FIG. I. NEW SIX-LANE DIVIDED HIGHWAY BRIDGE CROSSING BUSY NEWTOWN CREEK AT NEW YORK CITY.

New York's Latest Interborough Bridge

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***Contents in Brief**—Structural details of $4,500,000 bridge connecting Brooklyn and Queens over one of the city's busiest waterways. Acid soil required special foundation design and alkalizing procedure. Unusual method of installing heavy steel bracing for large cofferdams. Tieback cantilever erection method for high-level channel span.*

THE MEEKER AVE. BRIDGE recently opened for traffic provides another needed thoroughfare over water between the boroughs of New York City. Connecting Brooklyn and Queens over Newtown Creek, a busy waterway, the bridge is 6,415 ft. long, of which virtually only 300 ft., the high level span over Newtown Creek, crosses water. While expensive and heavy work was involved throughout, the exceptional construction problems centered near and at the foundations for the river span, where a highly acid soil called for special protective work, and in the erection of the high-level steel over a waterway the full width of which had to be kept clear for navigation. Description here is confined largely to the special work; technical data about the bridge structure follow in an appendix.

Acid soil alters plans

The planned foundations for the approach viaduct piers (see appendix) were cast-in-place concrete piles, and the greater number of piers have these foundations. But on the Queens approach for several piers near Newtown Creek the piles were abandoned. After the first pier near the creek was completed and most of the piles for the second pier were driven, it was discovered that the soil contained acid. The color of the water and the fact that pumps were corroded after a short period of use led to a sample being taken and tested. This sample was found to have a pH of 2.5, this being highly acid and injurious to steel and concrete.

On investigation, the source of this pollution was found to be the storage on the ground in this area about ten years ago of a chemical by-product. A contract was let for borings with a provision that water samples for testing be taken at intervals of 10 ft. to an average depth of about 50 ft. These tests showed a definite acid condition in six pier locations. It was deemed advisable, therefore, to protect the footings and it was determined that this could be properly done only by eliminating the piles and carrying the footings to a considerably greater depth where good bearing conditions could be had.

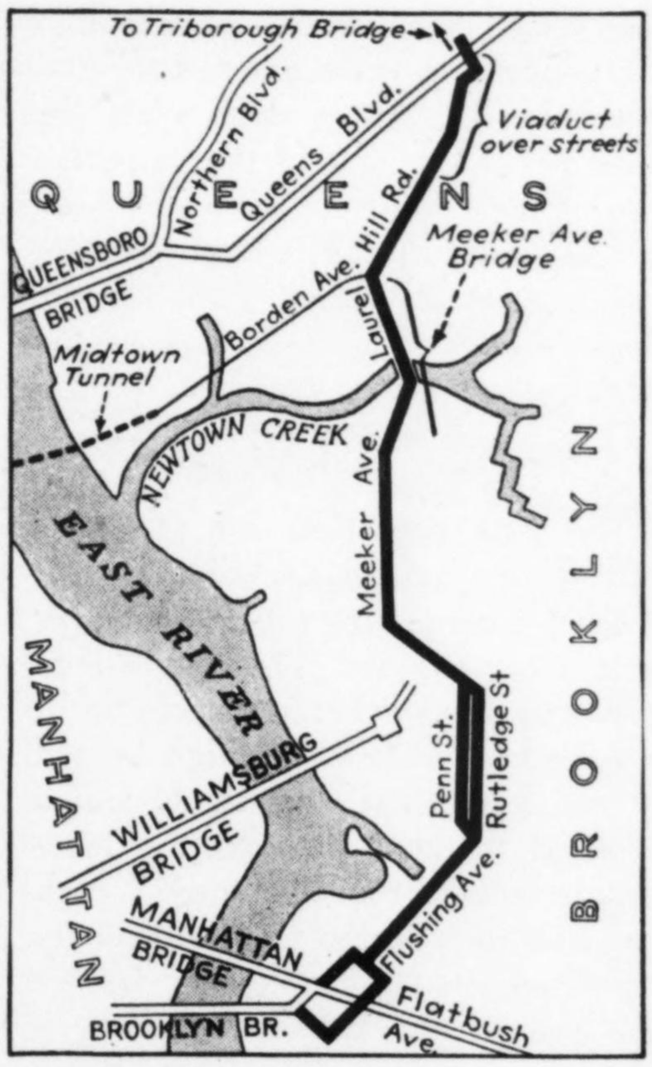
Three-ply membrane waterproofing was used at the base of the footings and for a height of 3 ft. around the sides, and the balance of the footings and the pier shafts were painted with

two coats of cutback asphalt up to within 1 ft. of the proposed ground surface. This treatment was applied to four piers, the construction of which was temporarily delayed pending the outcome of the investigation. All the sides of the previously completed footings and pier shafts were painted with two coats of asphalt and the backfill was mixed with hydrated lime, in the proportion of 2 bags of lime to 1 cu.yd. of backfill. The lime is expected to aid in neutralizing any acid in the soil around the footings.

Novel cofferdam construction

As shown by Fig. 4, the channel span is carried by braced steel towers on concrete piers. Both piers were built in steel sheetpile cofferdams about 130 ft. long and 47 ft. wide, Fig. 2. The distances between the faces of the piers is 250 ft. and between the centers 300 ft. The Queens pier extends to a depth of —40 mhw and is supported on 549 steel H-beam piles (Fig. 3) from 55 to 65 ft. long. The Brooklyn pier extends to a depth of —48 mhw and rests on good bearing soil.

The bottom of the river at each pier was leveled off by dredging, and 8 test piles were driven to determine the pile length. A line of temporary wooden piles was driven around the outside of the cofferdam and cut off to El. +21; another line was driven inside the cofferdam with piles opposite the outside piles. The piles on the inside were cut off at +4. Wooden battens 3x10 in. were spiked to the two lines of piles at El. +3 to form a platform on which to erect the steel interior bracing of the cofferdam. The total weight of the bracing when completed was 160 tons.



Brooklyn-Queens connecting highway and Meeker Ave. Bridge

After three tiers of the bracing were assembled on the temporary platform, the construction of the cofferdam walls commenced; interlocking steel piles 54 ft. long and 16 in. wide with a 5-in. arched web were used. The sheetpiles were guided to proper alignment on the outside by the wales and on the inside by the steel bracing.

After the sheeting was driven to El. —34, the load of the steel bracing was transferred to four 60-ton hydraulic jacks mounted on four elevated platforms inside the cofferdam, carried by clusters of four piles (Fig. 2). The battens between the outside and inside of the cofferdam were removed and the excavation proceeded to El. —22. The hydraulic jacks were inserted between lowering channels from which the steel framework was suspended. The steel bracing consisted of four tiers, 35 ft. in height when in final position, the first tier at +3, the second at —14, the third at —22, and the fourth at —32. The first three tiers were erected as a single unit; the fourth and lowest tier was an independent unit, and was temporarily supported in a position immediately below the third tier by lashings to the second tier; it was 1½ in. shorter on all sides to prevent it from binding against the sheetpiling.

The 60-ton hydraulic jacks were seated upon grillages made up of two 15-in. steel channels. On the side of each channel was a vertical 10-in. sliding channel to which the steel framework was attached. These channels were 39 ft. high and about 17 ft. above the first tier. On top of each jack was mounted a billet with one side flat and the other with a semicircular groove which engaged a 2 15/16-in. removable steel pin. The vertical suspender channels had 3-in. circular holes spaced 10½ in. on centers. The two 15-in. steel channels on the platforms also had 3-in. circular holes. On a platform in the center of the cofferdam was installed a hand-operated oil pump which was connected to each jack by copper tubing. Each tube had a control valve to operate each jack independently. As a safety precaution 1-in. shims were placed on each side of the jacks on shoulders built up from the grillages.

The lowering of the bracing was accomplished in drops of 10½ in. or the distance between the holes in the vertical channels. Two pins were used for each lowering device. The plunger of each jack was forced up to the top pin in the vertical chan-

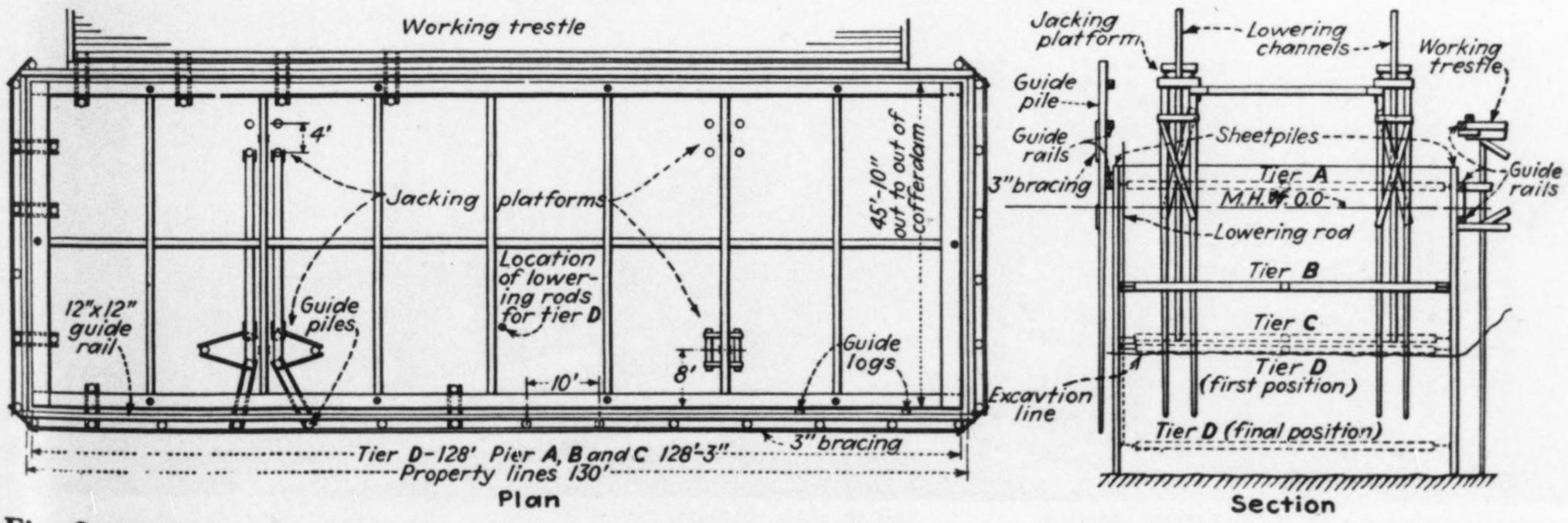


Fig. 2. Interior bracing weighing 160 tons for the main pier cofferdams was lowered inside the sheeting as a unit by four suspenders operated by hydraulic jacks.

nels, transferring load to the jacks. The lower pin in the grillage was then removed and the plungers were allowed to recede gradually, thus lowering the steel 10½ in. The bottom pin was then inserted through the grillage and the load transferred to the bottom pin. The top pin was removed and advanced to the next set of holes in the vertical suspenders. By this method the bracing was lowered about 22 ft.

When the third tier had reached its proper grade, the sheet-piling was driven home to El. —48 on the Queens side and to El. —58 on the Brooklyn side. The sheeting for the Brooklyn cofferdam was 64 ft. long. From brackets on the upper tier of the bracing, vertical 1⅛-in. steel rods about 38 ft. long and threaded for a distance of 17 ft. at their tops extended down to connect with the fourth tier. The fourth and last tier was lowered to its final grade while the cofferdam was being excavated, by turning nuts on the threaded rods.

After the fourth tier was lowered to its final position, the Queens cofferdam was excavated to —41, and the Brooklyn cofferdam to —48. The steel H-beam piles were driven in the Queens cofferdam and tremie concrete was poured to El. —28. The bottom of the Brooklyn cofferdam was sealed with tremie concrete to El. —24. The cofferdams were unwatered about three days after the seals were poured and the construction of the rest of the piers was completed in the dry. The steel sheeting was burned off under water on the channel sides to El. —28 and on the other three sides as required.

Erecting channel span

The first operation for the erection of the main span (Fig. 4) was to erect a temporary toggle bent over each tower support. The toggle bent consisted of a steel frame made up of two vertical posts 65 ft. high braced by two horizontal steel struts and a diagonal member between the horizontal struts. From the top of each post backstays in the form of eyebars were connected to temporary frames attached to the adjacent approach span trusses, counterweights being suspended from the approach span trusses to resist the uplift. On the Brooklyn side a counterweight of 200 tons was required, and 125 tons on the Queens side.

Two derrick travelers with 90-ft. booms and 20-ft. jibs capable of lifting 30 tons were used to erect the two halves of the span in three stages. Stage one consisted in advancing the travelers to the ends of the approach spans and erecting the end posts of the trusses, connecting the tops to the erection bent by auxiliary eyebars. With the end posts in place, erection of subsequent members proceeded to panel points L2. The travelers were then advanced to panel points L1 and the second stage of erection commenced. To prevent the trusses from swaying the top members of the portal struts were erected temporarily. In the second stage the top chords were attached at panel points U3 to the erection bents by eyebars, and the auxiliary eyebars were cut loose. The erected portions of the trusses were raised by hydraulic jacks placed in the main set of ties to secure proper clearance. The travelers were then moved ahead and the erection of the remaining halves of the trusses together with the floorbeams and bottom laterals was completed. At this stage there was a space of about 5 in. between the truss sections.

Trusses jacked to place

The trusses were then swung into their final position by eight hydraulic jacks. One set of four jacks was placed in line with the bottom chords for shifting the truss sections forward and the vertical alignment of the trusses was adjusted with the jacks in the main ties. After the bottom

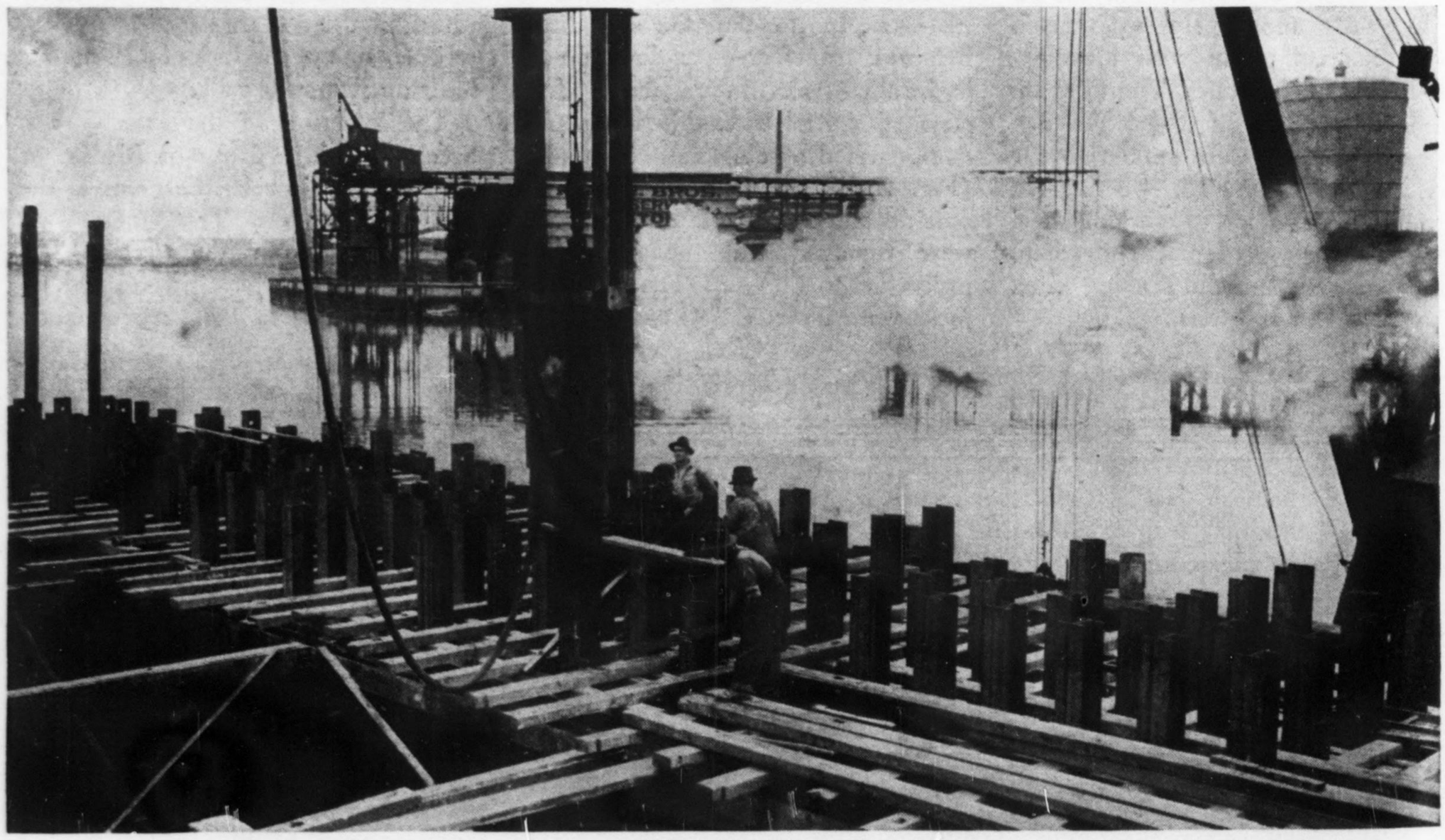


Fig. 3. Driving 549 steel H-beam piles 55 and 65 ft. long in the Queens pier cofferdam was a high spot in the substructure construction for the Newtown Creek bridge.

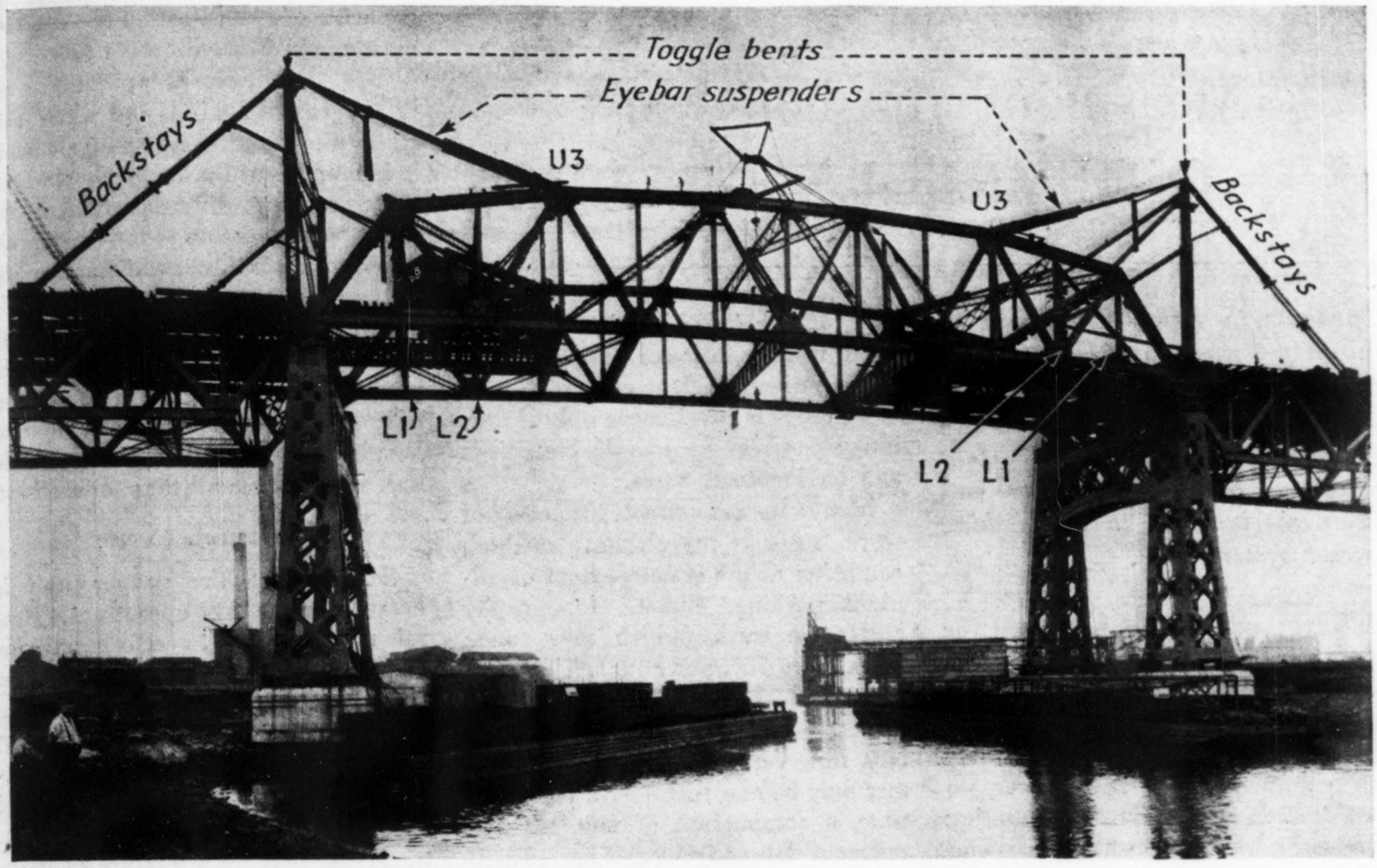


Fig. 4. Using tiebacks to counterweighted approach spans the channel span was erected as a cantilever 125 ft. high over an unimpeded waterway.

and top chords were connected and the last floorbeam set in place the eyebars were loosened and the travelers were moved backward filling in the remainder of the bracing and floor steel. After the travelers were again over the approach spans, they were used to erect the portals at each end of the trusses and also for dismantling the erection bents. The travelers were then dismantled by a crawler crane used for handling light members of the steel structure.

Erection of the two viaducts, main span and the two towers involving 17,000 tons of steel was accomplished in about four months.

Personnel

The Meeker Ave. Bridge was built for the city of New York from designs by the Department of Public Works, under the direction of Commissioner Irving V. A. Huie, Deputy Commissioner Homer R. Seely and Chief Engineer J. Frank Johnson. Construction was carried out by four contractors: river span piers, Charles F. Vachris, Inc.; approach piers and the Brooklyn ramp, Reiss & Weinsier, Inc.; Queens ramp, Elmhurst Contracting Co.; and superstructure, American Bridge Co. The writer was resident engineer.

TECHNICAL DATA ON NEW MEEKER AVE. BRIDGE, NEW YORK

The new Meeker Ave. Bridge over Newtown Creek connecting the boroughs of Brooklyn and Queens, is a vital link in a new 7-mile highway that taps the approaches to all of the East River Bridges and the new midtown tunnel, as shown on the accompanying map. Queens Blvd., its present terminus, gives access to the Long Island parkways, and it is planned to extend it to the Triborough Bridge.

The bridge with its approaches will be 6,415 ft. long; the greater part is 89 ft. wide and consists of two roadways each 32 ft. wide separated by a middle aisle 4 ft. wide and flanked by two sidewalks each 8 ft. wide. The essential structures are a closed ramp and a viaduct approach at each end and a center span over Newtown Creek.

Ramps—The Brooklyn Ramp, 2,142 ft. long, consists of a concrete roadway deck on floorbeams and stringers supported on columns on concrete footings. The sides of the ramp are faced with curtain walls to form a closed structure. There are two marginal ramps and three rigid-frame arches span three intersecting streets. For the support of the falsework the contractor elected to use steel brackets attached to the concrete columns at the top. Screw jacks mounted on top of the steel brackets were used for adjusting the forms for elevation. After the concrete was poured the brackets were removed and the holes in the columns plugged with mortar.

The Queens ramp is 750 ft. long and is similar in design to the Brooklyn ramp, except that it has no marginal ramps, and only one rigid-frame arch.

Viaduct Approaches—The Queens approach consists of deck trusses with the following spans: five of 120 ft., four of 159 ft., one of 198 ft., and one of 230 ft. The Brooklyn approach has four spans 120 ft. long, four 159 ft., one 216 ft. and one 230 ft. Falsework bents of steel or timber were used for the erection of the approach spans.

There are 21 land piers; each consists of two concrete shafts either on spread footings or on concrete cast-in-place piles. The high shafts are joined together at the top by arched beams about 16 ft. high.

Main Span—The main span 300 ft. long is supported on two steel towers 97 ft. high. It has a 4-ft. camber and is 43 ft. high. It has a maximum clearance of 125 ft. above mean high water. The trusses are spaced 75 ft. 10 in. on centers. The erection of the main span presented a difficult problem to the contractor because falsework could not be used due to interference of heavy marine traffic. After considerable study, the contractor elected to employ the cantilever method as has been described.

Quantities and Costs—The principal quantities involved were: Excavation 156,000 cu.yd.; concrete 88,120 cu.yd.; reinforcing steel 4,725 tons; structural steel, 16,315 tons. The cost of the bridge, including $606,720 for land, will be $5,588,582.