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WIRE ROPE EXCHANGE

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THE GEORGE WASHINGTON BRIDGE: 83 YEARS AND COUNTING

ENDURING ROOTS AND AN EDUCATION IN LEADERSHIP

THE LEGACY OF CF&I

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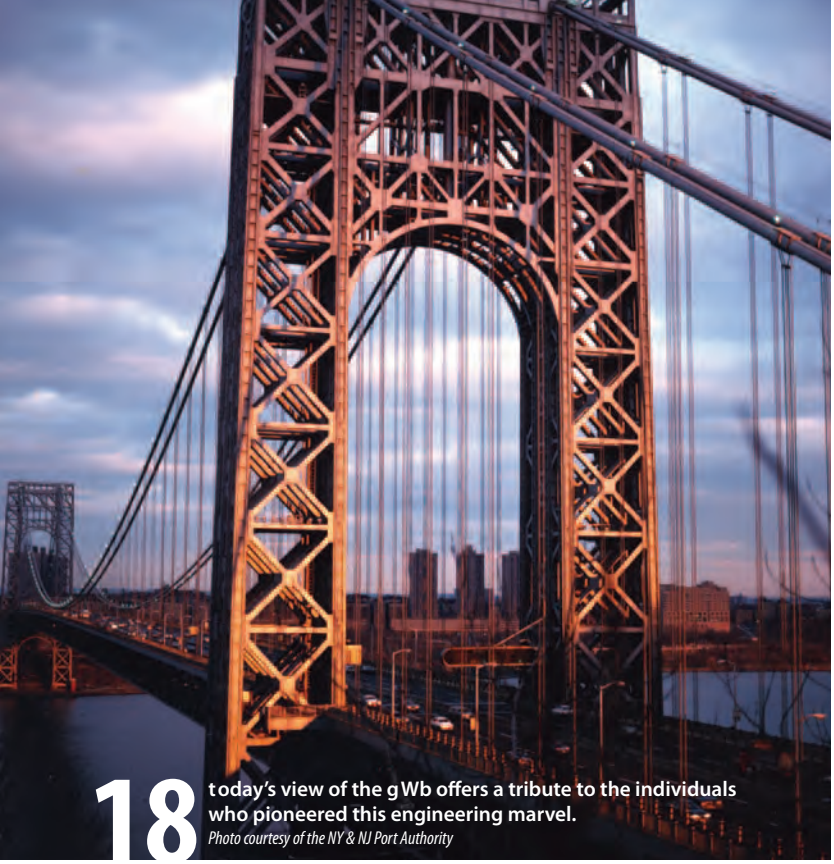

18 today's view of the gWb offers a tribute to the individuals who pioneered this engineering marvel.
Photo courtesy of the NY & NJ Port Authority

24 CF&i Wickwire spencer facility in palmer, mA circa 1900.
Photo courtesy of Jim Boyko, mill Valley splicing.

74 gaylin international's singapore facility sets the bar for current expansion plans.

WIRE ROPE EXCHANGE

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On the COver, JOhn A. rOebling 's sOns COmpAny CAble spinners with partially-completed cable strands on the george Washington bridge (gWb), 1930. the gWb initially named the "hudson river bridge," is a suspension bridge spanning the hudson river and connecting the neighborhood of Washington heights, nyC to that of Fort lee, nJ. Construction began in October 1927 and was completed in 1931.

83 YEARS AND COUNTING:

ROEBLING SUSPENDER ROPES STILL WORKING ON THE GEORGE WASHINGTON BRIDGE PART 1

BY: CLIFFORD W. ZINK

Fig 1: Allen Searls' photo of cable spinners with a Roebling Traveling Wheel on the George Washington Bridge, c1930. *Jan Searls and & Doc Searls.*

While San Francisco celebrates the Golden Gate Bridge's 75th anniversary this month, the Port Authority of New York and New Jersey is planning major work on the suspender ropes and cables – "the vitals of a suspension bridge," as *Fortune Magazine* noted in 1931 – on that other bridge engineering marvel of the 1930s, the George Washington Bridge.

Besides being two of the greatest public works of the Great Depression, these landmark bridges share another defining characteristic: the John A. Roebling's Sons Company of Trenton, N.J. was the cable contractor on both bridges (Fig. 1). This first of two articles focuses on the history of the Roebling cables and suspender ropes on the George Washington Bridge (Fig. 2), and the second will focus on the Port Authority's "once in a lifetime project."

"There were suspension bridges before those the Roeblings built, it is true," *Fortune* noted in 1931. "Not until steel-wire cables were devised, however, was the modern suspension bridge a possibility. Nor did it become a reality until the Roeblings had built the Brooklyn Bridge (Fig. 3)."

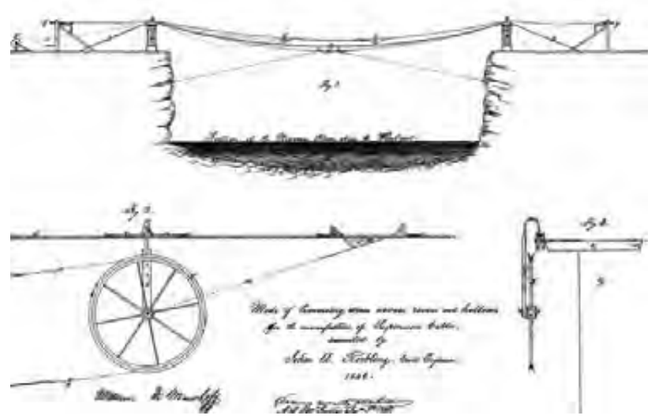
(right) Fig. 2: The John A. Roebling's Sons Company's innovative construction of the George Washington Bridge cables set the stage for its construction of the Golden Gate Bride cables five years later. *Photo courtesy of the NY & NJ Port Authority*

Fig. 3: (left) A Roebling traveling wheel for building the cables on the Brooklyn Bridge, 1877. *Smithsonian Institution*

Fig. 7: In 1931 the George Washington Bridge cables nearly doubled the record main span.
Photo courtesy of the NY & NJ Port Authority

"A sudden leap forward into a whole new range of magnitude"

Fig. 6: John A. Roebling's 1846 Patent Drawing of his traveling wheel "for the manufacture of Suspension Cables."
Rensselaer Polytechnic Institute, Institute Archives and Special Collections



"No ropes so long as would be required to support these walks had ever been built for such exacting service." - Engineering News-Record, 1930

Fig. 4: John A. Roebling, the pre-eminent suspension bridge engineer in the 19th century, founded a wire rope business that prospered for over 130 years.
Rutgers University Special Collections

John A. Roebling (Fig. 4) was born in Prussia in 1806, studied bridge engineering at the Royal Building Academy in Berlin, immigrated to America in 1831, and co-founded the town of Saxonburg in Butler County, 35 miles north of Pittsburgh.

Roebling's familiarity with the early efforts to make ropes out of wire led him to experiment with making a wire rope for the Allegheny Portage Railroad, which used costly hemp ropes to haul canal boats over the mountains (www.nps.gov/alpo/index.htm). Though he had no experience with making rope, he built a ropewalk on his farm and soon grasped the fundamental principles. As he wrote in 1843 in the *American Railroad Journal*, the *Wired* magazine of its day, "The novelty of my process chiefly consists in the spiral laying of the wires around a common axis *without twisting the fibers*; and secondly, in subjecting the individual wires while thus laying to a uniform and forcible tension under all circumstances. By this method, the greatest strength is obtained by the least amount of material, and, at the same time, a high degree of pliability."

Besides being an innovative engineer, Roebling was also an astute businessman. He installed his 7 x 19 wire rope (Fig. 5) on the Portage Railroad at his own expense, and with its success he began marketing his wire ropes for canals and for ships' tillers and rigging.

Roebling built his first suspension bridge, a canal aqueduct, in Pittsburgh in 1845, and he immediately patented the traveling wheel method he devised to lay individual wires into the aqueduct's 7- inch cables (Fig. 6). In 1849 he moved his wire rope business to Trenton, N.J., to be closer to his customers in the East. In the early 1850s he won fame as the world's pre-eminent suspension engineer by building the Niagara Falls Suspension Bridge with four 10½-inch cables spanning 800 feet. After serving in the Civil War, his son Washington A. Roebling joined him in completing the Cincinnati Covington Bridge, now called the John A. Roebling Bridge, in 1867 with 12½-inch cables spanning 1,056 feet.

Roebling designed the monumental Brooklyn Bridge with four 15½-inch cables and a span of 1,600 feet, but tragically died while surveying for the Brooklyn Tower foundation in 1869. Washington Roebling famously suffered his own injuries while building the Brooklyn Bridge (Fig. 2) and completed it in 1883 with help from his wife, Emily Warren Roebling.

John Roebling left his wire rope business, the John A. Roebling's Sons Company, to Washington and his brothers Ferdinand and Charles, and over the next 50 years they built it into the nation's leading manufacturer of wire rope. The Roebling Company built

Fig. 5: Replica of John A. Roebling's first successful wire rope used on the Allegheny Portage Railroad. Manufactured by Loos & Co. of Pomfret Center, Ct., in 2006 to commemorate the bicentennial of Roebling's birth. *Loos & Co.*

the cables on the Williamsburg Bridge in 1903, the Manhattan Bridge in 1909, and the Bear Mountain Bridge in 1924, and it manufactured and installed the suspender ropes for all of these.

The Roebling Company won the Port Authority of New York's cable contract for the George Washington Bridge in 1927. The unprecedented design by Othmar Ammann, the Authority's Bridge Engineer, presented numerous challenges for building four 36-inch cables spanning 3,500 feet, double the record span. Charles C. Sunderland, Roebling's Chief Bridge Engineer, called the proposed bridge "a sudden leap forward into a whole new range of magnitude (Fig. 7)."

One of Sunderland's biggest challenges was supporting the 3,500-foot main span of the two footwalks, or scaffolds, needed to build the four great cables. As *Engineering News-Record* noted in 1930, "No ropes so long as would be required to support these walks had ever been built for such exacting service. It was necessary to stretch these ropes after fabrication to loads in excess of the maximum working load, in order to eliminate erratic or excessive sag."

To solve this problem, Sunderland built a Prestretcher operation at the Roebling Company's Kinkora Works in Roebling, N.J. At the ends of the Prestretcher's 1,850 feet long track (Fig. 8), hydraulic machines stretched the looped footbridge ropes with 200,000 pounds of tension, 25 percent higher than the required working load of 160,000 pounds.

Engineering News-Record in 1930 cited the Roebling Prestretcher as "one of the most important advances made in the suspension bridge

Fig. 8: John A. Roebling's Sons Company Prestretcher at the Kinkora Works, Roebling, N.J., c1929. The Company developed the innovative 1,850-feet long track to prestretch the footbridge ropes for the George Washington Bridge. *Smithsonian Institution.*

field in many years." Donald Sayenga, a wire rope historian and former sales executive at Bethlehem Steel's wire rope division, recently called the Prestretcher "the first machine in the world intended to modify factory made cables by placing a full length of wire rope under tension for an extended period bearing the working load until the wires rearranged themselves to eliminate their inherent looseness."

For maximum efficiency, the Roebling Company fabricated the nearly 36 miles of 2 7/8-inch footbridge ropes with six 37-wire strands and an independent 7x19 wire rope center for double duty, which we'll get back to shortly.

Fig. 9: The Roebling Cable Crew with the Fort Lee Tower in the background. Allen Searls set up this photograph and is in the middle row in the sleeveless shirt behind the man with long sleeves. The "ROEBLING" letters on the 600-feet high Tower were lit at night and visible for miles around. *Jan Searls and & Doc Searls*

By 1930 Roebling had 175 men building the George Washington Bridge cables (Fig. 9), and one of them was 20-year-old Allen Searls, who had grown up on Hoyt Avenue a stone's throw from where the Fort Lee cut through the Palisades was then taking shape. Using John A. Roebling's spinning method, Searls and his fellow cable spinners laid 26,774, 3/16-inch "Roebling High Strength Galvanized Bridge Wires" into each of the four cables, for a total of 106,000 miles of wire (Figs. 1 & 7).

Jan Searls, a retired Navy Commander living in North Carolina, recalls her father talking about his work on the bridge when she and her brother, Doc Searls, were growing up in Maywood, N.J., where she could see the bridge's Fort Lee Tower from her bedroom window. "Dad grew up with the Palisades as his backyard, and his explorations there no doubt made him comfortable with great heights. A Roebling engineer renting the second floor in my grandparents' house got him the job on the bridge. Dad told us that working up on the bridge, you were always conscious of safety but you had to separate yourself from thinking about being that high and really focus on your work, otherwise you couldn't go up there and do it."

Fig. 10: Allen Searls on top of the Fort Lee Tower, with the cable wrapping nearly complete, 1931. *Jan Searls and & Doc Searls*

"Dad loved photography from growing up in Fort Lee where the early movies were made, and he developed all his own film. He loved observing and photographing the vistas from the footbridges and the towers, and he taught my brother and me to always look carefully at everything (Fig. 10). He also taught us about working together, and he used to say that each of the wires they spun on the bridge was not very strong on its own, but when they were all put together as a cable, look what they can do. The ideas he developed on the bridge about working together have always informed everything I've done in my career."

With innovations Sunderland and his engineering staff developed, and with their own diligent efforts, Searls and his fellow cable spinners completed the four cables in October 1930, 13 months ahead of schedule. They then disassembled the footbridges to prepare the footbridge ropes for their long-term duty. Cutting the ropes into 292 pieces of pre-marked lengths and socketing them at the bridge site, the Roebling crew installed them as the suspender ropes for holding up the bridge deck, where they remain in place today.

On opening day, October 25, 1931, fittingly 100 years after John A. Roebling immigrated to America, New York Governor Franklin D. Roosevelt told the crowd of 30,000 assembled at the bridge, "Today, faced with critical problems in every field, we are inclined to put our faith in mechanical panaceas, underestimating that most powerful of all machines, the human mind. These steel spans, these fine-spun cables are a vivid reminder that skill and scientific planning must be the keynote of all great achievements. Behind this mighty structure, that seems almost superhuman in its perfection, is an inspiring background of high intelligence."

Next issue we'll take a look at the Port Authority's upcoming work on the Roebling cables and suspender ropes. ▮