Brooklyn Bridge
Location: Manhattan and Brooklyn, New York, USA
 ► **First settlement in Brooklyn - 1636 by Dutch Farmers**

 ► **First ferry between Brooklyn and Manhattan - 1642, operated by Cornelius Dircksen, a row boat**

 ► **State Legislature receives petition to construct a bridge over the East River - 1802**
New York Legislature considers a bill to build a bridge over the East River – 1857

- Brooklyn population 1860 - 266,000
- Brooklyn population 1870 - 396,000 - 50% increase, the fastest growing city on the country

Bill passed by the New York State Legislature for construction - 1866
Manhattan Bridge opens 1909
Vital Statistics

- Total length: 5,989 feet
- Length of main span: 1,595 feet, 6 inches
- Length of approach:
  - 971 feet (Brooklyn approach)
  - 1,562 feet, 6 inches (Manhattan approach)
- Overall width: 85 feet
- Height of towers: 273 feet
- Depth of tower foundation below high water mark: Brooklyn tower: 45 feet
- Manhattan tower: 78 feet
- Size of tower at high water line: 140/59 feet
► Total height of tower above high water: 277 feet
► Clear height of bridge in center of river span above high water: 119 feet, 3 inches
► Grade of roadway: 3 ¼ feet in 100 feet
First to Jump from Bridge: May 19, 1885
R.E. Odlum (he died from the jump)
Plan of One Tower for the East River Bridge, 1867. From the National Archives.
ELEVATION OF BRIDGE, SHOWING TEMPORARY ROPES USED IN CABLE-MAKING.
SITUATION PLAN OF BROOKLYN APPROACH.

SITUATION PLAN OF NEW YORK APPROACH.
Date work began on Bridge - 2 January 1870, clearing the site for the Brooklyn Tower
RELICS FROM THE FOUNDATION.
Caisson details drawn by Roebling
102 feet by 172, be built to a thickness of 22 feet of dense Southern pitch-pine in timbers twelve inches square, laid in solid courses crossing each other, fastened with powerful through-bolts. The whole cavernous interior be lined with boiler iron, seamed air-tight, for its perfection as a diving-bell, and for protection against the danger of fire.
► Initial rate of caisson excavation and lowering - 6 inches per week (DBS)
► Workforce on Brooklyn Tower - 360 (DBS)
► Maximum air pressure in Brooklyn Caisson - 23 psig
AIR LOCK.
The caisson was placed in its berth in October, 1871, and rested on the rock in May, 1872, after less than one year's work in sinking it to its bed.
The Brooklyn tower was completed in May, 1875, and the New York tower in July, 1876.
Mr. E. F. Farrington, the master-mechanic

Friday afternoon, August 25, 1876
Wires, not twisted, but laid parallel, and bound together by a continuous wrapping of wire.

The wires are of size No. 7, or a little over one-eighth inch in thickness; they number over 5000 in each cable, and make a bundle 15 3/4 inches thick.
The great steel cables, fifteen and three-quarter inches in diameter
► Each cable contains nineteen strands of 278 wires each.
► Each skein is a continuous wire almost exactly one million feet, or nearly 200 miles, in length, passing from anchorage to anchorage, back and forth, 278 times.
After a skein is fully laid in position (passing, of course, over the tops of the towers) it is compressed to a cylindrical form at every point by large clamp tongs, and tightly bound with wire at intervals of about fifteen inches throughout its length.
THE DRUMS—SPLICING THE WIRES.
SECTION OF TOWER, SHOWING SADDLE-PLATE AND LOWERING OF STRAND INTO POSITION.
The running and regulating of the cable wires commenced June 11, 1877, and the last wire was run over October 15, 1878.
The anchorages are solid cubical structures of stone masonry, measuring 119 by 132 feet at the base, and rising some 90 feet above high-water mark. Their weight is about 60,000 tons each, which is utilized to resist the pull of the cables.

These plates measure 16½ by 17½ feet on the face, and are 21 feet thick at the centre. The weight of each plate is over 46,000 pounds.

The anchorages are solid cubical structures of stone masonry, measuring 119 by 132 feet at the base, and rising some 90 feet above high-water mark. Their weight is about 60,000 tons each, which is utilized to resist the pull of the cables.
THE GREAT EAST RIVER SUSPENSION BRIDGE.

1877
The weight of the whole suspended structure (central span), cables and all, is 6740 tons, and the maximum weight with which the bridge can be crowded by freely moving passengers, vehicles, and cars is estimated at 1380 tons, making a total weight borne by the cables and stays of 8120 tons, in the proportion of 6920 tons by the cables and 1190 tons by the stays.

The stress (or lengthwise pull) in the cables due to the load becomes about 11,700 tons, and their ultimate strength is 49,200 tons.
1883 Opening
Bridge opened to public: May 24, 1883 at 2:00 PM
Total of 150,300 people crossed opening day.
People charged 1 cent to cross, 3 cents thereafter

Box office opens on Brooklyn side to sell toll tickets - 11:20 PM (5/23)
New York ticket office opens - 11:30 PM (5/23)
World Record Status at Time of Completion

► Fifty percent longer than any suspension bridge (total length)
► First use of pneumatic caissons
► First Steel Cable Suspension Bridge
Brooklyn Bridge Traffic: - 144,000 Vehicle Crossings (average weekday in 1998)

By comparison:
- Queensboro Bridge - 192,000 vehicles
- Williamsburg Bridge - 110,000
- Manhattan Bridge - 78,000
Bridge opened to vehicles: May 24, 1883 at 5:00 PM after speeches at opening ceremony.

Total of 1800 vehicles crossed on the first day.

Vehicles charged 5 cents to cross.
► First Passenger Train over bridge: September 1883
► Last Train over bridge: 1948
PRESENT APPEARANCE OF THE NEW YORK TERMINAL
EASTERN END OF BROOKLYN STATION, SHOWING THE BROOKLYN ELEVATED RAILWAY STATION.
The bridge was designed by an architectural firm owned by John Augustus Roebling in Trenton, New Jersey.

- Roebling and his firm had built smaller suspension bridges, such as the John A. Roebling Suspension Bridge in Cincinnati, Ohio and the Waco Suspension Bridge in Waco, Texas, that served as the engineering prototypes for the final design.
John A. Roebling birthdate - June 12, 1806
John A. Roebling birthplace - Muehlhausen, Thuringia (Prussia)
John A. Roebling education - Civil Engineering Royal Polytechnic Institute of Berlin, 1826
John A. Roebling immigrated - 1831 (to Pennsylvania intending to be a farmer)
In the summer of 1869, while engaged in fixing the location of the Brooklyn tower, a ferry-boat entering the slip thrust the timbers on which he stood in such a manner as to catch and crush his foot.

The injury resulted in lock-jaw, he died of tetanus (破傷風) sixteen days after.
How tough was John Roebling? - Declined anesthetic for the amputation of his toes crushed in the 9 July 1869 accident.

John A. Roebling's Age at Death - 63
1806 - Born in Muhlhausen, Prussia.
1826 - Graduates from Royal Polytechnic School of Berlin (Civil Engineer).
1836 - Marries Johanna Herting.
1837 - Farming community fails; works as a surveyor.
1842 - First successful use of Roebling's wire rope: Allegheny Portage RR.

1845 - Completes first suspension bridge: Allegheny Aqueduct for Main Line Canal in Pittsburgh (removed 1861).

1846 - Smithfield Street Bridge, Pittsburgh (replaced 1883).

1847—1851 - Builds four D&H Canal aqueducts (three removed after 1898).
► 1850 - Founds wire rope factory in Trenton.
► 1855 - Bridge at Niagara Falls (removed 1897).
► 1860 - Sixth Street Bridge, Pittsburgh (removed 1893).
► 1867 - Cincinnati Bridge completed. Begins plans for Brooklyn Bridge.
► 1869 - Dies of tetanus from accident at Brooklyn Bridge site. Son, Washington Roebling, carries on John Roebling's work.
► 1883 - Brooklyn Bridge completed under the direction of Washington Roebling and his wife Emily.
His son, Washington, succeeded him, but was stricken with caisson disease (decompression sickness), due to working in compressed air with the sandhogs, and was only capable of limited speech or movement.

Date W. Roebling is stricken by caisson disease, becoming an invalid - Early summer 1872
Washington's wife, **Emily Warren Roebling**, trained herself in engineering so she could communicate his wishes to the builders.

Washington Roebling was unable to leave his home and watched the construction through a telescope.

When the bridge opened she was also the first person to cross it.
Emily Warren Roebling (1843 – 1903)

Her husband Washington Roebling was struck down with caisson disease (decompression sickness) during the works.

Emily Roebling then became a constant advocate of her husband and became his spokesman.

She taught herself civil engineering and directed much of the work during the final stages of the building of the bridge.
At first I thought I would succumb, but I had a strong tower to lean upon, my wife, a woman of infinite tact and wisest counsel.

--WASHINGTON ROEBLING
Emily Warren Roebling was born in 1843, in a small town called Cold Springs. She was the second youngest of twelve Warren children. However, only six of the twelve children survived past childhood. The Warren family was one of the prominent families in the county.

Cold Springs is in the upper Hudson Valley and is near the river. Because of this she knew the way of a life based upon a river and was very familiar with the Hudson itself. The town of Cold Springs was not a rich town in itself and the Warrens were not wealthy people. However, they were considered to be people of high social standing. The town was mostly made up of people who were distinguished artists and literary writers. This was the society in which Emily was raised.
On January 18, 1865, Emily got married to Washington Roebling in a small brick church on Main Street. His love for her is shown in his description of her found in a letter to his sister:

"I would send you a little tintype [of Emily] if it didn't happen to be such a horrid picture, not doing a particle of justness to the subject. Some people's beauty lies not in the features but in the varied expression that the countenance will assume under the various emotions, etc., etc. She is dark-brown eyed, slightly pug-nosed, lovely mouth and teeth, no dimples in her cheeks, like Laura the corners of the mouth supply that, and a most entertaining talker, which is a mighty good thing you know, I myself being so stupid. She is a little above medium size and has a most lovely complexion..." (McCullough, 454)
As her husband was observing the construction from afar, Emily made inspection visits to the Brooklyn Bridge everyday.

- As time progressed, the number of jobs and tasks Emily Roebling took on increased.
- She soon began taking her husband’s visitors - answering the questions of the bridge officials, representatives and contractors.

It is said that she answered their questions so well that many of these businessmen believed that she was the Chief Engineer.
Other tasks that Emily often completed included:

- Keeping all the records;
- Answering Washington Roebling’s mail;
- Delivering messages and requests to the bridge office;
- Representing Washington at social functions.
Emily's Monumental Accomplishment

► One of the things Emily Roebling is most famous for stemmed from representing her husband at one of these social gatherings.

► Emily Roebling was the first woman to ever address the American Society of Civil Engineers.

► Emily spoke at this meeting to defend her husband after questions arose of his ability to head the Brooklyn Bridge project.

► These questions were caused by an increase in the estimated cost and time required to complete the project.
"At first she was credited only with brushing up [her husband’s] English, which may have been the case. But by and by it was common gossip that hers was the real mind behind the great work and that this, the most monumental engineering triumph of the age, was actually the doing of a woman, which as a general proposition was taken in some quarters to be both preposterous and calamitous. In truth she had by then a thorough grasp of the engineering involved. She had a quick and retentive mind, a natural gift for mathematics, and she had been a diligent student during the long years he had been incapacitated"
Although never planning on being an engineer, Emily Roebling accomplished what was a huge engineering feat at the time. Throughout her work on the Brooklyn Bridge, she made many advances for women engineers. Emily later died in 1903 at the age of 60.