THE CONTRACTOR

Vol. XXIII. No. 3. CHICAGO, FEBRUARY 1, 1916. Whole No. 437

Building a Reinforced Concrete Arch Bridge at Fort Wayne

Mixer with Elevated Bins, Hoist Tower, Trestle and Concrete Cars Place All Concrete from Single Set-Up

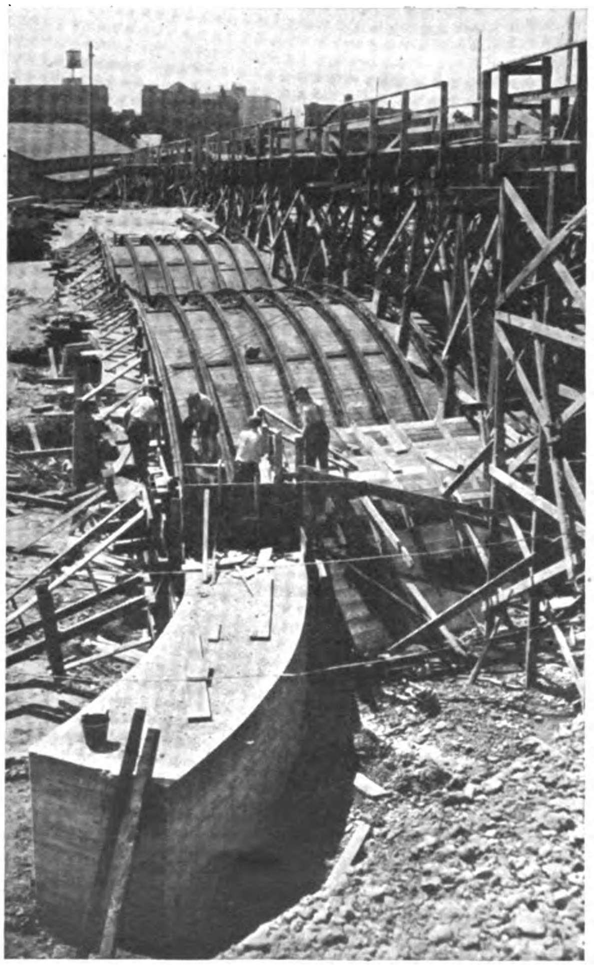
By Charles P. Stivers

The methods and equipment used in the construction of the bridge described in the accompanying article differ in many respects from those adopted by other contracting firms. The use of a mixer discharging either into cars or into a hoist bucket, and the use of the hoist tower in connection with cars on an elevated trestle offer some new ideas to the contractor.

As a sightly, permanent and economical structure, the reinforced concrete arch bridge has gained popularity rapidly in recent years. Its use has extended from the short span, single arch over a minor stream, to bridges consisting of a number of arches of spans running up nearly to 300 feet. As it becomes necessary, for one reason or another, to replace existing steel truss bridges, or to construct new bridges, the concrete arch is frequently chosen as the most suitable type of structure.

A bridge of this type has recently been built across the St. Marys river at Fort Wayne, Ind. The structure, known as the Harrison Street bridge, is just north of the main business section of the city and leads to an important district on the opposite side. It has been designed high enough to pass the maximum recorded flood, that of 1913. The bridge consists of 5 skew arches, 4 of 50-foot span and 1 river span of 136 feet. To carry the roadway at either end of the large arch, a spandrel arch extends from the pier to a point on the main arch ring about 30 feet from the pier. The pier at the north end of this long arch is designed as an abutment, to take the unbalanced thrust due to the unequal arch spans.

The bridge is reinforced by the Melan system of steel ribs consisting of built-up lattice girders. This reinforcing can easily be seen in several of the accompanying photographs. The spandrel and wing walls are of the gravity type. Between the arch ring and the roadway is an earth fill. The roadway proper is 32 feet wide, paved with brick, with 7-foot concrete walks on either side. Outside these walks is an ornamental hand rail, also of concrete. Five-light granite concrete standards are located at the abutments and over the piers. These were supplied by the Pettyjohn Company, of Terre Haute, Ind. The bridge was designed by Mr. A. W. Grosvenor of Fort Wayne.



View Along Bridge, Showing Reinforcing Ribs and Trestle.

The bridge itself was built by Allen county; the city of Fort Wayne constructed the approach fills. The contract for the work was awarded late in 1914 to the Carmichael-Cryder Company, of St. Louis, Mo., at $70,500. The contractors were on the ground January 1, 1915.

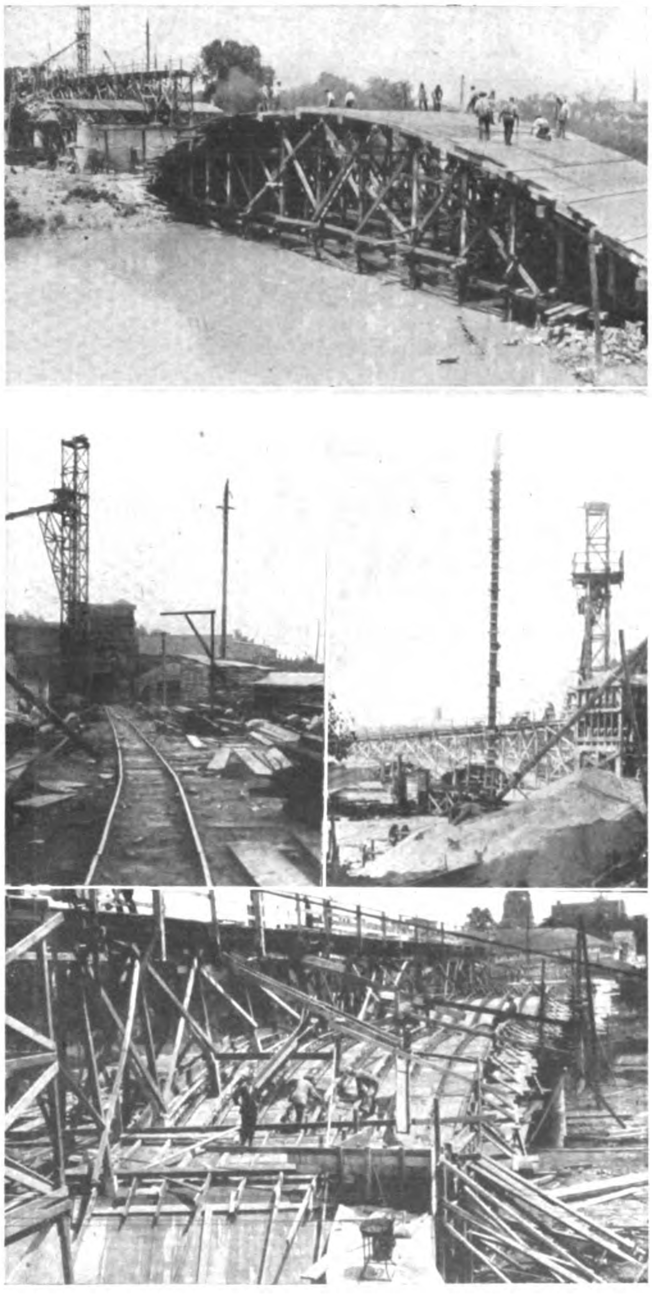
The first work to be done was the excavation for the piers and abutments. This was done by men loading round buckets, which were handled out of the excavation by derricks. Sheet piling cofferdams were constructed to keep out the water and to retain the walls of the excavations.

The south abutment and the abutment pier at the opposite end of the long or river span rest directly upon hard soil. The other piers and the north abutment are supported by round wood piles. An unusual feature of the south abutment design is that it also serves as the outfall for a 5-foot sewer, which dischaiges through it into the river.

Concrete for the entire structure was mixed in a single plant and placed from a single set-up. The concrete plant was located just east of the north end of the bridge. It consisted of a Ransome mixer set up under substantially constructed elevated bins. The mixer was placed so that it could discharge either into the bucket of a concrete hoist tower or into concrete cars running on a track on the ground. The concrete for the foundations of the piers, abutments and wing walls was placed by means of Koppel revolving scoop dump cars. The upper parts of the piers and abutments, the arch rings, spandrel walls and hand rail were poured by means of similar cars running on an elevated trestle extending the entire length of the bridge. The concrete was elevated from the mixer in the hoist tower to a height of about 50 feet and then chuted from the tower to the cars on a track on the north end of the trestle. The cars were then pushed by men to the point where the concrete was to be placed and dumped into metal lined wooden chutes, which carried the concrete to the forms. The chute from the tower to the trestle was of this same construction. It was supported at points out from the tower and trestle by inclined braces or brackets of latticed timber construction. The tower itself was of wood, about 70 feet in height, and was equipped with Insley hoppers. It was operated by an American hoist.

The trestle ran directly down the center line of the bridge. It was supported from below by the arch centering, to be described later. It consisted of light framed timber bents spaced about 10 feet apart and braced with longitudinal diagonals, topped by 2x10-inch girders running longitudinally and a plank flooring laid across them. The 2-foot gauge industrial track was laid on this floor. Substantial railings on either side gave safety to the workmen, a thing too frequently neglected on construction trestles of this sort.

The aggregates, sand and gravel, are brought to the work in standard railroad cars on tracks which run parallel to the river on the bank at the north end of the bridge. The materials are unloaded from the cars by a clam-shell bucket operated by an American guy derrick with a timber mast about 60 feet high and a timber boom. The bucket placed the sand and gravel in stock piles, from which it subsequently conveyed them to the elevated bins over the mixer. Medusa Portland cement in sacks was stored in a shed adjoining the mixer and elevated enough to be on the level of the charging platform of the mixer. It was carried from the shed to the mixer as needed.



Above—Placing Lagging on Form for Large Arch. Left—Hoist Tower and Track for Foundation Concrete. Right—Guy Derrick, Aggregate Piles and Bins Over Mixer. Below—View Along Bridge, Showing Reinforcing and Trestle Construction.

The false work and centering for the bridge construction was designed by Mr. C. B. Freeman, chief engineer for the contractors. The centering was supported on wooden piles driven in the river bed. These piles were capped both longitudinally and transversely by timbers. On these rose vertical posts supporting the arch from ribs. These posts were firmly cross braced in both directions. Across the tops of each transverse row of posts was a heavy timber cap. The arch from ribs, 2x10-inch timbers cut to the proper curvature and placed on edge about 1 foot apart, rested on these caps. The lagging was nailed transversely to these ribs.

The centering was made for half an arch and moved over on rollers on the lower pile caps, when the first half had been completed. The smaller arch rings were poured in 2 rings, one-half the arch at a time; the large arch was poured in 6 rings. The continuous run was about 100 yards on the small arches and 200 yards on the large one. The forms for the spandrel walls were of simple wooden construction, resting on the completed arch ring at the bottom.

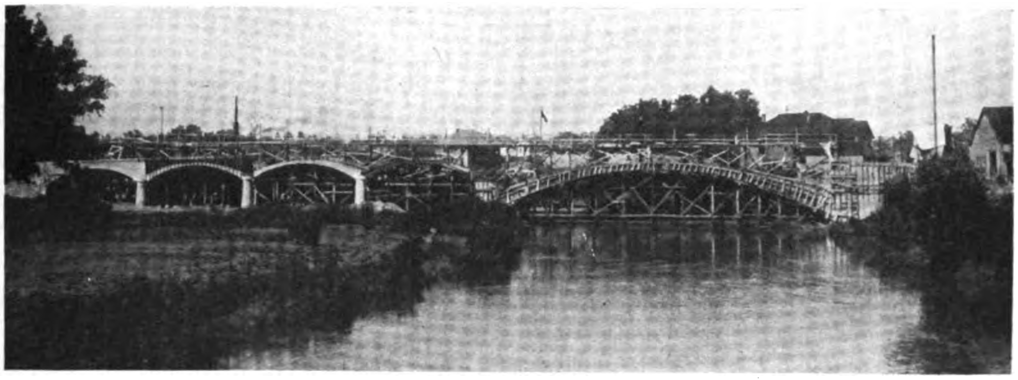
The proportions of the concrete varied considerably in the different parts of the structure. The foundations are of a 1:3:5 mixture. The arch rings and spandrel walls are of a 1:2:4 concrete. It is in the hand rail, however, that the more varied mixtures occur. The base is of 1:2:4 concrete, the spindles of 1:1:2 and the top rail of a 1:1:2 concrete inside, and a 1:3 facing of cement and red granite screenings. For the base and spindles, Medusa white Portland cement was used. For the top rail, grey Portland was used, the surface being scrubbed to bring out the red granite aggregate.

The hand rail consists of rather massive posts spaced about 10 feet in the clear, with a cast-in-place spindle rail between posts. The forms for the spindles are built in movable units, which rest on the base, the two sides being held together by bolts which pass through the holes between spindles. For placing these forms and working around them, a scaffolding is hung across the posts at either end of the section of spindle rail.

Pouring concrete was begun March 17, 1915. The last concrete in the bridge proper was poured during the summer and the central mixing plant was dismantled during September. The small amounts of concrete of various mixtures needed in the hand rail were mixed by hand. The total amount of concrete in the bridge is about 7,000 cubic yards.

After the concrete work had been completed, the top of the arch ring and the inside of the spandrel walls was waterproofed by painting with Barrett pitch. The earth fill, about 1,200 cubic yards, was placed later. Work on south approach fill was begun by the city before the bridge had been fully completed.

At the time the work was started, Mr. William Daunecker was superintendent for the Carmichael-Cryder Company. Later Mr. W. R. Carmichael became superintendent. The work was done under the inspection of Mr. O. B. Wiley, county bridge superintendent of Allen county.



General View of the Bridge Under Construction.

NEW RAILWAY CONSTRUCTION IN 1915.

During 1915, 933.24 miles of new first track was completed in the United States and 718.37 miles in Canada. In the same period 356.28 miles of second track was completed in the United States and 0.84 miles in Canada. There was also built during this period 64.70 miles of other multiple main tracks in the United States. Some activity is again noted in Mexico, where 36.50 miles of line were reported completed. The government railways of Alaska report 34 miles of line completed and 350 miles additional projected. These figures are based on reports made to the Railway Age Gazette by the various railroads, supplemented by that magazine's construction records.

As shown by the tabulation given below, the mileage of first track completed is much less than that for any of the 23 years during which that magazine has collected such statistics. In fact, the mileage reported this year is only about 65 per cent of the smallest mileage reported for any previous year since 1893. The mileage of line completed this year is only 15 per cent of that completed in 1902, the record year since 1893, and only about 25 per cent of the mileage completed during an average year.

The figures of new construction by years beginning with 1893 are as follows:

1893	3,024	1905	4,388
1894	1,760	1906	5,623
1895	1,428	1907	5,212
1896	1,692	1908	3,214
1897	2,109	1909	3,748
1898	3,265	1910	4,122
1899	4,569	1911	3,066
1900	4,894	1912	2,997
1901	5,368	1913	3,071
1902	6,026	1914	1,532
1903	5,652	1915	933
1904	3,832		

New mileage was reported completed in 38 states and territories. There are 11 states in which no new mileage was reported, while less than 5 miles was reported for each of 11 states and less than 10 miles for each of 16 states. Pennsylvania leads in mileage with 98.37 miles completed, while Oregon is second with 82.70 miles, Washington third with 70.88 miles and Kansas is fourth with 58.56 miles. Practically half the mileage reported was for the seven states of Pennsylvania, Oregon, Washington, Kansas, Alabama, Arizona and Kentucky.

The longest continuous line reported built during the year was that of the Gulf, Florida & Alabama from Broughton to Kimbrough, 52.40 miles. This is in marked contrast with extensions of 100 miles or more reported in previous years. The work was generally light in character, although there were one or two notable exceptions. The line involving the heaviest work was that of the Delaware, Lackawanna & Western, from Clark's Summit, Pa., to Hallstead, 39.43 miles. This line was built at an expenditure of over $12,000,000.

Reports show that 356.28 miles of second track was completed in the United States in 1915 as compared with 566 miles in 1914; 1,264 in 1913, and 1,073 miles in 1912. This work was distributed over 25 states, although less than 10 miles was built in each of 16 states and 20 miles or more was built in only six states. The greatest mileage built in any single state was 81.03 miles in Virginia, the next largest was 44.86 in Pennsylvania and the third largest was 39.90 miles in North Carolina, 37.90 of which was built by the Southern Railway between Pelham and Denim. This road also completed 28.40 miles of the second track built in Virginia. The 64.70 miles of other multiple tracks were divided between third track, 36.14 miles; fourth track, 22.96 miles; fifth track, 2.30 miles, and sixth track, 3.30 miles. The third and fourth track mileage consisted principally of that laid on the Clarks Summit line of the Lackawanna in Pennsylvania.

At the present time 1,207.18 miles of new line is reported under construction; 1,624.25 as definitely surveyed, and 2,061.81 miles as projected. Also, 289.41 miles of second track is under construction, 10 miles reported surveyed and 9.40 miles projected.

		Miles				
United States—	No. Cos. building	First track	Second track	Third track	Fourth or more track	Total
Alabama	2	53.15	27.85	....	....	81.00
Alaska	1	34.80	....	....	....	34.80
Arizona	2	50.00	....	....	....	50.00
Arkansas	1	19.00	1.00	....	....	20.00
California	4	32.00	....	....	....	32.00
Colorado	3	4.73	....	....	....	4.73
Florida	6	38.65	....	....	....	38.65
Georgia	5	31.64	....	....	....	31.64
Idaho	...	....	1.75	....	....	1.75
Illinois	4	6.90	24.78	....	....	31.68
Iowa	...	....	3.43	....	....	3.43
Kansas	4	58.56	4.09	....	....	62.65
Kentucky	3	48.89	6.92	....	....	55.81
Maine	1	1.33	....	....	....	1.33
Maryland	2	3.40	4.95	....	....	8.35
Massachusetts	2	2.00	....	....	....	2.00
Michigan	2	18.50	1.00	....	....	19.50
Minnesota	4	46.76	28.18	....	....	74.94
Mississippi	1	3.50	13.25	....	....	16.75
Missouri	1	.16	3.85	....	....	4.01
Montana	1	8.51	....	....	....	8.51
Nebraska	1	1.25	....	....	....	1.25
Nevada	1	7.00	....	....	....	7.00
New Jersey	1	.66	2.00	....	....	2.66
New Mexico	1	3.66	....	....	....	3.66
New York	3	2.84	13.84	9.27	15.97	41.92
North Carolina	3	33.30	39.90	....	....	73.20
North Dakota	2	26.29	....	....	....	26.29
Ohio	3	9.30	7.26	....	....	16.56
Oklahoma	3	34.74	....	....	....	34.74
Oregon	4	82.70	....	....	....	82.70
Pennsylvania	9	98.37	44.86	26.25	11.94	181.42
Rhode Island	...	....	....	.62	.65	1.27
South Carolina	...	....	1.00	....	....	1.00
Tennessee	4	12.15	18.71	....	....	30.86
Texas	2	4.40	.50	....	....	4.90
Utah	1	14.95	7.76	....	....	22.71
Virginia	2	17.80	81.03	....	....	98.83
Washington	6	70.88	9.27	....	....	80.15
West Virginia	7	13.78	1.32	....	....	15.10
Wisconsin	1	29.32	7.78	....	....	37.10
Wyoming	1	7.37	....	....	....	7.37
Total	104	933.24	356.28	36.14	28.56	1,354.22
Canada	17	718.37	.84	....	....	719.21
Mexico	2	36.50	....	....	....	36.50