Joseph B. Strauss

By Frank Griggs, Jr., Dist. M. ASCE, D. Eng., P.E., P.L.S.

Strauss is best known for the Golden Gate Bridge which opened May 27, 1937 with a span of 4,200 feet, making it then the longest span suspension bridge in the world. Joseph's engineering career spanned from 1892 to 1937, over which one observer called him, a "human dynamo." He was born in Cincinnati on January 7, 1870, the youngest of four children. His mother was a well-known musician and his father an artist. He lived not far from Roebling's Cincinnati Bridge, and it is thought that this bridge sparked his interest in bridge design. He attended Hughes High School and was elected class president. Upon graduating, Strauss was asked what he intended to do with his life.

He responded that he would accomplish something that "had never been done before." The first step in that quest was to enroll at the University of Cincinnati in 1888. At the time, a formal Civil Engineering Department did not exist. Civil Engineering was a part of the Mathematics and Civil Engineering department. The Civil Engineering Professors were Henry Eddy and Edward Hyde, who both offered a program that included a series of courses with a required thesis, which was "a discussion of some practical problem in engineering or the investigation of some theoretical question of importance" with associated drawings. His senior class consisted of 15 students, with only two majoring in Civil Engineering. He became the class president and also the class poet. His thesis was the design of a bridge to cross the Bering Strait, connecting N. America with Asia. He graduated in 1892 and traveled east to Trenton, New Jersey where he became a draftsman for the New Jersey Steel and Iron Company. It was a very large company in the 1880s, and the Delaware Bridge Company was the bridge design arm of the firm. This team built many major bridges until in 1884, when Charles Macdonald left the company to form the Union Bridge Company. Strauss remained with Union Bridge until 1894, when he returned to the University of Cincinnati to serve for part of one year as an Instructor of Civil Engineering replacing a professor who died in December 1894. At the end of the year, Joseph went to the Lassig Bridge and Iron Company of Chicago for two years working as a detailer, inspector, estimator and designer. He then spent two years as a designer for the Sanitary District of Chicago, which was in the process of building a drainage channel from Chicago to Lockport using water from Lake Michigan. The project was finished in 1899 and Strauss became a Principal Assistant Engineer in charge of the Chicago office of Modjeski and Angier. The firm was one of the leading designers of bridges in the country and designed some of the early movable, generally swing, bridges across the Chicago River. Strauss was charged with studying the use of bascule bridges across the river that would not need a mid-river swing pier. The earliest bridges used cast iron ingots to serve as counter-weights to lift the span about a horizontal axis located on the bank of the river. Legend has it that Strauss presented a new design that would use concrete counterweights, with his own system of links to lift the bridge. Modjeski did not like the plan, so Strauss resigned and appears to have become associated with the Rall Bascule Bridge Company, serving as Chief Engineer for a year. Theodore Rall was granted a patent for a bascule bridge in 1901, and built his first bridge with a span of 26½ feet over the Miami and Erie Canal for the Pittsburg, Fort Wayne and Chicago Railroad. Apparently Strauss believed he could do better than Rall and opened up an office in Chicago under the name the Strauss Bascule (Concrete) Bridge Company.

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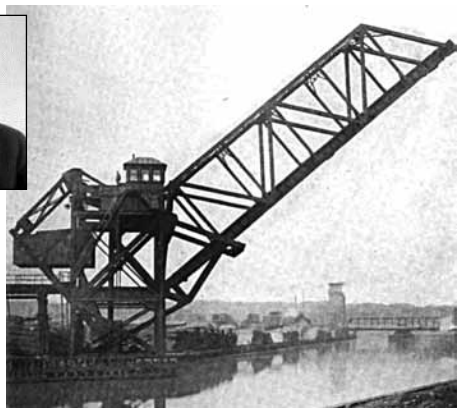

Wheeling and Lake Erie Bascule span, Strauss' first design.

The first bascule span Straus built on his own was for the Wheeling and Lake Erie Railroad in Cleveland, Ohio over the Cuyahoga River. He had to build it with his own finances to prove his concept. Opening in 1905, its span was 150 feet and used concrete as its counter weight. Since concrete was not as dense as cast iron, Strauss had "to so arrange the construction as to obtain either a longer leverage or the counter weight for to so dispose the counter weight as to obtain room for the greatly increased volume required by the concrete." This was the basis of his first patent issued in September 1903. He had a full page advertisement of this bridge and his patented ribbed concrete bridge in the March 1906 issue, page 448, of *Engineering World*. The Chief Engineer for the Wabash Railroad Company wrote, ""I consider the bridge lately put up for the Wabash Railroad Company at Cleveland the cheapest and best lift bridge on the market today. It is so well balanced that it can be stopped in any position and will remain there after the brakes have been released… I understand that the bridge has been looked at by many Engineers, and all those who are unbiased have declared it to be the best structure of its kind they have seen."

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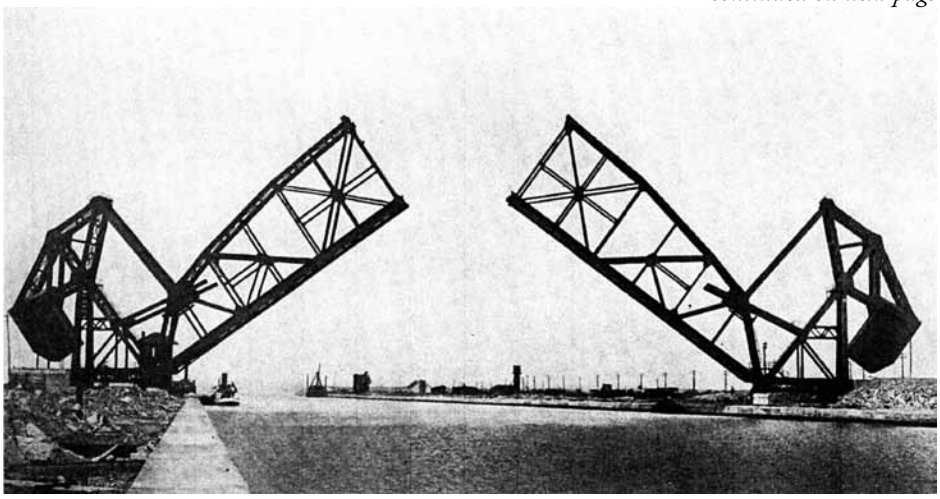
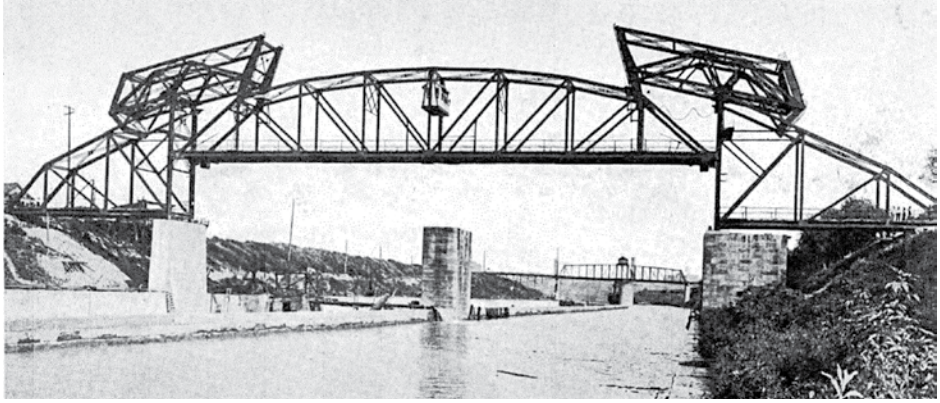


Sault St. Marie Bascule Bridge 1913.

The ribbed concrete bridge, patent number 811257, was for a concrete, or concrete and steel, bridge having hollow concrete forms for beam girders and hollow concrete forms for transverse joists. These were then connected by steel bars and loops, the hollow forms being erected to form a frame and filled with concrete to form a concrete bridge using prefabricated forms.

Strauss' second was the Kinzie Street Bridge for the Chicago and Northwest Railroad, completed in 1908 with a span of 170 feet. The design worked as he had anticipated, and it was the first in hundreds of bridges of this type he built around the United States. Over several years he developed four variations on his design that are called the heel trunnion, the vertical overhead counter weight, the underneath counter weight and the simple span type. In addition, he made a plan for an improved vertical lift bridge. He was selected to build his longest single leaf bascule, the St. Charles Air Line Railroad Bridge, over the Chicago River on 16th Street.

The full story of the history of development of the Bascule Bridge and Strauss' role in it can be found on line at **www.historicbridges.org/illinois/chicagobridges/pdf/strauss.pdf**. Strauss continued to patent various aspects of bascule design, and with them practically had a monopoly on their construction in the United States and elsewhere. One of his longest and most innovative spans was across Sault Ste. Marie for the Canadian Pacific Railroad crossing of the United States Canal. The span center to center of piers was 336 feet, and the top chords when closed were linked to support compression. The bottom chords were linked to support tension, thus making a complete truss under live loads. It was the first of its kind and was the longest span double leaf bascule bridge, longer in span than any vertical lift bridge at the time.



Louisville and Portland Canal vertical lift bridge 1915.

Another unique design was Strauss' vertical lift bridge, like the one he built across the Louisville and Portland Canal in Kentucky in 1915. The span length was 210 feet and Strauss called this his direct-lift bridge.

Strauss obtained patents on these two bridges. A full list of his patents can be found at **www.engrlib.uc.edu/strauss/patents/patentslist.html**. His first bascule and Patent #1,453,084 issued on April 24, 1923 was for a hybrid suspension-cantilever for the Golden Gate Bridge (not shown on list). His last bridge patent, #2,054,995 also not shown on list, was granted in 1936 for connecting suspension tower legs with cross bracing as in the Golden Gate Bridge.

In 1922, Joseph branched out from specializing in movable bridges to designing all bridge types when he hired Charles A. Ellis. Ellis resigned as a Professor of Civil Engineering at the University of Illinois in 1921 to work with Strauss. To broaden his list of potential clients, Strauss changed the name of the company to Strauss Engineering Corporation, Consulting Bridge Engineers. The letterhead advertised bascule, lift, swing and long span bridge designs, and Ellis was the prime designer of the long span bridges.

One long span bridge was the Longview, Washington Cantilever (now the Lewis and Clark Bridge) across the Columbia River. The bridge opened in 1930 with a cantilever span of 1,200 feet and a total length of 2,722 feet. It was the longest span cantilever bridge in the United States at the time. Another was Montreal Cantilever over the St. Lawrence River with Monsarrat & Pratley of Montreal. This bridge opened in 1930 and had a main cantilever span of 1,097 feet. He also designed major bridges at Peoria, Illinois over the Illinois River, at Quincy over the Mississippi River and at Independence over the Missouri River. He entered and won national and international bridge competitions between 1911 and 1926. A Catalogue Strauss published can be

Golden Gate Bridge 1937 to present.

found at **www.engrlib.uc.edu/strauss/articles/brochure/brochure.pdf**. He published his first catalogue in 1907.

His major bridge, however, was the Golden Gate Bridge in San Francisco, California. His first work in San Francisco was when he designed and built a variation of his bascule bridge as an amusement ride, named the Aeroscope, at the 1915 Panama-Pacific International Exposition. A bascule bridge followed over Islais Creek, and it was at this time he met Michael O'Shaughnessy, the City Engineer who was interested in building a bridge across the Golden Gate. Starting in 1919, Strauss worked with O'Shaughnessey on plans for a bridge. His first design was for a hybrid Cantilever-Suspension Bridge in 1921. He estimated he could build the bridge for just over $17,000,000. Other engineers thought the bridge would cost well above that. In 1925, Strauss had Leon Moisseff prepare a design for a pure 4,000 foot span suspension bridge, which he estimated would cost $19,400,000. Strauss kept promoting a bridge until 1929 when the legislature approved formation of the Golden Gate Bridge and Highway District opening the way for construction. The Board was not willing to give Strauss the design without considering proposals from other leading bridge engineers of the time. After interviewing many other engineers, the Board named Strauss as Chief Engineer with O. H. Ammann, Leon Moisseff and Charles Derleth as consultants. Charles Ellis prepared the preliminary plans and presented them on June 12, 1930. At the time it seemed to most of the players that Ellis was the brain behind the design, which apparently did not please Strauss. Friction continued between Strauss and Ellis. On November 26, 1931, Strauss told Ellis to take a vacation and turn all his calculations, etc. over to Charles Clarahan. Later Strauss effectively fired Ellis. From that time on he never gave Ellis any credit for the design.

For more on the engineers of the Golden Gate Bridge, and the interactions between Joseph Strauss and Charles Ellis, see the articles by Reinhardt Ludke, *The Real Story of the Golden Gate Bridge*, in the July and August 2012 issues of STRUCTURE® magazine.

The bridge was built between 1933 and 1937, and opened May 27, 1937 for pedestrians and May 28 for motor vehicles. With its 4,200 foot main span, it was then the longest suspension bridge in the world and its towers, primarily the work of Ellis, were admired for their beauty. Strauss wrote a poem on its completion that began with:

At last the mighty task is done;
Resplendent in the western sun
The bridge looms mountain high;
Its Titan piers grip ocean floor,
Its great steel arms link shore with shore,
Its towers pierce the sky.

Strauss submitted his final report in 1937 and died May 16, 1938 at the age of 68. He was buried in Glendale, California. His tomb in the mausoleum has a bronze plaque on it with his name, life span and a bas-relief image of the Golden Gate Bridge, his proudest creation. *Engineering News Record* in reporting his death gave a brief summary of his career, but wrote, "although credit for the design and building of the bridge belongs to members of his firm, to Prof. C. A. Ellis, then of his firm, and to members of the consulting Board, the Golden Gate Bridge nevertheless is Strauss' achievement."

Throughout his career Strauss, was indeed a human dynamo designing and building some of the major bridges of the period. His inventions in other areas were equally outstanding. For all his genius and innovation, he is mainly known as the designer of the Golden Gate Bridge. Even that accolade has been tarnished by his treatment of Charles Ellis and the contentious, patent related, relationships he had with other engineers at that time.▪

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 at ***fgriggs@nycap.rr.com****.*