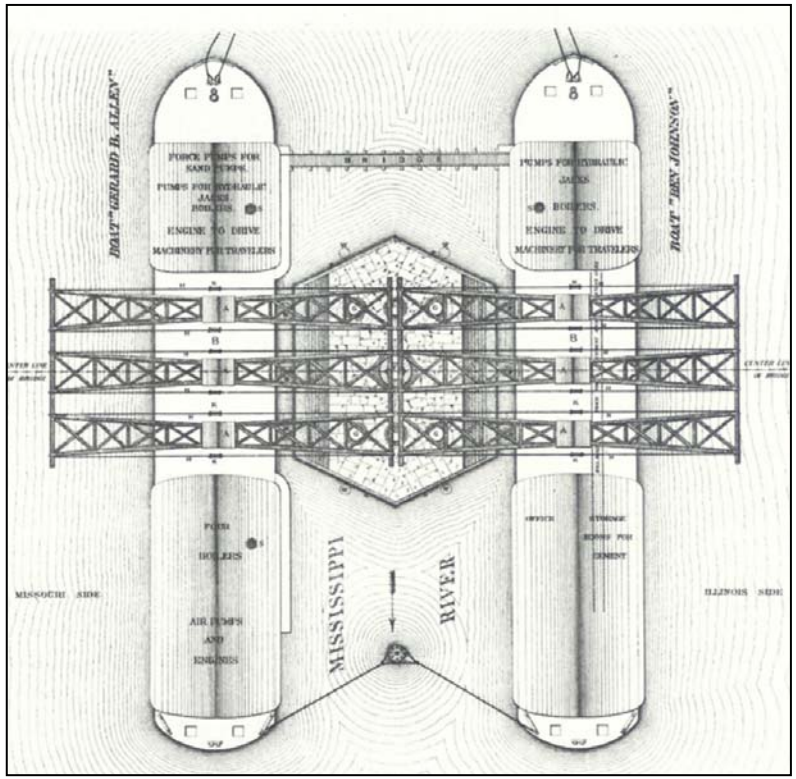
# Building the Piers (6 of 6)



# Caissons (1 of 2)



Derricks and Pontoons for the East Pier



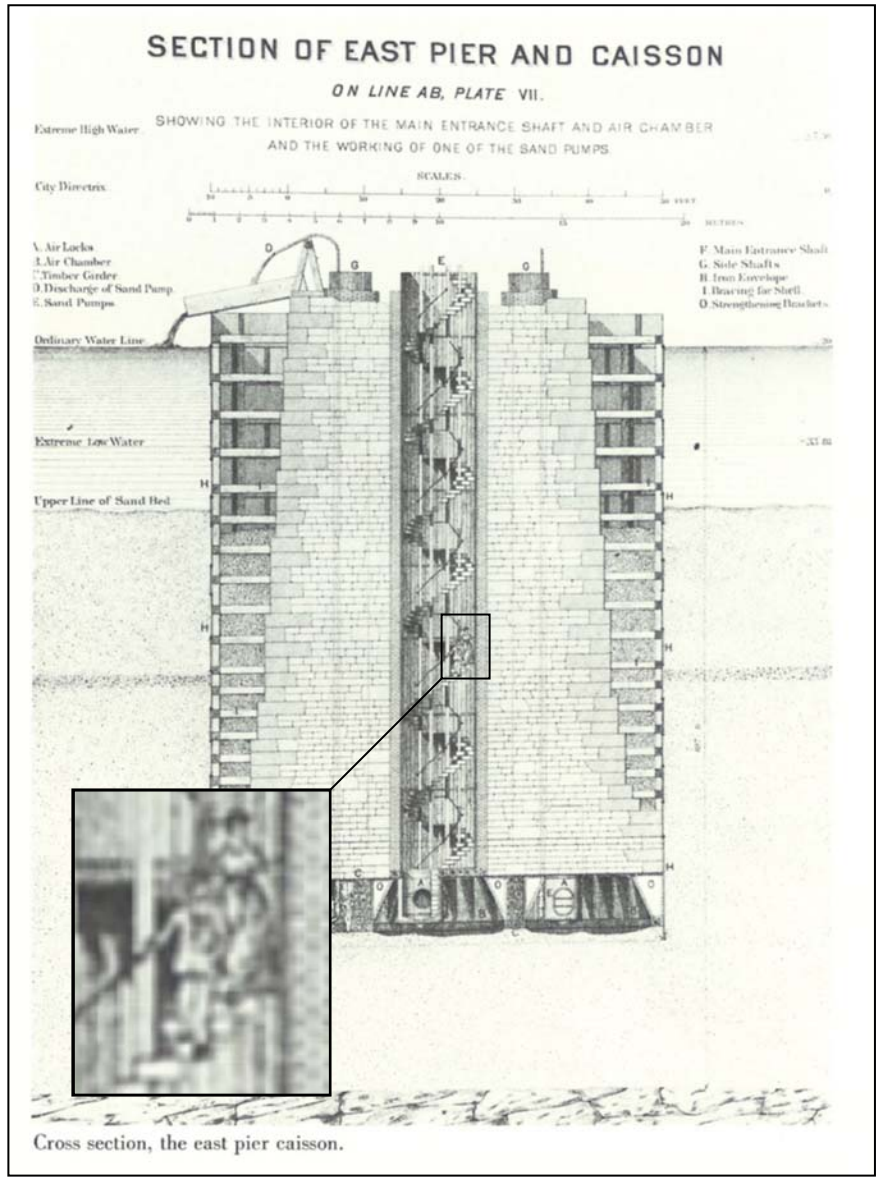

Plan View of Derricks and Pontoons

Construction of east pier began on 17 October 1869; reached bedrock on 28 February 1870; masonry to bedrock: 193 ft

Construction of west pier began in early 1870; Reached bedrock 01 April 1870; masonry to bedrock: 172 ft

# Caissons (2 of 2)

- Eads' caissons became a popular tourist attraction for Saint Louis society
- By this time, the competing bridge companies had settled their differences and merged
- Construction of east abutment began on 3 November 1871; reached bedrock in April 1871; masonry to bedrock: 197 ft
- The east abutment included an elevator and a floating hospital to treat workers with Caisson Disease



Cross section, the east pier caisson.

# Problems with Iron and Steel (1 of 2)

- Metal manufacturing lacked any standards in the 1870s
- Keystone Bridge Company received contract to build superstructure
- Butcher Steel Company awarded contract for steel parts and Kloman Carnegie received contract for iron parts
- Butcher's carbon steel failed all of Eads' test so Eads used chrome steel instead
- In reality, amounts of chrome varied greatly in the steel pieces
- The improvement in quality is probably more linked to experience and acceptance of Eads' exacting standards

# Problems with Iron and Steel (2 of 2)

- Eads inspectors rejected iron sample braces from Kloman Carnegie
- A compromise was made when Eads lowered the tensile requirements and Kloman Carnegie improved quality control
- Keystone could not produce steel couplings without bubbles or internal flaws
- Eads had to resort to wrought iron couplings
- Metallurgical problems delayed bridge construction for at least two years
- Eads Bridge ended up being more than half wrought iron

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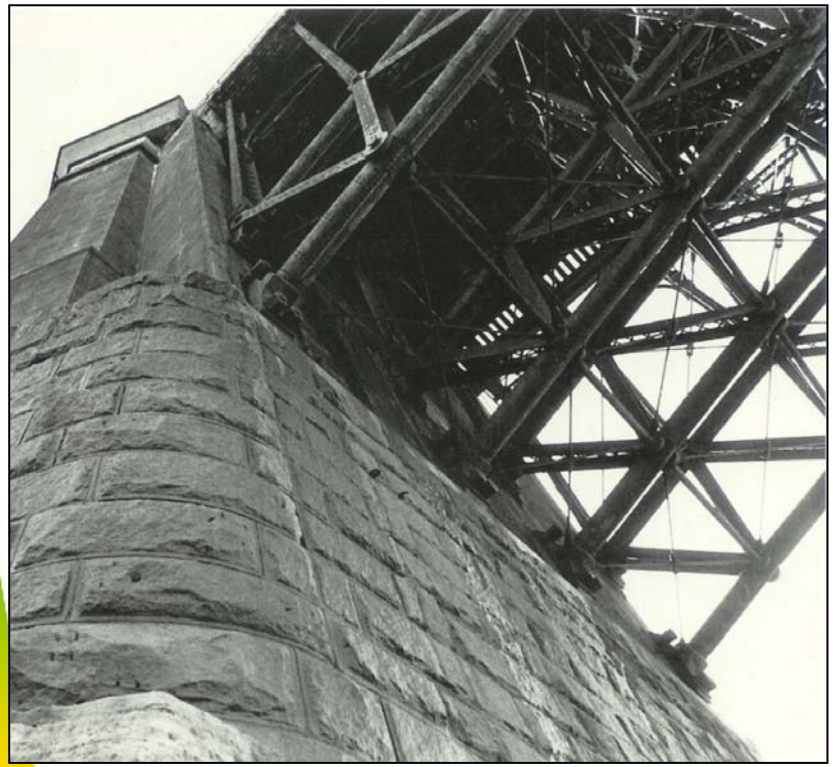
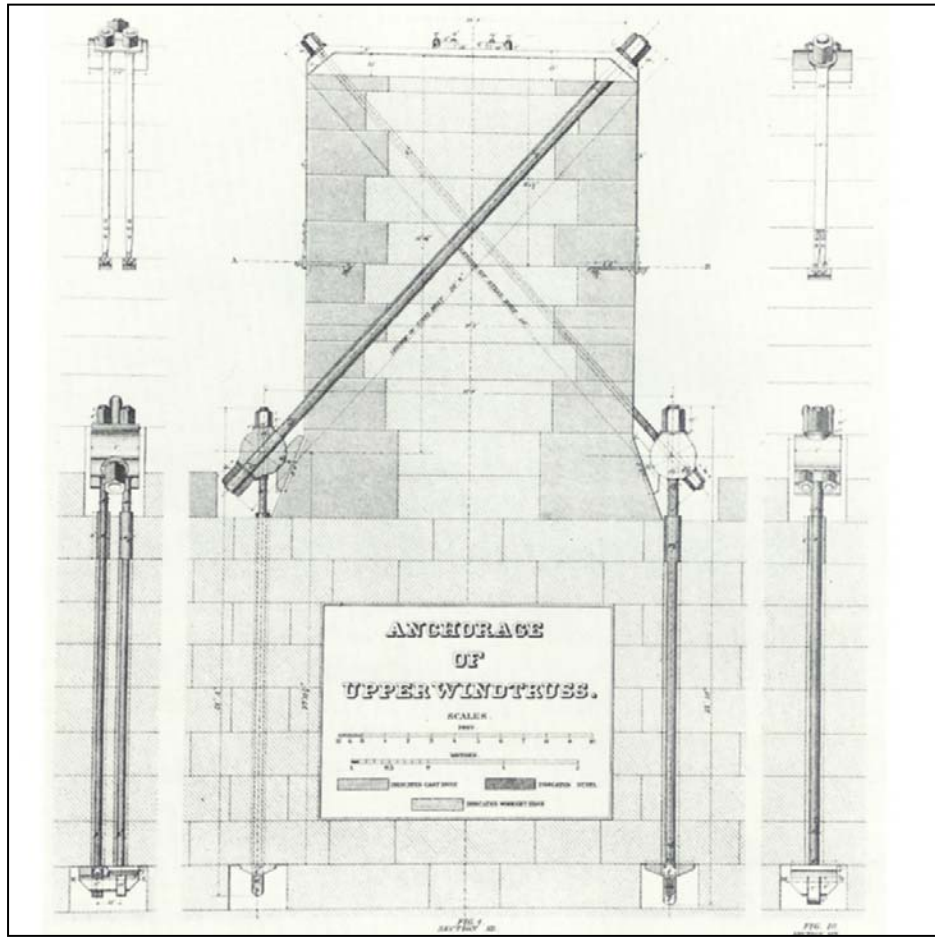
# Superstructure (1 of 4)

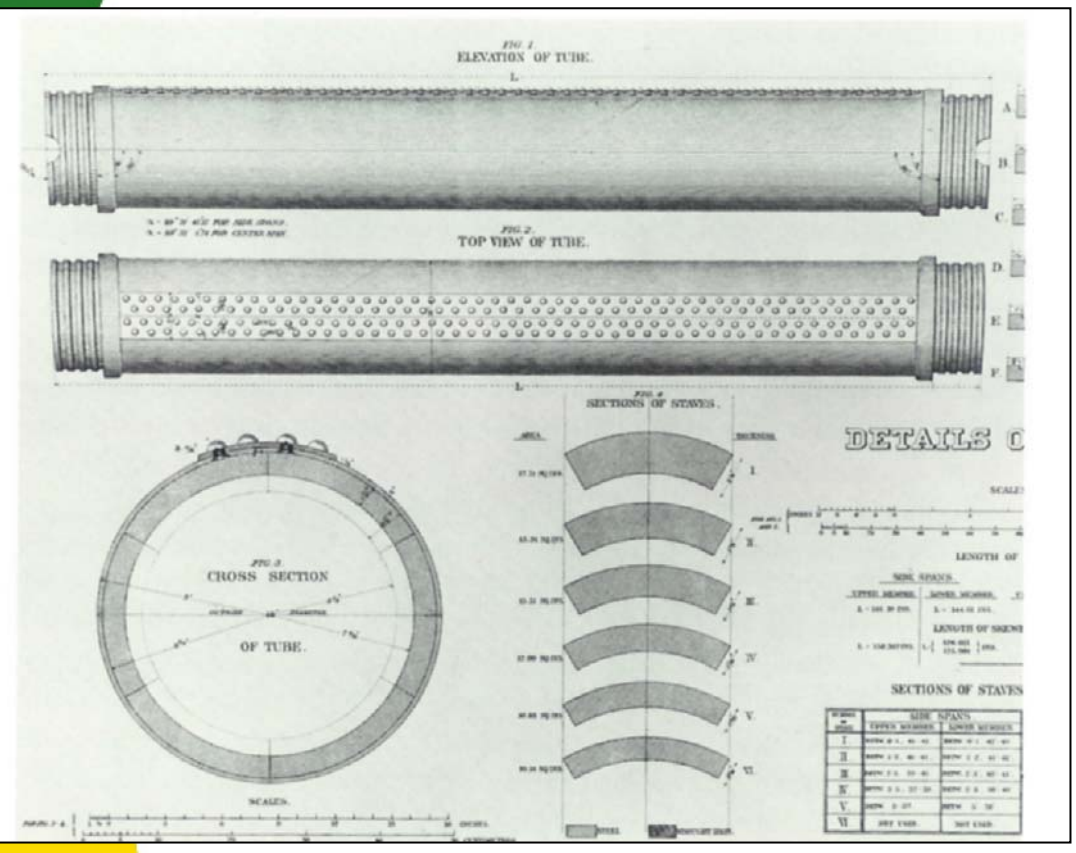


Superstructure
Connection to Masonry

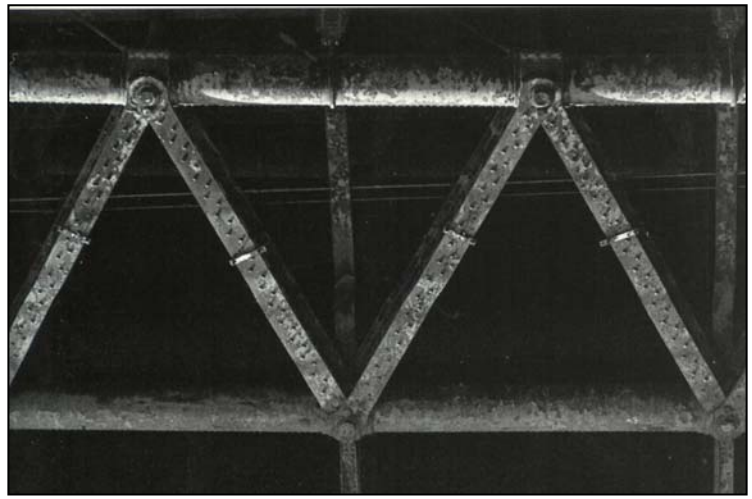



Cross-Section of Pier

# Superstructure (2 of 4)




Details of Steel Ribs

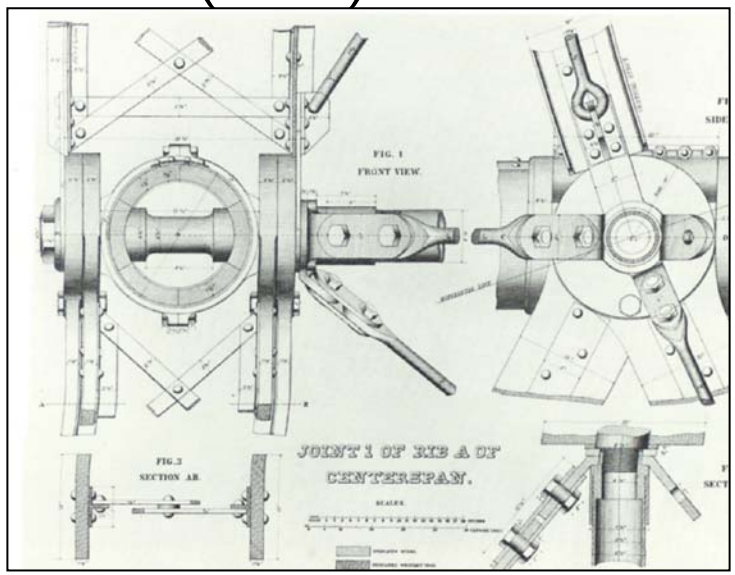


Assembled Ribs

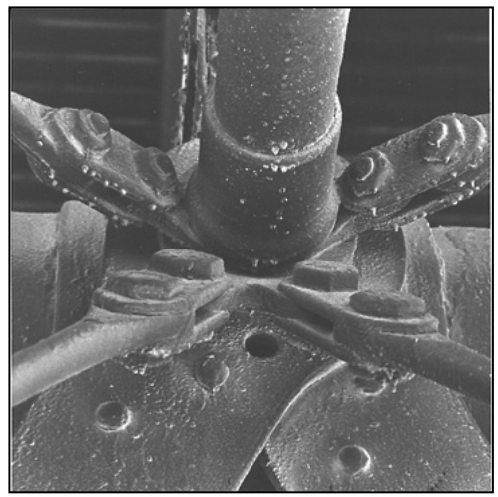
- A thin steel envelope bound the six steel staves together into a twelve foot rib
- Each end of the ribs was cut at a slight angle to make an arch

# Superstructure (3 of 4)

Assembled Ribs Showing Couplings and Braces

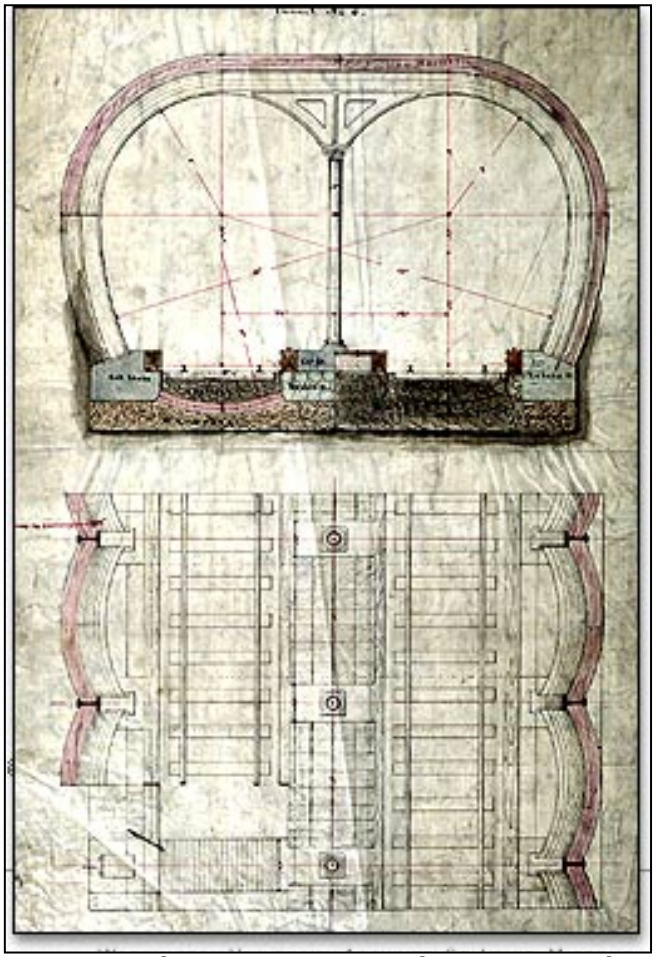



Detail of Rib Joint with Coupling and Braces

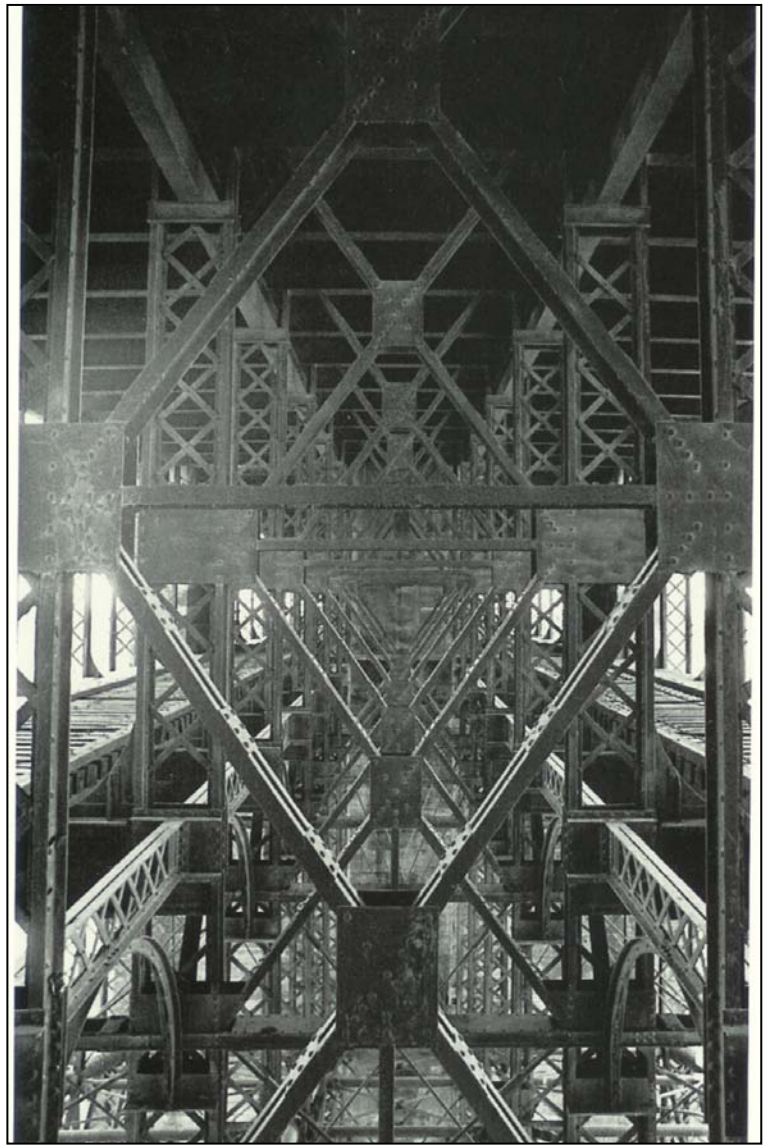


Up Close of Joint

# Superstructure (4 of 4)

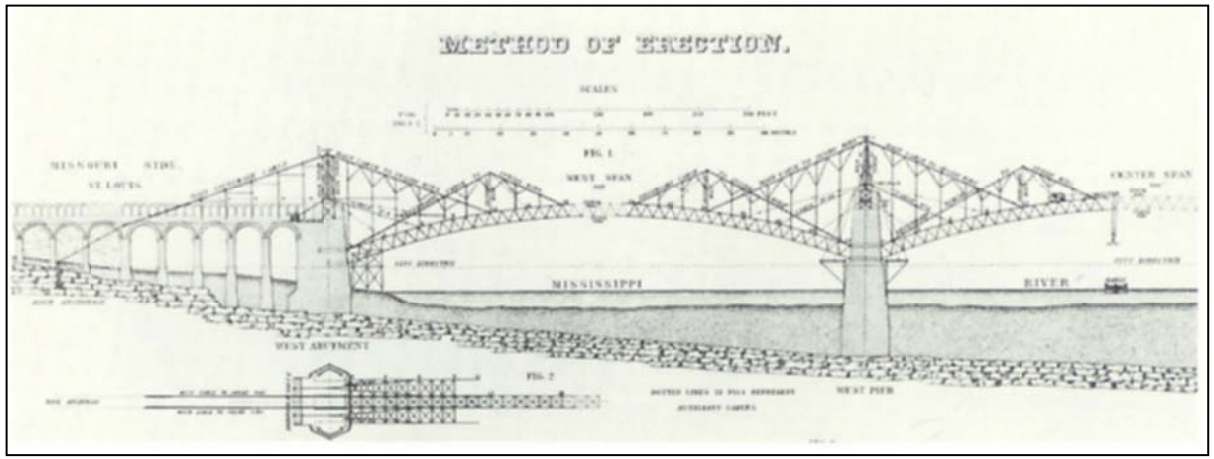


West Abutment Train Tunnel



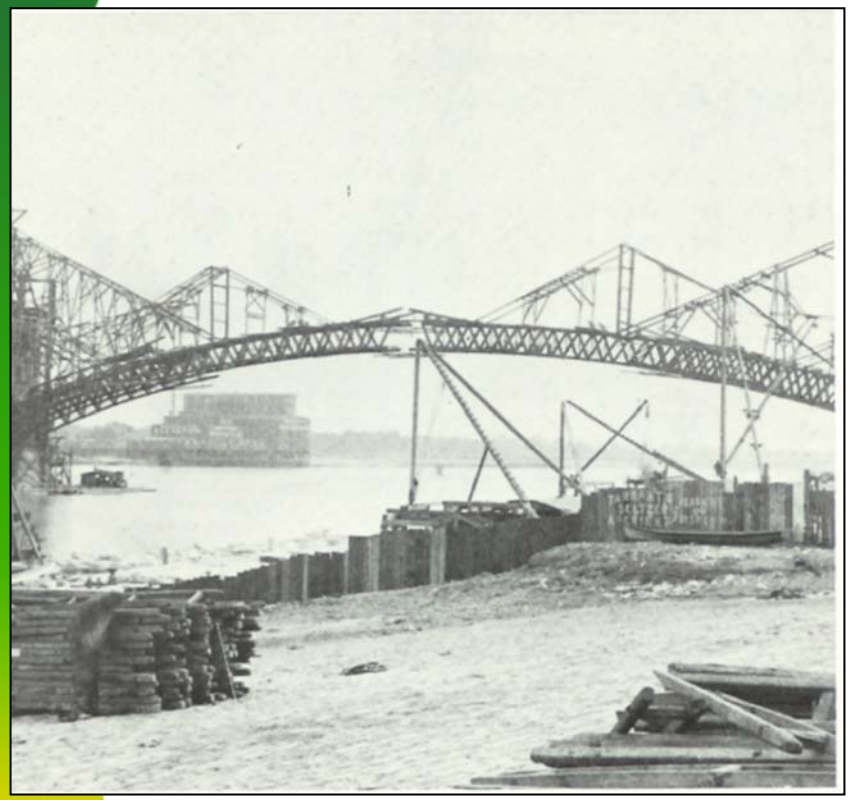
Road Deck Support

# Erecting the Superstructure (1 of 3)

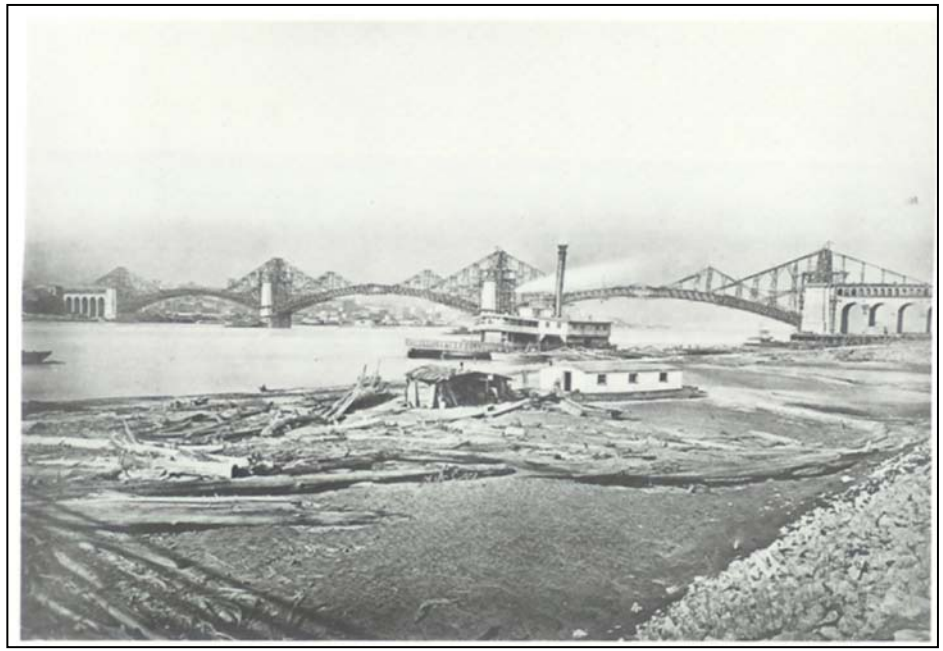



- Henry Flad, assistant engineer, devised a method of using cantilevers to construct the superstructure to keep the river clear of falseworks
- Boatmen tried to stop construction of the arches in conjunction with Secretary of War Belknap and General A. A. Humphreys, Chief of the Corps of Engineers
  - Eads appealed to his friend, President Grant, who ordered Belknap to drop the case

# Erecting the Superstructure (2 of 3)



Closing the East Span – September 1873



Closing the East and Center Spans – December 1873

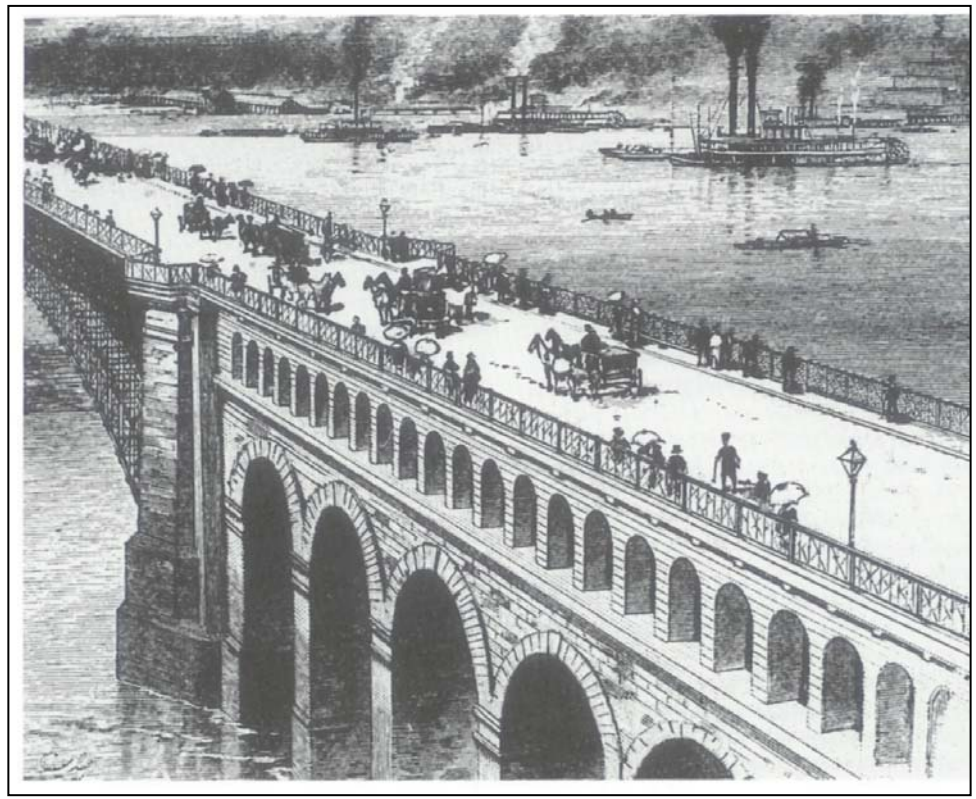
- Eads developed double threaded coupling to close the west span
- Flad attempted to close arches by packing them in ice, but had to resort to Eads' coupling

# Erecting the Superstructure (3 of 3)

Building the Road and Rail Decks – Spring 1874

# Completion and Opening

- Decks finished on 15 April 1874, but Keystone refused to open bridge before it received a payment bonus
- On 24 May, the city opened the sidewalks to pedestrians
- On 03 June, the road deck was opened to vehicles
- Grand-opening ceremony was a part of the 4th of July festivities



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# History of Use (1 of 7)

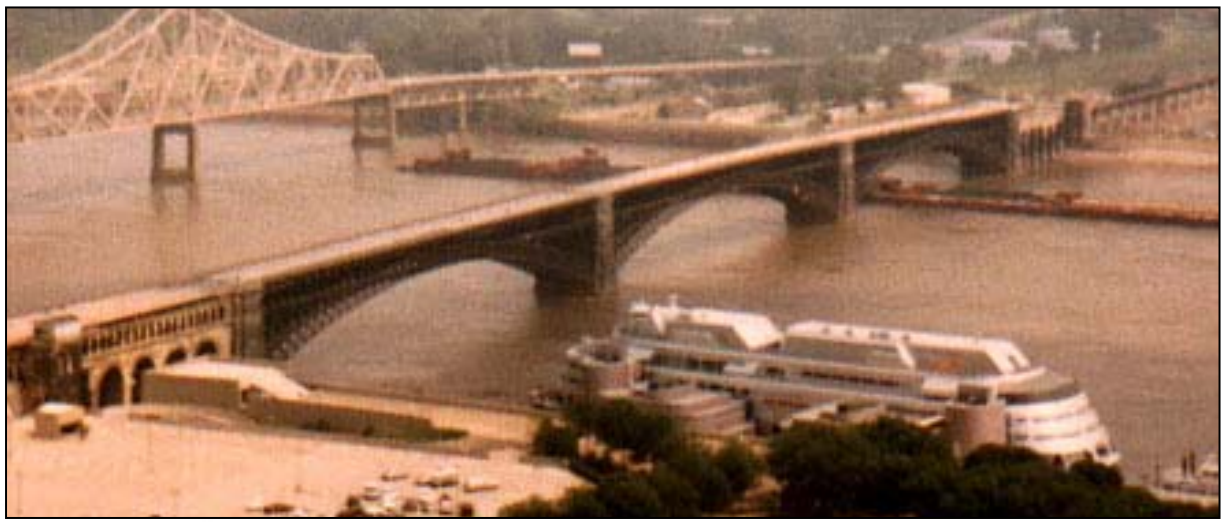
Saint Louis -1874

- Bridge never lived up to its expectations
- Coordination was never made to connect major rail lines to bridge
- Bridge went bankrupt within a year and was sold in December 1878 for $2 million

# History of Use (2 of 7)

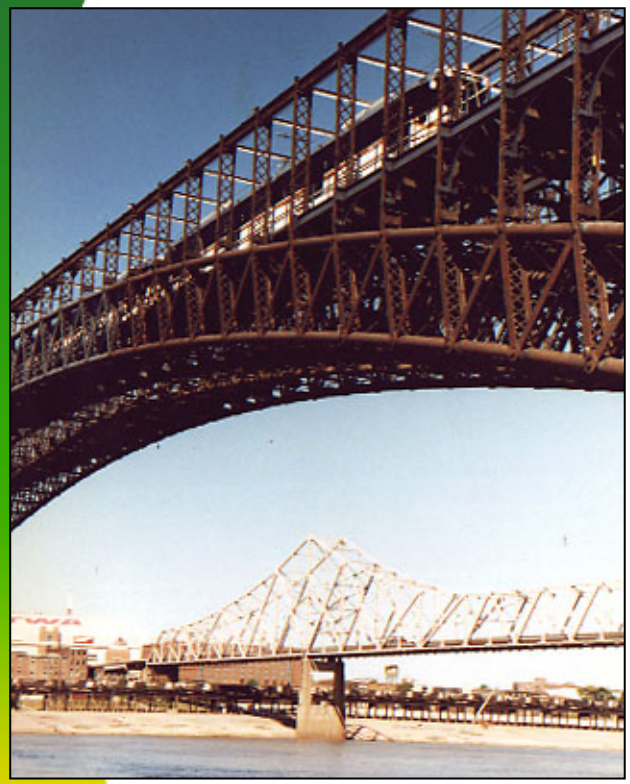
- Rail traffic ceased on the bridge in 1974
- Vehicular traffic stopped in 1991
- Illinois side removed approach

Saint Louis -1890

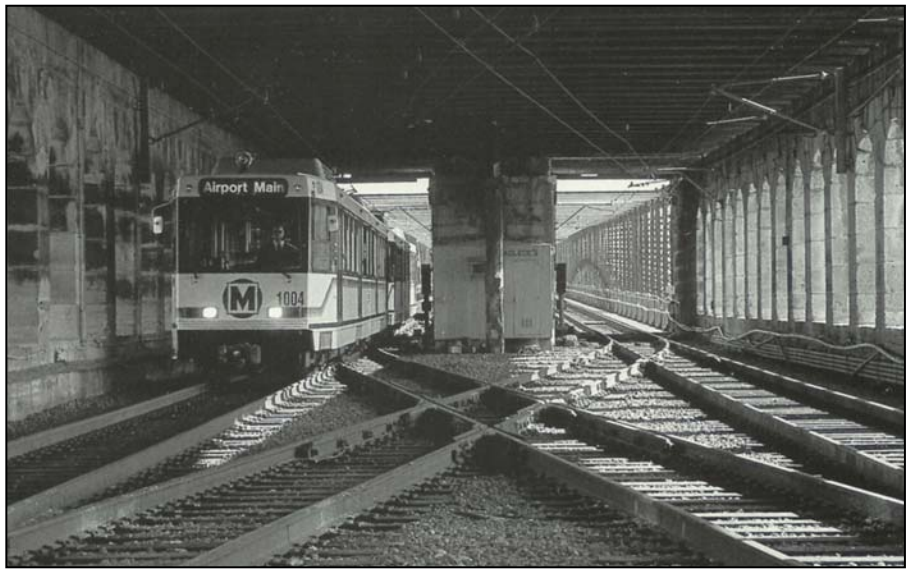


Eads Bridge – 1993 (note approach on east bank)

# History of Use (3 of 7)



Saint Louis' light rail system began to use rail deck and attached tunnels in 1993.



# History of Use (4 of 7)

Saint Louis - 1993

The bridge survived numerous floods.

Saint Louis - 1994

# History of Use (5 of 7)

Deterioration of
Abutment Masonry

The bridge continued to fall into disrepair and neglect.


Rusting Toll Booth

# History of Use (6 of 7)

Reopening Celebration

- Saint Louis lobbied for support and the bridge is now a protected National Landmark
- $25 million dollar restoration project began in late 1990s
- Bridge reopened during the 2003 4th of July festivities to pedestrian and vehicle traffic

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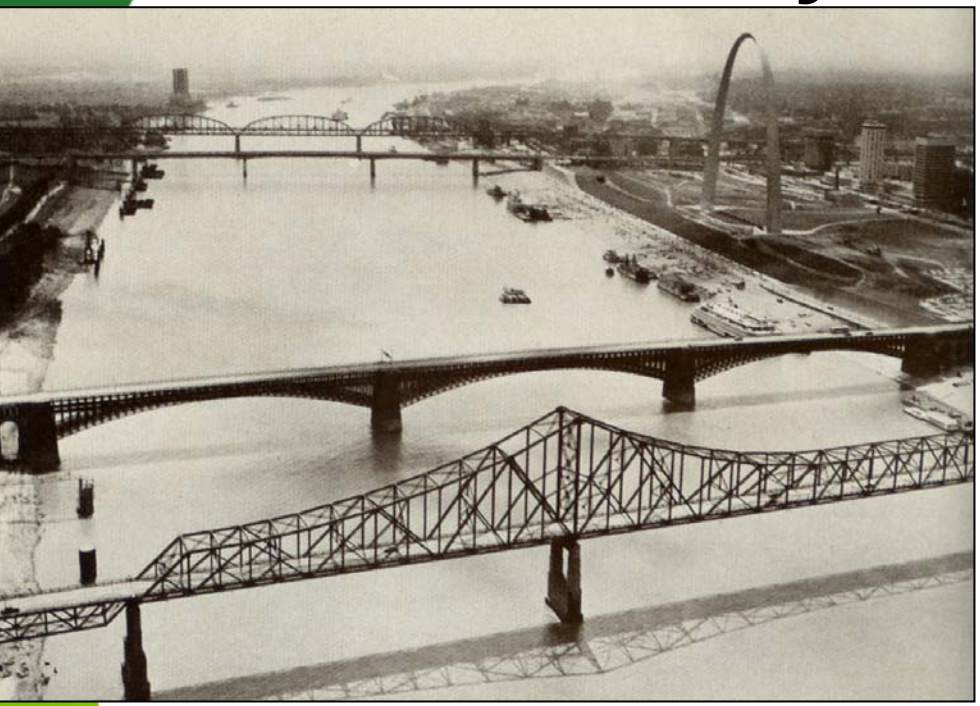
# History of Use (7 of 7)



Bridges of
Downtown
Saint Louis

Future Bridge in Saint Louis:
estimated cost - $1billion,
estimated completion - 2010

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# Summary

- The events leading up to the construction of the Eads bridge
- The design and construction of the bridge’s supports and superstructure
- Obstacles and delays during construction
- The history of the bridge since its completion

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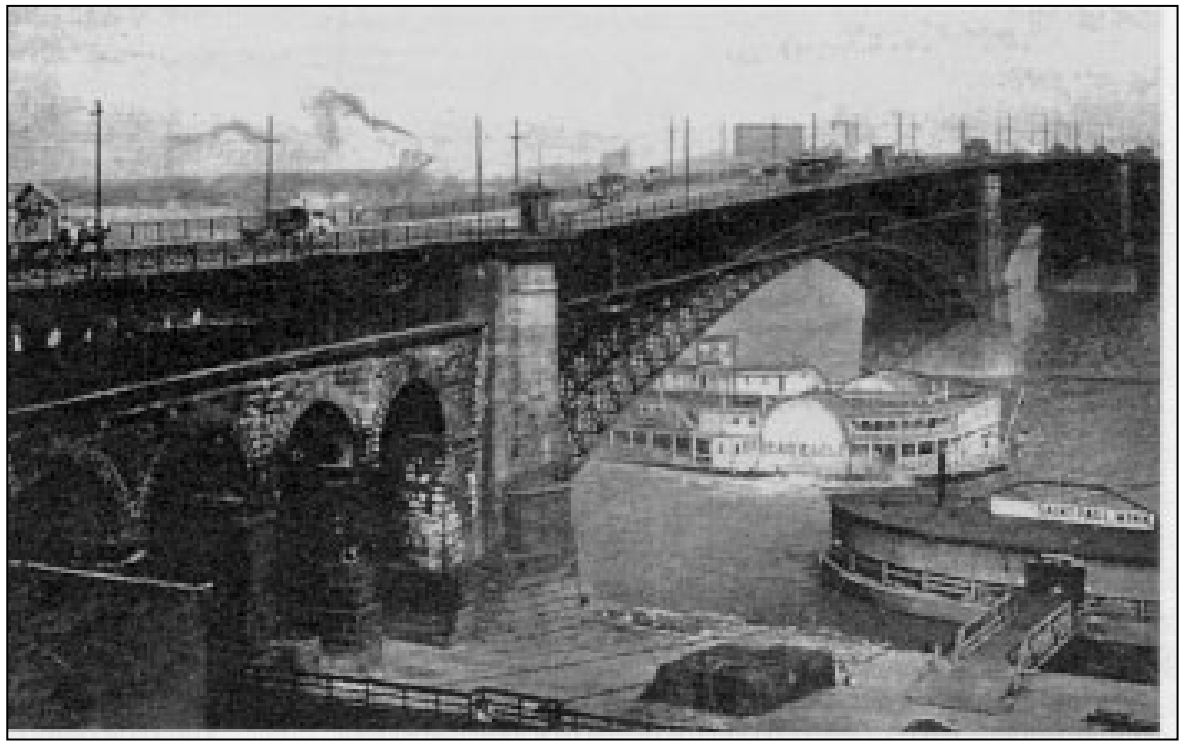
# Questions?

# Conclusion



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

- James B. Eads