Francis Henry Bainbridge 1863-1912
Inventor, Civil Engineer, ASCE
by *David A. Bainbridge*

Francis H. Bainbridge was the son of Robert and Martha 'Smith' Bainbridge. He graduated from Troy High School in 1880,[1] and Rensselaer Polytechnic Institute in the class of 1884. He majored in civil engineering and his thesis was "A Review of the Mohawk River Bridge on the line of the Boston, Hoosac Tunnel and Western Railroad."[2]

He started out as an assistant engineer for Buck and McNully in New York, then as assistant engineer for Edge Moor Iron Works in Wilmington, Delaware.[1] He entered railway service as inspector of shops at Northern Pacific Railroad. From 1886 to 1893, he was a draftsman at Edge Moor Bridge Works in Wilmington, Delaware. From 1893 to 1895 he was resident engineer a the Pencoyd Iron Works and Mount Vernon Bridge Company in Chicago.

From 1895 to 1898 he was an engineer for the Buffalo & Niagara Falls Electric Railway; and then moved to the office of Albert Noble, civil engineer. Noble had contracts for the Illinois Central Railroad and the Atchison Topeka & Santa Fe Railway.[3]

In 1894 he designed a 64-m high steel dam to be built across the Santa Ana River in California.[4] In 1895 Francis patented this innovative metal dam system.[5] The Santa Ana Ruver design was never built.This system was used to build a very successful and durable dam near Ash Fork, Arizona, to supply water for the railroad. The Ash Fork-Bainbridge Dam was the first large steel dam built, and one of only a handful constructed in the United States.[6] The dam was fabricated by the Wisconsin Bridge and Iron Company and shipped to the site in pieces. Dam construction began in 1897 and was completed on March 5, 1898, at a cost $63,519.

Steel dams use relatively thin angled steel plates with a framework of steel girders to transmit the load to the ground. The weight of the water puts compressive forces on the girders that support the angled plates, transmitting the force to the ground without the bending moment that a vertical wall would experience. The central steel section of the dam is 184 feet (56 m) long, 46 feet (14 m) high, and weighs about 460,000 pounds (210,000 kg). The dam

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[1] Nason, H. B. 1887. *Biographical Records of the Officers and Graduates of Rensselaer Polytechnic Institute 1824-1886.* W. H. Young, Troy, NY.

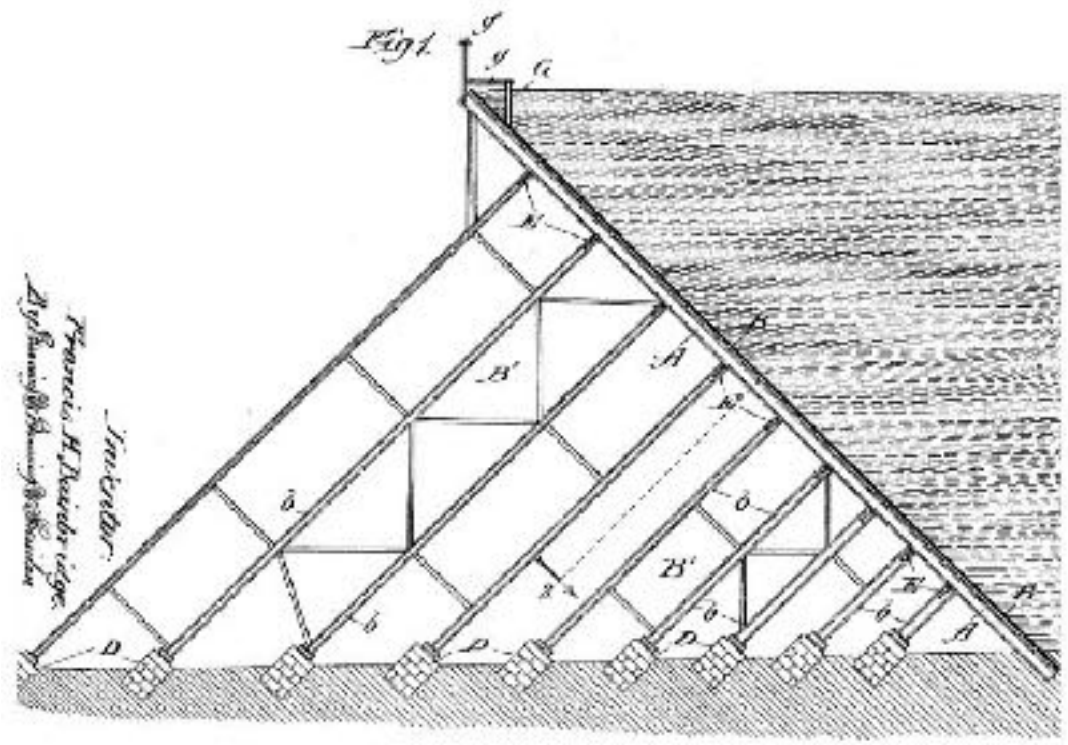
[2] Bainbridge, F. H. 1884. RPI Archives (Thesis), Archives (Microfilm), Folsom Mfilm Area. http://www.lib.rpi.edu/cgi-bin/bulletin.pl?vol=30&iss=1x&pg=5

[3] Buseby, T. A. 1906. *The Biographical Directory of the Railway Officials of America*. Compiled by The Railway Age. Chicago, IL http://www.onlinebiographies.info/railroad/b01.htm accessed May 3, 2009

[4] Reynolds, T.S. 1989. A narrow window of opportunity: the rise and fall of the fxed steel dam."Jounral of the Society for Industrial Archaeology, Volume 15, p. 1-20.

[5] *Dam*. Patent number 537520. . Issue date: Apr 16, 1895. Francis H. Bainbridge http://www.google.com/patents?id=INtkAAAAEBAJ&dq=francis+H.+Bainbridge

[6] *Ashfork-Bainbridge dam* http://en.wikipedia.org/wiki/Ashfork-Bainbridge_Steel_Dam



has no spillway and was designed to withstand overtopping with 6 feet (1.8 m) of water pouring directly over its crest. It provided 36 million gallons of water storage for the railroad's steam engines as they crossed the dry southwest as well as supplying the town of Ash Fork with water.

Steel dams made some sense for areas where concrete or masonry work would be costly

or difficult. The Ash Fork dam[7] is a registered historic landmark, identification number 76000373. George Lamb of the American Institute of Steel Construction described the

[7] Ashfork Dam http://www.nationalregisterofhistoricplaces.com/AZ/Coconino/state.html
ns p 239

condition of the dam as excellent with no evidence of corrosion or deterioration 50 years after its construction, “appears to be in as good condition as if it was just built.” Today, this innovative structure stands with negligible deterioration, providing water for wildlife, livestock and recreation. The Kaibab National Forest, USFS is now the owner of the dam.[8]

From 1898 to 1902, Francis H. Bainbridge was in charge of construction work for the Chicago & Northwestern Railway. From 1902 to April 1903, he was engineer for Western Expanded Metal Company. In April 1903 he began working for the Illinois Central Railroad, first as assistant engineer for bridges, then as engineer for bridges from, June 1904 to Feb. 1, 1905. In Feb. 1, 1905 he became principal assistant engineer and later bridge building superintendent for the Chicago & Northwestern Railway.[2] He was a member of American Society for Civil Engineering[9] and served on the wooden bridges and trestles committee of the American Railroad Engineering Association.[10] He was the resident engineer for the swing bridge at Clinton, Iowa, noted as a significant historic bridge.[11] The 855 m long Clinton, Iowa railroad bridge over the Mississippi cost a million dollars. It opened in 1909 and is still in use. In 1910 he was the Resident Engineer for the Milwaukee, Sparta & Western Railway.[12] His work on bridge foundations would cost him his life. He died of caisson disease[13] in December, 1912, at the age of just 49 in Chicago.[14,15] He was buried in Troy, New York.[16]

Publications:

Bainbridge, F. H. 1905. Structural steel dams. *Engineering News.* Volume 54:323-324.

Bainbridge, F. H. 1905. Structural steel dams. *Journal of the Society of Western Engineers*. Volume 10: 615-631.

Bainbridge, F. H. 1908. Methods and costs of testing for bridge foundations. *Engineering-Contractor*. Nov 25, Volume 30:352.

Bainbridge, F. H. 1909. New Bridge crossing the Mississippi River at Clinton, Iowa (Chicago & Northwestern Railway). *Engineering News*. Volume 61, January. 21:63.

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[8] Attebery, J., M. Rosness and J. Girand. 2002. *Distinguished Arizona Civil Engineers*. Arizona Society of Civil Engineers, ASCE. http://www.azsce.org/downloads/history-150thAnniversaryBooklet.pdf

[9] American Society of Civil Engineers. 1889. *Constitution, By-Laws and List of Members*. May. House of the Society, New York, NY.

[10] American Railway Engineering Association. 1913. *Proceedings of the American Railway Engineering Association* V. 14:42.

[11] Adeli, H. 2008. *Historic Bridges*. CRC Press, Boca Raton, FL.

[12] Stennett, W. H. 1910. *Yesterday and Today: A History of the Chicago and North Western Railway System*. Chicago and North Western Railway Company, Winship Company, Chicago, IL.

[13] The high air pressure needed to work in a submerged box (caisson in French) while preparing bridge foundations can result in illness and death. Caisson disease occurs when nitrogen is dissolved in the blood and absorbed by various tissues throughout the body. When this pressure is reduced quickly during decompression the nitrogen can form bubbles that wreak havoc on various tissues of the body and can result in seizures, paralysis, and other problems. In the 1870s the designer of the Brooklyn Bridge, Washington Roebling, suffered an extreme case of decompression illness and was left paralyzed for the rest of his life. Hundreds of workers and engineers suffered as well and many died as bridges were built around the US. The causes were not discovered until 1907 and not widely known for years after that.

[14] Obituaries. 1913. F. H. Bainbridge. *Railway World*. U.S. Railroad and Mining Register. V.57:70.

[15] Kidwall, E. P. 1997. Compressed air tunneling and caisson work decompression procedures: development, problems, and solutions. *Undersea and Hyperbaric Medicine*. Winter 24(4):337-45.

16 Obituary. 1912. Chicago Tribune. December, 4th. http://www.geocities.com/ljh9256/chicagodeathobits.txt Accessed May 4, 2009.