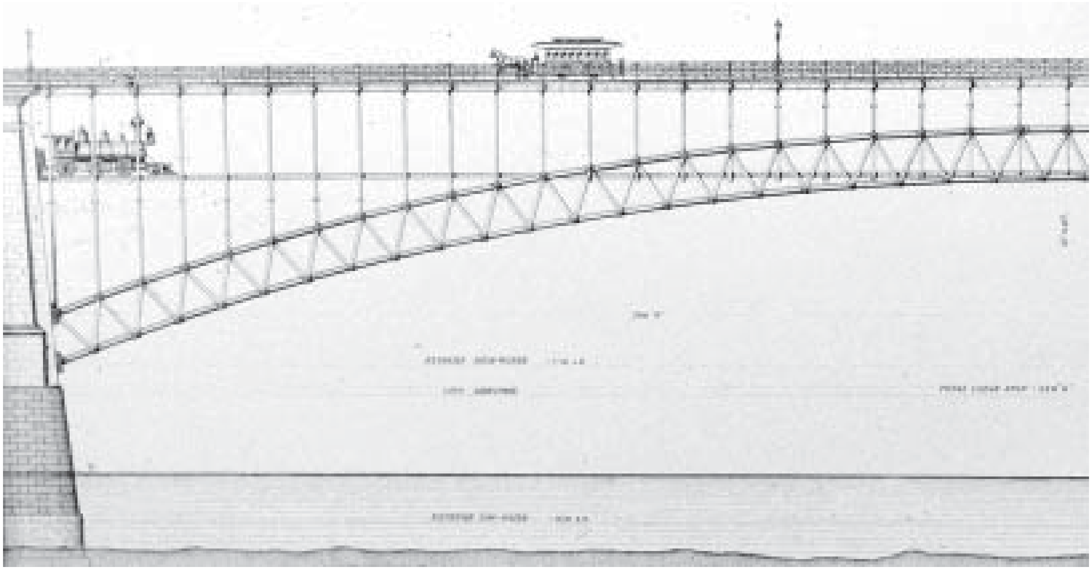

Centuries of Civil Engineering

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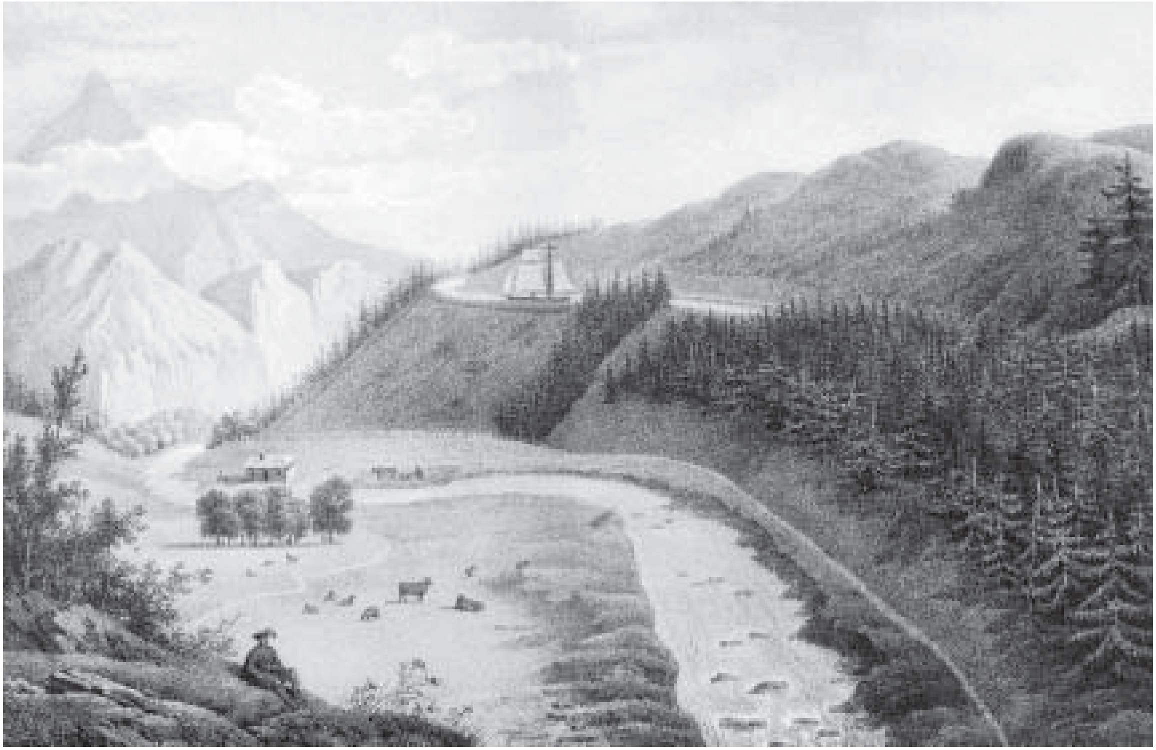

View of the Caledonian Canal, from FLACHAT, S. **Histoire des Travaux et de l'Aménagement des Eaux du Canal Calédonien**. *Paris,* 1828.

Front cover: *Detail of the arches and roadway for the St. Louis Bridge,* from WOODWARD, C.M. **A History of the St. Louis Bridge**. *St. Louis*, 1881.

Exhibit and catalog by William B. Ashworth, Jr. and Bruce Bradley
Photography and design by Bruce Bradley

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Centuries of Civil Engineering

An Exhibition Celebrating the Heritage of Civil Engineering

February 1 - July 31, 2002

LINDA HALL LIBRARY
of Science, Engineering, & Technology
Kansas City, Missouri

This exhibition of rare books is presented in honor of the American Society of Civil Engineers' 150th Anniversary. It celebrates the rich heritage and accomplishments of civil engineers, and the association of the ASCE with the Linda Hall Library of Science, Engineering, and Technology.

Centuries of Civil Engineering draws upon highlights from the Linda Hall Library collections to focus on the historical accomplishments of both American engineers and their European predecessors and counterparts. All of the books displayed in this exhibition are from the collections of the Linda Hall Library, and will be on display in the library's exhibition hall from February 1, 2002 to July 31, 2002.

The Linda Hall Library became the library for the American Society of Civil Engineers in 1995, when the Engineering Societies Library in New York was transferred to the Linda Hall Library in Kansas City. All ASCE publications are now deposited at the Linda Hall Library, where archival copies of all past ASCE publications may also be found.

Canals

Leonardo's Miter Gate

1 LEONARDO da Vinci (1452-1519)

Il Codice Atlantico. *Florence: Gaspero Barbera Editore; Giunti Publishing Group; [New York]: Johnson Reprint Corporation; Harcourt Brace Jovanich, publishers*, 1973-1975.

2 ZONCA, Vittorio (b. ca. 1580)

Novo teatro di machine et edificii per varie et sicure operationi. *Padova: Pietro Bertelli*, 1607.

The Languedoc Canal

3 ANDRÉOSSY, Antonia François, comte (1761-1828)

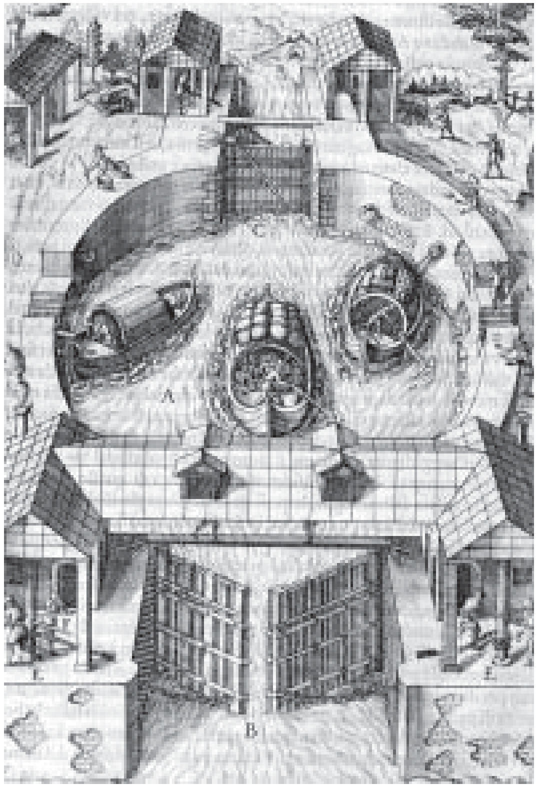
Histoire du Canal du Midi, ou Canal de Languedoc. Nouvelle éd. *Paris: Impr. de Crapelet*, 1804.

The Caledonian Canal

4 **REPORT of the Commissioners of the Caledonian Canal**. London, 1804-1870.

5 FLACHAT, Stephane

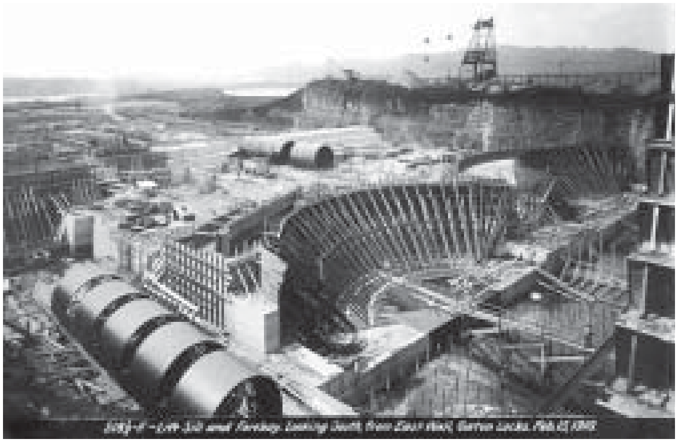
Histoire des Travaux et de l'Aménagement des Eaux du Canal Calédonien. *Paris: Firmin Didot*, 1828.



*Leonardo's Canal Lock***,** from ZONCA, V. **Novo teatro di machine et edificii.** *Padova*, 1607.

Leonardo designed a new type of gate for a canal lock, the miter gate, and it was used for a lock in the canal system of Milan that was completed in 1497. The engraving of a canal lock in Zonca's book, which describes and illustrates a host of mechanical achievements of his time, provides a realistic interpretation of Leonardo's design for a lock with a miter gate. Three small boats are ready to leave the lock, an oval shaped brick basin, just as the miter gate is opened by workmen straining at the windlasses. Nearly all modern water gates follow the principles of Leonardo's design, including the massive gates at Panama.

The Panama Canal



Gatun Locks under construction, Panama, from NICHOLS, A.B. **Panama Canal Notebooks**, 1882-1920.

The American plan for the canal called for locks, rather than a sea-level passage as the French had earlier attempted, and the largest of the various lock sites was Gatun. Three levels of enormous concrete and steel chambers were built in pairs to handle two-lane traffic of ships as large as the Titanic.

A Firsthand Account

6 NICHOLS, A.B.

Panama Canal Notebooks. *Manuscripts, typescripts, maps, blueprints, and printed materials, circa 1906-1920.* 94 volumes

7 NICHOLS, A.B.

Panama Canal Notebooks. *Albums of photographs, circa 1882-1920.* 3 volumes

A.B. Nichols was appointed to the Panama Canal service in 1904, became the Office Engineer at the headquarters in Culebra, and continued to work in the Canal Zone until 1914, when the Panama Canal was completed. Before that, he was in charge of surveys for the Nicaragua route for the U.S. Isthmian Canal Commission from 1899 to 1901. His engineering notebooks, including manuscript notes, typescripts, photographs, blueprints, maps, charts, and scrapbooks, provide a firsthand account of the building of the Panama Canal.

Water Supply

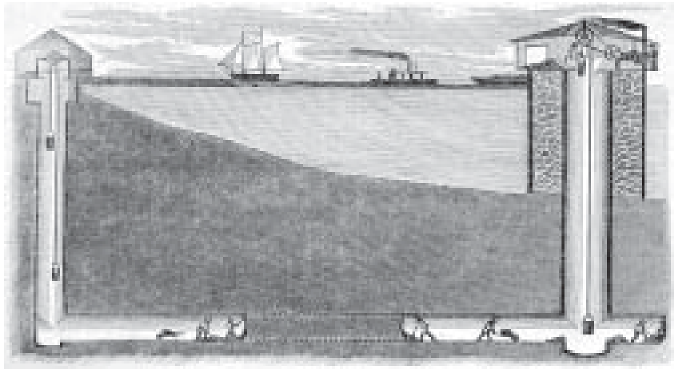
The Lake Tunnel in Chicago

8 **The Great Chicago Lake Tunnel**. *Chicago: Published by Jack Wing*, 1867.

9 **The Tunnels and Water System of Chicago: Under the Lake and Under the River**. *Chicago: J.M. Wing & Co.*, 1874.

10 ERICSON, John (M. Am. Soc. C.E., City Engineer of Chicago)

Report on the Water Supply System of Chicago: Its Past, Present and Future. *Chicago: City of Chicago*, 1905.



Cross section of the Two-Mile Crib and tunnel under the lake, from **The Great Chicago Lake Tunnel**. *Chicago*, 1867.

Reversal of the Chicago River

11 **The Traveling Cableway and Some Other Devices Employed by Contractors on the Chicago Main Drainage Canal**. *New York: Lidgerwood Manufacturing Co.*, 1895.

12 HILL, Charles Shattuck (C. E.)

The Chicago Main Drainage Channel: A Description of the Machinery Used and Methods of Work Adopted in Excavating the 28-mile Drainage Canal from Chicago to Lockport, Ill. *New York: The Engineering News Publishing Co.*, 1896.

Lake Michigan provided a plentiful and easily accessible supply of fresh water for Chicago in the mid-nineteenth century. But the city dumped its sewage into the Chicago River, and since the river ran right into the lake, the water supply grew increasingly contaminated. Ellis Chesbrough solved the problem in 1863 by designing a two-mile tunnel out into the fresher waters of Lake Michigan. A notable feature of the plan was the Two-Mile Crib, a mammoth timber intake structure launched in 1865 and placed in clean, deep waters on top of the lake-end of the tunnel. A more permanent solution to the problem was finally achieved by the monumental feat of reversing the flow of the Chicago River, so that it now flows from Lake Michigan into the Mississippi.

Monuments

Crossing the Hudson River Railroad, from GORRINGE, H. **Egyptian Obelisks**. *New York, 1882.*

On July 20, 1880, a ship carrying an ancient Egyptian obelisk docked in New York to begin the final stage of an engineering project that started several months earlier in Alexandria, Egypt. The project engineer, Lieutenant Commander Henry H. Gorringe, had successfully removed the obelisk known as Cleopatra's Needle from the site where it had stood, leaning slightly toward the sea, since the time the Romans had moved it from its original site in Heliopolis. Several weeks later the obelisk was placed in its present position near the Metropolitan Museum of Art in Central Park – a gift of the Egyptian government to the people of the United States.

Moving the Vatican Obelisk

13 FONTANA, Domenico (1543-1607)
Della Trasportatione dell' Obelisco Vaticano. *Rome: Appresso Domenico Basa*,1590.

Cleopatra's Needle comes to New York

14 GORRINGE, Henry H. (1841-1885)
Egyptian Obelisks. *New York: Published by the Author*, 1882.

The Monument to Peter the Great

15 CHARBOURES, Marinos, komis (d. 1782)
Monument élevé a la gloire de Pierre-le-Grand. *Paris: Nyon ainé, libraire; Stoupe, imprimeur-libraire*, 1777.

Bridges

The Strength of Materials

16 GALILEI, Galileo (1564-1642)

Discorsi e dimostrazioni matematiche, intorno à due nuoue scienze. *Leiden: appresso gli Elsevirii*, 1638.

Designing an Arch

17 HOOKE, Robert (1635-1703)

Lectiones Cutlerianæ, or A collection of lectures: physical, mechanical, geographical, & astronomical. *London: Printed for John Martyn*, 1679.

The Dresden Bridge

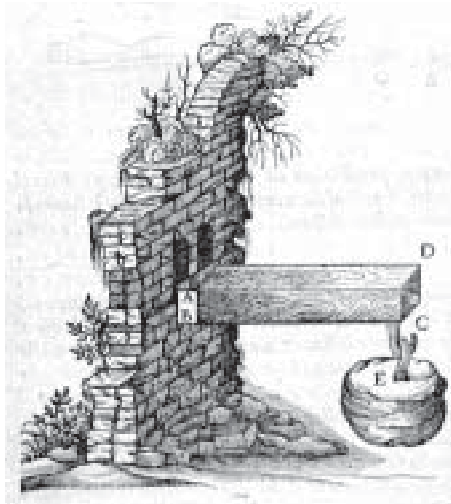
18 SCHRAMM, Carl Christian

Historischer Schauplatz, in welchem die merkwürdigsten Brücken aus allen vier Theilen der Welt, insonderheit aber die in den vollkommensten Stand versetzte Dressdner Elb-brücke ... vorgestellet und beschrieben werden. *Leipzig: B.C. Breitkopf*, 1735.

The Pont de Neuilly

19 PERRONET, Jean-Rodolphe (1708-1794)

Description des projets et de la construction des ponts de Neuilly, de Mantes, d'Orléans & autres; du projet du canal de Bourgogne, pour la communication des deux Mers par Dijon. *Paris, De l'Imprimerie royale*, 1782-83.



Demonstration of the breaking force on a beam, from GALILEI, Galileo. **Discorsi e dimostrazioni matematiche, intorno à due nuoue scienze**. *Leiden*, 1638.

One of the "Two New Sciences" that Galileo offered to the world in 1638 was the science of strength of materials, which analyzed the way that the size and shape of structural members affect their ability to carry and transmit loads. Galileo discovered that as the length of a beam increases, its strength decreases, unless you increase the thickness and breadth at an even greater rate. You cannot, therefore, simply double or triple the dimensions of a beam, and expect it to carry double or triple the load. The illustration of a cantilever beam demonstrates Galileo's discovery that the breaking force on a beam increases as the square of its length.

Bridges of the British Isles

Crossing the Menai Straits to the Isle of Anglesey, from KNIGHT, E.H. **Knight's American Mechanical Dictionary**. *New York*, 1876.

The Menai Straits in Wales formed a major obstacle to the construction of the London-Holyhead road that leads on to Dublin. The straits were first successfully bridged by Thomas Telford in 1826, with what was then the world's longest suspension bridge; the Telford bridge can be seen in the distance in the view above. In 1849 Robert Stephenson completed a tubular bridge of wrought iron to carry the first railway across the Straits; his Britannia Bridge, as it is called, is seen in the foreground.

The Menai Suspension Bridge

20 TELFORD, Thomas (1757-1834)

Life of Thomas Telford, Civil Engineer. Ed. by John Rickman. *London: Payne and Foss*, 1838.

The Britannia Bridge

21 KNIGHT, Edward H. (1824-1883)

Knight's American Mechanical Dictionary. *New York: Hurd and Houghton,* 1877 [c1876]

22 CLARK, Edwin (M.I.C.E.)

The Britannia and Conway Tubular Bridges. *London: Day and son [etc.],* 1850.

23 TOMLINSON, Charles (1808-1897)

Cyclopædia of Useful Arts, Mechanical and Chemical, Manufactures, Mining, And Engineering. *London, New York: G. Virtue & co.,* 1854.

24 DEMPSEY, G. Drysdale (d. 1859)

Tubular and Other Iron Girder Bridges, Particularly Describing the Britannia and Conway Tubular Bridges. *London: John Weale*, 1850.

The Forth Bridge

25 WESTHOFEN, W.

The Forth Bridge / Reprinted from "Engineering", February 28, 1890. 3rd ed, revised. *London: Offices of "Engineering"* [1890?].

Missouri Bridges

The Kansas City Bridge

26 CHANUTE, Octave (1832-1910) and George MORISON (1842-1903)

The Kansas City Bridge, with an Account of the Regimen of the Missouri River, and a Description of Methods Used for Founding in that River. *New York: D. Van Nostrand*, 1870.

A view from the southwest of the Kansas City Bridge across the Missouri River, August 2, 1869, from CHANUTE, O. **The Kansas City Bridge**. *New York*, 1870.

In 1869 Kansas City was still a minor town, much smaller and less important than Leavenworth to the north. The Kansas City Bridge (later called the Hannibal Bridge) changed that situation quite rapidly. Designed and erected by Octave Chanute, the bridge was the first across the Missouri River, and it made Kansas City into a railroad hub and a center for westward expansion. The bridge was constructed of wrought iron, sitting on limestone piers, with a swing section to allow shipping to pass through. It was replaced by a steel bridge in 1916.

The St. Louis Bridge

27 "The Great Bridge at St Louis: Erection of the Superstructure." **Scientific American**, Nov. 15, 1873, p. 311.

28 "Method of Sinking Foundations for the Piers of the St. Louis Bridge," **Engineering**, Feb 3, 1871, pp. 80-81.

29 WOODWARD, C. M. (1837-1914)

A History of the St. Louis Bridge. *St. Louis: G. I. Jones and Company*, 1881.

30 KEYSTONE BRIDGE COMPANY.

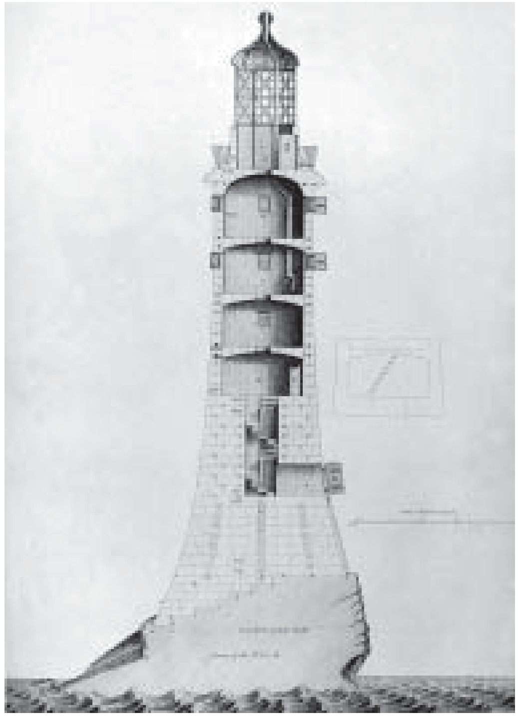
Descriptive Catalogue of Wrought-Iron Bridges, Fire-Proof Columns and Floor Girders … Manufactured by the Keystone Bridge Company. [*Philadelphia: Allen, Lane, and Scott*, 1874].

Closing the east arch of the St. Louis Bridge, from **Scientific American**, Nov. 15, 1873.

The St. Louis Bridge over the Mississippi River was designed by James Buchanan Eads. He chose an arch construction, with the arches made of cast steel tubes. It was the first use of cast steel in a major bridge. The arches were erected from each pier or abutment and supported by cantilevers until they could be joined at the center. The process of closure was a tricky one, as all eight tubes had to join precisely and simultaneously. This view shows the final closing of the east arch, which was successfully accomplished in September 1873.

Eddystone Lighthouse south elevation, from SMEATON, J. **A Narrative of the Building and a Description of the Construction of the Edystone Lighthouse**. *London,* 1791.

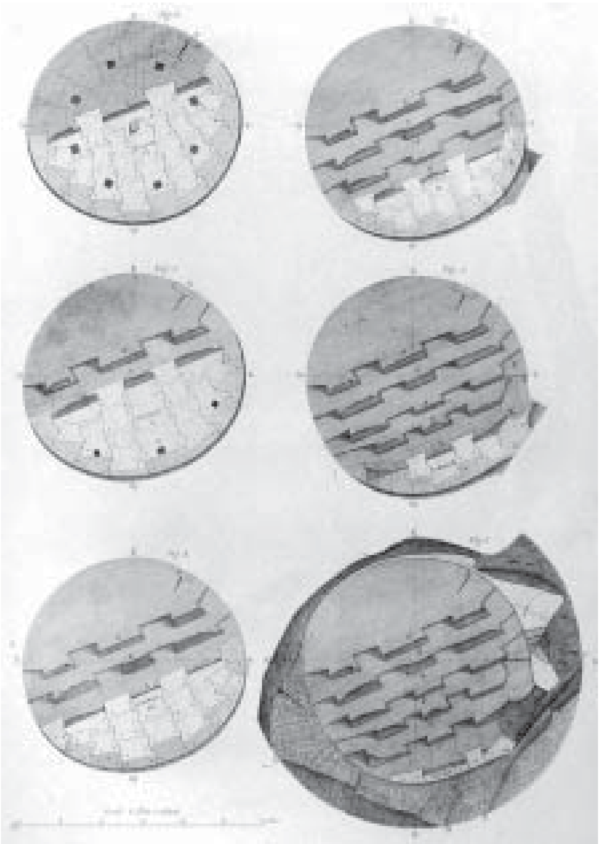
The Eddystone rocks, in the English Channel off Plymouth, were a considerable danger to shipping in the seventeenth century. The first lighthouse erected there, in 1698, washed away within five years; a second, built of timber, burned in 1755. The third and the most famous Eddystone Lighthouse was completed by John Smeaton in 1759. Smeaton modeled its shape after an oak tree, giving it a broad base and a slender top.



Eddystone Lighthouse cross section, from SMEATON, J. **A Narrative of the Building and a Description of the Construction of the Edystone Lighthouse**. *London,* 1791.

The section of the Smeaton lighthouse of 1759 shows why it was successful at resisting the continual battering of the sea. Each course or level was made of carefully cut stones that interlocked with each other, and each course was secured to the courses above and below by pins. It took two years to build the lighthouse under the most difficult of conditions in the stormy channel. But it stood for 130 years before it was replaced by a larger structure.

Lighthouses



The six foundation courses of the Eddystone Lighthouse, from SMEATON, J. **A Narrative of the Building and a Description of the Construction of the Edystone Lighthouse**, *2nd ed. London*, 1793.

The rock upon which the Eddystone Lighthouse was erected had an irregular shape, like a rough trapezoid. To level it out, and to secure the structure to the rock, Smeaton cut dovetails into the rock to hold the stones. The lowest course had only four stones, carefully fitted to the dovetails and then pinned. Five more courses were needed to create a level base for the rest of the tower. The six views above show the dovetail designs for each of the six foundation courses.

Eddystone Lighthouse

31 SMEATON, John (1724-1792)

A Narrative of the Building and a Description of the Construction of the Edystone Lighthouse with Stone. *London: Printed for the author by H. Hughs*, 1791.

32 SMEATON, John (1724-1792)

A Narrative of the Building and a Description of the Construction of the Edystone Lighthouse with Stone. 2nd ed. *London: Printed for G. Nichol*, 1793.

The New Eddystone Lighthouse

33 EDWARDS, E. Price.

The Eddystone Lighthouses (New and Old): An Account of the Building, and General Arrangements, of the New Tower. *London, Simpkin, Marshall*, 1882.

Viaducts & Aqueducts

The Crumlin Viaduct

34 HUMBER, William (1821-1881)

A Practical Treatise on Cast and Wrought Iron Bridges and Girders, as Applied to Railway Structures, and to Buildings Generally. *London: E. & F. N. Spon*, 1857.

The Kinzua Viaduct

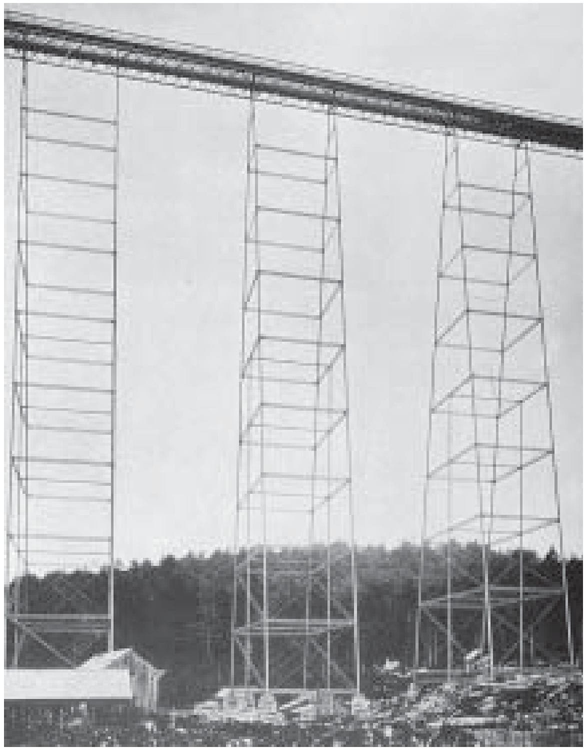
35 PHOENIX BRIDGE COMPANY

Album of Designs of the Phoenix Bridge Company : Successors to Clarke, Reeves & Co., Phoenixville Bridge Works. *Philadelphia: J.B. Lippincott*, 1885.

Croton Aqueduct

36 TOWER, F. B.

Illustrations of the Croton Aqueduct. *New York and London: Wiley and Putnam*, 1843.



Towers of the Kinzua Viaduct, from PHOENIX BRIDGE COMPANY, **Album of Designs**. *Philadelphia*, 1885.

The Kinzua Viaduct was built to carry coal trains across the Kinzua Creek Valley in western Pennsylvania. It was constructed in just over 100 days in the summer of 1882, and, with a maximum height of 302 feet and a total length of 2,050 feet, it was one of the highest and longest viaducts in the world. It was built by the Phoenix Bridge Company, who featured the bridge in their trade album of 1885. Because of increasing train loads, the entire structure was replaced by a similar but stronger steel viaduct in 1900.

Detail of a tube under construction for the Britannia Bridge, from CLARK, E. **The Britannia and Conway Tubular Bridges**. *London,* 1850.

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