STATE OF OHIO
THE MIAMI CONSERVANCY DISTRICT

Accounting and Cost Keeping of the Department of Engineering and Construction

BY

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TECHNICAL REPORTS
Part IX

DAYTON, OHIO
1922

Bridge at Huffman (403 cu. yds.)

		Cost Per Cu. Yd.
Superintendence and Overhead	$ 399.87	$ 0.99
Labor	10,513.66	26.09
Cement at $2.27 per barrel	1,657.10	4.11
Reinforcing Steel	1,128.58	2.80
Supplies	2,782.32	6.91
Plant Depreciation	399.84	.99
	$16,881.37	$41.89 per cu. yd.

The wage scale and the cost of materials for these jobs were about the same as those already given for the outlet and spillway structures at these dams. At the Germantown bridge the amount of cement per cubic yard of concrete was 1.7 barrels and at the Huffman bridge 1.8 barrels of cement per cubic yard were used.

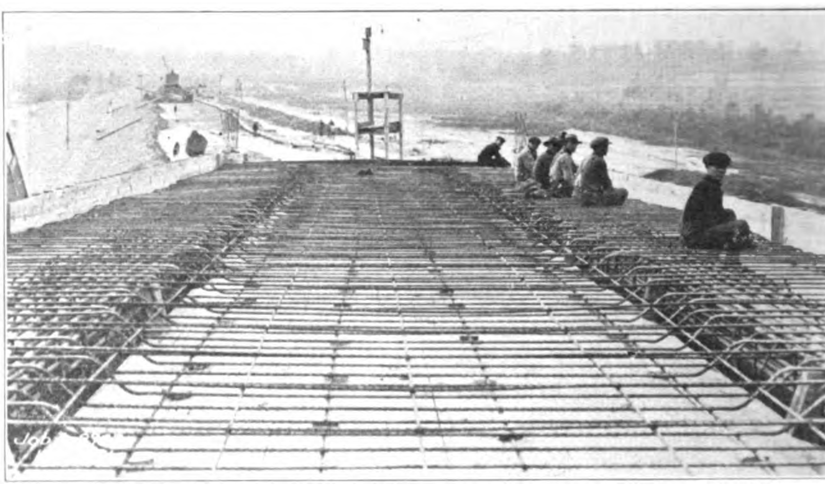

FIG. 115—STEEL IN PLACE FOR FLOOR SYSTEM FOR ONE SECTION OF TAYLORSVILLE SPILLWAY BRIDGE

Black Street Bridge at Hamilton

Description: The old Black Street Bridge at Hamilton was destroyed during the 1913 flood. Subsequently a foot bridge was erected on the same site, but the City had not considered itself able to undertake the replacement of a highway bridge at this place until about the time that the work of the District on the river channel was to be done. It was found that the interests of the District and the City would be served best by constructing a new bridge before the work of the District in this vicinity was undertaken. By such procedure the foot bridge could remain in service until the new bridge was opened to traffic, and the construction work on the bridge would not interfere with the other work of the District. Inasmuch as the District had the organization and equipment to do this work, an arrangement was made whereby the District would build the bridge and the cost would be assessed against the City.

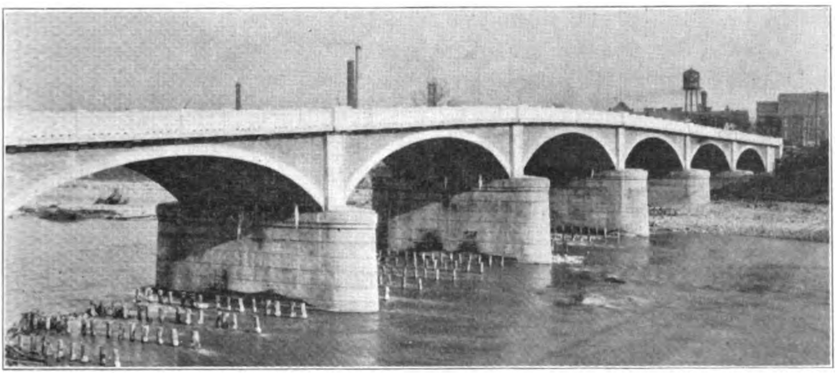

FIG. 116—BLACK STREET BRIDGE AT HAMILTON

This is a seven-span reinforced concrete structure 708 feet long with a 28-ft. roadway and two 6-ft. sidewalks. It contains nearly 10,000 cu. yds. of concrete and 340 tons of reinforcing steel.

This is a seven-span reinforced concrete bridge 708 feet long with a 28-ft. roadway and two 6-ft. sidewalks, designed for a live load of 200 pounds per square foot plus one 20-ton truck and a 50-ton street car traveling in the same direction. It contains nearly 10,000 cubic yards of concrete, and 340 tons of reinforcing steel. (See Fig. 116.)

Construction Plant: .. In Chapter II the use of a dragline machine on the excavation for these bridge piers has already been described, also in the same chapter mention has been made of the pile driving for the foundation of these piers. For the placing of the concrete a Lidgerwood cableway was erected, spanning the river on the center line of the bridge. It was used extensively, not only for the placing of the concrete but also for handling and transporting form lumber, reinforcing steel, waterproofing materials, and all other such items as were used in the construction of the bridge. For mixing the concrete a one-cubic yard Smith mixer was set up in the excavation for the east abutment directly under the line of the cableway. Details of any of this equipment may be had by reference to Chapter III. A batch hopper was installed directly above the mixer, and above that was a 33-cubic yard sand and gravel hopper. A 24-in gage track connected this sand and gravel hopper with the gravel storage pile, which had been placed on the river bank by a dragline machine which excavated for the piers. A small portable screening and washing plant was installed at this storage pile, and the prepared aggregate was hauled to the storage hopper over the mixer, in 1½-cubic yard cars hauled by a 3-ton gasoline locomotive. For the spandrel walls and railings, the concrete aggregates were purchased from a local gravel company which had recently started operations not far from the site. Close to the mixing plant a 3000-barrel cement shed was put up, and this was connected with the batch hopper by a plank runway. By extending the switch track belonging to one of the adjacent industries, it was possible to bring the cement up to this storage shed in carload lots .

Piers and Abutments: The pier footings are 62 feet in length, 20 to 24 feet wide, and vary in thickness from 6 feet at the sides to 9 feet in the center. The abutments are of the massive type commonly used for arch bridges. Before the cableway was erected, one of the abutments and a few of these footings were built by means of a small mixer set up on the bank of the excavation, the mixed concrete being handled in buckets by the dragline machine. As soon as the cableway was available, the use of the temporary mixing plant was discontinued. Each of the footings and abutments was built in three sections. A temporary hopper and chute was set up under the line of the cableway, for pouring the upstream and downstream sections. This hopper and chute were then picked up by the cableway and moved out of the way, and the middle section was poured direct. In the top of each footing were two rows of deep keyways and a large number of steel dowel bars to tie the shaft of the pier to the footing.

The pier shafts are 7 feet in thickness at the top and about 58 feet long. They are pointed, both upstream and downstream, and horizontal rustications were placed 3 feet apart on that part of the pier above low water. Forms were built in place, consisting of 2-inch lagging against 2 x 12 studding spaced 24 inches apart. The forms were held together by ¾-in. rods spaced about 4 feet apart, both horizontally and vertically, which were protected by tin tubing and afterwards removed. These piers were poured in about 6 foot lifts, the hopper and chutes set on top of the forms under the line of the cableway being used for distribution of the material. All day's-work

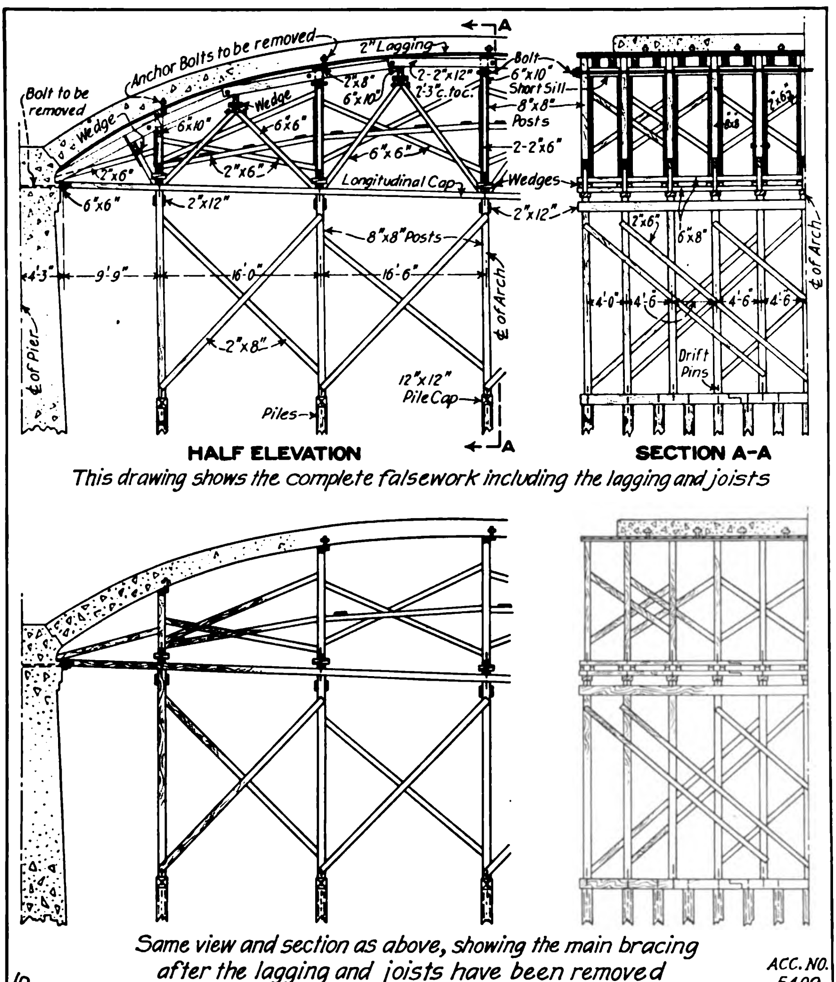

FIG. 117—DETAILS OF FALSE WORK FOR ARCHES OF BLACK STREET BRIDGE AT HAMILTON

The false work was so designed that most of it could be removed and still leave the posts in place to support the arch until the concrete was well hardened.

joints were made at rustications so as to render them practically invisible.

Several analyses of the bank run gravel at this place showed proportions of two parts gravel to one part sand with little variation. It was determined, therefore, to use the bank run material in the piers and abutments for this bridge. A mix of 5 sacks of cement per cubic yard of concrete was used except for the upstream nose of each pier, which was made of a richer mix having 6 sacks of cement per yard, because of the danger of wear from ice and drift. The concrete was mixed just wet enough to permit proper working in the forms; it was well tramped into place and carefully spaded.

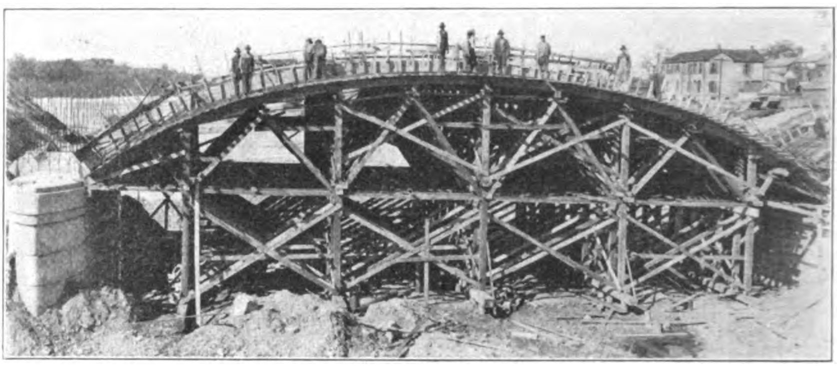

FIG. 118—VIEW OF ONE SPAN OF COMPLETED FALSE WORK OF BLACK STREET BRIDGE IN PLACE

Arches: The false work for the arches was so designed that most of it could be removed and still leave the posts in place to support the arch until the concrete was well hardened. Fig. 117 shows these details. Fig. 118 is a picture of one span of the completed false work in place. Because the posts could be left in place to carry the load while the lagging, joists, and most of the bracing were removed, it was possible to use much of the lumber several times, and of all the lumber used on the entire work about half was salvaged in good condition, and either sold or used again on other work.

Each arch was poured in three longitudinal sections of equal width, each section being poured in one run. The middle section was poured first, keys being placed in both sides. As soon as the concrete had set sufficiently to permit removal of the bulkheads, the outside sections were poured. To place the concrete, a hopper was set in the center of the arch, and chutes led to the ends of the section to be poured. Concrete was run alternately in each direction to balance the loading on the forms. It was found necessary to use top forms for a distance of 25 to 30 feet from the piers. These forms were built in sections about 6 feet long and placed one at a time as the concreting proceeded. Elevations were taken at frequent intervals while pouring, for the purpose of detecting any undue settlement that might occur. Settlement at the quarter points usually began

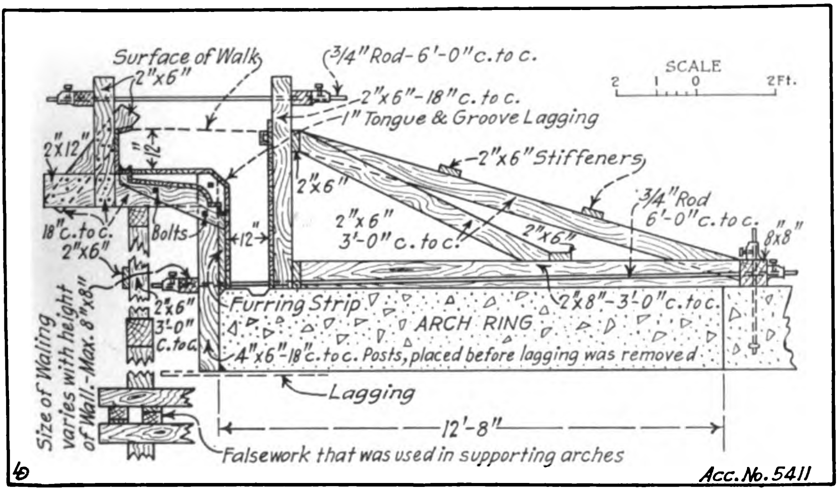

FIG. 119—FORMS AND SYSTEM OF BRACING FOR SPANDREL WALLS OF BLACK STREET BRIDGE

Outside forms were built first, most of the steel was placed next, and then the forms and bracing were completed.

when the concrete was within 5 to 10 feet from them, and in the center it did not occur until practically all of the concrete had been poured. The settlement was slight, in every case, and no more than had been provided for.

The mix used was approximately 1:2:4, using screened and washed sand and gravel, the largest of which would pass through a 3-inch circular opening. Steel stubs and keys were placed in the arch concrete to connect with the reinforcement for the spandrel walls and counterforts.

Spandrel Walls and Counterforts: The forms and system of bracing for spandrel walls are shown in Fig. 119. Outside forms were built first, most of the steel was placed next, and then the forms and bracing were completed. Such procedure was necessary because with both forms in place the space between them was too narrow for a man to work in. Keys and steel bars were placed in the sidewalk to furnish suitable bonding with the railing. Each spandrel wall, from pier to pier, is divided into four sections, by expansion joints. These sections were poured alternately, two sections, one on each side of the arch, being poured from one setting of the hopper. Each section was run continuously from arch ring to top of sidewalk. Expansion joints were filled with a strip of asphalt and felt compound,

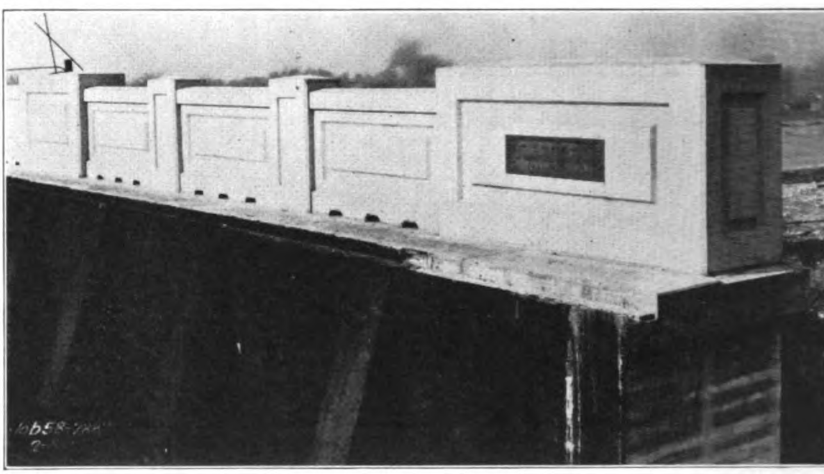

FIG. 120—RAILING ON BLACK STREET BRIDGE

Solid posts and panels were constructed, both reinforced with steel. They are strong enough to withstand the shock from a runaway automobile.

½-inch thick. Where railing posts were built over the expansion joints they were keyed on one side of the joint only, paper being placed under the other side to form a slip joint between the bottom of the post and the walk. Walks were finished with one inch of mortar colored with lamp black in the proportion of 2 pounds of lamp black to one barrel of cement.

The concrete for this part of the work was mixed about 1 : 1¾ : 3½ with the gravel limited in size to what would pass through a 1½-inch opening.

Pilasters: The pilasters over the piers were poured after the spandrel walls had been completed, and were separated from the latter by expansion joints. The form work and the methods of placing steel and concrete were similar to those used on the spandrel walls and require no special explanation. The mix

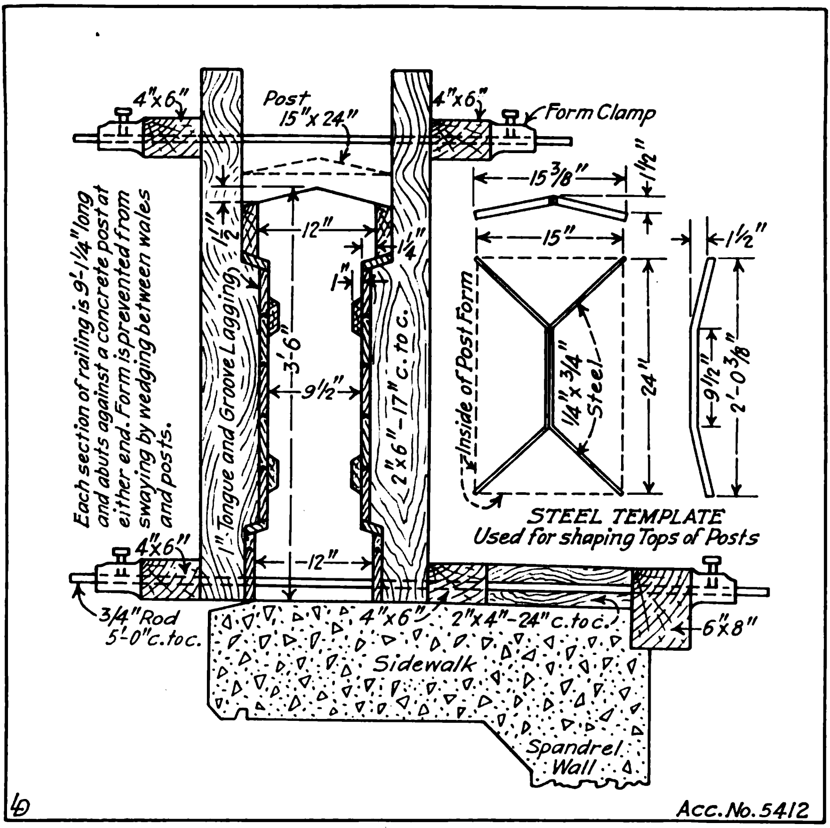

FIG. 121—DETAILS OF FORMS FOR PANELS AND POSTS OF RAILING ON BLACK STREET BRIDGE

The posts were concreted first, and after the forms had been removed the sections of railing were built between them. A steel template was used for shaping the tops of the posts and railings.

of concrete was the same. Fiber conduits were placed in the top of each pilaster to connect the lighting circuit with the lamp post to be placed over the pilaster.

Railings: The railing consisted of solid posts and panels as illustrated in Figs. 116 and 120. Both posts and panels were reinforced with steel and are strong enough to withstand the shock from a runaway automobile, which is a requirement now recognized as necessary in bridge construction. The aim was to make a plain serviceable railing of good appearance, in keeping with the rest of the structure, without going to extremes in the way of decorative treatment. The posts were concreted first and after the forms had been removed the sections of railing were built between them. Fig 121 shows the construction of the forms. The mix used was 1:1½: 3, sand and gravel being of the same quality as that used for the spandrel walls. The tops of posts and railings were finished with a steel trowel, no mortar being used. To obtain true lines for the ridges on posts and railings, frames were made of ¼-inch by ¾-inch iron, (shown in Fig. 121), and set in the top of each form as it was filled. The surface was troweled to this template which was then removed carefully and replaced with mortar.

After the forms were removed the railing was wetted and finished by rubbing with emery stones. When all irregularities had been smoothed off by the stones the entire railing was gone over with a damp brush. The openings shown at the bottom of the railing are for air circulation, to keep dust off the walks.

Waterproofing: Waterproofing was applied to the tops of all arches, tops of piers, to counterforts and spandrel walls below the top of the sidewalks. It consists of a bituminous oil primer coat and three coats of asphalt applied in alternation with two layers of cotton fabric. The primer was applied with brushes when the concrete was absolutely dry. It was found necessary to heat the primer and to thin it with gasoline except in very warm weather. Seven barrels, or 364 gallons of primer were used to cover the entire surface of 36,000 square feet. Asphalt was applied as soon as the primer had dried. It was melted in kettles such as are used in repairing streets, the kettles and aphalt being placed where wanted by means of the cableway. The temperature was maintained between 350 and 400 degrees Fahrenheit, usually at about 375 degrees. Sprinkling cans with the caps removed were used to distribute the asphalt. As it was poured on the surface it was spread with push brooms. Immediately following the first application, and while the asphalt was still hot, a strip of cotton fabric was applied, then another layer of asphalt and another strip of fabric, shingle fashion, beginning at the pier and working up the arch. The fabric was lapped far enough so that all parts of the surface were covered with two layers of it. A final coat of asphalt was then applied. The same process was followed on the spandrel walls beginning at the bottom.

Costs: Costs of the various classes of concrete here described, are given in the following tabulation. During the period of this construction, labor rates varied from 35c to 46c per hour; carpenters were paid from 65c to 80c; carpenter helpers 40c to 52c; cableway runner 75c; with half time extra for more than 8 hours. Most of this work was carried on in 10-hour shifts which added 10% to the above base rates. The average cost of cement, delivered to the job, including freight and loss on sacks, was $2.57 per barrel. Reinforcing steel cost about $57.60 per ton, delivered. The price of lumber averaged about $35 to $40 per M. ft. B. M.

Cost of Concrete in Black Street Bridge

Piers and Abutments—6921 Cu. Yds.

		Cost Per Cu. Yd.	Per Cent of Total
Superintendence and Overhead	$ 3,839.99	$ 0.55	3.2
Labor	59,239.62	8.55	49.8
Cement	20,380.10	2.94	17.1
Reinforcing Steel	2,250.20	0.32	1.9
Supplies	26,008.19	3.76	21.9
Plant Depreciation	7,251.20	1.04	6.1
	$118,969.30	$17.16	

Arches—1988 Cu. Yds.

Superintendence and Overhead	$ 3,317.12	$ 1.67	3.9
Labor	39,864.82	20.01	47.0
Cement	7,758.83	3.90	9.1
Reinforcing Steel	13,717.60	6.90	16.1
Supplies	12,315.65	6.20	14.5
Plant Depreciation	7,967.92	4.01	9.4
	$ 84,941.94	$42.69	

Spandrel Walls—693 Cu. Yds.

Superintendence and Overhead	$ 1,039.25	$ 1.50	2.7
Labor	24,995.79	36.14	64.5
Cement	3,423.24	4.95	8.8
Reinforcing Steel	3,177.10	4.48	8.0
Supplies	3,322.73	4.80	8.6
Plant Depreciation	2,892.54	4.17	7.4
	$38,850.65	$56.04	

Railing—191 Cu. Yds.

		Cost Per Cu. Yd.	Percent of Total
Superintendence and Overhead	$ 291.50	$ 1.53	2.5
Labor	9,115.29	47.73	76.6
Cement	1,012.58	5.32	8.5
Reinforcing Steel	483.36	2.53	4.0
Supplies	447.88	2.35	3.7
Plant Depreciation	558.77	2.92	4.7
	$11,909.38	$62.38	

(1415 lin. ft. @ $8.42 per lin. ft.)

Summary—

	Cu. Yds.	
Piers and Abutments	6,921	$118,969.30
Arches	1,988	84,941.94
Spandrel Walls	693	38,850.65
Railing	191	11,909.38
Totals and Average	9,793	$254,671.27

Average, $26.00 per cu. yd.

Waterproofing 36,086 sq. ft.—$4,545.11=12½c per sq. ft.

Adams Street Bridge at Troy

The unusual feature of constructing a new concrete bridge on top of a similar structure already in place, using the old bridge to support the forms for the new, was the most interesting thing about the reconstruction of the Adams Street Bridge at Troy. This work was an obligation of the County, but inasmuch as the District had the necessary organization and equipment, and was doing other work in the same locality, it was arranged for the District to do this work for the County, at an agreed price.

The old bridge was built in 1913, and consisted of four reinforced concrete arches. (See Fig. 122). The outward appearance of the structure was good, but the pier footings were inadequate and some of the concrete was in bad condition. The footings were so narrow that they could not take care of the unbalanced forces from the new arches with a sufficient margin for safety. They were also set practically on top of the river bed, and were placed on a foundation supposed to be composed of twelve-foot piling, but some of the piling proved to be only three feet long. The waterway under the bridge was wholly inadequate. The District calculated that it would be cheaper to reinforce the old piers and use them to carry the new bridge, to use the old arches to