Notes 01

Reading notes are typically due before the lecture is given

HISTORY

NEW YORK CITY
COLLEGE OF TECHNOLOGY
THE CITY UNIVERSITY OF NEW YORK
DEPARTMENT OF ARCHITECTURAL TECHNOLOGY

ARCH2431 Building Tech III

NOTES 01- Steel History and Introduction

DESCRIPTION The objective of this assignment is to help students engage in lectures by reading and taking notes of the lecture material prior to attending class. The notes will be collected by the professor before the beginning of class.

NAAB SC OBJECTIVES

Mastered:

SC.4 Technical Documentation
How the program ensures that students understand the established and emerging systems, technologies, and assemblies of building construction, and the methods and criteria architects use to assess those technologies against the design, economics, and performance objectives of projects.

PROCESS Read Allen and Iano, Fundamentals of Building Construction, 7th ed.

DELIVERABLES Read Chapter 11

- History P 396-398
- The Material Steel P 398-402
  - Steel
  - Structural Steel Alloys
- Based on the reading submit as a PDF.
- Your handwritten notes & at least one freehand sketch.

GRADING Each assignment will be grade from 0 to 3 as follows:
0 = Not submitted
1 = minimal requirements met
2 = good notes
3 = very good notes

Notes 01-Design and Construction Process					
	Allocation	Exceeded requirements	Met most requirements	Met some requirements	Barely met requirements
Technical Documentation (S.4)					
Comprehensiveness	40%	*Notes comprehensively covered the entire scope of the reading assignment*	*Notes sufficiently covered the entire scope of the reading assignment*	*Notes covered the entire reading assignment but some content was lacking*	*Notes barely covered the scope of the reading assignment*
Understanding	40%	*Notes demonstrated a strong understanding of the content*	*Notes demonstrated a basic understanding of the content*	*Notes demonstrated a limited understanding of the content*	*Notes demonstrated a minimal understanding of the content*
On Time					
On Time	20%	*Submitted on due date prior to the beginning of the class*	*Submitted on due date sometime during the class*	*Submitted in the class subsequent to the due date*	*Submitted a maximum of a week after the due date*

BT3.Notes 01- Steel History & Introduction.docx

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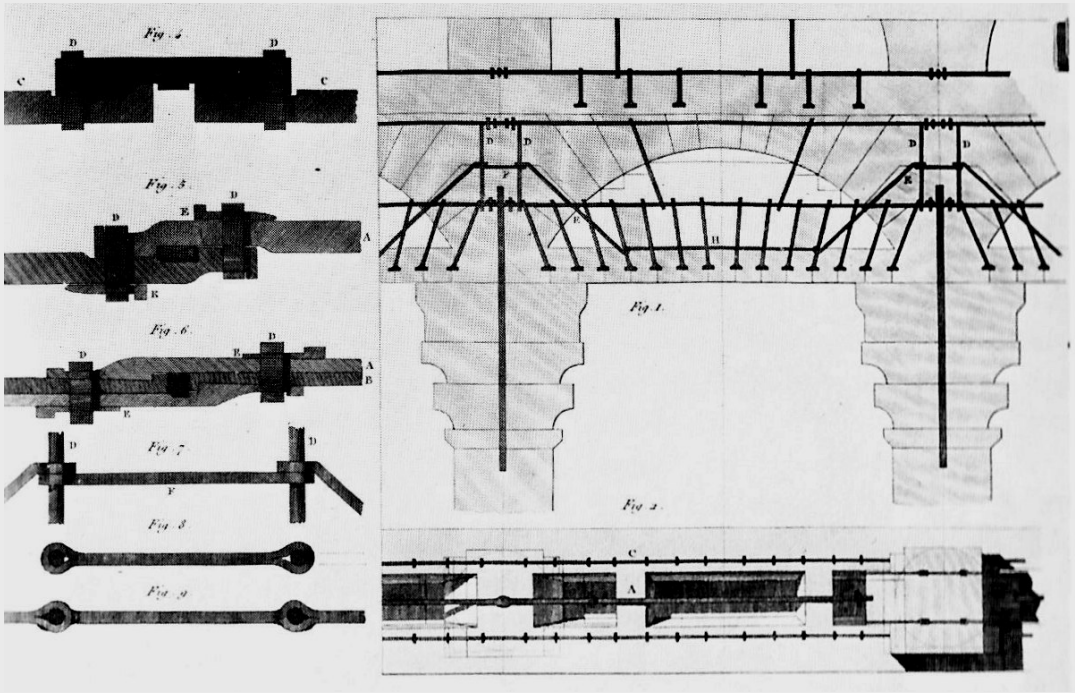
CITY TECH IS CUNY

HISTORY

Metals In Pre-Modern Building Construction

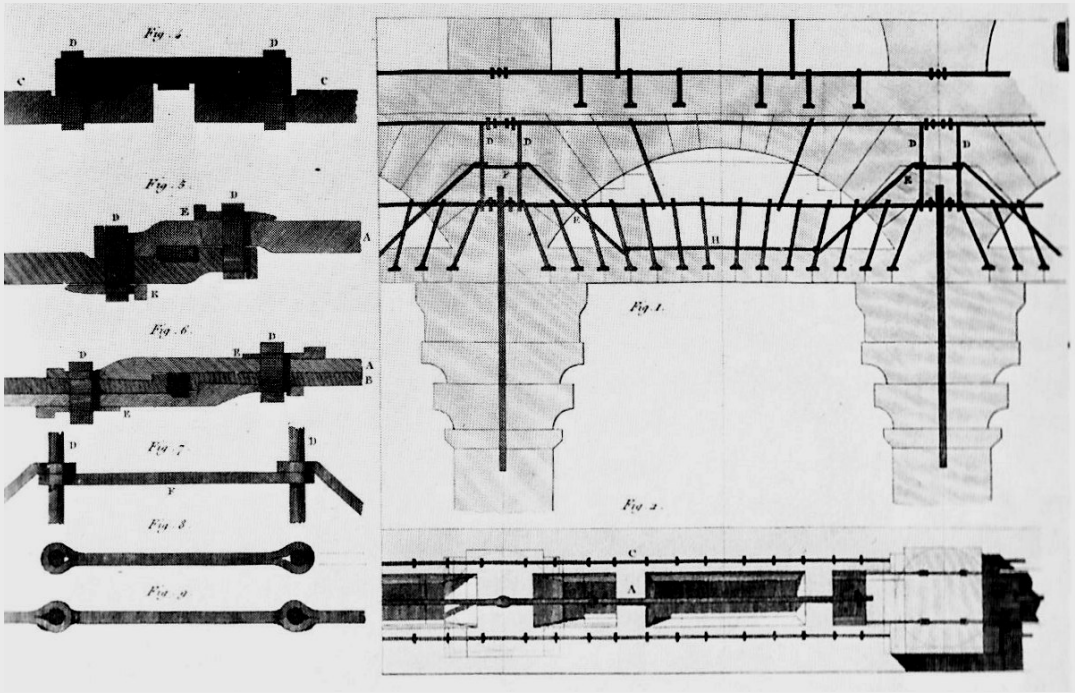
Greek and Roman bronze cramps used to join blocks of stone

Renaissance wrought iron chains and rods used to counter thrusts in arches and vaults

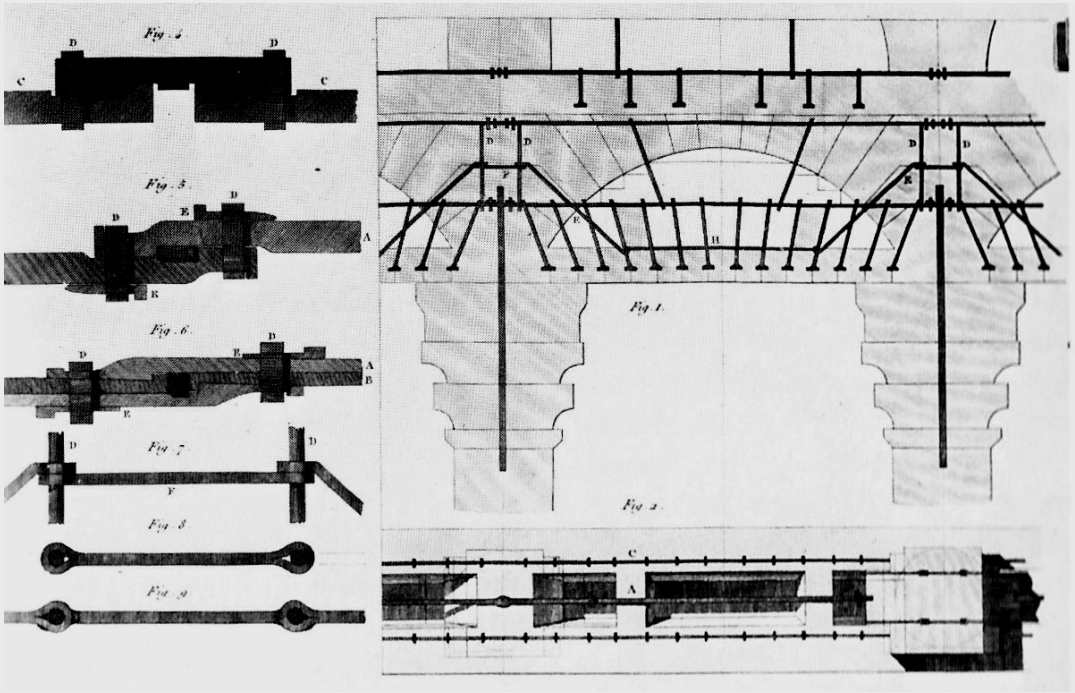


Making steel was labor intensive

Use of steel was limited to weapons (e.g., Damascus steel swords), cutlery, other specialties



Right: Iron tie rods and cramps in masonry construction, Pantheon, Paris, 1789



1750 and later

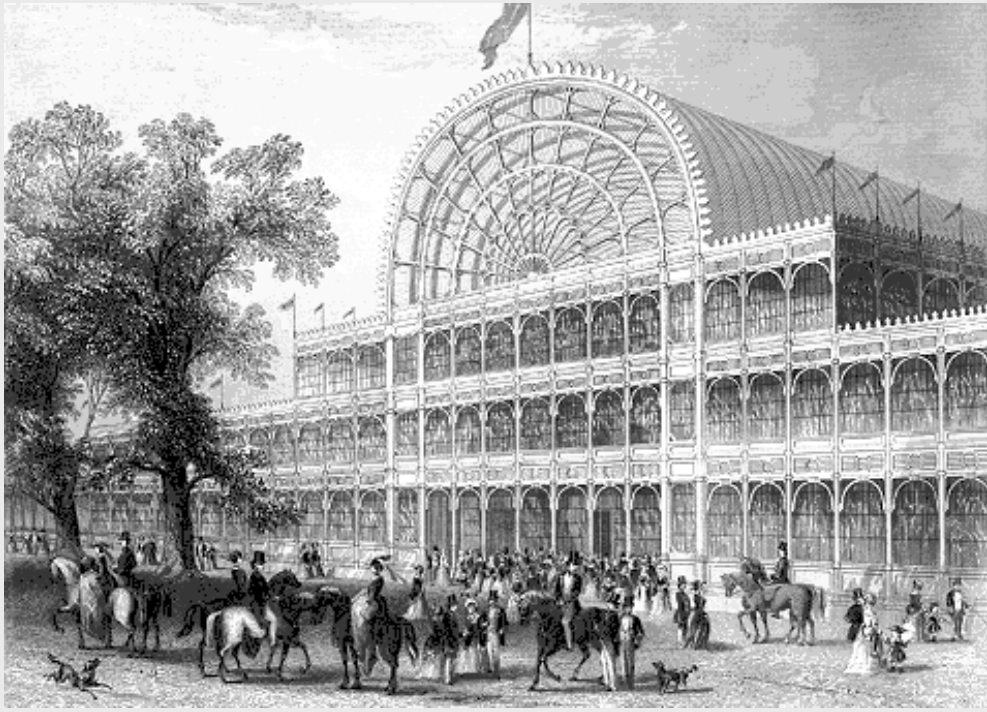
Growth in use of cast iron framing in industrial buildings and other structures

Right: Coalbrookdale Bridge, 1779, first all-metal structure

Right: Crystal Palace, 1851; cast iron and glass

Eiffel Tower, 1889

Wrought iron



1850 and later

Steel increasingly plentiful, with large scale production methods.

After the U.S. Civil War, excess steel making capacity sets the stage for the first use of steel in U.S. buildings.

1850 and later

Right: Home Insurance Company Building, 1885, William Le Baron Jenny

First tall building supported entirely by a fire-protected metal frame (cast iron and steel)

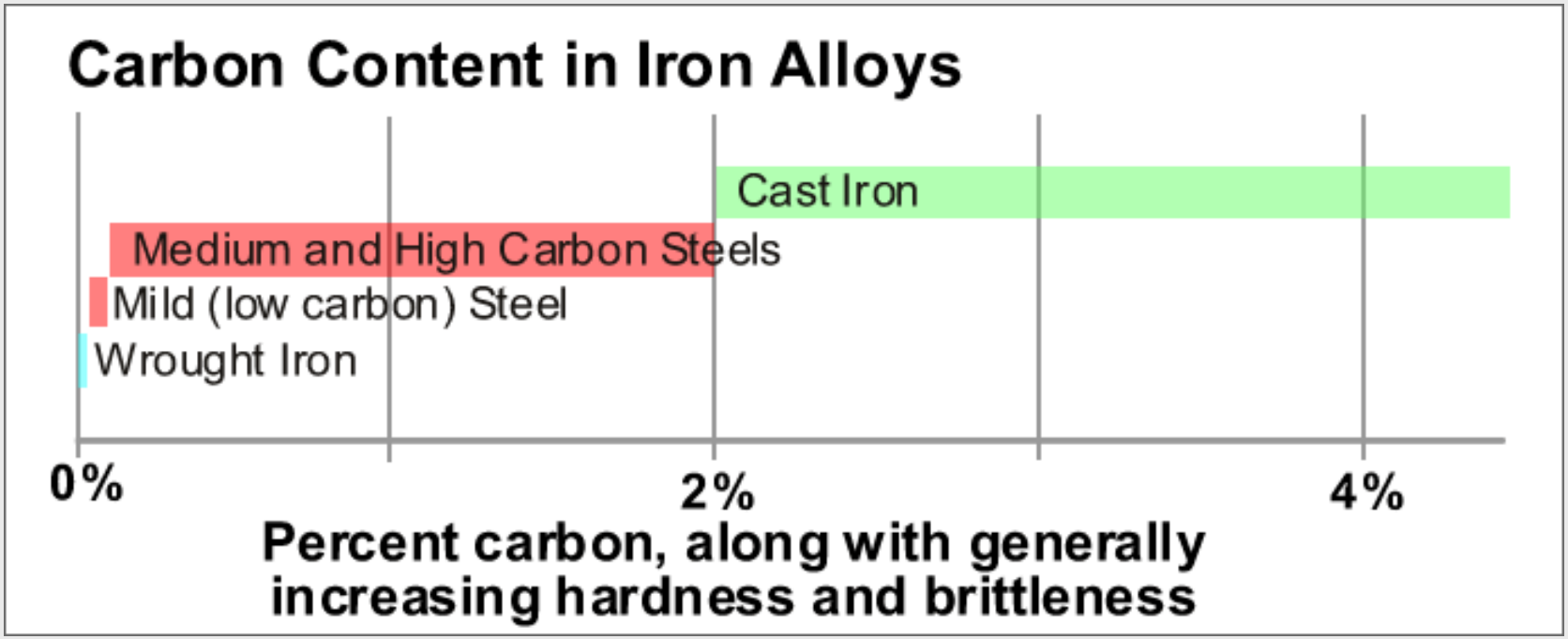
Modern

Steel is one of three commonly used noncombustible structural materials. Suitable for buildings of all sizes, from single family residences to the tallest skyscrapers.

THE MATERIAL STEEL

Carbon Content in Iron Alloys

Greater proportions of carbon generally increase the hardness and brittleness of the iron alloy.



Cast Iron

2% – 4% carbon

Strong in compression

Less strong in in tension

Brittle (vulnerable to sudden failure)

Wrought Iron

Little or no carbon

Strong in tension

Weaker in compression

Malleable (easily shaped) and relatively soft

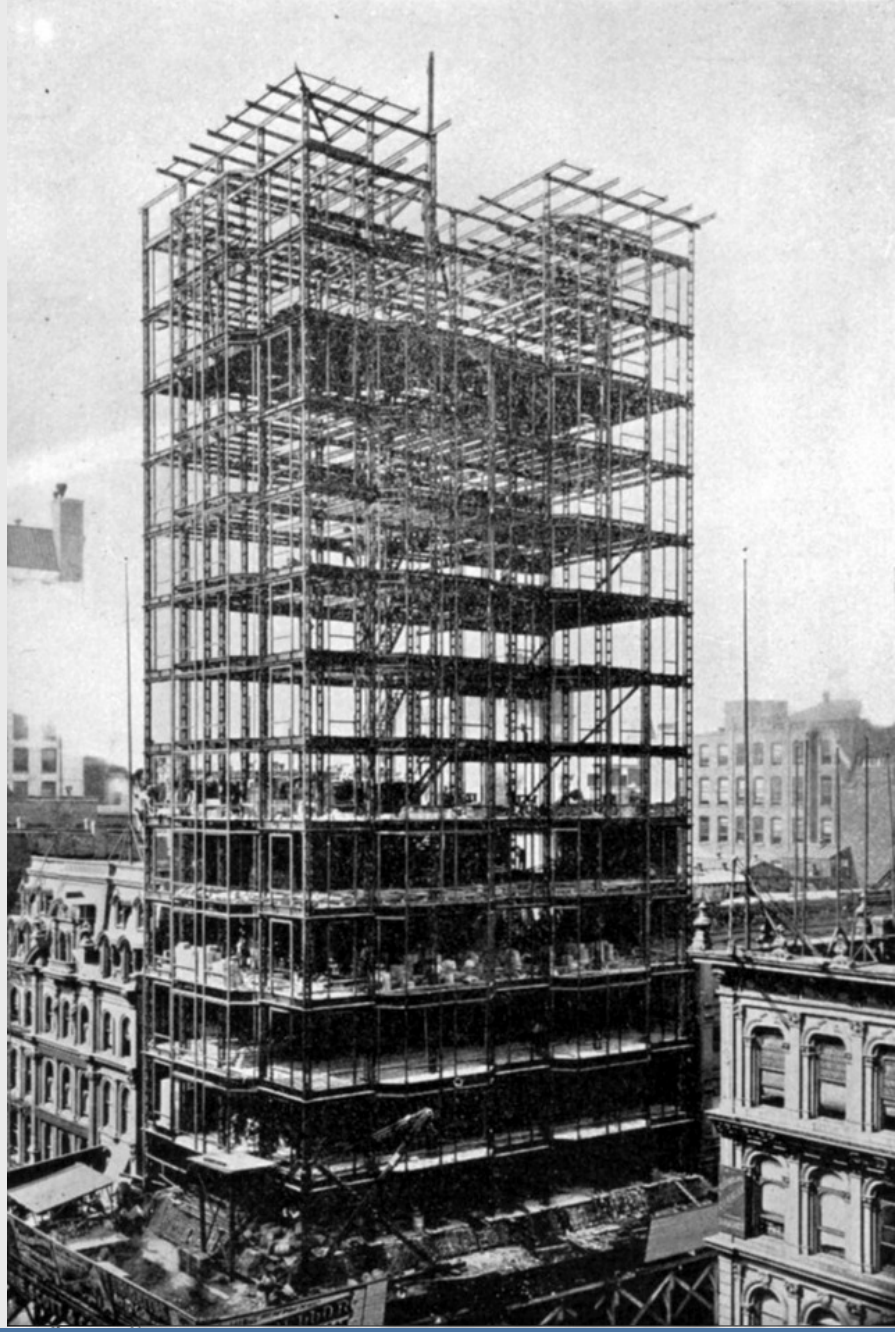
Steel

Less than 2% carbon

Strong in both tension and compression

Ductile (not prone to sudden failure)

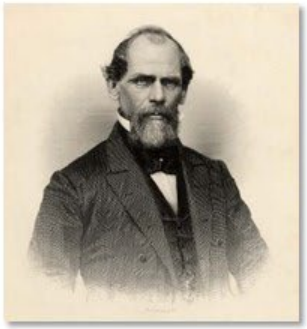
(Reliance Building, Chicago, 1895)



Roebling before the bridge

Prof. Paul C. King

John A. Roebling



History | Cast Iron & Wrought Iron in Suspension Bridges

Cast Iron — *A combination of iron and at least 2% carbon. In the 1800's during Roebling's time charcoal was used to add the carbon content. Cast Iron was melted and poured into a mold and allowed to cool. Cast Iron works well in compression and for bridges was used for large suspension cable saddles and heavy anchor plates.*

Wrought Iron — *Wrought or "worked" iron is heated and formed by working with tools. The beams and girders of Roebling's later bridges were wrought iron. English engineers called it "malleable" iron. Wrought iron works well in tension and was used for suspension chains and wire cables, suspenders and anchor chain bars.*

Iron Wire — *Iron wire used in suspension bridges is wrought iron. When drawn out into thinner and thinner diameters it gains tensile strength.*

Steel — *Roebling's Brooklyn Bridge was the first use of Galvanized Steel Wire (coated in zinc). It is less susceptible to rust and is stronger*

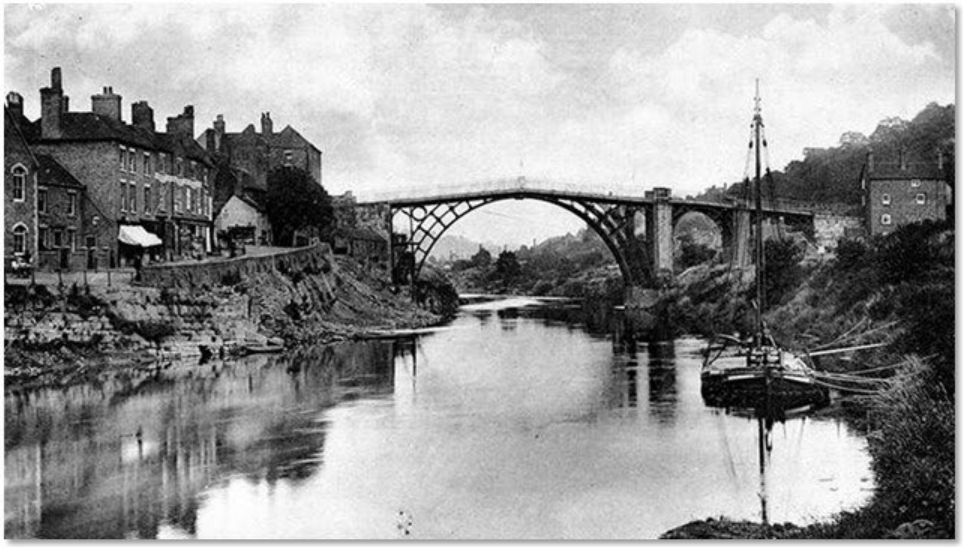
- *The industrial revolution began in England in the 18th century with the development of Cast Iron – which was used to build cast iron arch bridges starting in 1779 at Coalbrookdale. Wrought Iron developed later and would be used in the chains of English suspension bridge which developed starting in 1820 with the work of Samuel Brown.*
- *France would be second to develop both technologies – but their technological growth was slowed from the start of the French Revolution in 1789 until the 1815 Treaty of Vienna and the defeat of Napoleon I. When they began building suspension bridges, they adopted the use of wrought iron wire.*
- *Although American James Finley built the first modern chain suspension bridge in 1801 across Jacobs Creek in Pennsylvania, predating both English & French Engineers, few suspension bridges were built in America from 1816 until 1842 when Charles Ellet Jr. (who was trained in French methods) built the Fairmont Bridge using iron wire cables just outside Philadelphia. John Roebling would build his first iron wire suspension bridge in 1845 – an aqueduct in Pittsburgh across the Allegheny River.*

The Industrial Revolution

The industrial revolution began in England then spread to France and the rest of Europe and then came to America. Cast iron developed first and then wrought iron. For this reason, England has the greatest number of cast iron arch bridges

History | Cast Iron Arch Bridges

1779 Cast Iron Arch at Coalbrookdale
100' span Cast by Abraham Darby



1796 Buildwas across the Severn River
130' span Cast Iron Arch by Thomas Telford

Early Cast Iron Arch Bridges

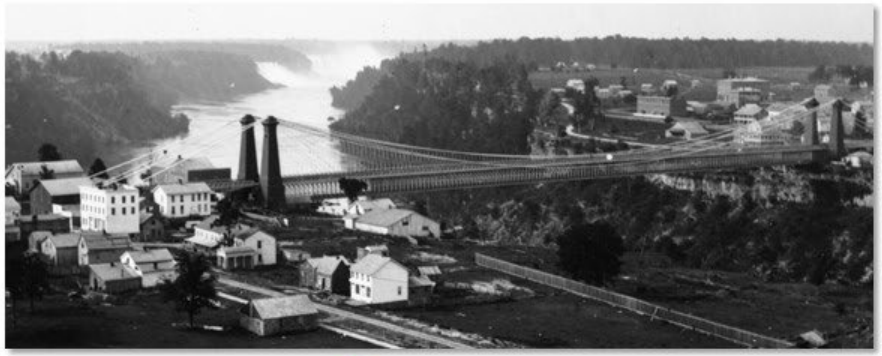
- The 1779 Cast Iron Arch at Coalbrookdale was England's first cast iron arch bridge. The semi-circular arch did no work well to resist the inward forces of the riverbanks.
- Thomas Telford's 1796 span used a shallow arch that worked better structurally to resist inward forces and used less cast iron to span a greater distance.

Roebling before the bridge

History | Why build a Suspension Bridge?

Prior to the advent of modern iron suspension bridges, most bridges were built of either wood or stone. These bridges were built close to the ground and longer distances were accomplished by combining multiple short spans with intermediate masonry piers in the river. Stone piers were targets of winter ice and spring freshets (floods), a disadvantage of this form of construction. Stone bridges also required wooden falsework be put up to support the stone during construction. After construction was complete and the stone arch was self-supporting, the wooden falsework was removed. This method of construction did not work well if the bridge required a long span or if it needed to cross a deep river or gorge, where the bottom was difficult to access, and falsework could not be built.

(from Roebling before the bridge)



1796
Cast Iron Sunderland Wearmouth Bridge

- The top image illustrates the bridge under construction with wooden falsework in place and the bottom image shows the bridge completed.
- A 236-foot span 100 feet above high-water mark, the bridge used components of a prototype cast iron arch bridge built by American Thomas Paine and exhibited in 1790 near Paddington in London, using methods he patented in England in 1788.
- England first large cast iron arch bridge, a 100'-6" span, was built across the River Severn at Coalbrookdale in 1781.

1852-1855 Roebling's Niagara Railway Bridge

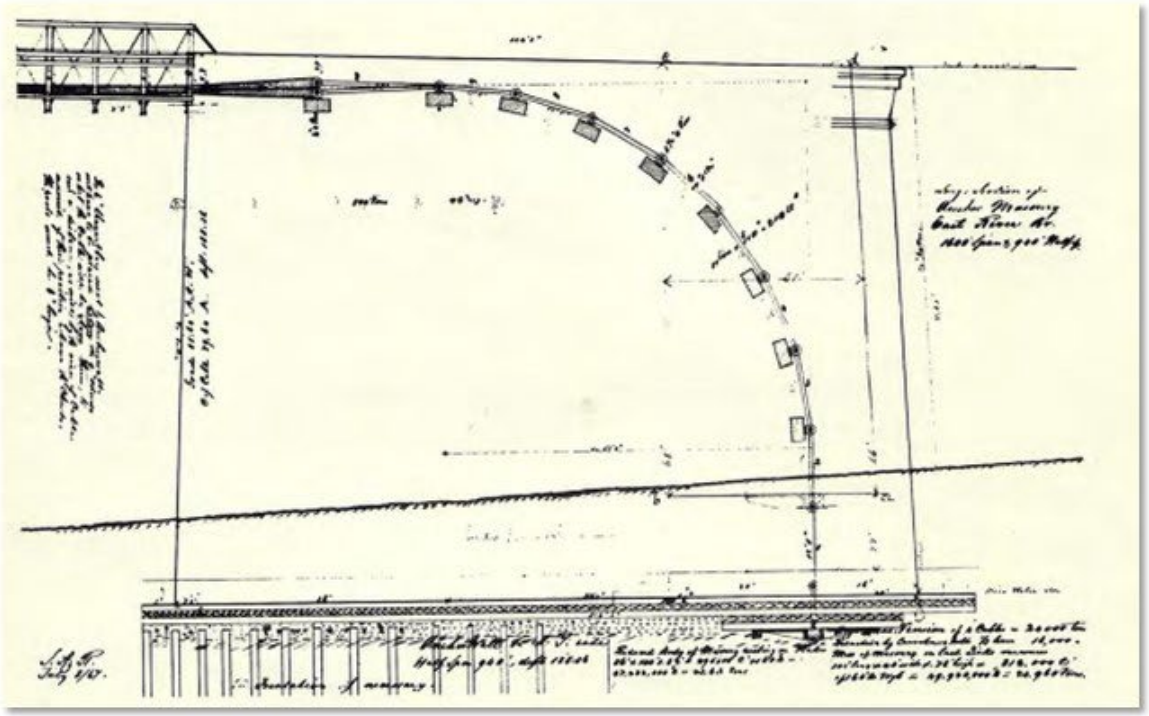
- Built from 1852 to 1855, across the Niagara Gorge – the worlds only successful Railway Suspension Bridge connecting the United States to Canada by railway for the first time.

19th Century | Suspension Bridges

- *Suspension bridges by contrast could be built in difficult locations. **If one could get the first rope across**, any gorge no matter how steep could be spanned and so bridges could now be constructed in locations that were previously impracticable. Suspension bridges simply required a means to anchor the suspended chain or wire cables at either end.*

Roebling before the bridge

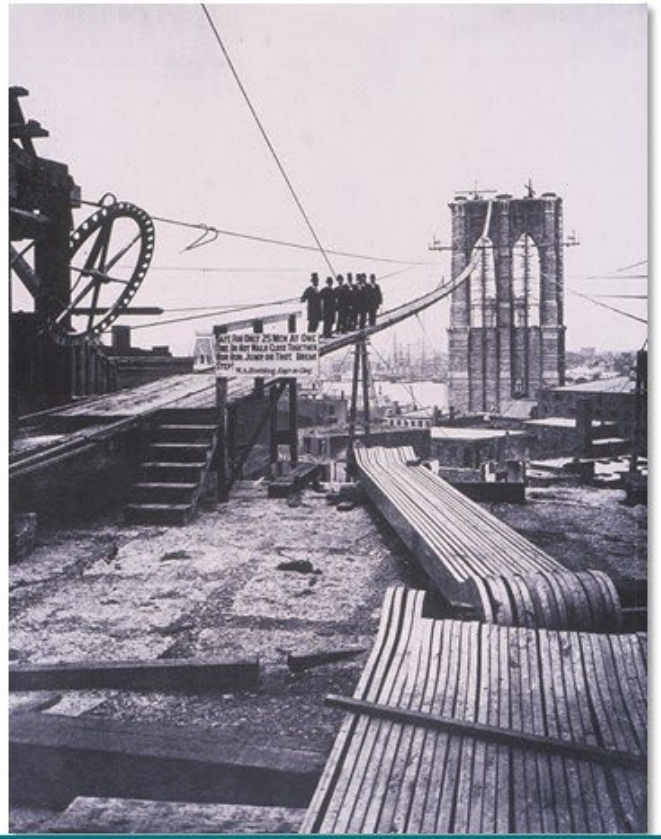
East River – Brooklyn Bridge | The Anchorages



1867 John A. Roebling proposed section of anchorage showing wrought iron anchor chains extending down to wooden timbers and anchor plate. As built wood timbers did not extend above the anchor plate but only as foundation to the masonry work.

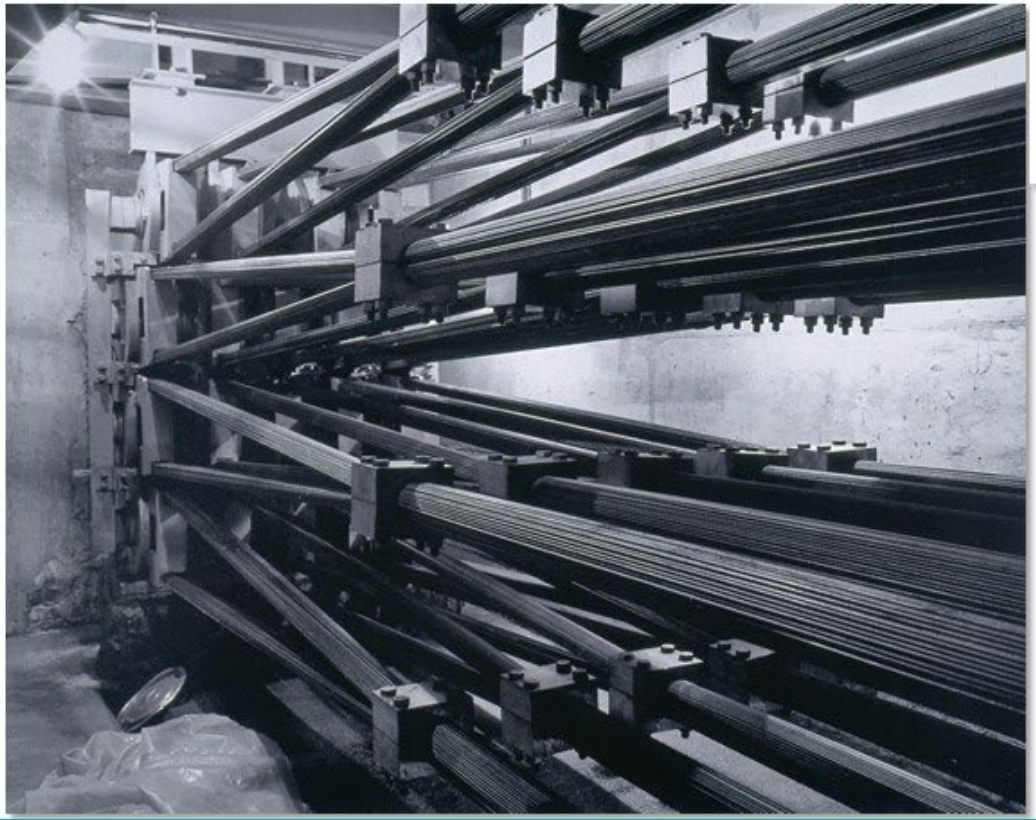
The Anchorage visible from the outside with masonry walls. The cables enter at top.

East River – Brooklyn Bridge | The Anchorages

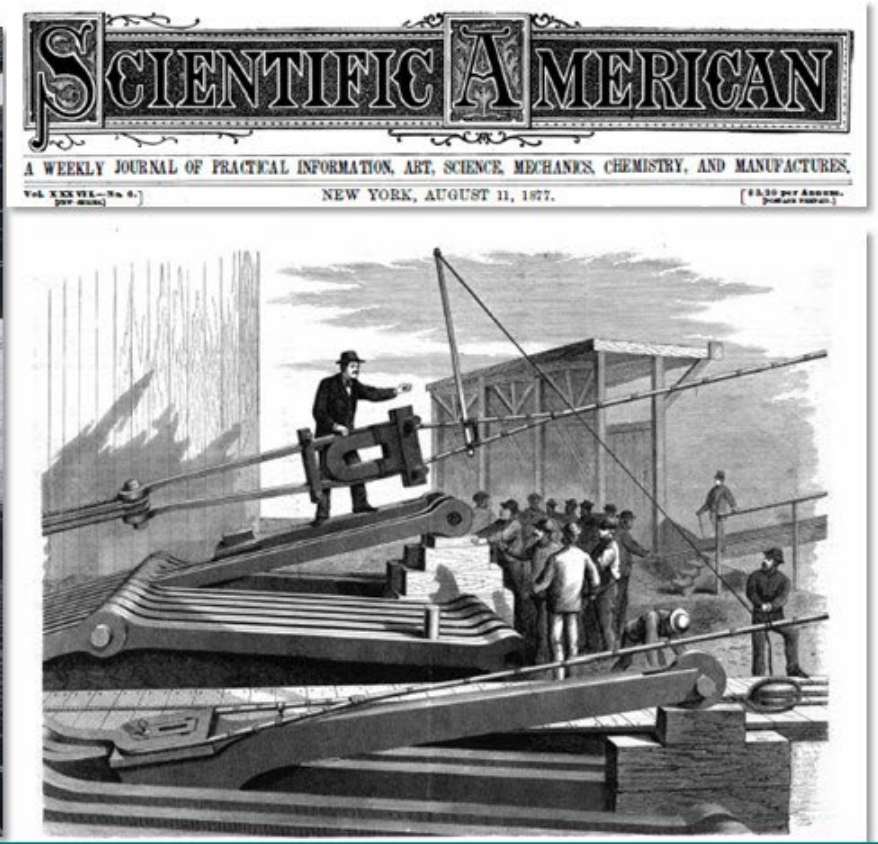


October 1878 - Brooklyn Anchorage - Shows the anchor chains as the extend and transition to the suspension cable strands. Note one of the strands looped around a cast iron shoe rotated horizontally during the spinning & the travelling wheel.

East River – Brooklyn Bridge | The Anchorages



Photograph inside the anchorage showing the 19 steel wire strands splitting to 38 strands to loop around the cast iron shoes



SCIENTIFIC AMERICAN

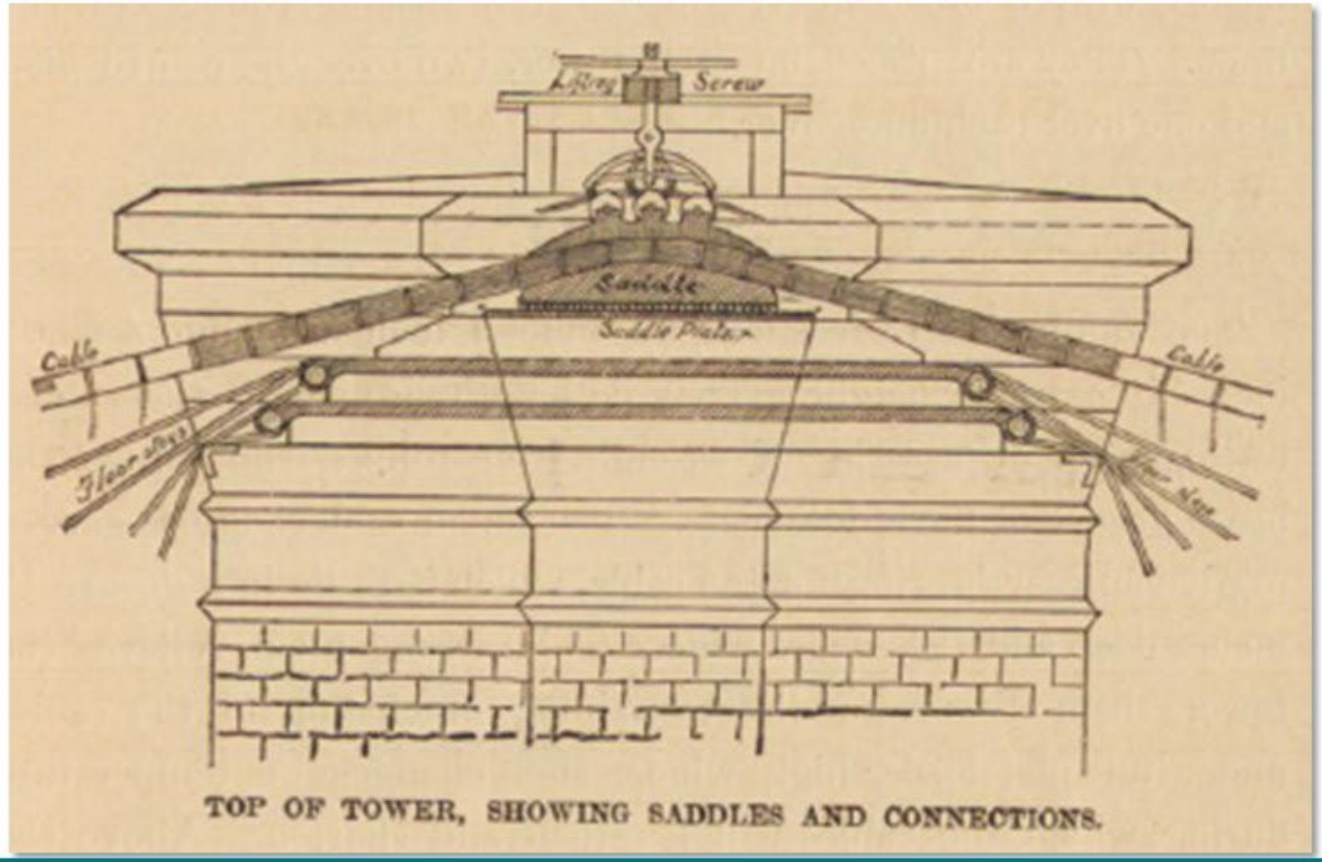
A WEEKLY JOURNAL OF PRACTICAL INFORMATION, ART, SCIENCE, MECHANICS, CHEMISTRY, AND MANUFACTURES.

NEW YORK, AUGUST 11, 1877.

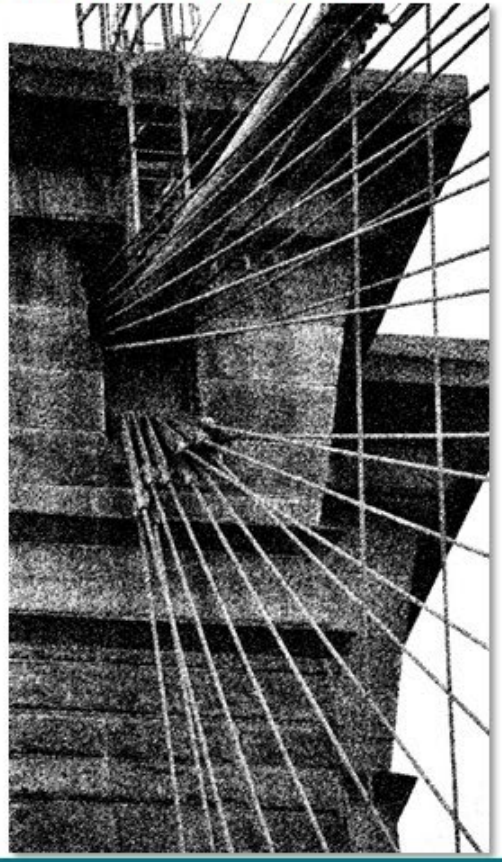
Depiction showing single strand looped around show and held above anchor chains until ready for pinning in place

Roebling before the bridge

East River – Brooklyn Bridge | The Cast Iron Moveable Saddles



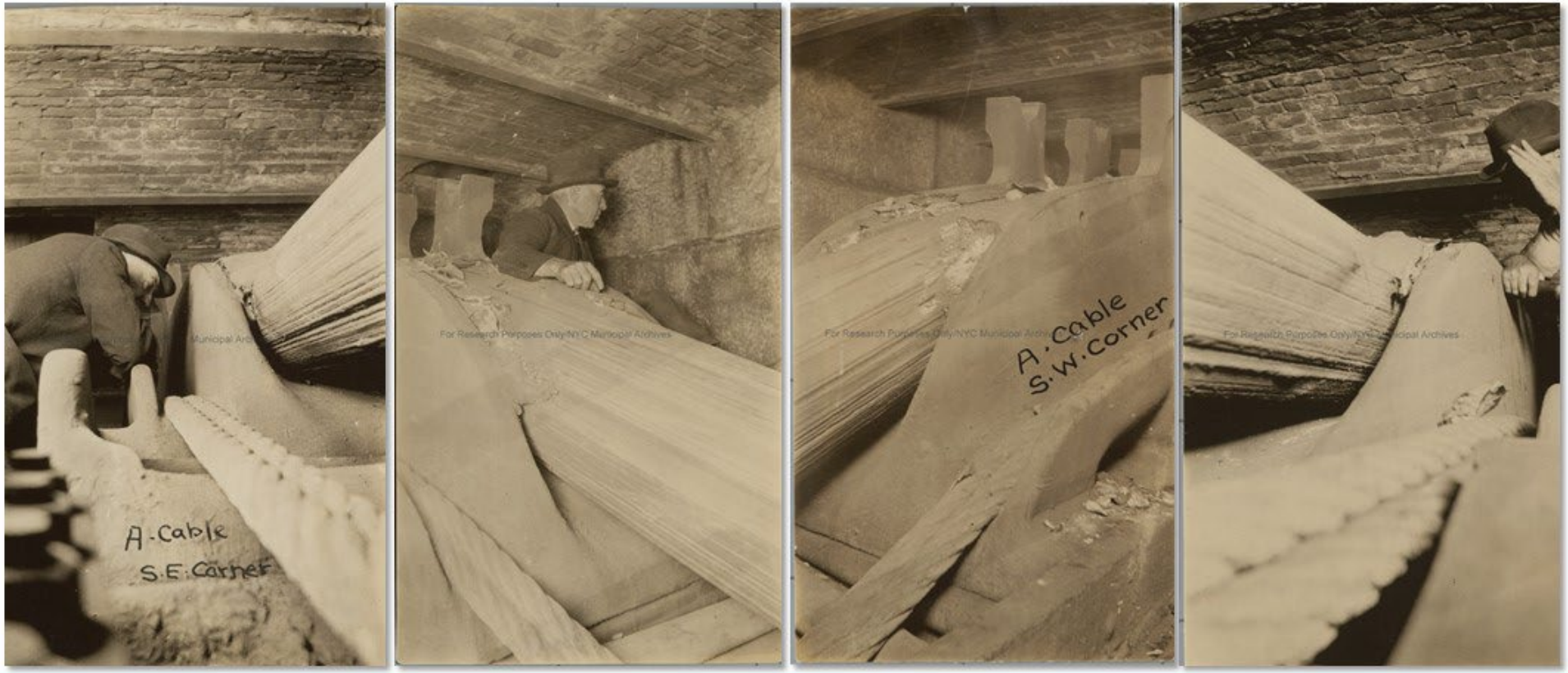
TOP OF TOWER, SHOWING SADDLES AND CONNECTIONS.



Drawing of moveable cast iron saddle on rollers at top of towers. Note the suspension cable is tied periodically prior to wrapping and the fixed diagonal stays are held in place by restraining bars which extend through the masonry.

Roebling before the bridge

East River – Brooklyn Bridge | The Cast Iron Moveable Saddles



Examining the saddles inside the towers.
Note the diagonal stays which run across the sides of the saddles. Also visible is a large roller below the saddle.

Today | Plan your Roebling Road Trip today! – *places to visit*

1848 | The Delaware Aqueduct for the D & H Canal

1866 | Covington & Cincinnati

1883 | The East River / Brooklyn Bridge

D & H Canal Historical Society

- High Falls NY
- https://www.canalmuseum.org/

The Neversink Museum of History & Innovation

- 26 Hoag Road, Cuddebackville, NY 12792
- https://neversinkmuseum.org/

Roebling Museum & the town of Roebling NJ

- 100 2nd Avenue, Roebling NJ 08554
- https://www.roeblingmuseum.org/

Delaware Aqueduct @Lackawaxen PA	Covington & Cincinnati Bridge Kentucky & Ohio	East River Brooklyn Bridge	D & H Canal History Museum The Neversink Museum of History & Innovation Roebling Museum

Roebling before the bridge

End of Day 1 Lecture

Reading Notes Assignments:

- Read Chapter 11
  - History
  - The Material Steel
    - Steel
    - Structural Steel Alloys

- Assignment:
  - Submit 1 to two pages of reading notes
  - hand-written notes and freehand sketches

– *Extra Questions:*

- *What is the difference between cast iron and wrought iron?*
- *What is the difference between iron and steel?*