Foundations Get Under Way on New Orleans Bridge

Special open caissons, to be sunk 180 ft. through 90 ft. of water by the sand-island method, have closely spaced wells in the concrete walls that provide access to the cutting edges —Willow mattresses sunk at each pier to prevent scour

The foundation contractor on the combined railway and highway bridge over the Mississippi River, 10 miles above the "old city" section of New Orleans, has initiated his work by weaving and sinking large willow mattresses over each of the river pier locations. These mattresses, four of which are now finished, are required to prevent scour as the caissons are being sunk. That such scour is a distinct possibility was revealed during the taking of test cores, when holes 12 to 14 ft. deep occurred around the 4-in. drill casings. Under normal conditions the river current has a velocity of 4 miles per hour. With the mat work completed, caisson work will be started. The deepest of these foundations will be sunk 180 ft. below mean gulf level, or about 195 ft. below the maximum working stage. It is planned to do this work without resorting to compressed air, as four of the caissons will be sunk far below limits for pneumatic work, and unusual open-bottom caissons have been designed for the purpose.

The New Orleans bridge is being built jointly by the Public Belt Railroad Commission and the state of Louisiana at an approximate cost of $13,000,000, loaned by the Reconstruction Finance Corporation. Upon completion the bridge will be used by the Southern Pacific Railroad in addition to the Public Belt Railroad and the main state highway into New Orleans from the northwest. The bridge and approaches have a total length of 23,000 ft., the river crossing being a cantilever structure with a 790-ft. main span and 530-ft. anchor arms. The remainder of the main bridge superstructure consists of a 530-ft. through span and four deck-truss spans varying in length from 333 to 269 ft. This span arrangement was made necessary to meet navigation requirements. The long viaducts will have tower spans of 45 ft. and intermediate spans varying in length from about 69 to 82 ft.

A vertical clearance of 135 ft. above mean high water is provided for the main bridge structure. The approach structures will be constructed with the railroad decks on descending grades of 1.25 per cent. The vehicle roadway, however, will descend on a 4 per cent grade. There are two of these vehicle roadways, each 18 ft. wide, supported outside the through trusses on cantilever extensions of the floor beams. On the approaches the roadways are supported on brackets cantilevered from the vertical members of the deck-truss spans and from the columns of the viaduct towers.

Foundation design

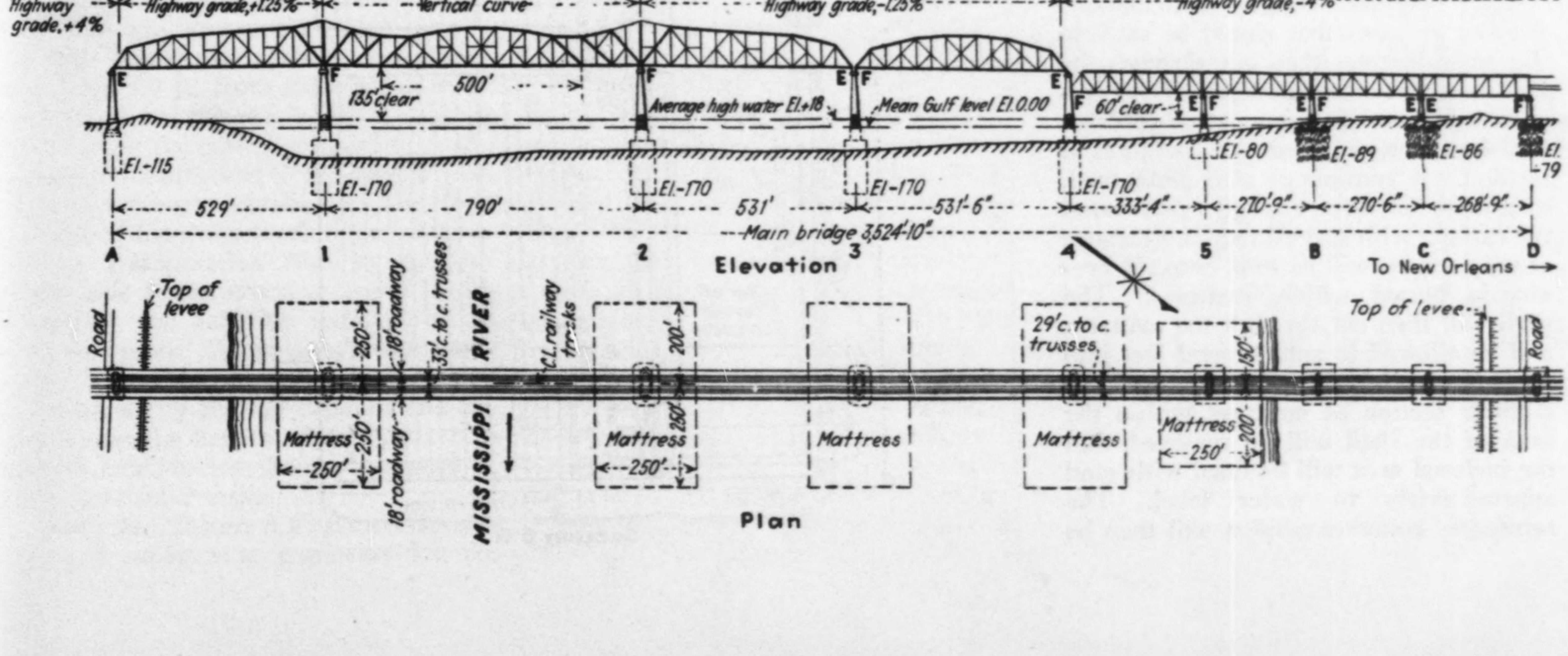
Nine piers will support the main bridge, two on pile foundations on the river side of the east levee, which is a "making" bank, one on piles behind the east levee, one caisson pier in the comparatively shallow water near the east bank, four caissons in the deeper portion of the river and one caisson behind the levee on the west bank. Any future shifting of the river channel would probably be toward the west, which is a "cutting" bank, and this accounts for the use of a caisson instead of a pile foundation behind the west levee.

The caissons planned for the bridge are of unusual design and will be open-dredged to the unprecedented depth of 180 ft. below gulf level. Until recently the deepest caisson was at Hawkesbury, Australia, open dredged to a total depth of 162 ft. below water level. During June of this year a caisson for the Atchafalaya River bridge at Morgan City, La., was sunk 176.5 ft., and one of the Trans-Bay Bridge piers at San Francisco will go down 226 ft.

The main caissons must be dredged through the semifluid silt forming the river bottom, and then through alternate layers of sand, clay and gumbo, finally landing on a compacted sand. In the design of the caissons two opposing factors required consideration: first, the unprecedented depth to which they must be sunk (through material that may offer great frictional resistance) requires a maximum weight during sinking; second, because of limitations in expected long-time settlement of the piers under load the maximum soil pressure on the compact sand at El. —170 was established at about 7 tons per square foot., or slightly under 3.8 tons per square foot in excess of natural soil pressure. This second requirement will be met by leaving the dredge wells of the caissons filled only with water from the level of the tremie base seals to the tops of the caissons proper at El. —35. The bottoms of the caissons are to be supported on tremie concrete seals 19 to 21 ft. thick, which transmit the soil pressures into the several bearing walls of the caissons, the walls themselves being heavily reinforced to resist direct bearing pressures and arch action that may occur against the exterior walls.

Timber cofferdams extending from the

Fig. 1—The main river crossing of the Mississippi River bridge at New Orleans will consist of a through cantilever structure. With approaches, the bridge will be more than 4 miles long. Willow mattresses have been sunk over each pier site to eliminate scour during caisson-sinking.



main caissons at El. —35 to El. +15 will permit unwatering to El. —35, so that the distributing blocks and pier shafts may be constructed in the dry. The dredge wells that will not be covered by the concrete distributing blocks will be provided with heavy timber covers securely locked in place to prevent them becoming filled with silt and thereby increasing the weight on the soil.

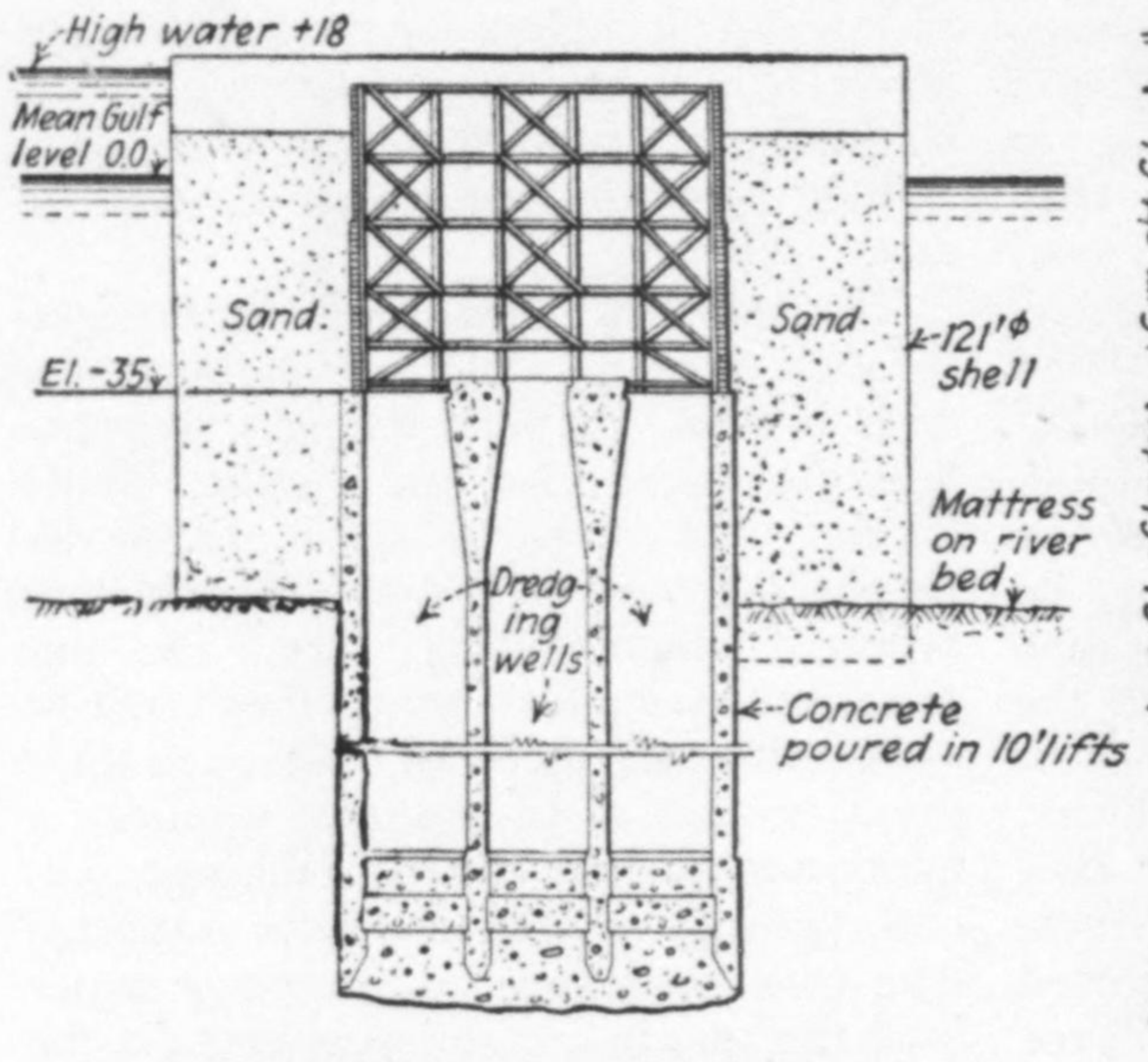
An unusual feature of the caisson design is the provision, in all exterior and interior concrete walls, for vertical tubes, closely spaced, which will provide access to the cutting edges for jetting, drilling or cutting away obstructions encountered during sinking. Soil borings made previous to the design, as well as borings made recently by the foundation contractor at the sites of the several piers, indicate sunken logs occurring at various depths from the river bottom down to El. —200. This, with the fact that certain of the clay strata are unusually tough, dictated the use of the vertical tubes in the caisson walls.

The original design contemplated floating caissons that would be sunk to the river bottom, then cut through the mattress and open-dredged to the required depths. The foundation contractor, however, adopted the sand-island method. A continuous steel-plate shell, of a diameter large enough to surround the caisson with several feet of clearance at the corners, will be sunk onto the previously placed willow mattress. The shell will then cut through the mattress and be allowed to sink several feet into the soft material of the river bottom. The circular section of mattress within the area of the shell will be removed, and the inclosed area will be filled with sand approximately to water level. The reinforced-concrete caisson will then be constructed in the dry on top of the sand fill, and when a suitable height of concrete is placed and sufficiently cured the dredging operations will be started. The caisson will be alternately dredged and built upward until it reaches the required depth. After the cutting edge of each caisson has penetrated some distance below the river bottom, it is planned to remove the sand island and re-use it at the site of another pier.

This method of pier construction is similar to that used for the piers of the Suisun Bay Bridge of the Southern Pacific Railroad Co., which were constructed by this same contractor (*ENR*, Jan. 30, 1930, p. 174). Certain features of the sand-island method have been patented by M. F. Clements, of St. Paul, Minn., who is consulting engineer for the contractor.

Mattress-sinking

The work on the main bridge foundations, due to the velocity of the current, the depth of the river and the unstable nature of the riverbed encountered, promises to be difficult and exacting. Before the caissons can be sunk, woven willow mattresses must be placed to prevent



Caisson After Being Sunk Through Artificial Sand Island

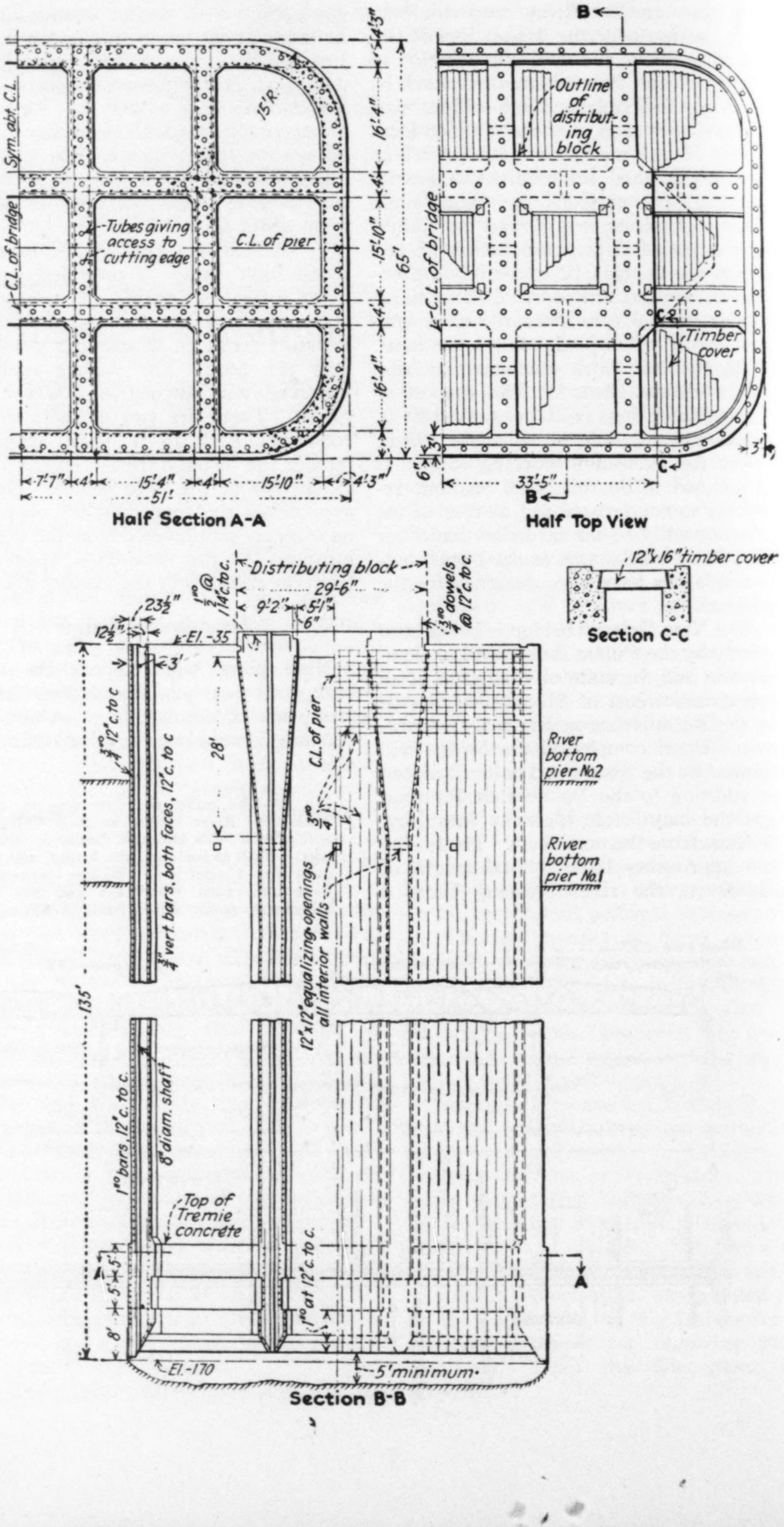


Fig. 2—Special concrete caissons will be sunk through artificial sand islands for the river piers. Note the wells in the walls of the caisson that provide access to the cutting edges for drilling, jetting and removal of obstructions such as logs.

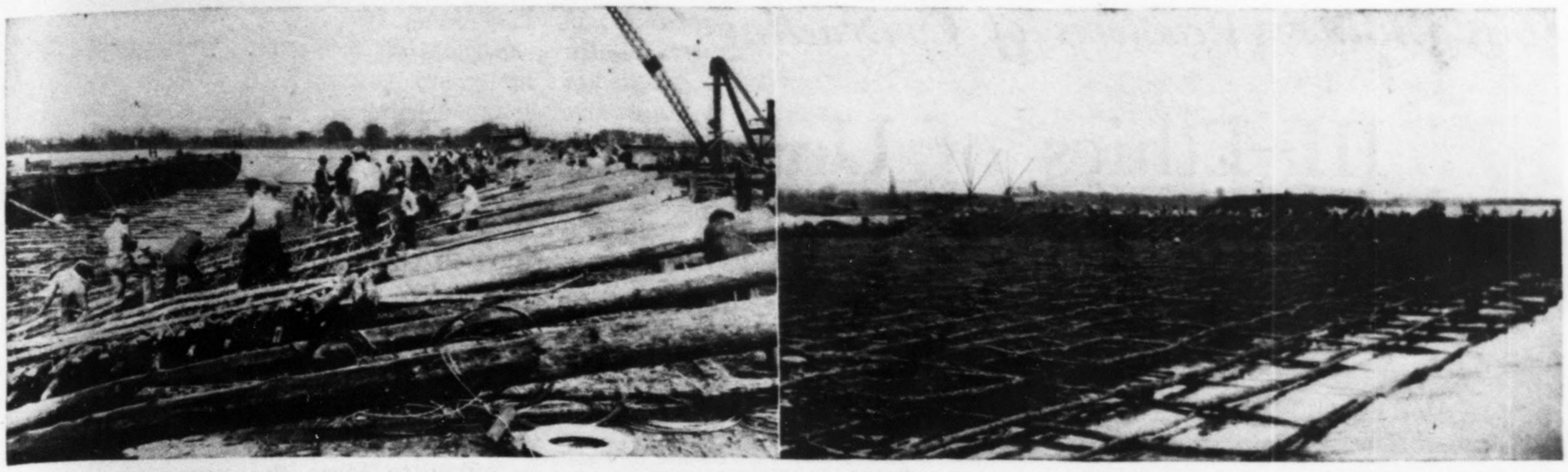


Fig. 3—The weaving of a willow mattress on inclined ways mounted on a barge is shown in the left view. As the mat is completed it is allowed to slide into the water, as shown at the right. The mats are sunk by weighting with stone, beginning at the upstream end.

scour. These mats for the four piers in the deeper portion of the riverbed, where the full effect of the current is felt, are 250x450 ft. in plan, the longest dimension being up- and downstream. The mattress for the eastern shore pier, which is less exposed, is 250x350 ft. in plan.

Mat-weaving has followed practice that has been well standardized in flood-control work on the Mississippi River. The weaving barge is equipped with inclined ways on which the mats are assembled from willow branches transferred from a supply barge. As the weaving progresses the barges are moved downstream and the mats are allowed to float on the surface. Fig. 3, left, shows the start of the mattress weaving; a section 20 ft. long and the full width of the mat (250 ft.) has been completed and is being wired up preparatory to launching. Fig. 3, right, shows the same mattress almost completed, with the weaving ways in the background.

After completion, the mattresses are uniformly ballasted with sandstone and lowered from the barges by manila lines connecting the upstream headers of the mats to timber heads set about 10 ft. apart on the barges. The upstream end is lowered to the bottom first so that the current will assist rather than hinder the work. After the mats are on the river bottom, additional ballast is dropped from barges moving slowly over the mat area. Experiments were carried out using captive weights dropped from the barges, to see how far the current would carry them downstream. The stone barges are kept above this point so that all ballast will land on the mats.

Three permanent anchors are placed upstream 600 ft. from the edge of each mattress. Steel cables from these anchors run through the entire length of the mattress and are attached to the downstream headers. Buoys attached to the four corners of the mats mark their location.

Four triangulation stations, two on either side of the river, are used in determining the accurate location of all mats and piers. Attendants at these stations, by means of visual signals and whistles, notify the tug captains and engineers on the barges when they are in proper location for the performance of their particular tasks.

Modjeski, Masters & Chase are designing and supervising engineers for the entire work, and Moran & Proctor are their consultants on the foundations. Siems-Helmers, Inc., St. Paul, has the $3,083,185 contract for the main substructure, and Bilhorn, Bowers & Peters, St. Louis, are subcontractors on the mattress work. MacDonald Engineering Co. is contractor on the approach substructure. The American Bridge Co. has the $2,618,670 contract for the main superstructure, and McClintic-Marshall Corp. has the $3,226,789 contract for the approach superstructure. C. Glennon Melville is engineer in charge of construction.

Length of Pavement Required for a Car to Pass a Truck of Maximum Length

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BECAUSE of recent legislation in a number of states limiting the overall length of trucks and trailers permitted on the highways, the length of clear pavement required for cars to pass trucks of maximum length is important in determining locations of highway markers at curves and on hills where the road is visible for only a limited distance.

The accompanying chart may be used to solve for the length of clear pavement required when the speeds of both the car and the truck are known. An example illustrates its use:

S_2 = speed of truck = 30 miles per hour.
S_1 = speed of car = 40 miles per hour.

The length of pavement required to gain 350 ft. (150 ft. behind to 150 ft. ahead of a 50-ft. truck) is found by drawing a straight line from 30 on the S_2 scale through 40 on the S_1 scale to the Q axis. Through the point thus located draw a straight line across the L scale to 350 on the D scale and read L = 1,400 ft.

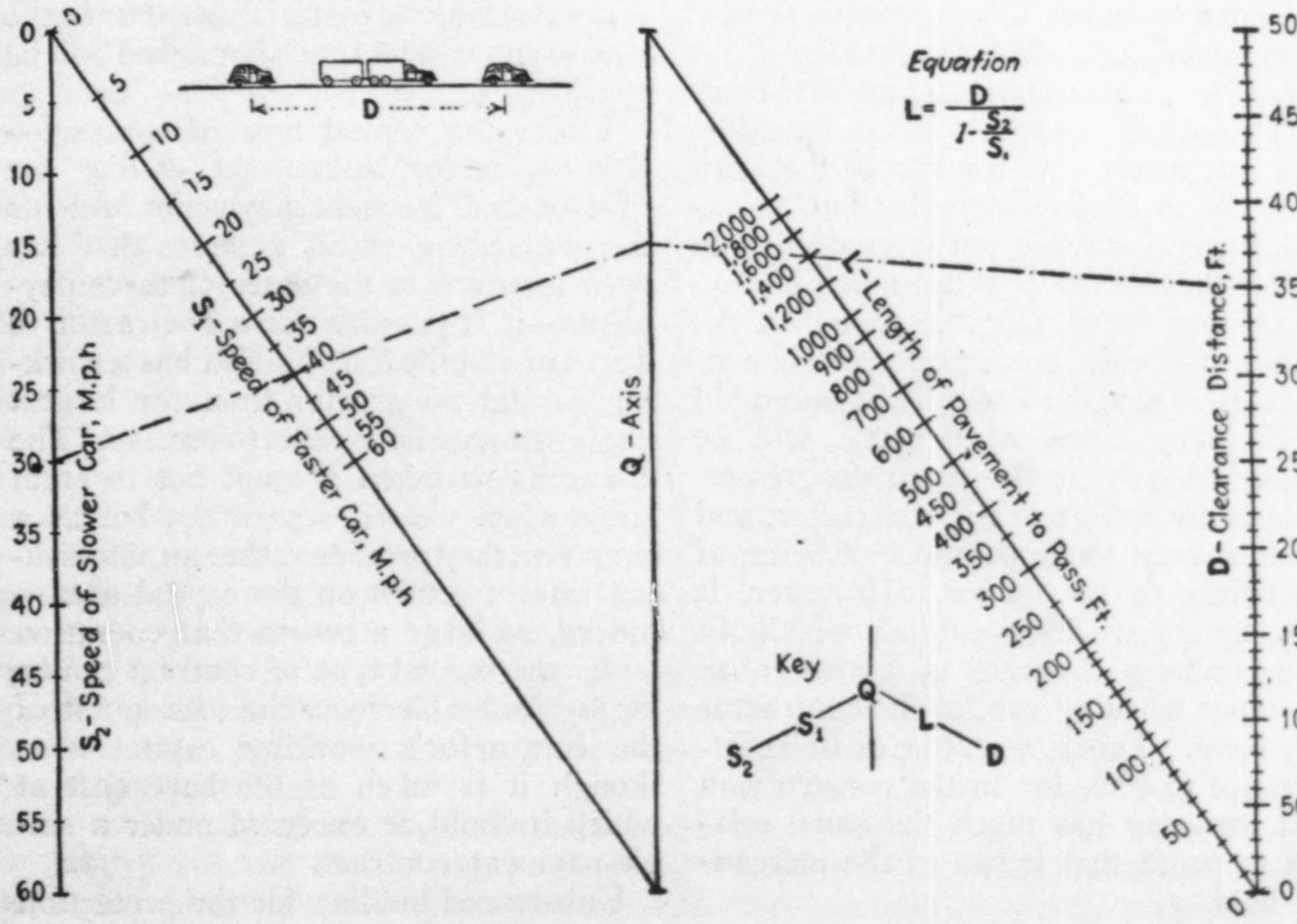


Chart for computing length of pavement required to pass a truck.

ENGINEERING NEWS-RECORD

New York

May 10, 1934

Pier Sinking Through Sand Islands at New Orleans

Four piers in the Mississippi River will have footings 170 ft. below low-water level—Pier caissons built on artificial sand islands are being sunk by dredging in open wells without use of compressed air

SINKING the pier foundations of the Mississippi River Bridge at New Orleans to a stable bearing at depths down to 170 ft. below low water through artificial sand islands is proving to be an eminently successful method of attacking a difficult job. At the time this is written caissons for two piers in the river channel (Piers 2 and 3, Fig. 2) have been sunk to El. —170, and the caissons have been sealed; the sand island for a third (Pier 1) has been completed, and sinking of the concrete caisson has started; and at the fourth pier work on the sand island is under way, the protective mat on the river bottom having been sunk some months ago as part of the general operations of sinking mats to protect the bottom from scour at each of the main river piers.

The bridge is to cross the Mississippi River about 6 miles west of the central business district of New Orleans (the river running in a general west-to-east direction past the city) and about 3 miles beyond the city limits on the Jefferson Highway. It is being built jointly by the state of Louisiana and the Public Belt Railroad Commission at a cost estimated at $13,000,000. Financing was made possible by an RFC loan. Upon completion, the bridge will be used jointly by the Public Belt R.R. and the railroads entering New Orleans from the West and by the state highway department.

Because of the low level of land on both sides of the river and the high clearance over the river required by the War Department (135 ft. above high water over a 500-ft. channel width), the bridge and approaches have a total length of 23,000 ft. The main river crossing has a total length of 3,525 ft. and is made up of a main 790-ft. cantilever span with 530-ft. anchor arms, one 531-ft. through-truss and four deck trusses of 333 to 269 ft., as shown in Fig. 2. Grades on the four main through-spans of the bridge for both railway tracks and highway decks will be 1.25 per cent up to a vertical curve on the cantilever span, but on four deck trusses of the river crossing and on the approach viaducts the two 18-ft. highway decks, carried as cantilevers on each side of the trusses and viaduct towers, have their grades increased to 4 per cent. The railroad grade is 1.25 throughout. The railway deck is to be of creosoted timber, entirely covered with galvanized sheets of copper-bearing steel as a precaution against fire from sparks.

Most of the concrete highway deck of the north approach has been placed, and laying of the railway deck was about

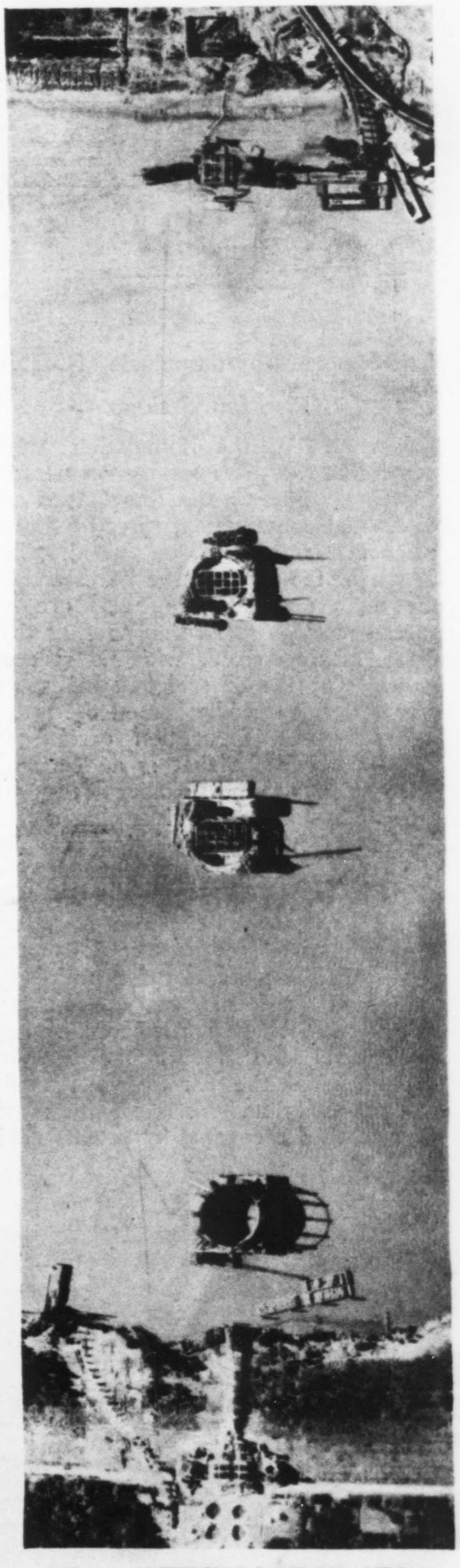


FIG. 1—ARTIFICIAL SAND ISLANDS are used to facilitate construction of the piers of the New Orleans Bridge. The islands for four piers, Nos. 1, 2, 3 and 5, reading from the bottom, are shown in this airplane picture. Construction of the island for Pier 4 has been begun since this picture was taken. At the lower edge of the picture is excavation for a viaduct tower footing, and above it, adjoining the road, is Pier A.

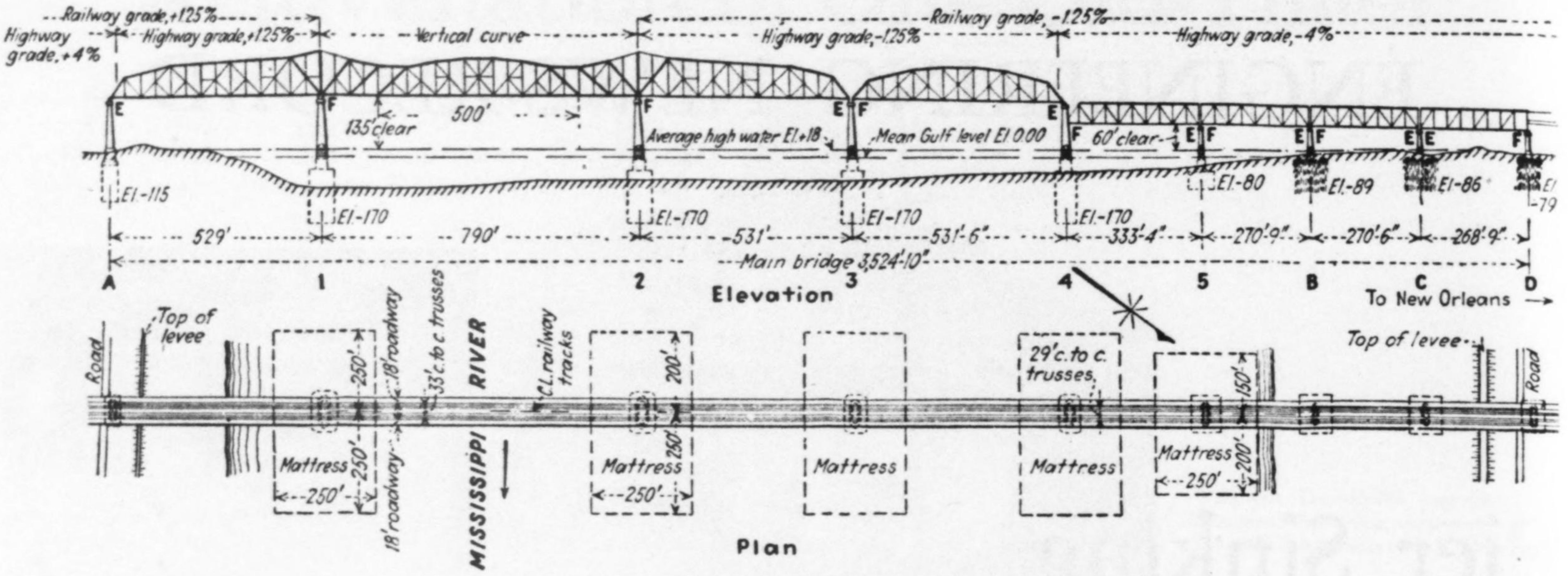


FIG. 2—MAIN RIVER CROSSING of the combined railway and highway bridge across the Mississippi River above New Orleans.

half completed by the middle of March.

Pier foundations

Interest in the foundation work centers in the piers for the main river crossing. The viaduct foundations are of normal construction, spread footings of concrete carried on wood piles. Three of the piers at the north end of the main river crossing also are on spread footings carried on piles, as that is a "making" bank with no risk of scour. On the other hand, the south pier (Pier A), while behind the levee, has a caisson foundation carried to El. —115 because that is a "cutting" bank with possible danger of scour through a shift in the river channel.

The following description of the pier-caisson sinking operations applies to Piers 1, 2, 3 and 4, as numbered in Fig. 2. The method employed is similar to that used by the present contractor in sinking the piers of the Suisun Bay Bridge in California (*ENR*, Jan. 30, 1930, p. 174). It consists of forming an artificial sand island at the pier site through which the pier caisson is sunk by open-dredging. Certain features of the method are covered by patents held by Nick F. Helmers and M. F. Clements, St. Paul.

No sand island was required in sinking the caisson for Pier A as it is on dry land; the caisson for Pier 5 was sunk through an artificial sand island, as in the case at Piers 1 to 4; but since it is in shallow water, the island was formed within a ring of vertical steel sheetpiling instead of in a special steel shell as in the other four piers; otherwise the procedure was identical with that to be described.

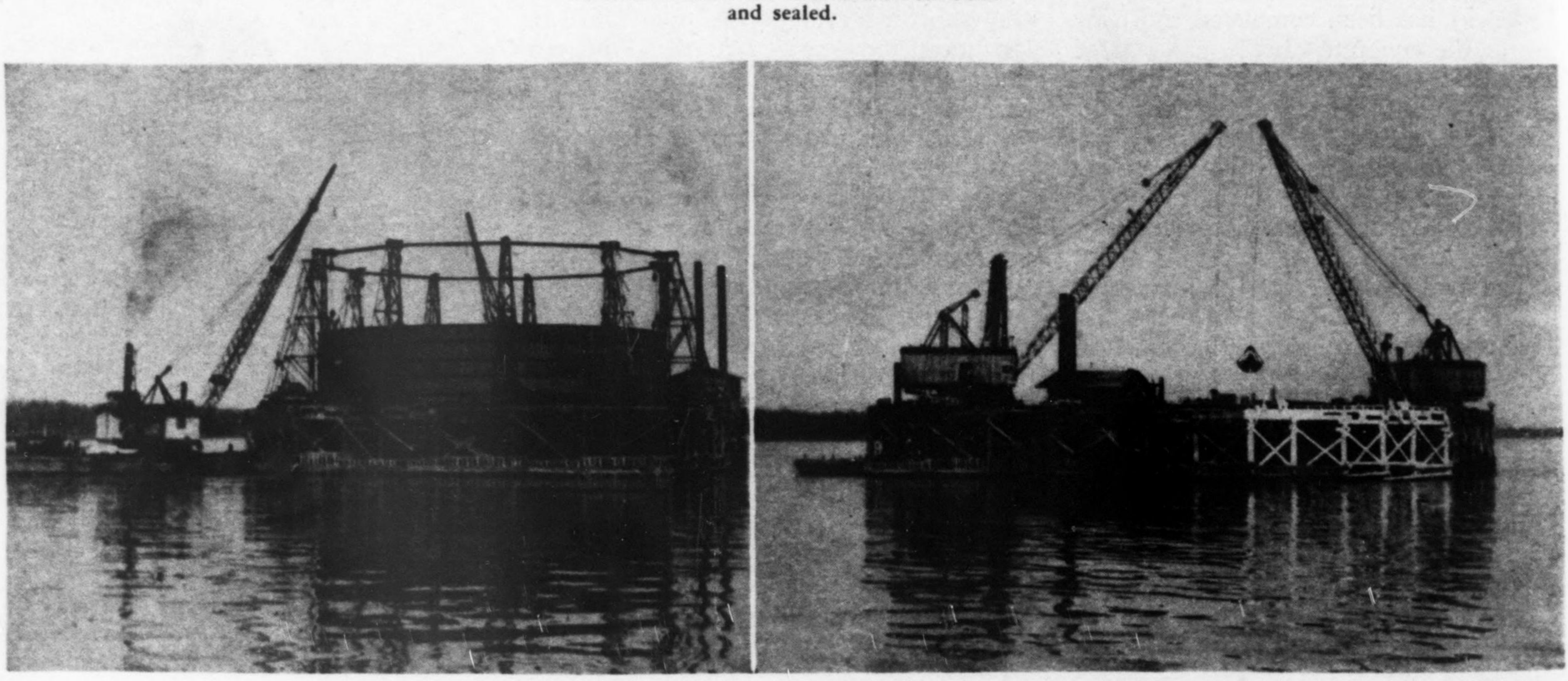
The river bottom is composed of layers of silt, sand, clay, or mixtures of all three to unknown depths. Near the surface the material is highly unstable and easily eroded. Because of this latter condition, willow mattresses 250 ft. wide and of varying lengths up to 500 ft. parallel to the direction of river flow were woven and sunk with riprap at the site of each of the five piers in the river (*ENR*, Aug. 17, 1933, p. 190), and within the area so protected against scour each pier is being built.

Upon completion of the mattress, a ring of falsework consisting of pile bents is constructed around the pier site, the inclosed circle having a diameter of 121 ft. at Piers 1 and 2, and of 111 ft. at Piers 3 and 4. Piles of Oregon fir ranging in lengths up to 135 ft. and driven to a penetration of about 25 ft. are used for this falsework.

Erection of the circular steel shell for the sand island is then begun within the falsework, each ring of the shell being made up of twelve curved sections. The lower steel ring is 5 ft. high, the next two are 2½ ft. high, and the remainder are 10 ft. high. Shell thicknesses range from ½ in. up, depending upon the vertical position of the ring in the finished shell.

The 2½-ft. high rings are employed near the lower edge to permit salvaging the largest possible amount of the shell upon completion of the operation.

FIG. 3—TWO STAGES in the sand-island construction are here shown. At the left are the derrick frames for lowering and raising the sand-island shell in place on the falsework. In this stage floating derricks are employed. At the right, after the shell has been sunk, two large revolving derricks are set up on the falsework to place the sand fill, dredge out the caisson and remove the sand fill after the caisson has been sunk and sealed.



The steel shell, to a height of 30 ft., is assembled on short needle beams along the inner face of the falsework, using either a floating derrick or derricks set upon the falsework. Upon completion of the 30-ft. section, twelve hoist frames are set up around the inner edge of the falsework, as shown in Fig. 3; and after the weight of the shell has been transferred to the hoists, the supports are withdrawn and the shell lowered 30 ft. When in lowered position, the shell weight again is transferred to needle beams at the deck level, and another 30 ft. section is erected. This process is continued until the steel shell is seated on the mattress on the bottom and extends to a safe distance above water level. The hoist towers then are taken down to clear the deck of the falsework for subsequent operations. At Piers 1 and 2 the shell so built was 100 ft. high, and at 3 and 4 it was 70 ft. high.

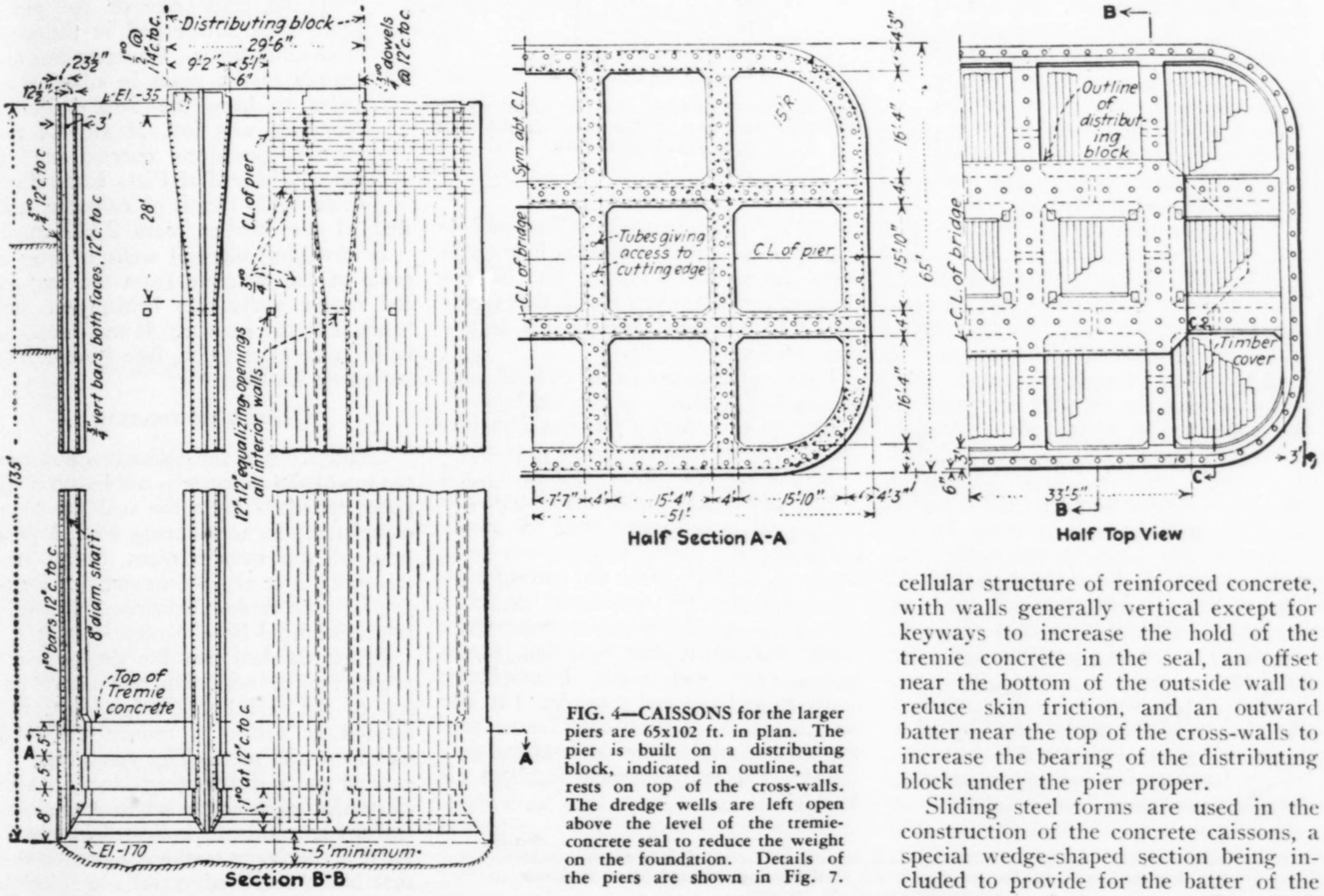


FIG. 4—CAISSONS for the larger piers are 65x102 ft. in plan. The pier is built on a distributing block, indicated in outline, that rests on top of the cross-walls. The dredge wells are left open above the level of the tremie-concrete seal to reduce the weight on the foundation. Details of the piers are shown in Fig. 7.

Although the operating scheme is varied somewhat to suit special conditions at each pier, the general plan calls for largely self-contained operations at each pier. For this purpose two large revolving derricks are mounted on opposite sides of the falsework ring on extensions of the falsework that roughly correspond to the corners of the square inclosing the ring. At a third corner there is a boiler plant supplying steam for operations requiring it. For use at the two larger piers, Nos. 1 and 2, the revolving derricks were specially built in order to meet the conditions created by the great size and depth of the excavation. They have 100-ft. booms and a lifting capacity of 12 tons at 85-ft. radius. They are equipped with check lines to keep the dredge buckets from spinning in the long lift from the bottom of the excavation.

The airplane view of the river crossing (Fig. 1) shows the steel shell being assembled for Pier 1 (first river pier in the foreground), concrete caissons under construction at Piers 2 and 3, and Pier 5 under construction in shallow water near the far shore. On the shore is the rectangular excavation for Pier B, a pier carried on piles. Work on Pier 4 had not started when this picture was taken. The general shape of the timber falsework at the other piers is clearly shown.

Following the sinking of the steel shell, the mattress within the shell is cut and pulled out, a pile hammer being employed to actuate the heavy chisel used to cut around the inner edge of the shell. With the mat out, filling the shell with sand is begun and is continued until the surface is above water level. The amount of settlement of the ring during the filling operation is surprisingly small, being only about 5 ft. at the deeper piers.

Sand for the filling is dredged a short distance up the river near the Southern Pacific Railway ferry slip at a point where the railway company finds it necessary to dredge currently to maintain a channel. It is brought down to the bridge in barges, and the two derricks on the pier falsework, operating 3-yd. buckets, place it within the shell.

On the island thus formed caisson sinking is carried forward by dredging through wells in the caisson, the caisson walls being built up as it sinks. Details of a typical caisson are shown in Figs. 4 and 5. Except for the temporary top, which is of timber, it is a cellular structure of reinforced concrete, with walls generally vertical except for keyways to increase the hold of the tremie concrete in the seal, an offset near the bottom of the outside wall to reduce skin friction, and an outward batter near the top of the cross-walls to increase the bearing of the distributing block under the pier proper.

Sliding steel forms are used in the construction of the concrete caissons, a special wedge-shaped section being included to provide for the batter of the upper part of the cross-walls. Each set of forms will have been used 28 times when the job is complete. The caissons are built up in 10-ft. lifts.

From the sections through the caisson shown in Fig. 4 it will be noted that 8-in.-diameter wells are formed into the concrete in both the outer walls and in the cross-walls to facilitate cutting obstructions from under the walls. In the sinking operations carried on to date these wells have not been needed. Set in the outer walls are 8-in.-diameter jet pipes leading to outlets near the cutting edge. These were included in the design as a precaution against skin friction overcoming the weight of the caisson, the contractor being required to equip a high-pressure pumping plant to supply water to them if needed. To date, this precautionary measure has not yet been brought into play, but the contractor has made good use of the high-pressure pumping plant in the sand-dredging operations.

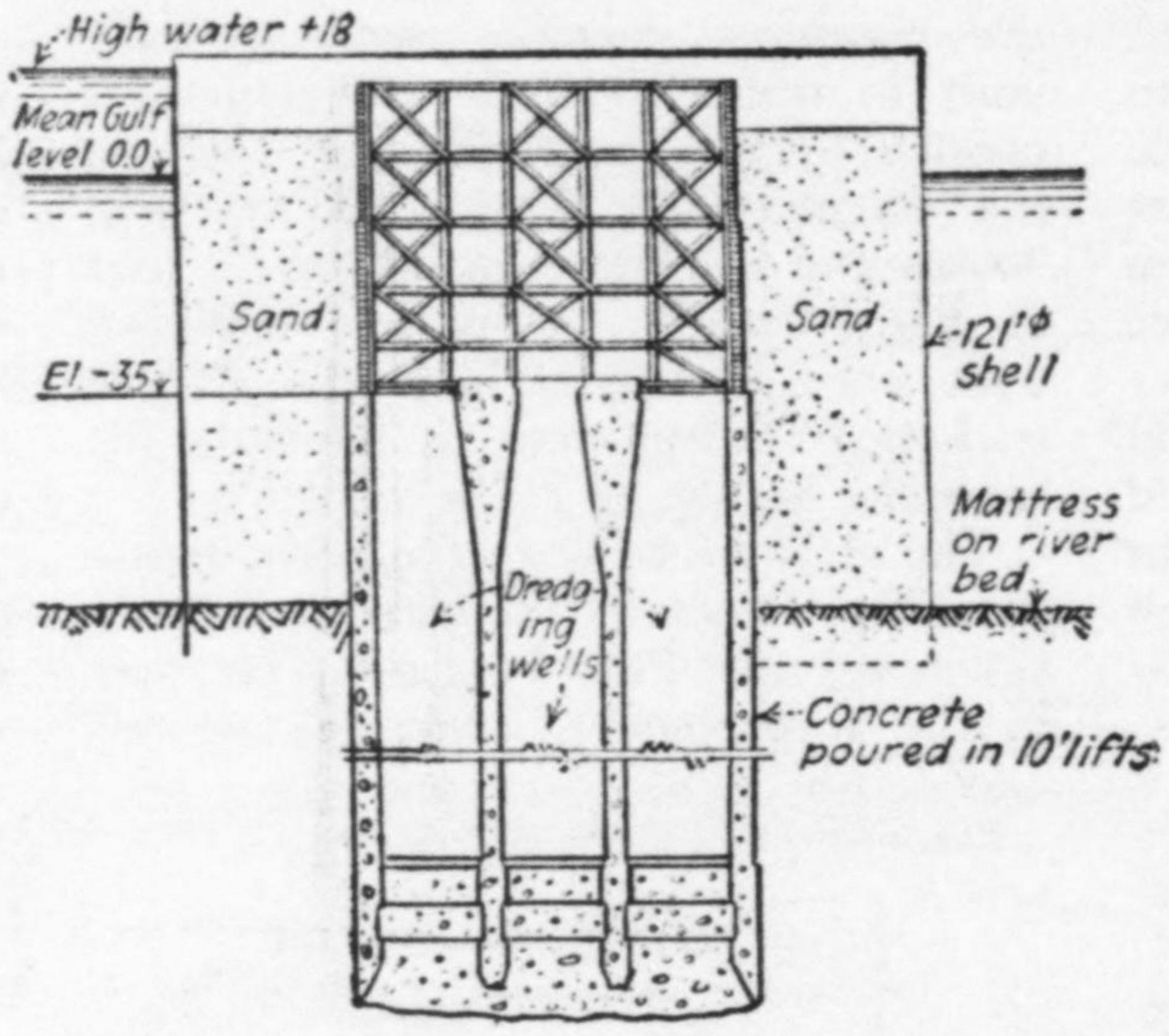


FIG. 5—THE RELATION of a pier caisson to the sand island is shown in this section on the short axis of a typical pier.

Dredging within the well is begun as soon as the caisson has reached a height of 20 ft. (two lifts of the sliding forms) and is carried forward until the predetermined depth is reached. In this work care is exercised in maintaining the water level within the caisson as close as possible to that of the river, thus minimizing the risk involved in building up hydrostatic pressure that might cause blows through the unstable river-bottom material.

So far, no unusual difficulties have delayed the work. Such hard layers as have been encountered have been cut through successfully by the expedient of dredging deeply close to the cutting edge of the caisson, undermining the hard layers that were encountered until they broke of their own weight and caved into the excavated pit.

The upper part of each caisson, the cofferdam for the pier, is of timber, 12x12 and 7x12, drift-bolted and calked. This timber section is employed on each caisson above El. —35, so that there will be no permanent caisson above that level to obstruct the river channel. The timber section is securely anchored to the concrete by hook rods extending down from the top and so arranged that they can be unhooked from the top to release the timber section after the pier has been carried up above water level.

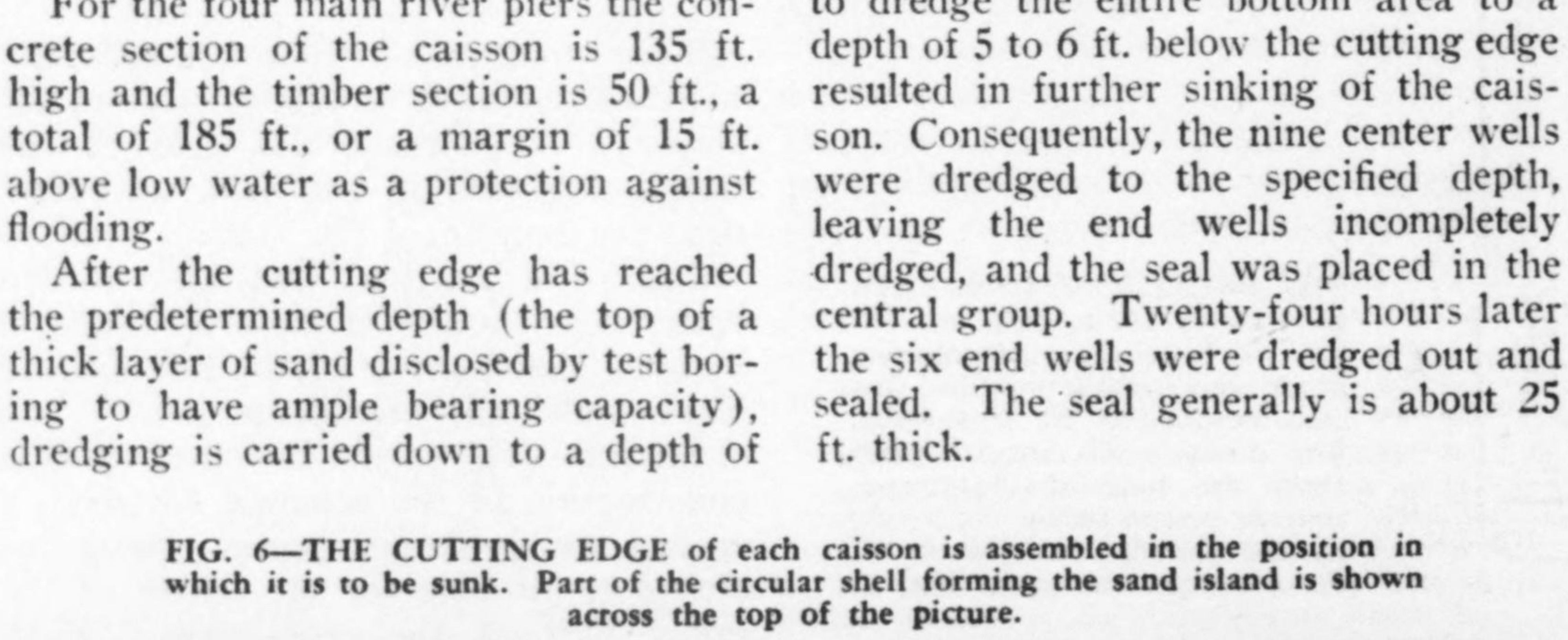
For the four main river piers the concrete section of the caisson is 135 ft. high and the timber section is 50 ft., a total of 185 ft., or a margin of 15 ft. above low water as a protection against flooding.

After the cutting edge has reached the predetermined depth (the top of a thick layer of sand disclosed by test boring to have ample bearing capacity), dredging is carried down to a depth of 6 to 8 ft. below the cross-walls. The bottom then is leveled as well as is possible with the dredge buckets, and if the dredged material checks with that determined by the test borings, the tremie concrete seal is placed.

Before placing the seal the lower ends of the dredge wells are cleaned by lowering into each well a jet pipe with jets at the ends of two horizontal crossarms.

In placing the tremie seal of Pier 2 it was not found possible to place the entire seal in one operation. Attempts to dredge the entire bottom area to a depth of 5 to 6 ft. below the cutting edge resulted in further sinking of the caisson. Consequently, the nine center wells were dredged to the specified depth, leaving the end wells incompletely dredged, and the seal was placed in the central group. Twenty-four hours later the six end wells were dredged out and sealed. The seal generally is about 25 ft. thick.

FIG. 6—THE CUTTING EDGE of each caisson is assembled in the position in which it is to be sunk. Part of the circular shell forming the sand island is shown across the top of the picture.



Placing of tremie concrete in the seals of Piers 2 and 3 is believed to be the largest tremie concreting operation at comparable depths yet attempted. The maximum water depth was 173 ft., and the tremie pipe had a total length of 191 ft. At the Morgan City Bridge over the Atchafalaya River (*ENR*, Dec. 28, 1933, p. 776) tremie concrete in a smaller pier was placed at a depth of 176.5 ft. below water level.

Four 10-in. tremie pipes with a 2-cu.yd. hopper were used in each operation, the ends of the pipes being kept submerged in the concrete at all times. Concrete was delivered to the pipes in rotation in order to keep the flow uniform. No plug was lost in any of the tremie operations carried out to date. The seal of Piers 1 and 2 require 3,400 cu.yd. of concrete, and that of the smaller piers 2,300 cu.yd.

In dredging the end wells of Pier 3 some of the concrete from the seal of the center wells was broken off and brought to the surface. It was found to be in perfect condition, free from segregation or washing.

Caisson unwatering

Unwatering of the cofferdam down to the top of the concrete is not begun until about ten days after the seal has been completed. In unwatering Pier 3 (the first of the deeper piers to be unwatered) a negligible amount of leakage into the caisson developed, although the unbalanced head exceeded 40 ft.

In the finished pier the dredge wells are not filled with concrete above the top of the seal but are left open and flooded in order to reduce the total weight of the pier. The pier proper is carried on a distributing block, a slab of reinforced concrete set over the central dredge wells, as indicated in Fig. 7. As a preliminary to the construction of that block, the dredge wells are decked over below the level of the tops of the cross-walls. Unwatering of the caisson, therefore, is carried only to a depth sufficient to permit the decking to be placed. The tops of the concrete cross-walls then are washed off, the reinforcing rods are straightened up and forms set for the distributing block.

In constructing the distributing block the main members of the crossbracing of the timber section of the cofferdam are left in place and are buried in the concrete. Subsequently they are cut off flush with the surface and the load transferred to the face of the concrete with wedges. In the pier proper, which is faced with granite, similar practice is followed except that the timber is cut off back of the granite face stones.

When the pier work is above water level, the caisson is flooded so that the timber section can be disconnected from the concrete base, floated to the surface and removed. Piers 1 and 2, flanking the main navigation channel, are to have

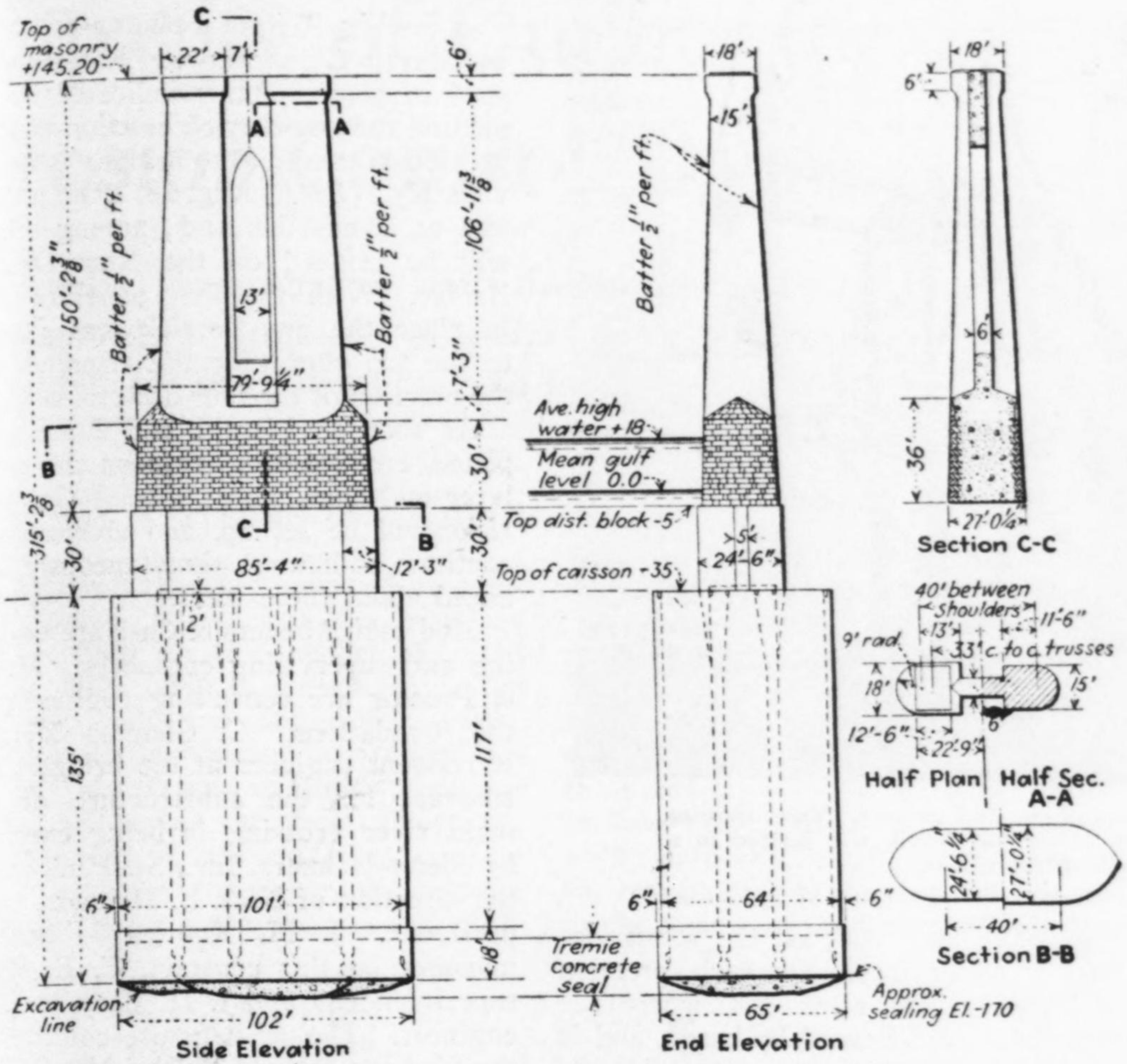


FIG. 7—THE PIERS have a maximum height above the bottom of the caisson of 315 ft. Above a level 35 ft. below low water they are made narrow in order to introduce as little obstruction to the channel as possible.

fenders of creosoted timber. These fenders will be supported on the distributing block and secured to the piers by steel rods extending back into the concrete core through the joints in the granite facing.

Sand-island removal

Removal of the sand islands is begun as soon as the cofferdam has been sealed. Sand inside the island is first dredged out, using the derricks on the pier falsework; when the bottom has been reached, a diver goes down on the inside and unbolts the lowest ring of the steel shell that he can reach. To facilitate this operation, special lug bolts are used, and the bolt holes are slotted so that a diver can knock the bolts out as soon as they are loosened. To date, only a small amount of the shell has been lost through being buried in the river bottom.

The steel shells for the sand islands are removed by reversal of the sinking operation, the twelve hoist frames being reset on the falsework and used to raise the shell from the bottom. Actual dismantling usually is done with floating derricks, as a derrick on the falsework cannot work to advantage with the hoist frames in place. Also, the sequence of operations requires the transfer of the large derricks to a new pier as soon as the sand shell has been dredged out.

After the shell has been removed, the inclosed area on the river bottom from which the protective mat was cut away at the start of the operation is covered with riprap to minimize the possibility of scour close to the piers.

Construction plant

Except for the revolving derricks and boiler plants mounted on the pier falsework, most of the pier contractor's plant is floating. The largest unit is the concrete plant. It includes oil-fired steam boilers supplying power for lighting, air compressors, cement pump, concrete mixers and hoist, and for the winches operating the maneuvering lines. There also is a revolving derrick on the concrete plant barge to transfer sand and gravel from the supply barges to the hoppers over the mixing plant. All materials are delivered by barge, the contractor having three bulk-cement barges of 1,500-bbl. capacity operating on the river between the job and the cement mill. Cement is pumped from the barges to the mixing plant.

The mixing plant contains two 2-cu.yd. mixers, served by automatic weighing batchers, discharging to a common hopper at the base of a 120-ft. distributing tower mounted on the forward end of the barge. The plant has a capacity of 100 cu.yd. per hour.

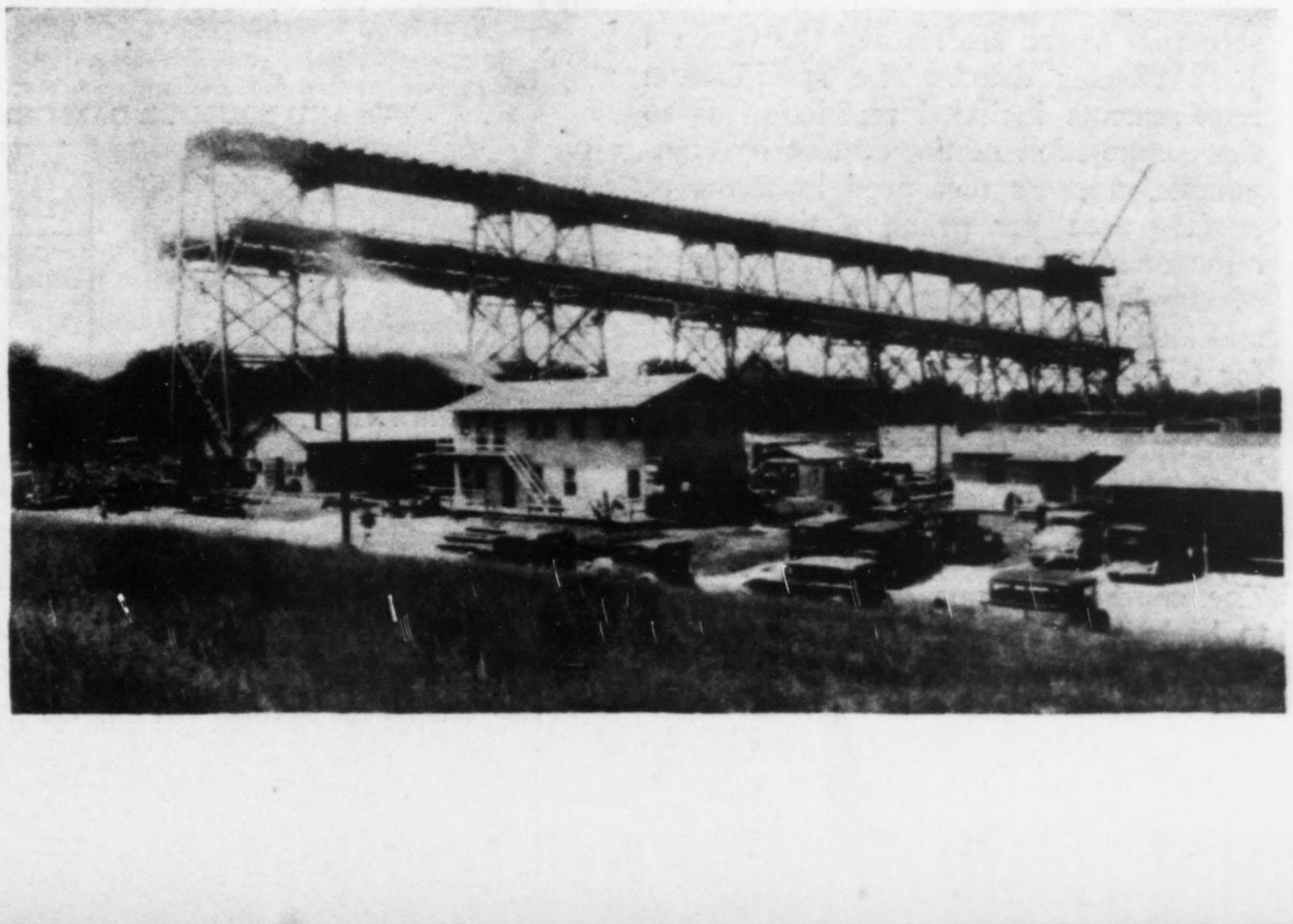
Concrete for all work on the river piers is delivered direct from the tower chute. For the piers on land the concrete was delivered by the floating plant to buckets on rail cars run out to the end of the construction trestles at the water's edge.

The sand dredge is another important element in the floating plant, its character being dictated in large part by the fact that a high-pressure pumping plant had to be supplied for possible use in the caisson sinking. Modification of the pumping plant for use in dredging is simple, an ejector-type dredging element being used to raise a mixture of sand and water to a flume supported on brackets against the long side of the house over the pumping plant, from which it is discharged through short chutes to a barge lying alongside the pump barge.

Approach viaduct construction

Construction of the long approach viaducts of steel girder and bent type on each side of the river is being carried forward independent of the work on the main-channel spans, under separate contracts for both foundations and super-

FIG. 8—VIADUCT APPROACHES consist of steel-tower-bent-and-girder construction. Tower spans are 45 ft., and intermediate spans from 69 to 82 ft. The railroad is carried on top, while the highways are cantilevered from the sides but come to grade in a much shorter distance than does the railway. The buildings are the contractor's and engineer's headquarters.



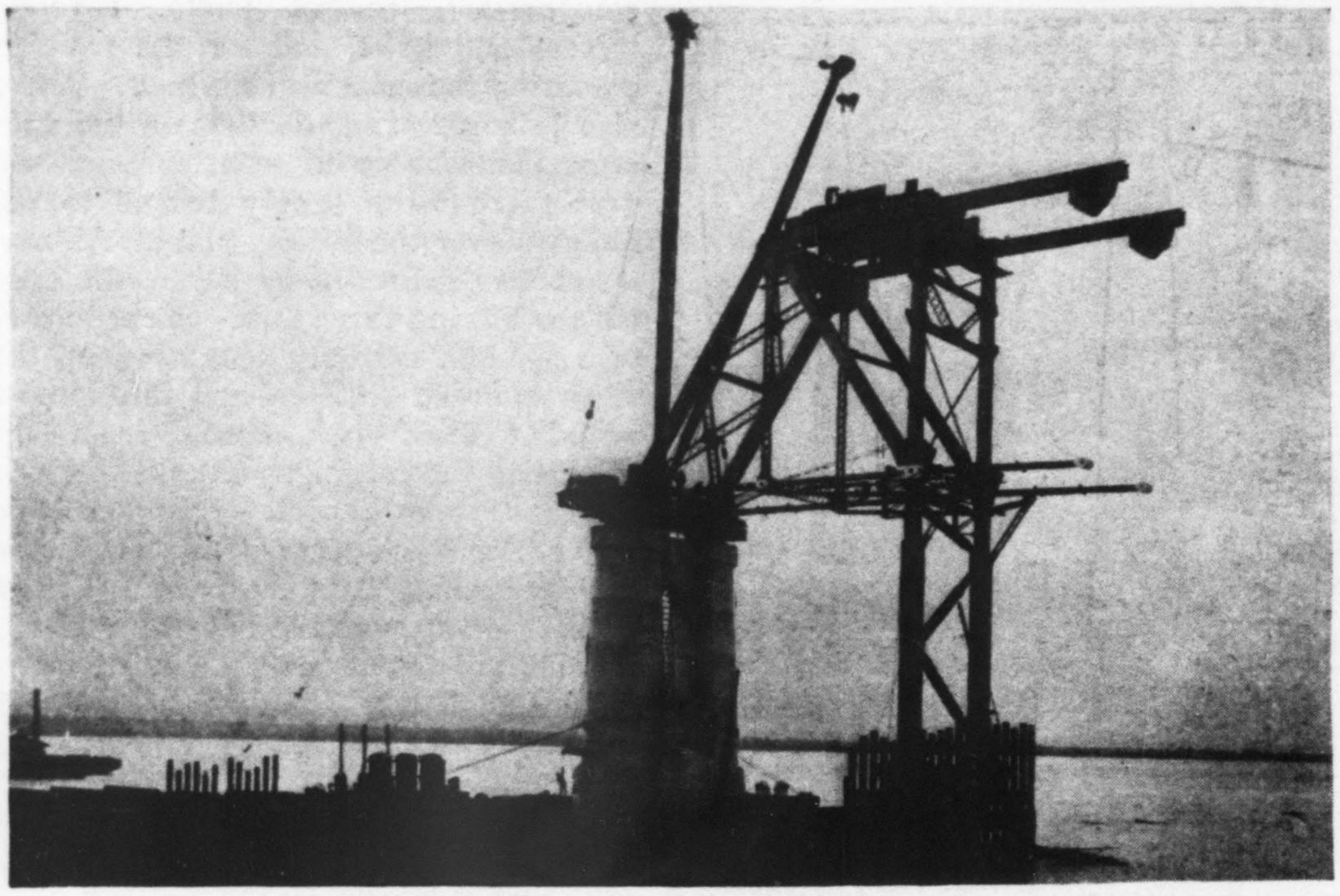


FIG. 9—GUY DERRICKS will erect the spans of the river crossing. View, showing start of work on Pier 5, was taken shortly before the derrick was jumped to a track on the top chords of the trusses.

structure. Although large in number, the individual foundations are not of great size, being low piers on shallow spread footings on wood piles. Concrete for these piers and footings is being distributed by pumping, in the hope of overcoming the distribution problem growing out of the fact that each approach extends inland about 2 miles.

Steel erection on the north viaduct is completed, and work on the south viaduct is under way. On each, erection is begun at the river end, where the materials are delivered by barge, and is continued inland, using a traveler on the viaduct. Steel is moved inland on a construction railroad parallel to the viaduct.

Steel erection for the river crossing began about the middle of March at Pier 5. Fig. 9, from a photograph taken on March 27, shows the first panel of steel in place. As is indicated by the picture, the guy-derrick erection method, previously used on the bridges at Louisville, Ky., (*ENR*, Aug. 28, 1930, p. 318) and at Evansville, Ind., among others, will be utilized on the New Orleans Bridge. With the first panel of steel in place the guy derrick was jumped to the top chord for the remainder of the erection of the four deck truss spans.

As soon as Piers 1 and 2 are completed, erection can begin on the cantilever and anchor arm spans. Guy derricks will be set up, and erection will continue both ways simultaneously, balanced about these piers.

Modjeski, Masters & Case are designing and supervising engineers. Moran & Proctor are consulting engineers on the foundations. C. Glennon Melville is resident engineer at the bridge. The contract for the substructure of the main river crossing is being executed by Siems-Helmers, Inc., St. Paul, under the direction of Nick F. Helmers, vice-president. J. M. Kellogg is general manager on this contract, C. E. Ryan superintendent, and J. H. Levy resident engineer. The substructure contract on the viaducts is held by the MacDonald Engineering Co. The superstructure contract on the approaches is held by the McClintic-Marshall Corp., and the American Bridge Co. has the contract for the main river spans.

Low-Heat Cement Specifications of Tennessee Valley Authority

SPECIFICATIONS for a portland cement of relatively low heat evolution, and also for a cement classified as a "modified normal portland cement," were prepared and used by the Tennessee Valley Authoritty for the purchase of the first order of 315,000 bbl. of cement to be used in the construction of the Norris and the General Joe Wheeler dams. The specification requirements included restriction as to the composition of the cement by compounds, fineness measured in terms of surface area per gram, a time of 60 min. for initial set, compressive strength of standard mortar specimens of 1,000 and 2,000 lb. per sq.in. (7 and 28 days) for the low-heat cement, and 1,500 and 2,500 lb. per sq.in. for the modified portland. The tensile-strength test is eliminated.

The specifications did not include any requirement for the heat of hydration. The concrete volume in the structures to be built is not unusual, as compared with Boulder Dam, and it is assumed that the requirements set forth for compound composition and fineness will be sufficient to produce a cement with a heat of hydration not exceeding the desirable limit.

The principal characteristics of the TVA specifications are tabulated, and, for the purpose of comparison, the table also includes the corresponding characteristics of the last Boulder Dam cement specifications (No. 566, March, 1934) and the original Boulder Dam cement specifications.

It will be noted from the table that the low-heat (type A) specification of the TVA is similar in most respects to the last specification for Boulder Dam cement, but the latter varies in several minor requirements from the original Boulder Dam specifications (*ENR*, Nov. 10, 1932, p. 558), which represented the first attempt to specify a cement designed particularly for mass concrete.

TVA AND BOULDER DAM CEMENT SPECIFICATIONS COMPARED

	Tennessee Valley Authority		Boulder Dam (Bureau of Reclamation)	
	Type A — Relatively Low Heat	Type B — Modified Portland	Spec. 566 March 26, 1934	Original (Tentative)*
Chemical Composition				
Loss on ignition, per cent	3.0	3.0	3.0	3.0
Insoluble residue, per cent	0.85	0.85	0.85	0.5
SO_3 per cent	2.0	2.0	2.0	2.0
Mg O per cent	5.0	5.0	5.0	4.5
Compound Composition				
Tricalcium silicate (max.)	35	35 to 55	40	..
Dicalcium silicate (max.)	60	Not spec.	65	60
Tricalcium aluminate (max.)	7	8	7	5
Tetracal. aluminoferrite	20	Not spec.	20	..
Fineness, sq.cm./gr	1,700–2,300	1,600–2,200	1,700–2,300	1,300–1,700
Time of set (initial)	60 min.	60 min.	60 min.	105 min.
Compressive strength (1:3 mortar lb./sq.in.) 7 days	1,000	1,500	1,000	1,000
Compressive strength (1:3 mortar lb./sq.in.) 28 days	2,000	2,500	2,000	2,400
Heat of hydration (calories/gram) 7 days	Not specified		65	60
Heat of hydration (calories/gram) 28 days	Not specified		75	70

*These tentative specifications were reviewed in *ENR*, Nov. 10, 1932, p. 558.