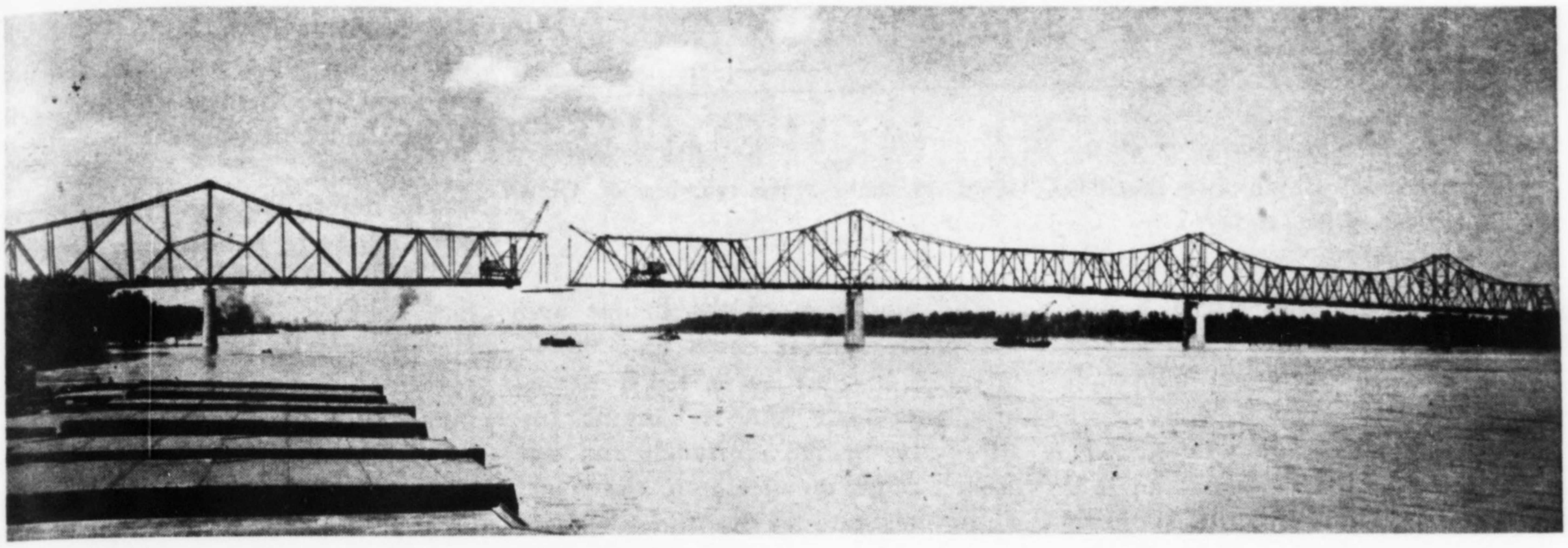

FIG. 1. CLOSURE OF THE NEW HIGHWAY BRIDGE ACROSS THE OHIO RIVER AT CAIRO, ILL.

Multiple Cantilever Completed at Cairo

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Unusual structure of three main spans with only one suspended section replaces ferries on Ohio River crossing

FINAL preparations for the opening, July 1, of the new Ohio River highway bridge at Cairo, Ill., were completed this week. Begun in 1936 by the Cairo Bridge Commission, a body created two years earlier by an act of Congress, the new structure has a total length of 5,865 ft. in which there are three main river spans of 800, 650 and 650 ft., respectively, to accommodate navigation and large floodflows.

From a technical standpoint the bridge is notable for its multiple cantilever layout, consisting of a series of alternate cantilever and anchor arms for three spans, with a suspended span in only one opening. The hinge points occur near natural points of contraflexure, so that the structure simulates a continuous bridge with fixed points of contraflexure. This arrangement, illustrated diagrammatically in Fig. 2, is by no means new in principle for it merely extends the cantilever idea farther than is customary. But there is no record of its having been used before in a major structure in this country. The bridge provides a 20-ft. roadway for highway traffic and from 50 to 60 ft. of vertical clearance for river traffic. The approaches to the main river crossing consist of deck trusses and deck girders—one truss span and five girder spans on the Illinois side and nine truss spans and twelve girder spans on the Kentucky side.

The location of Cairo at the tip of the Illinois peninsula where the Ohio River joins the Mississippi River makes it a natural focal point of highway traffic, which, in recent years, has been served by a number of Ohio River ferries and a bridge over the Mississippi, the former connecting with through routes in Kentucky and Illinois and the latter with the main highways of Missouri. Since ferry service has usually been interrupted for several weeks each year because of high river stages, numerous proposals for toll highway bridges across the Ohio at Cairo have been made in the past. The present bridge project dates from a War Department permit first issued in 1928.

Foundations

The main river piers are founded at a depth of from 52 to 72 ft. below low water in a stratum of good white sand containing clay pockets, a material which tests reveal has a moisture content of about 20 per cent. It is the same stratum used for the foundations of the Illinois Central Railroad Bridge, about two and one-half miles upstream. Borings revealed that alternate layers of sand and clay extend at least 150 ft. below low water at the bridge site. All piers are of concrete, and each of the main river piers has an arched opening in the upper shaft above high water level. All of the approach piers are founded on 16-in. square reinforced concrete piles 35 ft. long.

Foundation construction operations, begun in October, 1936, soon encountered trouble from the great Ohio River flood of early 1937. The contractor had elected to use shallow air caissons for the footings of the main river piers, with attached cofferdams above. Air was turned on in the first caisson, that at the Kentucky end of the main river bridge, on Dec. 28, but on Jan. 3, with the overall height of the caisson and cofferdam amounting to 43 ft., such a substantial rise of the river occurred that it was decided to release the air and permit the caisson to be flooded. A week later only some pipes and air shafts of the caisson

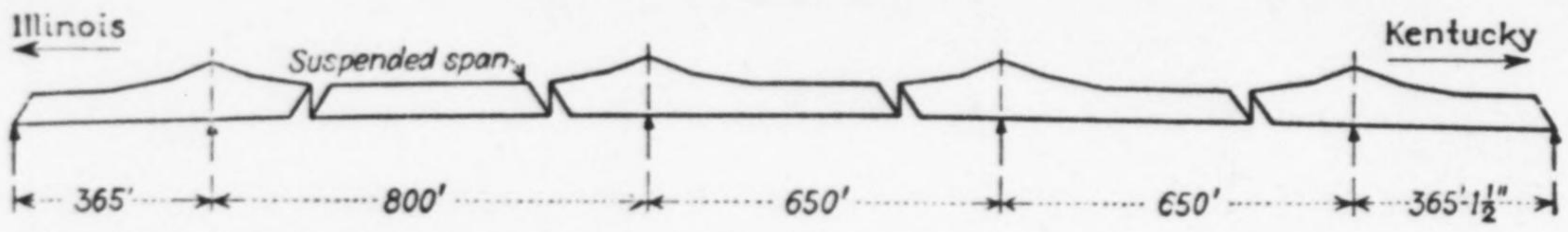

Fig. 2. **Diagram of multiple cantilever layout of main river crossing of Ohio River bridge at Cairo.**

projected above the rising water, and all of the pile driving that had been done on the Kentucky approach was inundated.

Some 600 cu.yd. of concrete had been placed in the caisson, and this provided enough weight to stabilize it against the swift current. It was not until March 13 that work could be resumed on the Kentucky approach and not until April 3 that operations were begun again at the caisson. It was found that the caisson had "decked itself" and that river bed materials had filled the working chamber and risen 6 ft. into the man shaft, requiring a substantial job of cleaning out.

After this long lay-off, foundation work proceeded rapidly and without mishap to completion of the substructure on Nov. 1. Some scour around the main piers occurred during high water stages in December, 1937, resulting in the decision to place stone rip-rap around the pier bases for future protection. The scour pits were filled in with 150- to 200-lb. stone to slightly above normal river bed level.

Steel erection

Superstructure work got under way in August, 1937, with the first operations being concentrated on the Kentucky approaches. Erection of the deck spans and girders was accomplished with a deck traveler; and the same traveler afterward proceeded to erect the main river cantilevers. Another traveler beginning on the Illinois side met the Kentucky traveler at the center of the suspended section in the first main span out from the Illinois shore.

The main bridge superstructure is generally of silicon steel, and is designed for H-20 loading. Fabricated sections are used throughout in the cantilevered trusses. Rolled wide-flange silicon steel stringers and floorbeams are employed on the main bridge to support the 7 in. reinforced concrete slab. On the approaches, transverse joist construction is used under the roadway slab.

The total cost of the bridge and approach roads is about $2,500,000, financed in part by a PWA grant. The state of Illinois is paying for all of the bridge approach and approach roads on its side of the river, while the state of Kentucky, as its contribution, is building a 3 mile road from the Kentucky end of the bridge to intersection with a main state highway at Wickliffe. The bridge will be operated as a toll structure by the Cairo Bridge Commission, a public body, of which Ray Williams is chairman.

The design and supervision of construction were handled by Modjeski & Masters, formerly Modjeski, Masters & Case, consulting engineers, Harrisburg, Pa. George H. Randall, principal assistant engineer, was in immediate charge of design, and W. C. Gorman was the resident engineer. The substructure contract was held by the Missouri Valley Bridge & Iron Co., and the superstructure fabrication and erection by the Mt. Vernon Bridge Co.

Presaturated Sand Bases

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WHEN dry sand is stirred while water is slowly added, it rapidly bulks. The admixing of 5 or 6 per cent of water by weight may cause the sand to increase in volume as much as 20 or even 30 per cent. Further additions of water tend to pack the sand and decrease its volume. When the sand is saturated or inundated, the volume is about the same as when measured dry. The amount of bulking varies with the type of sand.

These characteristics of sand should be borne in mind when concrete pavement is placed on a sand base. If the sand is not perfectly dry or is not entirely saturated with water at the time the pavement is placed on it, it is apt to be in a bulked condition. If the sand is bulked, it will eventually become saturated with water under the pavement, settle and cause the pavement to settle, or leave it suspended on an air pocket or pockets to carry the traffic loads by the beam strength.

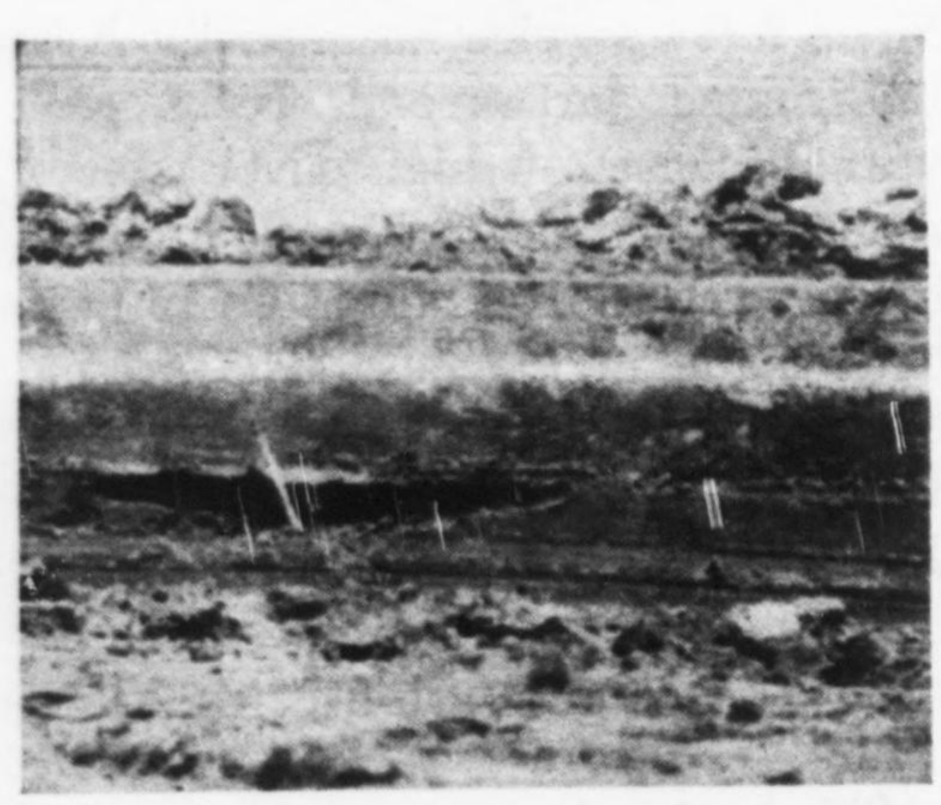

Fig. 1. **Sample of cavities found under a concrete pavement where the sand base had settled due to saturation.**

The plans for a pavement laid in Texas in 1935 called for a sand blanket to be placed entirely across the top of a clay-soil subgrade, and the pavement laid on the sand. A 20-ft. wide trench was first cut in the top of the clay subgrade; sand was then placed in the trench to the required 12 in. loose-measurement depth, and the 20 ft. concrete pavement was laid on the sand. The concrete was then cured by diking its edges with clay soil and keeping it covered with ponded water for 10 days.

After the curing period, when the clay shoulder soil was cut away to the bottom of the sand under the pavement in order to extend the sand blanket to intersections with the roadway side slopes, air pockets were found between the bottom of the edge of the pavement and the top of the sand blanket in several different places as illustrated.

It follows that to be sure the sand is thoroughly compacted, after the top of it is brought to the proper line and grade, it should be thoroughly saturated with water.