Lindenthal and his pursuit of a bridge across the Hudson River

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ABSTRACT: Gustav Lindenthal (1850-1935) at his death was referred to by some journals as "The Dean of American Bridge Builders". He was born in Bruun, Austria in 1850, and immigrated to the United States in 1874. He started his own consulting engineering firm in 1881. In 1888 he initiated the pursuit of building a major suspension bridge across the Hudson River connecting New Jersey with Manhattan, a pursuit which continued for the next 45 years. This paper examines the various schemes developed by Lindenthal, and the circumstances which prevented Lindenthal from achieving his lifelong dream of building a bridge across the Hudson River.

1 INTRODUCTION

The oldest written reference to bridging the Hudson River at New York is in the book "A Treatise on Bridge Architecture" by Thomas Pope, published in 1811. The author shows an arch with variable moment of inertia and labels it "View of T Pope's Flying Lever Bridge" (Pope 1811). Another scheme was proposed by Messrs. Anderson and Barr in 1884 which required placing piers in water to provide a clear span of 500 ft. (152.4 m) for navigation (Engineering News 1884a). This scheme was considered impractical and was ignored (Engineering News 1884b).

At a meeting of the American Society of Civil Engineers held in Kaeterskill, NY on January 4, 1888 Gustav Lindenthal read the paper "The North River Bridge Problem, with a Discussion on Long Span Bridges" (Engineering News 1888a). This was the first time that someone had seriously thought about building a bridge across the Hudson River. The basic details of Lindenthal's bridge are shown in Figures 1 and 2. The editorial in Engineering News stated that this is "the first definite description of a work which has at least a very fair chance of becoming the greatest of its kind on this continent, or in the world" (Engineering News 1888c). The details of the various elements of this suspension bridge such as foundations and masonry, piers for the towers, anchorages, towers, superstructure and loads, construction of details of cables, web system between cables, provision against tornados, and architectural features were covered in Engineering News (1888b, 1888d). The estimated construction cost was $15,000,000 and time of construction about 3½ years.

After the publication of his paper, Lindenthal patented details of sheet metal cable cover to protect the cable from weather and changes of temperature; and the method of making attachments to the cable and of joining the cable itself in sections (Engineering Record 1888).

Max Am Ende (Ende, 1889a) criticized Lindenthal's scheme and suggested to build an arch bridge instead. Lindenthal (1889) responded by personally attacking Ende, which was unusual. Ende (1889b) responded by pointing out the unwarranted personal attack by Lindenthal.

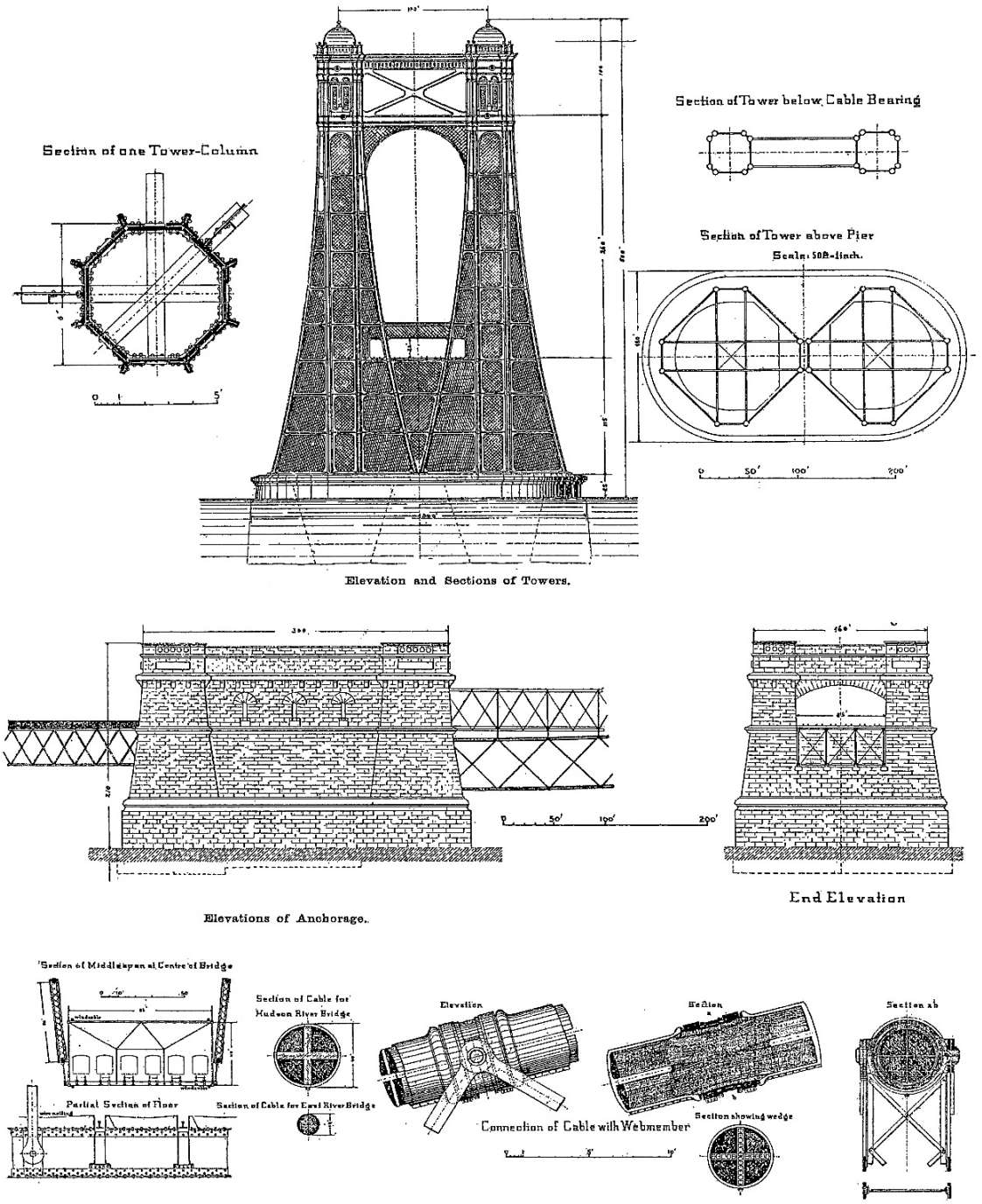

Figure 1. Details of the railway suspension bridge across the Hudson River proposed by Lindenthal in 1888 (Engineering News, 1888a)

2 FORMATION OF NORTH RIVER BRIDGE CO.

In the late 1880s the Pennsylvania Railroad (PennRR) wanted a direct rail entrance into New York City, and Lindenthal was retained by Mr. Samuel Rae of the PennRR to study the feasibility of such a move. The original scheme was to enter Lower Manhattan with a terminal at Washington Square. However, the cost seemed prohibitive for the PennRR to bear it alone. Lindenthal was asked by the PennRR to find out if other railroads would participate in building the bridge across the Hudson and sharing the cost of construction.

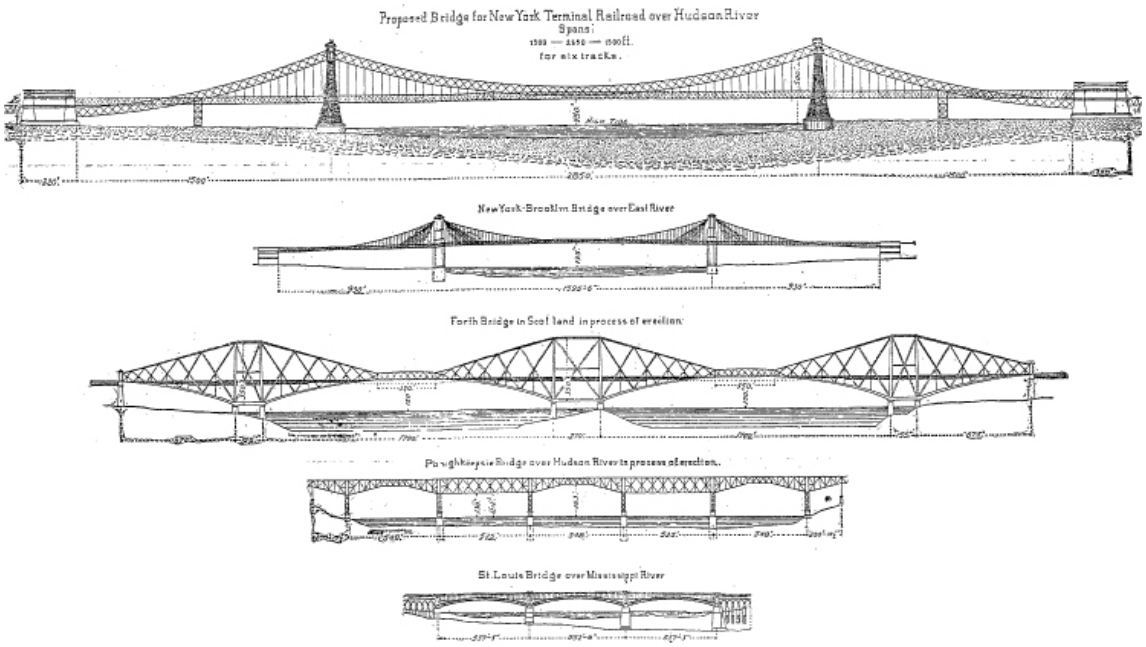

Figure 2. The proposed elevation of the Hudson River bridge (top) compared to already constructed bridges (Engineering & Building Record 1888a)

The result was the formation in 1890 of a Corporation called the North River Bridge Co., and the incorporators included Jordan L. Mott, Jr., King McLanahan, James Andrews, Thomas F. Ryan, Garrett A. Hobart, F.W. Roebling, Charles J. Canda, Edward F.C. Young, Henry Flad, Gustav Lindenthal, A.G. Dickinson, John H. Miller, William Brookfield, Samuel Rea, William F. Shunk, Philip E. Chapin, and their associates (Engineering News 1890b).

3 APPROVAL OF NORTH RIVER BRIDGE BILL IN CONGRESS

The supporters of Gustav Lindenthal introduced bills in July 1888 in both houses of Congress to build a bridge with a single span of 2,830 ft. (862.6 m). A hearing was scheduled to determine possible injury to navigation, but it did not take place until 1890.

The North River Bridge Bill was before the Senate in 1890 and was looked upon favorably by the War Department. General Casey of the U.S. Engineers Corps suggested two minor amendments, one to use the word “towers” instead of “piers”, and the second to provide a clearance under the bridge of 145 ft. (44.2 m) at the towers and 155 ft. (47.2 m) at the center of the span. The War Department also suggested a new section in the bill, requiring “the submission of plans satisfactory to the Secretary of War within one year after the passage of the bill, starting the construction one year after the approval of plans by the Secretary of War, and completing the bridge within 10 years of such approval; “otherwise the provisions of the act shall be null and void” (Engineering News 1890a).

The North River Bridge Bill was passed by both Houses of Congress by June 1890. This bill in express terms granted the right to make the necessary condemnation on both banks of the Hudson River without getting specific approvals from the States of New York and New Jersey (Engineering News 1890c). The plans for the North River Suspension Bridge designed by Lindenthal were approved by the Secretary of War in April of 1891 with a clear headway of 150 ft. (45.7 m) above high water (Engineering News 1891a).

Based on the annual report filed with the Interstate Commission, as of September 1891 Lindenthal’s company, the North River Bridge Co., had nearly completed the preliminary work prerequisite to actual construction. The bridge had two levels with a capacity of 14 standard gage railway tracks. The limits of the bridge were between Bloomfield and Twelfth Streets in Hoboken, and 23rd Street and Tenth Avenue in New York. From this point in New York, a steel viaduct would carry the 14 tracks to a high level station on Sixth Avenue, extending from 25th to 28th Streets with

a connection with the yards of the New York Central on 39th Street. The estimated total cost was $70,000,000 (Engineering News 1891b).

4 CONDEMNATION OF PROPERTY BY NORTH RIVER BRIDGE CO.

In March 1892, the North River Bridge Co. commenced proceedings to condemn property which was within its right-of-way under its charter from the Congress. A hearing took place in Trenton, NJ on March 20, 1892. The property owner argued through his lawyer that the bridge company, in the absence of State legislation, had no authority for such a proceeding. The judge appointed a commission to appraise the property (Engineering News 1892c). As of December 1893 the matter was pending before the U.S. Supreme Court, which stopped all construction field activities of the North River Bridge Co. (Railroad Gazette 1893). The lawsuit was decided in favor of the North River Bridge Co., but the business depression of 1893 forced indefinite postponement of the Hudson River Bridge project (Frankland 1940).

However, this did not stop Lindenthal from promoting his bridge. He wrote two articles, "Bridging the Hudson at New York" (Lindenthal 1893) and "Will a bridge across the Hudson River Pay?" (Lindenthal 1895).

5 LINDENTHAL'S COMPETITION TO BUILD A PARALLEL BRIDGE

There was a rival bridge company known as the Consolidated New York & New Jersey Bridge Co., organized under a consolidation of old and new charters obtained from the States of New York and New Jersey, but as of the end of 1891 was still without authority from the U.S. Government to cross the river. This company obtained a charter from the New York Legislature, which was then tacked on to an old New Jersey Bridge charter. However, it did not obtain any permission from the U.S. Government to build a bridge across the Hudson River (Engineering News 1892a). On December 24, 1891 the New York & New Jersey Bridge Co. conducted the ground breaking ceremony without having approval from Congress. There was no coordination between the organizers in New Jersey and the invited guests from New York. The heavy rain made any ceremony and speech delivery almost impossible (Engineering News 1892b).

Mr. Thomas C. Clarke, the Chief Engineer of the New York & New Jersey Bridge Co. proposed a cantilever bridge with a center span of 2,200 ft. (670.6 m) and two flanking spans of 1,050 ft. (320 m) each. The piers and the masonry would be built for an eight track bridge, but the superstructure would be built only for four tracks to satisfy the needs for the near future rather than for the life of the bridge. On the New Jersey side, the west approach would be carried through Bergen Hill either by a tunnel or an open cut. On the New York side, the landing would be at about 71st Street, and the line carried down Eleventh Avenue to 42nd Street and across to Broadway with ample terminals. The plans were changed to build a suspension bridge when permission was denied to build a pier in water for a cantilever bridge.

There was equal (if not more) coverage in technical journals of the activities of the New York and New Jersey Bridge Co. about building of a parallel bridge to the north of Lindenthal's bridge. However, to limit the size of this paper, the author has decided to concentrate on Lindenthal and his bridge.

6 APPOINTMENT OF A BOARD OF FIVE EXPERT BRIDGE ENGINEERS BY THE PRESIDENT IN 1894

In January of 1894, the New York and New Jersey Bridge Bill was filed with the House Committee on Commerce in Washington, D.C. Instead of determining whether a pier should be permitted in water for a cantilever bridge with a minimum span of 2,000 ft. (609.6 m), the House Committee passed a resolution on June 7, 1894 that the President shall appoint a board of five competent, practical, disinterested, expert bridge engineers, of whom the Chief of Engineers of the United States Army shall be one, to decide what length of spans, not less than 2,000 ft. (609.6 m), is safe and practicable for the Hudson River Bridge between 59th and 69th Streets in New York City (Engineering News 1894a).

The engineers appointed to the Board by President Grover Cleveland included G. Bouscaren, W.H. Burr, Theodore Cooper, George S. Morison, and Major C.W. Raymond.

The Board submitted its Report in September 1894. The Board considered feasibility of constructing a cantilever bridge of (a) 2,000 ft. (609.6 m) span and (b) 3,130 ft. (954 m) span, and their cost of construction, including the cost of piers in the Hudson where the rock was more than 200 ft. (60.96 m) below the surface. The Board also considered the construction of a 3,130 ft. (954 m) span railway suspension bridge. (Engineering News 1894b).

The Board concluded that:

1. A single span from pierhead to pierhead, built on either the cantilever or suspension principle, would be safe.
2. The estimated cost of the 3,100 ft. (944.9 m) clear span cantilever was about twice that of the short span, making this option impracticable on financial grounds.
3. The 3,100 ft. (944.9 m) span railway suspension bridge was practicable. However, as the cost of a single span suspension bridge was almost one-third greater than that of the 2,000 ft. (609.6 m) cantilever, the Board was unable to say that such greater cost was enough to render the suspension bridge impracticable.

The Board also felt "that the contingency attending the construction of the deep river foundation of the cantilever bridge is enough to balance a part of the greater cost of the suspension bridge", meaning that the suspension scheme would meet all the requirements of a single span, and cost-wise would be competitive.

The Report of the Board of Engineers also included several Appendices consisting of (a) A letter from Charles Macdonald of the Union Bridge Co. who would build the cantilever bridge for the New York and New Jersey Bridge Co. (Engineering Record 1894a), (b) Theory of continuous stiffening truss with ends anchored down but not fixed in a vertical plane (Engineering Record, 1894b), (c) Letters from Wilhelm Hildenbrand (Engineering Record 1894c), (d) A modified plan and estimate from Hildenbrand (Engineering Record 1894d), (e) A letter from Gustav H. Schwab expressing views of New York State Chamber of Commerce (Engineering Record 1894e), and (f) A description of the proposed North River Bridge (Lindenthal 1894).

7 APPOINTMENT OF A BOARD BY THE SECRETARY OF WAR IN 1894

While the Hudson River Bridge was debated in Congress, the Secretary of War Daniel S. Lamont appointed on January 29, 1894 a Board consisting of Major C.W. Raymond, and Captains W.H. Bixby and Edward Burr, all of the Corps of Engineers, to investigate and report its "conclusions as to the maximum length of span practicable for suspension bridges, and consistent with an amount of traffic probably sufficient to warrant the expense of construction".

To the above instructions Brigadier General Thomas L. Casey, of the Chief of Engineers, added the further instructions to include in the investigation "strength of materials, loads, foundations, wind pressure, oscillation and bracing". Captain Bixby (Bixby 1895) later published a well-researched and scholarly paper on wind pressure in engineering construction related to the Hudson River Bridge.

8 MAXIMUM PRACTICABLE LENGTH FOR SUSPENSION BRIDGES

This Board reviewed the Report prepared by the board of five expert engineers appointed by President Cleveland before publishing its report in October 1894 (Engineering News 1894c,d,e). The most significant finding as far as the Hudson River Bridge was concerned was that it was not only possible to erect a single-span structure of 3,200 ft. (975.4 m) at that point, but it was practicable to build a suspension bridge of 4,335 ft. (1,321 m) span. And, cost-wise, a suspension bridge with a 3,200 ft. (975.4 m) span would be very competitive to a cantilever bridge of a 2,000 ft. (609.6 m) span.

The report prepared by the three engineers from the U.S. Army Engineers Corps forced the New York and New Jersey Bridge Co. to revise its plan from a 2,200 ft. (670.56 m) cantilever to a 3,000 ft. (914.4 m) span suspension bridge.

9 ACTIVITIES FROM 1895 TO 1912

The recession of 1893 forced almost all railroads to withdraw their support of the Hudson River Bridge project. The railroads were not willing to discuss their plans for expansion to New York with other railroads and the Hudson River Bridge project was practically abandoned by the railroads who would provide the funding for the bridge. The promoters were telling the public that traffic that would make the bridge pay could be secured from the beginning.

The charter of the North River Bridge Co. was to expire on July 11, 1895 unless something was done by that time showing the sincere purpose of the North River Bridge Co. to construct the work for which it obtained the powers. It was to show this intention and prevent the charter from lapsing that the North River Bridge Co. quietly commenced work upon the New Jersey anchorage.

The North River Bridge Co., at its annual meeting in November 1896, elected Mr. Jordan L. Mott as President, Mr. Samuel Rea as Vice President, Mr. Charles J. Canda as Treasurer, and Mr. Thomas B. Rea as Secretary. According to the plans prepared by Lindenthal the bridge would cross the Hudson River in the vicinity of 23rd Street and would carry 14 railway tracks.

In 1897, the promoters of the North River Bridge Co. refused to provide any information on their plans for the bridge. However, it was known that the length of the suspension span and the total length of the bridge proper would be 3,100 ft. (944.9 m) and 7,340 ft. (2,237.2 m), respectively. No definite traffic arrangements were made with any of the railway companies operating on the New Jersey side. The railway companies did not show their willingness to cooperate with each other in the discussion of construction of the necessary connections and terminals. Without the support from the railroads the bridge project was dead (Engineering News 1897).

There was no activity reported by the promoters of Lindenthal's bridge during 1898 and 1899. In 1900, the U.S. Senate passed Senator Sewell's bill extending the time for completion of Lindenthal's bridge to January 1, 1902 (Railroad Gazette, 1900). In 1901, the North River Bridge Co. entered into discussions with two or three railroads to back its plan without any success (Railroad Gazette 1901).

For a two-year period, 1902-1903, Lindenthal was appointed as Commissioner of Bridges by Mayor Low of New York City; and no activities took place for the construction of the Hudson River Bridge.

The biggest setback to the Hudson River Bridge project came when the PennRR in 1904 decided to go it alone and build two tunnels under the Hudson, a major passenger terminal in Manhattan near 34th Street, and a yard for its trains in Queens by building tunnels under the East River. There were no major activities from 1905 to 1911.

10 ACTIVITIES FROM 1912 TO 1920

In an article published in the New York Times which was reprinted in Engineering News, Gustav Lindenthal (1912) acknowledged that the real deterrent to the construction of the Hudson River Bridge was its cost ranging from $70 million to $100 million including the cost of the right-of-way. He presented a case in his article for building the bridge by connecting it with the handling of freight in Manhattan.

The editorial analysis of the history of the Hudson River Bridge (Engineering News 1912) agreed with Lindenthal that time was ripe for the construction of the Hudson River Suspension Bridge.

One of the readers, who wrote a letter after reading Lindenthal's article and Engineering New's editorial comments, asked Lindenthal to reduce the cost of his bridge by putting one or two piers in the river (Smith 1913). In his reply, Lindenthal (1913) explained why one or two piers in the Hudson River would not reduce the cost of the bridge, and cautioned against underestimating the total cost of the project by not taking into account contingencies, delays, interest payment during construction, cost of administration, right-of-way, and connections and approaches to the bridge. In 1920, Lindenthal (1920) discussed the proposed Hudson River bridge, its capacity and cost compared with tunnels, and the bridge's influence on New York's transportation problems at a meeting of the American Society of Mechanical Engineers held in New York on December 9, 1920.

11 ACTIVITIES FROM 1921-1930 AND PARTICIPATION OF AMMANN

In 1921, the Hudson River Bridge and Terminal Association was formed to obtain public support to build the bridge designed by Lindenthal, with terminal facilities on both sides of the river for passengers and freight (Engineering News-Record 1921a). One of the members of the committee was Samuel Rae, president of the PennRR.

Another organization, the Hudson River Bridge Corporation, was formed also in 1921. Under its umbrella, a large engineering organization was built up which was at work under the direction of Gustav Lindenthal, chief engineer, making structural and traffic connection studies and developing plans. Cooperation of all railroads entering New York was secured in the effort to adapt the project as efficiently as possible to New York terminal traffic requirements.

Othmar H. Ammann, one of the best known and most respected long span bridge builders of the 20th century, worked for Lindenthal on the Hell Gate Bridge in New York City between 1912 and 1917. He left Lindenthal in 1917 due to lack of work, and rejoined in December 1920 to work on the Hudson River Suspension Bridge. During these 3 years, between 1917 and 1920, Lindenthal was planning the bridge on an even grander scale.

Lindenthal's new design published in the April 1921 issue of Scientific American connected West 57th Street in Manhattan with 50th Street in Weehawken in New Jersey. The proposed bridge had a main span of 3,240 ft. (987.6 m) and two decks. The upper deck was for pedestrians and 16 lanes of vehicular traffic, whereas the lower deck supported 12 railroad tracks. The granite-clad steel towers were 840 ft. (256 m) tall. Lindenthal even planned an office tower to generate income to pay for the $100 million bridge project (Figure 3). The elevation and cross-section of the bridge are shown in Figures 4 and 5, respectively.

Lindenthal often asked Ammann to present his scheme at public and professional meetings. The negative sentiments and loud opposition to the bridge project expressed at these meetings convinced Ammann that there was a real need for a vehicular bridge and not for a bridge with 12 railroad tracks. He pleaded with Lindenthal to reduce the scale of the project and relocate the site. Lindenthal criticized Ammann for this timidity and short-sightedness and for not looking far enough ahead (Rastorfer 2000). In March of 1923, Ammann left Lindenthal, and opened his own consulting engineering firm. He developed a proposal for a vehicular bridge across the Hudson River with a price tag of $40 million, and presented it at a meeting of the Connecticut Society of Engineers on February 19, 1924 (Rastorfer 2000). Ammann's design was approved by the Port of New York Authority, and the first vehicular bridge across the Hudson River was opened to traffic in 1931. It is known today as the George Washington Bridge.

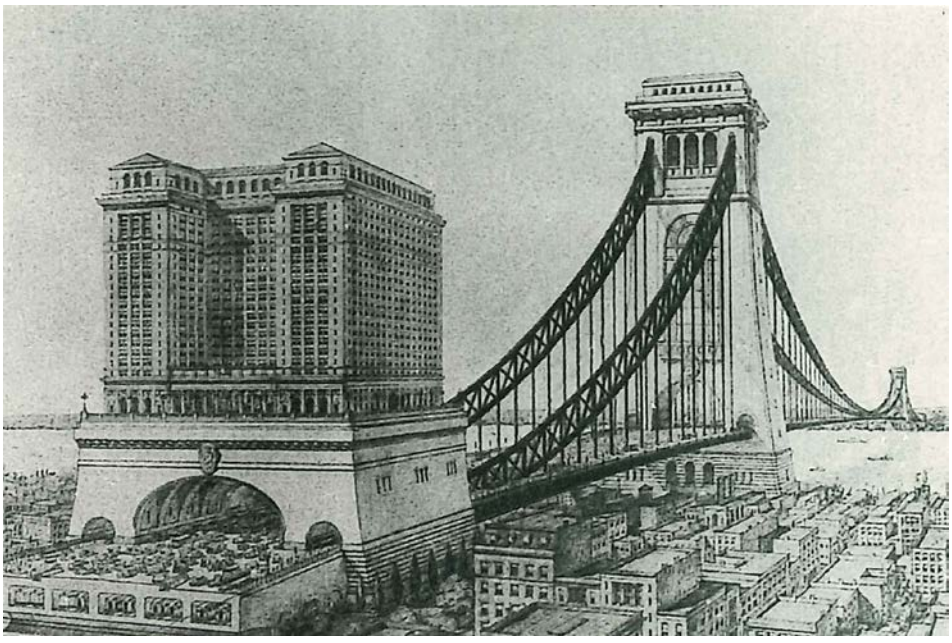

Figure 3. Rendering of Lindenthal's proposed bridge with office tower (Scientific American, 1921b)

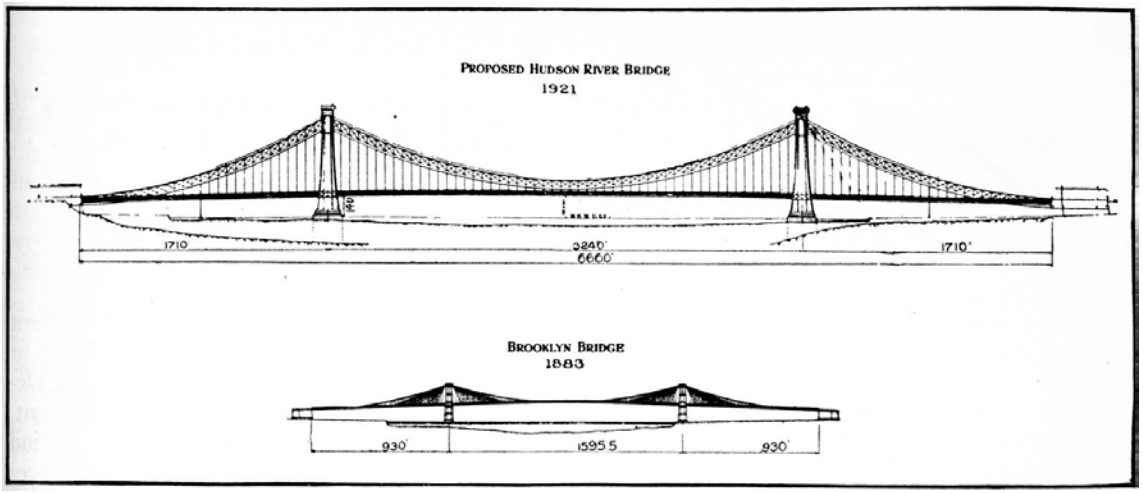

Figure 4. Elevation of proposed Hudson River Suspension Bridge compared with that of Brooklyn Bridge (Scientific American, 1921a)

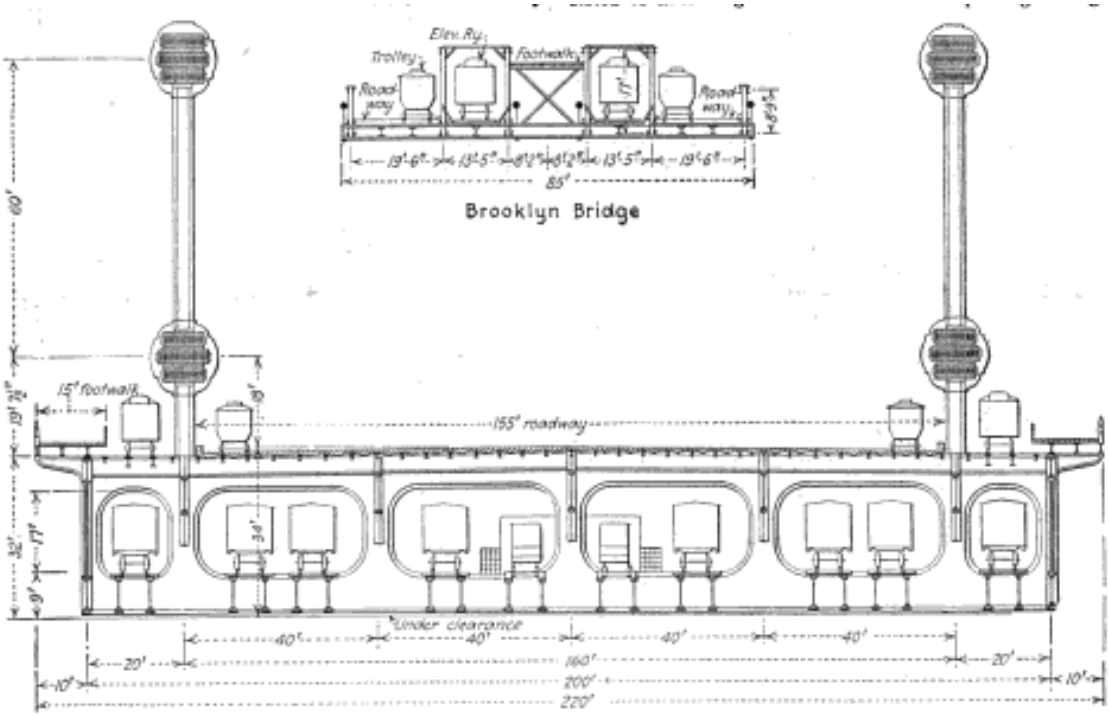

Figure 5. Cross section of proposed bridge (Scientific American, 1921a)

The application submitted by the North River Bridge Co. to the War Department for a permit to build the bridge showed a suspension bridge with minimum vertical clearance above the mean high water at center of 175 ft. (53.3 m) for a width of 500 ft. (152.4 m) and 166 ft. (50.6 m) for a width of 1,500 ft. (457.2 m) and an unobstructed channel between the established pierhead lines. The War Department scheduled a hearing in the Army Building at 39 Whitehall Street in New York City at 10:00 AM on September 9, 1927 (Engineering News-Record 1927a).

The hearing was headed by Colonel F.C. Boggs, and the project was presented by Lindenthal and supported by Francis Lee Stuart and Samuel Rae, the former president of the PennRR. Opposition to the application was voiced by shipping interests, and they asked for a clear height of 215 ft. (65.5 m) Others opposed to the bridge questioned the need for Lindenthal's bridge in view of the traffic facilities provided by the Fort Lee bridge and the Holland Tunnel under construction (Engineering New-Record 1927b). No decision was made by the army engineers.

Meanwhile, it was reported in Railway Age (1929a) that the Baltimore & Ohio RR acting with the North River Bridge Co. had filed an application with the Secretary of War for approval of Lindenthal's plans. The cost estimate submitted with the plans was $180 million. Secretary of War James W. Good stated on May 2, 1929 that General Edgar Jadwin, Chief of Engineers, would report on the examination of the general plans shortly. The Baltimore & Ohio RR made a statement that it was an "interested observer" of the bridge project, and flatly denied that it planned to use the bridge as a means of getting access to Manhattan for a railroad terminal (Engineering News-Record 1929a).

On May 29, 1929, Secretary of War Good made an announcement that he was rejecting the application of the North River Bridge Co. for permission to bridge the Hudson River at 57th Street in New York City unless the plans were revised to provide a 200 ft. (60.96 m) clearance above the mean high water at the center of the bridge, and 185 ft. (56.4 m) at the pierhead lines. The plans as submitted by the North River Bridge Co. provided only 175 ft. (53.3 m) of clearance at the center of the spans. The decision was concurred by Major General Edgar Jadwin, Chief of Engineers (Engineering News-Record 1929b).

In support of his decision, the report of the Secretary of War stated in part that "nowhere is the protection of navigation more important than at New York, which is preeminent among the ports of the United States and of the world as well." And, "that no unnecessary bar should be put in the way of the great vessels coming to this port laden with freight for Manhattan, or for the interior of the country" (Railway Age 1929c). The editorial in Railway Age (1929b) described the decision by the Secretary of War as "a judgement by the opponent's attorney".

In May of 1930, the new Secretary of War Hurly, accompanied by Chief of Engineers Major General Lytle Brown, inspected the proposed bridge site, and as a result a new hearing on the construction of a combined railroad and vehicular bridge across the Hudson River at 57 Street was scheduled on June 4, 1930 in New York City before a special board of officers headed by Col. G.M. Hoffman of the Corps of Engineers.

The new application was made by the North River Bridge Co. of Jersey City, NJ, and showed a maximum vertical clearance of 184.5 ft. (56.2 m) for a width of 300 ft. (91.44 m) at the center of the span, and the lowest 175.8 ft. (53.6 m) for the same width (Engineering News-Record 1930a).

At the hearing held in New York City on June 4, 1930, a special board of army engineers consisting of Colonels G.M. Hoffman, G.B. Pillsbury, and Harley B. Ferguson heard the testimony of a number of witnesses for and against the bridge (Engineering News-Record 1930b). The North River Bridge Co.'s arguments were presented by Francis Lee Stuart, a consulting engineer who stated that raising the vertical clearance to 200 ft. (60.96 m) would create too steep a grade for most locomotives to climb. Stuart also offered $3,000 to $8,000 per ship for telescoping of the upper masts and funnels of ships requiring more than 184 ft. (56.1 m) of vertical clearance. David B. Steinman, consulting engineer for the bridge company, argued that the trend was to reduce the mast heights of ships, and that the decision would have created a precedent to be followed in the future.

Arguments in opposition to the bridge included the effect on traffic congestion, lowering of the real estate values, and public sentiment that cross-river traffic should be cared for by tunnels than by overhead structures.

12 ACTIVITIES FROM 1931 TO 1933

The special board of army engineers submitted an adverse report on the application of the North River Bridge Co., stating that the clearances for the projected structure were inadequate (Engineering News-Record 1931a).

The Secretary of War disapproved the revised plans of the North River Bridge Co. on June 9, 1931. The revised plans had a center clearance of 179.8 ft. (54.8 m) and the pierhead clearance of 160.6 ft. (48.9 m), as opposed to the minimum center clearance of 200 ft. (60.96 m) as required by the Army Engineers Corps (Engineering News-Record 1931b).

The letter from the Secretary of War, Patrick J. Hurley, addressed to the President of the North River Bridge Co. read in part that "there are ships in operation in the harbor now which cannot maneuver under your proposed bridge without alterations in them more serious than the mere

lowering of the masts" (Engineering News-Record 1931c). The investigation by the Engineering News-Record indicated that of the ships entering the port of New York there were none with a funnel height of 175 ft. (53.3 m), and only one ship had a funnel height of over 150 ft. (45.7 m).

Lindenthal at the age of 83 filed one more application to obtain a permit from the Secretary of War to build his bridge at 57th Street in Manhattan; and one more time the application was declined. The Secretary of War stated that it was his interpretation of the law that when there is serious question as to the necessity of the bridge, any interference with navigation by it is to be considered unreasonable. The Secretary cited the opposition to the bridge, especially by the Port of New York Authority which had begun construction of a vehicle tunnel under the river at 38th Street (Engineering News-Record 1933), and the bridge would come into direct and powerful competition with the tunnel, for which the Authority had borrowed a large sum from the federal government (Railway Age 1933).

It is appropriate to include a short biography of this remarkable person, Gustav Lindenthal.

13 GUSTAV LINDENTHAL, 1850-1936 (FRANKLAND, 1940)

Gustav Lindenthal was born in Brunn, Austria on May 21, 1850 (Figure 6). He was educated at Politechnicum (Dresden, Germany) college, and received practical training from 1866 to 1870. He came to the U.S. in 1874. He worked at the Centennial Exposition as a laborer and then as a designer. In 1878 he joined Atlantic Great Western Railroad as a bridge engineer. In 1881, Lindenthal started his own engineering practice in Pittsburgh, and found assignments in the design and construction of important bridges for railroads and bridge companies.

He received recognition and very good publicity for replacing the Smithfield Street suspension bridge, originally built by John A. Roebling, with a 350 ft. (106.7 m) span double-elliptical steel truss in 1882. This and several other projects in Pittsburgh brought him to the attention of Samuel Rae of the Pennsylvania Railroad who later supported Lindenthal in the proposal for the Hudson River bridge. It was Lindenthal's paper in 1888 presented at the ASCE convention, "The North River Bridge Problem, with a Discussion on Long Span Bridges," that excited not only the engineering community but the general public. The real estate industry sold parcels of farmland at inflated prices to buyers who were speculating that the price of their properties would increase once the bridge was built.

Lindenthal spent his entire career in private practice except for a two year period (1902-1903) when he was appointed the Bridge Commissioner of New York City by Mayor Low. His activities and performance as New York City's Bridge Commissioner are covered in detail by Gandhi (2013). The most notable project of his professional practice was the Hell Gate Arch Bridge in New York. Originally the firm of Boller and Hodge was selected by the PennRR to design this bridge, but with the help of Samuel Rae the project was given to Lindenthal. On the Hell Gate arch project, Lindenthal hired Othmar H. Ammann, David B. Steinman, and Charles S. Whitney, who would later become world-renowned engineers in their own right.

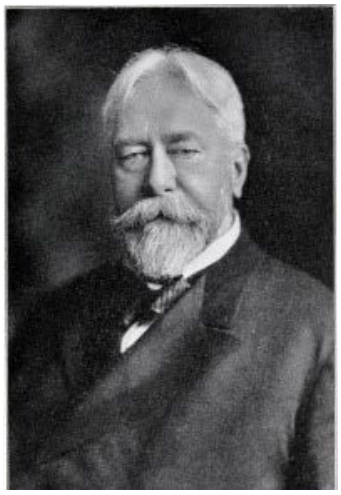

Figure 6. Gustav Lindenthal (Wildman 1921)

Before the Hell Gate Bridge was completed, the Norfolk and Western Railroad retained Lindenthal to design a bridge across the Ohio River at a site a few miles east of Sciotoville, Ohio with a river width of more than 2,000 ft. (609.6 m) and requirements of two navigation channels. Between 1914 and 1917 Lindenthal designed a two-span continuous bridge over a central pier with a record-breaking combined span-length of 1,550 ft. (457.2 m).

It was said of Lindenthal that he never designed two bridges alike because he looked to the design of each bridge as a unique problem and created a customized solution. His love of beauty in engineering works simultaneously with his search for the structural solution. In his search for aesthetic design, he did not hesitate to consult architects whenever he had to deal with an important bridge project.

Lindenthal's last professional assignment was design and construction of bridges in Portland, Oregon to carry the city's major thoroughfares across the Willamette River, which he completed in 1928. Lindenthal died on July 31, 1935, in his 86th year.

14 CONCLUSIONS

The conclusions as to why Lindenthal did not succeed in his lifelong quest for the Hudson River Railroad Suspension Bridge are summarized below.

This is a sad story with a sad ending as far as Lindenthal is concerned. He depended on railroads, specifically the PennRR, to raise the money to build his ambitious project. In the early 1890s, if the railroads agreed to contribute towards the building of the bridge, the space to build the station yards and connections was available in Manhattan at a reasonable price. However, the smaller railroads mistrusted the PennRR, and its overbearing influence in decision making in the overall project.

In the early 1900s when the economy once again started growing, the PennRR knew that the other railroads were not interested in teaming up; and in 1904 decided to go alone and build two tunnels under the Hudson, and Penn Station at 34th Street in Manhattan. The development of electric locomotives for use in the tunnels was one major reason to go with the tunnels by the PennRR. This caused Lindenthal to lose his biggest supporter of his bridge project.

It was evident, as early as 1903 that any bridge that ignored the growth of population in 40 or so towns in New Jersey, and about 500,000 commuters bravely crossing the Hudson daily, would not pay for itself. Lindenthal and his railroad friends ignored this trend, and kept adding the number of railroad tracks to the bridge, thereby increasing the cost of the project to an unreachable level.

In the early 1920s when the use of automobiles was on the rise and the railroads were declining, Ammann urged his boss Lindenthal to scale down his bridge, and move the bridge location to an undeveloped area in the north to reduce the cost of the project. Instead, Lindenthal ridiculed Ammann for his lack of imagination and not looking 1,000 years further down the road. This forced Ammann to leave Lindenthal, start his own business, and plan his own bridge to cross the Hudson, which was accepted by the newly formed bi-state agency Port of New York Authority in the mid-1920s.

Even after the opening of the George Washington Bridge crossing the Hudson River in 1931, Lindenthal deluded himself into believing that a railroad suspension bridge was still a viable option, and submitted his scheme as late as 1933 to the Army Corps of Engineers. This time it was the Port of New York Authority which filed objection to Lindenthal's bridge on the grounds that the Port Authority had borrowed funds from the U.S. Government for construction of the Lincoln Tunnel, and if the bridge were permitted to be built it would siphon off the toll from the Lincoln Tunnel. This was the last time, three years before his death, that Lindenthal faced his final defeat.

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