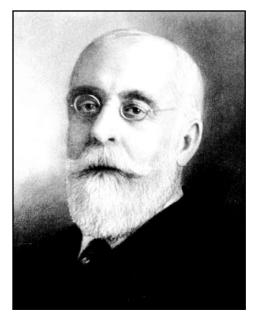
notable structural engineers



Thomas C. Clarke.

Thomas C. Clarke

By Frank Griggs, Jr., Ph.D., P.E., P.L.S.

homas Clarke was one of the leading L engineers in Canada and the United States from 1848 to 1901, working on railroads, waterways, buildings, and primarily bridges. He was born in Newton, Massachusetts on September 16, 1827 and enrolled at Harvard, graduating in 1848 with a Bachelor of Arts degree.

He began his engineering career on the Mobile and Ohio Railroad, followed by work on Ogdensburg and Lake Champlain Railroad in Northern New York. In 1852, he went to Canada where he worked on the Great Western Railroad and the Peterboro and Port Hope Railroad that ran north from Lake Ontario. He then was retained to survey the Montreal, Ottawa and Georgian Bay

Navigation that ran from Georgian Bay to, and down, the Ottawa River to Ottawa and thence to Montreal. This was followed by a contract to build the East and West Block Parliament Buildings in Ottawa. He returned to the United States in 1866, and began his bridge building career as Chief Engineer on one of the first major iron railroad bridges across the Mississippi River at Quincy, Illinois. On March 1, 1867, Clarke completed the design for the foundations and received tenders from 13 bridge companies for the superstructure. After reviewing all the proposals Clarke recommended the Quadrangular Whipple truss. He selected the proposal of the Detroit Bridge and Iron Works with cast iron upper chords and wrought iron diagonals and posts. The bridge was fabricated and erected between December 1867 and November 1868. Clarke wrote a complete bridge description that was published by Van Nostrands in 1869.

Clarke, now established as one of the leading bridge engineers, was recruited by Samuel Reeves of the Phoenix Iron works located in Phoenixville, Pennsylvania to set up a bridge design and construction firm. He had his offices in Philadelphia, in partnership with Charles Kellogg. Their company took the name of Kellogg, Clarke & Co. After two years, Samuel Reeves and Clarke established the firm Clarke, Reeves and Company with Kellogg moving on to his own company. They set up offices in New York and Philadelphia, and fabricated all their iron at their Phoenix Bridge Works.

Between late 1869 and January 1, 1873, Clarke, Kellogg designed, and or built, 176 spans with an equivalent total length of single-track bridge of 35,063 feet. One of their largest bridges was the Maiden Lane Bridge across the Hudson River at Albany, NY, built in 1872.

The Girard Avenue Bridge, over the Schuylkill River at Philadelphia, was one of the last bridges built by Kellogg & Clarke. Between 1869 and 1884, Clarke, Reeves & Co. and its predecessor designed and/or built well over 600 bridges, many of them short span trusses or plate girders. Included in that list were several elevated railways in New York City including the Gilbert Elevated the Harlem Extension of the Manhattan Elevated Railway from 83rd to 137th Street on 8th and 9th Avenues and the 2nd Avenue line from Chatham Square to the Harlem River at 129th Street. They also designed and built, to Octave Chanute's specifications, the well-known Kinzua Viaduct, which was the longest, highest bridge in the United States. They built bridges throughout the United States, Canada, Cuba, Mexico, Guatemala, Costa Rica, Peru, etc. and became one of the largest and most successful bridge companies in the United States.

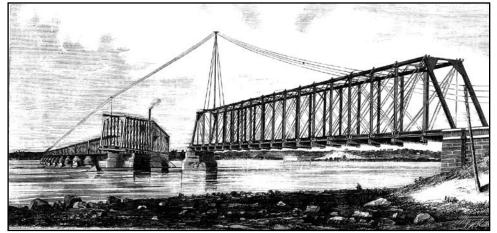


Albany, New York, Maiden Lane Bridge.

One of the major bridges Clarke prepared designs in a design competition for was the proposed Blackwell's Island Bridge at 76th Street over the East River in New York City. His proposal came in second, with the Board that evaluated the proposals concluding; "As a whole, the design provides for a structure of great merit." The competition of 1875-1876 had not guaranteed the winner that its bridge would be built. A new design by Clarke, accepted by the Company, was a greatly modified proposal from the one he entered in the competition. He completely flipped the design over from an arch to an inverted arch, or more specifically, a trussed chain suspension bridge.

Promoters failed to raise enough money to continue construction of the bridge, and work was abandoned after a cofferdam was placed and masonry started on the Ravenswood side of the east branch of the East River. A bridge was not built across Blackwell's Island until 1909.

In 1884, Clarke made another major move when the Phoenix Iron Company changed



Quincy Bridge 1868, 250' span in foreground.



Union Bridge Company proposal – Washington Bridge, Harlem River.

the name of Clarke, Reeves Company to the Phoenix Bridge Company, to strengthen the relationship between the bridge company and iron works. Clarke and Charles Macdonald formed the Union Bridge Company by combining the Central Bridge Company of Buffalo, NY and Kellogg and Maurice of Athens, Pennsylvania. They maintained shops at both locations and set up the main office in New York City.

In 1885, Clarke submitted a design in the competition for a bridge to cross the Harlem River, later known as the Washington Bridge. Clarke's bridge was a concrete bridge with granite facing with three 330-foot center-tocenter arches. It was recommended by a Board of Engineers to the Company, but was rejected by the company's attorney since concrete was not considered to be of the masonry called for in the original call for proposals. If this bridge were built it would have been one of the earliest major, long span, concrete bridges in the world.

Clarke and Macdonald designed and built the Louisville and New Albany Bridge, crossing the Ohio River at Louisville, Kentucky. After several false starts, the Union Bridge Company took over the contract in 1885 from the Delaware Bridge Company, Macdonald's former company. The bridge was completed June 21, 1886. The cantilever portion of the bridge was 1,843 feet long from end to end. The side and swing spans made the total length 2,448 feet. This was the first major bridge built by the Union Bridge Company under Clarke and Macdonald.

Over the next several years, they built many major bridges including the Poughkeepsie Cantilever Bridge over the Hudson River that opened in 1889. They started work on October 8, 1886, and the last pin in the



Clarke and Reeves Second Design for a Blackwell's Island Bridge.

east cantilever span was placed on August 29, 1888. They also built the Hawkesbury Bridge in Australia, beating out many bridgebuilding firms in a major international competition. The bridge had seven spans of 416 feet each, for a total length of 2,910 feet. Five piers were sunk to then record depths of between 150 to 160 feet below high water. The bridge officially opened on May 1, 1889.

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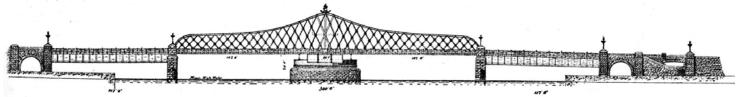
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Third Avenue Bridge.

In late 1887, after the foundation work was done and steel erection in progress on the Poughkeepsie Bridge, Clarke resigned from the Union Bridge Company and went into private consulting. Early in 1890, Clarke was retained by the New Orleans Terminal Railway and Bridge Company to design a railroad bridge across the Mississippi near New Orleans. The financial panic of 1893, along with resistance by the Secretary of War, resulted in no action being taken on his design. A railroad bridge across the Mississippi at New Orleans was not built until 1935 by Ralph Modjeski.



Poughkeepsie Bridge across Hudson River.

His next project was for the New York and New Jersey Bridge Company, who planned a bridge across the Hudson River. On March 23, 1892, Clarke submitted his design, prepared by Charles MacDonald to Clarke's specifications, to the U. S. Senate. Scientific American published the drawings and noted it was "an example of how a cantilever bridge can be redeemed from ugliness, for though it is in our sense the extreme development of the type, it resembles in its lines a suspension bridge..."

An Act in Congress was passed in 1894 authorizing the Company to build a bridge between 59th and 60th Streets, but included the stipulation that the War Department must approve the structure. A special Board of Engineers was appointed and, based upon their study, the Secretary of War disapproved Clarke's and MacDonald's 2,300-foot proposed cantilever. Clarke revised his specifications and asked for proposals for a bridge with a 3,000foot span with no piers in the river. Clarke resigned his position shortly after. Due to a lack of funding, as a result of the panic of 1893, the bridge was never built.

Clarke's next major bridge project was as Consulting Engineer for the City of New York for the construction of two swing bridges across the Harlem River at Willis Avenue and 3rd Avenue. The Third Avenue Bridge began when Clarke was selected as Engineer in 1893. It would replace a bridge that was built in 1868 of iron with only a clearance of five feet above high tide. He designed a bridge with a 300-foot swing span, flanked by two 115-foot plate girder spans and masonry approach spans for a total length of 2,800 feet.

What made this bridge unusual was the 86foot wide deck and the use of four lines of truss

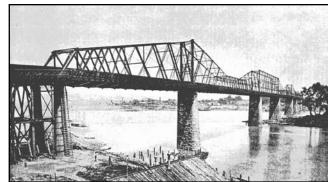
> work, making it "the largest and heaviest bridge of its kind in the World." Clarke noted, "It is really a double bridge built as a single one...so far as I know, no drawbridge of such a width has been constructed in this or any other country." For the first time, the grades and clearances required he use a riveted lattice steel truss without any pins. The usual American practice had each part fabricated off site and erected piece by piece on false-

work, or by cantilever methods, with pin connections. This bridge was fabricated off site with the entire structure riveted together. It was built on a barge and towed to its destination, and set bodily on the swing pier. Construction began in late 1893, and the bridge opened on August 1, 1898. The bridge was rehabilitated in 1953 when the Third Avenue Elevated was demolished. In 2005, after 107 years, the bridge was completely replaced by a swing bridge.

The Willis Avenue Bridge was built to replace an existing bridge and was only one half mile away from the Third Avenue Bridge. Clarke was named Engineer in 1894, and funds were approved for its construction in the same year. Clarke designed a swing bridge with a length of 304 feet. It was similar to the Third Avenue Bridge, with curved top chords and completely riveted. It was also built off site by the Edge Moor Iron Company of

Wilmington, Delaware and barged to its final location. Site conditions required Clarke to design a flanking 240-foor bowstring span on one side and a plate girder bridge on the other. The total length of bridge, including plate girder, approaches was 3,212 feet. It opened August 22, 1901, two months after Clarke's death. In 2001, a decision was made to replace the bridge with another swing bridge and is scheduled for completion in 2010.

Clarke was active in the American Society of Civil Engineers (ASCE), serving as Vice President in 1870-71. He was a member of the Board of Direction in 1878, and President in 1896-97 following his colleague George S. Morison. Clarke died June 15, 1901 and was buried in St. John's Cemetery in Port Hope, Ontario. The New York Times wrote, "Thomas Curtis Clarke Dead, Was one of the Most Widely Known Civil Engineers in America." His memoir in the Transactions ASCE stated, "Not withstanding his modesty and retiring disposition, Mr. Clarke was very popular...Mr. Clarke's life and works illustrate the highest form of engineering ability, while his modesty and straightforward, lovable character won for him hosts of friends. His death removed one of the brilliant lights of the engineering profession."



Kentucky and Indiana Bridge.

Dr. Griggs specializes in the restoration of historic bridges, having restored many 19th Century cast and wrought iron bridges. He was formerly Director of Historic Bridge Programs for Clough, Harbour & Associates LLP in Albany NY, and is now an independent Consulting Engineer. Dr. Griggs can be reached via email at fgriggs@nycap.rr.com.