work for unemployed men in research for technical societies and other non-profit organizations, and of making arrangements to allow unemployed men not in direct need to improve their time through attendance at regular lecture courses in local universities and colleges.

Collection of money has been begun; it will be speeded up next week by a general call to all employed engineers to contribute a definite share of their income each month for the next five months. All of the money that is contributed is to be applied to relief work, the committee expenses being separately underwritten.

Hoover Dam Notes

Rough grading of the streets of Boulder City is 84 per cent complete. Curb and gutter work is 10 per cent complete. Nearly 80 per cent of the water lines have been laid. Protection to all constructed buildings is afforded by 52 fire plugs in place. Construction of the presedimentation tank is complete. The sewer lines are 82 per cent complete, while one-third of the work has been done on the 4-in. service lines.

Tunnel progress to Oct. 30 is as follows: Tunnel No. 1 (outer Nevada), 1,307 ft. of pioneer headings; tunnel No. 2 (inner Nevada), 3,383 ft. of pioneer headings, 149 ft. of 38x56-ft. enlarged heading at lower portal; tunnel No. 3 (inner Arizona), 3,525 ft. of pioneer headings, 200 ft. enlarged heading; tunnel No. 4 (outer Arizona), 1,698 ft. of pioneer headings, 362 ft. of large heading at lower portal driven without aid of pioneer heading.

Prequalification Held Illegal for Mount Vernon School

A restraining order preventing the board of education of Mount Vernon, N. Y., from prequalifying contractors on the construction of an $800,000 addition to Washington school was granted by Supreme Court Justice Witschief on Nov. 6. Justice Witschief found no authority in the New York education law for prequalification and further found that Mount Vernon has no ordinance permitting the practice. The decision stated that prequalification prevented free competition and left "the door wide open to possible favoritism."

Twenty intending bidders on the project were asked to fill out qualification blanks. In the opinion of the private architect engaged by the school board, backed by the building committee of the board, eleven of these bidders failed to qualify and were refused plans for bidding. Three of the rejected contractors, the J. Weinstein Building Corp., the D. M. W. Contracting Co. and Lustig & Weil, all of New York City, filed a protest. The board of education withheld opening of any bids pending the decision. At this writing the corporation counsel of the city and the school board are undecided as to appealing the decision or as to further action. An abstract of the decision will appear in next week's issue.

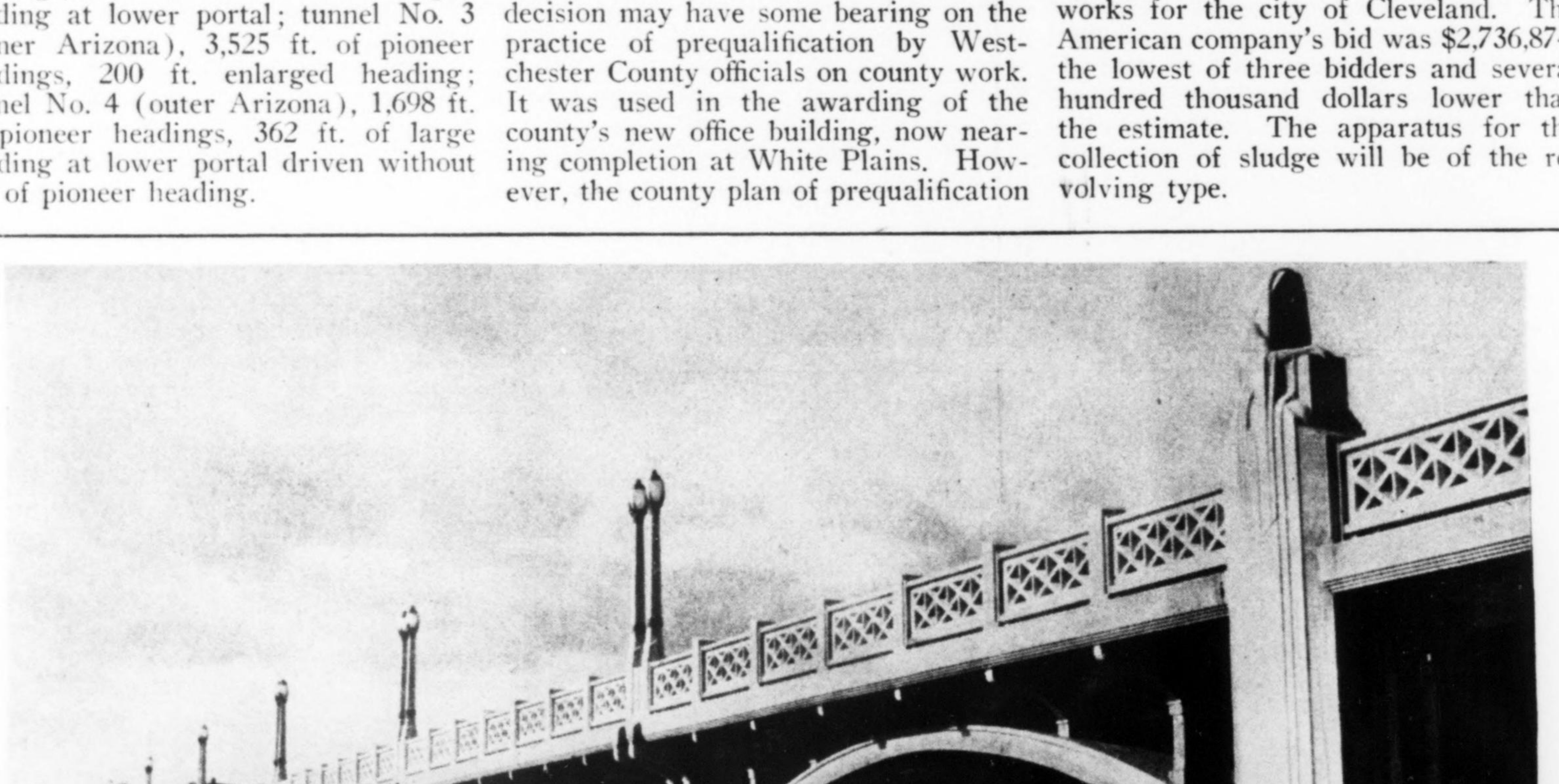
Fear has been expressed that the decision may have some bearing on the practice of prequalification by Westchester County officials on county work. It was used in the awarding of the county's new office building, now nearing completion at White Plains. However, the county plan of prequalification provides for an appeal to the county board of supervisors, and in the event an appeal is requested, the board examines the qualifications of all bidders, including those accepted by the awarding officer. No provision for an appeal was made in the Mount Vernon case.

Dynamited Sections of Owens River Aqueduct Repaired

Repairs to sections of the Owens River aqueduct at Los Angeles, dynamited by unidentified persons early Nov. 2 (*ENR*, Nov. 5, p. 744), were completed Nov. 5 and flow of water to the city reservoirs was resumed. Investigation by the Los Angeles department of water and power, city police and Los Angeles and Kern county authorities proceeded without an arrest (to Nov. 6), although several suspected persons, including a so-called labor agitator and a former employee of the department, were being sought.

Contract Let for Part of Cleveland's Sewage Plant

Contract has been awarded to the American Construction Co., of Cleveland, for the construction of reinforced-concrete aeration and sludge-settling tanks for the Easterly sewage-treatment plant, part of the $12,000,000 projected works for the city of Cleveland. The American company's bid was $2,736,874, the lowest of three bidders and several hundred thousand dollars lower than the estimate. The apparatus for the collection of sludge will be of the revolving type.



AURORA, ILL., OPENS MEMORIAL BRIDGE

Armistice Day, Nov. 11, was celebrated at Aurora, Ill., by the opening of the new concrete arch bridge over the Fox River at New York St. Statuary and architectural treatment supplement the engineering design to make this a war memorial structure. Ten 66-ft. arch spans are flanked by a girder span at each end. Designs were worked out under the cooperation of Walter E. Deuchler, city engineer; the Engineering Service Co., and Emory P. Seidel, sculptor. The John Ward Co. was the contractor. The cost of the bridge was about $300,000.

Concrete-Arch Memorial Bridge at Aurora, Ill.

Nine four-rib open-spandrel arches with abutment piers in the river and girder shore spans—Retaining walls with T-heads carry sidewalks on approaches

ARCHITECTURAL and sculptural treatment of a concrete-arch bridge design, in order to produce a structure worthy of being a war memorial, has been attempted in the new Fox River bridge at Aurora, Ill., which was opened on Nov. 11, 1931. Lowered construction costs during the period between the approval of the bond issue and the letting of the contract enabled the city to provide funds for this elaboration of the original design. A general view is shown in Fig. 2. (See also *ENR* of Nov. 12, 1931, p. 786.)

Old Wrought-Iron Bridge — A wrought-iron bridge on stone piers, built in 1883 to connect New York and Walnut Sts., had four through-truss spans of 175 ft. Its roadway had a clear width of only 20 ft., and with the heavy traffic of recent years the truss members were struck occasionally by motor trucks and automobiles, necessitating emergency repairs. But the amount of traffic precluded any narrowing of the roadway by guards that would keep all vehicles clear of the trusses.

This condition was the main reason for the replacement of the old bridge, for while the spans were somewhat light for modern loading, the material was in good condition, with very little corrosion, even at points where dirt collected and held moisture. After its removal, in 1930, the old piers were cut down to the level of the riverbed.

New Concrete-Arch Bridge — The new bridge is a reinforced-concrete structure, with nine arch spans of the open-spandrel type, 66 ft. c. to c. of piers, flanked at each end by a concrete-cased steel-girder span, with a short approach fill between retaining walls. Thus the arch thrust is taken by abutment piers instead of by solid abutments. These piers are in the river, outside of the shore line, and are made distinctive by heavy pylons (Fig. 2), which are carried up above the bridge deck. The bridge is designed for the H-20 loading provided in the specifications of the American Association of State Highway Officials, but with a further provision for a future double-track electric railway carrying 40-ton cars, while the sidewalks are designed for a uniform load of 125 lb. per sq.ft.

A city bond issue of $350,000 was approved in 1929, but definite plans were delayed by uncertainty as to the location of the east abutment. The Chicago, Aurora & Elgin Railway, an electric interurban line that ran formerly through one of the main streets, had purchased property for a relocation along the river bank to a new terminal station at New York St., adjacent to the bridge site. For this purpose it desired to fill in 40 ft. beyond the shore line, but as this was opposed by the War Department and some local interests, a permit for the bridge could not be obtained from the War Department. Finally, the matter was settled by approval of a 28-ft. width of fill to a new shore line, after which the bridge permit was issued.

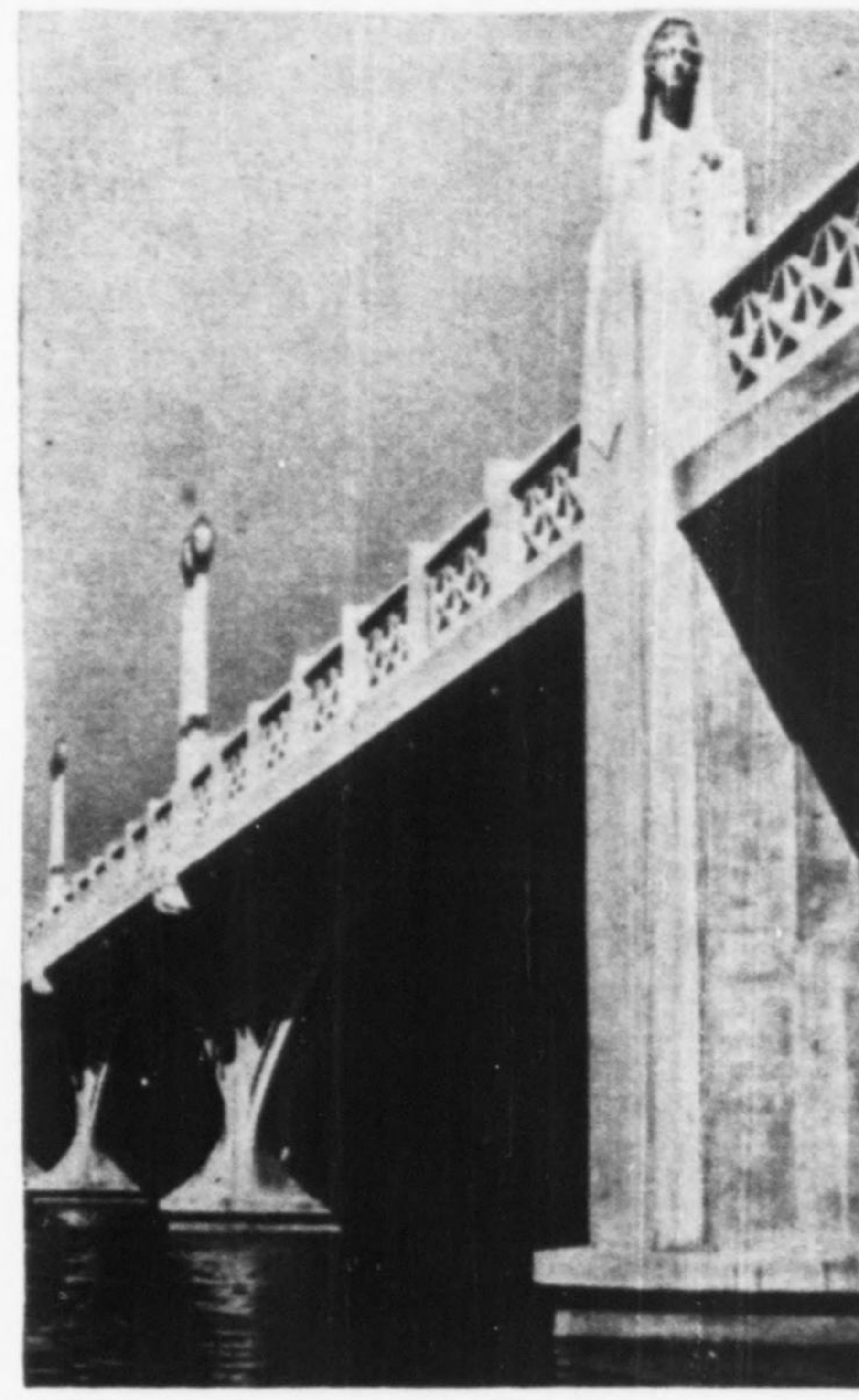
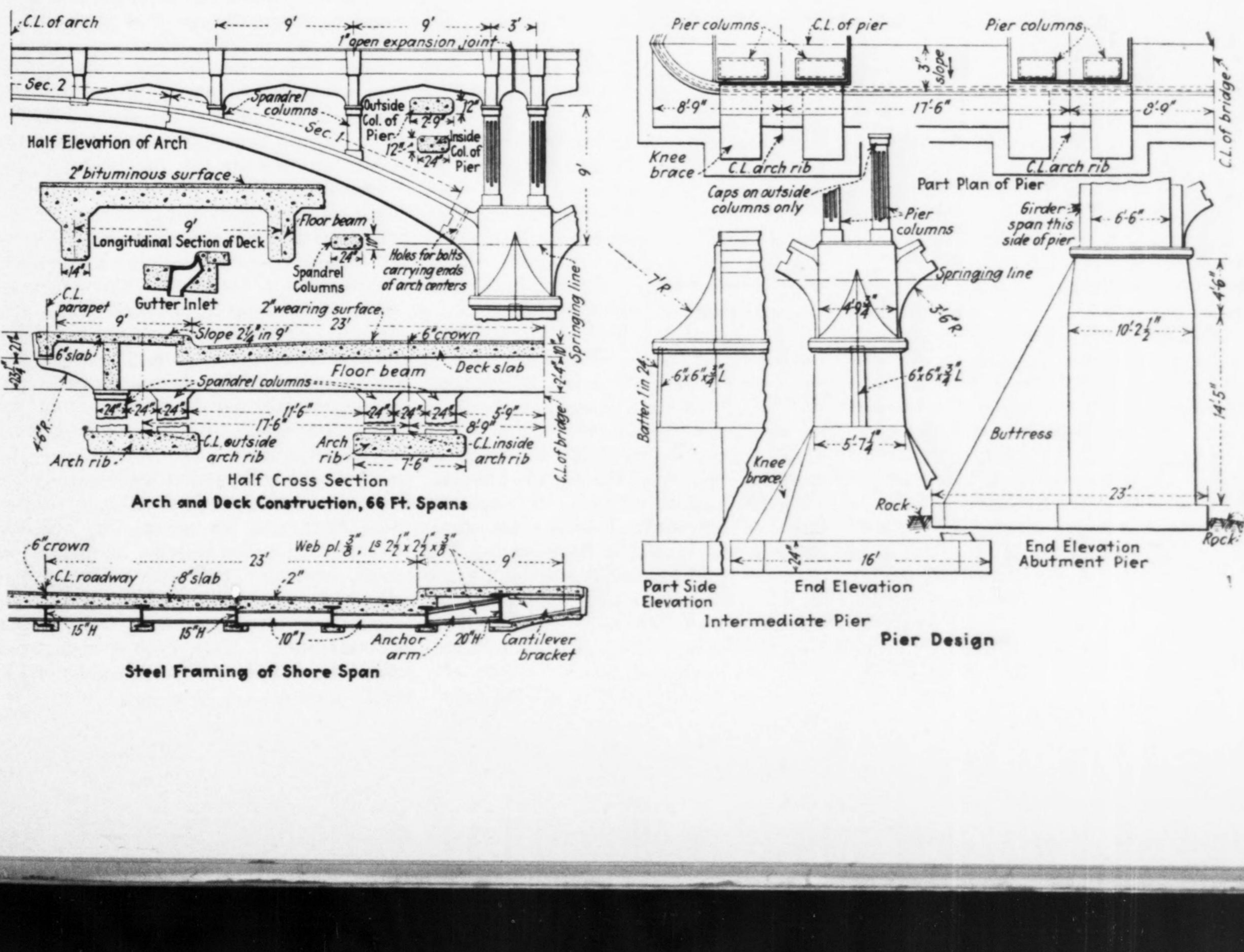


Fig. 2—Monumental abutment pier of new Fox River bridge at Aurora, Ill.

Fig. 1—Arch and deck construction and pier design details, Fox River bridge.



An interesting feature proposed, but not carried out, was a lateral approach to the middle of the bridge from an island just below it. This island, which is a part of the business district, has bridges on each side and a longitudinal street that was intended to extend to the bridge by a short concrete-girder approach viaduct. Opposition was made on the ground that such a structure could not be construed as an "approach" and therefore could not be paid for from the bond issue for "bridge and approaches." After some heated controversy this proposed connection was abandoned.

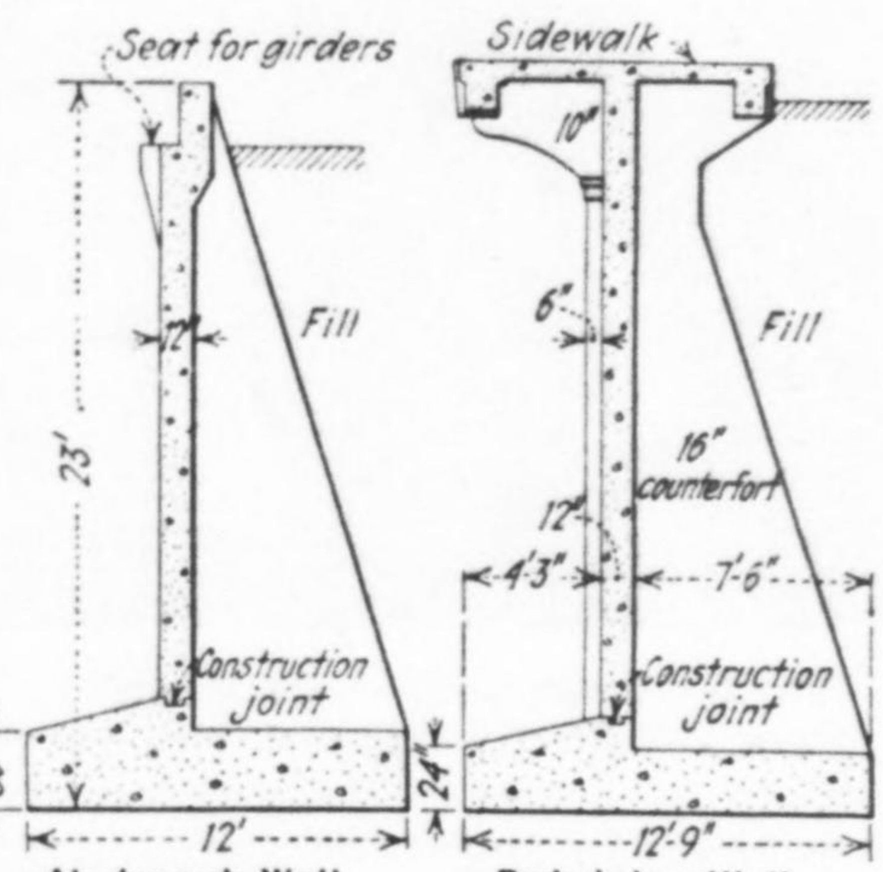


Fig. 3—Walls for filled approaches. Note T-head retaining walls forming sidewalks.

Piers and Foundations—Pier foundation conditions were favorable, bedrock being found at depths of 8 to 18 ft. below water level. This was excavated for about 12 in. to provide an even bearing in solid rock. The overburden of gravel and mud is 5 to 15 ft. thick. A depth of 2 to 5 ft. of water is maintained by a dam at the head of the island already mentioned. Wood piling was used under the retaining walls and abutment wall of the west approach, where the rock is 14 ft. below the footings. Typical plans of the end, or abutment, piers and the intermediate piers are shown in Fig. 1.

Piers 5½ ft. thick and 68 ft. long extend only about 18 in. above normal water level. The two abutment piers have their footings extended on the land side to support four heavy buttresses in line with the arch ribs, to take the end thrust. The other piers have four knee-braces on each side, in line with the ribs, to distribute the thrust over the footings and also to insure against any rocking or rotation of the piers. At the rounded ends of the piers the nose is faced with an angle or bent plate 6x6 in., secured by anchor straps, in order to protect the concrete from floating ice.

In the design it has been the aim to make the abutments significant features of the bridge ends. It was felt that with abutments at the shore lines, buildings erected at the street front and adjacent to the bridge would mask or spoil the effectiveness of such entrance treatment. To avoid this objection, the arch abutment piers were placed in the river, with their center lines 36 ft. from shore, each being flanked by a girder span connecting to an abutment wall on the bridge approach. The abutment piers were then made significant by pylons carried up high above the level of the bridge.

Arch Spans—All the arches are 66 ft. c. to c. of piers, with 63½-ft. clear openings and a rise of 9 ft. above the springing lines. Their construction is shown in Fig. 1. The arch curve was derived from the equations of Strassner, as adapted from the German by the designer. Each span is composed of four ribs 7½ ft. wide and 15 to 28 in. deep, each rib carrying two rows of spandrel columns. Upon these columns are transverse girders or floor beams 9 ft. apart and cantilevered about 5 ft. beyond the outer rows of columns. Double sets of spandrel columns are used at the piers, as the deck slab is not continuous but is interrupted by an expansion joint over each pier.

In the expansion joints, sliding connections are eliminated wherever possible. Over each pier a 1-in. space is provided between the adjacent roadway slabs, sidewalks and parapets. On the parapets this joint is left as a clear opening. On the sidewalks it is filled with a bituminous filler. In the roadway the joint is covered with a steel plate, over which the 2-in. wearing surface is laid as a continuous sheet.

The tops of the floor beams are cambered to the contour of the 10-in. deck slab for the roadway, which is 46 ft. wide between curbs, with a 2-in. bituminous paving, except at the gutters, where a 2-in. shoulder is formed to retain the roadway paving. Sidewalks have a clear width of 9 ft. inside the parapet walls, but the 6-in. slabs are about 10 ft. wide, giving a total over-all width of 66 ft. for the bridge. Between the spandrel columns of the outside rows are arched spandrel beams, forming two lines of longitudinal beams or struts between the transverse floor beams. The roadway rises from each side on a grade of 0.5 per cent to a central parabolic vertical curve 500 ft. in length, giving a maximum height of 13 ft. 9 in. above water at the central span.

Approaches—With the arch abutment piers placed in the river, a 33-ft. flanking span was provided at each end, to connect with the shore abutment and approach. Flat steel spans (Fig. 1) were adopted in order to make the series of arches more significant than if small approach arches had been introduced. Each steel span consists of 15-in. H-beams laid longitudinally and connected by transverse struts of 10 in. I-beams framed between them. These struts are at different elevations on the webs of the H-beams to allow for the camber of the 8-in. concrete deck slab. For each sidewalk there is a single 20-in. H-beam with 5-ft. cantilever brackets attached to its outer side, while on the inner side are corresponding anchor arms attached to the sidewalk beam and the adjacent 15-in. H-beam at the curb. All structural steel is incased with concrete.

Walls of counterfort type are used for the abutment wall of each steel span and for the retaining walls of the short filled approaches, as shown in Fig. 3. These retaining walls, however, are of curious design, being T-shaped in section, with a T-head 13 ft. wide forming the sidewalk slab, which is stiffened by a fascia girder and a curb. Upon this is built the concrete parapet. Cantilever brackets on each side support the slab. The object of this design was to prevent the usual settlement of sidewalks when built on a fill. While the roadway is built on the fill, special construction was provided to insure against its settlement at the bridge ends. Behind the abutment walls a transverse row of wood piles (two rows at the east end) was driven (Fig. 4) and was capped by a transverse concrete beam 20 in. wide and 26 in. deep. This beam supports the roadway slab, which extends from the abutment wall to the solid ground beyond the fill.

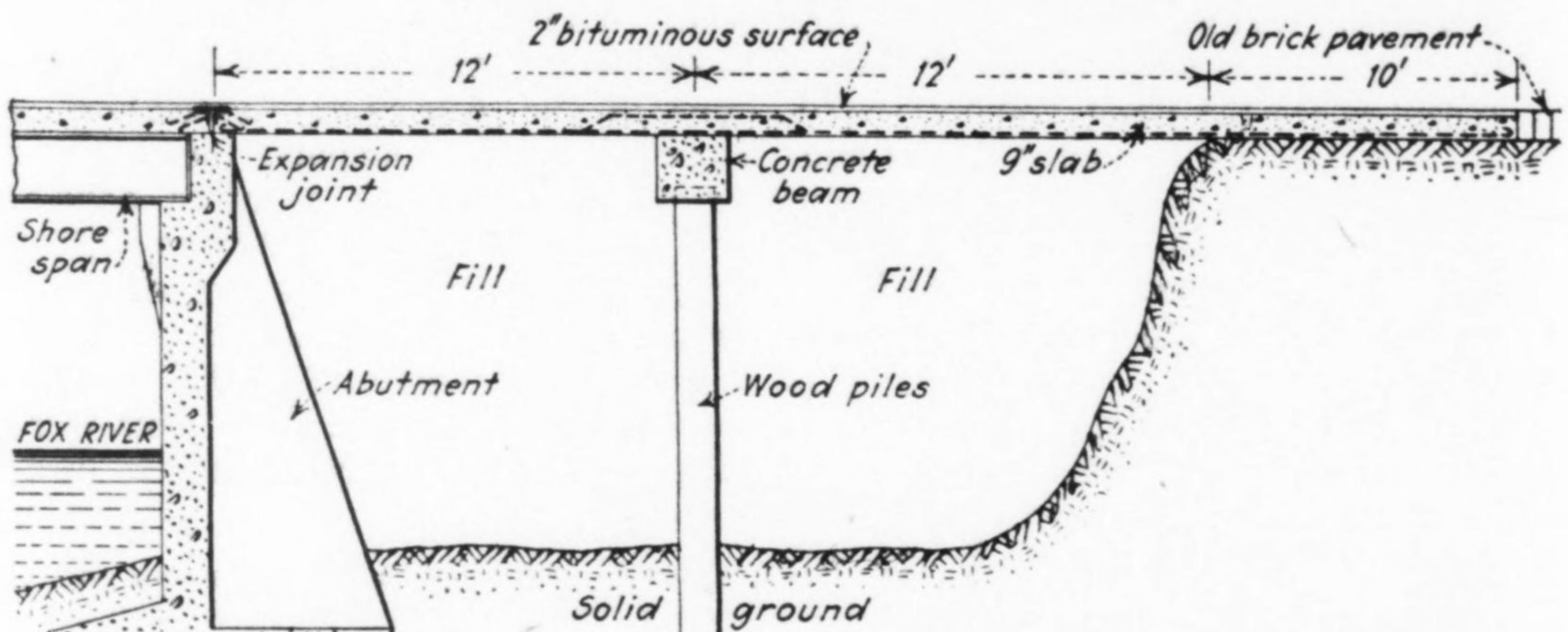


Fig. 4—Roadway slab supported over fill on a concrete-capped row of wood piles.

Decorative Treatment—Originally the bridge was designed of rather plain appearance; and to cover the original estimate, the bond issue, approved in 1929, was for $350,000. But prices dropped materially while the controversies already noted were being settled; and in May, 1930, the contract was let for $273,000, which did not include the approaches. As the contract price was so much below the amount of the bond issue, a movement was started to elaborate the design and make a structure architecturally suitable as a memorial to the local men who had served or died in the nation's wars. When this plan received public approval, competitive designs were asked from several sculptors and architects.

The adopted design included surmounting the four pylons of the arch abutment piers with figures representing Memory (Fig. 2), placing a bronze figure of Victory at the center of the bridge, using a more decorative form of parapet, mounting the electric-light standards in pairs as a distinctive feature, and introducing other minor decorative features. A pair of standards with the parapet wall and its open expansion joint is shown in Fig. 5. For the Victory statue a semicircular balcony was provided on the north side at the center of the middle span, where it would face the viaduct approach from the island, already mentioned. With the abandonment of this approach, it was necessary to balance the design by a similar balcony on the south side, and here a relief representing the several branches of the military service has been erected on a pedestal to face the statue. These balconies are supported by steel beams incased in concrete. The beams extend over the full width of the structure and serve as floor beams as well as cantilever extensions to carry the balconies. The parapet panels were all cast in place, as were the four figures on the pylons.

For the surface finish the forms were removed in about 36 to 48 hours after pouring, and the concrete was wetted and ground. Carborundum wheels were used at first, but as these were found to have a tendency to pull out fragments of the aggregate they were replaced with sandstone grinding wheels. After the first grinding the paste thus produced was allowed to dry, after which it was again wetted for a final grinding and sluiced with water to leave a clean surface. Bevel-edged wheels were required for finishing the rather intricate parapet work. With the standstone grinding a very white color is given to the concrete.

Construction — Excavation for the piers was done by a crane with clamshell bucket and by hand. In the forms for the piers composite struts were used, consisting of wooden end pieces and precast reinforced-concrete struts, the latter remaining embedded in the mass concrete. This plan is said to have reduced the cost of the pier form work. Each arch was poured in three sections, the haunches first and then the central portion, these sections being united by dowel rods and a mortise joint. This arrangement was adopted in order to compensate for shrinkage and to relieve initial stress in the steel due to the setting of the concrete. Steel

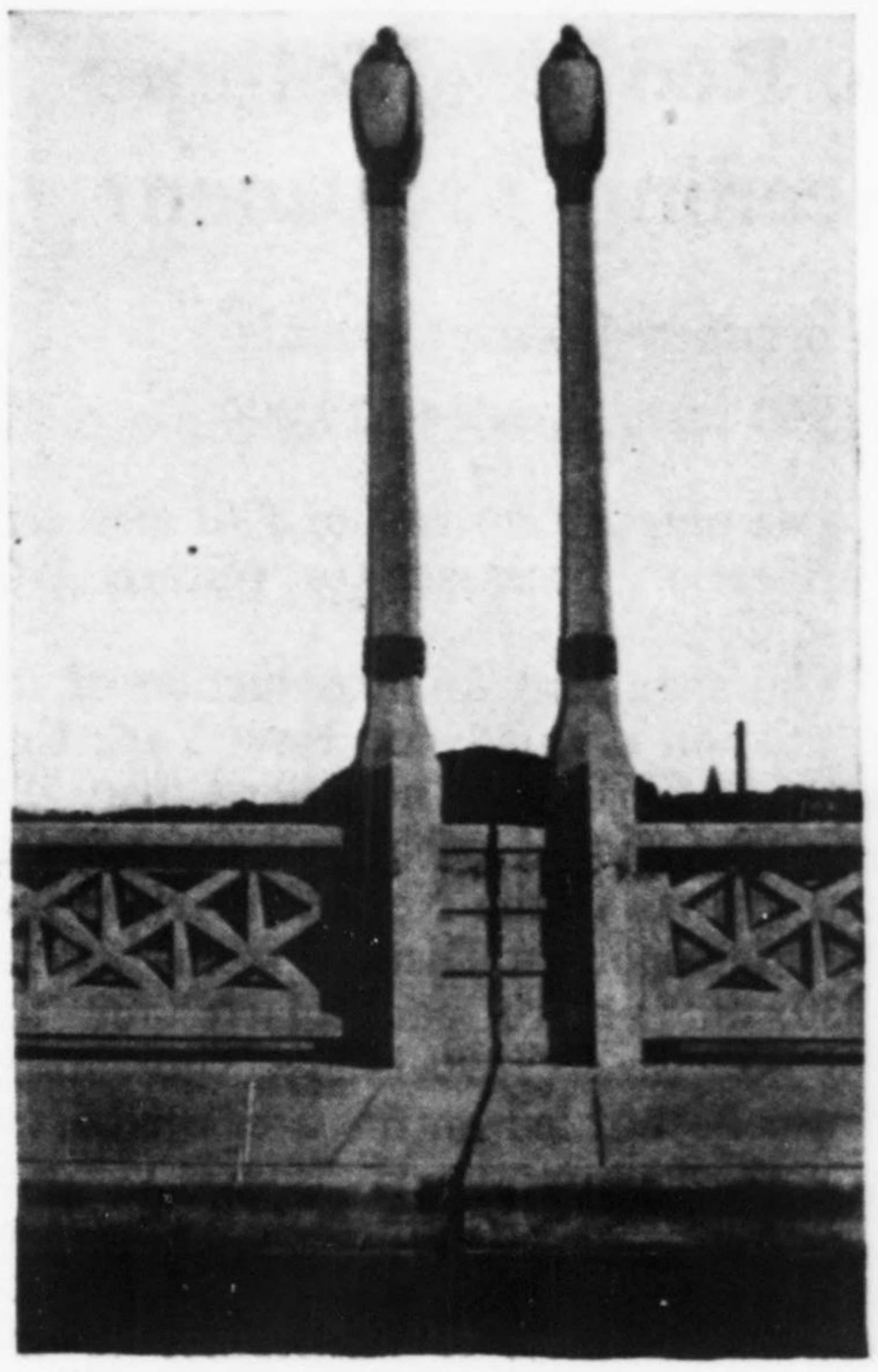


Fig. 5—Lamp standards and parapet. Expansion joint is open in parapet, filled in the sidewalk and covered by bituminous paving in the roadway.

trusses for the arch centers were suspended from the projecting stub ends or "umbrellas" of the arch ribs, which were built as parts of the piers. Diagonal bolts or rods through these umbrellas carried the seats for the trusses, as indicated in Fig. 1.

High-early-strength concrete was used for all work above the piers, the primary reason being to save time in construction and to reduce the cost of steel centering for the arches, since with such concrete the centers could be removed in three or four days and shifted to another span. The cost of extra cement for this concrete was about $4,000, an amount that was amply compensated for by the saving in time and the exceptionally good quality of the concrete. A mix of $1:1\frac{3}{4}:2\frac{1}{2}$ was proportioned by volume. On account of the reinforcement the mix was fairly wet, giving a slump of about 4 to 6 in., but the amount of water was measured mechanically for each batch and was not left to the judgment of the mixer operator. For the high-early-strength concrete the batch proportions were seven sacks of cement to 1,400 lb. of sand and 1,825 lb. of gravel, both the aggregates being weighed when wet.

For the piers and foundations the proportions were five sacks of cement to 1,350 lb. of sand and 1,825 lb. of gravel. In a richer mix for the parapet walls and the concrete figures on the pylons, crushed granite of $\frac{3}{4}$-in. maximum size was used for the coarse aggregate. Concrete was poured in place, mainly by chutes, with telescopic pipes or trunks for the foundation and pier work. Hand placing was required, however, for the parapet walls. In these walls the posts were poured first and served to support the forms for the panels. Wood forms were used throughout.

In casting the four pylon figures it was necessary to make two clay models and two plaster molds, for while they are identical in design the two pairs face opposite directions. The molds were made with wire lath, fiber and burlap, heavily braced with sand as backing to resist pressure. The concrete was then placed in two operations; a neat concrete made with sand only was applied to the face of the mold, and heavy concrete was then placed in the center and compacted so as to force the neat concrete into all the crevices of the mold, giving a smooth clean surface and sharp outlines.

Construction was started in May, 1930, and carried on during the following winter, the bridge being completed in July, 1931, except for decorative finish and the bronze statue and tablet. For the winter work steam pipes were used to heat the aggregate and the water was heated, so that concrete left the mixer at a temperature of about 84 deg. F. More than 500 control cylinders were made and tested, samples being taken every day. These cylinders were stored and cured on the work, so that when tested they would represent the actual condition of the concrete in corresponding parts of the structure. Thus, where concrete poured in cold weather was inclosed and kept warm by salamanders, the control cylinders from that concrete were stored in the inclosure. As these tests enabled the strength of concrete in particular parts of the structure to be determined at any time, the removal of forms was expedited materially.

Engineers and Contractors. The design for this bridge was prepared cooperatively by Walter E. Deuchler, city engineer, and the Engineering Service Co., of Aurora, Ill., with A. H. Sorenson as structural engineer of the company. The subsequent decorative treatment was designed by Emory P. Seidel, Chicago, who also modeled the concrete and bronze statuary. The John Ward Co., Aurora, had the general contract at $273,000. The total cost, including approaches and paving, was $335,000, of which the statuary and decorative work supplementing the original design represented about $30,000.

South Africa Using Steel Ties

About 6,000,000 steel ties are in use on the South African Government Railways, according to a report of the U. S. department of commerce, with nearly 5,000,000 purchased in the four years 1927-30. They are used with rails weighing 35, 45, 60 and 80 lb. per yard, all on tracks of $3\frac{1}{2}$ ft. gage. Their cost in 1930 averaged $1.54 and $2.34 each for track with 60- and 80-lb. rails respectively. All these ties were purchased in Europe, but a steel plant at Pretoria is expected to be in operation in 1933.