Silicon Steel Used Liberally in 1,257-Ft. Continuous Truss Bridge

Special Steel and Continuous Construction Result in Economies in Mississippi River Highway Bridge at Quincy, Ill.—Deep Piers Required for Main Spans

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CONTINUOUS-TRUSS construction over two channel spans of 627 ft., and extensive use of silicon steel in the trusses, are special features in the highway bridge now being built across the Mississippi River at Quincy, Ill., and named the Quincy Memorial Bridge in honor of the local men who served in the World War. After careful comparison of continuous-truss, simple span and cantilever designs the first was found to be the most economical, while a further noticeable economy was effected by liberal use of silicon steel. The trusses are 69.75 ft. deep, center to center of chords, and are spaced 31 ft. apart center to center. Their panel length is about 31.37 ft. Figs. 1 and 2 show the big spans under construction.

General Description—The deep-water channel on the Illinois side is spanned by the continuous-truss riveted steel structure, 1,257 feet long, covering two spans 627 ft. 8 in. center to center of piers. Its lowest steel is about 55 ft. above extreme high water and 70 ft. above the average stage of the river, while the roadway is about 61 ft. above high water. As the bank is high on the Illinois side, only eight approach spans are needed, including girder spans of 78 ft. and 99 ft. and I-beam spans of 35 and 50 ft. This approach has a grade of 1 per cent and a curve of 12 deg. to bring it into line with Maine St., the Quincy end of the bridge being within a few blocks of the center of the city.

Across the shallower part of the river, on the Missouri side, there is a 1,695-ft. viaduct of 27 spans, the first half of which descends from the main bridge on a grade of 4.95 per cent in order to reach the low ground on this side of the river. There are eleven girder spans of 78 ft. and sixteen I-beam spans of 50 ft. The total length of the bridge between abutments is 3,508 ft. A reinforced-concrete slab 20 ft. wide between curbs forms the roadway, and is extended to form 4-ft. sidewalks, all between the trusses. On the girder spans (Fig. 4) this concrete deck is carried by transverse 21-in. I-beams cantilevered 6½ ft. beyond the girders, which are spaced 15 ft. center to center.

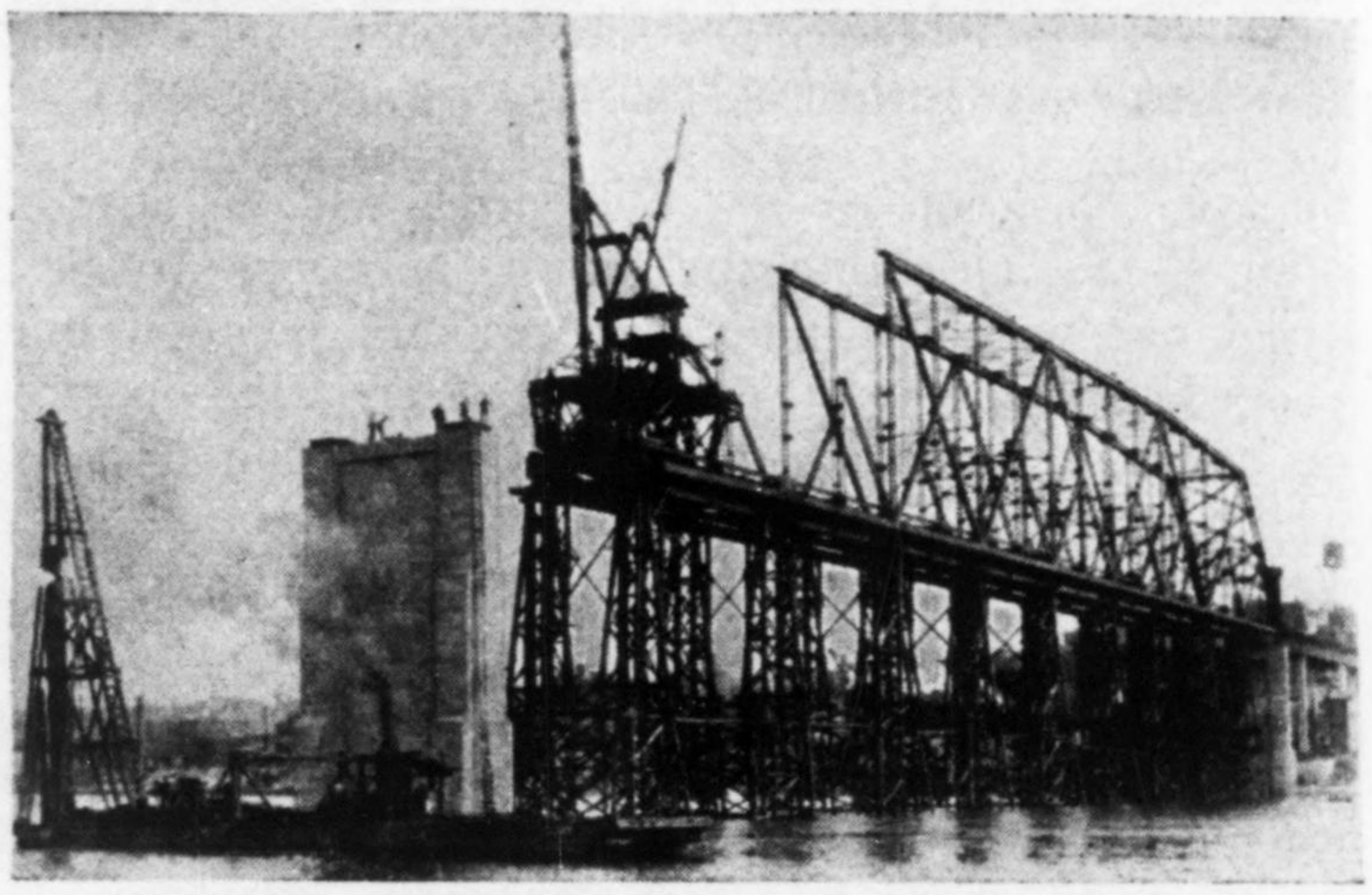

FIG. 1—ERECTING FIRST MAIN SPAN, QUINCY BRIDGE
This 627-ft. half of a continuous truss is between piers 8 and 9; shoes are being placed on pier 9.

Substructure—There are 36 piers and two abutments. All piers are in the water, with the exception of the seven for the Illinois approach; these are founded on rock at depths ranging from 5 ft. at the abutment to 30 ft. at pier 7. The east river pier and center pier of the channel spans are founded on rock, pier 8 being built in open cofferdam, while pier 9 consists of two reinforced-concrete caissons sunk partly by dredging and partly by the pneumatic system. The west pier, No. 10, is supported on piling, as borings showed rock at such a depth as to preclude the use of the pneumatic system.

This depth to rock below mean low water at the three piers of the main spans is about 20 ft., 105 ft. and 121 ft., respectively. Below ground, pier 9 has two cylindrical shafts, while above ground there are two rectangular shafts or columns connected by a heavy curtain wall, as shown in Fig. 6. Piers 8 and 10 have rectagular footings, above which they are similar to pier 9. On the west approach (Fig. 5) all the approach piers have untreated pile foundations and each pier consists of a pair of rectangular columns connected at intervals by diaphragms.

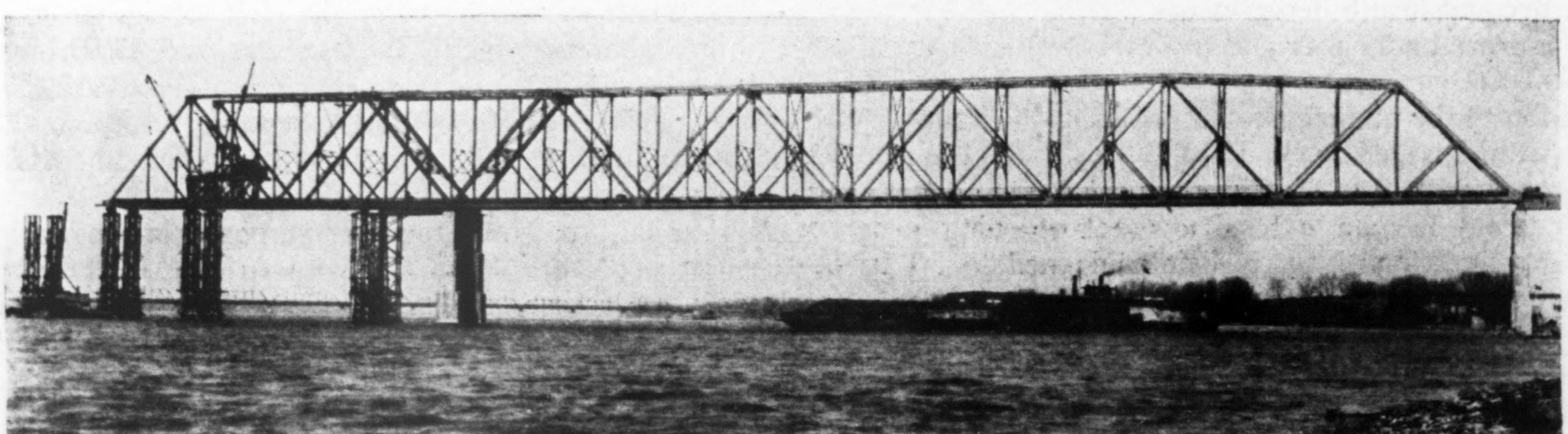

FIG. 2—ERECTING 1,257-FT. CONTINUOUS TRUSS
Work is extending over the second span from piers 9 to 10.

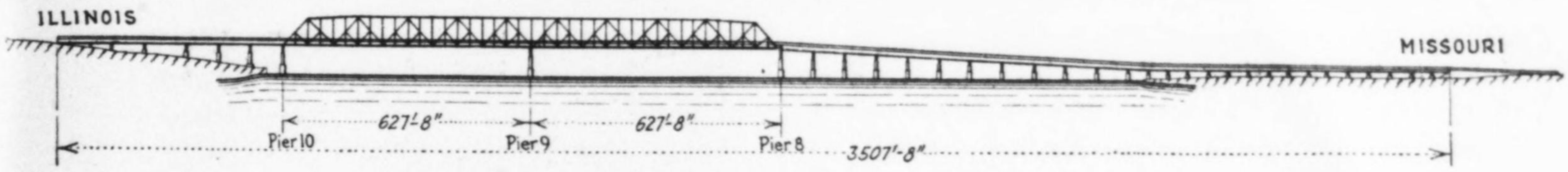

FIG. 3—MISSISSIPPI RIVER HIGHWAY BRIDGE, QUINCY, ILL.

Loading—The floor system and stringer spans were designed for a live load of one 20-ton truck for each traffic lane. The trusses and girders were designed for a uniform load of 600 lb. per linear foot for each traffic lane and a single concentrated load of 28,000 lb. The sidewalk on the stringer spans was designed for 100 lb. per square foot of sidewalk area. For the sidewalks on the trusses and girder spans the following was used: $P = (80 - L/8)(1 - W/40)$, where P = live load in pounds per square foot of sidewalk area, with minimum of 20 lb; L = loaded strength of sidewalk in feet, and W = clear width of sidewalk in feet. Transverse wind load was taken as 30 lb. per square foot on 1.5 times the area of vertical projection of span plus 150 lb. per linear foot. The longitudinal wind load was taken as seven-tenths of transverse wind load.

East Pier—The first river pier of the main span (No. 8) was founded on solid rock 20 ft. below low-water elevation. Details are shown in Fig. 6. Two cofferdams were constructed, 15x17 ft., with steel sheeting having a length of 40 ft. Considerable trouble was experienced in pumping out these cofferdams, it being required that the footing should be placed in the dry. Several blow-ins occurred, making it necessary to redrive this sheeting several times with the hope of penetrating the hard rock at least several inches. As the rock was found to slope about 6 ft. in the width of the cofferdam, it was stepped down in horizontal layers, all loose rock being removed. In addition, twenty holes were drilled 2 ft. deep in which 1-in.-square dowel rods were set for added security.

Center Pier—The construction of pier 9 offered several interesting features. The original plans contemplated the use of two cylindrical steel shells 35 ft. high, using $\frac{3}{8}$-in. steel plates for the inner and outer walls. The working chamber and cutting edge were likewise steel. Provision was also made for four 2-in. jet pipes. At the request of the contractor these plans were changed to permit the use of steel cylindrical frames 20 ft. high lagged with 3x6-in. wood sheeting on both the inner and the outer walls, and surmounted by timber caissons 20 ft. high. Standard sectional panel forms were then used to complete the caisson. A circular timber cofferdam was constructed on top of the completed caisson so that the pier shaft could be constructed under dry conditions. The diameter of the caissons at the cutting edge was 21 ft., with a working chamber 8 ft. in height. The dredging well was 8 ft. in diameter.

A heavy pile and timber platform for both the north and the south caissons carried two heavy A-frames spanned by 24-in. I-beams. Four $2\frac{1}{2}$-in. screw rods having a length of 20 ft. were suspended from these I-beams and attached to the caissons by means of cable slings, as shown in Fig. 7. Here the north caisson is shown sunk for a depth of 60 ft. below the water surface and the south caisson is partly lowered.

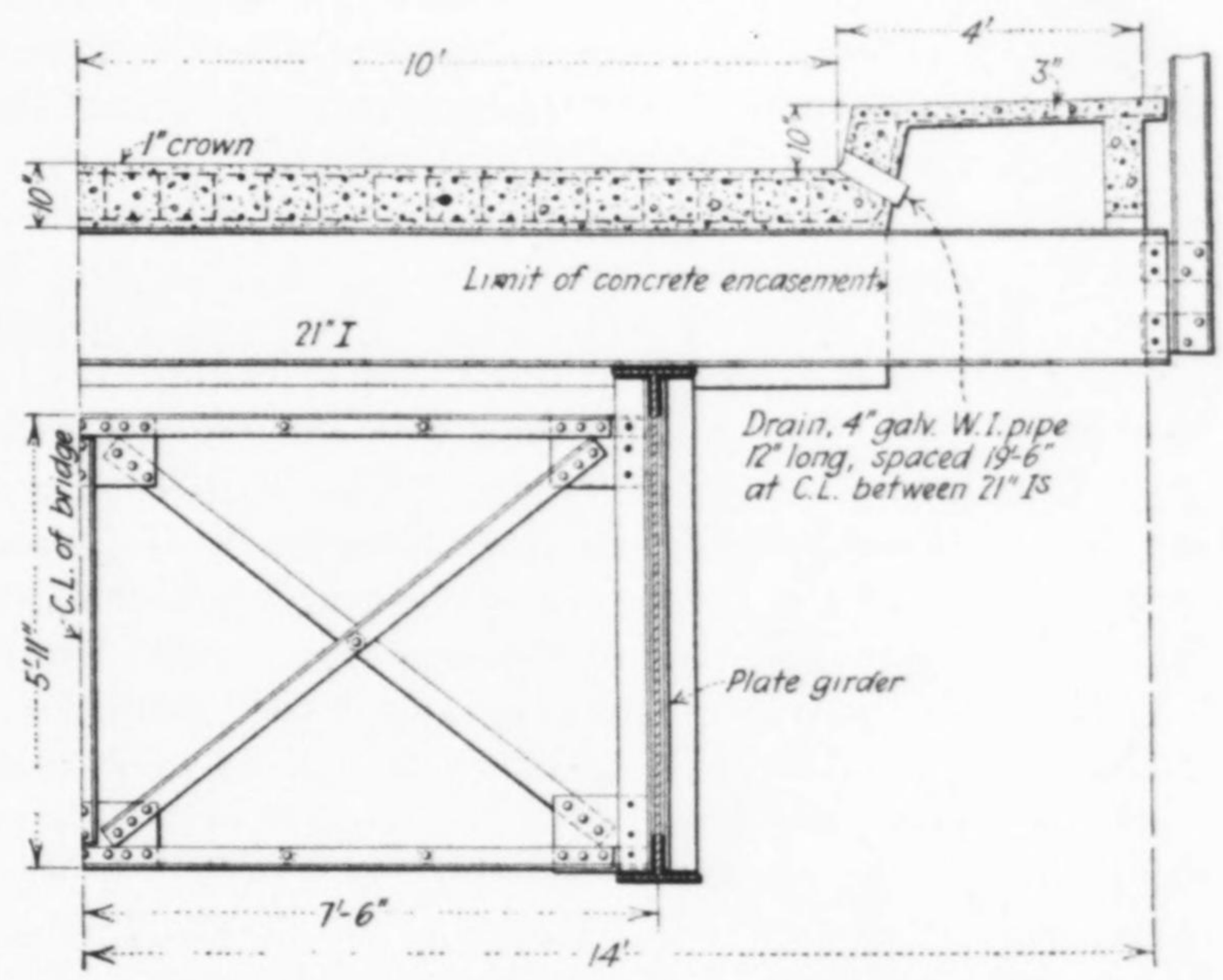

FIG. 4—DECK CONSTRUCTION ON GIRDER SPANS

The working chamber and wall were concreted in lifts of 3 and 4 ft. as lowering progressed, the caissons being lowered and held in position by means of the screws until the cutting edge penetrated the riverbed several feet. The cable lashings were then cut loose and sinking was resorted to by open dredging through the well. Both caissons were sunk in this manner for a depth of approximately 80 ft. below the water surface, after which compressed air was applied. The caisson had been built up for a height of 100 ft. when the air was applied. The deck was placed approximately

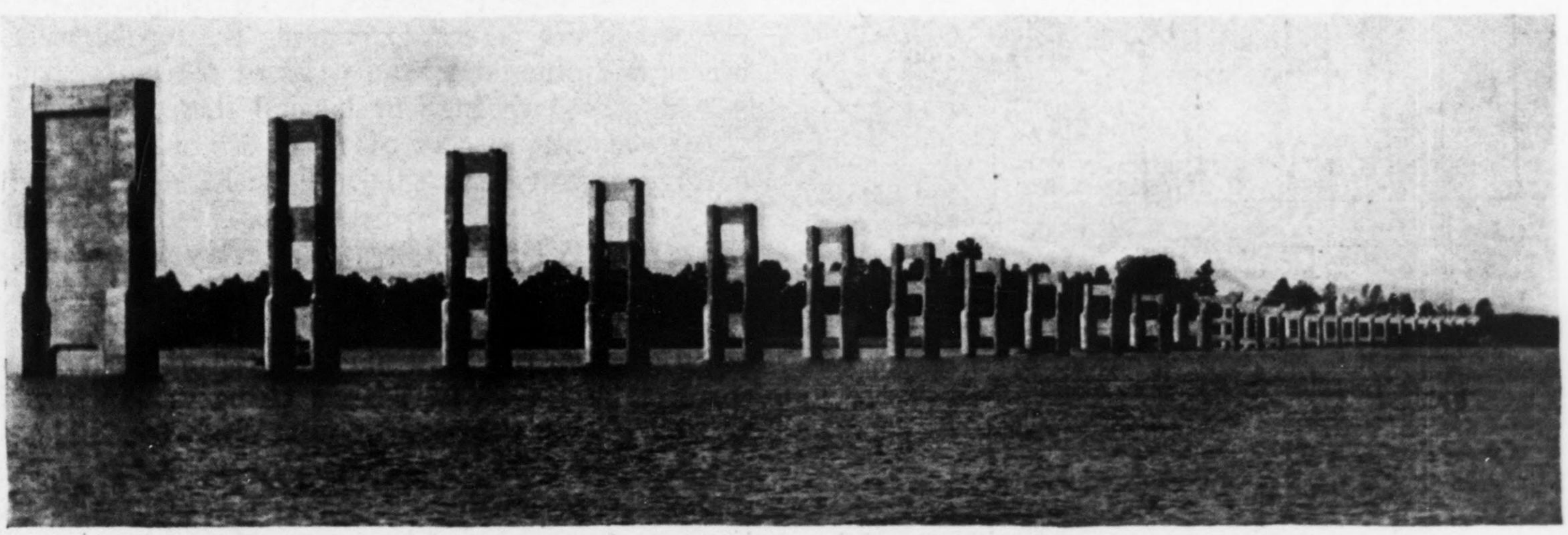

FIG. 5—PIERS OF WEST APPROACH
These piers are for 80-ft. girder spans. At the left is pier 10, for one of the 627-ft. channel spans.

80 ft. up from the cutting edge, offsets having been provided in the dredging well for this support. Two steam compressors on shore delivered air through a 4-in. pipe line 700 ft. in length, laid on the bed of the river.

These caissons were sunk to a total depth of 111 ft. below the water, the stage of the river being about 5 ft. above mean low water. The north caisson was landed on rock in nineteen working days after air pressure was applied for a total sinking of 26 ft. through an exceptionally hard material consisting of a mixture of sand, clay and gravel. The south caisson was landed on rock in fifteen working days for a total depth of 21 ft. A pressure of 48½ lb. was recorded on the air gages when the rock was cleaned. An inspection in both caissons showed the bedrock to be exceptionally hard limestone with numerous deep ridges, forming a perfect key for the bottom of pier.

West Pier—This third main pier, No. 10, is constructed upon 168 timber piles (see Fig. 6), varying in length from 27 to 35 ft. The base of the pier consists of a seal 63x24 ft. and 10 ft. thick and a footing 54x13 ft., also 10 ft. thick. A cofferdam was constructed with 50-ft. sheet piling in spliced lengths. The plans required that 18 ft. of this sheet piling, extending 15 ft. below the bottom of the seal, should be left in place. With this in view, four lengths of sheeting were used, 18 ft. and 20 ft. for the bottom portion, and 30 ft. and 32 ft. for the upper portion. These alternate splices were held by means of a ½-in. plate and two ½-in. bolts. Upon completion of the pier, the sheeting was pulled in the regular way, the ½-in. bolts shearing off at the splices, allowing the lower portion to remain in place.

For driving the timber piles, a skid piledriver rig was constructed on top of the cofferdam. On account of the depth of the water inside the cofferdam, telescopic leads were used so that the piles could be set and held at their correct locations. The piles were 30 ft. in length and the water was 35 ft. deep.

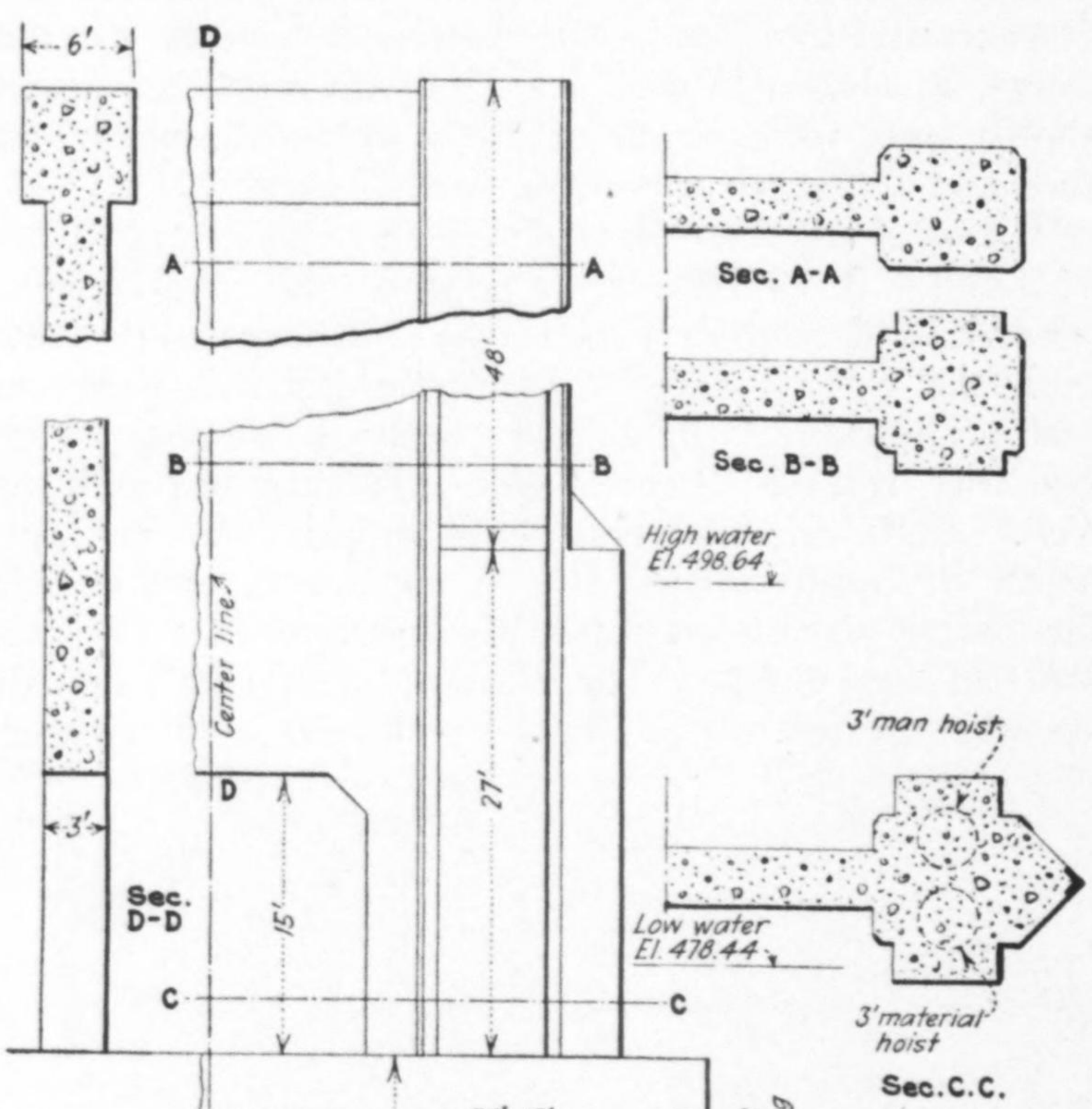

FIG. 6—DESIGN OF RIVER PIERS
Pier 8 has footing on solid rock. Pier 9 has concrete cylinder foundations. Pier 10 has sub-footing on timber piles.

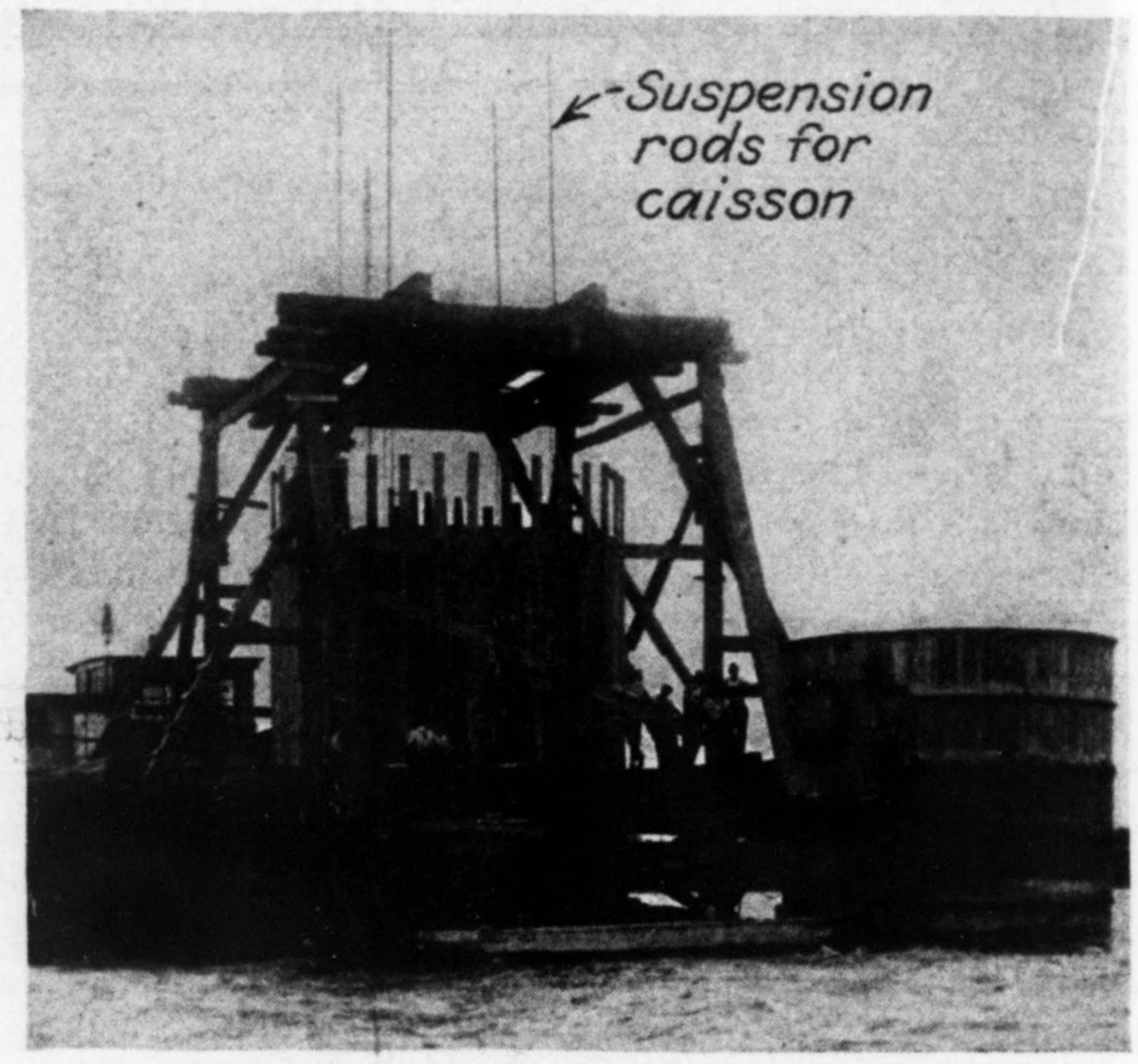

FIG. 7—SINKING CAISSONS FOR PIER 9

Steel Erection—Owing to delayed completion of the middle pier (No. 9) it was necessary to change the intended mode of erection. The original plan provided for starting at pier 9 and erecting both halves of the main span simultaneously, cantilevering part way and using pile and timber falsework supports where necessary. However, in order to progress as far as possible with the erection of the 1,254-ft. continuous span, prior to completion of this pier, it was decided to start at pier 8 (east side) and so to gage the erection progress as to be ready to land on pier 9 soon after its completion. Shoes and bottom chord steel were actually landed on pier 9 two days after the pier was finished (see Fig. 2).

The general scheme of erection involved the use of a single-boom traveler erected originally on top of the east approach girder spans and then moving to the west, erecting all steel in the project. This traveler was of timber construction with a steel A-frame, sills and back legs, and having a 70-ft. steel boom with a lifting capacity of 35 tons with boom flat. Steel was delivered to the traveler by a 5-ton gasoline locomotive on standard-gage tracks. A timber A-frame and 40-ft. boom on the rear of the traveler, operated by a 15-hp. steam hoisting engine, proved very effective in filling in light material behind the traveler, as the height of the traveler would not permit of erecting the top laterals, wind braces and other overhead parts of the truss span until it had passed through or beyond these points.

An elaborate system of falsework was used in supporting the east or first half of the 1,254-ft. span during erection. A piledriver barge was used in driving all pile bents. A bent was located at every main panel point and contained eighteen to twenty untreated cypress piles about 55 ft. in length, heavily braced and capped. Timber towers 40 to 50 ft. high, on top of the piles, were spanned by six 50-ft. I-beam stringers which were to be used for the permanent west approach. The semi-panel points were supported on these stringers. Upon completion of all the riveting in this span, the camber blocking was removed by means of jackhammers fitted with chisels, thus freeing or swinging the span.

Erection of the second or west span was simplified considerably by the elimination of the I-beam stringer supports and because it was possible to cantilever four panels a distance of about 125 ft., in the manner originally planned, at each end of the west span. Upon the completion of both spans, two 300-ton hydraulic jacks were placed under the floor beams at the roller ends (piers 8 and 10) and raised these ends until the tops of the floor beams were at the same elevation as at pier 9, at which elevation the actual and calculated reactions checked.

Because of extremely bad weather and river conditions, the progress has been delayed several months, with the result that the completion date of March 1, 1930, found the bridge unfinished but with all of the structural steel erected and riveted. Only the concrete floor and the painting then remained to be done.

Engineers and Contractors—This bridge project was proposed and financed by the Quincy Memorial Bridge Co., a local incorporated concern, of which Frank W. Crane is president and which is controlled by the city of Quincy and the Quincy Chamber of Commerce. The bridge was designed and its construction supervised by the Strauss Engineering Corp., Chicago, under the general direction of Joseph B. Strauss, president. C. E. Paine, vice-president, was in direct charge of the design and construction. The Kelly-Atkinson Construction Co., Chicago, was the general contractor, and built the land piers and erected the superstructure; W. J. Howard, president, was in direct charge of this erection, with Charles Chaney as superintendent. The Foundation Co., New York, erected all of the river piers, with John Hoskinson as superintendent, Frank Baras general foreman, and William Kaufman resident engineer. The American Bridge Co. furnished the steel. The writer is resident engineer for the Strauss Engineering Corp.

Lake Shore Protection Work at Lincoln Park, Chicago

Concrete Sheet Piling Forms Toe of Paved Slope—Timber Jetties to Create Sand Beach—Work by Park Forces

STORM DAMAGE along the lake front of Lincoln Park, Chicago, last winter, included the undermining and breaking up of large areas of the concrete paved beach, which damage is now being repaired, as shown in Fig. 2. The original construction, about 30 years old, consisted of a bulkhead 12 ft. wide having two rows of wood sheeting and round piles with loose rock filled between them, the piling being anchored by tie-rods to land piles. Over this bulkhead and extending inland was a concrete slab 47 ft. wide, laid on a bed of broken stone and having a slope of 1 on 12. The land slope the waves normally lose their force. The land side of the slope abuts against a retaining wall which rises 3 ft. above it and supports the fill for a 20-ft. concrete walk. Between this walk and the park area is a parapet wall. This construction is shown in Fig. 1. In some places the paving consisted of large granite blocks with asphalt-filled joints.

Undermining of the fill owing to breaks in the bulkhead, combined with the pounding of heavy waves on the top and the unusually high level of the lake, broke up the concrete slab and stone paving in several places, large portions being carried away and the fill scoured out. Heavy waves even ran over the beach walk, washing out the fill behind the retaining wall so that the 5-in. slab sagged and cracked in places.

For reconstruction, a single line of interlocking concrete sheet piles 10x18 in. in section and 16 ft. long is being driven behind the old bulkhead. Behind this sheeting, 10 in. thick, the rockfill and broken stone bed is replaced, dressed to the proper slope and covered with an 8-in. slab of concrete, reinforced near the bottom with rods in both directions at 4-ft. spacing. Anchor rods 6 and 8 ft. long run through the sheet piles to anchor plates embedded in the concrete. The slab extends the full 47-ft. length and is in widths of 30 ft. with asphalt-filled expansion joints between the sections and along the retaining wall. In some of the old work the concrete was in squares or panels about 12x12 ft., with asphalt joints, but in general it was of full width from bulkhead to retaining wall.

Pile driving is done by a 3,500-lb. drop hammer in leads suspended from the boom of a gasoline crawler crane which stands on timber pads on the old concrete slope. The crane handles the hoisting cable, the hammer line and a line supporting the hose of an iron jet pipe.

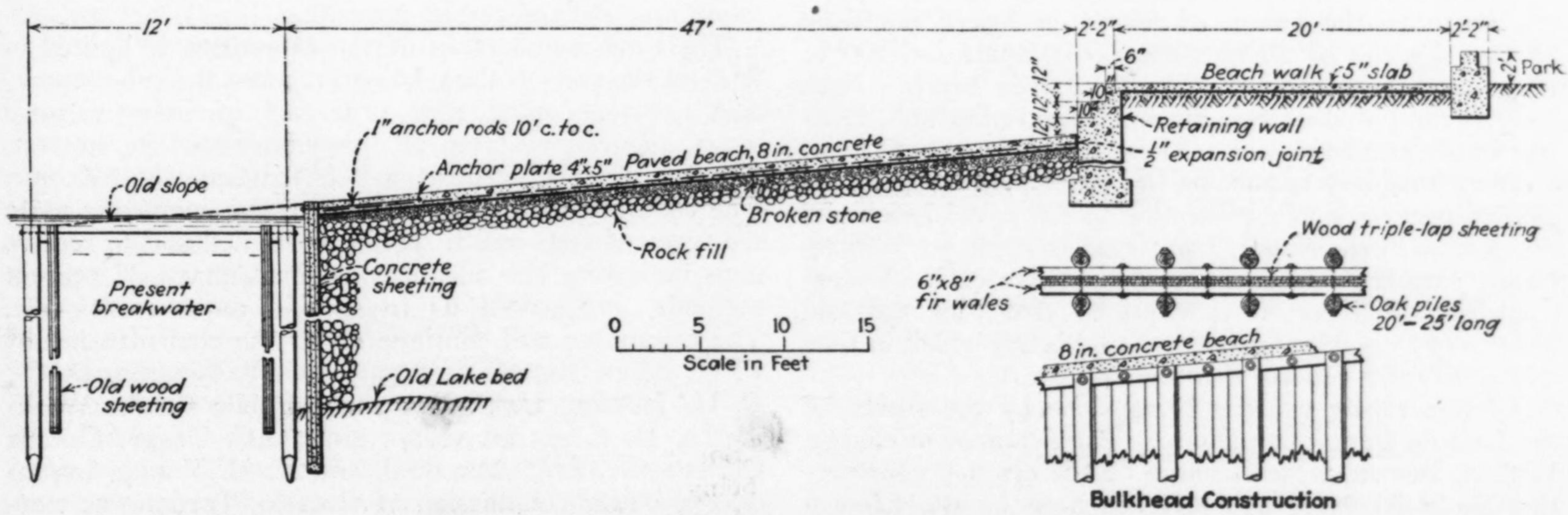

FIG. 1—SHORE PROTECTION AT LINCOLN PARK, CHICAGO