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PRICES AND SPENDING

Arlington Memorial Bridge spans the decades as a study in long-term price change

By Bradley Akin

The Arlington Memorial Bridge is one of seven existing bridges that carry automobile traffic across the Potomac River to and from Washington, DC. Though there have been bridges crossing the Potomac in the area since the first bridge constructed at the site of the Chain Bridge in 1797, these early bridges were often damaged by environmental factors, and others were replaced over time. Thus, the Arlington Memorial Bridge, opened for use on January 18, 1932, is the second-oldest of the bridges currently in use, after the Francis Scott Key Bridge (completed in 1923.) This article examines the history of the Arlington Memorial Bridge and compares the original

construction with a contemporary proposed rebuilding of it, which provides an interesting illustration of long-term price change in the United States, with the help of Bureau of Labor Statistics (BLS) data.

Original construction

Though it was opened in 1932, the Arlington Memorial Bridge had been proposed at least 80 years earlier. In 1851, Daniel Webster, then Secretary of State, called the Potomac at the eventual site of the bridge "the broad and beautiful river, separating two of the original thirteen States, which a late President [Andrew Jackson], a man of determined purpose and inflexible will, but patriotic heart, desired to span with arches of ever-enduring granite, symbolical of the firmly established union of the North and the South."[1] These tentative plans were disrupted by the Civil War, and were not revisited for more than 30 years. In 1886, the Senate directed the War Department to prepare a report on the feasibility of a bridge, and a design was proposed. Another, more elaborate design for a "General Ulysses S. Grant Memorial Bridge" was proposed in 1887 by Paul J. Pelz, known for his work on the Library of Congress.[2] No action was taken on these initial studies, but Congress continued to authorize additional studies and investigations, culminating in an 1899 competition to design a memorial bridge, to be judged by a board composed of officers from the Army Corps of Engineers, an architect employed by the Commissioners of the District of Columbia, and a former supervising architect of the Department of the Treasury. This board selected a design by William H. Burr and Edward Casey, which was unsuccessfully presented to Congress. The matter was raised again after the 1910 creation of the U.S. Commission on Fine Arts, whose members desired that "the large towers appearing on the bridge in the design would have to be eliminated so that there would be no competition with the treatment of the Lincoln Memorial terminus. They felt that the proposed bridge at the new location should be of the simplest possible design and should not detract by embellishment from the treatment of either terminus …."[3] Toward this end, Congress created and funded the Arlington Memorial Bridge Commission, with the goal of settling the design of the bridge.[4] However, these activities were halted by conflict once again, as funding was diverted due to the onset of World War I.

The Bridge Commission received the funding necessary to proceed in 1922. It is said that this was brought about when, while attending the dedication of the Tomb of the Unknown Soldier on November 11, 1921, President Warren G. Harding became caught in Washington's first traffic jam. He became so annoyed that he "expressed himself very forcibly regarding the confusion," and resolved to prevent such occurrences in the future.[5,6] The Bridge Commission, on the recommendation of the Commission of Fine Arts, opted to directly select the design of the bridge, and ultimately chose one submitted by William Mitchell Kendall of McKim, Mead, and White. Kendall's design was "a low, Neo-classical scheme" running on a line of sight from Arlington National Cemetery toward the Lincoln Memorial, and to be constructed of reinforced concrete faced with granite.[7] The bridge would also feature a central iron bascule draw span intended to allow the middle section of the bridge to be opened so that ship traffic could continue up the river.[8,9] Ultimately, in February of 1925, Congress appropriated $14.75 million for the Arlington Memorial Bridge project, of which $7.25 million was earmarked for the bridge itself.[10] A breakdown of the cost estimates from this appropriation are given below as table 1.

Table 1. Appropriations for Arlington Memorial Bridge

Line item	Original estimated cost
Piers	$2,800,000
Arches and deck	$720,000

See footnotes at end of table.

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Line item	Original estimated cost
Structural steel	$270,000
Bascule draw span, complete, unornamented	$450,000
Protection for draw span	$50,000
Grading for approaches	$75,000
Dredging	$96,000
Engineering and contingencies	$439,000
Ornamentation for draw span	$250,000
Granite facing	$1,200,000
Statues (40)	$392,000
Entrance pylons	$268,000
Ornamental lamp posts (40)	$18,400
Models	$4,150
Architecture and contingencies	$217,450
Total	**$7,250,000**

Source: KressCox Associates, PC, Historic Structures Report: Arlington Memorial Bridge, (1986), Book Collection of the Kiplinger Research Library of the Historical Society of Washington, D.C., p. I-1.

Preliminary work on the bridge began in 1925.[11] This work included boring, dredging, and the hiring of consulting engineer J.W. Douglas. The project hit a snag in January of 1926 when the Comptroller General declared the Bridge Commission's contracts with the architectural firm and the consulting engineer to be afoul of a law that forbade the government's hiring of general contractors and instead required that such individuals be hired as civil servants.[12] However, disruption was avoided when Congress acted to exempt the Bridge Commission from the civil service hiring requirements.[13] Work began on the piers and abutments, which consisted of an estimated 100,000 cubic yards of concrete, on March 15, 1926. The H.P. Converse Co. of Boston, MA, was awarded a $1.3 million contract for their construction. In July 1927, it was discovered that the company was requiring its workers to begin construction several extra hours early each day.[14] It fell to Lt. Col. Ulysses S. Grant III, as the executive officer of the Arlington Memorial Bridge Commission, to enforce the National Eight-Hour Law, which had been passed by Congress in 1868 and refined in a proclamation by his grandfather, President Ulysses S. Grant, in 1869. Subsequent work on the bridge was divided into smaller contracts, allowing more firms to compete for the work, and for more to be done simultaneously. This resulted in savings in both cost and time. As work continued on the superstructure, the Phoenix Bridge Co. was contracted to construct a bascule span designed by the J.B. Strauss Bascule Bridge Co.[15] Work on the bascule proceeded slowly, due in part to issues with fabricating components, and in part to the high density of material needed in order to fit a heavy enough counterweight into the allotted space such that it would not be visible. These delays caused budgetary overruns, which caused the bascule, estimated to cost around $700,000, to cost between $900,000 and $1,000,000.[16] Disputes relating to this cost overrun culminated in a lawsuit, which the government lost.[17] When the bascule was completed in October of 1930, it was "… the longest (216 ft), heaviest (3,000 tons), and fastest [opening] (one minute) draw span of its kind in the world."[18] The bridge was structurally complete by September 7, 1931, but its opening was delayed for several months because the roadways it would connect to remained unfinished.[19] While several elements of the bridge experienced cost overruns, these were minimized by reducing the amount of ornamentation and by scrapping plans for improvements to 23rd Street. In fact, as of June 30, 1933, the Arlington Memorial Bridge project was $2,541,419.43 under its budget. Table 2 compares the budgeted costs with the actual costs incurred.

Table 2: Budget and cost of Arlington Memorial Bridge project

Project	Estimate in 1925	Cost as of June 1933
Bridge plaza and watergate	$1,650,000	$1,893,107
Memorial Bridge proper	$7,250,000	$7,027,602
Columbia Island	$2,390,000	$1,393,994
Memorial Driveway and entrance	$1,390,000	$995,192
Constitution Ave. improvement	$2,070,000	$898,686
Total	**$14,750,000**	**$12,208,581**

Source: KressCox Associates, PC, Historic Structures Report: Arlington Memorial Bridge, (1986), Book Collection of the Kiplinger Research Library of the Historical Society of Washington, D.C., p. I-1.

Subsequent repairs

The Arlington Memorial Bridge has received repairs several times: in 1939, 1951, and 1985 for repaving, repainting, and similar routine maintenance.[20] The bascule span also required repair on different occasions, in 1936 and 1945, when the bridge became stuck open.[21] The bascule span was closed in 1961 because the construction of the fixed Theodore Roosevelt Bridge upstream removed the need for this function, as large ships would be unable to pass further upriver after passing through the draw span of the Arlington Memorial Bridge and reaching the new, non-opening, bridge.[22] In 1976, the bascule span was immobilized and sealed.[23] Work was also performed in 2012 to preserve and repair the bridge's sidewalks, curbs, and deck.[24] Nonetheless, the bridge continued to deteriorate, and a 2012 report of the Federal Highway Administration called for a complete overhaul.[25] The bridge, especially the bascule span, had corroded over time, and without extensive repairs, the bridge would likely need to be closed to vehicle traffic by 2021, putting additional strain on the other already-crowded Potomac crossings. In fact, weight restrictions have already been imposed on traffic crossing the bridge.[26] Although the National Park Service, the agency responsible for the bridge, has spent $9.3 million on measures to shore up columns in order to keep the bridge in service, officials described these measures as "Band-Aid" repairs.[27] In order to fully repair the "structurally deficient" bridge, the Park Service will need additional funding.[28] The National Park Service has put forth several plans for repairs to the bridge, summarized in table 3. They range from a "one-phase" plan, which completes the entire reconstruction as one large project, to a "six-phase" plan, which divides repairs to the main roadway surface of the bridge into four quarters, each its own phase, and separates work on the bascule and substructure into their own distinct phases. On July 5, 2016, elected officials announced that the bridge reconstruction project would receive $90 million in grant funding from the Department of Transportation.[29]

Table 3: Proposed plans for the reconstruction of the Arlington Memorial Bridge

Plan	Estimated cost as of February 2016
2-year, 1-phase reconstruction	$230,000,000
3-year, 2-phase reconstruction	$242,000,000
6-year, 6-phase reconstruction (not recommended)	$254,000,000
11-year, 6-phase reconstruction (not recommended)	$280,000,000

Sources: National Park Service and Federal Highway Administration.

Even the least costly of these estimates, the 2-year, one-phase rebuild, would cost $230 million, or more than 31 times the $7.25 million budgeted for the bridge's original construction and more than 15 times the $14.75 million

budgeted for the entire Arlington Memorial Bridge project in the original appropriation. Over the January 1932–May 2016 period, the Consumer Price Index for All Urban Consumers (CPI-U) US City Average series for All Items increased by roughly 14 times. From this observation, it would appear that the cost of infrastructure projects has increased significantly more than the general consumer price level, and this is supported by examining some component costs, shown in table 4.

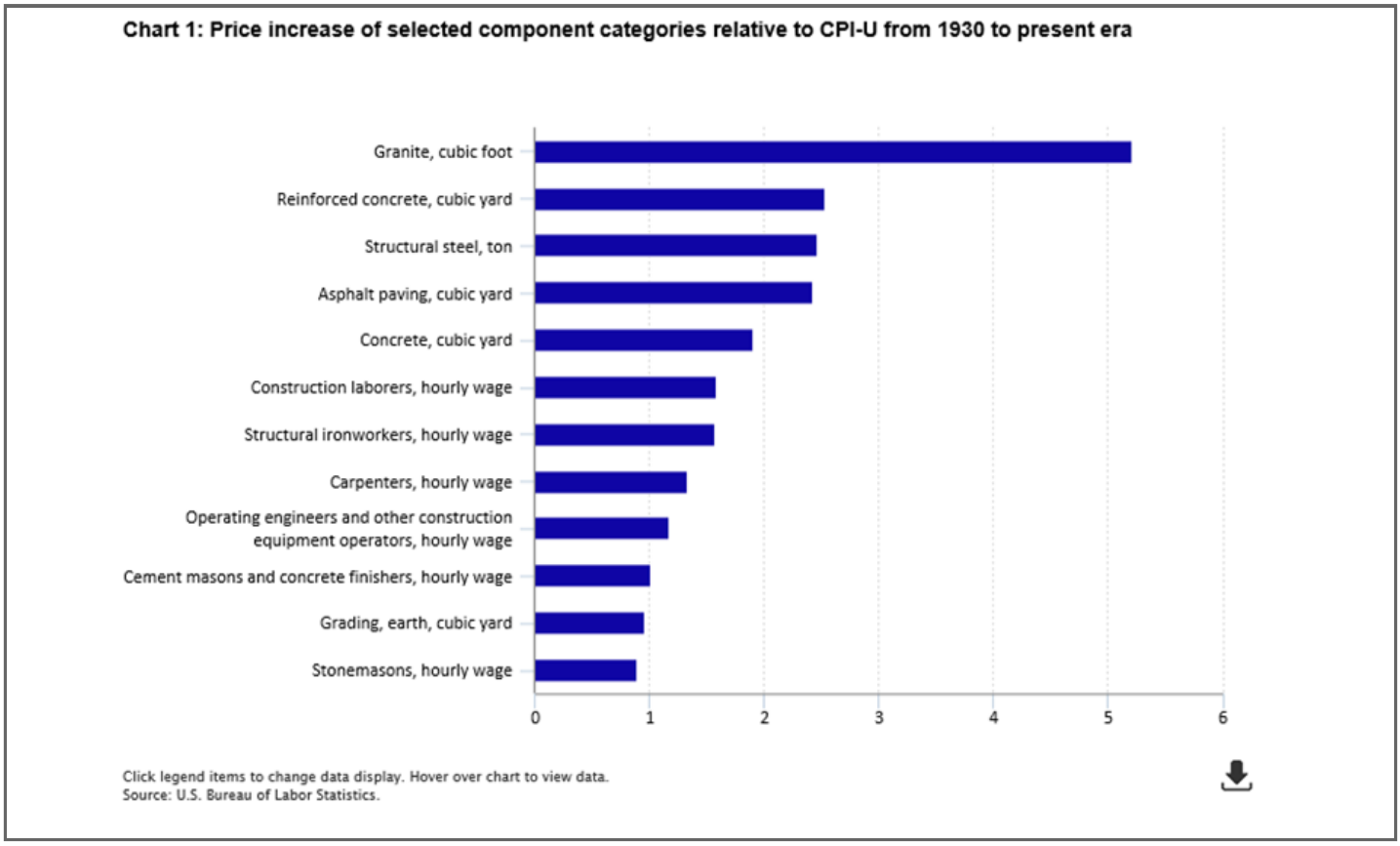
Table 4: Prices and wages in 1930 versus present era

Item	Original cost[1]	Present-day cost[2]	Percent increase	Increase relative to CPI-U
Materials				
Concrete, cubic yard	$28	$732.97	2,518	1.91
Reinforced concrete, cubic yard[3]	30	1,035.47	3,352	2.54
Structural steel, ton[4]	150	5,040.00	3,260	2.47
Granite, cubic foot[5]	10	700.00	6,900	5.22
Asphalt paving, cubic yard[6]	4.50	148.90	3,209	2.43
Grading, earth, cubic yard[7]	0.75	10.24	1,265	0.96
Labor	**May 1930**	**2016**		
Cement masons and concrete finishers, hourly wage[10]	$1.49	$21.70	1,356	1.03
Carpenters, hourly wage[11]	1.36	23.24	1,609	1.22
Construction laborers, hourly wage[12]	0.92	20.84	2,165	1.64
Stonemasons, hourly wage[13]	1.63	20.98	1,187	0.90
Operating engineers and other construction equipment operators, hourly wage[14]	1.59	27.27	1,615	1.22
Structural ironworkers, hourly wage[15]	1.54	31.42	1,940	1.47
Price Indexes	**May 1930**	**May 2016**		
CPI-U, US, All Items	16.9	240.2	1,322	
CPI-W, US, All Items	17.0	234.4	1,279	
PPI, All Commodities	15.3	185.3	1,111	
PPI, Iron and Steel	10.2	192.9	1,791	
PPI, Concrete Ingredients and Related Products	16.6	279.9	1,586	

See footnotes at end of table.

(1) KressCox Associates, PC (1986). Historic Structures Report: Arlington Memorial Bridge. Book collection of the Kiplinger Research Library of the Historical Society of Washington, D.C. (p. I-11).
(2) Highway Construction Costs, March 2016, Washington Department of Transportation (except granite).
(3) Current price estimated using 250 lbs. steel reinforcing bar per cubic yard of concrete.
(4) Current price estimated by multiplying the rate for 1 lb. structural steel by 2,000.
(5) Richard Zinsmeister, Consultant, North Carolina Granite Corp. Phone interview. (1-800-227-6243).
(6) Current price estimated assuming density of asphalt to be 2.025 tons per cubic yard.
(7) Grading, earth (1930) is mapped to roadway excavation (2016).
(8) Handbook of Labor Statistics, 1931 Edition; Bulletin of the United States Bureau of Labor Statistics No. 541 (September 1931), (p. 837–838) average rate of wages per hour, May 1930.
(9) OES May 2016 data for selected occupations, (NAICS code 237300), hourly mean wage.
(10) Cement finishers (1930) mapped to cement masons and concrete finishers (472051)(2016).
(11) Carpenters (Wharf and Bridge)(1930) mapped to carpenters(472031)(2016).
(12) Building laborers (1930) mapped to construction laborers (472061)(2016).
(13) Stonemasons (1930) mapped to stonemasons (foundation, structure, and building exterior contractors)(472022)(2016).
(14) Engineers (portable and hoisting) (1930) mapped to operating engineers and other construction equipment operators(472073)(2016).
(15) Structural ironworkers (1930) mapped to structural iron and steel workers (472221)(2016).

It appears that much of the increase in costs of an infrastructure project like the reconstruction of the Arlington Memorial Bridge, relative to the general rate of consumer inflation, can be ascribed to similarly rapid increases in the cost of construction materials. Structural steel, reinforced concrete, and asphalt have all increased in cost faster than the 31-fold increase in cost of reconstruction versus the original construction of the bridge. Producer Price Index estimates of cost increases for iron and steel and concrete ingredients and related products are more modest, but these categories have increased more rapidly than the PPI for all commodities. Figures from the PPI are used here to provide additional context about the rate of price change for specific nonconsumer commodities as opposed to the overall level of consumer inflation. The Mount Airy white granite used to face the piers, spandrel walls, and balustrades has increased in price even more rapidly than that. Although a cubic foot of the stone, as quarried, might cost only $80 to $100, a piece cut and finished for use as a balustrade would be $700 per cubic foot today, an increase more than 5 times the rate of consumer inflation. The only physical component to increase at a slower rate than the overall price level was the cost of grading earth. The costs of labor, in contrast, have increased often more rapidly than inflation, as measured by the change in the CPI, but not nearly so rapidly as the construction materials. The only group of workers considered here to have their average wage grow at a rate less than the change in the CPI were stonemasons, who saw their pay increase by approximately a factor of 13 over the period. The purchasing power of cement finishers remained roughly constant; that is their wages increased at roughly the same rate as consumer prices. Carpenters and operating engineers saw slight gains relative to inflation, while structural ironworkers and laborers realized larger gains. One of the most interesting shifts is in the ordering of the wages of these occupations. For example, stonemasons were once the highest earning subset of workers at $1.63 per hour, but recent data show them as the second-lowest earning group at $20.98 per hour, earning only slightly more than laborers, who earn $20.84 per hour, on average. Also, structural ironworkers, who were in the middle of the distribution in 1930 at $1.54 per hour, are now the highest earning among the trades considered, earning $31.42 per hour, on average. The changes in costs relative to the price level are presented in chart 1.



Conclusion

The costs of infrastructure projects have grown much faster than the general inflation rate over the decades since the Arlington Memorial Bridge was first constructed. The case examined here suggests that this is driven, in large part, by especially rapid growth in the cost of essential construction materials.

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NOTES

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3 Minutes of the Commission of Fine Arts, quoted in Myer, *Bridges and the City of Washington,* p. 18.

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5 "Washington's First Traffic Jam: Some Things Never Change," *The Washington Post*, June 5, 2002, https://www.washingtonpost.com/archive/politics/2002/06/05/washingtons-first-traffic-jam-some-things-never-change/fa5115ee-e3a4-4e27-91b4-bf9fc2a33ac9/.

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8 A bascule bridge is type of drawbridge consisting of two counterweighted leaves or spans that pivot upward on a horizontal axis to allow boat traffic to pass underneath. It is the most common type of movable bridge in the world.

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