

# The Brooklyn Bridge: tragedy overcome (part 2)



**Sean Brady** concludes the story of the Brooklyn Bridge, detailing how Emily Roebling defied the odds to see the project to completion.

## People's Day

It became known as the People's Day. From early morning on 24 May 1883 crowds began to descend on New York and Brooklyn<sup>1</sup>. Over 50 000 people arrived into the city by train, with a similar number arriving by boat. By noon all the hotels had sold out. It was a clear, sunny day and the East River was thronged with boats waiting for the spectacle that was about to unfold. Shops sold pictures of John and Washington Roebling, buildings were draped in red, white, and blue banners, and flags flew along Fifth Avenue and Broadway.

At 12:40pm, Chester A. Arthur, the 21st President of the USA, walked out of the Fifth Avenue Hotel and the waiting crowd went wild<sup>2</sup>. The President, along with New York Governor, Grover Cleveland, Congressman Henry Slocum, and New York Mayor, Franklin Edson, began the procession along Fifth Avenue to 14th Street. The 'Dandy' Seventh Regiment and its band led the way, crowds were immense, and the procession turned onto Broadway. As they approached the New York side of the newly completed Brooklyn Bridge (Figure 1), the President was greeted by William Kingsley, a wealthy contractor. For 14 years, the residents of New York and Brooklyn had watched the bridge take shape above the city's skyline, and when the President took his first step onto its span, the guns of nearby Fort Hamilton and the Navy Yard erupted in celebration.

While thousands of people would spend the afternoon and evening walking this engineering marvel, the formalities continued with over three hours of speeches being delivered to an invited crowd of 6000 guests. Among the guests was Emily Warren Roebling, wife of the chief engineer (Figure 2). While it may have looked like



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Emily was simply representing her husband, who couldn't attend because of illness, all changed when Congressman Abram S. Hewitt took to the podium and publically proclaimed Emily's role in what had been one of the most significant engineering achievements ever undertaken.

To many it was a revelation, but to those intimately involved in the bridge's construction, there was little surprise in the praise being afforded to Emily. To them, her contribution had been staggering, and all the more remarkable given the barriers to women taking such an active role in society, especially in the male-dominated profession of engineering.

## Prelude

Emily Warren was born in the village of Cold Spring in upstate New York in 1843<sup>3</sup>. She was the 11th of 12 children, and although they were not wealthy by Hudson River standards, they were a distinguished family. She attended Georgetown Visitation Convent in Washington D.C., with her studies including algebra, geometry, astronomy, chemistry and geology<sup>2</sup>. She became an expert horsewoman – a pursuit she continued into her adult life, despite it being viewed as 'inappropriate' for the 19th century lady. But Emily paid little heed to the limitations society imposed on her.

With the American Civil War under way,

**Figure 1**  
Brooklyn Bridge as it stands today

Emily visited her brother and attended a military ball. There she met a shy young engineer, Colonel Washington Roebling. The attraction between them was immediate. Over the course of the war they would correspond regularly, and in 1865 they married.

Both their lives would be changed dramatically when Washington's father, John Roebling, was appointed chief engineer for the Brooklyn Bridge. Tragically, he would die as a result of injuries sustained in a freak accident, leaving Washington, then only 32 years old, as chief engineer with the responsibility for finishing the bridge. Emily rekindled her interest in mathematics, but this time extended her studies to learn about strength of materials, stress analysis, cable construction, and calculation of catenary curves<sup>3</sup>. She was of the view that knowledge of such subjects would be of assistance to her husband – quite an understatement given what was to transpire.

## Tragedy

The shock of seeing her husband carried into their Brooklyn home after his second and more severe attack of the bends in 1872 would have been horrifying. He had presided over the sinking of the New York

and Brooklyn caissons, and had successfully defeated the fire that threatened the structural integrity of the Brooklyn tower, suffering his first attack of the bends in the process. Over a period of 221 days, he had managed the construction of the New York caisson to depths never previously attempted, but what should have been a time for celebration turned to tragedy when Washington was again taken ill<sup>1</sup>. He was in terrible pain and doctors did not expect him to survive the night. He was given days to live. Emily, now 29 years old, applied herself to nursing him, and the future of the bridge hung in the balance.

He survived the night, and the following day, and then appeared to rally. Soon, he was back on site, supervising the pouring of the concrete into the New York caisson. The timber and metal caisson that had provided a working space during construction would now become a permanent part of the structure. The weight of the limestone and granite tower would bear onto the caisson's 6.7m thick timber roof, which in turn would bear on its concrete-filled interior<sup>4</sup>. This timber roof, one of the bridge's critical load paths, was buried so deep in the East River, below the level of water and sea worms, that Washington's father, John, was of the view that it would last forever<sup>1</sup>.

Washington's recovery was, however, short-lived. He relapsed, suffering from fatigue, depression, irritability, stomach trouble, pain and loss of feeling in his legs. In his bedroom, despite the pain, he continued to work on the bridge<sup>1</sup>. The summer of 1872 turned to autumn, and by December 1872 the Brooklyn tower was 42m above the river, with the New York tower catching up.

By this stage Washington had been absent from both the site and the Trustees for some time, and Emily faced her first challenge in a role that would grow over the next 10 years. She travelled to New York and met Henry C. Murphy, president of the New York Bridge Company. Despite her husband's illness and absence, she convinced Murphy to leave him in the position of chief engineer. Murphy agreed on the condition that everything proceeded to go to plan with the bridge.

As winter turned to spring, doctors told Emily there was little chance of her husband recovering. It was only a matter of time before he died. He needed a break from the project, and in an attempt to revive him they visited a spa in Wiesbaden, Germany. They planned to stay for two months, but ended up staying six. Washington showed no improvement. The sea journey back to the USA was torture for him. It was now late 1873, and although they had bought a house in Brooklyn, they would move back into their

Trenton house, almost 100km from New York – distance from the bridge appeared to somewhat alleviate his pain.

### Progress

Work was now beginning on the Brooklyn anchorage. It was constructed from granite and contained four anchor plates, one per cable, each weighing more than 21t<sup>4</sup>. In 1875 work began on the New York anchorage, with old tenements and warehouses torn down to make way for it. Construction of the towers continued. Washington worked diligently from his bedroom, finalising detail after detail. He was relentless, achieving all this while never visiting the site; instead writing letters to his assistant engineers. His ability to identify potential future problems and resolve them before they became serious was legendary. Years later, Emily would praise the assistant engineers, saying the bridge would never have been completed without them. Some had worked with the Roebling family for years. The chief mechanic, Farrington, had worked with Washington's father on the Cincinnati and Niagara bridges, being the first to cross both rivers, hanging from the initial suspension wires put in place.

While Emily had been Washington's nurse since his illness struck – she was the only person he could bear near him – her role slowly began to change. Washington was convinced he was going blind, so to preserve his eyesight, he stopped reading and writing, and Emily became his secretary. He dictated all his correspondence to her. She would then read it back to him so he could make revisions. By his own admission, he had come to rely utterly on his wife: "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"<sup>1</sup>. The information that Emily naturally absorbed through this process augmented her previous study – she was fast becoming an authority on the bridge.

By 1876, both towers and anchorages were completed. Focus turned to stringing the cables across the East River. On 14 August 1876, a 1in. thick wire was spooled out from behind a boat beside the Brooklyn tower. The free end was pulled up over the tower and the boat crossed the river to the New York side, with the wire being allowed to sink to the riverbed. The wire was then taken up over the New York tower. A cannon was sounded to halt river traffic, and the watching crowds cheered as the wire was hoisted up to break the surface of the water until it hung in the air between the two towers. A second wire was added that day to make a continuous traveller rope that could be driven by an engine.

Finally, the two towers were linked. It was a moment of triumph. On 25 August – as with the Niagara Bridge and the Cincinnati Bridge – Farrington would swing across the river on a plank of wood secured to this thin wire, watched by thousands (Figure 3). Then 60 years of age, he wore his Sunday best, waved his hat to the enthusiastic crowd, and afterwards, in his typically unfazed manner, said "the ride gave me a magnificent view, and such pleasing sensations as probably I shall never experience again"<sup>1</sup>.

With this wire in place, the spinning of the bridge cables could proceed. Workers stood on special platforms as a continuous reel of wire was fed over one tower, across the river, over the second tower, through the anchorage, only to repeat its journey in the opposite direction. Each of the four cables would be 400mm in diameter. Each would be comprised of 5434 wires, and the total length of wire in each cable would be an incredible 5600km<sup>1</sup>.

The Roeblings moved back to their house in Brooklyn in 1877, and Washington, still too ill to visit the site, monitored construction from his bedroom window using a telescope. It was five years since he had been stricken with the bends, and Emily was fast becoming recognised as the public face of the chief engineer. She made daily trips to the site, delivering her husband's instructions and bringing back the issues from the assistant engineers that required attention. Soon she began resolving the issues herself. While she admired the engineers' loyalty, they were equally in awe of her technical knowledge and ability<sup>2</sup>.

There are many stories illustrating her mastery of the technical detail. When officials

 **Figure 2**  
Emily Roebling





or contactors visited the Roebling house to discuss issues with Washington, they usually met Emily, who resolved their concerns. Many became convinced she was indeed the chief engineer. In some cases, contractors marked their correspondence to her, not Washington. When bids for the steel and ironwork were released, the design called for unusually shaped members. Many perspective bidders approached Emily for clarification – clarification she, not Washington, provided. In 1879, Farrington gave a number of public lectures on the bridge's construction – one had over 2000 attendees. He was praised, but it was widely believed the lectures were written by Emily. The American Society of Civil Engineers records her as the first woman to ever address the society, more than 23 years before a woman, Nora Stanton Barney Blatch, would be admitted as a junior member in 1906, and more than 44 years before Elsie Eaves would be admitted as a full member in 1927<sup>3</sup>. (The Institution of Structural Engineers' first female associate-member was Florence Mary Taylor in 1926 and the first female Chartered Member was Mary Thompson-Irvine in 1947.)

When a delegation of Trustees visited the bridge for a tour of construction in 1881, upon climbing to deck level of the Brooklyn tower, they were surprised to be greeted by Emily. She explained the technical aspects of construction to them as they crossed a narrow timber walkway between the towers. Some of the Trustees decided not to make the return journey back across the bridge, instead taking the ferry. They were unnerved by the height. Emily appeared unperturbed.

### Triumph

Given such events, it is unsurprising that questions began to arise regarding Emily's role. Newspapers asked why the chief engineer was never seen in public. Was he ill or dead? Was Emily acting as chief engineer? Apparently, the press took the view that because the chief engineer trusted his wife with technical matters, he was clearly losing his mind.

While much of the speculation was negative, formidable champions came out in Emily's defence. The assistant engineers idolised her, and at a dinner for alumni of Rensselaer Polytechnic Institute – her husband's alma mater – Rossiter W. Raymond, an engineer, told those before him what many of them already knew. He began by declaring that, essentially, behind every good man was a good woman. He then summarised the feeling in the room, commencing with a statement that vividly illustrates the level of sexism Emily battled, but culminating in a backhanded compliment that illustrates the stature of Emily's reputation<sup>2</sup>:

"Gentlemen, I know that the name of a woman should not be lightly spoken in a public place... but I believe you will acquit me of a lack of decency or irreverence when I utter what this moment half articulates upon all your lips, the name of Mrs Washington Roebling."

But the challenges were far from over. Inferior wire was supplied by the wire manufacturer and had been woven into its cables before the discovery was made. The collapse of the Tay Bridge in 1879 raised questions as to whether it was folly to continue construction of such an ambitious bridge. Both Washington and Emily would stare down attempts to remove him as chief engineer. (There was a vote and the Trustees agreed to leave him in the role by a narrow vote of 10 to seven.) Finally, in April 1883, the bridge was finished, and preparations began for its official opening the following month. Rightly, prior to this opening ceremony, Emily would be the first to drive across the bridge,

doing so in a grasshopper gig with a retractable hood. Then in her late 30s, she would take with her a white rooster, a symbol of victory.

And the bridge was not the end of her achievements. She went on to study law and travelled widely, even attending the coronation of Tsar Nicholas II in Russia. She died at the age of 59, from what was believed to be cancer. Ironically, Washington, who had been given weeks to live in 1872, defied the doctors. He even remarried, before dying aged 89, having outlived Emily by 23 years.

### Legacy

And while there was much speculation as to the extent of Emily's involvement in the bridge, and disbelief that such an engineering marvel could be the work of a woman, David McCullough, in his book *The Great Bridge*, adeptly summarises her contribution<sup>1</sup>:

"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 had been a diligent student long before her husband was incapacitated."

Emily worked hard to hide the extent of her contribution – primarily to protect her husband. So while thousands of Brooklyn and New York

residents marvelled at their new bridge, it was only fitting that when Congressman Hewitt took to the podium, he began his tribute to Emily with the words: "One name, however, which may find no place in the official records, cannot be passed over here in silence." He described how, in ancient times, when a great structure was completed, a goddess was chosen to care and protect for it, as with Athena and the Acropolis, before declaring<sup>2</sup>:

"With this bridge will ever be coupled the thought of one, through the subtle alembic of whose brain, and by whose facile fingers, communication was maintained between the directing power of its construction, and the obedient agencies of its execution. It is thus an everlasting monument to the self-sacrificing devotion of a woman, and of her capacity for the higher education

from which she has been too long disbarred. The name of Mrs Emily Warren Roebling will thus be inseparably associated with all that is admirable in human nature, and with all that is wonderful in the constructive world of art."

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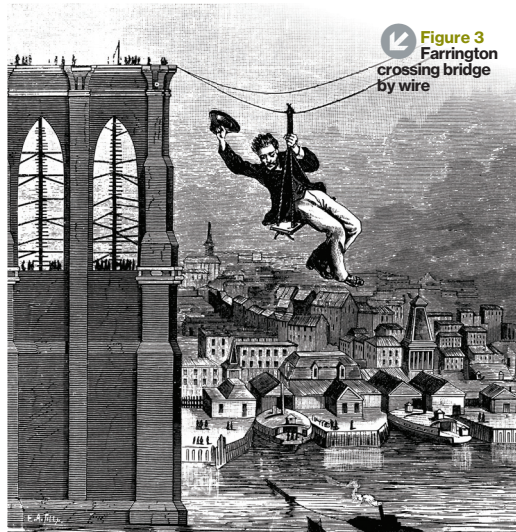


Figure 3  
Farrington  
crossing bridge  
by wire