THE BELLEFONTAINE BRIDGE.

comprising such works as, from their rarity or value, should not be lent out, all unbound periodicals, and such text books as ought to be found in a library of reference except when required by Committees of the Institute, or by members or holders of second class stock, who have obtained the sanction of the Committee. The second class shall include those books intended for circulation.

ARTICLE VI.—The Secretary shall have authority to loan to Members and to holders of second class stock, any work belonging to the SECOND CLASS, subject to the following regulations:

Section 1.—No individual shall be permitted to have more than *two books* out at one time, without a written permission, signed by at least two members of the Library Committe; nor shall a book be kept out more than TWO WEEKS; but if no one has applied fur it, the former borrower may renew the loan. Should any person have applied for it, the latter shall have the preference.

Section 2.—A FINE OF TEN CENTS PER WEEK shall be exacted for the detention of a book beyond the limited time; and if a book be not returned within three months it shall be deemed lost, and the borrower shall, in addition to his fines, forfeit its value.

Section 3.—Should any book be returned injured, the borrower shall pay for the injury, or replace the book, as the Library Committee may direct; and if one or more books, belonging to a set or sets, be lost, the borrower shall replace them or make full restitution.

ARTICLE VII.—Any person removing from the Hall, without permission from the proper authorities, any book, newspaper or other property in charge of the Library Committee, shall be reported to the Committee, who may inflict any fine not exceeding twenty-five dollars.

ARTICLE VIII.—No member or holder of second class stock, whose annual contribution for the current year shall be unpaid or who is in arrears for fines, shall be entitled to the privileges of the Library or Reading Room.

ARTICLE IX.—If any member or holder of second class stock, shall refuse or neglect to comply with the foregoing rules, it shall be the duty of the Secretary to report him to the Committee on the Library.

ARTICLE X.—Any Member or holder of second class stock, detected in mutilating the newspapers, pamphlets or books belonging to the Institute shall be deprived of his right of membership, and the name of the offender shall be made public.

Compliments of

GEO. S. MORISON,

Chief Engineer.

1742 Monadnock Block,
Chicago

THE BELLEFONTAINE BRIDGE.

A REPORT

TO CHARLES E. PERKINS, PRESIDENT OF THE CHICAGO, BURLINGTON & QUINCY RAILROAD,

BY

GEORGE S. MORISON, CHIEF ENGINEER OF THE BELLEFONTAINE BRIDGE

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Chicago, December 31, 1894.

Charles E. Perkins, Esq.,
President Chicago, Burlington & Quincy R. R. Company.

Dear Sir:—

I submit the following Final Report in relation to the Bridge across the Missouri River at Bellefontaine Bluffs, Missouri.

Yours truly,

George S. Morison,
Chief Engineer.

KNIGHT, LEONARD & CO. PRINTERS, CHICAGO.

THE BELLEFONTAINE BRIDGE.

I.

PRELIMINARY NARRATIVE.

The Bellefontaine Bridge is on the main line of the St. Louis Extension of the St. Louis, Keokuk & Northwestern R. R., one of the proprietary lines of the Chicago, Burlington & Quincy R. R. It is built under authority of an Act of Congress, approved February 17th, 1888, which charter is printed in Appendix B.

The selection of terminals for the St. Louis, Keokuk & Northwestern R. R. in the City of St. Louis, and the location of a line by which that railroad might be extended to the City of St. Louis, was placed by you in my hands in the early part of 1887. This extension involved a bridge across the Missouri River. An examination of the country north of St. Louis and of the Missouri River convinced me very early that the extension ought to be built through the bottom land between the Mississippi and Missouri Rivers, crossing the Missouri River so near the mouth that a low grade line could be built from the bridge to the city. The importance of a line of this kind was further emphasized from the fact that the place in which it was decided to purchase terminal yards was in the northern part of the city adjoining the Mississippi River. On the 19th of May, 1887, I examined the bluff from the northern limits of the city to a point called Jamestown Landing, from the fact that many years ago the cargo of the wrecked steamer JAMESTOWN had been landed there, and at that time selected the location on which the bridge has been built, as the best point to cross the river. This location is 8.2 miles from the mouth of the river according to the maps published by the Missouri River Commission. It is almost immediately opposite the City of Alton and only 4½ miles from that city. It was evident to me at the time, that if a bridge was also built across the Mississippi River at Alton, the Missouri River Bridge could be made to serve as the entrance to St. Louis for railroads from the east as well as from the west. Although your company did not see fit to undertake the construction of both bridges, the Alton Bridge has been built by another interest, simultaneously with the construction of the Bellefontaine Bridge.

The purchase of St. Louis terminals was begun in 1887 but was conducted secretly until May 10th, 1889, when deeds to the company were first placed on record in St. Louis. The actual location of the line was made in 1889 and 1890. In April, 1889, a party was sent to the site selected for the bridge, and borings were made to ascertain the depth to rock; these borings found rock at depths considerably greater than had been anticipated.

The plans for the structure were submitted to the Secretary of War and approved by a formal contract with the War Department dated December 21st, 1889, this contract being printed in Appendix B.

Actual construction was not begun till 1892, when, on the 19th of February, you authorized me to proceed with the construction of the bridge over the Missouri River.

Mr. B. L. Crosby was appointed Resident Engineer of the work, and on the 1st of July, 1892, he was relieved of the work of which he had been in charge in St. Louis, and his headquarters were established at the bridge.

As the situation was an inaccessible one and remote from any town, it became necessary to establish a camp at the site of the bridge and to construct buildings for use. The first actual work done in preparation was on April 7th, 1892, when a force began clearing timber from the right of way. On April 19th the building for the engineer's office was begun.

The steamer JOHN BERTRAM, with a full outfit of pneumatic machinery, which had been used at the Rulo, Nebraska City and Memphis Bridges, as well as for some repair work at the pivot pier of the Kansas City Bridge, was brought to the bridge site on the 7th day of May.

Eighteen hundred and ninety-two was a year of high water; the lower Missouri River as well as the Mississippi River at St. Louis were higher than at any time since 1858. The slope of the river opposite the City of St. Louis was, however, somewhat abnormal, and it is probable that the river at the site of the Bellefontaine Bridge was higher than it has been at any time since 1844. On the 18th day of May it reached elevation 115.1; the zero being a datum plane 100 feet below the St. Louis City directrix, to which datum all levels on the work were referred. This high water prevented any considerable amount of work being done during the first half of the year.

The first actual work done was on the 4th of July, 1892, when the excavation at the site for Pier I was begun. The first work on the river foundations was begun on the 13th of July, when the first timber was framed for one of the caissons.

The work of construction went on continuously without interruption till the completion of the work. The system on which the work was conducted was the same that had been adopted on other large bridges built under my direction. The foundations were put in by a force working under the immediate direction of the Resident Engineer. The masonry and superstructure were let by contract.

The contract for the masonry was let to the firm of Christie & Lowe, Mr. George A. Lederle being the resident partner, the contract being dated March 28th, 1892. The contract for superstructure of the bridge proper was let to the New Jersey Steel & Iron Company of

Treuton, N. J., the contract being dated June 18th, 1892. The contract for the steel viaduct at the north end was let to A. & P. Roberts & Company of Pencoyd, Pa., their contract being dated December 14th, 1892. On the 9th day of September, 1893, a contract was made with Mr. William Baird for the erection of the superstructure of the main bridge. Small contracts for the delivery of special materials were made from time to time, but there were no other important contracts.

The superstructure was erected and a track laid across the bridge so that the first train crossed on December 27th, 1893. No formal opening took place. The first regular time table went into effect March 4th, 1894, at which time the bridge was put in regular service as a double track structure.

II.

GENERAL DESCRIPTION.

The Bellefontaine Bridge is a double-track railroad bridge. It consists of four through spans, each 440 feet long between centers of end pins, resting on one masonry abutment and four masoury piers. At the north end of the bridge there is an iron viaduct 849.83 feet long, consisting of 28 spans, restiug on brick piers with pile foundations. The total length of the permanent structure from the face of the back wall of the abutment to the end of the iron viaduct is 2 630.77 feet. The four main spans of the bridge are built on a vertical curve corresponding to the camber of the trusses. The viaduct descends from the bridge northward with a grade of 0.5 per cent.

As the soutb abutment is founded on rock above low water, and the bluff rises rapidly from this rock, there is virtually no south approach.

The north approach consists of 2 960 feet of temporary timber trestle, which is built on the continuation of the grade on the iron viaduct; beyond this trestle is a solid earth embankment built to the same grade. The grade line south of the river was so laid that enough material would be taken from the cut through the bluffs to fill the eutire trestle, the track being first laid on a temporary location.

The bridge and north approach are on a single straight line. 6 984 feet from the north end of the viaduct, this tangent intersects two other tangents, one leadiug westward and forming the main line of the St. Louis, Keokuk & Northwestern R. R., and the other leading to the Alton Bridge. The bridge and approaches may properly be considered as extending from the south side of the abutment to the foot of the grade on each of the two diverging lines.

The location of the bridge is shown on Plate 1. The general character of the bridge and the profile of the approach are giveu on Plate 2. The piers were numbered from the south northward, the south abutment being Pier I, the north pier, Pier V. This same numbering, designated, however, by Arabic numerals, was extended to the viaduct piers.

III.

SUBSTRUCTURE.

The substructure of the bridge proper consists of one masonry abutment and four masonry piers. The abutmeut is at the south end and is designated as Pier I. The four masonry piers are designated as Piers II, III, IV and V; they are all founded on pneumatic caissons.

The caissons for Piers II, III and IV are all of the same horizontal dimensions, being 70 feet long, 30 feet wide and 16 feet high. They are surmounted by crib work filled with concrete, having the same horizontal dimensions as the caissons, but varying in height with the several piers. The caisson for Pier V is 24 feet wide, 60 feet long and 16 feet high and surmounted by a timber crib of the same character as that of the other piers. In the larger caissons there are four transverse braces of 16 inch square timber in the working chamber and also a longitudinal timber of the same size; in the smaller caisson the longitudinal timber was omitted, and there were only two transverse timbers. The insides of the chambers were lined with three-inch plank and then carefully caulked. The caissons were built of long leaf yellow pine throughout.

Piers II, III and IV are founded on the underlying bed rock. The foundation of Pier V was uot carried to rock.

The following table shows the heights of the four piers:

	Bottom of Foundation.	Height of Crib Work.	Height of Caisson and Crib Work.	Elevation bottom of Masonry.
Pier II.	23.47	24.4	40.4	63.87
Pier III.	3.08	43.15	60.95	64.03
Pier IV.	—9.17	56.1	73.9	64.73
Pier V.	9.26	64.0	80.0	89.26

All the caissons, except that for Pier II, were built on launching ways on the north side of the river and launched and towed into place. The caisson for Pier II was built on blocking on the sand bar at the site of the pier.

The plans of the several piers are shown on Plates 3, 4 and 5. The piers are of the same general plan that I have used on other large structures. Piers II, III and IV measure 12 feet thick and 34 feet long between shoulders, under the belting course. Pier V measures 9 feet thick and 39 feet long between shoulders under the belting course. Piers II, III and IV are precisely alike in all dimensions above the crib work except that Pier III is 0.45 feet higher than either of the other two, this difference providing for the vertical curve on the bridge.

The Specifications for Masonry are given in Appendix E. The work is built generally of limestone from the quarries near Bedford, Indiana, or at Romona, Indiana, the two stones being so much alike that they cannot be distinguished in the work. The face stone of the fourteen courses in Piers II, III and IV, from elevation 88.0 to the under side of the starling coping, are granite from St. Cloud, Minn.

The floating equipment furnished by the railroad company was as follows:

Steamer John Bertram,	390.49 tons
" Pauline,	60 "
Concrete mixer barge,	30 ft. x 90 ft.
Pile driver and derrick barge,	24 " x 70 "
Pressure men's house barge,	24 " x 64 "
Sounding barge,	16 " x 24 "
One material barge,	30 " x 81 "
Two " "	26 " x 80 "
One " "	24 " x 80 "
One " "	24 " x 70 "

Several other barges of various sizes were chartered during the work.

Besides this the contractors for the masonry had the following floating equipment:

Steamer Geo. L. Bass, 60 tons.	
One derrick barge,	40 ft. x 80 ft., with mast 80 ft. high.
One " "	30 " x 80 " " " 50 " "
Four barges	22 " x 80 "

In view of the great depth at which some of the foundation work had to be done, and as there was apprehension of an unhealthy season, special arrangements were made for the health and comfort of the men. A regular resident physician was engaged and attached to the engineering staff. A supply of drugs and simple surgical tools was provided, and a small hospital was erected. With these special provisions the work was carried through without any unusual trouble.

The launching ways were built of piles and capped. The first two caissons launched were precisely alike, and the order of their use was determined by the condition of the river at the time.

PIER I.

The first work done in construction was the excavation at the site of Pier I on the south bluff. Work, however, was not pressed and was only carried on at such times as forces could be conveniently spared from other parts of the work. The excavation, which was largely in loose rock, was not completed till December 2nd, 1892. The rock was leveled off with concrete and the first stone was set in this abutment on the 31st of May, 1893. The abutment was finally finished June 22nd, 1893.

PIER II.

The cutting edge of the caisson for Pier II was set up on blocking at the site of the pier on the 24th of October, 1892; the caisson was finished on the 5th of November and was lowered on the sand bottom on the 7th of November, 1892. The concrete filling was begun on the 14th of January, 1893. Air pressure was applied on the 19th of January. The concrete filling of the crib work was completed on the 12th of February. The laying of masonry was begun on the 7th of March. Rock was reached on the south side of the pier on March 30th at elevation 29.60. This rock was a solid ledge but sloped off rapidly to the north; the lowest point of the rock was at elevation 21.60, at the northeast corner, there being a difference of eight feet inside the caisson. Blasting was resorted to on March 31st, using rackarock as the explosive, and was continued until April 23rd when the caisson reached its final elevation of 23.47. The rock was removed from the caisson by the aid of a clay hoist of the same pattern as was used on the Rulo and Memphis Bridges. The rock was cleaned and the sealing of the caisson begun April 25th; the sealing was finished May 3rd.

On the north side the cutting edge did not reach the rock, except for a short distance near the northwest corner, but blocking was put under the shoulder of the cutting edge to support the caisson and the rock entirely cleared off so that the concrete filling reached to the rock throughout; at the northeast corner of the caisson the concrete was carried down more than two feet below the cutting edge.

During the filling of the chamber with concrete, there was a sharp rise in the river, which completely submerged the pier, only the shafts and pipes being kept above water; and they were protected from injury from drift logs, by a bulwark of bags of crushed stone built up on the nose of the pier and extended around the shafts. During the last day or two the water was five feet deep over the masonry of the pier.

The entire pier was finished July 4th, 1893.

PIER III.

The cutting edge of the caisson for Pier III was set up on the launching ways on the 30th of July, 1892, and the caisson was finished and launched on the 20th of August. When this caisson was being built the river fell rapidly and sand bars formed so that there was only from two to five feet of water at the site of the pier, while the caisson drew ten feet. On August 21st the steamer John Bertram was moored at the site of the pier and her wheels started to wash out the sand; this was successfully accomplished so that on the 23rd a basin from six to ten feet deep had been washed out. In the meantime barges had been placed on each side of the caisson, and heavy timbers, running across the caisson and barges, were securely bolted to the caisson. On the morning of the 23rd the steamer John Bertram was brought back to shore and placed behind the caisson; air connections were made with the caisson, and with the help of the steamers PAULINE and GEO. L. BASS, the caisson was towed out till it struck against a submerged bar in the middle of the river. Air was then pumped into the caisson until it was raised enough to pass over the bar; as the caisson was raised by air pressure, blocking was placed on the barges under the heavy timbers bolted across the caisson, to keep it from tipping. The caisson was then towed further till it grounded again near the site of the pier, was again raised until it drew only four feet and a half, was then finally placed, the air pressure released, and the caisson left in position on the sand.

The concrete filling was begun on the 28th of August, and air pressure was applied on the 2nd of September. The concrete filling of the crib work was completed on the 23rd of September. The laying of masonry was begun on the 9th of November. The caisson finally reached the rock at elevation 3.08 on January 3rd, 1893. The rock was cleaned and the sealing of the caisson begun January 5th; the sealing was finished January 11th and the pier was finished May 19th, 1893.

PIER IV.

The cutting edge of the caisson for Pier IV was set up on the launching ways on August 26th, 1892; the caisson was finished and launched on September 20th, on the 24th it was towed into position and securely fastened to four clusters of anchor piles near the four corners; by means of lines leading from these clusters of piles, it was held accurately in position and sunk down to the sand. When the caisson was placed, soundings showed 14 feet of water at the west end and 13 feet at the east end. The work of building up the crib was started that night and continued till the 29th when concreting was begun; at this time the soundings showed about twenty feet of water all around the floating caisson. As the weight of the concrete settled the caisson, the current gradually cut away the sand below the edge; on the morning of the 30th the water all around averaged 23 feet deep, with 25.5 feet at the northwest corner; in the afternoon the caisson grounded on the south side, and on the morning of the 1st of October it was still aground on the south side, but on the north side the water was 25 feet deep; about 600 bags of sand were thrown in on the up stream end, and on the morning of the 2nd the caisson was aground at this end. Concreting was continued during the 2nd and 3rd, and on the afternoon of the 3rd more sand bags were thrown in along the north side as cutting had begun again there. On the morning of the 4th the air pipes were connected and air pressure applied. On trying to enter the caisson through the air lock, the door of the main shaft below the lock was found to be blocked so that it could only be opened a few inches. Pressure was let off, and a man was lowered into one of the supply shafts, the top put on the shaft, and the air pressure restored; this man entered the caisson and found that a part of a temporary false bottom that had been used in launching had not been removed, and some of the timbers were jammed against the main shaft door; these be cleared away, and the caisson could be entered through the lock. The Resident Engineer entered and found that along the south side and east end the caisson was filled with sand nearly to the roof, while along the north side and west end the sand was below the cutting edge. Some of the false bottom had become wedged under the cross beams, and as weight had been put on the caisson above, it was pressed down till the cross beams supported the greater part of the weight of caisson and concrete. All the cross beams were split, and the vertical posts between them and the roof were either pressed up into the roof or down into the beams; the second cross beam from the down stream end was pressed so that the distance between it and the roof was only 3 feet 4 inches instead of 4 feet, the vertical post at the center was split for its entire length and crushed into the longitudinal beam. Concreting was at once stopped and men began leveling the sand and clearing out under the beams; when this was done, the beam that had been pushed eight inches came back to within three inches of its original position. As soon as everything was cleared the cracked beams were jacked into place and securely bolted, new posts were put in alongside the damaged posts, and the work went on as usual.

The concrete filling of the crib work was completed on October 23rd. The laying of masonry was begun on October 25th. The caisson finally reached the rock at elevation –9.17 on November 18th. The bed rock in the caisson was covered to a depth of two or three feet with boulders ranging in size from an egg to a barrel; there were too many to attempt to remove without a special hoist, which was not available, and it was decided to work them into the concrete filling of the chamber, cleaning off the bed rock a section at a time and using up the boulders as rapidly as possible. The sealing of the caisson was begun November 20th and finished November 29th, 1892, and the pier was finished April 29th, 1893.

PIER V.

The cutting edge of the caisson for Pier V was set up on the launching ways on November 8th, 1892, the caisson was finished November 25th, launched December 11th, and was placed in position December 16th. The concrete filling was commenced December 16th and the caisson grounded on December 17th. Air pressure was applied on the 21st of December, 1892.

The concrete filling of the crib work was finished February 28th, 1893. The laying of masonry was begun on March 2nd. The caisson reached its final resting place with the cutting edge in sand at elevation 9.26, on March 7th. The sealing of the caisson was begun on that day and finished on March 12th, and the pier was completed May 27th, 1893.

The full details of the five piers are given on Plates 3, 4, 5 and 6. The rate of progress in sinking is illustrated graphically on Plate 7. Full records of the progress in detail in sinking these foundations were kept and are given in Appendix C. The cost of sinking is given in Appendix D.

The cost of the four pneumatic foundations is shown in detail in the following table:

	Cost, Excluding Freight Charges.	Freight Charges.	Cost, Including Freight Charges.			
FOUNDATION, PIER II.						
Caisson—						
Material	$ 10 161.11	$ 45.86	$ 10 206.97			
Labor	5 657.66		5 657.66			
				$ 15 864.63		
Concrete Filling—						
Material	10 275.20	120.00	10 395.20			
Labor	5 628.56		5 628.56			
				16 023.76		
					$ 31 888.39	
Cutting Edge, Air Lock, Shafts, Etc.	3 927.57		3 927.57		3 927.57	
Erection and Removal of Machinery	2 277.53		2 277.53		2 277.53	
Sinking—						
Material	3 440.60	526.10	3 966.70			
Labor	13 752.73		13 752.73			
					17 719.43	
Work Train Service	87.00				87.00	
	55 207.96	691.96				$ 55 899.92
FOUNDATION, PIER III.						
Caisson—						
Material	13 540.55	16.83	13 557.38			
Labor	7 377.28		7 377.28			
				20 934.66		
Concrete Filling—						
Material	10 932.53	5.98	10 938.51			
Labor	5 870.17		5 870.17			
				16 808.68		
					37 743.34	
Cutting Edge, Air Lock, Shafts, Etc.	4 699.26	10.81	4 710.07		4 710.07	
Erection and Removal of Machinery	1 995.50		1 995.50		1 995.50	
Sinking—						
Material	3 090.16	1.89	3 092.05			
Labor	12 433.91		12 433.91			
					15 525.96	
Work Train Service	10.54				10.54	
	$ 59 949.90	35.51				59 985.41
Carried forward						$115 885.33
Brought forward						$115 885.33
FOUNDATION, PIER IV.						
Caisson—						
Material	$ 14 861.44	$ 15.00	$ 14 876.44			
Labor	8 062.34		8 062.34			
				$ 22 938.78		
Concrete Filling—						
Material	14 394.12	3.60	14 397.72			
Labor	7 081.33		7 081.33			
				21 479 05		
					$ 44 417.83	
Cutting Edge, Air Lock, Shafts, Etc.	5 217.29	22.62	5 239.91		5 239.91	
Sinking—						
Material	3 253.06		3 253.06			
Labor	14 580,74		14 589.74			
					17 842.80	
	67 459.32	41.22				67 500.54
FOUNDATION, PIER V.						
Caisson—						
Material	11 827.23	93.41	11 920.64			
Labor	6 379.29		6 379.29			
				18 299.93		
Concrete Filling—						
Material	8 395.64	421.10	8 816.74			
Labor	6 943.83		6 943.83			
				15 760.57		
					34 000.50	
Cutting Edge, Air Lock, Shafts, Etc.	3 555.10		3 555.10		3 555.10	
Sinking—						
Material	2 424.59	383.55	2 808.14			
Labor	6 792.10		6 792.10			
					9 600.24	
Work Train Service	179.70				179.70	
	46 497.48	898.06				47 395.54
Grand Total Cost of Four Foundations	$229 114.66	$ 1 666.75				$230 781.41

The cost and the quantities of masonry in the five piers are shown in detail in the following table :

	Pier 1, Abutment.			Pier 11.			Pier III.			Pier IV.			Pier V.		
Masonry laid....@ $17.00	1 314.76 c. y.		$23 350.92	2 787.71 c. y.		$47 391.07	2 793.17 c. y.		$47 483.89	2 784.55 c. y.		$47 337.35	1 341.84 c. y.		$22 811.28
Allowance for Granite hauled from St. Louis by barge, track not being completed in time....						434.91			854.59			402.75			
Drain Tile for Weepers....			2.40												
Work Train Service....			200.40			224.63			36.85			36.84			110.54
Portland Cement ....@ $3.02	5 bbls.	$ 15.10		120 bbls.	$362.40		253.5 bbls.	$765.57		273.5 bbls.	$825.97		73 bbls.	$220.46	
" " ....@ 2.89	140 "	404.60		222 "	641.58		262 "	757.18		137 "	395.93		134 "	387.26	
Louisville Cement....@ 0.64½	174 "	112.23		497 "	320.56										
" " ....@ 0.62							275 "	170.50							
" " ....@ 0.67	51 "	34.17								406 "	272.02		163 "	109.21	
Labor handling Cement....		19.44			46.37			41.93			40.87			18.94	
			585.54			1 370.91			1 735.18			1 534.79			735.87
Total....			$23 139.26			$49 421.52			$50 110.51			$49 311.73			$23 657.69
Cost per Cubic Yard of Masonry....			17.60			17.73			17.94			17.71			17.63
Average Cost per Cubic Yard of Masonry....															17.75

The amount of masonry and concrete in the several piers and the amount of cement used is given in the following table:

	Masonry, Cu. Yds.	Concrete, Cu. Yds.	Total Cu. Yds.	Cement, Bbls.				
				In Masonry.		In Concrete.		Total.
				Portland.	Louisville.	Portland.	Louisville.	
Pier 1....	1 314.76	130.00	1 444.76	145.0	225	127	68	565
Pier 11....	2 787.71	2 325.00	5 112.71	342.0	497	1553	1638	4030
Pier 111....	2 793.17	3 510.90	6 304.07	515.5	275	887	4785	6462.5
Pier 1V....	2 784.55	4 251.30	7 035.85	410.5	406	1222	5555	7593.5
Pier V....	1 341.84	3 198.00	4 539.84	207.0	163	1097	4057	5524
Total....	11 022.03	13 415.20	24 437.23	1 620.0	1566	4886	16103	24175.0

The cost of the five piers was as follows:

	Cost, Excluding Freight.			Freight Charges.			Cost, Including Freight.			Gross Volume. Cu. Ft.	Cost per Cubic Foot. Cents.	Cubic Feet sunk. Area of base × feet sunk.	Cost per Cubic Foot. Cents.	Vertical Feet sunk below Standard Low Water.	Cost per Vertical Foot.
FOUNDATION, PIER I (ABUTMENT).															
Excavation and Concrete	$ 2 289.17			$ 23.15			$ 2 312.32								
		$ 2 289.17			$ 23.15			$ 2 312.32							
FOUNDATION, PIER II.															
Caisson and Filling, including Cutting Edge, etc.	35 650.10			165.86			35 815.96			84 840	42 22				
Sinking Caisson	17 193.33			526.10			17 719.43					143 703	12.33	68.43	$ 258.94
Erection and Removal of Machinery	2 277 53						2 277.53								
Work Train Service	87.00						87.00								
		55 207.96			691 96			55 899.92							
FOUNDATION, PIER III.															
Caisson and Filling, including Cutting Edge, etc.	42 419.79			33.62			42 453.41			127 995	33.17				
Sinking Caisson	15 524.07			1.89			15 525.96					186 532	8.32	88.82	174.80
Erection and Removal of Machinery	1 995.50						1 995.50								
Work Train Service	10.54						10.54								
		59 949.90			35.51			59 985.41							
FOUNDATION, PIER IV.															
Caisson and Filling, including Cutting Edge, etc.	49 616.52			41.22			49 657.74			155 190	31.90				
Sinking Caisson	17 842.80						17 842.80					212 247	8.41	101.07	176.54
		67 459.32			41.22			67 500.54							
FOUNDATION, PIER V.															
Caisson and Filling, including Cutting Edge, etc.	37 101.09			514.51			37 615.60			115 200	32.65				
Sinking Caisson	9 216.69			383.55			9 600.24					119 002	8.07	82.64	116.17
Work Train Service	179.70						179.70								
		46 497.48			898.06			47 395.54					Mean 9.17		Mean $177.99
Total Cost of Foundations			$ 231 403.83			$ 1 689.90			$ 233 093.73						
Masonry, Pier I	23 129.69			9.57			23 139.26								
Masonry, Pier II	49 394.19			27.33			49 421.52								
Masonry, Pier III	50 110.51						50 110.51								
Masonry, Pier IV	49 311.73						49 311.73								
Masonry, Pier V	23 657.69						23 657.69								
Total Cost of Masonry			195 603.81			36.90			195 640.71						
Grand Total Cost of Five Piers			$ 427 007.64			$ 1 726.80			$ 428 734.44						

The total cost of each pier is given in the following table:

	Foundations.	Masonry.	Total.
Pier I.	$ 2 312.32	$23 139.26	$ 25 451.58
Pier II.	55 899.92	49 421.52	105 321.44
Pier III.	59 985.41	50 110.51	110 095.92
Pier IV.	67 500.54	49 311.73	116 812.27
Pier V.	47 395.54	23 657.69	71 053.23
TOTAL.	$233 093.73	$195 640.71	$428 734.44

IV.

SUPERSTRUCTURE.

The superstructure consists of four through spans. Each span is 440 feet long between centers of end pins and 55 feet deep, divided into eight panels of 55 feet each, which are subdivided into sixteen panels, each 27.5 feet long. The trusses are placed 30 feet between centers.

The double-track members of the superstructure are proportioned on a Class C basis, that is, on a basis of a moving load of 3 000 pounds per lineal foot of track, but the single-track members are proportioned on a Class A basis, that is, on a basis of 4 000 pounds per lineal foot. In proportioning the floor system these loads are doubled on a wheel base of 20 feet, and this double load is reduced at the rate of one per cent for each additional foot over 20 feet. The stringers, which are single-track members, are, therefore, proportioned for a moving load of 7 700 pounds per lineal foot, and the floor beams, which are double-track members, for a moving load of 5 775 pounds per lineal foot of track.

The entire superstructure is of steel.

The bridge is provided with a substantial steel fence on each side, this being for the protection of the watchmen and others who have to cross the bridge and adding materially to the apparent strength of the structure.

Expansion is provided for on Piers II and IV. The details of the expansion bearings are of the form I have recently adopted for all bridges, using segmental rollers 12 inches in diameter, and distributing the weight over these rollers by a rocker plate with two cylindrical surfaces at right angles to each other, so that any possible irregularity is taken up.*

The trusses have single system webs and are made absolutely without adjustment; the top and bottom lateral systems are riveted. Full details of these trusses are given on Plates 9, 10, 11, 12 and 13. The strains and the basis under which they are computed are shown on Plate 14.

The full specifications for the superstructure are given in Appendix F. The record of the tests of full size bars is given in Appendix G.

The entire superstructure, except the eye bars, was manufactured by the New Jersey Steel & Iron Company who took the contract for the whole. The workmanship was unusually good.

The steel was rolled by the following parties:

Carbon Steel Company.
Carnegie Steel Company.
Midvale Steel Company.
Pencoyd Iron Works.
Pennsylvania Steel Company.

The steel castings were made by the Standard Steel Casting Company.

The eye bars, except the bottom chord bars for one span (which were made by the Union Bridge Company at Athens, Pa.), were manufactured at the Keystone Bridge Works, in Pittsburg.

The weights of the four spans were as follows:

I–II	2 795 906 lbs.
II–III	2 807 928 "
III–IV	2 804 909 "
IV–V	2 815 007 "
	11 223 750 lbs.

As it is convenient for purposes of comparison to classify these weights, the average weight of the four spans may be distributed as follows:

Classification.	Pounds.	Pounds per foot.	Coefficients.
Trusses.	1 899 262	4 316	9.81
Wind bracing.	166 268	378	0.86
Floor	602 697	1 370	3.11
End Supports.	87 094	198	0.45
Fence and Ladders.	50 233	114	0.26
	2 805 554	6 376	14.49

The coefficients are the weights divided by the length of span.

The four spans were erected by Mr. William Baird whose experience in this class of work is greater than that of any other man living. The dates at which the several trusses were erected are shown in the following table:

	First Steel Placed.	Span Swung.
Span I–II.	December 10, 1893.	December 18, 1893.
Span II–III.	September 4, 1893.	October 18, 1893.
Span III–IV.	November 18, 1893.	November 27, 1893.
Span IV–V.	November 3, 1893.	November 11, 1893.

The timber floor was laid by the company's men working under the direction of the Resident Engineer. The painting was done in the same manner.

The total cost of the superstructure is given in the following table:

STEEL WORK.			
Steel and Iron.	$429 559.59		
Freight Charges from Chicago.	16 392.21		
		$445 951.80	
Erection.		79 526.16	
Cement, etc., for filling Castings.		13.14	
Work Train Service.		969.92	
FLOOR.			$526 460.02
Material.		9 904.74	
Freight.		300.16	
Labor.		2 508.68	
Work Train Service.		67.26	
PAINTING.			12 780.84
Material.		1 415.09	
Freight.		32.98	
Labor.		4 354.56	
Work Train Service.		2.35	
			5 804.98
TOTAL SUPERSTRUCTURE.			$545 045.84

* Patented October 25, 1892.

V.

VIADUCT.

The viaduct at the north end of the bridge consists of 28 spans supported on 27 bents. The north bent is shorter than the others and is carried on a special masonry pier; the others are braced together into 13 towers. The spans are alternately 28′ 6″ and 32′ 2″ long, the shorter spans occurring over the towers. The viaduct is made throughout of the S steel of the specifications, the work being punched and riveted without reaming. It was manufactured and erected by A. & P. Roberts & Co. or the Pencoyd Iron Works.

The bracing of the towers is rigid without adjustment.

The girders over the towers are riveted rigidly to the tops of the towers, and the ends project slightly beyond the towers. The intermediate girders, which are of precisely the same length as those over the towers, are supported on these projecting ends. The actual bearing is taken on short pins which are split horizontally through the center, the whole being locked together by bronze keys in an arrangement which permits of a slight rocking of the bearing and of a slight longitudinal motion, the weight being transferred at the neutral axis, so that no sliding takes place under a moving load, the expansion occurring when the structure is light.

The bents and cross girders are proportioned on a Class C basis, the stringers on Class A basis.

The floor of the viaduct is identical with that of the main bridge.

The full details of this viaduct are shown on Plates 15 and 16.

The towers are supported on brick piers resting on piles. Piers 6, 7, 8 and 9 come between the restored shore line and the shore line as it existed when the work was begun; each of these piers has nine piles under it which were cut off at elevation 95 and support a timber grillage on which a block of concrete rests. Each of the other piers rests on seven piles which are buried in a block of concrete. All concrete blocks finish at elevation 101. Above the concrete the piers are built of Galesburg paving brick laid in Portland cement mortar and are finished with cast iron caps, the whole work being done by the company's men under the direction of the Resident Engineer.

The total amount of material in the viaduct piers is as follows:

	52 Small Piers.	Pier 32.	Total.
Piles in work, lineal feet	13 765	1 431	15 196
Timber in work, feet B. M	29 952	....	29 952
Concrete, cubic yards	851.57	151.85	1 003.42
Brick Masonry, cubic yards	449.94	....	449.94
Stone Masonry, cubic yards	....	162	162
Anchor Rods, pounds	17 775	....	17 775
Cast Iron Caps, pounds	72 215	....	72 215
Portland Cement, barrels	379	196	575
Louisville Cement, barrels	1 036	11	1 047

The total weight of the viaduct superstructure is as follows:

	Total. Pounds.	Per Foot. Pounds.
Towers	894 874	1 053
Girders	829 639	976
Fence	108 007	127
	1 832 520	2 156

As the average height of the viaduct from the cast iron caps to top of stringers is 47.66 feet the average weight per square foot of surface is 45.24 pounds equivalent to 22.62 pounds for a single track viaduct.

The cost of the piers is as follows:

	52 Small Piers.	Pier 32.	Total.
Excavation and Refilling	$2 010.63	$ 110.37	$2 121.00
Piles and Timber	5 462.12	479.18	5 941.30
Concrete	8 514.45	763.59	9 278.04
Brick Masonry	7 591.97	....	7 591.97
Stone Masonry	....	2 539.80	2 539.80
Anchor Rods	657.27	....	657.27
Cast Iron Caps	1 744.92	....	1 744.92
Riprap	2 551.65	....	2 551.65
Total	$28 533.01	$3 892.94	$32 425.95

The cost of the piers per lineal foot of viaduct is $38.15.

The cost of the viaduct superstructure is as follows:

METAL WORK.			
Iron and Steel, erected	$59 960.28		
Freight Charges from Chicago	2 894.86		
		$62 855.14	
Work Train Service		130.93	
			$62 986.07
FLOOR.			
Material		2 623.84	
Freight		62.89	
Labor		945.99	
Work Train Service		8.79	
			3 641.51
PAINTING.			
Material		412.88	
Freight		13.56	
Labor		1 676.06	
Work Train Service		.79	2 103.29
TOTAL VIADUCT SUPERSTRUCTURE			$68 730.87

The cost of superstructure per lineal foot of viaduct is $80.88.

On the same basis used above for weights, the cost per square foot of surface of viaduct is $1.697, or about 85 cents per square foot for a single track viaduct.

The total cost of the viaduct is $101 156.82 and the total cost per lineal foot is $119.03.

VI.

NORTH APPROACH.

The North Approach was built as a double-track trestle 2 960 feet long under the direction of the Resident Engineer. This trestle contains 1 437 763 feet board measure of timber and 35 220 lineal feet of piles. As it was intended to fill this trestle at once, perishable wood was used for piles, and no specification was made for sap in the timber.

North of this trestle is an earth embankment of ordinary description.

In June, 1894, a steam shovel was placed in the cut at the south end of the bridge and a regular force organized to take out this cut, working under the direction of the Resident Engineer. The plant in use consisted of a Barnhart Class "A. A." steam shovel, a special car fitted with a Lidgerwood Rapid Unloader, 60 flat cars fitted with aprons for the work, one Barnhart's standard center and one standard side ballast unloader, and a spreading plow made on the work. The material excavated from the cut was taken across the river and used to fill the trestle. About 325 000 cubic yards have been removed from the cut at the end of December, and it is expected that the whole work will be completed in the spring of 1895.

The cost of the earth work in the embankment of the North Approach and the filling of the trestle, is not included in the Table of Cost of the bridge, but forms part of the cost of grading the railroad in the two counties of St. Charles and St. Louis.

VII.

PROTECTION WORK.

The only protection work on the south side of the river consists of a roughly pitched pavement upon the slope of the embankment which encloses the abutment.

On the north side of the river a considerable amount of protection was required. When the location of the bridge was first made the shore line was where Pier V now stands, but during the period which elapsed before actual construction began, about 150 feet of this shore was washed away, and it was thought best to restore the original shore line. The erosion at this point is of rather peculiar character; it does not occur at high water; one mile above the bridge Little's Island divides the river into two channels, the north channel being dry at low water; during high water, the water passing through the north channel throws the current against the south bluff at the bridge site, and no erosion takes place on the north shore; but at low water the entire current of the river passing south of Little's Island strikes the rocky bluff above the bridge and is deflected to the north shore. As this shore had to be protected only against the erosion of low or medium stage, the work was comparatively simple.

The work comprised two parts, the protection of the existing shore line and the restoration of the original shore line. The former was accomplished by a mat of the kind commonly used by the Missouri River Commission, and the latter by constructing a screen dike into the river. The location of this mat and dike is shown on Plate 18. The mat is from 150 to 200 feet wide, formed of woven willows and covered with riprap. It was built in 1893. The shore was first trimmed to a slope of about three horizontal to one vertical, and on this the mat was woven extending out into the river; it was then loaded with rock and sunk: it was anchored to the shore by wire strands at intervals of 16 feet, every sixth strand being ¾" diameter and the others ½". The screen dike is a pile bridge, the piles being driven through a mat 100 feet wide which had previously been sunk on the bottom of the river, the mat not being woven like the shore mat, but built like those used by the Mississippi River Commission, a framework of poles being used above and below the brush and the whole wired together; a vertical mat similar to the shore mat, but of lighter character, was fastened to the outer side of the piles; this screen dike was built in 1892 and 1893. During the winter of 1893 this revetment was further strengthened by putting 853 cars of rock around the piles; it was originally intended to bring this filling rock to elevation 105 throughout, but it was not found expedient to do so, as the weight was evidently more than it was wise to put on the foundation mat.

The total amount of brush, rock and timber used in the protection work was as follows:

	Cords of Brush.	Pounds of Riprap.	Number of Piles.	Feet B. M. Timber.
Protection Mat	3 523.54	22 636 948		
Screen Dike	1 767.73	44 254 199	296	208 020

In addition to the above there was used in temporary shore protection in 1892, 452 cords of brush and 1 451 358 pounds of stone.

The total cost of the protection work was $67 691.02.

VIII.

COST.

The cost of the bridge is shown in the following table:

	Cost, Excluding Freight Charges.			Freight Charges.			Cost, Including Freight Charges.		
Foundation, Pier I (Abutment).	$ 2 289.17			$ 23.15			$ 2 312.32		
Foundation, Pier II.	55 207.96			691.96			55 899.92		
Foundation, Pier III.	59 949 90			35.51			59 985.41		
Foundation, Pier IV	67 459.32			41.22			67 500.54		
Foundation, Pier V	46 497.48			898.06			47 395.54		
Total Foundations.		$ 231 403.83			$ 1 689.90			$ 233 093.73	
Masonry, Pier I.	23 129.69			9.57			23 139.26		
Masonry, Pier II.	49 394.19			27.33			49 421.52		
Masonry, Pier III.	50 110.51						50 110.51		
Masonry, Pier IV.	49 311.73						49 311.73		
Masonry, Pier V.	23 657 69						23 657.69		
Total Masonry.		195 603.81			36.90			195 640.71	
Total Substructure.			$ 427 007 64			$ 1 736.80			$ 428 734.44
Steel Work	510 067.81			16 392.21			526 460.02		
Floor.	12 480.68			300.16			12 780.84		
Painting.	5 772.00			32.98			5 804.98		
Total Superstructure.			528 320.49			16 725.35			545 045.84
Viaduct Foundations.	30 533.05			1 892.90			32 425.95		
Viaduct Superstructure.	65 759.56			2 971.31			68 730.87		
Total Viaduct.		96 292.61			4 864.21			101 156.82	
Timber Trestle.		48 461.01			655.09			49 116.10	
Total North Approach.			144 753.62			5 519.30			150 272.92
Permanent Track.			8 511.26			8.98			8 520.24
Shore Protection.			64 075.16			3 615.86			67 691.02
Tools and Machinery.		41 984.25			30.43			42 014 68	
Service Tracks.		13 993.47						13 993.47	
Buildings.		13 749.36			5.26			13 754.62	
Real Estate.		1 533.91						1 533.91	
Watching.		1 834.99						1 834.99	
Total Sundries			73 095.98			35.69			73 131.67
Engineering Salaries.	44 202.38						44 202.38		
Engineering Expenses.	5 090.86			30.02			5 120.88		
Total Engineering			49 293.24			30.02			49 323.26
Total Cost.			$1 295 057.39			$ 27 662.00			$1 322 719.39

The item of freight includes freight on the C., B. & Q. system only. In comparing the cost of the bridge with that of other structures, the cost without freight forms the most correct basis for comparison.

This table may be condensed into the following:

	Cost, excluding Freight Charges.	Freight Charges.	Cost, including Freight Charges.
Substructure.	$427 007.64	$ 1 726.80	$428 734.44
Superstructure	528 320.49	16 725.35	545 045.84
Total Bridge Proper.	955 328.13	18 452.15	973 780.28
North Approach.	144 753.62	5 519.30	150 272.92
Permanent Track.	8 511.26	8.98	8 520.24
Shore Protection.	64 075.16	3 615.86	67 691.02
Tools, Service Tracks, etc.	73 095.98	35 69	73 131.67
Engineering.	49 293.24	30.02	49 323.26
Total Cost	$1 295 057.39	$27 662.00	$1 322 719.39


BRIDGE
Burlington Route

APPENDIX A.

LIST OF ENGINEERS, EMPLOYEES AND CONTRACTORS.

ENGINEERS AND COMPANY'S EMPLOYEES.

NAME AND OCCUPATION.	TIME OF SERVICE.
George S. Morison, Chief Engineer.	
Alfred Noble, Assistant Chief Engineer.	
Ben. L. Crosby, Resident Engineer	Feb. 20, 1892, to date.
Ernest G. Freeman, Assistant Engineer	July 1, 1892, to Dec. 31, 1893
Homer Reed Stanford, " "	April 1, 1892, to Aug. 18, 1892
Wm. G. Brenneke, " "	June 23, 1892, to June 30, 1894
Wm. L. Smith, " "	Aug. 20, 1892, to Jan. 31, 1894
James W. G. Walker, " "	Aug. 25, 1892, to July 31, 1893
Wm. R. Johnson, Inspector	July 1, 1892, to July 15, 1893
August T. Holmgren, Rodman and Inspector	Mar. 22, 1893, to June 30, 1894
John F. Lindgren, Cement Tester	July 26, 1892, to Dec. 31, 1893
James M. Richardson, Clerk	July 8, 1892, to date.
Robert F. Thayer, Timekeeper	June 4, 1892, to Feb. 16, 1894
David Nowlin, M. D., Resident Physician	Sept. 26, 1892, to July 31, 1893
H. H. Born, M. D., " "	Aug. 1, 1893, to Dec. 31, 1893
E. Gerber, Office Engineer.	
O. E. Hovey, Chief Superstructure Draughtsman.	
I. Dickinson, Record Draughtsman.	
Homer Reed Stanford, Insp'r of Superstructure	Aug. 19, 1892, to Oct. 31, 1893
Charles Stears, Inspector at Quarries	May 13, 1892, to Sept. 17, 1892
O. W. Davis, " " "	Mar. 1, 1893, to May 31, 1893
L. S. Stewart, General Foreman	May 1, 1892, to May 15, 1893
Dennis Leonard, Foreman of Pressure Work	June 15, 1892, to May 3, 1893
M. F. Comer, Foreman of Carpenters	June 27, 1892, to June 30, 1894
George Capel, Master Mechanic	July 27, 1892, to June 3, 1893
John M. Gilham, Master of Steamers Pauline and John Bertram	Aug. 25, 1892, to date.

CONTRACTORS.

Christie & Lowe	Masonry.
Geo. A. Lederle	Resident Partner.
Charles Stears	Foreman of Masons.
New Jersey Steel & Iron Company	Superstructure.
William Baird	Erection.
A. & P. Roberts & Company	Viaduct.
John Eagler	Foreman of Erection.
Joseph K. Golike	Mattress Brush and Riprap.
Mooresville Stone Company	Riprap.

APPENDIX B.

CHARTER AND CONTRACT WITH WAR DEPARTMENT.

CHARTER.

An Act authorizing the Construction of a Bridge across the Missouri River at some Accessible Point in the County of Saint Charles, in the State of Missouri, below the City of Saint Charles.

Be it enacted by the Senate and House of Representatives of the United States of America, in Congress assembled, That the Saint Louis, Keokuk & Northwestern Railroad Company, an incorporation organized under the laws of the State of Iowa, and owning and operating a railroad in the State of Missouri, its assigns or successors, is hereby authorized to construct and maintain a bridge across the Missouri River at such point as may be hereafter selected by said corporation between the City of Saint Charles and the mouth of the Missouri River, in the County of Saint Charles, in the State of Missouri, as shall best promote the public convenience and welfare and the necessities of business and commerce; and also to construct accessory works to secure the best practicable channel-way for navigation, and confine the flow of the water to a permanent channel at such point, and to lay on and over said bridge one or more railroad tracks for the more perfect connection of any railroads that are or shall be constructed to said river at or opposite said point.

Sec. 2. That said bridge shall be constructed and built without interference with the security and convenience of navigation of said river beyond what is necessary to carry into effect the rights and privileges hereby granted; and in order to secure that object the said company or corporation shall submit to the Secretary of War, for his examination and approval, a design and drawings of the bridge, and a map of the location, giving for the space of one mile above and one mile below the proposed location, the topography of the banks of the river, the shore lines to high and low water, the location of any other bridge or bridges, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until the said plan and location of the bridge are approved by the Secretary of War, the bridge shall not be built: Provided, that if the said bridge shall be made with unbroken and continuous spans, it shall have three or more channel spans, and shall not be of less elevation in any case than fifty feet above high-water mark, as understood at the point of location, to the lowest part of the superstructure, nor shall the spans of said bridge be less than three hundred feet in length, and the piers of said bridge shall be parallel with the current of said river, and the main span shall be over the main channel of the river, and not less than three hundred feet in length: And Provided also, that if any bridge built under this act shall be constructed as a draw-bridge, the same shall be constructed as a pivot draw-bridge, with a draw over the main channel of the river at an accessible and navigable point, and with spans of not less than one hundred and sixty feet in length in the clear on each side of the central or pivot pier of the draw, and the next adjoining span or spans to the draw shall not be less than three hundred feet, and the head room under such span shall not be less than ten feet above high-water mark: Provided also, that said draw shall be opened promptly upon reasonable signal for the passing of boats; and said company or corporation shall maintain, at its own expense, from sunset till sunrise, such lights or other signals on said bridge as the Light-House Board shall prescribe: Provided also, that all railroad companies desiring the use of said bridge shall have and be entitled to equal rights and privileges relative to the passage of railway trains over the same, and over the approaches thereto, upon payment of a reasonable compensation for such use; and in case the owner or owners of said bridge and the several railroad companies, or any one of them desiring such use, shall fail to agree upon the sum or sums to be paid, and upon rules and conditions to which each shall conform in using said bridge, all matters at issue between them shall be decided by the Secretary of War, upon a hearing of the allegations and proofs of the parties.

Sec. 3. That the Secretary of War is hereby authorized and directed, upon receiving such plan and map and other information, and upon being satisfied that a bridge built on such plan, and with such accessory works and at such locality, will conform to the prescribed conditions of this act, to notify the company that he approves the same; and upon receiving such notification the said company may proceed to an erection of said bridge, conforming strictly to the approved plan and location; and should any change be made in the plan of the bridge or said accessory works, during the progress of the work thereon, such change shall be subject likewise to the approval of the Secretary of War, and in case of any litigation arising from any obstruction or alleged obstruction to the free navigation of said river, caused or alleged to be caused by said bridge, the case may be brought in the Circuit Court of the United States of the Eastern District of the State of Missouri, in whose jurisdiction any portion of said obstruction or bridge may be located.

Sec. 4. That the said bridge and accessory works, when built and constructed under this act and according to the terms and limitations thereof, shall be lawful structures; and said bridge shall be recognized and known as a post-route, upon which also no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States than the rate per mile paid for the transportation over the railroads or public highways leading to said bridge; and said bridge shall enjoy the rights and privileges of other post-routes in the United States.

Sec. 5. That the United States shall have the right of way for such postal and telegraph lines across said bridge as the government may construct or control.

Sec. 6. That Congress shall have power at any time to alter, amend or repeal this act, so as to prevent or remove all material and substantial obstructions to the navigation of said river by the construction of said bridge and its accessory works; and all alterations of said bridge shall be made, and all such obstructions shall be removed at the expense of the owners of or persons controlling such bridge. Provided further, that nothing in this act shall be so construed as to repeal or modify any of the provisions of law now existing in reference to the protection of the navigation of rivers, or to exempt this bridge from the operation of the same.

Approved, February 17, 1888.

APPENDIX B.—CONTINUED.

CONTRACT WITH WAR DEPARTMENT.

WHEREAS, By an act of Congress, approved February 17th, 1888, entitled "An act authorizing the construction of a bridge across the Missouri River at some accessible point in the County of St. Charles, in the State of Missouri, below the City of St. Charles," the St. Louis, Keokuk & Northwestern Railroad Company, a corporation existing under the laws of the State of Iowa, and owning and operating a railroad in the State of Missouri, its successors and assigns, was authorized to construct and maintain a railroad bridge across the Missouri River at such point as might be selected by said corporation, between the City of St. Charles and the mouth of the Missouri River, in the County of St. Charles, in the State of Missouri, and as would best promote the public convenience and welfare and the necessities of business and commerce; and, also, to construct accessory works to secure the best practicable channel-way for navigation, and confine the flow of the water to a permanent channel at such point: and,

WHEREAS, It is provided by section two of the said Act, "That said bridge shall be constructed and built without interference with the security and convenience of navigation of said river, beyond what is necessary to carry into effect the rights and privileges hereby granted; and in order to secure that object the said company or corporation shall submit to the Secretary of War, for his examination and approval, a design and drawing of the bridge, and a map of the location, giving for the space of one mile above and one mile below the proposed location, the topography of the banks of the river, the shore lines to high and low water, the location of any other bridge or bridges, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until the said plan and location of the bridge are approved by the Secretary of War, the bridge shall not be built;" and by section three of the said act, "That the Secretary of War is hereby authorized and directed, upon receiving such plan and map and other information, and upon being satisfied that a bridge built on such plan and with such accessory works and at such locality will conform to the prescribed conditions of this act, to notify the company that he approves the same; and upon receiving such notification the said company may proceed to an erection of said bridge, conforming strictly to the approved plan and location; and should any change be made in the plan of the bridge or said accessory works, during the progress of the work thereon, such change shall be subject likewise to the approval of the Secretary of War;" and,

WHEREAS, The St. Louis, Keokuk & Northwestern Railroad Company aforesaid has accepted the provisions of the Act of Congress aforesaid, and, in compliance therewith, has submitted to the Secretary of War, for his examination and approval, a design and drawing and a map of location of a proposed bridge across the Missouri River at a point between the City of St. Charles and the mouth of the Missouri River, in the County of St. Charles, State of Missouri; and, Lieutenant-Colonel Charles R. Suter, corps of engineers, reports that the plans submitted conform to the requirements of the said act, and also to the requirements which had been deemed necessary by the Missouri River Commission, and recommends that they be approved, and the Chief of Engineers, United States Army, concurs in said recommendation,

Now, therefore, I, Redfield Proctor, Secretary of War, having examined and considered the design and drawing and the map of location aforesaid, submitted by the St. Louis, Keokuk & Northwestern Railroad Company as aforesaid, and which are hereto attached, do hereby approve the same, subject, however, to the following express condition:

1. That the Engineer Officer of the United States Army, in charge of the district within which the bridge is to be built, may supervise its construction so far as may be necessary in order that the plans herein approved shall be complied with and the bridge built accordingly.

Witness my hand this 21st day of December, 1889.

(Signed) REDFIELD PROCTOR,
Secretary of War.

This instrument is also executed by the St. Louis, Keokuk & Northwestern Railroad Company by W. W. Baldwin, its President, thereunto lawfully authorized, this 14th day of December, 1889, in testimony of the acceptance by said company of the provisions of the Act of Congress aforesaid, and of the condition herein imposed.

(Signed) THE ST. LOUIS, KEOKUK & NORTHWESTERN RAILROAD COMPANY,
By W. W. BALDWIN,
President.

In presence of
(Sgd.) H. E. JARVIS.

Attest: (Sgd.) J. H. STUBBS,
Secretary.

[Seal of R. R. Co.]
[Seal United States of America—War Office.]

APPENDIX C.

RECORD OF SINKING CAISSONS.

PIER II.

Observations taken at 8 o'clock.

Date.	Elevations of Cutting Edge: N. E	N. W	S. E.	S. W.	Average.	Sinkage: In 24 Hours	Total.	Elevations of Ground: N. E.	N. W.	S. E.	S. W.	Average.	Average Penetration of Caisson.	Water Gauge.	Depth Immersed.	Weights: Caisson: Timber	Iron.	Concrete.	Air Lock Shafts, etc.	Masonry.	Sand.	Water.	Total.	Air Pressure: Indicated.	Calculated.	Reaction due to Air Pressure.	Net Weight.	Surface in Contact.	Average Weight per sq. foot on surface exposed to friction	Material.	Remarks.
1892						Ft.	Ft.						Ft.		Ft.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Lbs.	Lbs.	Tons.	Tons.	Sq. Ft.	Lbs.		Framing of timber commenced Sept. 28, 1892. Cutting edge set up on blocking at site of pier, Oct. 24. First section of caisson finished on blocking Nov. 6. Caisson lowered to sand.
Nov. 7	......	......	......	......	95.40	......	......	......	......	......	......	......	......	92.70	......	289	35	......	3	......	......	......	327	......	......	......	......	......	......	......	
8	92.39	92.55	92.71	92.63	92.57	2.83	2.83	93.40	93.50	93.70	93.60	93.50	0.93	92.70	0.13	289	35	......	3	......	......	......	327	......	......	......	......	186	......	......	
1893																															
Jan. 15	92.23	92.47	92.52	92.52	92.44	0.13	2.96	93.40	93.50	93.70	93.60	93.50	1.06	93.90	1.46	289	35	144	3	......	......	......	471	......	......	......	......	212	......	......	Concreting commenced Jan. 14.
16	92.23	92.47	92.52	92.52	92.44	0.00	2.96	93.49	93.50	93.70	93.60	93.50	1.06	93.90	1.16	289	35	171	3	......	......	......	498	......	......	......	......	212	......	......	
17	92.22	92.47	92.48	92.49	92.42	0.02	2.98	93.40	93.50	93.70	93.60	93.50	1.08	94.20	1.78	289	35	337	3	......	......	......	664	......	......	......	......	216	......	......	
18	92.22	92.47	92.48	92.49	92.42	0.00	2.98	93.40	93.50	93.70	93.60	93.50	1.08	94.50	2.08	289	35	393	8	......	......	......	725	......	......	......	......	216	......	......	
19	91.98	92.43	92.27	92.48	92.29	0.13	3.11	93.40	93.50	93.70	93.60	93.70	1.41	94.55	2.26	289	35	507	8	......	......	......	839	......	0.98	148	691	282	4900	Coarse sand	Air pumps started at 15.40 o'clock and sand pumps at 19.10 o'clock.
20	89.10	90.51	89.33	90.50	89.86	2.43	5.54	93.80	93.10	93.50	93.10	93.17	3.31	94.65	4.79	289	35	507	8	......	......	......	839	2.75	2.08	314	525	662	1586	"	
21	86.66	86.02	87.06	86.01	86.44	3.42	8.96	91.70	91.60	94.80	94.80	93.10	6.66	94.70	8.26	341	38	507	8	......	......	......	894	4.00	3.58	541	353	1332	530	"	
22	83.56	84.25	83.75	84.20	83.94	2.50	11.46	95.60	93.20	95.00	96.00	95.00	11.06	94.70	10.76	372	41	507	8	......	......	......	928	4.25	4.67	705	223	2332	190	"	Sand pumps stopped at 5.55 o'clock, waiting for concrete.
23	83.52	84.23	83.72	84.19	83.91	0.03	11.49	95.60	93.20	95.60	96.00	95.60	11.60	94.70	10.79	408	41	507	8	......	......	......	964	4.25	4.68	707	257	2338	220	"	
24	83.51	84.22	83.72	84.19	83.91	0.00	11.49	95.60	93.20	95.60	96.00	95.60	11.69	94.80	10.89	431	43	734	9	......	......	......	1207	4.00	4.73	714	493	2338	422	"	
25	83.49	84.20	83.70	84.17	83.89	0.02	11.51	95.60	93.10	95.00	96.00	95.62	11.73	94.90	11.01	421	43	1017	9	......	......	......	1490	4.50	4.78	722	768	2346	655	"	Sand pumps started at 19.35 o'clock.
26	81.83	81.55	82.66	82.14	82.04	1.85	13.36	97.50	93.40	95.10	97.00	96.39	14.35	94.90	12.86	421	43	1131	9	......	......	......	1604	4.75	5.58	843	761	2870	530	"	
27	77.92	77.84	78.89	78.57	78.30	3.74	17.10	96.90	94.80	95.90	96.40	96.25	17.95	94.75	16.45	421	43	1244	9	......	......	......	1717	6.75	7.14	1079	638	3390	355	"	
28	77.74	77.06	78.65	77.73	77.79	0.51	17.61	96.20	95.10	95.70	95.70	96.06	18.27	94.75	16.96	429	43	1355	9	......	......	......	1836	6.00	7.36	1112	724	3657	396	"	Sand pumps stopped at 16.52 o'clock.
29	77.31	76.40	78.16	77.01	77.22	0.57	18.18	95.80	94.40	95.70	95.50	95.88	18.66	94.60	17.38	460	48	1355	9	......	......	......	1872	7.00	7.54	1141	731	3732	393	"	
30	77.28	76.37	78.14	76.99	77.19	0.03	18.21	96.30	94.90	95.60	95.50	96.20	19.01	94.60	17.41	502	48	1355	10	......	......	......	1915	7.75	7.56	1142	773	3802	407	"	
31	76.87	75.93	77.61	76.42	76.71	0.48	18.69	96.10	94.90	95.60	95.40	96.10	19.39	94.45	17.74	502	48	1632	10	......	......	......	2102	8.25	7.70	1163	1029	3878	531	"	
Feb. 1	76.85	75.91	77.58	76.40	76.69	0.02	18.71	96.10	94.90	95.60	95.40	96.10	19.41	94.30	17.61	502	48	1854	10	......	......	......	2414	8.00	7.64	1154	1260	3882	649	"	
2	76.65	75.75	77.37	76.23	76.50	0.19	18.90	96.10	91.90	95.60	95.40	96.10	19.60	93.90	17.40	502	48	1877	10	......	......	......	2437	8.00	7.55	1140	1297	3920	662	"	
3	76.64	75.74	77.36	76.22	76.49	0.01	18.91	96.10	94.90	95.60	95.40	96.10	19.61	93.70	17.21	502	48	1910	10	......	......	......	2470	8.00	7.47	1128	1342	3922	684	"	
4	76.48	75.70	77.16	76.14	76.37	0.12	19.03	96.50	95.20	95.70	95.60	96.50	20.13	93.40	17.03	513	49	2194	10	......	......	......	2766	8.50	7.39	1116	1650	4026	820	"	Sand pumps started at 11.45 o'clock.
5	74.85	72.85	75.66	73.42	74.19	2.18	21.21	96.50	95.20	97.70	95.90	96.26	22.07	93.50	19.31	546	54	2191	10	......	......	......	2804	8.00	8.38	1266	1538	4414	697	"	
6	72.44	70.84	73.17	71.33	71.94	2.25	23.46	95.90	94.80	95.20	96.10	95.85	23.91	93.90	21.96	583	55	2194	10	......	......	......	2812	9.00	9.53	1440	1402	4782	586	"	
7	70.37	69.44	70.88	69.81	70.10	1.84	25.30	96.30	94.80	95.40	96.80	96.28	26.18	93.80	23.70	583	55	2250	10	......	......	......	2898	10.25	10.29	1554	1344	5236	513	"	Sand pumps stopped at 14.10 o'clock; timber work finished.
8	69.29	68.70	69.86	69.03	69.22	0.88	26.18	95.80	94.00	95.90	96.50	96.14	26.92	93.85	24.63	583	56	2250	12	......	......	......	2901	11.00	10.69	1587	1314	5384	488	"	Sand pumps started at 21.00 o'clock.
9	67.73	67.53	68.25	67.81	67.83	1.39	27.57	95.70	93.50	96.30	94.80	95.81	27.98	94.00	26.17	583	56	2591	12	......	......	......	3242	11.25	11.36	1716	1526	5596	545	"	
10	66.12	66.09	66.57	66.30	66.27	1.56	29.13	95.60	94.10	96.60	96.30	95.82	29.55	94.20	27.93	583	56	2873	12	......	......	......	3524	12.00	12.12	1831	1693	5910	573	"	Sand pumps stopped at 16.35 o'clock. Air pumps at 20.45 o'clock.
11	64.59	64.54	64.98	64.69	64.70	1.57	30.70	96.10	95.10	96.50	96.70	95.88	31.18	94.20	29.50	583	56	3213	12	......	......	......	3864	......	......	......	......	6236	......	"	
12	64.54	64.49	64.98	64.69	64.67	0.03	30.73	96.00	95.20	96.70	96.20	96.06	31.39	94.29	29.53	583	56	3500	12	......	......	......	4151	......	......	......	......	6278	......	"	Concreting finished Feb. 12.
13	64.31	64.25	64.96	64.66	64.55	0.12	30.85	96.00	95.20	96.70	96.20	96.06	31.51	94.25	29.70	583	56	3689	12	......	......	......	4340	......	......	......	......	6302	......	"	
Mar. 14	64.25	64.19	64.68	64.40	64.38	0.17	31.02	94.50	89.00	96.50	90.00	93.63	29.25	99.00	34.62	583	56	3689	16	1061	......	......	5405	15.75	15.03	2270	3135	5650	1110	"	Laying of masonry commenced March 6th.
15	63.81	63.24	64.25	63.46	63.69	0.69	31.71	93.90	89.40	95.90	89.40	92.78	29.09	98.40	34.71	583	56	3689	16	1061	......	......	5405	16.00	15.06	2275	3130	5818	1076	"	Air pumps started at 13.10 o'clock, sand pumps at 17.30 o'clock, March 13.
16	61.09	60.64	61.35	60.68	60.94	2.75	34.46	94.60	88.10	96.60	88.10	92.93	31.99	98.10	37.16	583	56	3689	16	1061	......	......	5405	17.00	16.13	2436	2969	6398	928	"	
17	59.07	58.52	59.30	58.53	58.85	2.00	36.55	94.70	88.80	96.30	86.70	92.42	33.57	98.75	39.90	583	56	3689	16	1292	......	......	5636	19.00	17.32	2616	3020	6714	900	"	
18	56.37	56.15	56.59	56.15	56.32	2.53	39.08	97.70	89.10	97.10	88.20	93.44	37.12	100.15	43.83	583	56	3689	16	1292	......	84	5730	20.75	19.02	2873	2847	7424	767	"	
19	52.88	52.86	53.09	52.85	52.92	3.40	42.48	93.90	91.90	96.90	91.90	93.48	40.56	100.90	47.98	583	56	3689	16	1292	6	112	5734	22.00	20.82	3145	2609	8105	644	"	
20	51.05	50.96	51.27	50.96	51.06	1.86	44.34	92.70	87.10	95.70	86.60	91.44	40.38	100.65	49.59	583	56	3689	16	1292	......	364	5900	23.25	21.52	3251	2649	8076	656	"	
21	49.20	49.32	49.41	49.31	49.31	1.75	46.09	92.80	86.90	94.90	85.80	91.27	41.96	99.85	50.54	583	56	3689	19	1518	60	258	6183	23.50	21.93	3313	2870	8319	690	"	
22	47.13	47.53	47.36	47.54	47.39	1.92	48.01	88.00	87.10	94.60	88.00	89.72	42.33	99.05	51.66	583	56	3689	19	1635	74	287	6343	24.00	22.42	3387	2956	8376	706	"	
23	45.66	45.76	45.89	45.77	45.77	1.62	49.63	89.00	86.60	94.50	91.10	90.38	44.61	99.05	53.28	583	56	3689	19	1813	170	281	6611	24.75	23.12	3402	3119	8718	716	"	

APPENDIX C.—Continued.
RECORD OF SINKING CAISSONS.
PIER II.—Continued.

Observations taken at 8 o'clock.

Date.	Elevations of Cutting Edge: N. E.	N. W.	S. E.	S. W.	Average.	Sinkage: In 24 Hours	Total.	Elevations of Ground: N. E.	N. W.	S. E.	S. W.	Average.	Average Penetration of Caisson.	Water Gauge	Depth Immersed.	Weights: Caisson: Timber	Iron.	Concrete.	Air Lock Shafts, etc.	Masonry	Sand.	Water.	Total.	Air Pressure: Indicated.	Calculated.	Reaction due to Air Pressure	Net Weight.	Surface in Contact	Average Weight per sq. foot on surface exposed to friction	Material.	Remarks
1893						Ft.	Ft.						Ft.		Ft.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Lbs.	Lbs.	Tons.	Tons.	Sq. Ft.	Lbs.		
Mar. 24	42.31	42.56	42.45	42.48	42.45	3.32	52.95	90.30	86.30	94.30	88.30	89.84	47.39	99.30	56.85	583	56	3689	20	1946	304	318	6916	25.00	24.67	3727	3189	9122	699	Coarse sand	
25	39.08	38.65	39.24	38.59	38.89	3.56	56.51	89.30	86.30	91.30	86.30	88.50	49.70	98.30	59.41	583	56	3689	20	2036	428	328	7140	27.00	25.78	3894	3246	9447	687	"	
26	37.48	37.84	37.67	37.81	37.70	1.19	57.70	87.20	85.60	96.10	86.20	88.57	50.87	97.65	59.95	583	56	3689	20	2208	491	307	7354	27.00	26.02	3930	3424	9611	712	"	
27	34.05	34.14	34.16	34.03	34.09	3.61	61.31	88.30	84.30	92.30	86.30	87.81	53.75	97.30	63.21	583	56	3689	20	2208	646	321	7523	28.00	27.43	4143	3380	10013	675	"	Large oak log found in caisson.
28	32.60	32.63	32.69	32.50	34.60	1.49	62.80	84.70	83.50	92.50	86.50	87.46	54.86	97.50	61.90	583	56	3689	20	2404	706	342	7800	29.50	28.17	4255	3545	10167	697	"	
29	31.89	32.10	31.96	31.95	31.97	0.63	63.43	87.90	84.40	93.40	90.40	89.23	57.26	97.40	65.43	583	56	3689	20	2553	837	278	8016	29.75	28.40	4289	3727	10502	710	"	More logs found; reached first boulder.
30	30.70	30.78	30.76	30.62	30.71	1.26	64.69	88.10	86.10	90.10	87.10	88.85	58.14	97.10	66.39	583	56	3689	20	2590	885	281	8104	29.75	28.81	4352	3752	10031	707	"	
31	30.00	30.12	30.07	29.97	30.04	0.67	65.36	87.90	85.40	94.90	89.90	89.90	59.86	96.90	66.86	583	56	3689	20	2590	979	239	8156	30.50	29.02	4384	3772	10858	695	"	Reached rock and boulders on south side.
Apr. 1	29.25	29.37	29.30	29.20	29.28	0.76	66.12	87.30	84.80	93.80	88.80	89.68	60.40	96.80	67.52	583	56	3689	20	2590	1009	243	8190	31.00	29.30	4426	3764	10932	689	Sand and boulders	
2	28.53	28.62	28.60	28.47	28.55	0.73	66.85	87.20	85.30	96.80	91.70	90.58	62.03	96.75	68.20	583	56	3689	21	2627	1073	211	8260	30.25	29.60	4471	3789	11156	679	"	
3	27.73	27.81	27.81	27.67	27.75	0.80	67.65	86.60	85.60	95.80	91.60	90.79	63.04	96.60	68.55	583	56	3689	21	2627	1155	199	8330	30.00	29.88	4514	3816	11294	676	"	
4	27.16	27.20	27.22	27.04	27.15	0.60	68.25	87.90	85.90	95.40	93.40	90.92	63.77	96.40	69.25	583	56	3689	26	2817	1196	188	8555	32.00	30.05	4539	4016	11394	705	"	Clay hoist started 12.15 o'clock.
5	26.98	27.01	27.06	26.87	26.98	0.17	68.42	87.40	86.30	95.30	93.90	91.10	64.12	96.35	69.37	583	56	3689	26	2817	1213	198	8585	30.00	30.11	4548	4037	11442	706	"	
6	26.98	27.01	27.06	26.87	26.98	0.00	68.42	87.60	83.70	93.60	94.70	90.84	63.86	96.65	69.67	583	56	3689	26	2817	1201	180	8553	30.00	30.24	4568	3984	11406	699	Sand and rock	
7	26.90	26.94	26.98	26.80	26.90	0.08	68.50	89.20	83.70	94.20	93.20	91.99	65.09	97.20	70.30	583	56	3689	26	2817	1269	179	8619	32.00	30.51	4609	4010	11574	693	"	
8	26.51	26.48	26.60	26.35	26.48	0.42	68.92	89.20	84.70	95.70	92.70	92.45	65.97	97.20	70.72	583	56	3689	26	2817	1318	163	8652	31.00	30.69	4636	4016	11694	687	"	Commenced blasting rock.
9	26.34	26.32	26.43	26.19	26.32	0.16	69.08	87.90	86.40	95.90	92.90	91.86	65.54	96.90	70.58	583	56	3689	26	2817	1294	173	8645	31.00	30.63	4627	4011	11635	689	"	
10	25.71	25.73	25.80	25.60	25.71	0.61	69.69	87.80	85.70	96.70	94.80	91.63	65.92	98.27	72.54	583	56	3689	26	2817	1316	227	8714	32.00	31.48	4755	3959	11687	678	"	
11	25.58	25.61	25.69	25.50	25.59	0.12	69.81	90.90	83.40	96.90	92.40	91.57	65.98	100.40	74.81	583	56	3689	27	2817	1319	304	8795	33.50	32.47	4905	3890	11695	665	"	
12	25.44	25.51	25.57	25.40	25.47	0.12	69.93	82.80	82.70	94.70	87.30	87.71	62.24	102.77	77.28	583	56	3689	28	2870	1111	520	8866	33.00	33.54	5066	3800	11183	680	"	
13	25.24	25.26	25.36	25.16	25.25	0.22	70.15	83.70	83.70	93.70	87.70	87.45	62.20	103.70	78.45	583	56	3689	28	3015	1109	563	9043	35.00	34.05	5143	3900	11179	698	"	
14	25.09	25.16	25.22	25.07	25.13	0.12	70.27	83.70	83.60	84.60	87.70	88.15	63.02	103.65	78.52	583	56	3689	28	3088	1154	537	9135	35.00	34.08	5148	3987	11305	705	"	
15	25.07	25.14	25.20	25.05	25.11	0.02	70.29	88.50	81.50	89.50	87.50	87.67	62.56	103.50	78.39	583	56	3689	28	3088	1129	548	9121	34.50	34.02	5139	3982	11229	709	"	
16	24.95	24.98	25.08	24.89	24.97	0.14	70.43	82.80	78.00	92.80	85.00	86.93	61.96	103.85	78.88	583	56	3689	28	3088	1095	586	9125	35.50	34.23	5171	3954	11147	709	"	
17	24.39	24.45	24.53	24.37	24.43	0.54	70.97	84.90	78.90	93.90	88.90	87.73	63.30	103.90	79.47	583	56	3689	28	3088	1170	561	9175	34.00	34.06	5145	4030	11330	711	"	
18	24.34	24.42	24.49	24.33	24.40	0.03	71.00	86.10	81.20	94.10	89.70	89.51	65.11	103.15	78.75	583	56	3689	28	3088	1270	472	9187	35.00	34.18	5163	4024	11577	695	"	
19	24.34	24.41	24.47	24.32	24.38	0.02	71.02	87.00	83.90	93.90	90.00	90.33	65.95	101.95	77.57	583	56	3689	28	3088	1317	402	9163	34.75	33.67	5080	4077	11601	697	"	
20	24.30	24.36	24.43	24.27	24.34	0.04	71.06	86.70	82.70	94.20	87.70	89.95	65.61	102.20	77.86	583	56	3689	28	3088	1298	424	9166	35.00	33.79	5104	4062	11645	698	"	
21	24.16	24.11	24.30	24.03	24.15	0.19	71.25	85.90	82.00	92.90	78.90	88.65	64.50	105.90	81.75	583	56	3689	28	3088	1236	635	9305	35.75	35.48	5350	3946	11494	687	"	
22	24.14	24.11	24.26	24.01	24.13	0.02	71.27	86.30	81.30	92.30	80.30	88.18	64.05	106.30	82.17	583	56	3689	28	3088	1211	655	9310	36.25	35.66	5387	3923	11432	686	"	
23	23.67	23.74	23.82	23.67	23.72	0.41	71.68	86.70	83.70	91.20	81.70	87.62	63.90	105.70	81.98	583	56	3689	29	3088	1203	654	9302	35.25	35.58	5375	3927	11412	688	"	Final settlement made at 15.30 o'clock.
24	23.42	23.54	23.56	23.46	23.50	0.22	71.90	81.20	80.80	90.90	80.30	85.75	62.25	105.25	81.75	583	56	3689	29	3088	1111	701	9257	36.00	35.48	5359	3898	11186	697	....	
25	23.42	23.54	23.56	23.46	23.50	0.00	71.90	82.20	78.20	89.20	80.20	85.20	61.70	105.20	81.70	583	56	3689	29	3088	1081	717	9243	36.00	35.46	5356	3887	11111	700	....	Sealing commenced at 14.05 o'clock.
26	23.42	23.54	23.56	23.46	23.50	0.00	71.90	83.30	79.40	92.40	81.30	83.35	59.85	105.35	81.85	583	56	3689	24	3088	979	788	9207	36.00	35.52	5366	3841	10857	......	....	
27	23.42	23.54	23.56	23.46	23.50	0.00	71.90	83.20	79.20	92.20	81.20	83.60	60.10	106.20	82.70	583	56	3689	24	3088	963	825	9258	36.00	35.89	5421	3837	10801	......	....	
28	23.42	23.54	23.56	23.46	23.50	0.00	71.90	81.70	78.80	91.70	81.80	83.50	60.00	106.75	83.25	583	56	3689	24	3088	987	865	9292	37.00	36.13	5458	3834	10877	......	....	Pumping sand finished at 18.35 o'clock.
29	23.42	23.54	23.50	23.46	23.50	0.00	71.90	81.90	79.90	89.00	81.90	83.40	59.90	106.90	83.40	583	56	3689	24	3088	982	878	9300	37.00	36.20	5468	3832	10864	......	....	
May 4	23.39	23.51	23.53	23.43	23.47	0.03	71.93	84.50	81.60	90.60	97.60	88.98	65.51	109.55	86.08	583	56	3689	24	3088	1323	854	9617	......	......	......	......	11631	......	....	Sealing finished 6.00 o'clock and air taken off at 13.00 o'clock, May 3rd.

APPENDIX C.—CONTINUED.

RECORD OF SINKING CAISSONS.

PIER III.

Observations taken at 8 o'clock.

Date.	Elevations of Cutting Edge. N. E.	N. W.	S. E.	S. W.	Average	Sinkage. In 24 Hours	Total.	Elevations of Ground N. E.	N. W.	S. E.	S. W.	Average	Average Penetration of Caisson.	Water Gauge.	Depth Immersed	Weights. Caisson Timber	Iron	Concrete.	Air Lock, Shafts etc	Masonry.	Sand	Water	Total.	Air Pressure. Indicated	Calculated.	Reaction due to Air Pressure.	Net Weight.	Surface in Contact.	Average Weight per sq. foot on surface exposed to friction	Material	Remarks.
1893.						Ft.	Ft.						Ft.		Ft.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons	Lbs.	Lbs.	Tons.	Tons.	Sq. ft.	Lbs.		Cutting edge set up July 30.
Aug. 20	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	Caisson launched.
23	86.14	86.76	83.26	86.13	86.07	......	......	86.70	86.70	85.70	87.70	86.70	0.63	95.20	9.13	262	35	......	5	......	......	......	302	......	......	......	302	123	4832	......	Caisson placed in position at 13:50 o'clock.
28	85.06	86.57	84.85	85.81	85.77	0.30	0.30	85.93	80.51	85.68	87.18	86.32	0.35	94.68	8 91	309	36	......	9	......	......	......	354	......	......	......	354	110	6436	......	Concreting commenced.
29	85.50	86.19	84.27	85.21	85.29	0.48	0.78	85.91	86.51	85 20	87.03	86.16	0.87	94.70	9.41	335	36	239	9	......	......	......	619	......	......	......	019	174	7115	......	
30	85.30	85.69	83.91	84 46	84.86	0.43	1.21	86.15	86.57	85.65	86.65	86.25	1.39	94.65	9.79	371	40	486	9	......	......	......	906	......	......	......	906	278	6518	......	
31	85.78	85.59	83.80	84.36	84 76	0.10	1.31	86.02	86.43	85.56	86.60	86.15	1.39	94.60	9.84	371	43	486	10	......	......	......	910	......	......	......	910	279	6523	......	
Sept. 1	85.08	85.10	83.69	84.05	84.50	0.26	1.57	86.10	86.43	86.43	86.27	86.31	1.81	94.60	10.10	384	43	789	10	......	......	......	1226	......	......	......	1220	360	6811	Medium Sand.	Air pumps started at 9:23 o'clock, sand pumps at 11:10.
2	82.08	82.81	83.23	83.41	83.08	1.42	2.99	86.16	86.04	86.45	85.83	86.12	3.04	94.58	11.50	402	44	1071	10	......	......	......	1527	5.5	4.99	754	773	607	2547	" "	
3	81.05	79.71	80.63	79.53	80.23	2.83	5.84	85.60	85.30	90.85	91.80	88.29	8.16	94.50	14.27	436	44	1292	10	......	......	......	1782	7.0	6.10	935	847	1631	1039	" "	
4	77.93	78.75	78.01	79.08	78.44	1.70	7.63	86.00	85.40	93.10	94.05	89.64	11.20	94.37	15.93	488	45	1564	11	......	......	......	2108	8.25	6.91	1044	1064	2238	951	" "	
5	75.19	75.30	75.47	75.92	75.49	2.95	10.38	86.91	86 16	95.83	94.13	90.76	15.27	94.41	18.92	499	51	1564	11	......	......	......	2125	9.08	8.21	1240	885	3053	580	" "	
6	72.10	72.42	72.12	72.69	72.33	3.16	13.74	85.15	85.15	94.97	94.10	89.84	17.51	94.30	22.03	526	51	1837	12	......	......	......	2426	10.50	9.56	1444	982	3503	561	Fine Sand.	
7	70.15	69.94	70.12	70.16	70.09	2.24	15.98	85.07	84.95	95.28	94.95	90.06	19.97	94.20	24.11	546	52	2181	13	......	......	......	2792	11.50	10.46	1580	1212	3995	607	Coarse "	
8	67.38	68.82	67.48	69.17	68.22	1.87	17.85	85.34	84.97	95.50	95.00	90.20	21.98	94.25	26.03	580	53	2415	13	......	......	......	3061	12.25	11.29	1705	1356	4398	617	" "	
9	66.32	65.95	66.43	66.31	66.25	1.97	19.82	85.48	84 86	95.78	95.33	90.36	24.11	94.22	27.97	591	56	2766	15	......	......	......	3428	13.00	12.14	1832	1595	4822	662	" "	
10	64.68	64.93	64.88	63.38	64.97	1.28	21.10	85.10	85.20	95.80	95.40	90.38	25.41	94.15	29.18	622	56	3217	16	......	......	......	3911	13.50	12.66	1912	1999	5082	777	" "	
11	62.58	62.53	62.82	63.02	62.74	2.23	23.33	85.11	85.53	95.47	95.63	90.44	27.70	94.10	31.36	652	58	3430	16	......	......	......	4165	14.50	13.61	2055	2110	5540	762	" "	
12	60.18	60.94	60.55	61.56	60.81	1.93	25.26	84.81	85.25	95.39	95.83	90.32	29.51	94.19	33.38	652	59	3439	16	......	......	......	4166	15.00	14 49	2189	1977	5903	670	" "	
13	58.04	58.33	58.41	58.95	58.43	2.38	27.64	84.82	85.22	95.28	95.80	90.28	31.85	94.76	36.33	689	64	3550	17	......	......	......	4320	17.00	15.77	2382	1938	6370	609	Fine Sand.	
14	56.27	56.66	56.70	57.43	56.79	1.64	29.28	84.92	85.02	95.90	96.14	90.49	33.70	94.27	37.48	742	66	3828	19	......	......	......	4655	17.75	16.27	2458	2197	6741	652	Medium Sand with clay lumps.	
15	55.61	54.91	55.80	55.35	55.42	1.37	30.65	85.60	85.70	95.47	96.24	90.75	35.33	94.07	38.65	778	71	4105	19	......	......	......	4968	18.50	16.77	2533	2435	7072	689	"	
16	52.35	51.31	52.90	52.31	52.27	3.15	33.80	85.20	86.36	95.71	96.26	90.90	38.63	93.86	41.59	783	71	4439	20	......	......	......	5313	19.00	18.05	2727	2586	7725	670	"	
17	51.39	50.87	51.87	51.70	51.48	0.70	34.59	85.28	86.48	95.53	96.58	90.94	39.49	93.68	42.20	822	72	4662	20	......	......	......	5576	20.00	18.31	2766	2810	7898	712	"	
18	50.14	49.33	50.68	50.32	50.17	1.31	35.90	85.18	86.22	95.10	96.48	90.75	40.58	93.46	43.29	832	73	4940	20	......	......	......	5865	19.25	18.79	2838	3027	8016	746	"	
19	48.41	47.80	48.82	48.46	48.37	1.80	37.70	85.00	86.58	94.91	96.60	90.92	42.55	93.33	44.96	832	73	4940	20	......	......	......	5865	20.50	19.51	2947	2918	8510	686	"	
20	46.46	46.04	40.90	46.73	46.53	1.84	39.54	85.50	86.12	94.80	96.57	90.75	44.22	93.25	46.72	837	73	5217	22	......	......	......	6149	21.00	20.28	3063	3086	8843	698	"	
21	44.11	43.76	44.53	44.40	44.19	2.34	41.88	85.38	86.50	92.94	92.40	89.31	45.12	93.19	49.00	842	73	5440	23	......	......	......	6378	23.50	21.27	3213	3165	9022	702	"	Timber work on caisson finished, air taken off at 11:45 o'clock, and Bertram moved to shore.
22	44.07	43.72	44.47	44.37	44.16	0.03	41.91	85.12	86.17	93.10	93.10	89.37	45.21	93.10	48.94	842	74	5824	23	......	......	......	6763	......	......	......	6703	9043	1496	"	
23	44.07	43.72	44.46	44 36	44.15	0.01	41.92	85.20	86.32	93.04	93.21	89.44	45.29	93.04	48.89	842	74	5992	24	......	......	......	6932	......	......	......	6932	9059	1530	"	Concreting finished.

APPENDIX C.—CONTINUED.
RECORD OF SINKING CAISSONS.
PIER III.—CONTINUED.

Observations taken at 8 o'clock.

Date.	Elevations of Cutting Edge. N. E.	N. W.	S. E.	S. W.	Average.	Sinkage. In 24 Hours.	Total.	Elevations of Ground. N. E.	N. W.	S. E.	S. W.	Average.	Average Penetration of Caisson.	Water Gauge.	Depth Immersed.	Weights. Caisson. Timber.	Iron.	Concrete.	Air Lock Shafts, etc.	Masonry.	Sand.	Water.	Total.	Air Pressure. Indicated.	Calculated.	Reaction due to Air Pressure.	Net Weight.	Surface in Contact.	Average Weight per sq. foot on surface exposed to friction.	Material.	Remarks.
1892.						Ft.	Ft.						Ft.		Ft.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Lbs.	Lbs.	Tons.	Tons.	Sq. ft.	Lbs.		Laying masonry commenced Nov. 9th.
Dec. 4	44.06	43.71	44.44	44.34	44.14	0.01	41.93	91.50	81.40	95.20	88.30	89.10	44.96	92.30	48.16	842	74	5992	27	825	......	......	7760	20.50	20.90	3157	4603	8993	1024	Medium Sand.	Air pumps (stationary plant) started at 15.00 o'clock and sand pumps at 19.00 o'clock Dec. 3.
5	44.02	43.61	44.40	44.24	44.07	0.07	42.00	91.60	81.60	95.30	88.30	89.20	45.13	92.10	48.03	842	74	5992	27	825	......	......	7760	20.50	20.85	3150	4610	9026	1021	" "	
6	41.18	41.30	41.36	41.73	41.39	2.68	44.68	91.00	81.00	94.50	88.10	88.65	47.26	92.60	50.61	842	74	5992	27	825	......	......	7760	21.00	21.96	3317	4443	9452	940	" "	
7	39.44	39.38	39.71	40.00	39.66	1.73	46.41	90.90	82.50	92.90	88.40	88.68	49.02	92.20	52.54	842	74	5992	27	825	......	......	7760	21.50	22.80	3444	4316	9803	880	" "	
8	36.01	35.90	36.20	36.34	36.11	3.55	49.96	91.00	81.20	93.80	88.30	88.58	52.47	92.20	56.09	842	74	5992	27	825	......	......	7760	23.70	24.34	3677	4083	10493	778	Sand and clay.	
9	32.07	32.18	32.19	32.55	32.25	3.86	53.82	91.10	82.00	93.80	88.80	88.92	56.67	93.00	60.75	842	74	5992	27	825	......	......	7760	25.50	26.37	3983	3777	11336	666	" "	Two logs found, one about 12 in. diam. and 25 feet long, the other somewhat smaller.
10	30.77	30.67	30.81	30.94	30.79	1.46	55.28	89.80	81.80	94.30	89.80	88.92	58.13	93.40	62.61	842	74	5992	27	825	......	40	7800	27.25	27.17	4104	3696	11419	643	" "	
11	27.47	26.93	27.47	27.18	27.26	3.53	58.81	89.20	83.20	93.00	87.00	88.10	60.84	93.20	65.94	842	74	5992	30	1061	......	129	8128	28.00	28.62	4323	3805	12168	626	" "	
12	27.46	26.92	27.46	27.17	27.25	0.01	58.82	86.00	79.80	92.00	88.90	87.13	59.88	93.20	65.95	842	74	5992	30	1061	......	129	8128	28.00	28.62	4323	3805	11976	636	" "	Sand pump machinery out of order.
13	27.42	26.90	27.41	27.18	27.23	0.02	58.84	90.80	78.80	88.10	87.10	86.20	58.97	93.10	65.87	842	74	5992	30	1293	......	127	8357	28.00	28.59	4319	4038	11794	685	" "	Bertram moved to site of pier and its water pump used.
14	26.04	25.76	26.03	26.00	25.96	1.27	60.11	88.40	81.40	89.40	89.90	87.27	61.31	92.90	66.94	842	74	5992	30	1518	14	149	8619	28.50	29.05	4388	4231	12245	691	" "	
15	23.11	22.94	23.09	23.17	23.08	2.88	62.99	86.30	81.30	92.20	86.70	86.63	63.55	92.80	69.72	842	74	5992	31	1741	100	187	8967	29.50	30.26	4571	4396	12572	700	" "	
16	21.79	21.61	21.76	21.86	21.76	1.32	64.31	85.70	82.50	90.10	86.60	86.22	64.46	92.50	70.74	842	74	5992	40	1941	137	197	9223	30.00	30.70	4637	4586	12720	721	" "	
17	18.97	18.82	18.80	18.99	18.92	2.84	67.15	87.20	82.20	92.00	88.00	87.35	68.43	92.20	73.28	842	74	5992	40	2121	381	162	9562	31.25	31.80	4804	4758	13201	716	" "	
18	14.93	14.88	14.84	15.04	14.92	4.00	71.15	84.70	82.20	93.80	87.70	87.10	72.18	91.90	76.98	842	74	5992	40	2244	531	161	9884	33.00	33.41	5047	4837	13816	700	" "	
19	11.79	11.90	11.69	12.05	11.86	3.06	74.21	85.70	80.50	92.40	87.40	86.45	74.59	91.60	79.74	842	74	5992	42	2244	662	174	10030	33.25	34.61	5228	4802	14135	679	" "	
20	9.60	9.67	9.43	9.75	9.61	2.25	76.46	82.30	82.30	93.00	87.50	86.28	76.67	91.60	81.90	842	74	5992	48	2361	775	180	10272	34.75	35.58	5375	4897	14417	680	" "	
21	8.21	8.11	8.16	8.31	8.20	1.41	77.87	82.10	81.40	92.80	88.00	86.08	77.88	91.40	83.20	842	74	5992	50	2474	841	180	10453	34.25	36.11	5455	4998	14585	685	" "	Water pump of stationary plant running, Bertram moved to Pier V.
22	6.93	6.94	6.81	7.07	6.91	1.26	79.13	81.60	81.90	92.00	90.60	86.52	79.58	91.20	84.26	842	74	5992	50	2518	934	170	10569	35.00	36.57	5524	5045	14814	681	" "	
23	4.78	4.82	4.69	5.00	4.82	2.12	81.25	80.20	82.20	91.20	91.40	86.25	81.13	91.20	86.35	842	74	5992	50	2518	1036	169	10681	37.00	37.49	5663	5018	15067	666	" "	Caisson reached bed rock at 16.00 o'clock.
24	3.59	3.81	3.64	4.11	3.79	1.03	82.28	80.60	82.40	90.80	91.60	86.35	82.56	90.85	87.06	842	74	5992	50	2518	1098	153	10727	37.00	37.78	5707	5020	15217	660	" "	
25	3.57	3.79	3.62	4.09	3.77	0.02	82.30	81.00	82.10	91.30	91.20	86.40	82.63	90.60	86.83	842	74	5992	50	2518	1102	143	10721	37.00	37.68	5692	5029	15227	660	Bed rock.	Cutting out rock.
26	3.57	3.79	3.62	4.09	3.77	0.00	82.30	80.20	81.40	91.10	91.40	86.02	82.25	90.00	86.23	842	74	5992	50	2518	1081	136	10693	36.50	37.42	5653	5040	15175	664	" "	
27	3.57	3.76	3.61	4.05	3.75	0.02	82.32	70.40	81.80	91.80	91.40	86.10	82.35	89.50	85.75	842	74	5992	50	2518	1087	116	10679	36.50	37.21	5621	5058	15189	666	" "	
28	3.57	3.76	3.61	4.05	3.75	0.00	82.32	79.00	80.67	90.40	91.25	85.32	81.57	89.05	85.30	842	74	5992	50	2518	1043	127	10646	36.00	37.02	5592	5054	15082	670	" "	
29	3.56	3.75	3.60	4.04	3.74	0.01	82.33	79.40	80.40	80.50	91.00	85.08	81.34	89.45	85.71	842	74	5992	50	2518	1031	149	10656	36.00	37.20	5619	5037	15057	669	" "	
30	3.55	3.75	3.59	4.04	3.73	0.01	82.34	77.90	82.90	90.20	91.20	85.55	81.82	89.85	86.12	842	74	5992	50	2518	1057	146	10679	36.00	37.38	5646	5033	15116	666	" "	
31	3.50	3.71	3.54	4.00	3.69	0.04	82.38	78.60	81.50	91.30	92.30	85.92	82.23	90.00	86.31	842	74	5992	50	2518	1080	139	10695	36.00	37.46	5659	5036	15172	664	" "	
1893.																															
Jan. 1	3.35	3.49	3.38	3.77	3.50	0.19	82.57	80.90	83.00	91.40	92.40	87.15	83.65	90.10	86.60	842	74	5992	50	2518	1159	101	10736	36.75	37.58	5677	5059	15366	658	" "	
2	3.10	3.15	3.10	3.40	3.19	0.31	82.88	83.00	83.50	90.60	91.60	87.18	83.99	90.10	86.91	842	74	5992	50	2518	1177	100	10753	36.50	37.72	5697	5056	15413	656	" "	
3	3.02	3.09	3.01	3.33	3.11	0.08	82.96	87.30	82.30	89.00	90.00	87.15	84.04	89.80	86.61	842	74	5992	50	2518	1180	90	10740	36.00	37.62	5683	5063	15420	657	" "	
4	3.01	3.08	3.01	3.33	3.11	0.00	82.96	87.40	83.40	89.30	91.30	87.85	84.74	89.70	86.59	842	74	5992	50	2518	1219	63	10758	36.00	37.58	5677	5081	15510	655	" "	
5	3.01	3.08	3.01	3.33	3.11	0.00	82.96	87.10	83.10	89.30	91.30	87.70	84.59	90.80	87.60	842	74	5992	50	2518	1211	101	10788	36.50	38.06	5749	5039	15489	651	" "	Pumping finished at 10.55 o'clock. Sealing commenced at 16.00 o'clock.
12	2.99	3.03	3.00	3.29	3.08	0.03	82.99	87.60	87.60	91.10	90.10	89.10	86.02	93.90	90.82	842	74	5992	50	2518	1291	161	10931	....	....	....	....	15683	....	....	Sealing finished at 17.30 o'clock Jan. 11, air taken off 7.35 o'clock Jan. 12.

APPENDIX C.—Continued.

RECORD OF SINKING CAISSONS.

PIER IV.

Observations taken at 8 o'clock.

Date	Elevations of Cutting Edge: N. E.	N. W.	S. E.	S. W.	Average.	Sinkage: In 24 Hours.	Total.	Elevations of Ground: N. E.	N. W.	S. E.	S. W.	Average	Average Penetration of Caisson.	Water Gauge.	Depth Immersed
1892.						Ft.	Ft.						Ft.		Ft.
Sept. 24	......	......	......	......	83.00	......	......	80.00	79.00	81.00	79.00	79.75	......	93.00	10.00
25	......	......	......	......	82.40	0.60	0.60	76.40	74.90	76.40	73.90	75.40	......	92.90	10.50
26	......	......	......	......	81.30	1.10	1.70	74.90	74.90	74.90	72.90	74.40	......	92.90	11.60
27	80.30	80.20	79.90	79.80	80.05	1.25	2.95	72.70	73.70	73.70	72.70	73.20	......	92.70	12.65
28	81.45	81.55	80.50	80.60	81.02	—0.97	1.98	73.65	74.65	74.65	74.65	73.90	......	92.65	11.63
29	80.81	80.93	80.42	80.54	80.68	0.34	2.32	72.60	71.60	72.60	72.60	72.35	......	92.60	11.92
30	74.84	75.88	74.81	75.85	75.35	5.33	7.65	69.05	67.05	70.05	69.05	68.80	......	92.55	17.20
Oct. 1	71.81	72.12	71.66	71.97	71.89	3.46	11.11	68.22	68.22	69.72	66.82	68.25	......	92.72	20.83
2	70.99	69.72	71.33	70.06	70.52	1.37	12.48	68.60	71.50	71.50	68.60	70.05	......	92.70	22.18
3	70.38	68.44	71.54	69.60	69.99	0.53	13.01	69.70	68.80	74.50	72.60	71.40	1.41	92.57	22.58
4	69.99	68.09	71.39	69.49	69.74	0.25	13.26	71.78	71.78	74.03	71.63	72.31	2.57	92.48	22.74
5	69.23	67.88	70.12	68.75	68.99	0.75	14.01	71.78	72.28	74.43	70.28	72.18	3.19	92.43	23.44
6	67.98	67.90	67.84	67.76	67.87	1.12	15.13	71.57	71.57	76.87	70.87	72.72	4.85	92.37	24.50
7	67.98	67.88	67.83	67.73	67.85	0.02	15.15	71.58	70.38	77.49	68.28	71.93	4.08	92.28	24.43
8	65.96	66.10	65.78	65.72	65.84	2.01	17.16	71.84	69.34	76.25	69.25	71.67	5.83	92.25	26.41
9	63.53	61.66	64.07	62.21	62.87	2.97	20.13	70.41	69.40	74.71	69.71	71.06	8.19	92.21	29.34
10	60.32	59.10	60.66	59.44	59.88	2.99	23.12	71.57	69.07	74.90	67.40	70.73	10.85	92.15	32.27
11	57.97	56.72	58.03	56.78	57.38	2.50	25.62	71.38	69.38	75.08	70.00	71.46	14.08	92.08	34.70
12	55.33	53.78	55.35	53.80	54.56	2.82	28.44	72.00	70.00	74.55	72.00	72.14	17.58	92.05	37.49
13	52.84	52.09	52.72	51.97	52.41	2.15	30.59	71.33	69.33	74.25	72.75	71.92	19.51	92.00	39.59
14	49.86	47.74	49.96	47.84	48.85	3.56	34.15	71.10	68.10	73.60	71.60	71.10	23.25	91.93	43.08
15	43.91	42.84	44.12	43.05	43.48	5.37	39.52	72.70	68.20	72.60	72.20	71.43	27.95	91.90	48.42
16	41.54	40.36	41.79	40.61	41.07	2.41	41.93	74.10	68.10	73.20	72.50	72.00	30.93	91.87	50.80
17	40.70	39.02	40.91	39.23	39.97	1.10	43.03	74.85	66.85	71.60	73.10	71.60	31.63	91.85	51.88
18	39.39	38.33	39.59	38.53	38.96	1.01	44.04	72.10	68.07	73.00	74.07	71.81	32.85	91.87	52.91
19	35.70	34.25	35.90	34.45	35.07	3.89	47.93	71.45	66.45	73.45	71.95	70.82	35.75	91.95	56.88
20	31.38	30.10	31.59	30.31	30.85	4.22	52.15	74.23	65.73	73.35	72.65	71.49	40.64	92.15	61.30
21	29.74	28.56	29.98	28.80	29.27	1.58	53.73	68.40	67.40	74.20	72.70	70.68	41.41	92.20	62.93
22	26.47	25.31	26.67	25.51	25.99	3.28	57.01	70.00	67.50	74.30	74.40	71.55	45.56	92.10	66.11
23	23.22	22.18	23.41	22.37	22.79	3.20	60.21	74.68	66.68	74.66	74.16	72.55	49.76	92.08	69.29
24	21.22	20.27	21.38	20.43	20.83	1.96	62.17	75.50	66.80	74.60	74.10	72.75	51.92	92.08	71.25
25	21.21	20.25	21.36	20.40	20.81	0.02	62.19	71.10	67.60	74.80	73.30	71.70	50.89	92.22	71.41

Date	Weights: Caisson: Timber	Iron	Concrete.	Air Lock, Shafts, Etc.	Masonry.	Sand	Water.	Total.	Air Pressure: Indicated.	Calculated.	Reaction due to Air Pressure	Net Weight.	Surface in Contact.	Average Weight per sq. ft. on surface exposed to friction	Material.	Remarks.
1892.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Lbs.	Lbs.	Tons.	Tons.	Sq. Ft.	Lbs.		
Sept. 24	293	35	......	9	......	......	......	337	......	......	......	......	......	......	......	Framing of caisson timber commenced Aug. 18th. Cutting edge set up Aug. 26th. Caisson launched Sept. 20th. Caisson located at site of pier.
25	345	37	......	9	......	......	......	391	......	......	......	......	......	......	......	
26	366	41	......	10	......	......	......	417	......	......	......	......	......	......	......	
27	398	42	......	10	......	......	48	498	......	......	......	......	......	......	......	
28	410	43	......	10	......	......	......	463	......	......	......	......	......	......	......	Water pumped out of caisson.
29	444	44	......	10	......	......	......	498	......	......	......	......	......	......	......	Concreting commenced at 8.50 o'clock.
30	486	45	239	10	......	......	......	780	......	......	......	......	......	......	......	
Oct. 1	506	49	619	10	......	......	......	1184	......	......	......	......	......	......	......	
2	527	51	958	10	......	......	......	1546	......	......	......	......	42	......	......	
3	548	52	1204	12	......	......	......	1816	......	......	......	......	266	......	......	
4	550	53	1477	13	......	......	......	2093	9.00	9.87	1491	602	512	2350	Fine sand.	Air pumps started at 7.45, sand pumps at 18.05 o'clock
5	550	53	1673	14	......	......	......	2290	9.75	10.17	1536	754	638	2364	" "	
6	587	53	1673	14	......	......	......	2337	10.50	10.63	1606	721	970	1487	" "	Sand pumps stopped at 2.50 o'clock. Caisson straightened [up.
7	624	55	2060	14	......	......	......	2753	11.50	10.60	1601	1152	816	2824	" "	Repairing working chamber. Sand pumps resumed work at 15.28 o'clock.
8	624	59	2395	14	......	......	......	3092	12.75	11.45	1730	1362	1166	2336	" "	
9	656	59	2731	15	......	......	......	3161	13.00	12.73	1923	1538	1638	1878	" "	
10	673	60	3010	16	......	......	......	3759	15.00	14.01	2116	1643	2171	1514	" "	
11	733	62	3343	16	......	......	......	4154	16.00	15.06	2275	1879	2817	1334	Medium sand.	
12	754	67	3732	17	......	......	......	4570	16.75	16.27	2458	2112	3515	1202	Heavy sand.	
13	793	68	4177	19	......	......	......	5057	18.00	17.18	2595	2462	3902	1262	Fine blue sand.	
14	837	69	4622	20	......	......	......	5538	20.50	18.70	2825	2713	4450	1219	" "	
15	870	73	4955	22	......	......	......	5929	23.00	21.01	3174	2755	5589	986	" "	
16	912	77	5066	22	......	......	......	6077	23.00	22.04	3329	2748	6180	889	" "	
17	925	77	5177	23	......	......	......	6202	24.00	22.52	3402	2800	6327	885	" "	
18	967	78	5510	23	......	......	......	6578	23.25	22.96	3468	3110	6570	947	" "	
19	994	83	5733	25	......	......	......	6835	26.00	24.69	3730	3105	7150	864	" "	
20	1023	85	6122	26	......	......	......	7256	28.00	26.60	4018	3238	8129	797	Fine sand with clay balls	
21	1031	86	6456	28	......	......	......	7601	27.25	27.31	4125	3476	8281	839	" "	Timber work of caisson finished.
22	1031	86	6811	29	......	......	......	7957	29.75	28.69	4334	3623	9112	795	" "	
23	1031	86	7123	30	......	......	......	8270	30.00	30.07	4542	3728	9950	749	Coarse sand.	Concreting of caisson finished.
24	1031	86	7200	30	......	......	......	8347	31.00	30.92	4671	3676	10385	708	" "	
25	1031	86	7200	38	......	......	......	8355	31.50	30.99	4681	3674	10179	722	" "	Laying of masonry commenced.

APPENDIX C.—CONTINUED.

RECORD OF SINKING CAISSONS.

PIER IV.—CONTINUED.

Observations taken at 8 o'clock.

Date.	Elevations of Cutting Edge. N. E.	N. W.	S. E.	S. W.	Average	Sinkage. In 24 Hours.	Total.	Elevations of Ground. N. E.	N. W.	S. E.	S. W.	Average.	Average Penetration of Caisson	Water Gauge	Depth Immersed	Weights. Caisson. Timber	Iron.	Concrete	Air Lock, Shafts, Etc.	Masonry.	Sand.	Water.	Total.	Air Pressure. Indicated.	Calculated.	Reaction due to Air Pressure.	Net Weight.	Surface in Contact	Average Weight per sq. ft. on surface exposed to friction	Material.	Remarks.
1862.						Ft.	Ft.						Ft.		Ft.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Lbs.	Lbs.	Tons.	Tons.	Sq. ft.	Lbs.		
Oct. 26	21.21	20.25	21.36	20.40	20.81	0.00	62.19	75.60	66.20	75.00	74.00	72.70	51.89	92.36	71.55	1031	86	7200	38	311	......	......	8666	32.00	31.05	4690	3976	10379	766	Coarse sand.	
27	19.84	18.94	20.03	19.13	19.49	1.32	63.51	76.20	71.70	75.60	73.60	74.40	54.91	92.35	72.86	1031	86	7239	38	449	......	......	8843	32.75	31.62	4776	4067	10973	741	" "	
28	17.36	16.90	17.44	16.68	17.17	2.32	65.83	80.10	72.50	77.30	75.50	76.40	59.23	92.65	75.48	1031	86	7239	39	706	......	37	9138	33.00	32.76	4949	4189	11836	708	" "	
26	14.92	14.53	14.98	14.59	14.75	2.42	68.25	81.20	74.70	76.60	73.60	76.52	61.77	93.57	78.82	1031	86	7239	39	919	......	129	9443	34.50	34.21	5168	4275	12354	692	" "	
30	13.21	12.85	13.28	12.92	13.06	1.69	69.94	76.70	75.20	79.90	74.90	76.70	63.64	93.79	80.73	1031	86	7239	30	1149	......	190	9734	35.25	35.04	5293	4441	12722	698	" "	
31	10.51	10.30	10.53	10.32	10.42	2.64	72.58	79.40	73.90	82.00	77.00	78.07	67.65	93.70	83.28	1031	86	7236	39	1172	......	275	6842	36.00	36.14	5456	4383	13532	648	" "	
Nov. 1	8.68	8.52	8.72	8.56	8.62	1.80	74.38	79.70	80.70	83.50	78.50	80.60	71.98	93.50	84.88	1031	86	7239	39	1317	......	329	10041	36.50	36.84	5565	4476	14396	622	" "	
2	7.07	6.87	7.06	6.86	6.97	1.65	76.03	81.80	81.80	84.10	76.10	80.95	73.98	93.30	86.33	1031	86	7239	40	1512	......	377	10285	37.25	37.47	5660	4625	14797	625	" "	
3	3.69	3.54	3.69	3.54	3.81	3.36	79.39	79.40	79.40	83.60	75.60	79.50	75.89	93.10	89.49	1031	86	7239	40	1761	74	442	10673	39.00	38.84	5867	4806	15088	637	" "	
4	1.92	1.75	1.92	1.75	1.84	1.77	81.16	83.00	83.00	83.00	80.00	82.25	80.41	93.00	91.16	1031	86	7239	41	1966	273	365	11001	38.50	39.56	5976	5025	15601	644	" "	
5	0.59	0.52	0.56	0.49	0.54	1.30	82.46	83.50	80.00	86.60	81.60	83.00	82.46	92.90	92.36	1031	86	7239	43	2168	392	342	11301	40.50	40.08	6054	5247	16010	655	" "	
6	—0.86	—0.93	—0.89	—0.96	—0.91	1.45	83.91	83.30	80.30	89.10	81.10	83.45	84.36	92.80	93.71	1031	86	7239	43	2286	499	316	11500	42.00	40.67	6143	5357	16286	658	" "	
7	—2.75	—2.82	—2.82	—2.89	—2.82	1.91	85.82	85.50	77.70	88.50	81.00	83.20	86.02	92.70	95.52	1031	86	7239	44	2286	589	322	11597	41.50	41.46	6263	5334	16316	646	" "	
8	—4.11	—4.12	—4.18	—4.19	—4.15	1.33	87.15	83.00	79.00	89.10	82.60	83.43	87.58	92.70	96.85	1031	86	7239	44	2437	673	315	11825	42.50	42.03	6349	5476	16734	654	" "	
9	—5.65	—5.67	—5.76	—5.78	—5.71	1.56	88.71	83.40	82.40	88.40	85.40	84.00	90.61	92.60	98.31	1031	86	7239	44	2518	806	262	11980	43.00	42.67	6446	5543	17147	646	" "	
10	—6.61	—6.95	—6.97	—7.01	—6.96	1.25	89.96	84.40	84.40	87.90	87.00	85.62	92.88	92.70	69.66	1031	86	7239	44	2518	963	231	12112	43.00	43.25	6533	5579	17455	639	" "	
11	—7.92	—7.89	—8.02	—7.99	—7.95	0.99	90.95	89.80	90.80	91.20	87.20	89.75	97.70	92.60	100.55	1031	86	7239	44	2518	1230	97	12245	43.75	43.64	6592	5653	18103	625	Gravel and boulders.	
12	—7.94	—7.91	—8.05	—8.02	—7.98	0.03	90.98	89.10	89.30	90.00	86.00	88.60	96.58	92.60	100.58	1031	86	7239	44	2518	1168	137	12223	44.50	43.63	6594	5629	17957	627	" "	
13	—8.05	—8.03	—8.16	—8.14	—8.09	0.11	91.09	88.50	78.80	88.90	78.90	83.80	91.89	92.60	100.69	1031	86	7239	44	2518	909	300	12127	44.00	43.70	6601	5526	17305	638	" "	
14	—8.40	—8.36	—8.52	—8.48	—8.44	0.35	91.44	86.60	78.60	88.80	79.80	83.45	91.89	92.60	101.04	1031	86	7239	44	2518	909	318	12140	44.50	43.85	6624	5516	17305	637	" "	
15	—8.83	—8.76	—9.02	—8.95	—8.88	0.45	91.89	85.60	77.60	88.50	79.30	82.75	91.64	92.60	101.49	1031	86	7239	44	2518	895	337	12150	43.50	44.05	6654	5496	17276	636	" "	
16	—8.83	—8.76	—9.02	—8.95	—8.89	0.00	91.80	84.50	76.50	85.70	80.70	81.85	90.74	92.30	101.39	1031	86	7239	44	2518	837	364	12119	44.25	44.00	6646	5473	17160	638	" "	
17	—8.83	—8.76	—9.02	—8.95	—8.88	0.00	91.89	85.30	75.80	84.10	80.10	81.32	90.21	92.50	101.49	1031	86	7239	44	2518	817	386	12121	44.00	44.05	6654	5467	17032	640	" "	
18	—8.83	—8.76	—9.02	—8.95	—8.89	0.00	91.89	86.30	76.60	89.50	78.10	82.62	91.51	92.50	101.39	1031	86	7239	44	2518	888	338	12144	44.75	44.00	6646	5498	17266	637	" "	Final settlement made at 15.50 o'clock.
19	—9.17	—9.03	—9.32	—9.18	—9.17	0.28	92.17	85.90	77.40	90.20	77.00	82.62	91.79	92.40	101.57	1031	86	7239	44	2518	903	334	12155	45.00	44.08	6659	5496	17305	635	" "	Pumping finished at 19 30 o'clock.
20	—9.17	—9.03	—9.32	—9.18	—9.17	0.00	92.17	86.10	77.10	90.30	77.80	82.80	91.97	92.60	101.77	1031	86	7239	44	2518	913	335	12166	44.75	44.17	6672	5494	17330	634	" "	Sealing commenced at 12.30.
30	—9.17	—9.03	—9.32	—9.18	—9.17	0.00	92.17	84.60	76.60	90.80	77.80	82.45	91.62	92.60	101.77	1031	86	7239	44	2518	894	347	12159	......	......	......	......	17282	......	......	Sealing finished at 2.00 o'clock and air taken off at 16.15 [o'clock.

APPENDIX C.—Continued.

RECORD OF SINKING CAISSONS.

PIER V.

Observations taken at 8 o'clock.

Date.	Elevations of Cutting Edge: N. E.	N. W.	S. E.	S. W.	Average	Sinkage: In 24 Hours.	Total.	Elevations of Ground: N. E.	N. W.	S. E.	S. W.	Average.	Average Penetration of Caisson.	Water Gauge.	Depth Immersed	Weights: Caisson: Timber.	Iron.	Concrete.	Air Lock Shafts, etc.	Masonry.	Sand.	Water.	Total.	Air Pressure: Indicated	Calculated	Reaction due to Air Pressure.	Net Weight.	Surface in Contact.	Average Weight per sq. foot on surface exposed to friction	Material.	Remarks.
1892						Ft.	Ft.						Ft.		Ft.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Lbs.	Lbs.	Tons.	Tons.	Sq. Ft.	Lbs.		
Dec. 14	83.20	82.80	83.20	82.80	83.00	...	...	74.40	70.40	78.20	73.20	74.05	...	92.90	9.90	204	28	...	8	...	...	...	240	...	...	...	...	...	...	...	Framing of caisson timber commenced Nov. 6th, cutting edge set up on launching ways Nov. 8th, building of first section finished Nov. 23d, and caisson launched Dec. 11. Caisson located at site of pier, afloat.
15	81.10	80.80	82.00	81.70	81.40	1.60	1.60	74.10	73.10	77.20	77.20	75.40	...	92.80	11.40	262	30	...	8	...	...	...	300	...	...	...	...	...	...	...	
16	80.83	80.40	81.75	81.30	81.08	0.32	1.92	73.70	73.00	79.00	72.20	74.48	...	92.50	11.42	285	34	...	8	...	...	...	327	...	...	...	...	...	...	...	Concreting commenced.
17	79.20	78.00	80.40	79.20	79.20	1.88	3.80	73.40	72.40	78.70	72.70	74.30	...	92.20	13.00	296	34	46	8	...	...	...	384	...	...	...	...	...	...	...	Caisson landed on south side at 10:00 o'clock; 1950 sacks
18	76.64	75.20	78.02	76.58	76.61	2.59	6.39	75.90	75.90	77.90	75.90	76.40	...	91.90	15.29	296	34	108	8	...	...	...	446	...	...	...	...	...	...	...	[thrown in during afternoon.
19	75.30	73.30	77.35	75.35	75.32	1.29	7.68	76.60	76.10	78.60	73.90	76.30	0.98	91.60	16.28	296	34	407	8	...	...	...	745	...	...	...	...	231	6742	...	
20	74.87	72.07	77.23	73.35	75.10	0.22	7.90	76.20	76.80	80.40	76.60	77.50	2.40	91.60	16.50	296	34	600	8	...	...	...	938	...	...	...	...	403	4655	...	
21	74.58	72.77	77.14	75.33	74.95	0.15	8.05	77.40	75.90	82.20	77.40	78.23	3.28	91.40	16.45	296	34	676	8	...	...	...	1014	...	...	...	...	549	3694	...	Air pumps started at 11:30 o'clock, clearing out caisson.
22	74.28	72.65	76.88	75.25	74.76	0.19	8.24	77.20	75.70	81.70	77.20	77.95	6.19	91.20	16.44	296	34	676	9	...	...	...	1015	6.50	7.13	738	277	535	1035	...	
23	74.28	72.65	76.50	74.87	74.58	0.18	8.42	77.50	76.50	78.80	77.30	77.52	2.94	91.20	16.62	303	35	676	9	...	...	...	1023	7.50	7.21	747	276	496	1113	...	Sand pumps started at 20:10 o'clock.
24	72.76	72.85	72.75	72.84	72.80	1.78	10.20	79.10	76.60	84.80	79.30	79.93	7.15	90.83	18.05	325	35	896	9	...	...	...	1265	8.00	7.83	811	454	1201	736	Medium Sand.	
25	69.23	69.48	69.43	69.68	69.46	3.34	13.54	79.20	76.60	85.70	79.20	80.17	10.71	90.60	21.14	333	36	1118	9	...	...	...	1518	9.00	9.17	940	569	1801	632	"	Sand pumps stopped at 10:40 o'clock, waiting for timber
26	68.92	68.13	69.00	68.21	68.56	0.90	14.44	79.40	76.90	88.80	78.50	80.90	12.31	90.00	21.44	355	36	1118	10	...	...	...	1519	9.50	9.30	963	556	2072	537	"	[work.
27	68.92	68.13	69.00	68.21	68.56	0.00	14.44	78.00	77.00	88.50	77.50	80.27	11.69	89.50	20.94	370	39	1118	10	...	...	...	1537	9.25	9.09	941	596	1963	607	"	
28	68.92	68.13	69.00	68.21	68.56	0.00	14.44	78.50	77.50	89.00	79.00	81.00	12.44	89.05	20.49	390	40	1118	10	...	...	...	1558	9.75	8.89	920	638	2089	611	"	Sand pumps resumed work at 20:00 o'clock.
29	67.27	67.03	67.21	66.97	67.12	1.44	15.88	77.50	79.40	89.30	78.40	81.65	14.53	89.45	22.33	390	40	1378	10	...	...	...	1818	11.00	9.69	1003	815	2357	692	"	
30	65.16	65.47	65.04	65.35	65.25	1.87	17.75	76.10	79.50	89.90	78.80	81.08	15.83	89.85	24.60	427	41	1606	10	...	...	...	2084	11.25	10.68	1106	978	2658	736	"	[work.
31	62.17	63.41	61.75	62.99	62.58	2.67	20.42	75.60	84.10	88.30	80.80	82.20	19.63	90.00	27.42	442	42	1796	12	...	...	...	2292	12.75	11.90	1232	1060	3296	643	"	Sand pumps stopped at 21:30 o'clock, waiting for timber
1893																															
Jan. 1	60.79	62.00	60.56	61.77	61.28	1.30	21.72	76.60	81.60	88.30	87.30	83.45	22.17	90.10	28.82	464	43	1796	13	...	...	...	2316	13.00	12.51	1295	1021	3725	548	"	
2	60.79	61.92	60.56	61.69	61.24	0.04	21.76	77.70	82.20	88.40	83.90	83.05	21.81	90.10	28.86	472	43	1796	13	...	...	...	2324	13.50	12.53	1297	1027	3664	561	"	
3	60.74	61.76	60.47	61.49	61.12	0.12	21.88	77.50	82.50	87.60	83.10	82.68	21.56	89.80	28.68	492	47	2060	13	...	...	...	2612	13.00	12.45	1289	1323	3622	731	"	
4	60.40	60.58	60.24	60.42	60.41	0.71	22.59	78.30	78.80	87.50	82.50	81.78	21.34	89.70	29.29	500	47	2098	13	...	...	...	2658	14.00	12.71	1316	1342	3585	749	"	Sand pumps resumed at 9:40 o'clock.
5	57.92	58.00	57.80	57.88	57.90	2.51	25.10	77.20	82.20	86.00	85.00	82.60	24.70	90.80	32.90	500	47	2400	15	...	...	...	2962	15.75	14.28	1479	1483	4130	715	"	
6	54.85	55.15	54.50	54.80	54.82	3.08	28.18	76.50	89.50	85.20	80.20	85.10	30.28	93.00	38.18	500	47	2400	15	...	...	...	2962	17.50	16.57	1715	1247	5087	490	"	Sand pumps stopped at 8:00 o'clock, waiting for timber
7	54.77	55.06	54.42	54.71	54.74	0.08	28.26	76.10	88.10	87.70	89.70	85.40	30.66	93.10	38.36	500	47	2627	15	...	...	...	3189	18.00	16.65	1724	1465	5151	569	"	[work.
8	54.77	55.06	54.42	54.71	54.74	0.00	28.26	76.00	88.40	87.50	91.50	85.85	31.11	93.50	38.76	507	47	2853	15	...	...	...	3422	18.00	16.82	1742	1680	5226	643	"	
9	54.77	55.06	54.42	54.71	54.74	0.00	28.26	75.80	88.30	86.80	88.80	84.92	30.18	93.40	38.66	544	48	2853	15	...	...	...	3460	18.00	16.78	1737	1723	5070	680	"	
10	54.77	55.06	54.42	54.71	54.74	0.00	28.26	75.30	88.30	86.90	88.90	84.85	30.11	93.50	38.76	566	51	2853	15	...	...	...	3485	18.50	16.82	1742	1743	5058	688	"	
11	54.77	55.06	54.42	54.71	54.74	0.00	28.26	75.10	87.70	86.70	88.30	84.45	29.71	93.60	38.86	577	52	2853	15	...	...	...	3497	18.50	16.87	1747	1750	4991	701	"	
12	54.77	55.06	54.42	54.71	54.74	0.00	28.26	75.10	88.00	86.90	88.90	84.72	29.98	93.90	39.16	587	53	2853	15	...	...	...	3508	18.50	17.00	1760	1748	5037	694	"	
13	54.77	55.06	54.42	54.71	54.74	0.00	28.26	75.30	88.30	86.80	88.30	84.67	29.93	94.00	39.26	587	53	2853	13	...	...	...	3508	18.50	17.04	1764	1744	5028	694	"	
14	54.77	55.06	54.42	54.71	54.74	0.00	28.26	75.10	88.60	86.70	88.30	84.67	29.93	94.00	39.26	587	53	2853	13	...	...	...	3508	18.00	17.04	1764	1744	5028	694	"	
15	54.77	55.06	54.42	54.71	54.74	0.00	28.26	75.60	88.30	86.70	88.30	84.70	29.96	93.90	39.16	587	53	2853	15	...	...	...	3508	18.00	17.00	1760	1748	5033	695	"	
16	54.77	55.06	54.42	54.71	54.74	0.00	28.26	74.60	85.60	85.20	87.70	83.27	28.53	93.90	39.16	587	53	2853	15	...	...	...	3508	18.00	17.00	1760	1748	4793	729	"	
17	54.77	55.06	54.42	54.71	54.74	0.00	28.26	76.00	86.50	85.60	88.60	84.16	29.42	94.20	39.46	587	53	2853	15	...	...	...	3508	18.00	17.13	1774	1734	4943	702	"	
18	54.77	55.06	54.42	54.71	54.74	0.00	28.26	76.40	88.30	86.00	89.20	84.97	30.23	94.50	39.76	587	53	3004	15	...	...	...	3658	18.25	17.26	1787	1872	5079	737	"	
19	54.77	55.06	54.42	54.71	54.74	0.00	28.26	76.20	87.20	85.40	89.30	84.52	29.78	94.55	39.81	587	53	3004	15	...	...	...	3659	18.25	17.28	1789	1870	5008	748	"	
20	54.77	55.06	54.42	54.71	54.74	0.00	28.26	77.00	87.00	86.40	88.90	84.82	30.08	94.65	39.91	587	53	3155	17	...	...	...	3812	18.25	17.32	1793	2019	5053	799	"	
21	54.77	55.06	54.42	54.71	54.74	0.00	28.26	77.10	87.10	86.40	88.50	84.77	30.03	94.70	39.96	587	53	3155	17	...	...	...	3812	18.50	17.34	1795	2017	5045	800	"	
22	54.77	55.06	54.42	54.71	54.74	0.00	28.26	76.70	86.70	86.90	87.90	84.55	29.81	94.70	39.96	587	53	3155	17	...	...	...	3812	18.50	17.34	1795	2017	5008	805	"	
23	50.74	50.47	50.38	50.11	50.42	4.32	32.58	76.70	86.70	86.90	87.90	84.53	34.13	94.70	44.28	587	53	3155	17	...	...	...	3812	21.00	19.22	1990	1822	5734	635	"	Pumping sand resumed at 13:35 o'clock.
24	49.07	48.82	48.80	48.55	48.81	1.61	34.19	77.20	86.90	87.60	87.10	84.70	35.89	94.80	45.09	587	53	3155	17	...	...	...	3812	21.75	19.86	2067	1745	6029	579	"	Pumping sand stopped at 15:50 o'clock, waiting for concrete
25	49.07	48.82	48.76	48.51	48.79	0.02	34.21	76.10	87.10	87.60	86.60	84.35	35.56	94.90	46.11	624	54	3155	17	...	...	...	3850	22.00	20.01	2072	1778	5974	595	"	

APPENDIX C.—CONTINUED.
RECORD OF SINKING CAISSONS.
PIER V.—CONTINUED.

Observations taken at 8 o'clock.

Date.	Elevations of Cutting Edge. N. E	Elevations of Cutting Edge. N. W	Elevations of Cutting Edge. S. E.	Elevations of Cutting Edge. S. W.	Elevations of Cutting Edge. Average.	Sinkage. In 24 Hours.	Sinkage. Total	Elevations of Ground. N. E	Elevations of Ground. N. W.	Elevations of Ground. S. E	Elevations of Ground. S. W.	Elevations of Ground. Average.	Average Penetration of Caisson.	Water Gauge.	Depth Immersed.	Weights. Caisson. Timber	Weights. Caisson. Iron.	Weights. Concrete	Weights. Air Lock, Shafts, etc.	Weights. Masonry.	Weights. Sand	Weights. Water.	Weights. Total.	Air Pressure. Indicated.	Air Pressure. Calculated.	Reaction due to Air Pressure	Net Weight	Surface in Contact	Average Weight per sq. foot on surface exposed to friction	Material	Remarks.
1893						Ft.	Ft.						Ft.		Ft.	Tons.	Tons.	Tons.	Tons.	Tons	Tons	Tons.	Tons.	Lbs.	Lbs.	Tons.	Tons.	Sq. Ft.	Lbs.		
Jan. 26	49.07	48.82	48.76	48.51	48.79	0.00	34.21	74.80	87.10	87.70	85.70	83.82	35.08	94.90	46.11	624	54	3155	17				3850	22.50	20.01	2072	1778	5885	604	Medium Sand.	
27	49.07	48.82	48.76	48.51	48.70	0.00	34.21	74.80	86.70	86.90	86.80	83.80	35.01	94.75	45.06	645	54	3155	17				3871	23.00	19.95	2066	1805	5892	612	"	
28	49.07	48.82	48.76	48.51	48.70	0.00	34.21	73.20	85.30	86.90	85.90	82.82	34.03	94.75	45.96	645	54	3155	17				3871	23.00	19.95	2066	1805	5717	631	"	
29	48.85	48.55	48.55	48.25	48.55	0.24	34.45	74.50	84.00	86.20	84.20	82.22	33.67	94.60	46.05	645	54	3155	17				3871	23.00	19.90	2070	1801	5657	637	"	
30	48.85	48.55	48.55	48.25	48.55	0.00	34.45	75.10	82.10	87.70	82.80	81.92	33.37	94.60	46.05	645	54	3155	17				3871	23.00	19.99	2070	1801	5606	643	"	
31	48.85	48.55	48.55	48.25	48.55	0.00	34.45	75.20	81.70	85.60	82.60	81.27	32.72	94.45	45.00	645	54	3155	17				3871	23.00	19.92	2063	1808	5467	658	"	
Feb. 1	48.85	48.55	48.55	48.25	48.55	0.00	34.45	74.60	80.00	87.50	81.10	80.80	32.25	94.30	45.75	645	54	3155	17				3871	23.25	19.86	2056	1815	5418	670	"	
2	48.85	48.55	48.55	48.25	48.55	0.00	34.45	76.10	81.10	86.70	82.10	81.50	32.95	93.00	47.35	645	54	3155	17				3871	23.25	19.68	2038	1833	5536	662	"	
3	48.85	48.55	48.55	48.25	48.55	0.00	34.45	76.70	81.50	87.00	81.80	81.70	33.15	93.70	45.15	645	54	3155	17				3871	23.00	19.60	2029	1842	5569	662	"	
4	48.85	48.55	48.55	48.25	48.55	0.00	34.45	78.20	82.10	87.30	80.70	82.07	33.52	93.40	44.85	645	54	3155	17				3871	23.00	19.46	2014	1857	5631	660	"	
5	48.85	48.55	48.55	48.25	48.55	0.00	34.45	75.10	81.60	87.40	80.90	81.25	32.70	93.50	44.95	645	54	3155	17				3871	22.50	19.51	2020	1851	5464	674	"	
6	48.87	48.55	48.55	48.25	48.55	0.00	34.45	75.40	80.00	80.80	80.30	80.62	32.07	93.90	45.35	645	54	3155	17				3871	22.25	19.68	2038	1833	5388	680	"	
7	48.85	48.55	48.55	48.25	48.55	0.00	34.45	75.60	80.60	87.70	80.20	81.02	32.47	93.80	45.25	645	54	3155	17				3871	22.00	19.64	2034	1837	5455	674	"	
8	48.85	48.55	48.55	48.25	48.55	0.00	34.45	77.00	80.00	86.90	80.40	81.07	32.52	93.85	45.30	645	54	3155	17				3871	22.00	19.66	2036	1835	5463	672	"	
9	48.85	48.55	48.55	48.25	48.55	0.00	34.45	76.00	80.40	87.50	80.50	81.32	32.77	94.00	45.45	645	54	3155	17				3871	22.00	19.73	2043	1828	5505	664	"	
10	48.85	48.55	48.55	48.25	48.55	0.00	34.45	77.30	80.80	87.30	80.50	81.47	32.92	94.20	45.65	645	54	3155	17				3871	23.00	19.81	2051	1820	5531	658	"	
11	48.85	48.55	48.55	48.25	48.55	0.00	34.45	76.40	81.40	87.80	80.80	81.60	33.05	94.20	45.65	645	54	3155	17				3871	22.00	19.81	2051	1820	5552	656	"	
12	48.85	48.55	48.55	48.25	48.55	0.00	34.45	77.10	79.60	86.70	78.70	80.52	31.97	94.20	45.65	645	54	3155	19				3873	22.00	19.81	2051	1822	5371	678	"	
13	48.85	48.55	48.55	48.25	48.55	0.00	34.45	76.80	83.30	87.80	80.30	82.05	33.50	94.25	45.70	645	54	3155	19				3873	22.00	19.88	2053	1820	5628	647	"	
14	48.83	48.54	48.51	48.22	48.52	0.03	34.48	76.50	80.40	88.50	80.40	81.45	32.93	94.45	45.93	645	54	3457	19				4175	22.00	19.93	2064	2111	5532	763	"	Sand pumps started at 15.30 o'clock.
15	46.73	46.47	46.56	46.30	46.51	2.01	36.49	78.30	80.20	92.80	81.80	83.27	36.76	94.95	48.44	645	54	3722	19				4440	23.00	21.02	2176	2264	6176	733	"	
16	44.14	43.96	43.85	43.07	43.90	2.61	39.10	75.80	80.80	91.50	78.50	81.65	37.75	96.00	52.10	684	58	3722	19				4483	23.00	22.61	2341	2142	6242	686	"	
17	40.42	39.97	40.09	39.64	40.03	3.87	42.97	77.20	78.70	90.70	79.70	81.57	41.54	97.10	57.07	691	59	3616	19				4685	25.50	24.77	2565	2120	6979	608	"	Sand pumps stopped at 11.35 o'clock waiting for concrete.
18	39.39	38.91	39.09	38.61	39.00	1.03	44.00	76.00	78.00	90.00	78.00	80.50	41.50	96.70	57.70	691	59	3916	19				4685	26.50	25.04	2593	2092	6972	600	"	Sand pump started at 15.30 o'clock.
19	37.15	36.89	36.83	36.57	36.86	2.14	46.14	75.00	79.00	90.70	77.70	80.60	43.74	96.65	59.59	691	58	4243	19				5011	27.00	25.95	2686	2325	7348	633	"	Sand pump stopped at 12.45. Ice moved out without damage.
20	35.38	35.07	35.00	34.69	35.03	1.83	47.07	78.00	77.00	87.50	76.50	79.75	44.72	94.50	59.47	691	58	4370	20				5139	26.00	25.81	2672	2467	7513	657	"	
21	35.38	35.06	35.00	34.08	35.03	0.00	47.97	76.10	75.10	87.20	77.20	78.90	43.87	94.90	59.87	691	58	4370	20				5139	27.00	25.98	2690	2449	7370	665	"	
22	35.38	35.06	35.00	34.68	35.03	0.00	47.97	76.20	73.20	86.90	75.90	78.05	43.02	94.70	59.67	691	58	4697	20				5466	27.50	25.90	2682	2784	7227	770	"	Pumping sand resumed at 18.30 o'clock.
23	35.24	34.84	34.85	34.45	34.84	0.19	48.16	76.40	75.40	89.60	75.60	79.25	44.41	94.60	59.76	732	61	4697	20				5510	27.50	25.64	2686	2824	7461	757	"	
24	31.00	31.50	31.50	32.10	31.50	3.34	51.50	77.60	74.60	89.60	76.60	79.60	48.10	94.80	63.30	755	69	4697	20				5541	30.00	27.47	2844	2697	8081	667	"	Timber work finished.
25	29.67	29.23	29.35	28.92	29.29	2.21	53.71	74.60	73.60	90.00	73.00	77.55	48.26	95.40	66.11	755	69	4898	22				5744	30.00	28.09	2971	2773	8108	684	"	
26	26.42	25.99	26.08	25.65	26.03	3.26	56.97	72.30	70.30	84.30	68.30	73.80	47.77	95.95	69.92	755	69	5185	22				6031	31.00	30.35	3142	2889	8025	720	"	
27	22.05	21.82	21.73	21.50	21.78	4.25	61.22	74.80	70.80	83.40	71.40	75.10	53.32	95.80	74.02	755	69	5185	22				6031	32.60	32.12	3326	2705	8658	604	"	Pumping sand stopped at 13.15 o'clock.
28	21.49	21.25	21.19	20.95	21.22	0.56	61.78	74.00	75.00	81.00	72.00	75.50	54.28	96.20	74.08	755	69	5432	22				6278	32.50	32.54	3368	2909	9119	638	"	Concreting caisson finished.
Mar. 1	21.40	21.18	21.09	20.87	21.14	0.08	61.86	74.30	75.40	82.60	75.00	76.88	55.54	96.85	75.71	755	69	5637	22				6483	32.00	32.80	3402	3081	9331	660	"	
2	21.26	21.02	20.94	20.70	20.98	0.16	62.02	75.40	72.40	75.50	77.50	75.20	54.22	96.90	75.92	755	69	5637	22	15			6498	33.25	32.95	3412	3086	9109	678	"	Pumping sand resumed at 14.00 o'clock, masonry commenced.
3	19.10	19.02	18.83	18.75	18.93	2.05	64.07	74.80	72.80	82.00	71.60	75.45	56.52	96.80	77.87	755	69	5637	24	235			6720	34.00	33.80	3500	3220	9495	678	"	
4	17.54	17.50	17.30	17.26	17.40	1.53	65.60	75.20	73.20	81.40	71.90	75.42	58.02	96.50	76.10	755	69	5637	24	457			6942	34.50	34.33	3555	3387	9747	695	"	
5	15.00	15.00	14.78	14.78	14.89	2.51	68.11	70.90	71.90	79.40	72.40	73.65	58.76	96.40	81.51	755	69	5637	24	473		33	6991	36.00	35.38	3663	3328	9872	674	"	
6	11.43	11.53	11.37	11.47	11.45	3.44	71.55	74.40	71.40	82.00	71.50	74.82	63.37	96.25	84.80	755	69	5637	25	586		106	7178	37.00	36.80	3810	3368	10646	633	"	
7	10.52	10.51	10.56	10.55	10.54	0.91	72.46	77.00	71.90	81.30	73.30	75.87	65.33	95.95	85.41	755	69	5637	26	667		121	7275	38.00	37.07	3838	3437	10975	626	"	Sealing commenced at 16.00 o'clock.
8	9.30	9.45	9.34	9.49	9.39	1.15	73.61	76.80	75.80	79.70	70.20	75.62	66.23	95.80	87.41	755	69	5637	26	667		145	7299	38.00	37.50	3883	3416	11127	614	"	
9	9.24	9.28	9.28	9.32	9.28	0.11	73.72	77.10	73.20	81.50	74.50	76.57	67.29	96.15	86.87	755	69	5637	26	667		156	7310	38.00	37.70	3903	3407	11303	603	"	Pumping sand finally stopped at 15.50 o'clock.
10	9.23	9.26	9.27	9.30	9.27	0.01	73.73	77.40	72.40	83.30	71.80	76.22	66.95	98.40	89.13	755	69	5637	26	667		210	7364	38.75	38.68	4005	3359	11248	597		
13	9.23	9.24	9.28	9.29	9.26	0.01	73.74	77.70	74.70	81.70	76.70	77.70	68.44	96.55	90.29	755	69	5637	26	667		238	7392					11498			Sealing finished at 16.00 o'clock March 12th. Air pumps stopped at 6.40 o'clock March 13th.

APPENDIX D.

TIME, COST AND MATERIALS USED IN FOUNDATIONS.

PIER II.

Date 1893	Principal Foreman Days	Principal Foreman Amount	Night Foreman Days	Night Foreman Amount	Sub. Foremen Days	Sub. Foremen Amount	Lock Tenders Days	Lock Tenders Amount	Pressure Men Days	Pressure Men Amount	Coffee House Men Days	Coffee House Men Amount	Clay Hoist Men Days	Clay Hoist Men Amount	Coffee Lbs.	Coffee Amount	Sugar Lbs.	Sugar Amount	Candles No	Candles Amount	Red Lead Lbs.	Red Lead Amount	Coal for Heating 200 Lbs Boxes	Coal for Heating Amount	Watchmen Days	Watchmen Amount	Day Engineers Days	Day Engineers Amount	Night Engineers Days	Night Engineers Amount
Jan. 18	1	5.00	½	1.75			½	1.00	5½	11.00					2	.51			8	.15			2	.55			1	3.00	1	3.00
19	1	5.00	1	3.50	1	3.00	2	4.00	25	50.00	2	3.50			4	1.02			37	.68			2	.55			1	3.00	1	3.00
20	1	5.00	1	3.50	2	6.00	3	6.00	31	62.00	2	3.50			4	1.02			16	.30			2	.56			1	3.00	1	3.30
21	1	5.00	1	3.50	2	6.00	3	6.00	32	64.00	2	3.50			2	.51			46	.85			2	.56			1	3.00	1	3.30
22	½	2.50	1	3.50	2	6.00	3	6.00	19	38.00	2	3.50							19	.35			2	.55			1	3.00	1	3.30
23							3	6.00			1	1.75			1	.25			4	.07			2	.55			1	3.30	1	3.30
24			1	3.50			3	6.00			2	3.50			4	1.02	5	.25	4	.07			4	1.12			1	3.30	1	3.30
25	½	2.50	1	3.50	½	1.50	3	6.00	4	8.00	2	3.50					2	.10	4	.07			1	.28			1	3.30	1	3.30
26	1	5.00	1	3.50	3	9.00	3	6.00	29	58.00	2	3.50			5	1.27	7	.35	15	.28			2	.56			1	3.30	1	3.30
27	1	5.00	1	3.50	2½	7.50	3	6.00	26½	53.00	2	3.50			3	.77	7	.35	13	.24			2	.55			1	3.30	1	3.30
28	1	5.00	1	3.50			3	6.00			2	3.50							3	.06			2	.55			1	3.30	1	3.30
29	1	5.00	1	3.50			3	6.00			2	3.50			2	.51	2	.10	4	.07			2	.56			1	3.30	1	3.30
30	1	5.00	1	3.50			3	0.00			2	3.50							4	.07			1	.28			1	3.30	1	3.30
31	1	5.00	1	3.50			3	6.00			2	3.50			2	.51	2	.10	4	.07			1	.27			1	3.30	1	3.30
Feb. 1	1	5.00	1	3.50			3	6.00			2	3.50							4	.07			2	.55			1	3.30	1	3.30
2	1	5.00	1	5.50			3	6.00			2	3.50							3	.06			2	.56			1	3.30	1	3.30
3	1	5.00	1	3.50			3	6.00	5	10.00	2	3.50			3	.77	4	.20	6	11			2	.55			1	3.30	1	3.30
4	1	5.00	1	3.50	3	9.00	3	6.00	33	66.00	2	3.50			4	1.02	5	.25	14	.26			2	.55			1	3.30	1	3.30
5	1	5.00	1	3.50	3	9.00	3	6.00	34	68.00	2	3.50			4	1.02	7	.36	12	.22			2	.55			1	3.30	1	3.30
6	1	5.00	1	3.50	3	9.00	3	6.00	33	66.00	2	3.50			4	1.02	7	.36	5	.09			2	.49			1	3.30	1	3.30
7	1	5.00	1	3.50	2½	7.50	3	6.00	27½	55.00	2	3.50			4	1.02	5	.26	6	.11			2	.49			1	3.30	1	3.30
8	1	5.00	1	3.50	½	1.50	3	6.00	4½	9.00	2	3.50					4	.20	2	.04			2	.49			1	3.30	1	3.30
9	1	5.00	1	3.50	3	9.00	3	6.00	34	68.00	2	3.50			6	1.53	5	.25	2	.04			2	.49			1	3.30	1	3.30
10	1	5.00	1	3.50	3	9.00	3	6.00	32	64.00	2	3.50															1	3.30	1	3.30
11			1	3.50			3	6.00			1	1.75																	1	3.30
Mar. 13	½	2.50			1	3.00	½	1.00	10	20.00	1	1.75			4	1.02	4	.20	6	.11			2	.49	1	2.00	1	3.23		
14	1	5.00	1	3.00	2	6.00	2	4.00	24	48.00	2	3.50					4	.20	3	.06			2	.49	2	4.00	1	3.23	1	3.23
15	1	5.00	1	3.00	3	9.00	2	4.00	28	56.00	2	3.50			3	.77	7	.35	5	.09			2	.49	2	4.00	1	3.23	1	3.23
16	1	5.00	1	3.50	3	9.00	2	4.00	32	64.00	2	3.50			2	.51	6	.30	12	.22			2	.49	2	4.00	1	3.23	1	3.23
17	1	5.00	1	3.50	3	9.00	2	4.00	36	72.00	2	3.50			5	1.27	6	.30	6	.11			2	.49	2	4.00	1	3.23	1	3.23
18	1	5.00	1	3.50	3	9.00	2	4.00	36	72.00	2	3.50			2	.51	6	.30	9	.17			2	.49	2	4.00	1	3.23	1	3.23
19	1	5.00	1	3.50	3	9.00	2	4.00	37	74.00	2	3.50			5	1.27	6	.30	9	.17			2	.49	2	4.00	1	3.23	1	3.23
20	1	5.00	1	3.50	3	9.50	2	4.40	38	86.20	2	3.50			5	1.27	6	.31	8	.15			2	.49	2	4.00	1	3.23	1	3.23
21	1	5.00	1	3.75	5	15.65	2	4.80	50	120.00	3	5.25			2	.51	8	.41	16	.30			1	.25	2	4.00	1	3.23	1	3.23
22	1	5.00	1	3.75	5	15.65	2	4.80	49	117.60	3	5.25			5	1.27	8	.40	16	.30			1	.24	2	4.10	1	3.23	1	3.23
23	1	5.00	1	3.75	5	15.65	2	4.80	50	120.00	3	5.25			3	.77	8	.40	13	.24			2	.49	2	4.10	1	3.22	1	3.22
24	1	5.00	1	3.75	5	15.65	2	4.80	51	122.40	3	5.25			3	.77	8	.40	12	.22			2	.49	2	3.92	1	3.22	1	3.22
25	1	5.00	1	3.75	5	15.65	2	4.80	51	122.40	3	5.25			5	1.28	12	.60	21	.39			2	.49	2	4.10	1	3.22	1	3.22
26	1	5.00	1	3.75	5	15.65	2	4.80	50	120.00	3	5.25			3	.77	7	.35	45	.83			2	.49	2	4.10	1	3.22	1	3.22
27	1	5.00	1	3.75	5	15.65	2	4.80	50	120.00	3	5.25			2	.51	7	.35	71	1.31			2	.49	2	3.92	1	3.22	1	3.22
28	1	5.00	1	3.75	5	15.65	2	4.80	43½	104.40	3	5.25			6	1.52	8	.41	65	1.20			2	.49	2	4.10	1	3.22	1	3.22
29	1	5.00	1	3.75	5	15.65	2	4.80	50	120.00	3	5.25			2	.50	8	.40	95	1.76			2	.49	2	4.10	1	3.22	1	3.22
30	1	5.00	1	3.75	5	15.65	2	4.80	48	115.20	3	5.25			2	.50	6	.30	28	.52			2	.49	2	3.92	1	3.22	1	3.22
31	1	5.00	1	3.75	5	15.65	2	4.80	46½	111.60	3	5.25			6	1.50	12	.61	46	.85			2	.49	2	4.10	1	3.22	1	3.22
Forward		197.50		147.00		328.65		225.20		2535.80		164.50		......		30.29		10.03		13.33		.....		21.03		74.46		138 98		139.95

Date 1893	Pump Men Days	Pump Men Amount	Helpers Days	Helpers Amount	Firemen Days	Firemen Amount	Coal Passers Days	Coal Passers Amount	Ditching Days	Ditching Amount	Coal for Boilers Tons	Coal for Boilers Amount	Signal Oil Pints	Signal Oil Amount	Black Oil Pints	Black Oil Amount	Cylinder Oil Pints	Cylinder Oil Amount	Waste Lbs.	Waste Amount	Coal Oil Pints	Coal Oil Amount	Totals for Each Day	Feet Sunk per Day	Material	Water Pumps Hours run	Water Pumps No. of strokes	Air Pumps No. of revolutions	Remarks
Jan. 18					2	4.80	2	4.20			8.2	24.95											$ 59.91	0.13	Coarse sand.	9 55/60	38	21	Air pumps started at 15.40, sand pumps at 19.10 o'clock.
19			2	5.75	2	4.80	2	4.20			15.1	45.95			32	.42	8	.55	5	.30			139.22	2.43	"	24	49	30	
20			1	2.25	2	4.80	2	4.20			19.0	57.82	6	.70			16	1.10					165.05	3.42	"	23	54	27	
21			3	6.50	2	4.80	2	4.20	1 1/10	2.28	12.7	38.64			24	.32	24	1.65	9	.54			155.15	2.50	"	16 35/60	53	29	Stopped sand pump at 5.55 o'c'k Jan. 22.
22			2	4.00	2	4.80	2	4.20			19.9	60 55					80	5.50					145.75	0.03	"			25	(Working day from 8.00 o'clock to 8.00 o'clock next date).
23			2	4.00	2	4.80	2	4.20			7.1	21.60			40	.53					16	.22	50.57	0.00	"			27	
24			2	4.00	2	4 80	2	4 20			6.2	18.87											53.93	0.02	"			24	
25			3	6.50	2	4.80	2	4.20			9.3	28.30							11	.66			76.51	1.85	"	12 55/60	49	25	Started sand pump at 19.35 o'clock.
26			2	4.00	2	4.80	2	4.20			20.4	62.08											169.14	3.74	"	24	52	25	
27			1	2.25	2	4.80	2	4.20	1	1.75	10.1	30.73											130.74	0.51	"	8 52/60	42	21	Stopped sand pump at 16.52 o'clock.
28			1½	3.12	2	4.80	2	4.20			2.5	7.61											44.94	0.57	"			20	
29			2	4.00	2	4.80	2	4.20			5.6	17.04											55.88	0.03	"			19	
30			2	4.00	2	4.80	2	4.20			6.3	19.17											57.12	0.48	"			19	
31			2	4.00	2	4.80	2	4.20			6.5	19.78											58.33	0.02	"			20	
Feb. 1			2	4.00	2	4.80	2	4.20			0.7	2.13			40	.53			5	.30			41.18	0.19	"			20	
2			2	4.00	2	4.80	2	4.20			5.5	16.74	16	1.04									56.00	0.01	"			21	
3			2	4.00	2	4.80	2	4.20			13.5	41.08											90.31	0.12	"			21	
4			2	4.00	2	1.80	2	4.20			16.2	49.29					16	.36					164.33	2.18	"	20 15/60	50	26	Started sand pump at 11.45 o'clock.
5			2	4.00	2	4.80	2	4.20			18.8	57.20					80	3.74					177.60	2.25	"	22 47/60	52	29	
6			2	4.00	2	4.80	2	4.20	½	1.00	14.0	31.73									16	.22	147.51	1.84	"	24	44	34	
7			2	4.00	2	4.80	2	4.20			11.8	26.75											128.73	0.88	"	6 10/60	40	44	
8			2	4.00	2	4.80	2	4.20			22.3	50.54											99.37	1.39	"	4	52	33	
9			2	4.00	2	4.80	2	4.20			19.5	44.20			40	.51					16	.22	161.84	1.56	"	24	46	25	Sand pump stopped at 16:35, air pumps at 20:45 o'clock, and stationary plant dismantled.
10			2	4.00	2	4.80	2	4 20			5.8	13.15											123.75	1.57	"	8 35/60	52	24	
11			1	2.25	1	2.40	1	2.10															21.30	.....	"				
Mar. 13	1	2.40	1	2.40	1	2.40	1	2.10			6.5	14.73									40	.55	59.88	0.17	"	5 10/60	50	26	Bertram moved to site of pier. Air pumps started at 13.10 o'clock, and sand pump at 17.50 oclock.
14	2	4.80	1	2.40	2	4.80	2	4.20			13.0	29.47											126.38	0.69	"	19 40/60	49	29	
15	2	4.80	1	2.40	2	4.80	2	4.20			15.6	35.36											144.22	2.02	Verycoarse sand.	24	38	25	
16	2	4.80	1	2.40	2	4.80	2	4.20			16.1	36.49											153.67	1.92	"	24	36	31	
17	2	4.80	1	2.40	2	4.80	2	4.20			17.5	39.66			80	1.00							166.50	2.53	"	24	37	33	
18	2	4.80	1	2.40	2	4.80	2	4.20			13.8	31.28											156.41	3.40	"	23 5/60	39	33	
19	2	4.80	1	2.40	2	4.80	2	4.20			18.5	41.93											169.82	1.86	"	22 40/60	32	29	
20	2	4.80	1	2.40	2	4.80	2	4.20			17.8	40.34											181.52	1.75	"	21 5/60	37	30	
21	2	4.80	1	2.40	2	4.80	2	4.20			15.5	36.33											218.91	1.92	"	21 20/60	46	28	
22	2	4.80	1	2.40	2	4.80	2	4.20			16.3	40.75											221.77	1.62	"	20 25/60	48	31	
23	2	4.80	1	2.40	2	4.80	2	4.20			17.1	42.75											225.84	3.32	"	24	48	32	
24	2	4.80	1	2.40	2	4.80	2	4.20			19.5	46.14											231.43	3.56	"	22 55/60	48	33	
25	2	4.80	1	2.40	2	4.80	2	4.20			17.7	37.46											223.81	1.19	"	24	49	34	
26	2	4.80	1	2.40	2	4.80	2	4.20			17.5	37.04											220.67	3.61	"	20 5/60	50	35	
27	2	4.80	1	2.40	2	4.80	2	4.20			15.3	32.39											216.06	1.49	"	14 55/60	47	35	
28	2	4.80	1	2.40	2	4.80	2	4.20			16.6	35.13											204.34	0.63	"	11 45/60	38	39	
29	2	4.80	1	2.40	2	4.80	2	4.20			16.5	34.92											219.26	1.26	"	3 40/60	46	32	
30	1½	3.00	1	2.40	2	4.80	2	4.20			17.8	37 68											213.90	0.67	"	6 30/60	43	27	
31	½	1.20	1	2.40	2	4.80	2	4 20			13.0	27.52			80	1.00	80	1.86					203.02	0.76	"	7 5/60	42	26	
Forward		83.40		142.22		206 40		180.60		5.03		1463.27		1.74		4.31		14.76		1.80		1.21	$ 6131.66						

APPENDIX D.—Continued.

TIME, COST AND MATERIALS USED IN FOUNDATIONS.

PIER II.—Continued.

Date 1893	Principal Foreman Days	Principal Foreman Amount	Night Foreman Days	Night Foreman Amount	Sub Foremen Days	Sub Foremen Amount	Lock Tenders Days	Lock Tenders Amount	Pressure Men Days	Pressure Men Amount	Coffee House Men Days	Coffee House Men Amount	Clay Hoist Men Days	Clay Hoist Men Amount
Brought forward		197.50		147.00		328.65		225.20		2535.80		161.50		.....
April 1	1	5.00	1	3.75	5	15.65	2	4.80	49	117.60	3	5.25		
2	1	5.00	1	3.75	5	15.65	2	4.80	48	115.20	3	5.25		
3	1	5.00	1	3.75	5	15.65	2	4.80	48	115.20	3	5.25		
4	1	5.00	1	4.00	9	29.25	2	5.00	65	162.50	3	5.25	1½	2.95
5	1	5.00	1	4.00	8½	27.50	2	5.00	65	162.50	3	5.25	6	13.20
6	1	5.00	1	4.00	9	29.25	2	5.00	67	167.50	3	5.25	6	13.20
7	1	5.00	1	4.00	9	29.25	2	5.00	66	165.00	3	5.25	6	13.20
8	1	5.00	1	4.00	9	29.25	2	5.00	67	167.50	3	5.25	6	13.20
9	1	5.00	1	4.00	9	29.25	2	5.00	66½	166.25	3	5.25	6	13.20
10	1	5.00	1	4.00	9	29.25	2	5.00	66	165.00	3	5.25	6	13.20
11	1	5.00	1	4.00	9	29.25	2	5.00	64½	161.25	3	5.25	6	13.20
12	1	5.00	1	4.00	9	29.25	2	5.00	66	165.00	3	5.25	6	13.20
13	1	5.00	1	4.00	9	29.25	2	5.00	63	157.50	3	5.25	6	13.20
14	1	5.00	1	4.00	9	29.25	2	5.00	63½	158.00	3	5.25	6	13.20
15	1	5.00	1	4.00	8½	27.50	2	5.00	59½	148.75	3	5.25	6	13.20
16	1	5.00	1	4.00	9	29.25	2	5.00	59	147.50	3	5.25	6	13.20
17	1	5.00	1	4.00	9	29.25	2	5.00	61½	153.75	3	5.25	6	13.20
18	1	5.00	1	4.00	9	29.25	2	5.00	58½	146.25	3	5.25	6	13.20
19	1	5.00	1	4.00	9	29.25	2	5.00	55½	138.75	3	5.25	6	13.20
20	1	5.00	1	4.00	9	29.25	2	5.00	60	150.00	3	5.25	6	13.20
21	1	5.00	1	4.30	8	28.90	2	5.60	58½	163.80	3	5.25	6	13.20
22	1	5.00	1	4.30	9	31.95	2	5.60	59½	166.60	3	5.25	6	13.20
23	1	5.00	1	4.30	9	31.95	2	5.60	60	168.00	3	5.25	5 6/10	12.32
24	1	5.00	1	4.30	9	31.95	2	5.60	61	170.80	3	5.25	6	13.20
25	1	5.00	1	4.30	9	33.45	2	6.10	60½	184.63	3	5.25	3	6.93
26	1	5.00	1	4.80	9	36.45	2	6.60	61½	202.93	3	5.25		
27	1	5.00	1	4.80	9	36.45	2	6.60	58 7/10	193.71	3	5.25		
28	1	5.00	1	4.80	9	36.45	2	6.60	57	188.10	3	5.25		
29	1	5.00	1	4.80	9	36.45	2	6.60	55	181.50	3	5.25		
30	1	5.00	1	4.80	9	36.45	2	6.60	52	171.60	3	5.25		
May 1	1	5.00	1	4.80	9	36.45	2	6.60	50	165.00	3	5.25		
2	1	5.00	1	4.80	8	32.90	2	6.60	51	168.30	3	5.25		
3	1	5.00	1	4.80	6½	25.70	2	6.60	31½	103.95	3	5.25		
Total		302.50		286.15		1304.85		405.90		7795.76		387.75		273.02

Date 1893	Coffee Lbs	Coffee Amount	Sugar Lbs	Sugar Amount	Candles No.	Candles Amount	Red Lead Lbs.	Red Lead Amount	Coal for Heating 300 Lbs Boxes	Coal for Heating Amount	Watchmen Days	Watchmen Amount	Day Engineers Days	Day Engineers Amount	Night Engineers Days	Night Engineers Amount	Pump Men Days	Pump Men Amount
Brought forward		30.29		10.03		13.33		....		21.03		74.40		138.98		130.95		83.40
April 1	3	.75	6	.31	26	.50			2	.49	2	4.00	1	3.33	1	3.33	1½	3.60
2	3	.75	7	.36	21	.39			2	.49	2	4.00	1	3.33	1	3.33	1⅙	2.80
3	6	1.50	8	.40	27	.50			2	.49	2	4.00	1	3.34	1	3.34	½	1.20
4	5	1.25	10	.50	46	.85			2	.49	2	4.00	1	3.33	1	3.33		
5	3	.75	10	.51	42	.78			2	.49	2	4.00	1	3.33	1	3.33	15/24	1.50
6	5	1.25	8	.40	28	.54			2	.49	2	4.00	1	3.34	1	3.34	2	5.40
7	5	1.25	12	.61	12	.25			2	.49	2	4.00	1	3.33	1	3.33	2	5.40
8	5	1.25	10	.51	13	.27			2	.49	2	4.00	1	3.33	1	3.33	2	5.40
9	5	1.25	11	.56	14	.28			2	.49	2	4.00	1	3.34	1	3.34		
10	7	1.75	6	.30	18	.34			2	.49	2	4.00	1	3.33	1	3.33		
11	7	1.75	11	.56	23	.45			2	.49	2	4.00	1	3.33	1	3.33		
12	3	.75	13	.65	49	.91			2	.49	2	4.00	1	3.34	1	3.34		
13	5	1.25	11	.56	24	.47			2	.49	2	4.00	1	3.33	1	3.33		
14	5	1.25	12	.66	22	.43			2	.49	2	4.00	1	3.33	1	3.33	1 5/12	4.25
15	3	.75	10	.56	26	.48			2	.49	2	4.00	1	3.34	1	3.34		
16	5	1.25	13	.73	24	.44			2	.49	2	4.00	1	3.33	1	3.33		
17	3	.75	9	.50	26	.48			2	.49	2	4.00	1	3.33	1	3.33		
18	3	.75	10	.56	34	.63			2	.49	2	4.00	1	3.34	1	3.34		
19	8	2.00	11	.61	23	.43			2	.49	2	4.00	1	3.33	1	3.33	1 5/12	4.25
20	3	.75	11	.61	22	.43			2	.49	2	4.00	1	3.33	1	3.33	2	5.40
21	5	1.25	15	.84	22	.43			2	.49	2	4.00	1	3.34	1	3.34		
22	5	1.25	13	.73	20	.54			2	.49	2	4.00	1	3.33	1	3.33		
23	5	1.25	12	.67	34	.62			2	.49	2	4.00	1	3.33	1	3.33		
24	3	.75	8	.45	20	.54			2	.49	2	4.00	1	3.34	1	3.34		
25			8	.45	6	.12			2	.49	2	4.00	1	3.33	1	3.33		
26					14	.26			2	.49	2	4.00	1	3.33	1	3.33		
27	7	1.75	9	.50	41	.56			2	.49	2	4.00	1	3.34	1	3.34	4/9	1.20
28	3	.75	7	.39	42	.77			2	.49	2	4.00	1	3.33	1	3.33	4/9	1.20
29	5	1.25	11	.61	30	.56			2	.49	2	4.00	1	3.33	1	3.33		
30	3	.75	12	.67	4	.08			2	.49	2	4.00	1	3.34	1	3.34		
May 1	5	1.25	11	.60	18	.33			2	.49	2	4.00	1	3.22	1	3.22		
2	3	.75	12	.67	10	.19			2	.49	2	4.00	1	3.22	1	3.22		
3							2	.12			2	4.00	1	3.22	1	3.22		
Total		64.25		27.07		28.38		.12		36.71		206.46		248.64		240.61		125.00

Date 1893	Helpers Days	Helpers Amount	Firemen Days	Firemen Amount	Coal Passers Days	Coal Passers Amount	Ditching Days	Ditching Amount	Coal for Boilers Tons	Coal for Boilers Amount	Signal Oil Pints	Signal Oil Amount	Black Oil Pints	Black Oil Amount	Cylinder Oil Pints	Cylinder Oil Amount	Waste Lbs.	Waste Amount	Coal Oil Pints	Coal Oil Amount
Brought forward		142.22		206.40		180.60		5.03		1463.27		1.74		4.31		14.76		1.80		1.21
April 1	1	2.40	2	4.80	2	4.20			22.0	51.98										
2	1	2.40	2	4.80	2	4.20			10.5	24.81										
3	1	2.40	2	4.80	2	4.20			12.3	29.06										
4	1	2.40	2	4.80	2	4.20			8.3	19.60										
5	1	2.40	2	4.80	2	4.20			7.3	17.24										
6	1	2.40	2	4.80	2	4.20			19.0	44.89					32	.72	15	.90		
7	1	2.40	2	4.80	2	4.20			11.5	27.16										
8	1	2.40	2	4.80	2	4.20			13.3	31.42										
9	1	2.40	2	4.80	2	4.20			10.8	25.52										
10	1	2.40	2	4.80	2	4.20			7.7	18.46										
11	1	2.40	2	4.80	2	4.20			11.5	27.16										
12	1	2.40	2	4.80	2	4.20			9.7	22.92										
13	1	2.40	2	4.80	2	4.20			10.3	24.33	16	1.04								
14	1	2.40	2	4.80	2	4.20			11.5	27.17										
15	1	2.40	2	4.80	2	4.20			7.0	16.54										
16	1	2.40	2	4.80	2	4.20			12.0	28.35										
17	1	2.40	2	4.80	2	4.20			9.8	23.15										
18	1	2.40	2	4.80	2	4.20			10.5	24.81										
19	1	2.40	2	4.80	2	4.20			7.5	16.67										
20	1	2.40	2	4.80	2	4.20			11.3	26.70										
21	1	2.40	2	4.80	2	4.20			10.3	24.33										
22	1	2.40	2	4.80	2	4.20			9.5	22.46							12	.72		
23	1	2.40	2	4.80	2	4.20			10.3	21.80										
24	1	2.40	2	4.80	2	4.20			8.0	16.94										
25	1	2.40	2	4.80	2	4.20			9.3	19.69			80	1.00						
26	1	2.40	2	4.80	2	4.20			12.6	26.66										
27	1	2.40	2	4.80	2	4.20			9.5	20.11										
28	1	2.40	2	4.80	2	4.20			7.0	14.81										
29	1	2.40	2	4.80	2	4.20			11.5	24.34										
30	1	2.40	2	4.80	2	4.20			8.3	17.57										
May 1	1	2.40	2	4.80	2	4.20			8.6	18.20										
2	1	2.40	2	4.80	2	4.20			5.0	10.59										
3	1	2.40	2	4.80	2	4.20			3.0	6.35										
Total		221.42		364.80		319.20		5.03		2235.06		2.78		5.31		15.48		3.42		1.21

Date 1893	Totals for Each Day	Feet Sunk per Day	Material	Water Pumps Hours run	Water Pumps No. of strokes	Air Pumps No. of revolutions	Remarks
Brought forward	$ 6131.66						
April 1	231.74	0.73	Sand and bowlders.	18 15/60	38	27	
2	201.11	0.80	"	9 45/60	36	29	Sand pump stopped at 24.00 o'clock.
3	204.88	0.60	"			30	
4	258.50	0.17	"	0 10/60	44	32	Sand pump started at 7.20 o'c'k April 5.
5	265.78	0.00	"	24	47	32	
6	305.87	0.08	Sand and rock.	23 50/60	41	32	
7	283.92	0.42	"	22 10/60	41	32	
8	290.60	0.16	"	10 40/60	46	33	Sand pump stopped at 18.30 o'clock; began blasting.
9	278.13	0.61	"			37	
10	270.10	0.12	"			32	
11	275.42	0.12	"			30	
12	274.50	0.22	"	6 5/60	32	33	Sand pump started at 1.20 o'clock.
13	269.40	0.12	"	6 25/60	30	32	
14	276.01	0.02	"	11	30	32	Sand pump stopped at 10.00 o'clock.
15	249.60	0.14	"			34	
16	262.52	0.54	"			26	
17	262.88	0.03	"			36	Stopped one air pump at 14.14 o'clock.
18	257.27	0.03	"	11 20/60	42	32	Sand pump started at 20.40 o'clock.
19	246.96	0.04	"	21 55/60	41	23	Started second air pump at 8.05 o'clock.
20	268.14	0.19	"	6	45	21	Sand pump stopped at 16.25 o'clock.
21	275.47	0.02	"			22	
22	280.15	0.41	"			34	
23	279.31	0.22	"			35	
24	277.35	....	"	6 40/60	31	37	Sand pump started at 22.45, stopped at 5.25 o'clock.
25	289.51	....	"			36	Sealing commenced at 14.05 o'clock.
26	310.53	....	Sand and gravel.			37	
27	298.70	....	"	3 55/60	40	26	Sand pump started at 10.15 o'clock.
28	286.67	....	"	6 25/60	47	26	Sand pump stopped at 18.35 o'clock.
29	288.91	....				30	
30	271.34	....				21	
May 1	265.81	....				22	
2	257.38	....				35	Air pressure taken off at 13.00 o'clock.
3	179.61	....				19	
Total	$14925.92						
Other expenses charged to Sinking	2793.51						
	$17719.43						

APPENDIX D.—Continued.

TIME, COST AND MATERIALS USED IN FOUNDATIONS.

PIER III.

Date.	Principal Foreman		Night Foreman		Sub Foremen		Lock Tenders.		Pressure Men		Coffee House Men		Coffee		Sugar		Candles		Red Lead		Coal for Heating 350 Lbs Boxes.		Master or Watchman.		Day Engineers		Night Engineers.		Pump Men.		Elevator Men.		Firemen.		Coal Passers.		Coal for Boilers.		Signal Oil.		Black Oil.		Cylinder Oil.		Waste		Coal Oil.		Totals for Each Day	Feet Sunk per Day	Material.	Water Pumps		Air Pumps	Remarks
1892	Days	Amount	Days	Amount	Days	Amount	Days	Amount.	Days.	Amount.	Days	Amount.	Lbs	Amount	Lbs.	Amount	No	Amount	Lbs.	Amount	Boxes	Amount.	Days	Amount	Days	Amount.	Days	Amount.	Days	Amount	Days.	Amount	Days.	Amount.	Days.	Amount	Tons.	Amount	Pints	Amount	Pints.	Amount.	Pints.	Amount.	Lbs.	Amount	Pints	Amount.				Hours run	No. of strokes	No. of revolutions	
Sept. 1	1	5.00			3	9.00	1	2.00	10	20.00													1	3.34	1	3.34	1	3.34	1	2.10			2	4.80	1	2.10	7.2	21.27											$ 76.50	1 42	Medium sand.	20 5/60	38	20	Started air pump No. 1 at 9:23 o'clock; [sand pump at 11:10.
2	1	5.00	1	3.50	3½	10.50	2	4.00	30	60.00	1	1.75											1	3.34	1	3.31	1	3.34	2	4.80			2	4.80	2	4.20	9.6	28.37											136.94	2.85		22 58/60	41	21	Started air pump No. 2 at 21:30 o'clock.
3	1	5.00	1	3.50	3	9.00	2	4.00	25	50.00	2	3.50	2	.48	3	.13							1	3.34	1	3.34	1	3.34	2	4.80			2	4.80	2	4.20	9.1	26.84											126.27	1.79		22 16/60	42	19	
4	1	5.00	1	3.50	3	9.00	2	4.00	25	50.00	2	3.50	2	.48	5	.22	20	.41			1	.29	1	3.34	1	3.34	1	3.34	2	4.80			2	4.80	2	4.20	9.2	27.29											127.31	2.95		22 55/60	45	21	
5	1	5.00	1	3.50	3	9.00	2	4.00	23	46.00	2	3.50	2	.49	2	.10	32	.72			1	.30	1	3.34	1	3.34	1	3.34	2	4.80			2	4.80	2	4.20	10.5	31.03											127.47	3.16		23 44/60	44	19	
6	1	5.00	1	3.50	3	9.00	2	4.00	23	46.00	2	3.50	4	.96	5	.25	38	.77			1	.29	1	3.34	1	3.34	1	3.34	2	4.80			2	4.80	2	4.20	9.7	28.66											125.75	2.24	Fine sand.	24	45	16	
7	1	5.00	1	3.50	3	9.00	2	4.00	23	46.00	2	3.50	3	.72	5	.25	58	1.18			1	.30	1	3.34	1	3.34	1	3.34		4.80			2	4.80	2	4.20	10.7	30.14											127.41	1.87	Coarse sand.	21 48/60	41	20	
8	1	5.00			3	9.00	2	4.00	24	48.00	2	3.50	3	.72	5	.25	14	.27			1	.29	1	3.34	1	3.34	1	3.34	2	4.80			2	4.80	2	4.20	10.3	30.43							15	.90			126.18	1.97	"	23 20/60	43	31	
9	1	5.00	1	3.50	3	9.00	2	4.00	24	48.00	2	3.50	3	.72	5	.25	24	.44			1	.30	1	3.34	1	3.34	1	3.34	2	4.80			2	4.80	2	4.20	9.5	28.07											126.60	1.28	"	23 8/60	47	23	
10	1	5.00	1	3.50	3	9.00	2	4.00	25	50.00	2	3.50	3	.73	5	.25	38	.70	¼	.04	1	.29	1	3.34	1	3.34	1	3.34	2	4.80			2	4.80	2	4.20	10.2	30.14			80	.80							131.77	2.23	"	24	48	21	
11	1	5.00	1	3.50	3	9.00	2	4.00	26	52.00	2	3.50	3	.72	10	.50	24	.47			1	.30	1	3.33	1	3.33	1	3.33	2	4.80			2	4.80	2	4.20	11.8	34.87											137.65	1.93	"	24	46	22	
12	1	5.00	1	3.50	3	9.00	2	4.00	26	52.00	2	3.50	3	.72	10	.50	32	.65			1	.29	1	3.33	1	3.33	1	3.38	2	4.80			2	4.80	2	4.20	10.2	30.14											133.09	2.38	"	20 15/60	50	21	
13	1	5.00	1	3.50	3	9.00	2	4.00	26	52.00	2	3.50	3	.72	5	.25	23	.45			1	.30	1	3.33	1	3.33	1	3.33	2	4.80			2	4.80	2	4.20	10.7	31.62											134.13	1.64	Fine sand.	21 48/60	45	29	
14	1	5.00	1	3.50	3	9.00	2	4.00	27	54.00	2	3.50	3	.72	5	.25	46	.92			1	.29	1	3.33	1	3.33	1	3.33	2	4.80			2	4.80	2	4.20	10.1	29.84											134.81	1.37	Medium sand with clay lumps	22 20/60	45	25	
15	1	5.00	1	3.50	3	9.00	2	4.00	27	54.00	2	3.50					12	.24			1	.30	1	3.33	1	3.33	1	3.33	2	4.80			2	4.80	2	4.20	10.4	30.73	16	.60									134.66	3.15		24	45	21	
16	1	5.00	1	3.50	2	0.00	2	4.00	24	48.00	2	3.50	3	.73	5	.25	10	.18			1	.29	1	3.33	1	3.33	1	3.33	2	4.80			2	4.80	2	4.20	10.2	30.14											125.38	0.79	"	24	41	20	
17	1	5.00	1	3.50	2	6.00	2	4.00	26	52.00	2	3.50	3	.72	5	.25	26	.51			1	.30	1	3.33	1	3.33	1	3.33	2	4.80			2	4.80	2	4.20	9.8	28.96			40	.50							120.03	1.31	"	23	42	20	
18	1	5.00	1	3.50	3	9.00	2	4.00	26	52.00	2	3.50	3	.72	5	.25	26	.52			1	.29	1	3.33	1	3.33	1	3.33	2	4.80			2	4.80	2	4.20	13.1	38.71											141.28	1.80	"	23 24/60	50	21	Both boilers fired. Wheels turned to
19	1	5.00	1	3.50	3	9.00	2	4.00	26	52.00	2	3.50	3	.72	5	.25	34	.68			1	.30	1	3.33	1	3.33	1	3.33	2	4.80			2	4.80	2	4.20	10.4	30.73											133.47	1.84	"	24	51	22	[wash out sand. Boiler damaged.
20	1	5.00	1	3.50	3	9.00	2	4.00	26	52.00	2	3.50	3	.73	5	.25	29	.57					1	3.33	1	3.33	1	3.33	2	4.80			2	4.80	2	4.20	6.2	18.32											120.66	2.34	"	5 36/60	53	21	Machinery stopped to clean boiler.
21	1	5.00	1	3.50	2	6.00	1	2.00	19	38.00	2	3.50					22	.44					1	3.33	1	3.33			1	2.40			1	2.40	1	2.10	3.3	9.75											81.76	0.03	"	2 5/60	47	37	Sand pumps stopped at 10:05 o'clock; air [pumps at 11:45 and Bertram tak'n ashore
Dec. 3	1	5.00							12	24.00			3	.74	3	.15	27	.50			1	.20			½	1.25							1	2.00			8.0	23.64											57.57	0.01	Medium sand.	5	50	42	Air pumps of stationary plant started at
4	1	5.00	1	3.50	4	12.00	2	4.00	47	94.00	2	3.50	3	.74	5	.25	32	.59			1	.30			1	2.75	1	2.75					2	4.80			10.0	29.55											163.73	0.07	"	9 5/60	55	26	[15:00 o'clock; sand pumps at 19:00 o'clk.
5	1	5.00	1	3.50	4	12.00	2	4.00	49½	99.00	2	3.50	3	.74	5	.25	24	.44			1	.29			1	2.75	1	2.75					2½	5.40	½	0.87	10.4	30.73			36	.40	16	.90					172.52	2.68	"	19	54	28	
6	1	5.00	1	3.75	4	13.00	2	4.80	51	122.40	2	3.50	7	1.70	14	.70	49	.91			2	.59			1	2.75	1	2.75					2	4.80	2	4.20	12.0	35.46					16	.90	5	.30			207.51	1.73	"	24	55	35	
7	1	5.00	1	3.75	4	13.00	2	4.80	51½	123.60	2	3.50	6	1.48	7	.35	58	1.07			2	.60			1	2.75	1	2.75					2	4.80	2	4.20	13.3	39.30					16	.90					211.83	3.55	"	22 55/60	58	33	
8	1	5.00	1	3.75	4	13.00	2	4.80	52	124.80	2	3.50	9	2.10	16	.80	54	1.00			2	.59			1	3.30	1	3.30					2	4.80	2	4.20	12.5	36.94					16	.87	16	.96	16	.22	214.02	3.86	Sand and clay.	23 15/60	54	30	
9	1	5.00	1	3.75	4	13.00	2	4.80	50	120.00	2	3.50	6	1.46	13	.65	15	.28			2	.60			1	3.30	1	3.30					2	4.80	2	4.20	20.0	59.09					16	.84					228.57	1.46	"	21 35/60	60	33	Log found in Caisson.
10	1	5.00	1	3.75	4	13.00	2	4.80	51	122.40	2	3.50	4	.97	12	.60	6	.11			2	.59			1	3.30	1	3.30					3	6.80	2	4.20	3.0	8.86			40	.50			7	.42			182.10	3.53	"	23 45/60	53	28	
11	1	5.00	1	3.75	4	13.00	2	4.80	49½	118.80	2	3.50	6	1.46	12	.60	20	.37			1	.29			1	3.30	1	3.30					3	6.80	2	4.20	5.5	16.25					16	.84					186.26	0.01	"	6 44/60	51	34	Water pump stopped at 13:50 o'clock for [repairs.
12	1	5.00	1	3.75	4	13.00	2	4.80	51	122.40	2	3.50	8	1.96	8	.40	25	.46			2	.59			1	3.30	1	3.30					3	6.80	2	4.20	4.5	13.30					16	.84			16	.22	187.82	0.02	"	......		33	Water pump sent away for repairs.
Forward		155.00		99.75		296.50		121.60		2093.40		99.75		25.22		9.20		15.86		.04		9.45		70.03		98.78		94.20		96.00		.....		150.20		114.27		880.17		.60		2.20		6.09		2.58		.44	$4450.34						

APPENDIX D.—Continued
TIME, COST AND MATERIALS USED IN FOUNDATIONS.
PIER III.—Continued.

Date 1892.	Principal Foreman Days	Principal Foreman Amount	Night Foreman Days	Night Foreman Amount	Sub Foremen Days	Sub Foremen Amount	Lock Tenders Days	Lock Tenders Amount	Pressure Men Days	Pressure Men Amount	Coffee House Men Days	Coffee House Men Amount	Coffee Lbs.	Coffee Amount	Sugar Lbs.	Sugar Amount	Candles No.	Candles Amount
Brought forward		155.00		91.75		296.50		121.60		2093.40		99.75		25.22		9.20		15.86
Dec. 13	1	5.00	1	3.75	4	13.00	2	4.80	48½	116.40	2	3.50	4	.97	10	.50	4	.07
14	1	5.00	1	3.75	4	13.00	2	4.80	51	122.40	2	3.50	6	1.45	5	.25	8	.15
15	1	5.00	1	3.75	3	9.75	2	4.80	41	98.40	2	3.50	7	1.69	13	.65	10	.18
16	1	5.00	1	4.00	8	26.50	2	5.00	65½	163.75	3	5.25	4	.97	21	1.05	20	.37
17	1	5.00	1	4.00	8	26.50	2	5.00	65½	163.75	3	5.25	9	2.19	13	.65	22	.41
18	1	5.00	1	4.00	8	26.50	2	5.00	64	160.00	3	5.25	4	.97	11	.55	17	.31
19	1	5.00	1	4.00	8	26.50	2	5.00	68	170.00	3	5.25	6	1.46	30	1.50	20	.37
20	1	5.00	1	4.00	8	27.40	2	5.30	70	185.35	3	5.25	4	.97	14	.70	27	.50
21	1	5.00	1	4.30	8	28.90	2	5.60	65	182.00	3	5.25	8	1.94	..	.....	16	.30
22	1	5.00	1	4.30	8	28.90	2	5.60	67½	189.00	3	5.25	4	.97	..	.....	32	.56
23	½	2.50	1	4.30	8	28.90	2	5.60	67½	189.00	3	5.25	6	1.45	15	.75	18	.33
24	½	2.50	1	4.30	6½	23.20	2	5.60	66½	186.20	3	5.25	6	1.45	15	.76	48	.89
25	½	2.50	1	4.30	5½	19.40	2	5.60	46½	130.20	3	5.25	4	.99	7	.35	46	.85
26	1	5.00	1	4.30	3	10.65	2	5.60	17½	49.00	2	3.50	5	1.27	10	.51	8	.15
27	1	5.00	1	4.30	5	18.25	2	5.60	57½	161.00	3	5.25	4	1.02	14	.71	45	.83
28	½	2.50	1	4.30	7	25.10	2	5.60	63½	177.80	3	5.25	9	2.29	9	.45	57	1.05
29	½	2.50	1	4.30	8	28.90	2	5.60	67½	189.00	3	5.25	9	2.30	15	.76	24	.44
30	½	2.50	1	4.30	8	28.90	2	5.60	71	198.80	3	5.25	8	2.04	15	.76	43	.80
31	½	2.50	1	4.30	8	28.90	2	5.60	71	198.80	3	5.25	6	1.53	12	.61	46	.83
1893																		
Jan. 1	1	5.00	1	4.30	8	28.90	2	5.60	68½	191.80	3	5.25	4	1.02	15	.76	29	.54
2	1	5.00	1	4.30	8	28.90	2	5.60	72	201.60	3	5.25	6	1.53	14	.70	21	.39
3	1	5.00	1	4.30	8	28.80	2	5.60	72½	203.00	3	5.25	12	3.06	14	.71	20	.37
4	½	2.50	......		8	28.90	2	5.60	70	196.00	3	5.25	8	2.04	15	.76	29	.54
5	½	2.50	1	4.30	8	28.90	2	5.60	67½	189.00	3	5.25	7	1.78	13	.66	33	.61
6	1	5.00	1	4.30	8	28.90	2	5.60	66½	186.20	3	5.25	10	2.55	18	.81	34	.63
7	1	5.00	1	4.30	8	31.00	2	6.30	69½	218.40	3	5.25	8	2.04	22	1.10	32	.59
8	1	5.00	1	5.00	8	34.50	2	7.00	66½	232.75	3	5.25	6	1.30	15	.76	23	.46
9	1	5.00	1	5.00	8	31.50	2	7.00	69	241.50	3	5.25	4	1.01	14	.70	12	.22
10	1	5.00	1	5.00	8	34.50	2	7.00	68	238.00	3	5.25	7	1.76	0	.....	24	.44
11	1	5.00	1	5.00	8	34.50	2	7.00	69	241.50	3	5.25	4	1.01	0	.....	26	.48
Totals		282.50		224.10		1078.05		200.80		7464.00		230.25		72.44		27.77		30.57

Date	Red Lead Lbs.	Red Lead Amount	Coal for Heating 200 Lbs. Boxes	Coal for Heating Amount	Master or Watchmen Days	Master or Watchmen Amount	Day Engineers Days	Day Engineers Amount	Night Engineers Days	Night Engineers Amount	Pump Men Days	Pump Men Amount	Elevator Men Days	Elevator Men Amount	Firemen Days	Firemen Amount	Coal Passers Days	Coal Passers Amount	Coal for Boilers Tons	Coal for Boilers Amount
Brought forward		.04		9.45		70.03		98.78		94.20		96.00		......		150.20		114.27		881.17
Dec. 13	......		1	.30	2	3.50	2	6.53	2	6.53	½	1.20	......		4	9.20	2½	5.25	15.3	45.21
14	......		2	.36	2	3.50	2	6.53	2	6.53	2	4.80	......		5	11.35	4	8.40	13.4	36.64
15	......		2	.60	2	3.50	2	6.53	2	6.53	2	4.80	......		5	11.35	4	8.40	12.0	38.41
16	......		2	.59	2	3.50	2	6.53	2	6.53	2	4.80	2	5.00	5	11.35	4	8.40	13.6	40.18
17	......		2	.59	2	3.50	2	6.53	2	6.53	2	4.80	2	5.00	6	13.75	4	8.40	12.7	37.53
18	......		2	.60	2	3.50	2	6.53	2	6.53	2	4.80	2	5.00	6	13.75	4	8.40	11.3	33.38
19	......		2	.59	2	3.50	2	6.53	2	6.53	2	4.80	2	5.00	6	13.75	4	8.40	12.5	36.94
20	......		2	.59	2	3.50	1½	4.91	2	6.52	1½	3.60	2	5.00	5	11.35	3½	7.35	18.1	53.47
21	......		2	.60	......		1	3.30	1	3.30	......		2	5.00	3	6.55	2	4.20	9.5	28.07
22	......		2	.59	......		1	3.30	1	3.30	......		2	5.00	3	6.55	2	4.20	12.5	36.94
23	......		2	.59	......		(	3.30	1	3.30	......		2	5.00	3	6.55	2	4.20	12.9	38.12
24	......		2	.60	......		1	3.30	1	3.30	......		2	5.00	3	6.55	2	4.20	7.0	20.68
25	......		2	.50	......		1	3.30	1	3.30	......		2	5.00	3	6.55	2	4.20	11.2	33.08
26	......		3	.88	......		1	3.30	1	3.30	......		2	5.00	3	6.55	2	4.20	6.6	19.50
27	......		3	.88	......		1	3.30	1	3.30	......		2	5.00	3	6.55	2	4.20	10.5	31.03
28	......		3	.89	......		1	3.30	1	3.30	......		2	5.00	3	6.55	2	4.20	10.0	29.51
29	......		2	.59	......		1	3.30	1	3.30	......		2	5.00	3	6.55	2	4.20	9.5	28.07
30	5	.31	2	.59	......		1	3.30	1	3.30	......		2	5.00	3	6.55	2	4.20	9.5	28.07
31	......		2	.60	......		1	3.30	1	3.30	......		2	5.00	3	6.55	2	4.20	11.5	33.98
1893																				
Jan. 1	......		2	.59	......		2	5.80	1	3.30	......		2	5.00	3	6.55	2	4.20	7.2	21.26
2	......		2	.59	......		2	5.80	1	3.30	......		2	5.00	3	6.55	2	4.20	7.0	20.68
3	......		2	.59	......		2	5.30	1	3.30	......		2	5.00	3	6.55	2	4.20	22.5	66.48
4	......		2	.59	......		2	5.80	1	3.20	......		2	5.00	3	6.55	2	4.20	3.7	10.93
5	......		2	.59	......		2	6.80	1	3.30	......		2	5.00	3	6.55	2	4.20	10.3	30.43
6	......		3	.88	......		2	5.80	1	3.30	......		2	5.00	3	6.55	$1\frac{4}{10}$	2.97	11.1	32.80
7	......		2	.59	......		2	5.80	1	3.30	......		2	5.00	3	6.55	2	4.20	10.1	29.84
8	......		2	.59	......		1	3.30	1	3.30	......		2	5.00	3	6.55	2	4.20	10.8	31.91
9	......		2	.59	......		1	3.30	1	3.30	......		2	5.00	3	6.55	2	4.20	20.0	59.10
10	......		2	.59	......		2	5.80	1	3.30	......		2	5.00	3	6.55	2	4.20	6.4	18.91
11	......		2	.59	......		2	5.80	1	3.30	......		2	5.00	3	6.55	2	4.20	7.5	22.16
Totals		.35		28.08		98.03		245.00		219.03		129.60		133.00		390.15		268.44		1882.52

Date	Signal Oil Pints	Signal Oil Amount	Black Oil Pints	Black Oil Amount	Cylinder Oil Pints	Cylinder Oil Amount	Waste Lbs.	Waste Amount	Coal Oil Pints	Coal Oil Amount	Totals for Each Day	Feet Sunk per Day	Material	Water Pumps Hours run	Water Pumps No. of strokes	Air Pumps No. of revolutions	Remarks
Brought forward		.60		2.20		6.09		2.58		.44	$4450.34						
Dec. 13	......		......		......		......		......		225.71	1.27	Sand and clay.	18$\frac{42}{60}$	47	32	Bertram moved to site of pier; her water pump started at 13:00 o'clock.
14	......		......		......		11	.06	......		233.30	2.88	"	22$\frac{15}{60}$	48	29	
15	......		......		......		......		40	.55	208.39	1.32	"	23$\frac{43}{60}$	48	30	Elevator put on.
16	......		40	.50	16	.84	......		......		300.11	2.84	"	24	45	35	
17	......		......		......		......		......		298.38	4.00	"	24	49	38	
18	......		......		......		......		......		290.07	3.06	"	24	47	39	
19	......		......		......		......		......		305.12	2.25	"	24	46	32	Water pump on stationary plant started at 6:10 o'clock. Water pump on Bertram stopped at 8:50 o'clock and Bertram taken away.
20	......		......		16	.84	7½	.45	16	.22	332.27	1.41	"	2$\frac{5}{60}$	54	27	
21	......		......		16	.84	6	.36	......		285.51	1.26	"	21$\frac{48}{60}$	57	28	
22	8	.35	......		64	3.36	......		......		303.20	2.12	"	22$\frac{45}{60}$	56	31	
23	......		40	.50	......		......		......		299.64	1.03	"	17$\frac{5}{60}$	56	34	
24	......		......		......		......		......		273.78	0.02	"	10$\frac{40}{60}$	58	39	Struck rock on south side about 16:00 o'clock. Commenced chipping rock.
25	......		......		......		......		......		225.46	0.00	Bed Rock.	......	..	39	
26	......		......		......		......		......		122.71	0.02	"	......		43	
27	......		......		......		5	.30	16	.22	256.74	0.00	"	......		48	
28	......		12	.15	......		......		......		277.27	0.01	"	...		43	
29	......		......		80	4.20	......		......		294.26	0.01	"	......		44	
30	......		40	.50	......		7	.42	......		301.19	0.04	"	......		44	
31	......		......		......		......		......		305.27	0.19	"	12$\frac{35}{60}$	59	36	Pumping out for final settlement.
1893																	
Jan. 1	......		......		......		......		......		289.87	0.31	"	22$\frac{55}{60}$	60	38	Jetting under cutting edge on south side.
2	......		......		......		......		......		299.39	0.08	"	11$\frac{10}{60}$	59	36	Cutting out high points of rock. Final settlement 22:00 o'clock.
3	......		......		......		12	.72	......		348.33	0.00	"	18$\frac{25}{60}$	52	32	
4	......		......		......		......		......		277.96	0.00	"	21$\frac{45}{60}$	51	30	
5	......		......		......		......		......		265.47	0.03	......	2$\frac{55}{60}$	55	29	Sand pump stopped at 10:55 o'clock. Sealing commenced at 16:00 o'clock.
6	......		40	.52	......		......		16	.22	297.38	0.00	......	......		34	
7	......		......		......		......		......		329.26	0.00	......	......		33	
8	......		......		......		......		......		347.67	0.00	......	......		26	
9	......		......		......		6	.36	......		382.58	0.00	......	......		32	
10	......		......		......		......		......		341.30	0.00	......	......		18	[taken off 7:35 o'clock.
11	......		......		......		......		16	.22	347.36	0.00	......	......		16	Sealing finished at 17:30 o'clock. Air pumps
Totals		.95		4.37		16.17		5.85		1.87	$13145.89						

Other expenses charged to Sinking 2380.07

$15525.96

APPENDIX D.—CONTINUED.

TIME, COST AND MATERIALS USED IN FOUNDATIONS.

PIER IV.

Date 1892	Principal Foreman Days	Principal Foreman Amount	Night Foreman Days	Night Foreman Amount	Sub Foremen Days	Sub Foremen Amount	Lock Tenders Days	Lock Tenders Amount	Pressure Men Days	Pressure Men Amount	Coffee House Men Days	Coffee House Men Amount	Coffee Lbs	Coffee Amount	Sugar Lbs.	Sugar Amount	Candles No.	Candles Amount	Red Lead Lbs.	Red Lead Amount	Wick Lbs.	Wick Amount	Coal for Heating 200 Lbs. Boxes	Coal for Heating Amount	Linseed Oil Pints	Linseed Oil Amount
Oct. 4	1	5.00	1	3.50	2	4.50	1	2.00	21	42.00	1	1.75	3	.65	5	.24	45	.90					1	.23		
5	1	5.00	1	3.50	4	13.50	2	4.00	40.5	81.00	2	3.50	3	.65	5	.25	16	.32					1	.23		
6	1	5.00	1	3.50	5	15.00	2	4.00	37	74.00	2	3.50	3	.65	5	.24	41	.82					1	.23		
7	1	5.00	1	3.50	3	9.00	2	4.00	26.5	53.00	2	3.50	3	.65	5	.25	43	.86					1	.23		
8	1	5.00	1	3.50	3	9.00	2	4.00	25.5	51.00	2	3.50	3	.65	5	.24	21	.42					1	.23		
9	1	5.00	1	3.50	3	9.00	2	4.00	27	54.00	2	3.50			5	.25	10	.20					1	.23		
10	1	5.00	1	3.50	3	9.00	2	4.00	26	52.00	2	3.50	3	.65	5	.24	16	.32					1	.23		
11	1	5.00	1	3.50	3	9.00	2	4.00	27	54.00	2	3.50	3	.65	5	.25	33	.66					1	.24		
12	1	5.00	1	3.50	3	9.00	2	4.00	26	52.00	2	3.50	3	.65	5	.24	10	.20					1	.23		
13	1	5.00	1	3.50	3	9.00	2	4.00	27	54.00	2	3.50	3	.65	5	.25	23	.46					1	.23		
14	1	5.00	1	3.50	3	9.00	2	4.00	27	54.00	2	3.50	3	.65	5	.24							1	.23		
15	1	5.00	1	3.75	3	9.25	2	4.40	27.6	57.60	2	3.50	3	.65	5	.25										
16	1	5.00	1	3.75	1	3.25	2	4.80	15	36.00	2	3.50			5	.24	6	.12					1	.23		
17	1	5.00	1	3.75	1	3.25	2	4.80	12.5	30.00	2	3.50	3	.65	5	.25							1	.23		
18	1	5.00	1	3.75	2	6.50	2	4.80	20	48.00	2	3.50	3	.65	5	.24	11	.22					1	.23		
19	1	5.00	1	3.75	4	13.00	2	4.80	37	88.80	2	3.50	3	.65	5	.25	13	.26					1	.24		
20	1	5.00	1	3.75	4	13.00	2	4.80	35.5	85.20	2	3.50	3	.65	5	.24	14	.28					1	.23		
21	1	5.00	1	3.75	4	13.00	2	4.80	38.5	92.40	2	3.50	3	.65	5	.25	14	.28					1	.23		
22	1	5.00	1	3.75	4	13.00	2	4.80	40.5	97.20	2	3.50	3	.65	5	.24	6	.12					1	.23		
23	1	5.00	1	3.75	4	13.00	2	4.80	41.25	99.00	2	3.50	7	1.52	5	.25	7	.14					1	.24		
24	1	5.00	1	3.75	2	6.50	1	2.40	19	45.60	2	3.50			5	.24	6	.12					1	.23		
25	1	5.00			5	16.25	2	4.80	53	127.20	2	3.50	3	.65	10	.49							1	.24		
26	1	5.00	1	4.00	4	13.75	2	5.00	41	101.50	2	3.50	4	.86	5	.25	10	.20					1	.23		
27	1	5.00	1	4.00	7.5	24.75	2	5.00	69.5	173.75	3	5.25	4	.87	10	.49	11	.23					1	.24		
28	1	5.00	1	4.00	7	23.00	2	5.00	70.5	176.25	3	5.25	7	1.52	15	.73	48	.98					2	.46		
29	1	5.00	1	4.00	7	23.00	2	5.00	69.5	173.75	3	5.25	4	.86	10	.49	32	.64					2	.46		
30	1	5.00	1	4.30	9	32.70	2	5.60	69	193.20	3	5.25	9	1.95	11	.54	13	.26					1	.24		
31	1	5.00	1	4.30	8	28.90	2	5.60	69.5	194.60	3	5.25	8	1.73	15	.73	12	.24					1	.23		
Forward		140.00		100.60		361.10		123.20		2441.60		105.00		21.01		8.86		9.25		...		....		6.72		....

Date 1892	Watchmen Days	Watchmen Amount	Day Engineer Days	Day Engineer Amount	Night Engineer Days	Night Engineer Amount	Pump Men Days	Pump Men Amount	Elevator Men Days	Elevator Men Amount	Firemen Days	Firemen Amount	Coal Passers Days	Coal Passers Amount	Coal for Boilers Tons	Coal for Boilers Amount	Signal Oil Pints	Signal Oil Amount	Black Oil Pints	Black Oil Amount	Cylinder Oil Pints	Cylinder Oil Amount	Waste Lbs.	Waste Amount	Coal Oil Pints	Coal Oil Amount	Totals for Each Day	Feet Sunk per Day	Material	Water Pumps Hours run	Water Pumps No. of strokes	Air Pumps No. of revolutions	Remarks
Oct. 4	1	1.62	1	3.23			1	2.40			1	2.40	1	2.10	10.5	26.81									81	.92	$ 100.25	0.75	Fine sand.	12 44/60	41	31	Air pumps started at 7.45; sand pumps
5	1	1.62	1	3.23	1	3.23	2	4.80			2	4.80	2	4.20	11.8	30.13									2	.02	163.98	1.12	"	18 50/60	49	33	Sand pumps stopped at 2.50. [at 18.05.
6	2	3.37	1	3.23	1	3.23	2	4.80			2	4.80	2	4.20	8.0	20.42									5	.06	151.05	0.02	"	......	...	23	
7	2	3.37	1	3.23	1	3.23	2	4.80			2	4.80	2	4.20	8.7	22.21											125.83	2.01	"	16 35/60	45	22	Sand pumps started at 15.28.
8	2	3.37	1	3.23	1	3.23	2	4.80			2	4.80	2	4.20	11.8	30.13											131.30	2.97	"	24	46	24	
9	2	3.37	1	3.23	1	3.23	2	4.80			2	4.80	2	4.20	11.7	29.87											133.18	2.99	"	24	48	23	
10	2	3.36	1	3.23	1	3.23	2	4.80			2	4.80	2	4.20	11.7	29.87			16	.16			10	.60			132.69	2.50	"	21 50/60	49	24	
11	2	3.36	1	3.23	1	3.23	2	4.80			2	4.80	2	4.20	14.3	36.51											140.93	2.82	Medium sand.	22 40/60	47	33	
12	2	3.36	1	3.23	1	3.23	2	4.80			2.5	6.00	2	4.20	14.0	35.74			80	.70							139.58	2.15	Heavy sand.	22 53/60	46	46	
13	2	3.36	1	3.23	1	3.23	2	4.80			3	7.20	3	6.30	15.8	40.34											149.05	3.56	Fine blue sand.	20 40/60	44	33	
14	2	3.36	1	3.23	1	3.23	2	4.80			3	7.20	2	4.20	15.5	39.57											145.71	5.37	"	22 35/60	48	27	
15	2	3.36	1	3.23	1	3.23	2	4.80			3	7.20	2	4.20	13.2	33.70											144.12	2.41	"	17 55/60	47	20	
16	2	3.36	1	3.23	1	3.23	2	4.80			2 7/12	6.20	2	4.20	8.4	21.45							10	.60			103.96	1.10	"	6 5/60	50	19	
17	2	3.36	1	3.23	1	3.23	2	4.80			3	7.20	2	4.20	8.4	21.45											98.90	1.01	"	10 10/60	47	23	
18	2	3.36	1	3.23	1	3.23	2	4.80			3	7.20	2	4.20	11.7	29.87											128.78	3.89	"	22 5/60	47	21	
19	2	3.36	1	3.22	1	3.22	2	4.80			3	7.20	2	4.20	11.1	28.34					80	4.50					179.09	4.22	"	22 4/60	50	19	
20	2	3.36	1	3.22	1	3.22	2	4.80			3	7.20	2	4.20	13.2	31.15									6	.07	173.87	1.58	Fine sand with clay balls.	21 50/60	53	24	
21	2	3.36	1	3.22	1	3.22	2	4.80			3	7.20	2	4.20	12.8	32.68											182.54	3.28	"	23 47/60	48	21	
22	2	3.36	1	3.22	1	3.22	2	4.80			3	7.20	2	4.20	11.5	29.36											183.85	3.20	"	21 50/60	51	21	
23	2	3.36	1	3.22	1	3.22	2	4.80			3	7.20	2	4.20	13.1	33.44											190.64	1.96	Coarse sand.	8 55/60	49	21	
24	2	3.36	1	3.22	1	3.22	2	4.80			3	7.20	2	4.20	6.6	16.85											110.19	0.02	"	......	...	25	
25	2	3.36	1	3.22	1	3.22	2	4.80			3	7.20	2	4.20	6.3	16.08	16	.60									200.80	0.00	"	......	...	20	
26	2	3.36	1	3.22	1	3.22	2	4.80	1	2.50	3	7.20	2	4.20	14.5	37.02											199.81	1.32	"	23 50/60	48	22	
27	2	3.36	1	3.22	1	3.22	2	4.80	2	5.00	3	7.20	2	4.20	18.0	45.95			80	.70							297.23	2.32	"	23 5/60	46	22	
28	2	3.36	1	3.22	1	3.22	2	4.80	2	5.00	3	7.20	2	4.20	15.3	39.06											292.25	2.42	"	23 32/60	49	24	
29	2	3.36	1	3.22	1	3.22	2	4.80	2	5.00	3	7.20	2	4.20	14.1	36.00									16	.18	285.63	1.69	"	20 45/60	47	26	
30	2	3.36	1	3.22	1	3.22	2	4.80	2	5.00	3	7.20	2	4.20	13.4	34.21											314.25	2.64	"	22 7/60	50	30	
31	2	3.36	1	3.22	1	3.22	2	4.80	2	5.00	3	7.20	2	4.20	14.8	37.78											315.36	1.80	"	23 30/60	49	34	
Forward		90.64		90.31		87.08		132.00		27.50		177.80		117.60		865.99		.60		1.56		4.50		1.20		1.25	$4914.82						

APPENDIX D.—CONTINUED.

TIME, COST AND MATERIALS USED IN FOUNDATIONS.

PIER IV.—CONTINUED.

Date 1892	Principal Foreman Days	Principal Foreman Amount	Night Foreman Days	Night Foreman Amount	Sub Foremen Days	Sub Foremen Amount	Lock Tenders Days	Lock Tenders Amount	Pressure Men Days	Pressure Men Amount	Coffee House Men Days	Coffee House Men Amount	Coffee Lbs	Coffee Amount	Sugar Lbs	Sugar Amount	Candles No.	Candles Amount
Brought forward.		140.00		100.00		361.10		123.20		2441.05		105.00		21.01		8.86		9.25
Nov. 1	1	5.00	1	4.30	8	28.90	2	5.60	70	196.00	3	5.25	4	.86	15	.73	11	.24
2	1	5.00	1	4.30	8	28.90	2	5.60	70.5	107.40	3	5.25	11	2.38	10	.49	45	.02
3	1	5.00	1	4.30	8	28.90	2	5.60	70	196.00	3	5.25	7	1.52	5	.24	9	.20
4	1	5.00	1	4.50	8	30.50	2	6.00	72	216.00	3	5.25	10	2.17	10	.48	25	.52
5	1	5.00	1	4.50	8	30.50	2	6.00	73	219.00	3	5.25	12	2.70	15	.73	9	.20
6	1	5.00	1	4.50	8	30.50	2	6.00	75	225.00	3	5.25	8	1.89	10	.49	9	.20
7	1	5.00	1	4.50	8	30.50	2	6.00	71.5	214.50	3	5.25	7	1.63	15	.73	27	.56
8	1	5.00	1	4.50	8	30.50	2	6.00	71.5	214.50	3	5.25	7	1.64	15	.73	12	.24
9	1	5.00	1	4.50	8	30.50	2	6.00	72	216.00	3	5.25	7	1.63	10	.49	14	.30
10	1	5.00	1	4.50	8	30.50	2	6.00	74	222.00	3	5.25	7	1.64	10	.49	22	.44
11	1	5.00	1	4.50	7	27.25	2	6.00	72.5	214.50	3	5.25	9	2.10	15	.73	28	.56
12	1	5.00	1	4.50	7	27.25	2	6.00	69	207.00	3	5.25	6	1.40	10	.49	67	1.36
13	1	5.00	1	4.50	8	30.50	2	6.00	67.5	202.50	3	5.25	3	.70	10	.49	36	.72
14	1	5.00	1	4.50	8	30.50	2	6.00	69.5	208.50	3	5.25	14	3.27	15	.73	26	.54
15	1	5.00	1	4.50	8	30.50	2	6.00	70.5	211.50	3	5.25	4	.94	15	.73	10	.22
16	1	5.00	1	4.50	8	30.50	2	6.00	69.5	208.50	3	5.25	3	.70	10	.48	10	.22
17	1	5.00	1	4.50	8	30.50	2	6.00	69.5	208.50	3	5.25	6	1.40	15	.73	18	.38
18	1	5.00	1	4.50	8	30.50	2	6.00	69.5	208.50	3	5.25	9	2.10	10	.48	29	.59
19	1	5.00	1	4.50	8	30.50	2	6.00	75	225.00	3	5.25	7	1.64	15	.73	18	.35
20	1	5.00	1	4.50	8	32.00	2	6.00	74	239.00	3	5.25	9	2.10	15	.73	14	.28
21	1	5.00	1	5.00	8	34.50	2	7.00	$72\frac{1}{3}$	253.16	3	5.25	13	3.04	10	.48	16	.32
22	1	5.00	1	5.00	8	34.50	2	7.00	73	255.50	3	5.25			20	.07	16	.32
23	1	5.00	1	5.00	8	34.50	2	7.00	$68\frac{2}{3}$	240.33	3	5.25	7	1.64	15	.73	14	.28
24	1	5.00	1	5.00	8	34.50	2	7.00	77	269.50	3	5.25	11	2.65	15	.73	24	.50
25	1	5.00	1	5.00	8	34.50	2	7.00	$76\frac{1}{3}$	267.16	2	3.50	10	2.41	14	.68	17	.36
26	1	5.00	1	5.00	8	34.50	2	7.00	75	262.50	3	5.25	11	2.65	22	1.07	16	.32
27	1	5.00	1	5.00	8	34.50	2	7.00	75	262.50	3	5.25	8	1.92	15	.73	9	.20
28	1	5.00	1	5.00	9	39.00	2	7.00	$74\frac{1}{3}$	260.16	3	5.25	7	1.69	17	.83	16	.41
29	1	5.00	1	5.00	9	39.75	2	7.00	$76\frac{2}{3}$	268.33	3	5.25	11	2.76	14	.71	20	.70
30	1	5.00			5	21.75	1	3.50	34	119.00	2	3.50						
		290.00		235.00		1303.30		308.50		9149.09		259.00		74.18		27.71		21.50

Date 1892	Red Lead Lbs.	Red Lead Amount	Wick Lbs.	Wick Amount	Coal for Heating 250 Lbs. Boxes	Coal for Heating Amount	Linseed Oil Pints	Linseed Oil Amount	Watchmen Days	Watchmen Amount	Day Engineer Days	Day Engineer Amount	Night Engineer Days	Night Engineer Amount	Pump Men Days	Pump Men Amount	Elevator Men Days	Elevator Men Amount	Firemen Days	Firemen Amount	Coal Passers Days	Coal Passers Amount
Brought forward.						6.72				90.64		90.31		87.08		132.00		27.50		177.80		117.60
Nov. 1					2	.46			2	3.42	1	3.34	1	3.34	2	4.80	2	5.00	3	7.20	2	4.20
2					1	.23			2	3.42	1	3.34	1	3.34	2	4.80	2	5.00	3	7.20	2	4.20
3					2	.46			2	3.42	1	3.34	1	3.31	2	4.80	2	5.00	3	7.20	2	4.20
4					2	.46			2	3.42	1	3.34	1	3.34	2	4.80	2	5.00	3	7.20	2	4.20
5					2	.46			2	3.42	1	3.34	1	3.34	2	4.80	2	5.00	3	7.20	2	4.20
6					2	.46			2	3.42	1	3.34	1	3.34	2	4.80	2	5.00	3	7.20	2	4.20
7					2	.47			2	3.42	1	3.34	1	3.34	2	4.80	2	5.00	3	7.20	2	4.20
8					2	.46			2	3.42	1	3.34	1	3.34	2	4.80	2	5.00	3	7.20	2	4.20
9					2	.46			2	3.42	1	3.34	1	3.34	2	4.80	2	5.00	3	7.20	2	4.20
10					2	.46			2	3.42	1	3.34	1	3.31	2	4.80	2	5.00	3	7.20	2	4.20
11					2	.46			2	3.42	1	3.33	1	3.33	2	4.80	2	5.00	3	7.20	2	4.20
12					2	.46			2	3.41	1	3.33	1	3.33	2	4.80	2	5.00	3	7.20	2	4.20
13					1	.23			2	3.41	1	3.33	1	3.33	2	4.80	2	5.00	3	7.20	2	4.20
14					2	.46			2	3.42	1	3.33	1	3.33	2	4.80	2	5.00	3	7.20	2	4.20
15					2	.46			2	3.41	1	3.33	1	3.33	2	4.80	2	5.00	3	7.20	2	4.20
16					2	.46			2	3.41	1	3.33	1	3.33	2	4.80	2	5.00	3	7.20	2	4.20
17					2	.46			2	3.41	1	3.33	1	3.33	2	4.80	2	5.00	3	7.20	2	4.20
18					2	.46			2	3.41	1	3.33	1	3.33	2	4.80	2	5.00	3	7.20	2	4.20
19					2	.46			2	3.42	1	3.33	1	3.33	2	4.80	2	5.00	3	7.20	2	4.20
20					2	.47			2	3.42	1	3.33	1	3.33	1.9	3.80	2	5.00	3	7.20	2	4.20
21					2	.46			2	3.41	1	3.33	1	3.33			2	5.00	3	7.20	2	4.20
22					2	.46			2	3.41	1	3.33	1	3.33			2	5.00	3	7.20	2	4.20
23					2	.46			2	3.41	1	3.33	1	3.33			2	5.00	3	7.20	2	4.20
24					2	.46			2	3.41	1	3.33	1	3.33			2	5.00	3	7.20	2	4.20
25					2	.46			2	3.41	1	3.33	1	3.33			2	5.00	3	7.20	2	4.20
26					2	.46			2	3.41	1	3.33	1	3.33			2	5.00	3	7.20	2	4.20
27					2	.46			2	3.41	1	3.33	1	3.33			2	5.00	3	7.20	2	4.20
28					2	.46			2	3.41	1	3.33	1	3.33			2	5.00	3	7.20	2	4.20
29	$10\frac{1}{4}$	.69	$\frac{1}{4}$	.05	2	.46	4	.22	2	3.41	1	3.33	1	3.33			2	5.00	4	9.60	2	4.20
30									2	3.41	1	3.33	1	3.33			1	2.50	3	7.20	2	4.20
		.69		.05		19.62		22		193.08		190.31		187.08		227.00		175.00		396.20		243.60

Date 1892	Coal for Boilers Tons	Coal for Boilers Amount	Signal Oil Pints	Signal Oil Amount	Black Oil Pints	Black Oil Amount	Cylinder Oil Pints	Cylinder Oil Amount	Waste Lbs	Waste Amount	Coal Oil Pints	Coal Oil Amount	Totals for Each Day	Feet Sunk per Day	Material	Water Pumps Hours run	Water Pumps No. of strokes	Air Pumps No. of revolutions	Remarks
Brought forward.		865.99		.60		1.56		4.50		1.25		1.25	$ 4914.82						
Nov. 1	10.8	27.57					80	4.50	14	.84			311.55	1.65	Coarse sand.	$16\frac{33}{60}$	50	36	
2	11.3	28.85									16	.18	310.80	3.36	"	$21\frac{40}{60}$	53	37	
3	14.3	36.51			80	1.00							316.28	1.77	"	$19\frac{55}{60}$	50	37	
4	14.2	36.25											338.43	1.30	"	$18\frac{5}{60}$	49	40	
5	15.2	38.81											344.45	1.45		$23\frac{15}{60}$	52	36	
6	13.9	35.40											346.08	1.91	"	$13\frac{48}{60}$	51	40	
7	15.5	39.57			80	1.00							341.01	1.33	"	$21\frac{40}{60}$	53	33	
8	16.7	42.64											342.76	1.56	"	$23\frac{5}{60}$	51	36	
9	15.1	38.55											339.98	1.25	"	$15\frac{35}{60}$	49	42	
10	16.4	41.87							2	.12			349.57	0.90	"	18	46	41	
11	15.9	40.59											338.22	0.03	Gravel and boulders.	$19\frac{45}{60}$	48	36	
12	17.4	44.42			80	1.00							335.40	0.11	"	$23\frac{47}{60}$	49	37	
13	10.8	27.57											314.73	0.35	"	$0\frac{20}{60}$	47	43	
14	13.9	35.49											331.52	0.45	"			42	
15	9.9	25.27											321.64		"	$12\frac{5}{60}$	48	45	
16	10.8	27.57											320.45		"	24	47	46	
17	11.4	29.10									16	.18	323.27		"	$14\frac{5}{60}$	44	42	
18	10.1	25.78											320.43	0.28	"	$8\frac{15}{60}$	46	49	
19	10.4	26.65			80	1.00							338.36		"	$11\frac{36}{60}$	49	47	Pumping sand finished 19.30.
20	8.8	23.47											348.08					48	Sealing commenced 12.30.
21	9.7	24.76											365.44					51	
22	9.8	25.02											365.49					57	
23	10.0	25.53											352.19					55	
24	8.8	22.47											379.58					52	
25	9.6	24.51	4	.09									377.14					56	
26	8.3	21.19											371.41					46	
27	8.3	21.19											370.22					42	
28	9.2	23.49											374.76					45	
29	8.8	22.47											387.06					28	[taken off at 16.35 o'clock
30	3.5	8.94											185.66					21	Sealing finished at 2.00 o'clock, and air
		1756.58		.69		5.56		9.00		2.16		1.61	$15076.73						
Other expenses charged to Sinking													$ 2766.07						
													$17842.80						

APPENDIX D.—CONTINUED.

TIME, COST AND MATERIALS USED IN FOUNDATIONS.

PIER V.

Date.	Principal Foreman.		Night Foreman.		Sub-Foremen.		Lock Tenders.		Pressure Men.		Coffee House Men.		Coffee.		Sugar.		Candles.		Red Lead.		Wick.		Coal for Heating 20 Lbs. Boxes.		Watchmen.		Day Engineer.		Night Engineer.		Pump Men.		Helpers.		Firemen.		Coal Passers.		Coal for Boilers.		Signal Oil.		Black Oil.		Cylinder Oil.		Waste.		Coal Oil.		Totals for Each Day.	Feet Sunk per Day.	Material.	Water Pumps.		Air Pumps.	Remarks
1892	Days.	Amount.	Days.	Amount.	Days.	Amount.	Days.	Amount.	Days.	Amount.	Days.	Amount.	Lbs.	Amount.	Lbs.	Amount.	No.	Amount.	Lbs.	Amount.	Lbs.	Amount.	Boxes.	Amount.	Days.	Amount.	Days.	Amount.	Days.	Amount.	Days.	Amount.	Days.	Amount.	Days.	Amount.	Days.	Amount.	Tons.	Amount.	Pints.	Amount.	Pints.	Amount.	Pints.	Amount.	Lbs.	Amount.	Pints.	Amount.				Hours run.	No. of strokes.	No. of revolutions.	
Dec. 21					1	3.00	½	1.40	5½	11.00			15	3.61											2	3.50	1	3.22	1	3.22			1	2.40	2	4.80	2	4.20	4.5	10.67			21	.21							$ 51.23	0.19	Med. sand.			21	Started air pumps at 11:30 o'clock.
22					3½	10.50	2	5.60	25	50.00	1	1.75					30	.56							2	3.50	1	3.22	1	3.22			1	2.40	2	4.80	2	4.20	6.8	16.13											105.88	0.18	"			18	
23	½	2.50			3	9.00	2	5.60	24	48.00	2	3.50			22	1.11	26	.48							2	3.50	1	3.22	1	3.22	2	4.80	1	2.40	2	4.80	2	4.20	9.7	23.01	2	.09									119.43	1.78	"	11 50/60	31	20	Sand pump started at 20:10 o'clock.
24	½	2.50			3	9.00	2	5.60	24	48.00	2	3.50					17	.31							2	3.50	1	3.22	1	3.22	2	4.80	1	2.40	2	4.80	2	4.20	11.7	27.75											122.80	3.34	"	21 10/60	44	18	
25	½	2.50			1½	4.50	2	5.60	12	24.00	2	3.50					12	.32							2	3.50	1	3.22	1	3.22	2	4.80	1	2.40	2	4.80	2	4.20	12.2	28.94	2	.09									95.59	0.90	"	2 40/60	48	19	Sand pumps stopped at 10:40 o'clock.
26					2½	7.50	2	5.60	3½	7.00	2	3.50					9	.16							2	3.50	1	3.22	1	3.22	2	4.80	1	2.40	2	4.80	2	4.20	7.5	17.79			30	.30							67.99	0.00	"			14	
27					½	1.50	2	5.60			2	3.50					7	.13							2	3.50	1	3.22	1	3.22	2	4.80	1	2.40	2	4.80	2	4.20	7.6	18.03	8	.35									55.25	0.00	"			13	
28	½	2.50			2½	7.50	2	5.60	7½	15.00	2	3.50					10	.19							2	3.50	1	3.22	1	3.22	2	4.80	1	2.40	2	4.80	2	4.20	11.0	26.00											86.52	1.44	"	11 10/60	42	18	Sand pumps started at 20:00 o'clock.
29	½	2.50			3	9.00	2	5.60	24	48.00	2	3.50					29	.54							2	3.50	1	3.22	1	3.22	2	4.80	1	2.40	2	4.80	2	4.20	14.0	33.21											128.49	1.87	"	20 24/60	42	36	
30	½	2.50			3	9.00	2	5.60	25	50.00	2	3.50	15	3.61			24	.44							2	3.50	1	3.22	1	3.22	2	4.80	1	2.40	2	4.80	2	4.20	14.0	33.21	2	.09	80	1.00							135.09	2.67	"	19 45/60	43	44	
31	½	2.50			3	9.00	2	5.60	24	48.00	2	3.50			20	1.02	19	.35							2	3.75	1	3.22	1	3.22	2	4.80	1	2.40	2	4.80	2	4.20	13.5	32.02											128.38	1.30	"	11 50/60	46	21	Sand pumps stopped at 21:30 o'clock.
1893																																																									
Jan. 1							2	5.60			2	3.50					10	.19					2	.47	2	3.75	1	3.23	1	3.23	2	4.80	1	2.40	2	4.80	2	4.20	11.2	26.56											62.73	0.04	"			17	
2							2	5.60			2	3.50					9	.16					2	.47	2	3.75	1	3.23	1	3.23	2	4.80	1	2.40	2	4.80	2	4.20	8.9	21.10											57.24	0.12	"			17	
3							2	5.60			2	3.50					9	.16					3	.71	2	3.75	1	3.23	1	3.23	2	4.80	1	2.40	2	4.80	2	4.20	8.2	19.45											53.83	0.71	"			18	
4	½	2.50			2	6.00	2	5.60	17	34.00	2	3.50					17	.31					2	.48	2	3.75	1	3.23	1	3.23	2	4.80	1	2.40	2	4.80	2	4.20	11.5	27.28	2	.09									106.17	2.51	"	20 36/60	45	22	[Two logs found. Sand pumps started at 9:40 o'clock.
5	½	2.50			3	9.00	2	5.60	25	50.00	2	3.50	15	3.76			36	.67					2	.47	2	3.75	1	3.23	1	3.23	2	4.80	1	2.40	2	4.80	2	4.20	11.0	19.37							10	.60			121.88	3.08	"	22 55/60	49	24	Sand pumps stopped at 8:00 o'clock, [January 6.
6					2	6.00	2	5.60	16	32.00	2	3.50					18	.33					1	.23	2	3.75	1	3.23	1	3.23	2	4.80	1	2.40	2	4.80	2	4.20	9.5	22.53											96.60	0.08	"			24	
7							2	5.60			2	3.50					8	.14					2	.48	2	3.75	1	3.23	1	3.23	2	4.80	1	2.40	2	4.80	2	4.20	6.5	15.42											51.55	0.00	"			22	
8							2	5.60			2	3.50					9	.16					1	.24	2	3.75	1	3.23	1	3.23	2	4.80	1	2.40	2	4.80	2	4.20	9.5	22.53											58.44	0.00	"			23	
9							2	5.60			2	3.50					9	.16					3	.71	2	3.75	1	3.23	1	3.23	2	4.80	1	2.40	2	4.80	2	4.20	9.5	22.53											58.91	0.00	"			22	
10							2	5.60			2	3.50					16	.30					1	.23	2	3.75	1	3.23	1	3.23	2	4.80	1	2.40	2	4.80	2	4.20	9.5	22.54											58.58	0.00	"			23	
11							2	5.60			2	3.50					9	.16					2	.47	2	3.75	1	3.23	1	3.23	2	4.80	1	2.40	2	4.80	2	4.20	9.8	23.24							1	.06			59.44	0.00	"			23	
12							2	5.60			2	3.50					9	.16					2	.47	2	3.75	1	3.23	1	3.23	2	4.80	1	2.40	2	4.80	2	4.20	8.0	18.97											55.11	0.00	"			22	
13							2	4.00									9	.16					2	.48	2	3.75	1	3.23	1	3.23			1	2.40	2	4.80	2	4.20	6.5	15.43											41.68	0.00	"			22	
14							2	4.00									12	.22					2	.47	2	3.75	1	3.23	1	3.23			1	2.40	2	4.80	2	4.20	7.9	18.74			80	1.05			10	.60			46.69	0.00	"			22	
15							2	4.00									13	.24					2	.48	2	3.75	1	3.23	1	3.23			1	2.40	2	4.80	2	4.20	8.2	19.46											45.79	0.00	"			22	
16							2	4.00									13	.24					2	.48	2	3.75	1	3.23	1	3.23			1	2.40	2	4.80	2	4.20	7.0	16.60											42.93	0.00	"			22	
17							2	4.00									12	.22					2	.47	2	3.75	1	3.23	1	3.23			1	2.40	2	4.80	2	4.20	7.5	17.79											44.09	0.00	"			22	
18							2	4.00									12	.22					2	.47	2	3.75	1	3.23	1	3.23			1	2.40	2	4.80	2	4.20	6.8	16.14											42.44	0.00	"			22	
19							2	4.00									13	.24					2	.48	2	3.75	1	3.22	1	3.22			1	2.40	2	4.80	2	4.20	6.0	14.23											40.54	0.00	"			22	
20							2	4.00									14	.26					2	.47	2	3.75	1	3.22	1	3.22			1	2.40	2	4.80	2	4.20	3.9	9.26									40	.55	36.13	0.00	"			18	
21							2	4.00									13	.24					2	.48	2	3.75	1	3.22	1	3.22			1	2.40	2	4.80	2	4.20	4.5	10.67	4	.13									37.11	0.00	"			19	
22	½	2.50			1	3.00	2	4.00	10	20.00	2	3.50					12	.22					4	.95	2	3.75	1	3.22	1	3.22	½	.60	1	2.40	2	4.80	2	4.20	10.2	24.19											80.55	4.32	"	16 25/60	49	21	Sand pumps started at 15:35 o'clock.
23	1	5.00	1	3.50	2½	7.50	2	4.00	26½	53.00	½	.52					43	.80					3	.71	2	3.75	1	3.22	1	3.22	2	4.80	1	2.40	2	4.80	2	4.20	7.5	17.73											119.15	1.61	"	7 50/60	50	21	Sand pumps stopped at 15:50 o'clock.
24	1	5.00					2	4.00									5	.09					2	.48	2	3.75	1	3.22	1	3.22			1	2.40	2	4.80	2	4.20	4.2	9.90									40	.55	41.67	0.02	"			18	
25	½	2.50					2	4.00									3	.06					3	.71	2	3.75	1	3.22	1	3.22			1	2.40	2	4.80	2	4.20	4.8	11.38	4	.13									40.37	0.00	"			18	
26							2	4.00									4	.07					2	.48	2	3.75	1	3.22	1	3.22			1	2.40	2	4.80	2	4.20	4.5	10.68											36.82	0.00	"			18	
27							2	4.00									3	.06					2	.47	2	3.75	1	3.22	1	3.22			1	2.40	2	4.80	2	4.20													26.12	0.00	"			17	
28							2	4.00									4	.07					2	.48	2	3.75	1	3.22	1	3.22			1	2.40	2	4.80	2	4.20							16	1.10	14	.84			28.08	0.24	"			17	
29							2	4.00									13	.23					2	.48	2	3.75	1	3.22	1	3.22			1	2.40	2	4.80	2	4.20	11.5	27.29											53.59	0.00	"			16	
30							2	4.00									14	.26					2	.47	2	3.75	1	3.22	1	3.22			1	2.40	2	4.80	2	4.20	7.3	17.30	4	.13									43.75	0.00	"			16	
31							2	4.00									13	.23					2	.48	2	3.75	1	3.22	1	3.22			1	2.40	2	4.80	2	4.20	7.0	16.60									40	.55	43.45	0.00	"			15	
Forward		37.50		3.50		111.00		200.60		538.00		79.27		10.98		2.13		10.51						15.42		155.00		135.42		135.42		106.20		100.80		201.60		176.40		801.82		1.10		2.56		1.10		2.10		1.65	$2830.08						

APPENDIX D.—CONTINUED.

TIME, COST AND MATERIALS USED IN FOUNDATIONS.

PIER V.—CONTINUED.

Date. 1893	Principal Foreman Days	Principal Foreman Amount	Night Foreman Days	Night Foreman Amount	Sub Foremen Days	Sub Foremen Amount	Lock Tenders Days	Lock Tenders Amount	Pressure Men Days	Pressure Men Amount	Coffee House Men Days	Coffee House Men Amount	Coffee Lbs.	Coffee Amount	Sugar Lbs.	Sugar Amount	Candles No.	Candles Amount	Red Lead Lbs.	Red Lead Amount	Wick Lbs.	Wick Amount	Coal for Heating, 200 Lbs Boxes, Boxes	Coal for Heating Amount	Watchmen Days	Watchmen Amount	Day Engineer Days	Day Engineer Amount	Night Engineer Days	Night Engineer Amount	Pump Men Days	Pump Men Amount
Feb. 1							2	4.00									3	.07					1	.17	2	3.75	1	3.58	1	3.58		
2							2	4.00									12	.22					2	.35	2	3.75	1	3.58	1	3.58		
3							2	4.00									12	.23					2	.35	2	3.75	1	3.58	1	3.58		
4							2	4.00									8	.14					2	.36	2	3.75	1	3.58	1	3.58		
5							2	4.00									4	.07					2	.35	2	3.75	1	3.57	1	3.57		
6							2	4.00									9	.16					2	.35	2	3.75	1	3.57	1	3.57		
7							3	6.00									8	.14					2	.36	2	3.75	1	3.57	1	3.57		
8							3	6.00									4	.07					2	.35	2	3.75	1	3.57	1	3.57		
9							2	4.00									3	.08					2	.35	2	3.75	1	3.57	1	3.57		
10							2	4.00									2	.05					2	.36	2	3.75	1	3.57	1	3.57		
11							2	4.00									2	.05					2	.35	2	3.75	1	3.57	1	3.57		
12			1	3.50			2	4.00									2	.05					2	.35	2	3.75	1	3.57	1	3.57		
13							2	4.00									2	.05					1	.18	2	3.75	1	3.57	1	3.57		
14	½	2.50			1	3.00	2	4.00	10	20.00	½	.87	5	1.28	6	.31	10	.19					2	.35	2	3.75	1	3.57	1	3.57	¼	0.60
15	1	5.00	1	3.50	3	9.00	2	4.00	25½	51.00	2	3.50	2	.51			8	.14	2½	.15			2	.36	2	3.75	1	3.57	1	3.57	2	4.80
16	1	5.00	1	3.75	4	13.00	2	4.80	40½	97.20	2	3.50	4	1.02	6	.31	13	.24					2	.35	2	3.75	1	3.57	1	3.57	2	4.80
17	1	5.00	1	3.75	3	9.75	2	4.80	30½	73.20	2	3.50			7	.35	14	.26					2	.36	2	3.75	1	3.57	1	3.57	2	4.80
18	1	5.00	1	3.75	1	3.25	2	4.80	7½	18.00	2	3.50	2	.51			12	.22					2	.35	2	3.75	1	3.57	1	3.57	2	4.80
19	1	5.00	1	3.75	3	9.75	2	4.80	28	67.20	2	3.50	4	1.02	7	.35	14	.26					2	.35	2	3.75	1	3.57	1	3.57	2	4.80
20	1	5.00	1	3.75			2	4.80			2	3.50					13	.24					2	.35	2	3.75	1	3.57	1	3.57	2	4.80
21	1	5.00	1	3.75			2	4.80			2	3.50					13	.24					2	.35	2	3.75	1	3.57	1	3.30	2	4.80
22	1	5.00	1	3.75	1	3.25	2	4.80	7	16.80	2	3.50			4	.20	8	.19					2	.35	2	3.75	1	3.57	1	3.30	2	4.80
23	1	5.00	1	3.75	2	6.50	2	4.80	38½	92.40	2	3.50	2	.51	7	.35	8	.19					2	.36	2	3.75	1	3.57	1	3.30	2	4.80
24	1	5.00	1	3.75	4	13.00	2	4.80	37	88.80	2	3.50	5	1.28	6	.30	8	.19					2	.35	2	3.75	1	3.57	1	3.30	2	4.80
25	1	5.00	1	3.75	4	13.00	2	4.80	42	100.80	2	3.50	2	.51	7	.35	7	.14					1	.17	2	3.75	1	3.57	1	3.30	2	4.80
26	1	5.00	1	3.75	5	17.00	2	4.90	51	125.50	2	3.50	5	1.28	9	.45	9	.18					1	.18	2	4.00	1	3.57	1	3.30	2	4.80
27	1	5.00	1	4.00	8	26.50	2	5.00	56½	141.25	3	5.25	6	1.53	5	.25	15	.30					1	.17	2	3.75	1	3.57	1	3.30	2	4.80
28	1	5.00	1	4.00			2	5.00			2	3.50											1	.18	2	3.75	1	3.57	1	3.30	2	4.80
Mar. 1	1	5.00	1	4.00			2	5.00			2	3.50											1	.16	2	3.75	1	3.23	1	3.23	2	4.80
2	1	5.00	1	4.00	3	10.50	2	5.00	17	42.50	2	3.50			5	.25	12	.22					1	.18	2	3.75	1	3.23	1	3.23	2	4.80
3	1	5.00	1	4.00	7	23.75	2	5.00	47	117.50	3	5.25			5	.25	11	.20					2	.35	2	3.75	1	3.23	1	3.23	2	4.80
4	1	5.00	1	4.00	7	24.65	2	5.30	56	142.80	3	5.25	2	.51	9	.45	18	.33					2	.35	2	4.25	1	3.23	1	3.23	2	4.80
5	1	5.00	1	4.30	8	28.90	2	5.60	53½	149.80	3	5.25	5	1.28	7	.35	17	.32					2	.36	2	4.50	1	3.23	1	3.23	2	4.80
6	1	5.00	1	4.30	8	28.90	2	5.60	52½	147.00	3	5.25	2	.51	3	.15	18	.33					1	.17	2	4.50	1	3.23	1	3.23	2	4.80
7	1	5.00	1	4.30	8	28.90	2	5.60	52½	147.00	3	5.25	3	.76	7	.36	14	.26					1	.18	2	4.50	1	3.23	1	3.23	1	2.40
8	1	5.00	1	4.80	8	32.90	2	6.60	54	178.20	3	5.24	4	1.02	12	.61	12	.22					1	.17	2	4.00	1	3.23	1	3.23	1	2.40
9	1	5.00	1	4.80	8	32.90	2	6.60	53	174.90	3	5.25	5	1.28	6	.30	11	.20					1	.18	2	4.00	1	3.23	1	3.23	⅙	0.40
10	1	5.00	1	4.80	7½	30.75	2	6.60	56	184.80	3	5.25	5	1.28	8	.40	22	.41					2	.35	2	4.00	1	3.23	1	3.23		
11	1	5.00	1	4.30	7	29.35	2	6.60	52½	173.25	3	5.25	3	.76	7	.36	24	.44					2	.35	2	4.00	1	3.23	1	3.23		
12	1	5.00	1	4.30	7	29.35	2	6.60	50½	166.65	3	5.25	4	1.02	7	.36	24	.44			1	.20	2	.36	2	4.00	1	3.23	1	3.23		
13							1	3.30			1	1.75													1	2.00			1	3.23		
		170.00		111.65		538.85		400.90		3054.55		192.13		28.85		9.19		18.24		.15		20		27.41		311.25		274.18		275.25		208.00

Date. 1893	Helpers Days	Helpers Amount	Firemen Days	Firemen Amount	Coal Passers Days	Coal Passers Amount	Coal for Boilers Tons	Coal for Boilers Amount	Signal Oil Pints	Signal Oil Amount	Black Oil Pints	Black Oil Amount	Cylinder Oil Pints	Cylinder Oil Amount	Waste Lbs	Waste Amount	Coal Oil Pints	Coal Oil Amount	Totals for each Day	Feet Sunk per Day	Material	Water Pumps Hours run	Water Pumps No. of strokes	Air Pumps No. of revolutions	Remarks
Feb. 1	1	2.40	2	4.80	2	4.20	4.2	7.74											34.29	0.00	Medium sand			15	
2	1	2.40	2	4.80	2	4.20	4.7	8.66											35.54	0.00	"			16	
3	1	2.40	2	4.80	2	4.20	4.3	7.92											34.81	0.00	"			16	
4	1	2.40	2	4.80	2	4.20	4.2	7.37											34.18	0.00	"			16	
5	1	2.40	2	4.80	2	4.20	4.0	7.74											34.45	0.00	"			16	
6	1	2.40	2	4.80	2	4.20	2.2	4.05	8	.52							40	.55	31.92	0.00	"			16	
7	1	2.40	2	4.80	2	4.20	4.5	8.29											37.88	0.00	"			16	
8	1	2.40	2	4.80	1	2.10	4.0	7.37											33.98	0.00	"			16	
9	1	2.40	2	4.80	1	2.10	4.4	8.10											32.72	0.00	"			16	
10	1	2.40	2	4.80	1	2.10	4.5	8.29			80	1.05							33.94	0.00	"			16	
11	1	2.40	2	4.80	1	2.10	4.8	8.79											33.38	0.00	"			15	
12	1	2.40	2	4.80	1	2.10	5.0	9.22											37.31	0.00	"			16	
13	1	2.40	2	4.80	1	2.10	5.7	10.51	32	2.08			72	4.95					41.96	0.00	"			16	
14	1	2.40	2	4.80	1	2.10	12.5	23.04											76.33	0.03	"	16 30/60	51	17	Sand pumps started at 15.30 o'clock.
15	1	2.40	2	4.80	2	4.20	13.7	25.23											129.48	2.01	"	22 30/60	49	23	
16	1	2.40	2	4.80	2	4.20	13.9	25.62									32	.44	182.32	2.61	"	24	45	23	
17	1	2.40	2	4.80	2	4.20	8.5	15.67											143.73	3.87	"	3 35/60	43	22	
18	1	2.40	2	4.80	2	4.20	11.0	20.27											86.74	1.03	"	16 40/60	43	24	
19	1	2.40	2	4.80	2	4.20	6.3	11.61											134.68	2.14	"	4 45/60	38	23	Sand pumps stopped at 12.45 o'clock.
20	1	2.40	2	4.80	2	4.20	4.2	7.74											52.47	1.83	"			21	
21	1	2.40	2	4.80	2	4.20	7.5	13.83											58.29	0.00	"			21	
22	1	2.40	2	4.80	2	4.20	10.0	18.43							12	.72			83.81	0.00	"	15 30/60	38	26	Sand pumps started at 16.30 o'clock.
23	1	2.40	2	4.80	2	4.20	14.0	25.80											169.08	0.19	"	24	43	34	
24	1	2.40	2	4.80	2	4.20	14.3	26.35											174.14	3.34	"	22 30/60	46	22	
25	1	2.40	2	4.80	2	4.20	15.3	28.19											187.03	3.26	"	24	46	22	
26	1	2.40	2	4.80	2	4.20	15.3	28.19											217.00	4.25	"	23 15/60	47	25	
27	1	2.40	2	4.80	2	4.20	11.8	21.73											237.80	0.56	"	5 15/60	43	25	Sand pump stopped at 13.15 o'clock.
28	1	2.40	2	4.80	2	4.20	8.4	15.49											59.99	0.08	"			22	
Mar. 1	1	2.40	2	4.80	2	4.20	8.5	15.63											59.72	0.16	"			21	
2	1	2.40	2	4.80	2	4.20	12.8	23.59					80	1.05					122.20	2.05	"	17 30/60	48	28	Sand pump started at 14.50 o'clock.
3	1	2.40	2	4.80	2	4.20	15.4	28.30											216.10	1.53	"	22 5/60	48	20	
4	1	2.40	2	4.80	2	4.20	17.2	31.71											247.26	2.31	"	24	47	25	
5	1	2.40	2	4.80	2	4.20	17.8	32.80											261.12	3.44	"	24	42	27	
6	1	2.40	2	4.80	2	4.20	16.6	31.61											255.98	0.91	"	22	35	30	
7	1	2.40	2	4.80	2	4.20	15.0	27.66											250.03	1.15	"	9 35/60	34	31	Sealing commenced at 16.00 o'clock.
8	1	2.40	2	4.80	2	4.20	16.5	30.40							12	.72			200.14	0.11	"	10 30/60	41	32	
9	1	2.40	2	4.80	2	4.20	13.0	23.97			58	.76							278.40	0.01	"	3 30/60	44	32	Sand pumps stopped at 15.50 o'clock.
10	1	2.40	2	4.80	2	4.20	10.5	19.37											280.87	0.01				30	
11	1	2.40	2	4.80	2	4.20	10.7	19.73											267.25					25	
12	1	2.40	2	4.80	2	4.20	10.2	18.81											260.20					24	Air taken off at 6.40 o'clock.
13			1	2.40	1	2.10													14.78						
		196.80		396.00		331.80		1516.73		3.70		4.37		7.10		3.54		2.64	8083.48						

Other expenses charged to Sinking....................1516.76

$9600.24

APPENDIX E.

SPECIFICATIONS FOR MASONRY.

GENERAL.

1. The masonry will comprise one abutment and four piers.

2. The piers will be numbered from the St. Louis County shore to the St. Charles County shore, the East or South Abutment being Pier I and the pier next to the St. Charles County bank Pier V.

3. Pier I will be an abutment with square wing walls.

4. Piers II and IV will measure 12 feet thick and 34 feet long between shoulders under the belting course. The ends will be round for the upper 38 feet and pointed below.

5. Pier III will be precisely like Piers II and IV, except that it will be six and one-half inches higher, this difference being added to the round ended portion.

6. Pier V will measure 9 feet thick and 37 feet long between shoulders under the belting course, and will have round ends throughout.

7. Pier I will be built entirely of oolitic limestone from the quarries near Bedford, Indiana. It is estimated to contain approximately 1300 cubic yards.

8. Piers II, III and IV will be built of Bedford limestone except that the face stones of the entire piers for a height of 30 feet below the pointed copings will be granite. Each of these piers will contain approximately 2800 cubic yards of masony of which approximately 700 cubic yards will be granite.

9. Pier V will be built entirely of Bedford limestone and will contain approximately 1300 cubic yards of masonry.

10. The entire masonry shall be built according to detail plans furnished by the Chief Engineer.

STONE.

11. The face stone must be strong, compact, of uniform quality and appearance and free from any defects which in the judgment of the Engineer may impair its strength or durability. The so-called blue stone which does not stand quarrying in the winter shall only be used below the level of the granite work or in backing.

12. No course shall be less than sixteen inches in thickness and no course below the belting course shall be thicker than the one beneath it.

13. Each bed of every stone shall measure at least thirty-six inches in each direction, except that where the thickness of the course is less than twenty-four inches the bed need not exceed one and one-half times the thickness of the stone.

14. The bottom bed shall always be the full size of the stone and no stone shall have an overhanging top bed.

15. Stretchers shall not be less than four feet nor more than seven feet long, and stretchers of the same width shall not be placed together vertically, but this shall not apply to the ends of stretchers where headers come centrally between stretchers.

16. Headers shall be at least five feet long and shall be at least three-quarters their full width for the whole length. There shall be at least three headers on each side of every course between the shoulders.

17. The backing shall be composed of stones of the same thickness as the face stones, with beds cut in the same manner as required for the face stones and with no overhanging top beds. The spaces between the large stones shall not occupy more than one-fifth of the entire area of the pier inside of the face stones, and these spaces shall be filled with good rubble masonry carefully laid up in full mortar beds and well rammed.

CUTTING.

18. The face lines of each stone shall be true, and the rise as fixed by the face lines shall not vary anywhere more than $\frac{1}{8}$ of an inch from the true rise of the course.

19. The upper and lower beds shall be truly parallel and cut to conform with the requirements for the face lines. Depressions of more than one-quarter of an inch below the true planes shall never exceed one-tenth of the area of the bed.

20. Joints shall be cut vertical and at right angles to the face of the stone unless otherwise shown on special plans. The cutting for at least 12 inches back from the face shall be the same as that required for the beds.

21. Joints shall be broken at least fifteen inches on the face.

22. The vertical joints shall not average more than three-eighths of an inch and shall not exceed one-half inch. Thin, horizontal mortar joints will not be insisted on, but every stone shall be set in a full bed of mortar and settled to a proper bearing, no levelers being allowed.

23. The face of the granite cutwaters of Piers II, III and IV shall be fine pointed work with no projections exceeding one-half inch.

24. The copings, including those over the pointed starlings, shall have the upper surface, wash, face and the lower beds for a width of six inches back bush-hammered with true lines and surfaces. The lower bed of the belting courses shall be bush-hammered to the same extent.

25. The coping shall be cut with close joints throughout the whole pier and according to special plans.

26. A four-inch draft line shall be cut on all vertical angles and around the lower edges of the belting course below the coping.

27. All other portions of the piers shall have a rough quarry face with no projections exceeding three inches, the quarry face to average at least one and a half inches from the pitch line of the joints and never to run back of such pitch line.

28. No grab holes shall be made in the face of the coping or on the pointed work of the cutwater.

MORTAR.

29. All face stones shall be laid in Portland cement mortar, two parts of sand to one part of cement. The backing shall be laid in American cement mortar, two parts of sand to one part of cement.

30. When masonry is laid up in freezing weather the backing shall be laid in Portland cement, three parts of sand and one part of cement, and such other precautions taken against freezing as the Engineer may direct.

31. All stones must be carefully cleaned and wet before setting, and no mortar beds shall be laid until the course below has been cleaned and wet.

32. The joints of the face stones shall be cleaned out to a depth of one and one-half inches, and pointed in mild weather with a mortar composed of two parts of sand and one part of Portland Cement, which shall be driven in with a calking iron.

33. The cement will be furnished by the Railroad Company, but the contractor will be held responsible for all waste or injury to the same.

IRONING.

34. The stones of the curved up stream starlings of Piers II, III and IV shall be dowelled into those of the course below with one and one-eighth inch steel dowels extending six inches into each course, these dowels to be placed about ten inches back from the face and seven inches on each side of each joint. The stones of the upper course shall be drilled through before setting, after which the hole shall be extended six inches into the lower course, a small quantity of mortar shall be put into the hole, the dowel dropped in and the hole filled with mortar and well rammed.

35. The joints in the three courses below the coping in all piers shall be cramped with cramps of one-inch round iron sixteen inches long, the ends put four inches into each stone.

APPENDIX E.—CONTINUED.

TERMS.

36. The foundations will be prepared by the Railroad Company.

37. Pier I will be founded on rock above the level of high water. The necessary excavation will be made and the foundation leveled up with concrete by the Railroad Company.

38. Piers II, III, IV and V will be founded on pneumatic caissons, and the contractor will be required to lay this masonry as the sinking proceeds and to accommodate his tools and machinery to the requirements of the pneumatic work.

39. The contractor will be required to do without charge whatever hoisting may be required at the pier in placing or removing the shafts and locks used in the pneumatic work while masonry is being laid.

40. Preparations must be made on the supposition that one of the three piers II, III and IV will be ready for masonry on August 1, 1892, that another will be ready six weeks thereafter and that the third will be ready by November 1, 1892.

41. The contractor must be prepared to lay at least two courses daily while the sinking is in progress and will be responsible for any delays due to his inability to lay up the masonry at this rate.

42. The contractor must be prepared to begin work on Pier V on January 1, 1893, and to begin work on the east abutment not later than March 1, 1893.

43. Piers II, III and IV shall be finished in the order which the Engineer may direct, and the entire masonry of the bridge shall be completed on or before May 1, 1893.

44. The contractor shall provide a stone yard near the north end of the bridge in St. Charles county and shall begin the delivery of stone at this yard as early as possible and shall have a sufficient amount of stone to complete the granite work of Piers II, III and IV delivered at this yard on or before August 1, 1892.

45. The contractor shall furnish all tools, machinery and materials of every kind except cement, and complete the masonry ready to receive the superstructure.

46. No work shall be paid for which does not form a part of the permanent structure.

PAYMENTS.

47. Monthly payments shall be made to the contractor on or about the middle of each month. These monthly payments shall be based on approximate estimates made of the work performed up to the end of the preceding month, ten per cent. being held back till completion of contract.

48. In these estimates material delivered ready for use but not yet in place in the permanent structure shall be estimated at the following prices:

Limestone, including backing, cut, delivered and unloaded, ten dollars ($10) per cubic yard.

Granite cut, delivered and unloaded, twenty dollars ($20) per cubic yard.

MISCELLANEOUS.

49. No free transportation will be furnished by the railroad nor will any tools be supplied by the Railroad Company.

50. Wherever the word Engineer is used in these specifications, it is understood to be the Chief Engineer of the work. In the absence of the Chief Engineer the Resident Engineer will be considered as his representative and instructions coming from the Resident Engineer will be considered equivalent to those given by the Chief Engineer.

51. All elevations mentioned in these specifications are referred to a datum 100 feet below the St. Louis city directrix.

52. In general it is understood that the work is to be done in a first-class manner and that wherever these specifications admit of a doubt the interpretation which makes the best work shall be followed.

GEORGE S. MORISON,
Chief Engineer.

March 4, 1892.

APPENDIX F.

SPECIFICATIONS FOR SUPERSTRUCTURE.

A.—GENERAL DESCRIPTION.

1. The Superstructure will consist of four spans, 440 feet each, all built for double track, the trusses being placed 30 feet between centers. Each truss will be divided into eight panels of 55 feet each and will be 55 feet deep between centers. The floor will be divided into sixteen panels of 27 feet 6 inches each, the intermediate floor beams being suspended from the middle of each panel.

2. Each span is estimated to weigh approximately 2 800 000 pounds, including fences and bearings.

3. The entire structure will be of M steel, subject to the provisions of the Specifications permitting the use of HM and MS steel in details. Rivets, fences and the lateral rods of the floor system will be of S steel.

4. The expansion and fixed bearings may be of forged Bessemer steel, except such parts as are specified to be of cast steel.

5. The entire structure will therefore be of steel of one kind or another.

6. Full detail plans showing all dimensions will be furnished by the Chief Engineer. The work shall be built in all respects according to these plans and similar plans will be furnished to the inspector. The use of these plans will not relieve the contractor from the responsibility of correcting errors, provided those errors are of a manifest character which could be discovered by a careful inspection of the plans.

7. Should the contractor desire to make his own shop plans, they will be for his use only, and he will be held responsible for any variations between such plans and those furnished by the Engineer.

B.—STEEL.

CLASSES.

1. Steel will be divided into four classes: HM, M, MS and S, of which M and S will be standards, and HM and MS intermediates.

2. Class M will be known as Medium Steel and will be used in those portions of every member which constitute the calculated section.

3. Class S will be known as Soft Steel and will be used for rivets, fences and the lateral rods of the floor system.

4. HM and MS steel will be accepted for details and parts which do not form portions of the calculated sections.

MANUFACTURE.

5. Steel shall be made by the open hearth process, and no steel shall be made at works which have not been in successful operation for at least one year; but this provision shall not be held to exclude new furnaces erected in connection with old works.

6. If made in an acid furnace, the amount of phosphorus in the finished product shall never exceed eight one-hundredths of one per cent., this being a maximum and not an average requirement.

7. If made in a basic furnace, the amount of phosphorus shall never exceed four one-hundredths of one per cent., this being a maximum and not an average requirement, and being considered necessary to show a proper amount of work in the furnace.

8. The finished product shall be perfect in all parts and free from irregularities and surface imperfections of all kinds. All steel must be free from piping.

9. The cross sections shall never differ more than 2½ per cent. from the ordered cross sections as shown by the dimensions on the plans.

10. Steel for pins more than four inches in diameter shall be hammered.

11. Every finished plate, bar or angle shall be stamped on one side, near the middle, with a number identifying the melt, and this stamp shall be surrounded with a heavy circle of white paint. Steel for pins shall have the melt numbers stamped on the ends. Rivet steel and small pieces which do not form part of the calculated section of members may be shipped in bundles, wired together, with the melt number on a metal tag attached.

TESTS.

12. A sample bar not more than two inches wide, and having a cross section of one square inch when the material is not less than one-half inch thick, shall be cut from the finished product of every melt. When taken from metal more than two inches thick this sample may be a turned, round bar. The laboratory tests shall be made on this sample bar in its natural state without annealing.

13. When a melt is rolled into several varieties of material, each variety shall be separately tested. A variety shall consist entirely of one of the following shapes: Sheared Plates, Universal Mill Plates, Angles, Z's, Channels, I beams Flats, Rounds, Squares, Pin Steel and Eyebar Steel. Flats will include all flats not intended to be forged into eyebars. Where several sizes of the same variety are rolled, the cross section of the largest size shall not be more than twice that of the smallest size, and the sample shall be taken from the size which comes nearest to a mean.

14. In the laboratory tests, measurements to determine elongation shall be made on a length of eight inches.

15. A piece of each sample bar shall be bent 180 degrees and closed up against itself. In no case shall any crack appear until the circle around which the bar is bent becomes less than the thickness of the bar. Except when the sample is taken from a pin, the sample bar shall close up against itself without showing any crack or flaw on the outside of the bent portion.

16. The sample bar shall be tested in a lever machine and the following requirements fulfilled:

	CLASS OF STEEL.			
	HM.	M.	MS.	S.
Ultimate Strength, lbs. per square inch	70 000	66 000	62 000	58 000
Elastic Limit, " " " "	35 000	33 000	31 000	29 000
Percentage of Elongation in 8 inches..	18	22	24	26
" " Reduction at Fracture..	36	44	48	52

17. Where the sample is taken from a pin, the elongation and reduction will be reduced to 15 and 30 per cent. for the HM steel and to 18 and 36 per cent. for the M steel.

18. The entire fracture shall be silky.

19. The requirements for ultimate strength are means, and steel will be accepted when the ultimate strength does not differ more than 4000 lbs. from the requirements of the table.

20. The requirements for elastic limit, elongation and reduction are minimum requirements, and no steel will be accepted which falls below these conditions.

21. The elastic limit will be observed by the falling of the beam of the testing machine.

22. Duplicate tests may be made when the first sample tested fulfills four of the five requirements. If the second test and also the average of the two tests meet all the requirements, the melt may be accepted. Cases in which the tests are thought not to give fair indications of the character of the material, shall be referred to the Engineer.

23. Analyses shall be made showing the amount of phosphorus and carbon in every melt, the drillings for these analyses being taken directly from one of the ingots. Besides this, a set of analyses of phosphorus, carbon, silicon and manganese shall be made from every ten melts, the drillings to be taken from a sample test bar.

INSPECTION.

24. The mill inspection shall be performed at the expense of the manufacturer by an inspector accepted by the Engineer. It will be the duty of this inspector to send the notices required below.

25. The acceptance of material by such inspector will not be considered final, but the right is reserved to reject material which may prove defective or objectionable at any time during manufacture and erection.

APPENDIX F.--CONTINUED.

26. Two notices of the acceptance of each melt shall be mailed on the day of such acceptance, stating the number of the accepted melt and quality of steel. One of these notices shall be sent to the Engineer and one to the shop inspector.

27. Two notices of the shipment of manufactured material, identifying the melts and dimensions, shall be mailed on the day after such shipments are made, in the same manner as the notices of the acceptance of material.

28. Weekly reports in full detail, including reports of chemical analyses, for whatever reason made, and certified by the mill inspector, shall be sent to the Engineer not later than the end of the week succeeding the week in which such tests are made.

D.—GENERAL SHOP REQUIREMENTS.

1. The work shall be done in all respects according to the detail plans furnished by the Engineer.

2. Where there is room for doubt as to the quality of work required by the plans or specifications, the doubt shall be decided by using the best class of work which any interpretation would admit of.

3. All workmanship, whether particularly specified or not, must be of the best kind now in use. Past work done for the same Engineer will never be recognized as a precedent for the use of other than the best kind of work.

4. All material shall be cleaned, and if necessary, scraped, and given one heavy coat of Cleveland Iron Clad Paint, purple brand, put on with boiled linseed oil before shipment. This applies to everything except machine-finished surfaces.

5. The same paint shall be used wherever painting is required.

6. All machine surfaces shall be cleaned, oiled and given a heavy coat of white lead and tallow before shipment. The inspector must see that this is a substantial coat, such as is used on machinery, and not a merely nominal covering.

7. All small bolts, all pins less than six inches in diameter, the expansion rollers and everything with special work on it, shall be carefully boxed before shipment.

E.—RIVETED WORK.

1. All plates, angles and shapes shall be carefully straightened at the shop before they are put together; mill straightening will not be considered as meeting this requirement.

2. If the rivet holes are marked from templets, these templets shall lie flat without distortion when the marking is made.

3. The size of rivets shown on the plans is the size of the cold rivet before heating.

4. The diameter of the finished rivet hole shall not be more than $\frac{1}{16}$ inch greater than the diameter of the cold rivet. The heated rivet shall not drop into the hole, but require a slight pressure to force it in; the relative size of the rivet and rivet hole must be such as to meet this requirement.

5. In all cases where riveting is to be done in the field, the parts so to be riveted shall be fitted together in the shops and the rivet holes reamed out while they are so assembled, or an iron templet at least one inch thick shall be made and both parts reamed to fit this templet.

6. All surfaces in contact shall be cleaned and painted before they are put together.

7. The rivets shall be driven by power wherever this is possible. The manufacturer will be required to procure special riveting machines to meet special positions. This applies specially to four web chords.

8. All rivets shall be regular in shape, with hemispherical heads concentric with the axes, absolutely tight, and shall completely fill the holes. Tightening by calking or recupping will not be allowed. This applies to both power driven and hand-driven rivets.

9. The angles of stringers must be square and straight. The web-plate must not project above the angles, and the outside edges of the top angles must never be above a true plane and never more than $\frac{1}{16}$ inch below a true plane coincident with the roots of the angles.

10. The outside angle at the root of the angles connecting stringers with floor beams, floor beams with posts, or in other like details, shall never be less than a right angle, and the excess over a right angle shall never be greater than $\frac{1}{8}$ inch in the longer leg of the angle; the angle shall be perfectly straight.

11. These angles shall be so fitted that the length, measured to the root of any one of the angles, does not vary more than $\frac{1}{16}$ inch from the true length. The effect of these requirements will be to prevent more than $\frac{1}{16}$ inch reduction of area at the root of the angle by facing and to secure a true surface for the whole width of the connection, which will require no strain in the rivets to draw the parts together.

12. All sheared or rough edges shall be carefully planed off.

13. The material may be punched with holes $\frac{1}{8}$ inch smaller than the size of the rivets shown on the plans, except as provided below.

14. When the thickness of the metal is greater than a thickness $\frac{1}{8}$ inch less than the diameter of the rivet, the punched hole shall be $\frac{1}{4}$ inch smaller than the diameter of the rivet.

15. When the thickness of the metal is greater than a thickness $\frac{1}{8}$ inch more than the diameter of the rivet, no punching will be allowed, but the holes must be drilled.

16. After the several pieces have been punched, or drilled, they shall be assembled. The holes shall then be reamed to the diameter required by the size of the rivets, while the pieces are together.

17. After reaming, every hole shall be entirely smooth, showing that the reaming tool has everywhere touched the metal. In special cases where this fails, the Engineer may authorize the hole to be reamed to a larger size and larger rivets used.

18. A reamer shall be run over the outer edges of every hole so as to remove the sharp edges and make a fillet of at least $\frac{1}{16}$ inch under each rivet head.

19. After the reaming is completed the several pieces shall be taken apart and cleaned.

20. The surfaces in contact shall then be painted, the parts assembled while the paint is fresh and riveted up according to the foregoing requirements.

21. The fences which are made of S steel may be punched and riveted without reaming.

F.—FORGED WORK.

1. The heads of eyebars and enlarged screw-ends shall be formed by upsetting and forging into shape by a process acceptable to the Engineer. No welds will be allowed.

2. After the working is completed, the bars shall be annealed in a suitable annealing furnace by heating them to a uniform dark red heat and allowing them to cool slowly.

3. The form of the heads of steel eyebars may be modified by the contractors to suit the process in use at their works, but the thickness of the head shall not be more than $\frac{1}{16}$ inch greater than that of the body of the bar, and the heads shall be of sufficient strength to break the body of the bar.

4. Eyebars shall be bored truly and at exact distances, the pin-holes to be exactly on the axis of the bar and at exactly right angles to the planes of the flat surfaces.

5. When six bars of the same billed length are piled together, the two pins shall pass through both pin-holes at the same time without driving. Every bar shall be tested for this requirement.

6. Pin-holes shall be bored with a sharp tool that will make a clean, smooth cut. Two cuts shall always be taken, the finishing cut never to be more than $\frac{1}{8}$ inch. Roughness in pin-holes will be sufficient reason for rejecting bars.

7. The full number of bars of each billed size shall be made at one time, and one more bar shall be made than the number required for the structure. When the bars are finished, one bar of each lot shall be selected by the inspector for testing. This will require 14 full-size test bars in all.

8. No bars known to be defective in any way shall be taken for test bars, but the bars shall be selected as fair average specimens of the good bars which would be accepted for the work.

9. The test of full-size eyebars shall be made in the large testing machine at Athens, Pa., unless some other machine is specially accepted by the Engineer.

10. These bars will be required to develop an average stretch of twelve per

APPENDIX F.—Continued.

cent., and a minimum stretch of ten per cent. before breaking. The elongation shall be measured on a length of not less than twenty feet, including the fracture.

11. The bars will be required to break in the body.

12. They shall also show an elastic limit of not less than 32 000 pounds, and an ultimate strength of not less than 60 000 pounds, as indicated by the registering gauges of the testing machine at Athens.

13. In case of bars too long for the machine, the test bar shall be selected before the bars are annealed; the bar selected shall then be cut in two, each half shall be reheaded, and both halves shall be annealed, bored and tested, the two tests, however, to count as a single bar.

14. In the test of full-size bars, a failure to meet the required elongation will be considered fatal and be a sufficient cause for condemning the bars represented by the bar so tested; but the engineer shall examine carefully into the cause of the breakage of any bar which does not meet the requirements and may order additional tests if he sees fit.

15. When a bar breaks in the head, but develops ten per cent. elongation before breaking, a second bar shall be selected from the same lot of bars. If this bar breaks in the body, and the two bars develop the average stretch of twelve per cent., the bars of this lot may be accepted; provided, however, that if more than one-third of the total number of bars tested break in the head, the entire bill of eyebars may be rejected.

G.—MACHINE WORK.

1. The planing, drilling and reaming required under the provisions for riveted work shall always be performed.

2. The ends of the chord sections shall be faced so as to be perfectly true after they are riveted up complete, excepting only the projecting splice plates. A special riveting machine will be required to rivet on the splice plates of the four web chords after facing.

3. When four chord pieces are fitted together complete in the shop, there shall be no perceptible wind in the length of the four sections.

4. All chord sections shall be stamped at each end on the outside with letters and numbers designating the joints in accordance with a diagram furnished by the Engineer.

5. All pin-holes and holes for turned bolts passing through the whole width of a riveted member, shall be bored or drilled after all other work is completed.

6. Pin-holes shall be bored truly and at exact distances, parallel with one another, and at exactly right angles to the axis of the member.

7. Pin-holes shall be bored with a sharp tool which will make a clean, smooth cut. Two cuts shall always be taken, the finishing cut never to be more than $\frac{1}{8}$ inch. Roughness in pin-holes will be sufficient reason for rejecting a whole member.

8. Pin-holes shall be bored to fit the pins with a play not exceeding $\frac{1}{50}$ inch. These requirements apply to lateral connections as well as to other pins.

9. The plans show the distance between the centers of pin-holes. Shop measurements shall be made between the bearing edges of tension or compression members, with a proper allowance for the diameter of the pin. An iron standard of the same temperature as the piece measured shall always be used.

10. All pins shall be accurately turned to a gauge and shall be of full size throughout.

11. The ends of stringers and of floor beams shall be squared in a facer, as shall also all other similar connections.

12. All bearing surfaces shall be truly faced.

13. All surfaces so designated on the plans shall be planed.

14. All screws cut on steel shall have a truncated V thread, United States standard, eight threads to the inch.

H.—BEARINGS.

1. The Expansion Bearing will consist of five parts: 1, the Base Plate; 2, the Rollers; 3, the Bearing Plate; 4, the Rocker Plate; 5, the Top Plate.

2. The Fixed Bearing will consist of three parts: 1, the Support; 2, the Rocker Plate; 3, the Top Plate. The Rocker Plate and the Top Plate will be precisely like the Rocker Plate and the Top Plate of the Expansion Bearing.

3. The Base Plate will consist of a plate $1\frac{1}{4}$ in. thick, to which are riveted a number of steel rails, these rails to be Pennsylvania Steel Company, Section 78, 5 in. high, with heads $2\frac{5}{8}$ in. wide, the rails placed 3 in. between centers. The base of the rails shall be planed off in the manner shown on the plan and the rails riveted to the plate. The bottom of the plate shall then be planed, after which the plate shall be placed on a planer and the tops of the rails and the outside faces of the two outside heads shall be planed. The top bearing surface shall then be polished to such an extent that the tool marks cannot be seen. The side edges of the bottom plate shall also be planed.

4. The Rollers will be of forged steel. The ends and parallel sides shall be planed. The rolling surfaces shall be turned and polished. The hollow faces of the sides may be left rough. The pins at the ends of the rollers shall be screwed into the rollers and keyed with a $\frac{1}{4}$ in. key $1\frac{1}{2}$ in. long, the key seat being bored through the threads of the screw. The side plates shall be drilled to fit the pins with a play not exceeding $\frac{1}{32}$ in. All screws on pins shall have truncated V threads, eight threads to the inch.

5. The Bearing Plate shall be of cast steel. The side edges shall be planed, and the bearing surface shall be planed and polished. When this surface is finished, there shall be no blow-hole visible exceeding one inch in either dimension, nor exceeding one-half square inch in area. The length of blow-holes cut by any straight line laid in any direction, shall never exceed one inch in any one foot. The hollow cylindrical surface of the socket shall be turned true and polished; there shall be no blow or sand hole on this surface exceeding one-half an inch in either direction, nor exceeding one-sixteenth square inch in area, and the total area of holes shall not exceed two per cent. of the entire surface; the sides of the socket shall be turned true.

6. The Rocker Plate shall be a steel forging. The four sides shall be planed and fit the sides of the socket within $\frac{1}{50}$ inch; the cylindrical surfaces shall be turned and polished to fit the corresponding surfaces of the sockets exactly.

7. The Top Plate shall be a steel casting, the upper surface being planed and having the same requirements as to blow-holes as the lower surface of the Bearing Plate. The hollow socket shall be subject to the same requirements as the socket of the Bearing Plate.

8. The Support will be a steel casting. The bottom shall be planed and the requirements as to blow-holes shall be the same as for the bottom of the Bearing Plate of the Expansion Bearing. The requirements for the socket shall also be the same.

9. The Base Plate, the Rollers including side plates, and the Rocker Plate, may be of Bessemer steel of the same quality as the best Bessemer rail steel, the finished pieces to be free from all surface defects and entirely free from piping.

10. Every steel casting shall be cast with a coupon for testing, which coupon shall be cut off after annealing, and the test shall be made on a $\frac{3}{4}$ in. round turned from this coupon. When tested this test piece shall show an ultimate strength of at least 70 000 lbs., an elastic limit of at least 40 000 lbs., an elongation of at least 15 per cent. in two inches and a reduction of 20 per cent. at the point of fracture.

11. The workmanship shall all be first-class, and when the bearing is set up there shall be no visible break of contact between the polished surface of the rollers and that of the plates, either above or below.

I.—ERECTION.

1. The Chicago, Burlington and Quincy Railroad will transport the material from Chicago to the bridge site, delivering it on a side track where it can be unloaded conveniently on the north side of the river. No other transportation or switching will be furnished.

2. The contractor will be expected to receive all material as it arrives on the cars, to unload this material and store it in a material yard until ready for erection.

3. He will be held responsible for the custody and care of all superstructure material after its arrival.

4. A track will be laid to a convenient position for unloading material and no switching will be done after the material has once been unloaded.

5. The contractor will be required to keep all the material in good condition,

APPENDIX F.—Continued.

and in case of its becoming dirty or rusty, will be expected to clean it before erecting.

6. The contractor will be required to paint all surfaces which will be inaccessible for painting after erection, the paint being furnished by the Railroad Company.

7. The contractor will be required to furnish all tools, barges and false work of every description.

8. The contractor will be required to remove all work which he may put in the river, so that there will be nothing left either to interfere with navigation or to catch drift.

9. No holes shall be drilled or bolts placed in the piers without the express permission of the Engineer. All bolts so put in shall be removed and the holes carefully filled with Portland cement mortar, and any damages done shall be charged to the contractor.

10. The setting of the wall plate castings, including the drilling of holes in masonry for the anchor bolts, the packing of rust cement under the castings, if used, and all other work connected therewith is to be done by the contractor.

11. The contractor will be required to erect the superstructure complete in every respect including riveting ready to receive the timber floor.

12. The erection shall include the placing and riveting of the fence and the ladders over the piers.

13. The provisions as to riveting given under the head of Riveted Work, will apply to riveting done during erection.

14. Rivets connecting the floor beams with the posts shall be driven by power, and, if necessary, the contractor must procure a special machine for this purpose.

K.—TERMS.

1. The work will be paid for by the pound of finished work loaded on cars and delivered to the Chicago, Burlington & Quincy Railroad, at Chicago, the cars to go through without transfer at Chicago.

2. No material will be paid for that does not form a part of the finished structure.

3. All cost of testing shall be borne by the contractor.

4. The contractor will be required to furnish the field rivets for erection, furnishing twenty per cent. in excess of each size over and above the number actually required, but this excess will not be estimated, but considered as taking the place of the work which is not done on these rivets. The contractor for erection will be required to provide whatever rivets may be needed in excess of this surplusage.

5. The contractor will be required to furnish pin pilots, two for each size of pin, these pin pilots to be paid for at the same price per pound as the rest of the work and to belong to the Railroad Company.

6. Approximate estimates shall be made at the end of each month of material received and work performed up to that time.

7. In these estimates material received at the shops but not manufactured, will be estimated at 60 per cent. of the contract price for finished material.

8. Material manufactured but not shipped shall be estimated at 80 per cent. of the contract price.

9. Material completed and shipped shall be estimated at the full contract price.

10. The erection shall be paid for at a fixed price per span, no estimate to be made on account of any span until that span is self-sustaining.

11. Payments shall be made on or about the middle of each month, on the basis of the estimates made of work performed up to the end of the preceding month, deducting therefrom ten per cent., which will be held as security until the completion of the entire contract.

12. The four several spans shall be delivered complete in Chicago on or before the following dates:

First Span	January 1st, 1893.
Second Span	February 1st, 1893.
Third Span	July 1st, 1893.
Fourth Span	August 1st, 1893.

13. It is expected that the masonry will be ready for the first span on or before January 1st, 1893; for the second span on or before February 1st, 1893; and for the other two spans on or before July 1st, 1893.

14. The erection shall follow the delivery of the material, if the river is in a suitable condition to permit of it, and the entire erection shall be completed so that the track can be laid across the bridge on or before October 15th, 1893.

15. These dates are of the essence of the contract, and no monthly estimates will be paid to the contractor while he is in arrears in deliveries or erection; and in case of the failure of the contractor to have the work completed so that the track can be laid across the bridge by October 15th, 1893, he will be held responsible for all expenses and other damages which the railroad company may be put to by reason of such delay.

May 23d, 1892.

GEO. S. MORISON,
Chief Engineer, St. Louis Extension.

APPENDIX G.

TEST OF STEEL EYE BARS.

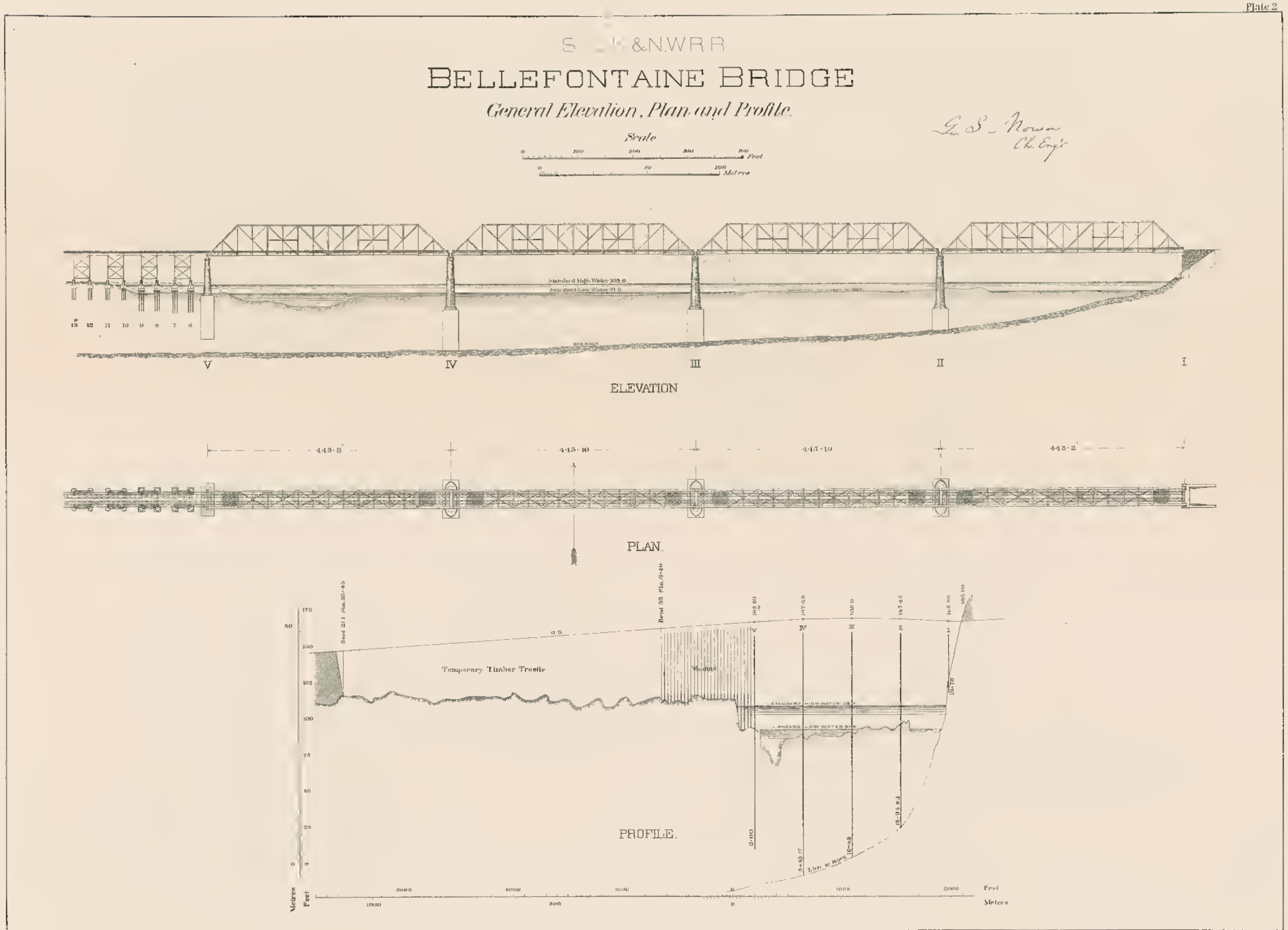
Remarks	Tests on Full Size Eye Bars. Dimensions, Inches. Original. Nominal. Width.	Nominal. Thickness.	Actual. Length C. to C.	Actual. Gaug'd Length.	Actual. Width.	Actual. Thickness.	After Test. Width.	After Test. Thickness.	Results of Mechanical Tests. Reduction of Area Per Cent.	Elongation. Inches.	Elongation. Per Cent.	Elastic Limit. Lbs. per sq. inch.	Maximum Load, Lbs. per sq. inch.	Place of Fracture.	Tests on Sample Bars from Same Melts. Melt Number.	Areas. Original sq. inch.	Areas. After testing sq. inch.	Reduction. Per Cent.	Elongation. Per Cent.	Elastic Limit. Lbs. per sq. inch.	Maximum Load. Lbs. per sq. inch.	Phosphorus Per Cent.	Kind of Steel.	Made by	Forged by	Tested by
Bar 38.88 ft. long cut in two pieces, first half	7	1 1/16	136.29	96	7.12	1.06	5.75	0.81	38.3	10.6	11.1	37 035	73 380	Body.	70 280	1.203	.649	46.1	29.4	39 900	68 080	.010	Basic Open Hearth	Carnegie Steel Co.	Keystone Bridge W'ks.	Keystone Bridge W'ks.
second half	7	1 1/16	239.98	204	7.13	1.06	......	......	......	10.3	5.0	37 840	67 080	Flaw in head.									" " "	" " "	" " "	" " "
	7	1 3/8	239.29	204	7.00	1.35	......	......	......	13.8	6.8	33 700	58 470	" " "	70 261	1.116	.539	51.7	27.5	39 600	62 100	.016	" " "	" " "	" " "	" " "
	7	1 3/8	239.92	204	7.02	1.37	5.50	1.01	42.2	40.4	19.8	36 756	65 675	Body.	70 255	1.150	.608	47.1	30.0	38 700	64 870	.021	" " "	" " "	" " "	" " "
Bar 38.87 ft. long cut in two pieces, first half	10	2	239.97	192	10.15	2.00	7.68	1.40	47.0	37.0	19.3	32 450	59 380	"	8 854	1.307	.670	48.7	30.0	38 640	65 110	.048	Acid " "	" " "	" " "	Union Bridge Co.
second half	10	2	132.37	84	10.15	2.00	8.10	1.53	39.0	20.0	23.8	33 660	60 380	"									" " "	" " "	" " "	" " "
Bar 38.87 ft. long cut in two pieces, first half	10	1 3/4	239.37	192	9.97	1.75	8.12	1.39	35.3	26.0	13.5	33 660	66 040	"	013 699	1.183	.529	55.3	31.2	39 730	62 390	.024	Basic " "	" " "	" " "	" " "
second half	10	1 3/4	132.17	84	9.95	1.75	7.78	1.33	40.5	18.8	22.4	33 290	67 360	"									" " "	" " "	" " "	" " "
Bar 38.88 ft. long cut in two pieces, first half	7	1 1/16	241.57	204	7.07	1.06	5.38	0.76	45.4	42.1	20.6	33 500	61 810	"	70 256	1.383	.653	52.8	31.2	36 370	62 040	.024	" " "	" " "	" " "	" " "
second half	7	1 1/16	136.97	108	7.07	1.06	5.55	0.70	48.2	20.5	19.0	34 855	61 810	"									" " "	" " "	" " "	" " "
Bar 38.88 ft. long cut in two pieces, first half	10	1 3/4	238.77	192	10.06	1.73	7.95	1.32	39.7	40.0	20.8	33 660	66 110	"	70 256	"	"	"	"	"	"	"	" " "	" " "	" " "	" " "
second half	10	1 3/4	132.37	84	10.06	1.75	8.17	1.36	36.9	20.1	23.9	33 930	67 180	"									" " "	" " "	" " "	" " "
Bar 47.15 ft. long cut in two pieces, first half	9	1 1/4	232.07	192	9.00	1.25	6.82	0.88	46.7	48.6	25.3	33 540	61 640	"	70 308	1.071	.497	53.6	28.7	40 150	63 030	.026	" " "	" " "	" " "	" " "
second half	9	1 1/4	237.12	192	9.03	1.25	7.00	0.92	43.0	39.0	20.3	33 780	61 970	"									" " "	" " "	" " "	" " "
Bar 54.97 ft. long cut in two pieces, first half	10	1 1/4	279.97	240	10.04	1.25	9.07	1.09	21.2	40.4	16.9	36 240	68 740	"	70 280	1.203	.649	46.1	29.4	39 900	68 080	.010	" " "	" " "	" " "	" " "
second half	10	1 1/4	280.47	240	10.05	1.25	7.96	0.97	38.5	45.3	18.9	34 910	66 900	"									" " "	" " "	" " "	" " "
	7	1 3/8	239.97	204	7.17	1.37	5.52	1.00	43.8	40.5	19.9	43 620	71 140	"	70 257	1.450	.789	45.6	28.0	38 350	62 830	.019	" " "	" " "	" " "	" " "
Bar 54.97 ft. long cut in two pieces, first half	10	2 5/16	284.17	240	10.05	2.33	9.78	2.28	4.8	10.9	4.5	32 310	51 810	Not broken.*	11 745	1.445	.796	44.9	24.0	34 950	67 200	.023	" " "	" " "	" " "	" " "
second half	10	2 5/16	283.17	240	10.03	2.34	9.82	2.29	4.2	10.0	4.2	32 680	52 500	" " *									" " "	" " "	" " "	" " "
Bar 54.97 ft. long cut in two pieces, first half	10	2 5/8	281.17	240	10.05	2.63	9.85	2.56	4.6	9.3	3.9	30 480	47 070	" " *	70 272	1.325	.679	48.8	28.0	39 550	63 780	.011	" " "	" " "	" " "	" " "
Above piece planed for 10 ft. to area equivalent to 75 per cent of original	.....	.....	292.27	96	6.74	2.56	5.30	1.98	42.1	14.8	15.4	30 480	61 110	Broken in planed section.†									" " "	" " "	" " "	" " "
second half	10	2 5/8	280.77	240	10.06	2.63	9.94	2.60	3.3	7.1	3.0	33 130	47 020	Not broken.*									" " "	" " "	" " "	" " "
Bar 52.97 ft. long cut in two pieces, first half	10	2 1/2	268.47	228	10.01	2.50	9.80	2.43	4.9	9.0	3.9	31 210	48 890	" " *	70 288	1.258	.678	46.1	28.0	39 350	64 230	.011	" " "	" " "	" " "	" " "
Above piece planed for 10 ft. to area equivalent to 75 per cent of original	.....	.....	278.77	108	6.97	2.43	5.53	1.90	41.0	23.1	21.4	31 210	63 300	Broken in planed section.†									" " "	" " "	" " "	" " "
second half	10	2 1/2	268.57	228	10.00	2.50	9.78	2.43	4.9	10.3	4.5	31 820	49 380	Not broken.*									" " "	" " "	" " "	" " "
Above piece planed for 10 ft. to area equivalent to 75 per cent of original	.....	.....	280.67	108	7.02	2.43	5.22	1.73	49.7	19.6	18.2	31 820	59 700	Broken in planed section.†									" " "	" " "	" " "	" " "
Bar 52.97 ft. long cut in two pieces, first half	10	2 3/8	269.97	228	10.04	2.38	9.82	2.33	4.3	8.4	3.7	30 890	49 330	Not broken.*	70 265	1.270	.607	47.5	28.7	37 710	63 700	.013	" " "	" " "	" " "	" " "
Above piece planed for 10 ft. to area equivalent to 75 per cent of original	.....	.....	280.17	108	7.31	2.33	5.81	1.80	41.2	16.8	15.6	30 890	63 860	Broken in planed section.†									" " "	" " "	" " "	" " "
second half	10	2 3/8	269.47	228	10.02	2.37	9.75	2.31	5.2	11.0	4.8	32 290	50 930	Not broken.*									" " "	" " "	" " "	" " "
Bar 38.87 ft. long cut in two pieces, first half	10	2 5/8	238.67	192	10.06	2.63	9.88	2.57	4.0	6.1	3.2	29 520	46 170	" " *	11 068	1.252	.667	46.7	27.0	41 050	63 900	.014	" " "	" " "	" " "	" " "
second half	10	2 5/8	131.27	84	10.06	2.63	9.90	2.57	3.9	3.1	3.7	29 900	46 480	" " *									" " "	" " "	" " "	" " "
Bar 38.87 ft. long out in two pieces, first half	10	2 3/8	238.37	192	10.00	2.35	9.70	2.26	6.7	11.6	6.0	31 070	50 430	" " *	70 298	1.333	.729	45.3	23.7	38 640	65 570	.015	" " "	" " "	" " "	" " "
second half	10	2 3/8	130.47	84	10.00	2.35	9.76	2.29	4.9	4.1	2.9	33 500	49 300	" " *									" " "	" " "	" " "	" " "
Bar 52.97 ft. long cut in two pieces, first half	10	2 3/8	287.95	240	10.08	2.37	7.86	1.72	43.3	29.2	12.2	32 530	66 900	Body.	2 153	1.010	.553	45.3	25.0	40 000	67 910	.029	" " "	" " "	Union Bridge Co.	U. B. Co. to limit of machine. Phœnix Br. Co. to destruction.
second half	10	2 3/8	292.75	252	10.06	2.37	7.98	1.78	40.4	29.4	11.7	33 365	69 500	"									" " "	" " "	" " "	" " "
Bar 52.97 ft. long cut in two pieces, first half	10	2 1/2	280.45	240	10.08	2.47	8.10	1.88	38.8	30.1	12.6	32 350	67 600	"	2 150	1.588	.855	46.2	27.0	39 730	67 440	.025	" " "	" " "	" " "	" " "
second half	10	2 1/2	280.35	240	10.08	2.50	7.85	1.85	42.4	31.2	13.0	31 570	64 300	"									" " "	" " "	" " "	" " "
Bar 54.97 ft. long cut in two pieces, first half	10	2 5/16	303.05	252	10.09	2.31	7.70	1.59	47.5	35.5	14.1	31 670	61 800	"	8 864	1.225	.681	44.4	28.0	38 930	66 110	.057	Acid " "	" " "	" " "	" " "
second half	10	2 5/16	303.95	264	10.09	2.31	7.78	1.70	43.2	36.7	13.9	32 550	63 400	"									" " "	" " "	" " "	" " "
Bar 54.97 ft. long cut in two pieces, first half	10	1 1/4	289.35	240	10.06	1.26	7.95	0.95	40.5	32.3	13.5	33 460	61 280	"	70 258	1.384	.700	49.4	28.1	37 570	64 600	.019	Basic " "	" " "	" " "	Union Bridge Co.
second half	10	1 1/4	290.30	240	10.06	1.26	8.30	0.99	35.2	32.3	13.5	33 940	64 020	"									" " "	" " "	" " "	" " "
Bar 54.97 ft. long cut in two pieces, first half	10	2 5/8	292.53	252	10.06	2.63	......	......	......	6.3	2.5	32 380	45 100	Body, in flaw at grip marks.	9 115	1.117	.554	50.4	25.0	40 560	66 610	.038	Acid " "	" " "	" " "	" " "
second half	10	2 5/8	292.15	252	10.06	2.63	7.80	1.98	41.6	35.5	14.1	32 230	61 200	Body.									" " "	" " "	" " "	U. B. Co. to limit of machine. Phœnix Br. Co. to destruction.
Bar 54.97 ft. long cut in two pieces, first half	10	2 5/16	282.63	240	10.02	2.30	7.83	1.78	39.5	31.3	13.0	31 900	61 800	"	14 215	1.015	.558	45.0	22.0	40 780	67 190	.016	Basic " "	" " "	Keystone Bridge W'ks.	Phœnix Bridge Co.
second half	10	2 5/16	270.28	240	10.00	2.30	7.83	1.75	40.4	47.9	20.0	33 300	63 100	"									" " "	" " "	" " "	" " "
Bar 54.97 ft. long cut in two pieces, first half	10	1 1/4	280.40	240	10.01	1.24	9.54	1.16	10.8	22.3	9.3	36 700	69 900	Body (slight flaw).	11 193	1.010	.559	44.7	27.0	40 000	67 030	.017	" " "	" " "	" " "	" " "
second half	10	1 1/4	280.40	240	10.02	1.25	8.18	0.96	37.3	43.6	18.2	37 600	71 400	Body.									" " "	" " "	" " "	" " "
	7	1 3/8	239.87	204	7.00	1.37	Area =	5.67	41.1	31.7	15.6	36 060	67 550	"	11 195	1.015	.567	44.1	22.0	39 900	67 190	.021	" " "	" " "	" " "	Keystone Bridge W'ks.
	7	1 3/8	239.87	204	7.00	1.37	" "	5.15	44.3	42.3	20.7	34 036	62 530	"	11 169	.990	.500	49.5	25.5	41 930	68 110	.013	" " "	" " "	" " "	" " "
	9	1 1/4	566.14	528	8.86	1.23	6.92	0.92	41.6	64.0	12.1	33 580	66 330	"	70 319	1.261	.591	53.1	29.0	36 710	62 480	.010	" " "	" " "	" " "	Phœnix Bridge Co.
	7	1 1/16	466.54	420	7.08	1.04	5.62	0.80	38.9	42.9	10.2	35 870	65 220	"	11 169	.990	.500	49.5	25.5	41 930	68 110	.013	" " "	" " "	" " "	" " "
	10	2 1/2	466.46	420	10.02	2.52	7.50	1.67	50.4	85.9	20.4	29 700	56 300	"	11 602	1.534	.800	47.9	27.5	37 810	68 720	.010	" " "	" " "	" " "	" " "
	10	2 3/8	466.42	420	10.08	2.36	7.90	1.81	39.9	48.6	11.6	30 900	60 780	"	10 130	1.040	.564	43.7	28.0	38 850	64 990	.026	" " "	" " "	" " "	" " "
	10	1 3/4	466.46	420	10.03	1.72	7.43	1.06	54.3	54.8	13.0	30 430	56 170	"	2 160	1.209	.600	50.3	28.7	40 360	65 430	.011	" " "	" " "	" " "	" " "
Bar 54.97 ft. long cut in two pieces, first half	10	2 5/8	279.64	240	10.06	2.60	7.52	1.94	44.2	44.5	18.5	28 440	54 470	"	15 154	1.452	.718	50.6	31.2	34 640	62 470	.018	" " "	" " "	" " "	" " "
second half	10	2 5/8	280.12	240	10.07	2.61	8.06	2.09	35.9	42.4	17.7	30 250	58 220	"									" " "	" " "	" " "	" " "
Bar 54.97 ft. long cut in two pieces, not reannealed after forging new heads, first half	10	2 5/8	291.58	252	10.00	2.62	7.95	2.02	38.7	31.8	14.6	32 180	58 970	"	9 115	1.117	.554	50.4	25.0	40 560	66 610	.038	Acid " "	" " "	Union Bridge Co.	" " "
second half	10	2 5/8	290.30	252	10.04	2.62	9.94	2.60	1.8	3.8	1.5	30 040	34 220	Body, in grip marks.									" " "	" " "	" " "	" " "
Second half of above reheaded and reannealed	10	2 5/8	223.04	180	9.97	2.59	7.57	1.88	44.9	27.9	15.5	33 460	59 370	Body.									" " "	" " "	" " "	" " "

* Results from highest strain to which bar was subjected. † Combined results of two tests.

Plate I.

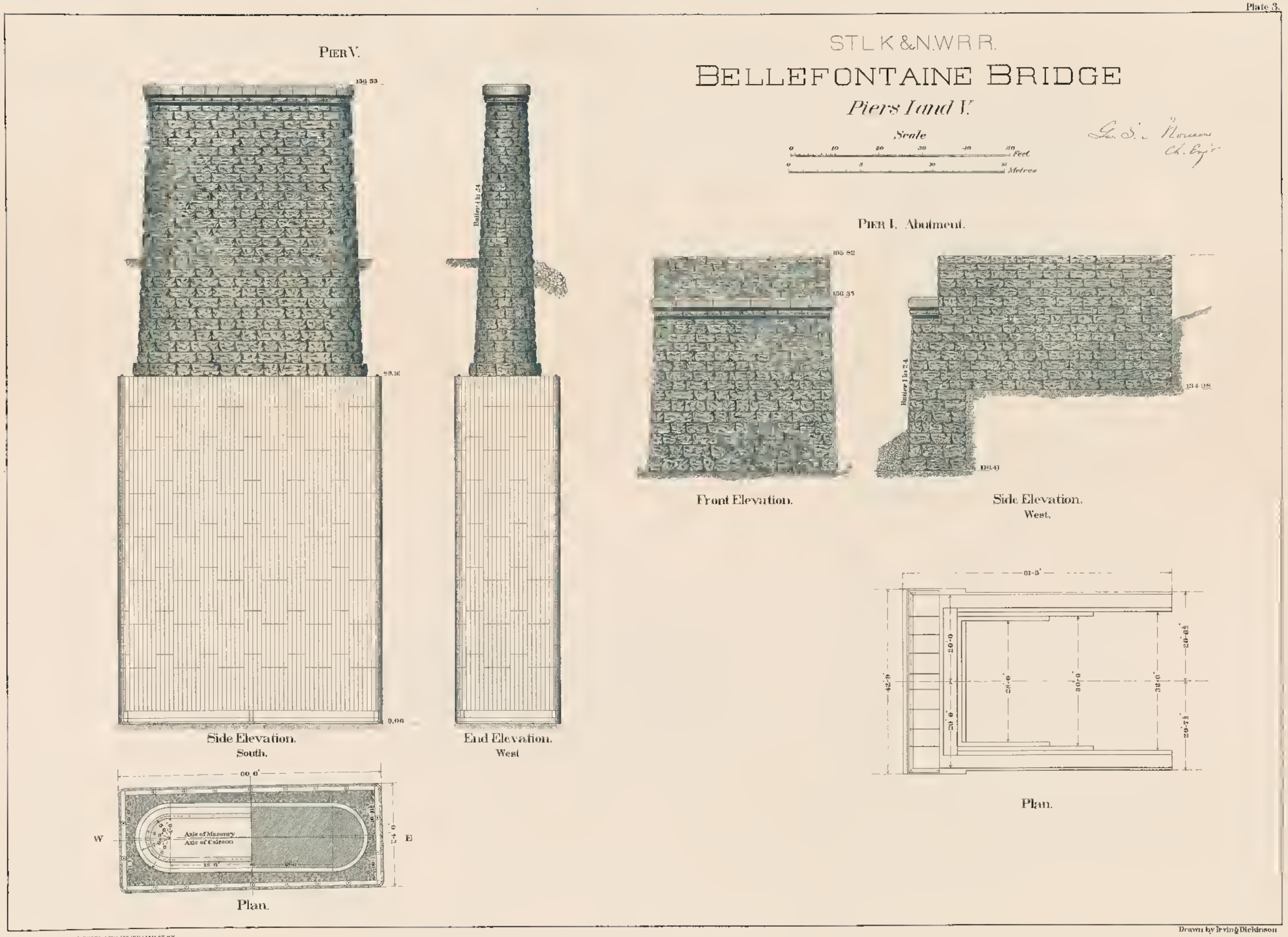
ROBERTA WELKE PHOTO LITH 178 WILLIAM ST NY

Drawn by Irving Dickinson



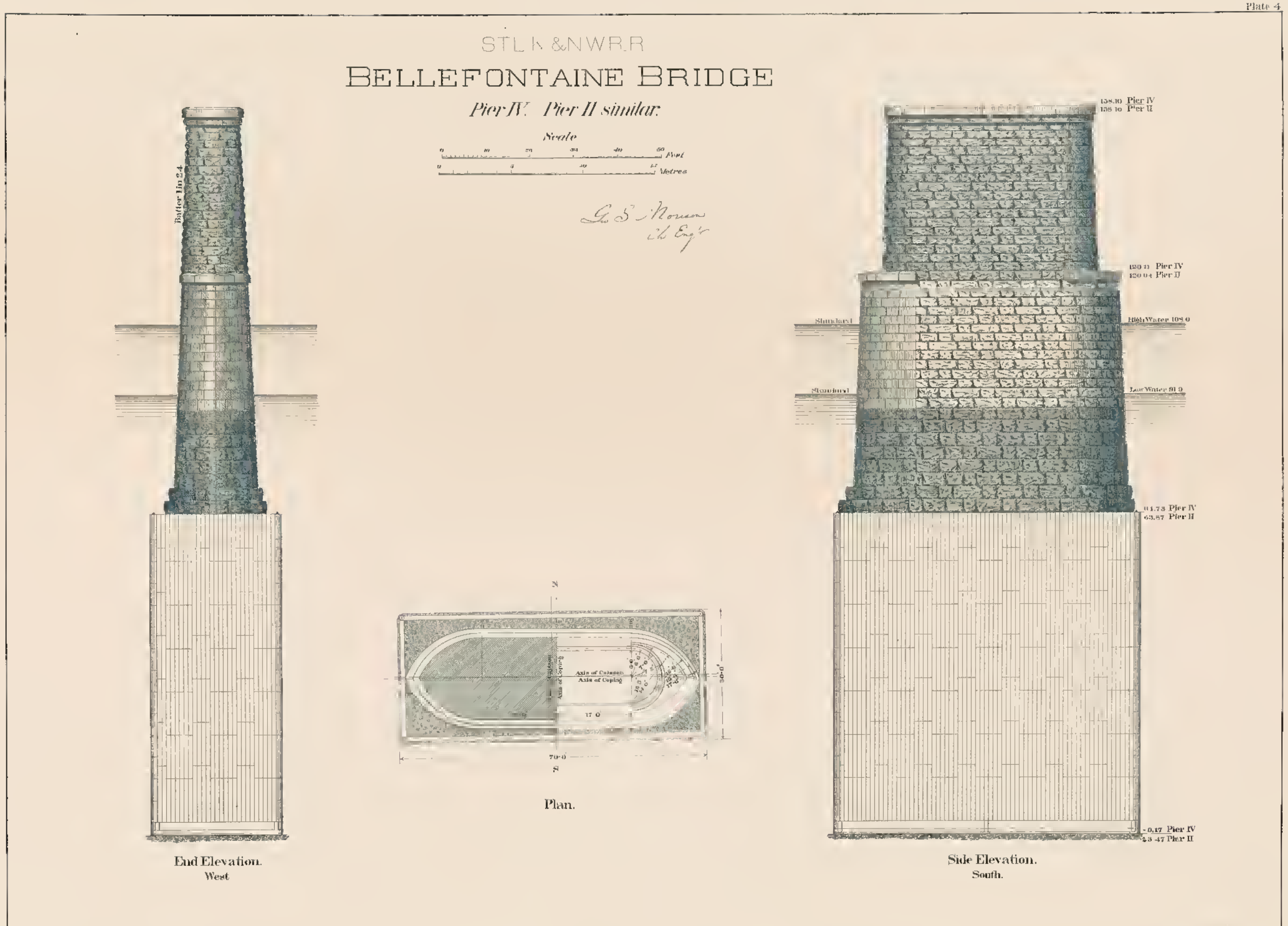
ROBERT A. WELKE PHOTO. LITH. 178 WILLIAM ST. N.Y.

Drawn by Irving Dickinson.

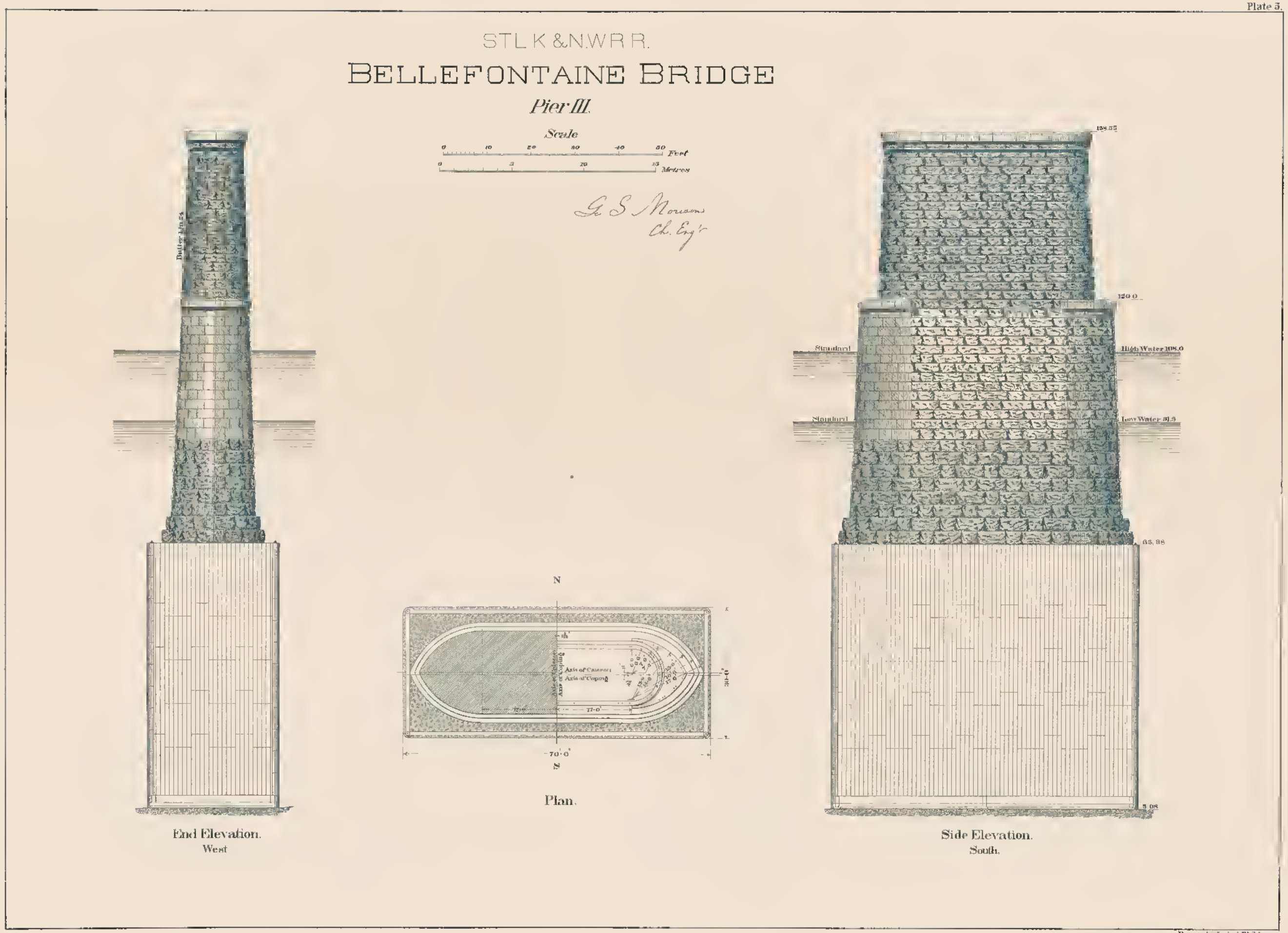


Drawn by Irving Dickinson

ROBERTA WELKE PHOTO LITH 179 WILLIAM ST NY



ROBERTA WELKE PHOTO-LITH 178 WILLIAM ST N.Y.
Drawn by Irving Dickinson



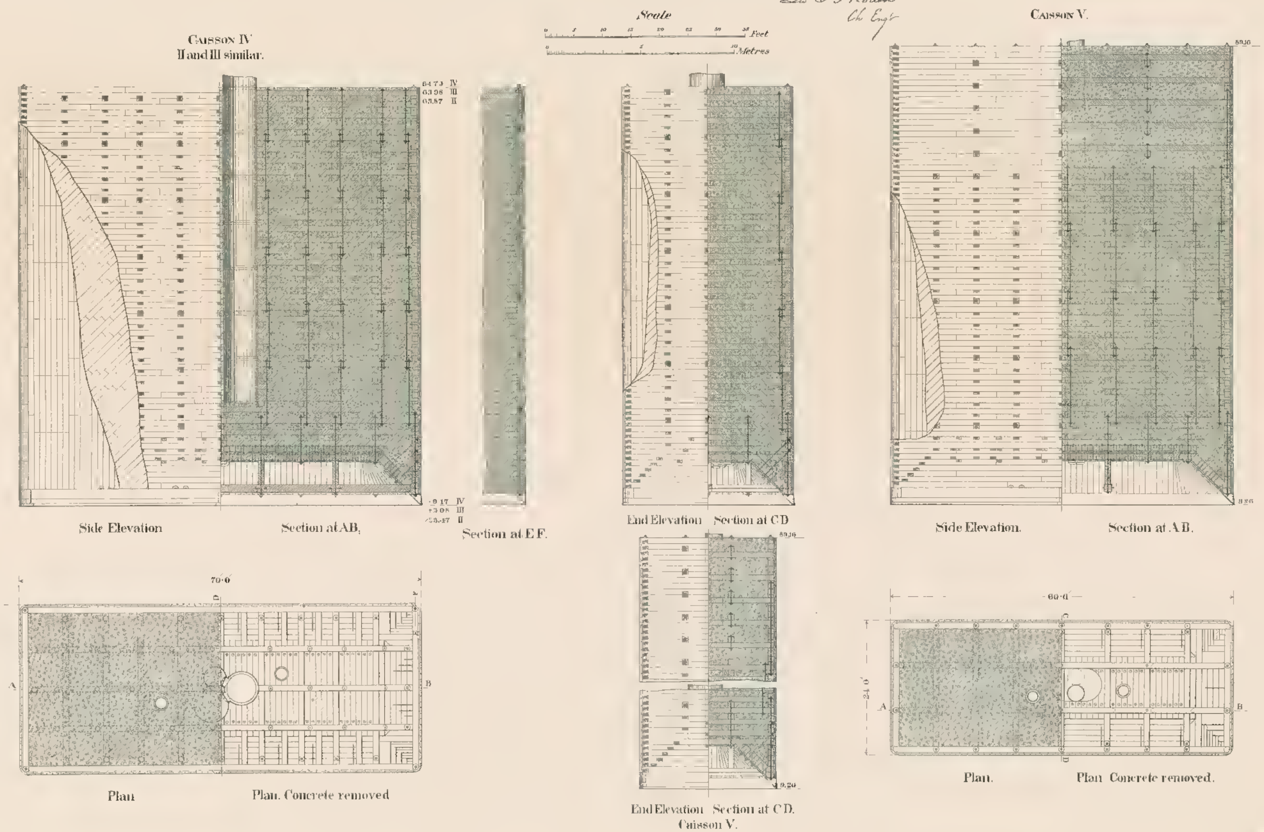
ROBERTA WEISE PHOTO LITH 178 WILLIAM ST N.Y. Drawn by Irving Dickinson

ST. L. K. & N. W. R. R.

BELLEFONTAINE BRIDGE

Caissons.

G. S. Morison
Ch. Engr.



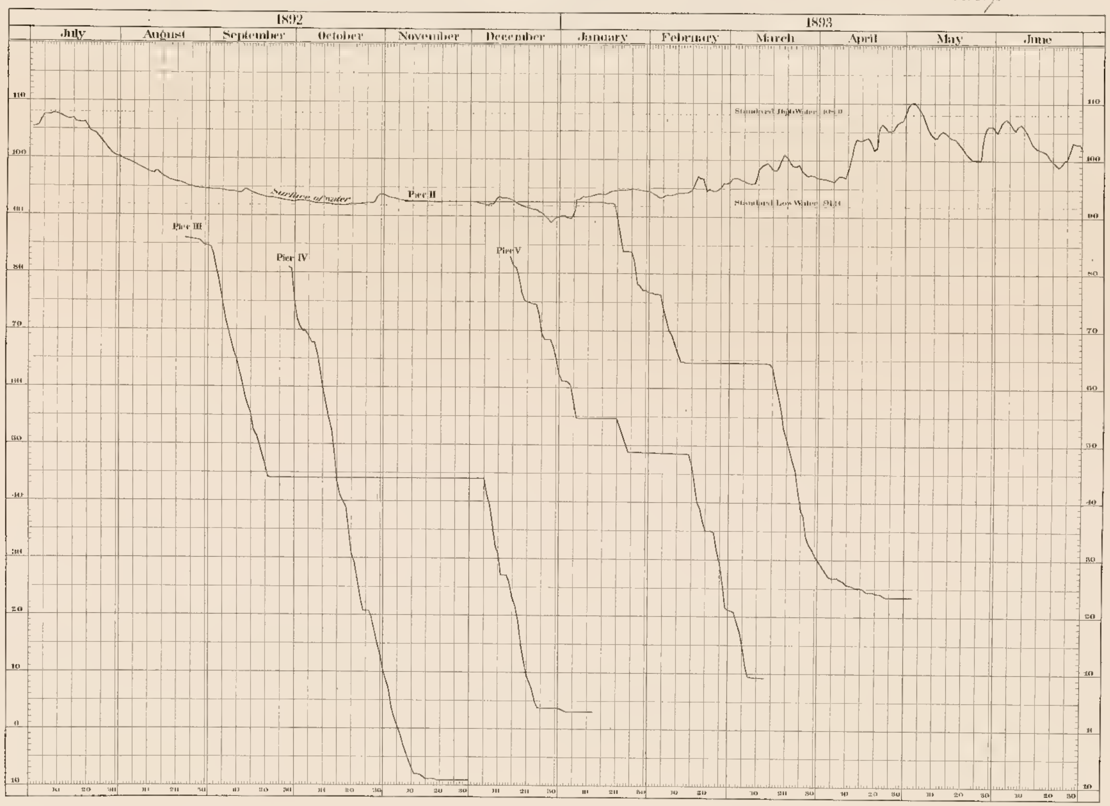
Roberts & Lee Photo Lith. 119 William St. N.Y.
Drawn by Irving Dickinson.

STL K & N W R R

BELLEFONTAINE BRIDGE

Diagram showing rate of progress in sinking caissons.

G. S. Morison
Ch. Eng'r



Datum is 100 feet below St Louis City Directrix.

ROBERTA WELKE PHOTO-LITH 178 WILLIAM ST N.Y.
Drawn by Irving Dickinson.

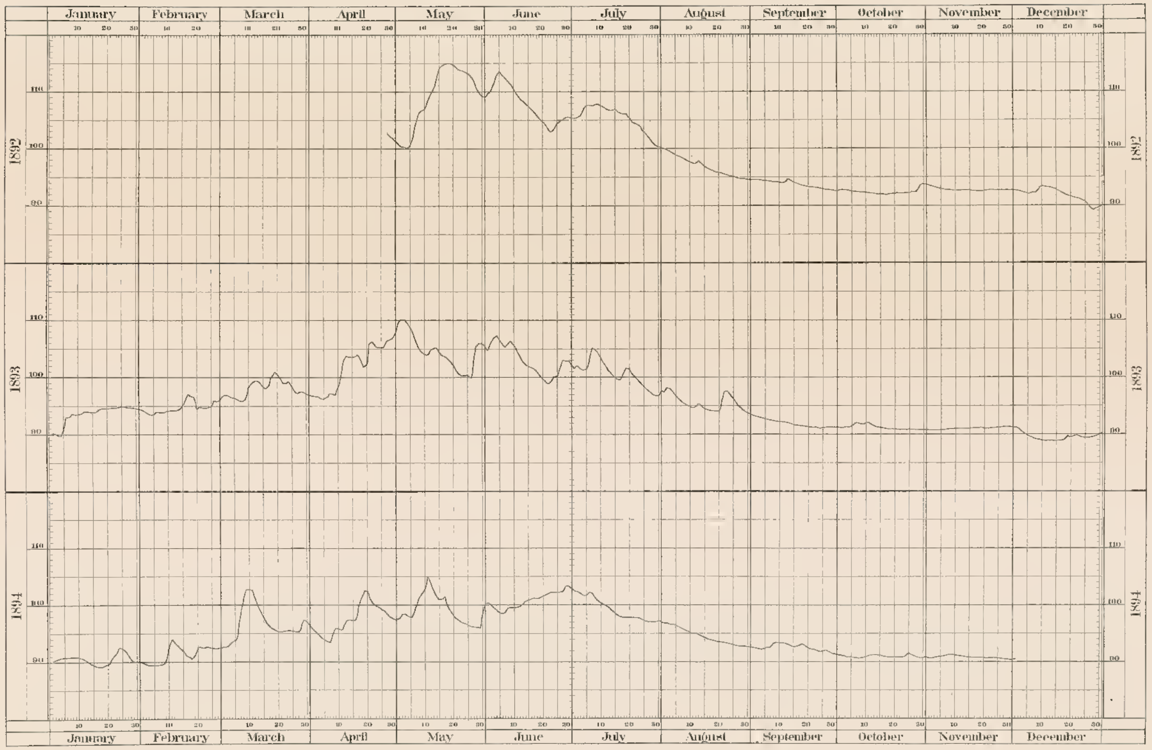
Plate 8.

ST. L. K. & N. W. R. R.

BELLEFONTAINE BRIDGE

Water Gauge Record.

Geo. S. Morison
Ch. Engr.



Datum is 100 feet below St Louis City Directrix,
or 312.731 feet above mean tide at Biloxi

Drawn by Irving Dickinson

ROBERT A. WELKE PHOTO LITH 178 WILLIAM ST. N.Y.

STL.K.&NWRR

BELLEFONTAINE BRIDGE

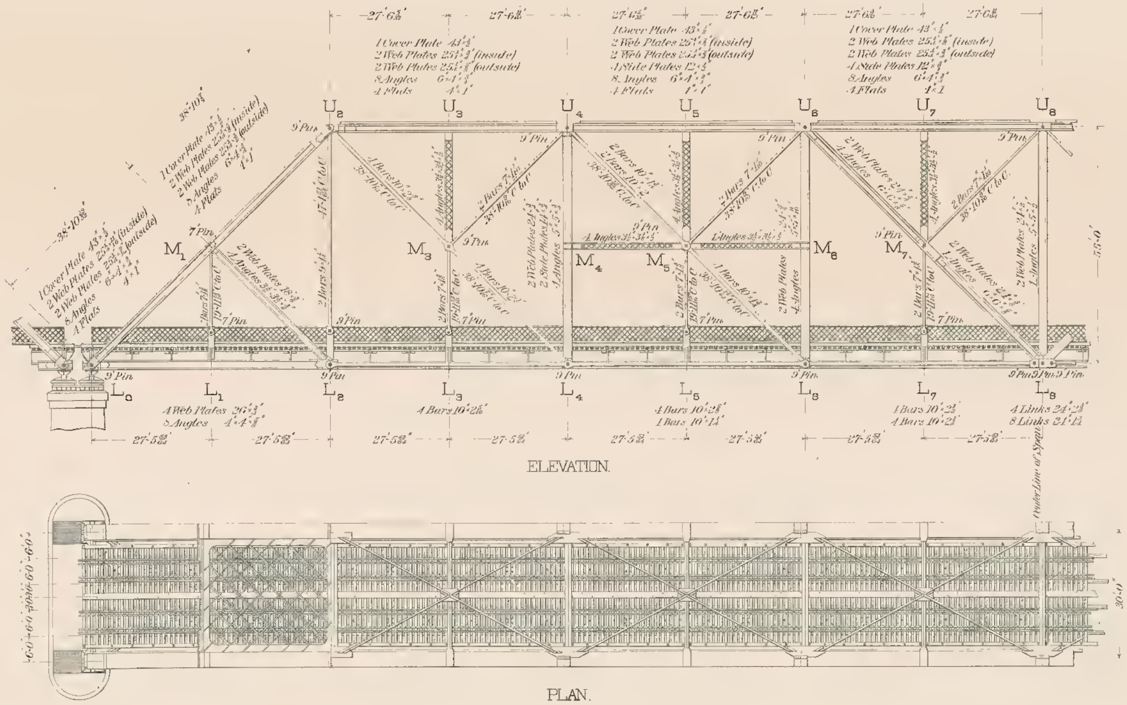
440-0" Span. General Elevation.

Scale

Feet 0 10 20 30 40 50

Metres 0 5 10 15

G. S. Morison
Ch. Engr.



ELEVATION.

PLAN.

ROBERT A. WELKE PHOTO. LITH. 178 WILLIAM ST. N.Y.

Drawn by Irving Dickinson.

ST. L. K. & N. W. R. R.

BELLEFONTAINE BRIDGE.

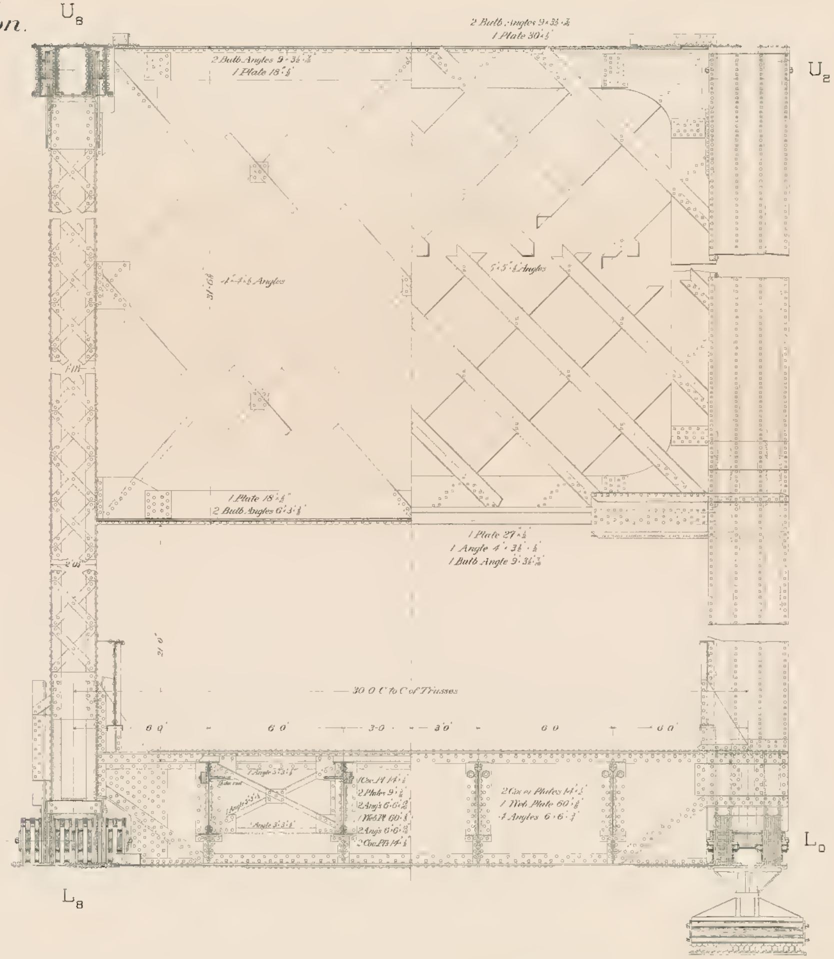
440' 0" Span. End Elevation and Section.

Scale

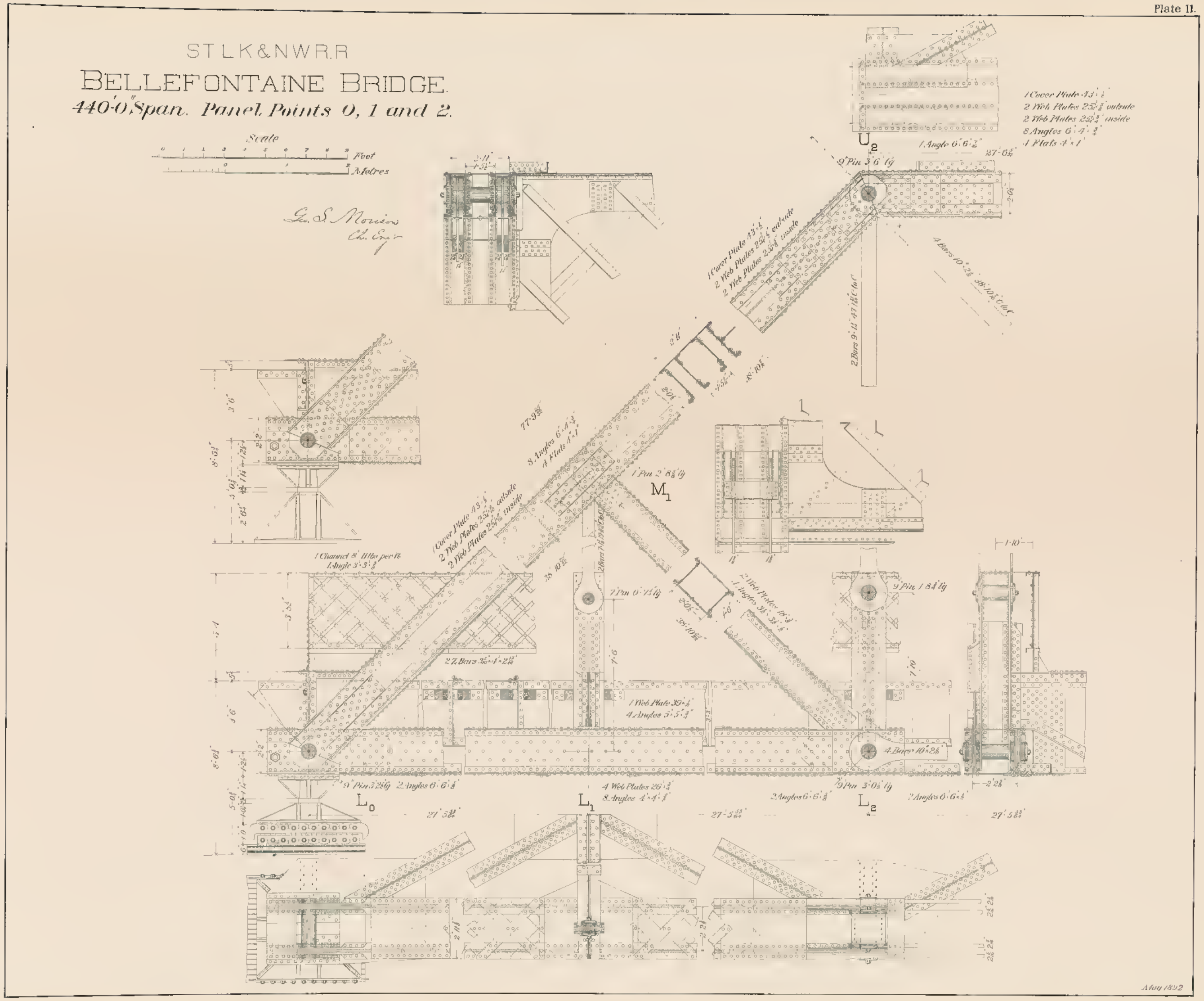
Feet

Metres

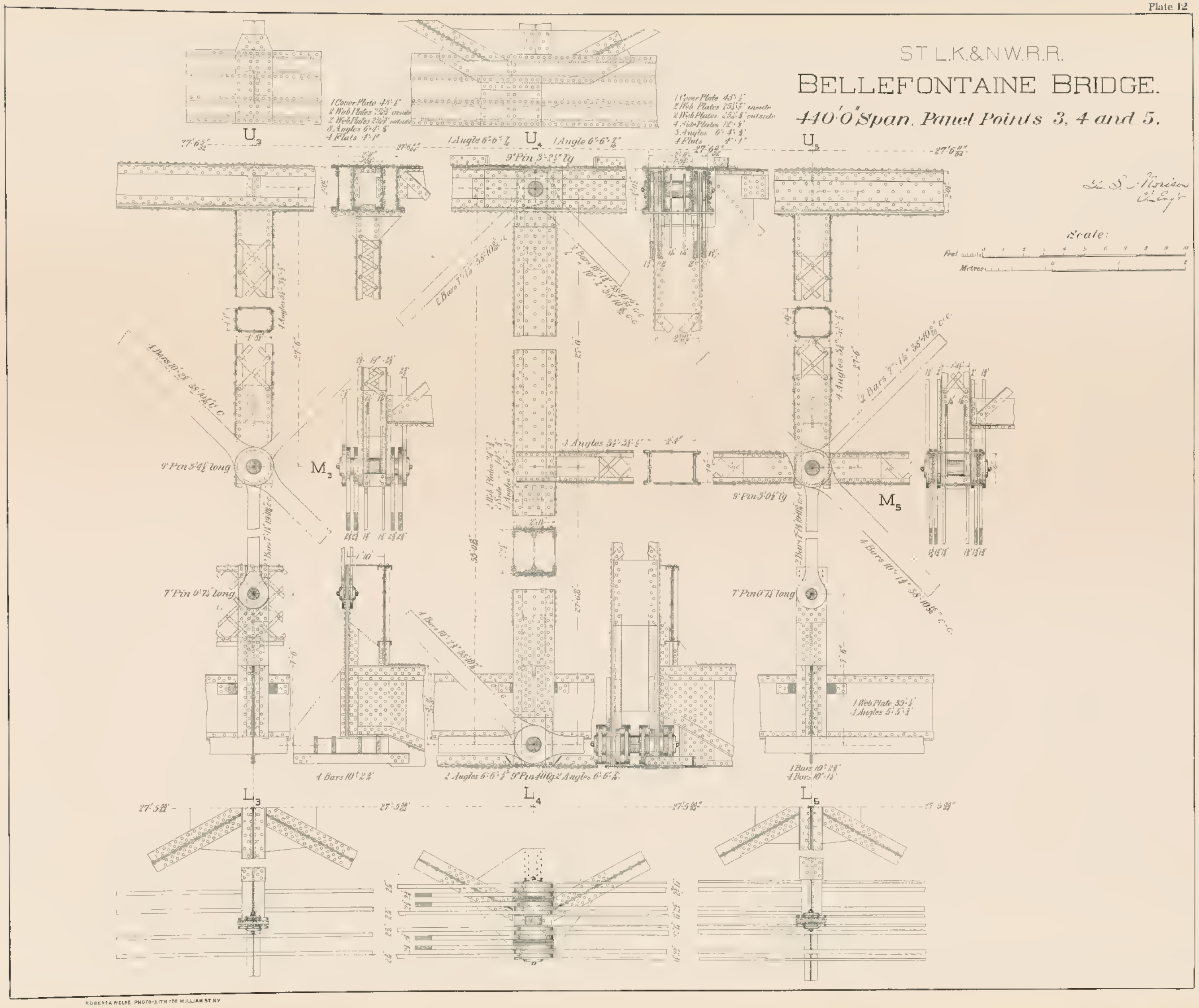
Geo. S. Morison
Ch. Engr.

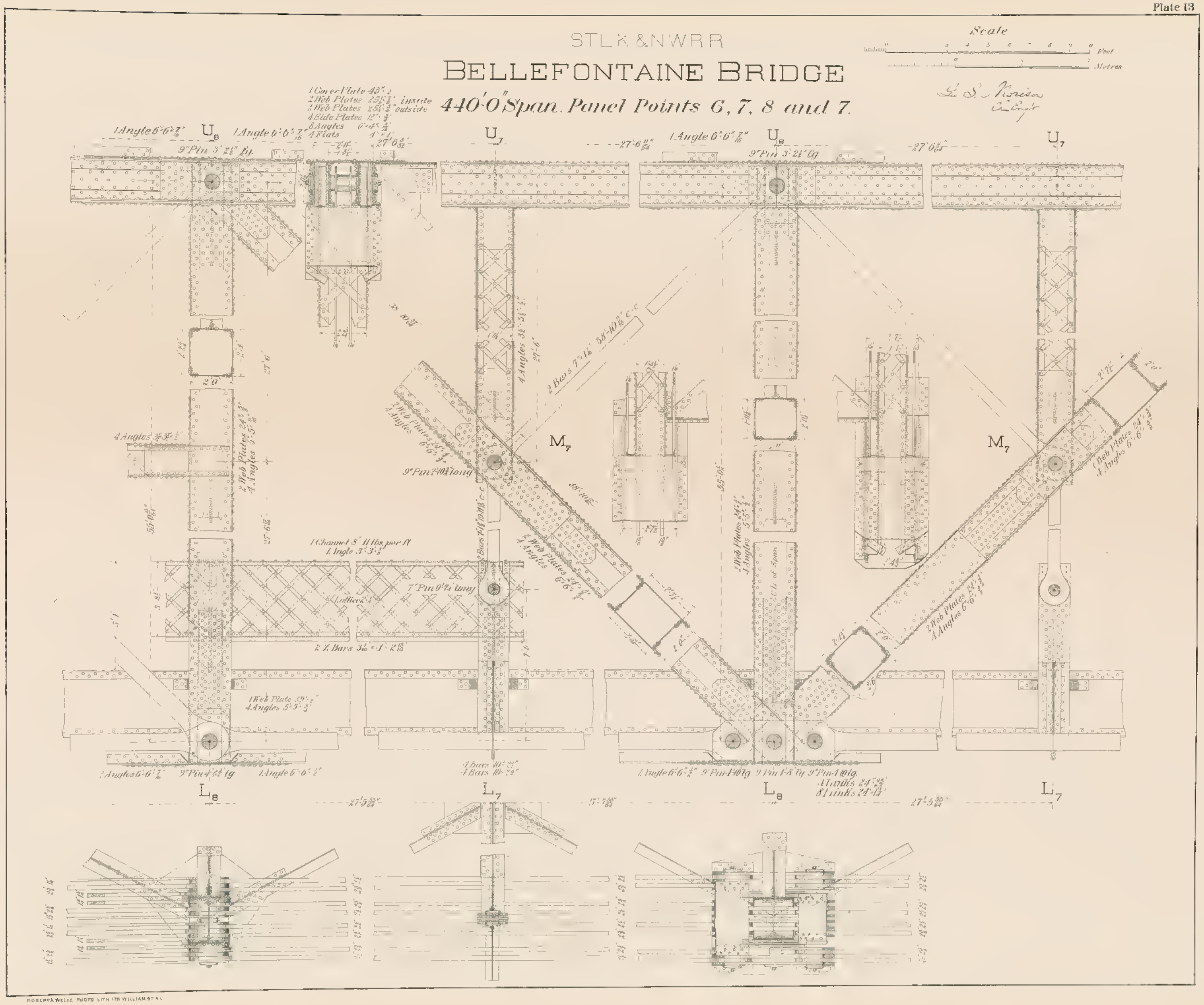


ROBERT A. WELCKE PHOT. LITH. 115 WILLIAM ST. N.Y.



ROBERTS & WELBE PHOTO-LITH 178 WILLIAM ST N.Y.


ST L.K.&N.W.R.R.
BELLEFONTAINE BRIDGE.
440'0" Span. Panel Points 3, 4 and 5.
Scale:
Feet
Metres
U3
U4
U5
M3
M5
L3
L4
L5
9" Pin 5'4½" long
7" Pin 0'7½" long
4 Bars 10"×2⅛"
1 Web Plate 39"×½"
4 Angles 5"×5"×½"


ST L K & N W R R
BELLEFONTAINE BRIDGE
440'0" Span. Panel Points 6, 7, 8 and 7.
Scale
Feet
Metres
U8
U7
U8
U7
M7
M7
L8
L7
L8
L7

ST.L.K.&N.W.R.R.

BELLEFONTAINE BRIDGE

440'0" Span. Strain Sheet.

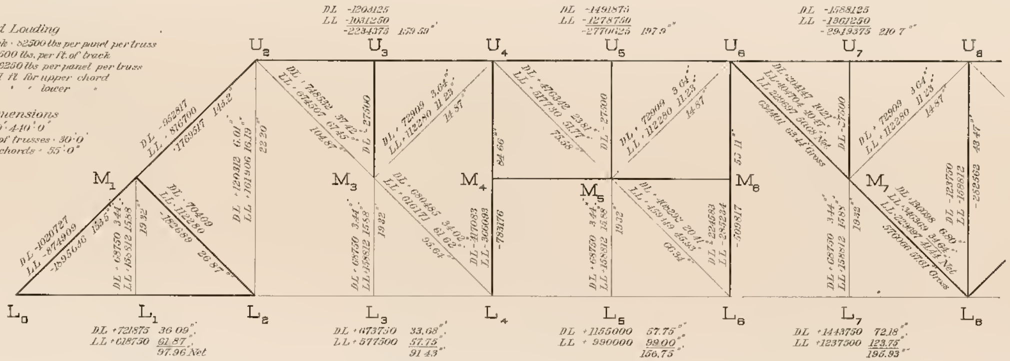
Geo. S. Morison
Ch. Eng'r

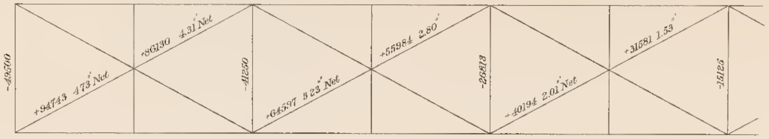
Assumed Loading

Live Load · 3000 lbs per ft. of track · 82500 lbs per panel per truss
Dead Load · 2500 lbs + 1000 lbs. · 3500 lbs. per ft. of track
· 68750 lbs + 27500 lbs · 96250 lbs per panel per truss
Wind Pressure 300 lbs per lineal ft. for upper chord
" " 600 " " " " " lower "

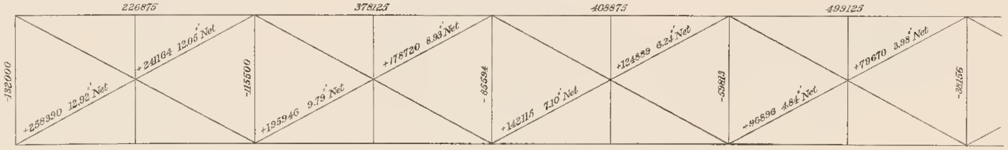
General Dimensions

8 Panels of 55'0" · 440'0"
Distance c. to c. of trusses · 30'0"
Depth c to c of chords · 55'0"



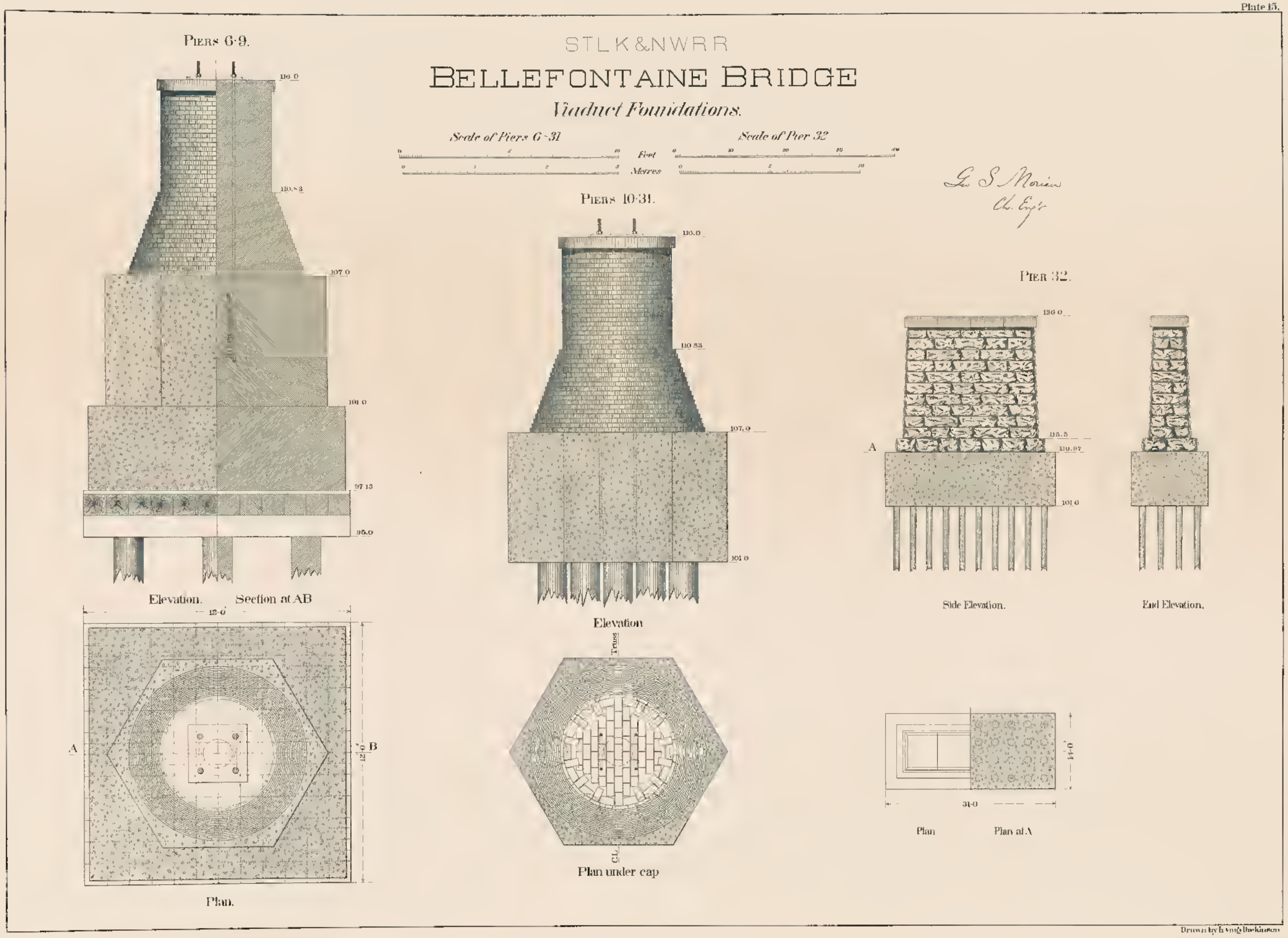


UPPER LATERAL BRACING.



LOWER LATERAL BRACING.

Drawn by Irving Dickinson



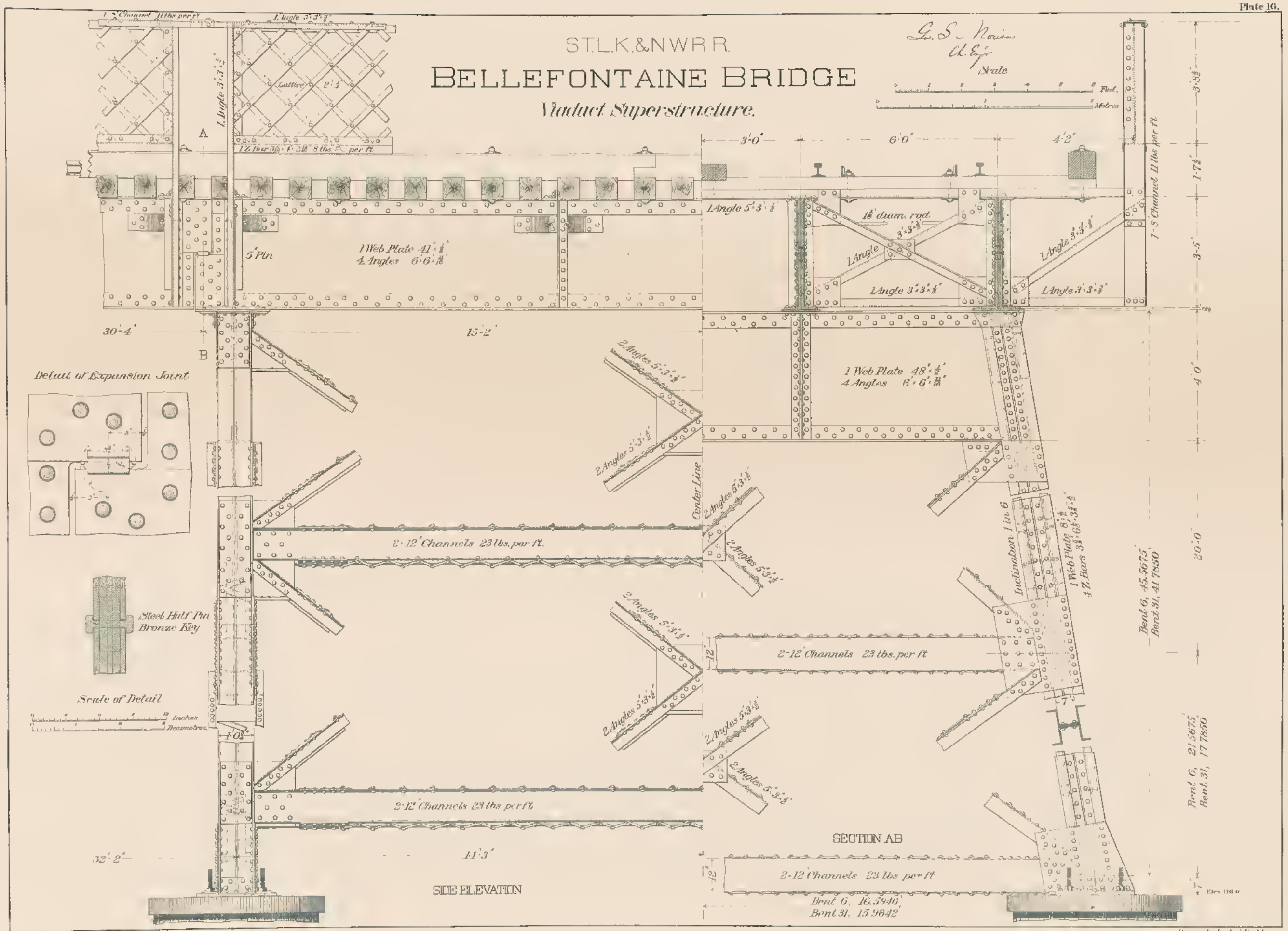
ROBERT A. WELKE PHOTO LITH 178 WILLIAM ST N.Y.

Drawn by Irving Dickinson

ST. L. K. & N. W. R. R.

BELLEFONTAINE BRIDGE

Viaduct Superstructure.



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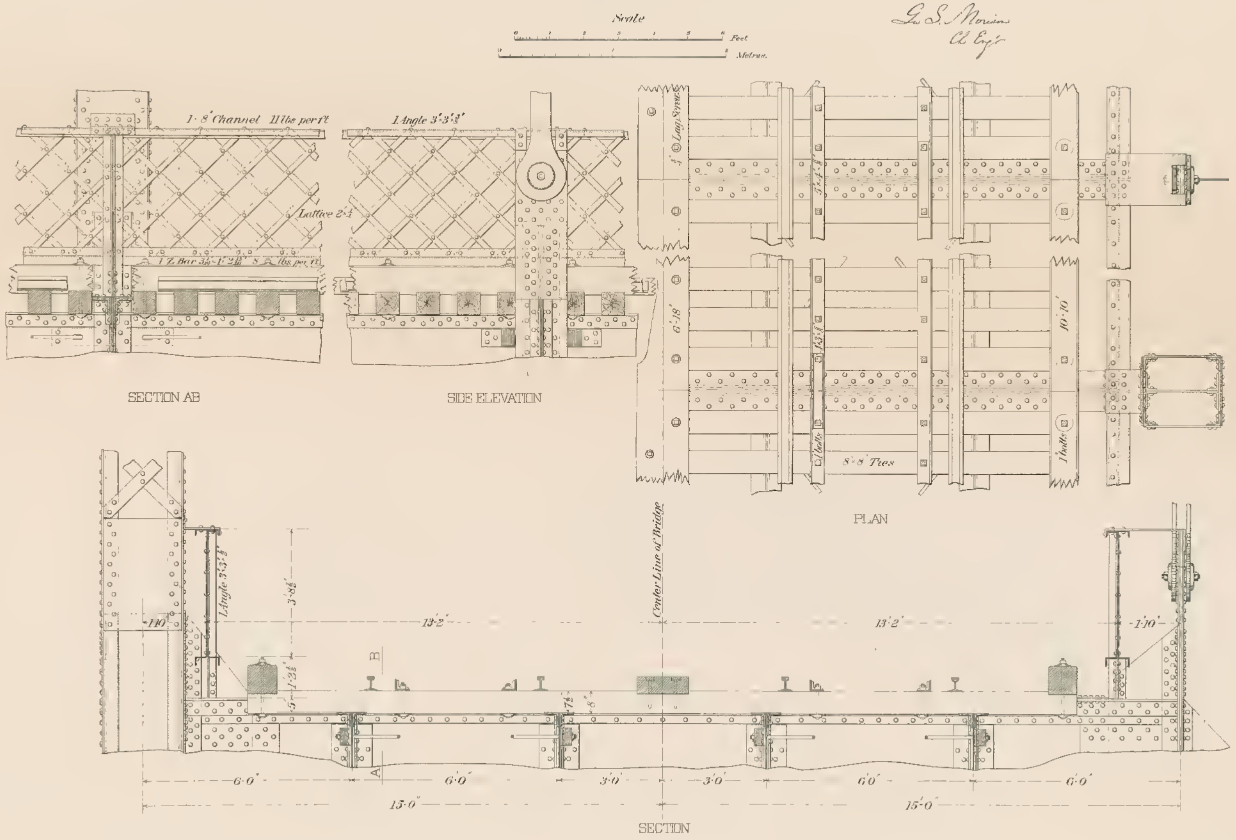
Drawn by Irving Dickinson

ST. L. K. & N. W. R. R.

BELLEFONTAINE BRIDGE

Floor.



ROBERTA WELKE PHOTO. LITH 178 WILLIAM ST N.Y.
Drawn by Irving Dickinson.

ST L K & N W R R

BELLEFONTAINE BRIDGE

Shore Protection.

ROBERTA WELKE PHOTO-LITH 178 WILLIAM ST N.Y.

Drawn by Irving Bickinson