Reinforced Concrete Through Arch Bridge in Ohio

There has recently been completed near Cincinnati, O., a concrete bridge of unusual design. It is situated in Sycamore township, about 8 miles from Cincinnati, and carries Benson street, the main road between Reading and Lockland, across Millcreek. The new structure replaces a through Howe truss bridge of 73 ft. span, with Phoenix columns and cast iron intersections, which had been in use since 1860.

It is the policy of the Hamilton county commissioners, under whose authority the new bridge was built, to put up concrete bridges when it becomes necessary to replace old structures. Because of the large amount of water carried by the creek at flood periods it was necessary to select a type of bridge that would not decrease the waterway; therefore, the usual arch bridge could not be built.

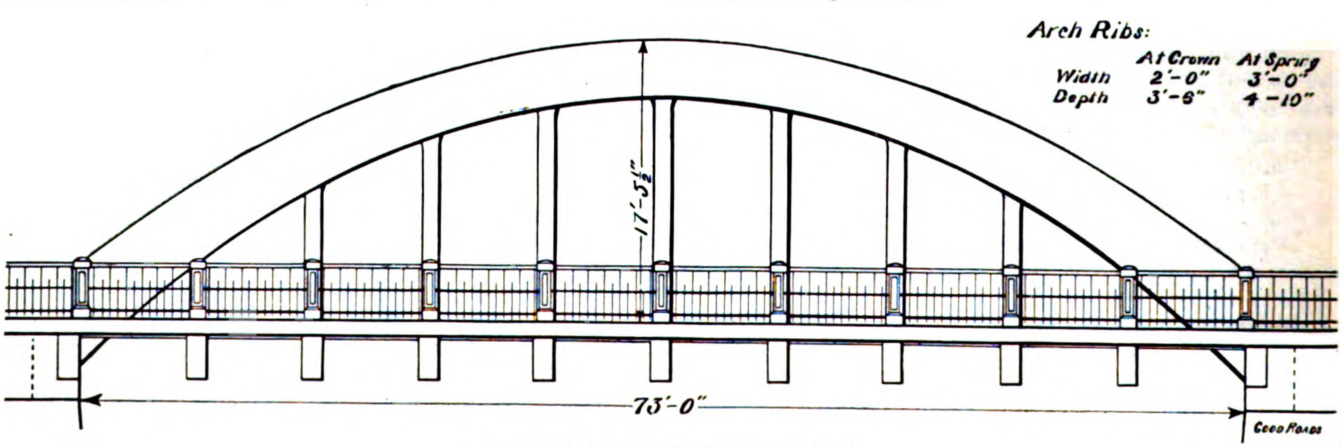
Two reinforced arch ribs without hinges, built above the roadway, carry the floor of the bridge which is hung below them by eighteen hangers of reinforced concrete. The thrust is taken up by steel rods in the plane of the floor between the ends of the arches and tied to the steel in the ribs, thus leaving only the vertical load to be carried by the abutments. The old masonry abutments were found to be large enough and in sufficiently good condition to carry this load, provided it could be uniformly distributed across their widths. To do this, heavy transverse beams were laid directly upon the old masonry, no provision being made for movements due to temperature changes.

The bridge floor is of the slab and transverse girder design, with cantilevered sidewalks. Each girder is attached to the two transversely opposite hangers, the hanger reinforcement being tied at top and bottom to the steel in the ribs and in the girders. The details of the reinforcement are shown in the accompanying plans.

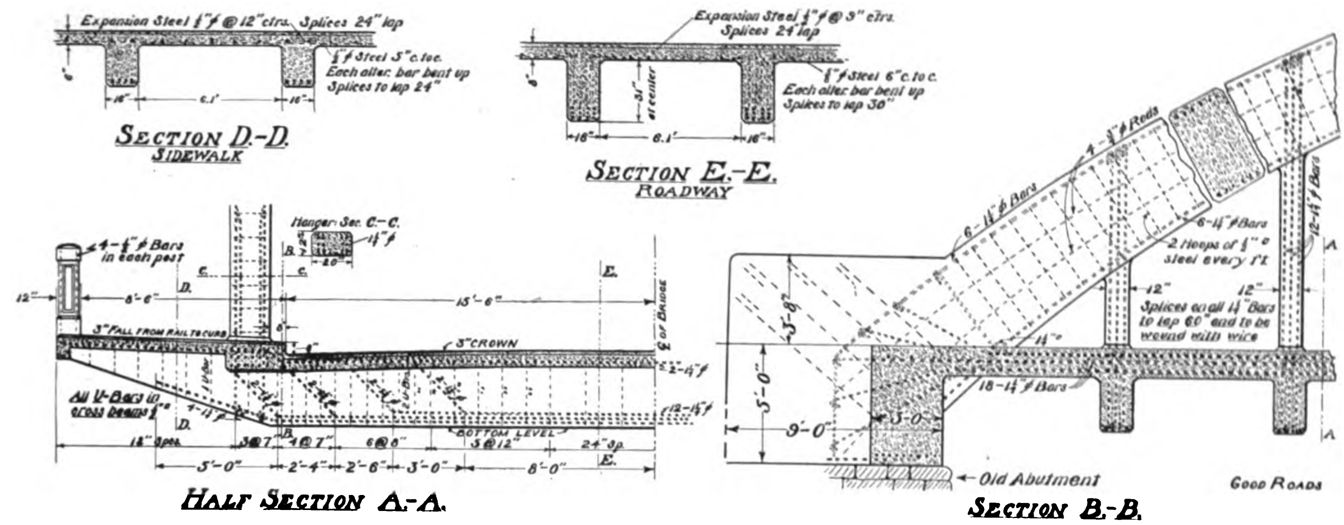
REINFORCED CONCRETE THROUGH ARCH BRIDGE OVER MILLCREEK IN SYCAMORE TOWNSHIP, HAMILTON COUNTY, OHIO.

It was decided to construct a bridge of 73 ft. span, carrying a 31-ft. roadway and two 9½-ft. sidewalks, and estimates were accordingly made for a steel girder bridge and for a reinforced concrete structure. The estimated cost of the former was $11,000 and that of the concrete bridge $8,600. The commissioners decided in favor of the concrete bridge, plans were prepared, and the present structure erected.

The bridge was designed to carry two 40-ton street railway cars, the maximum allowable stresses being 16,000 lbs. per sq. in. for steel and 600 lbs. per sq. in. for concrete in compression.

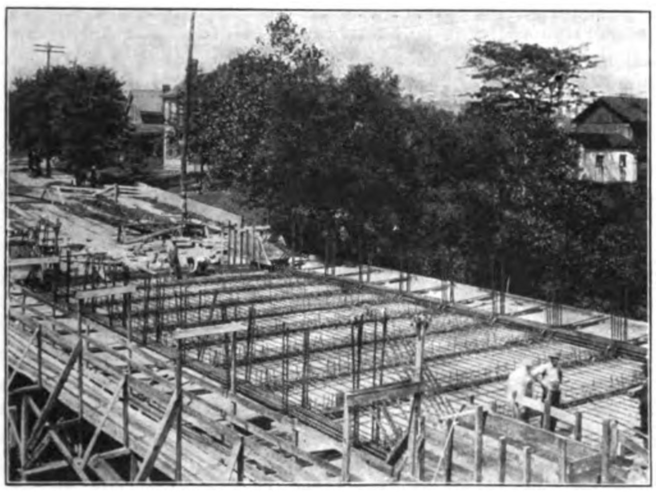


ELEVATION—MILLCREEK BRIDGE.

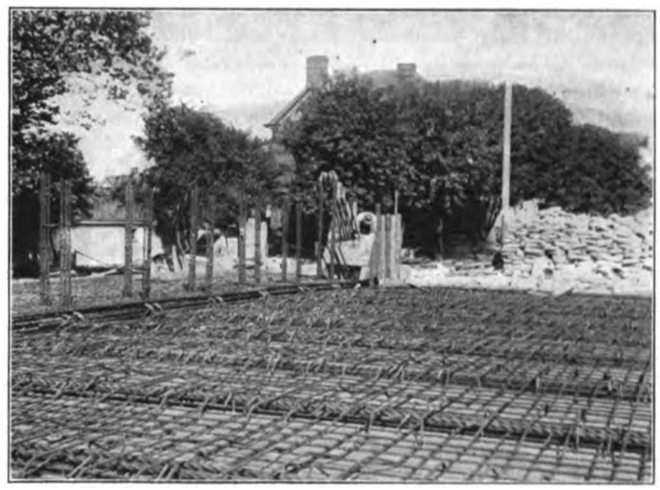


DETAIL SECTIONS—MILLCREEK BRIDGE.

In erecting the bridge the floor and haunches of the arches were built on heavy falsework, then the hangers were built, and, lastly, the arches completed. The concrete for the floor was placed in sections, a girder with half of the slab on each side of it being cast as a monolith in order to secure the T-beam effect. After the floor had been completed, the hangers were finished, forms being built around the steel, and the concrete poured, thus furnishing a rigid support for the construction of the arch forms. Placing the concrete in the arch gave little difficulty. The concrete was raised in a small car traveling on an inclined track and about 12 hours were required for filling one arch form.



FLOOR FORMS WITH STEEL PARTLY IN PLACE—SHOWING FORMS FOR ARCH HAUNCHES.



FLOOR REINFORCEMENT ALL IN PLACE—READY FOR CONCRETING.

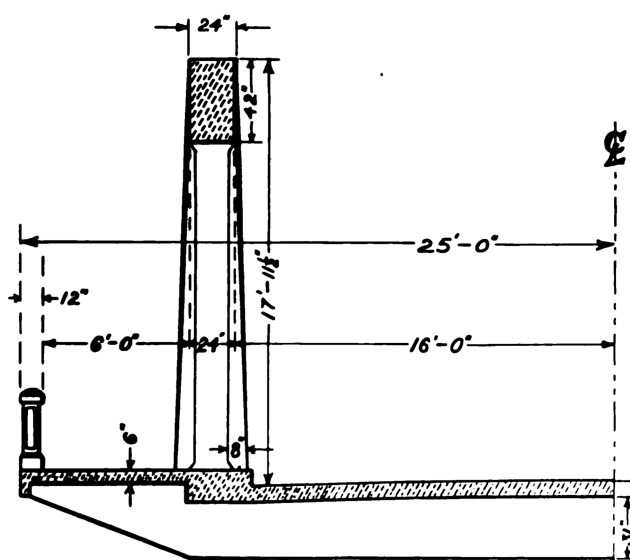
The old bridge was left in place and travel maintained over it until the falsework was ready for the floor forms. The falsework was utilized as a working platform for the removal of the old bridge.

Cold twisted steel was used for all the reinforcing and all the bending was done at the site. Considerable difficulty was encountered in attempting to place the reinforcing in the girders because of their depth. This was finally overcome by assembling the steel above the girder forms, wiring it together thoroughly, and lowering it into place.

The posts for the sidewalk railing were cast in place with the 3-in. iron pipe hand rail. The iron fencing was bolted in position afterward. Provision was made at each post for expansion.

Bids received for the building of the bridge varied from $7,127 to $14,114. The one accepted was $12 per cu. yd. for concrete, including all falsework and forms, and 3 cts. per lb. for steel in place.

The bridge was designed and its construction supervised by E. A. Gast, deputy county surveyor of Hamilton county, under the direction of Clinton Cowen, county surveyor. Hugo Eichler assisted in the work of design an checked all computations.



HALF SECTION AT CENTER—SLIGHTLY ENLARGED.

32d

PROCEEDINGS

of the

Ohio Engineering Society

Thirty-Second Annual Meeting
January 24, 25, 26, 1911

PUBLISHED BY THE SOCIETY
CLYDE J. KNISELY, Secretary-Treasurer

COLUMBUS, OHIO
The J. L. Trauger Printing Company

Through Arch Bridge of Reinforced Concrete.

By E. A. Gast.

This bridge is located about eight miles north of the business center of Cincinnati, Ohio. It carries Benson street, (the main thoroughfare between the villages of Reading and Lockland) over the East Fork of Millcreek.

The old bridge at this site was a Through Howe Truss Bridge with Phoenix columns and cast iron intersections. The span was 73 feet with a height of about 20 feet from creek bed to roadway surface. A peculiar feature of this old design was the fact that the lighter diagonal tension members were made up of pipe sections to give them a heavier appearance. Although this bridge had been in use since 1860, a period of 50 years, it was found to be in an excellent state of preservation when torn down. The new bridge was built by the authority of the Hamilton County Commissioners, whose policy it is, to rebuild the bridges in the county of reinforced concrete as fast as the old ones of wood and iron become unfit for use. In looking over the site of this bridge it was found that the present waterway opening must be preserved, due to the large amount of water coming through the creek at flood periods. This fact prevented us from using any of the usual types of arch bridges. The bridge decided upon was to have a span of 73 feet and a roadway of 31 feet with two sidewalks of 9 1-2 feet each, making a total width of 50 feet. Two estimates were made for this bridge, one of steel girder construction, estimate being $11,000.00, the other of reinforced concrete construction, the estimated cost of which was $8,600.00.

The county commissioners decided upon the latter and ordered plans prepared for same. The design chosen, using hingeless arch ribs above the floor line, is an unusual one and possibly the first of its kind in this country, although several like it have been built in Europe.

The bridge consists of two reinforced hingeless arches built entirely above the roadway, one being placed along the line of each curb. The thrust of these arches was provided for by placing tension steel in the floor in the plane of the arch, thus relieving the abutments of all thrust. From these arches the roadway is suspended by means of nine hangers. The floor is of slab and transverse girder design with cantilever sidewalks, each girder being attached to two transversely opposite hangers. The design and details are clearly shown in figures one and two. The bridge is designed to carry two forty ton traction cars. The maximum stresses allowed were 16,000 pounds per square inch for steel and

600 pounds per square inch for concrete. The reinforcing was entirely of twisted steel rods.

The bids for this work varied from $7,127.0. to $14,114.00. The successful bid amounted to $12.00 per yard for concrete including all false work and forms, and three cents a pound for steel in place.

A novel plan was decided upon in erection of this bridge. The floor and haunches of the arches were built on a heavy false work, then the hangers were erected and cast in concrete, finally the real supporting members, the arches, were built in place. Due to this method of construction it was necessary to build a very heavy false work. This false work was made up of six lumber bents placed latterly, one at each abutment and one under every other cross girder. The caps of these bents were built to such an elevation that they produced the proper camber in the bridge. On these bents eleven lines of 12 by 12 longitudinal joints were placed, equally spaced. These joists rested upon 12 by 12 corbels, which in turn rested upon wooden wedges laid on the bents. These wedges were used in finally swinging the bridge.

The form work with the exception of the girder bottoms and 2 by 6 joists supporting the slab forms, was built entirely of 7-8 inch sheeting.

The reinforcing was entirely of cold twisted steel. The bending was all done on the site. Considerable trouble was experienced in trying to place the steel in the girders owing to their depth, this however was overcome by assembling the steel frame and wiring it thoroughly together above the girder form, and then lowering it into place with block and tackle. The remainder of the reinforcing offered very little resistance to rapid placing.

The concrete for the floor was poured in sections, each girder and its slab extending half way to the next girder on each side was cast monolithic, in order to obtain the T beam effect.

After the entire floor was finished the steel for the hangers was erected, forms built around it and the concrete poured. This gave a rigid support for the building of the arch forms. Concreting the arches offered little difficulty, the concrete was raised by a small car running on an inclined track. The time required to fill one arch was about 12 hours, using a small Smith Mixer.

The sidewalk fencing was erected by casting the concrete posts in place together with the three-inch iron pipe hand-rail. After the forms were removed the iron fence was put in place and bolted. The fence has provision for expansion at each post, thus avoiding all danger of buckling out of line from the heat.

The lamp posts are of concrete cast in place. The wiring of same being placed in loricated iron tubing concealed in the concrete.

The arches were designed by the method given in Reutherthal's Hand Book of reinforced concrete, this proved a rapid accurate method when compared with several other methods used for checking. The wind bracing and also the long column effect in the arches was taken care of by the hangers. The steel in the same being placed near the short sides to reinforce them for this purpose. The designing of this bridge and supervision of construction was done by the writer, under the direction of Mr. Clinton Cowen the surveyor for Hamilton county. Mr. Hugo Eichler assisted in the design and checked all computations.

DISCUSSION.

A Member: I would like to ask when this concrete bow-string arch was built, and what the results were and something about how much false work was under it.

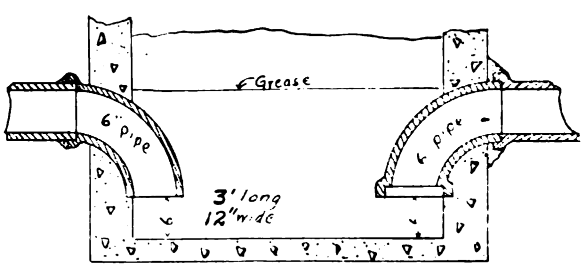
Mr. Harper: It was completed, the false work was removed about two months ago. The engineer who designed the structure took levels over it and staid out there until the forms were completely removed, and the deflection was a little less than 1-16 of an inch in the center.

Mr. Bone: Across the Tennessee river at Nashville, there is a similar structure. The peculiar thing is there is no diagonal whatsoever. It is a bow-string truss without a diagonal. The arch is made in the shape of a parabola, and the shear reinforcement is provided in the depth of that arch.

which are bored holes with a small gimlet as closely together as possible. Through each hole is dropped a nail having a head a little larger than the hole. The liquid spreads over the board and runs through the holes down the nails, thus making an even distribution over the filter bed.

Such a tank requires cleaning out about once a year and some have gone three years without cleaning. The sludge taken from them may be placed on the garden patch and plowed in.

Many farmers have made septic tanks by digging holes in the ground with a diameter about 12″ to 16″ larger than a barrel. Then a barrel is placed in the hole to act as a form and concrete poured around it and under it. The barrel, of course, is allowed to remain. Two barrels are used and they are placed about one foot apart with a siphon made of 4″ cast iron pipe connecting them. In one barrel the siphon goes to within 8″ of the bottom, and in the other it is about 8″ or 10″ shorter. About the middle of the first barrel is a pipe through which the sewage enters, so it will not disturb the scum covering. A tight cover is fitted over



Grease Trap

each barrel, with a 1″ pipe as a vent rising about 10′ above the ground. The second barrel has a siphon outlet which keeps the liquid at the same level as it is in the first barrel. A third barrel, or a box if desired, contains three feet of coarse filtering material, and the siphon enters this box near the top. At the other side of the box is a siphon of different form—a real siphon in which the outer leg is longer than the inner leg, and has a tipping pan on the outside as a seal. When the bed is filled with sewage the pan fills and tips, thus causing the siphon to draw off all the liquid from the filter bed, or contact bed, to use the correct term. This admits air to the bed and strengthens the bacteria which purify the sewage, for a new attack on the next lot that is delivered.

Such an outfit is low in cost and more efficient than the one first described. Concrete is the best material to use for such tanks because of its durability. Since the tanks are so useful and so low in cost they should supplant cess-pools and privy vaults everywhere.

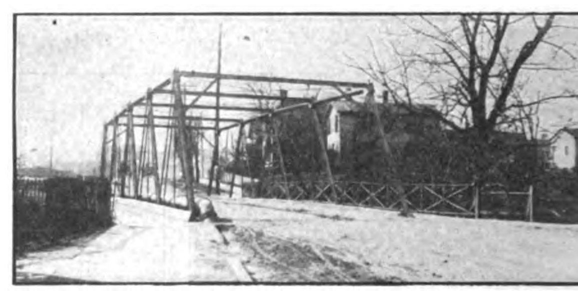
No grease should be permitted to get into a septic tank. A separate grease trap should be used in order that all grease may be caught before the water carrying it is permitted access to the tanks. A simple grease trap is illustrated.

A THROUGH REINFORCED CONCRETE ARCH BRIDGE IN HAMILTON COUNTY, OHIO.

BY E. A. GAST.

This bridge is located about eight miles north of the business center of Cincinnati, Ohio. It carries Benson street, the main thoroughfare, between the villages of Reading and Lockland, over the east fork of Millcreek. The old bridge at the site was a through Howe truss bridge, with Phoenix columns and cast iron intersections. The span was 73′, with a clearance of 20′ from creek bed to roadway surface. A peculiar feature of this old design was the fact that the lighter diagonal members were made up of pipe sections, to give them a heavier appearance. Although this bridge had been in use since 1860, it was found to be in an excellent state of preservation when torn down.

The new bridge was built by the authority of the Hamilton County Commissioners, whose policy it is



The Old Bridge

to rebuild the bridges in the county of reinforced concrete as fast as the old ones of wood and iron become unfit for use.

The style of bridge chosen for this site is a new one in this county, it being the first of its kind built here. The bridge consists of a floor and sidewalk of reinforced concrete. This floor is suspended from

The New Bridge

two hingeless arch ribs of reinforced concrete. These ribs are entirely above the roadway, one being placed along each curb line, as will be seen in the illustration. The floor is hung from the ribs by steel rods which are encased in concrete, these rods being hooked over the steel in the arch rib and under the steel in the beams of the floor.

In erecting this bridge, the old bridge was left in place to maintain traffic until the falsework had been erected, then the old bridge was removed by using the falsework as a support. This falsework was made up of six bents of 12″ x 12″ timber with concrete mud sills 3′ wide at the bottom. The tops of these bents were built to such an elevation that they produced a 3″ camber in the finished bridge. The formwork was carried on 12″ x 12″ joist laid on these bents, but having wedges under them, to facilitate striking the forms.

The formwork for the floor was then built, as shown in the illustration. This form was entirely of ⅞″ sheathing except the beam bottoms, which were 2″ thick. After the forms for the floor were built, the work progressed more rapidly and with greater safety to the men, as they had a smooth floor on which to work.

Steel for the beams and floor was now bent and placed. The steel was all cold twisted and was bent to shape on the site. Considerable trouble was encountered in trying to place the steel in the girders, but this was overcome by assembling the steed rods and U-bars, wiring them together over the girder form and then lowering them in place with block and tackle.

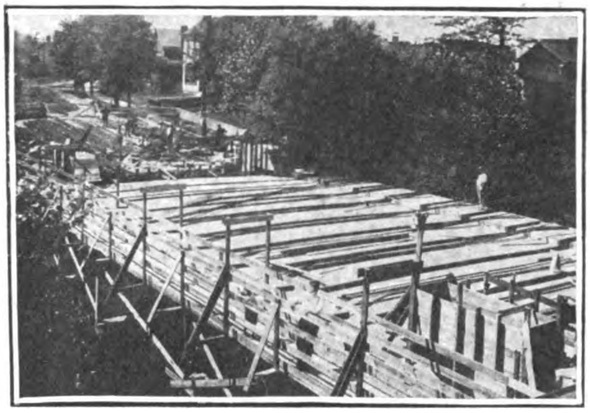
Concrete was now laid on the floor; this was put on in sections, the dividing line being in the middle of a slab, half way between girders. The floor concrete was laid 6″ thick and a 2″ cement finish was put on immediately. No other roadway surface was used. The concrete was mixed in a small "Smith" mixer, the concrete being conveyed to the spot where it was to be placed by a small car with a removable end board. This car ran on tracks elevated above the floor steel, the mixer being at one end of the bridge. The stone, sand and cement were hauled from the railroad yard, two blocks away. Stone used was clean crushed boulders, passing a 1″ ring. The cement was Edison Portland. The mixer was not equipped with a loader, so all material had to be wheeled up an incline to a loading platform.

Constructing the Arches.

The floor being finished, it was now necessary to erect the supporting members of the structure, that is, the arches. The hangers, nine on each side, were erected first. Steel was placed, forms put around and filled with concrete. The reason for concreting the hangers was that they were more conveniently accessible at this time and having been set up in two days they were rigid enough laterally to support the arch forms without any side bracing. The bottom of the arch ribs was next put in place. This was of ⅞″ sheathing and was also supported between the hangers by additional bracing. The sides of the arch forms were then erected. These were also of ⅞″ sheathing, laid horizontally, not trimmed to curve, and nailed to 2″ x 4″ pieces set upright on outside. The steel was next put in place. This was 1¼″ twisted steel, there being six bars in the bottom and six on top of the arch. They were placed 3″ from the top and the bottom. Hoops encircling these bars were of ½″ plain square steel and all were wired together at each intersection. Considerable difficulty was experienced in placing this steel in the forms. Possibly this could have been prevented by leaving off one side until the steel was placed, or, at least moving it out 2′ or 3′ and then putting it in place when the steel was all located. Concrete was now placed in the arches, with the same car used for the floor. This car was run on an inclined track and deposited the concrete at the crown, from which it was distributed with shovels. No form was used on the top of the arch. I believe that if one had been used, especially on the steep ends, more rapid progress would have resulted. After forms were removed the entire bridge was washed with neat Portland cement grout.

Ornamentation Cast in Place.

The hand railing was made up of iron panels and concrete posts, cast in place. Each post has a loose coupling with the hand rail, permitting expansion at each panel, thus preventing the rail from buckling in hot weather. Lamp posts were also of concrete, cast in place. The electric wiring was all concealed in the concrete.



Form Work for Bridge Floor

Contract price of this bridge complete was $7,127. The price bid for concrete was $12 per yard, and this included all falsework and form work. Steel was paid for in addition, at the rate of 3c per pound, in place.

To give a detailed list of the cost of each item on this bridge would be useless, as anyone wishing to build one would be governed by prices in his locality. I have therefore reduced all costs of labor to so many hours per yard of concrete.

Labor hours per cubic yard of concrete, 14 hours.

Carpenter hours per cubic yard of concrete, 4.6 hours.

Labor hours handling, bending and placing steel (no bender was used), 0.0373 hours per pound.

Lumber for formwork, 90′ B. M. per cubic yard. Falsework not included.

For example, if a contractor wished to erect a bridge of this type, he would first find out how much concrete was required for the structure, then with his local prices and wages, using the above factors, he could find very closely his total cost.

The design of this bridge and supervision of construction were done by the writer, under the direction of Clinton Cowen, county surveyor. Hugo Eichler assisted in the design and checked all computations.