forms were made of reinforced concrete in sections from 6 ft. 6 ins. to 13 ft. high having a shell thickness of 8 ins.

The bottom section of each cylinder is provided with a cast-iron cutting edge, and into each section are moulded cast-iron jointing rings for the purpose of bolting the sections together. The sections, after seasoning, were built up and bolted together inside a steel tower supported on pile staging and fitted with hydraulic gear, so that when sufficient length to come above the water level had been bolted together the cylinder could be lowered to sea bottom. The cylinder was then sunk to the required depth by excavating inside and weighting, further sections being

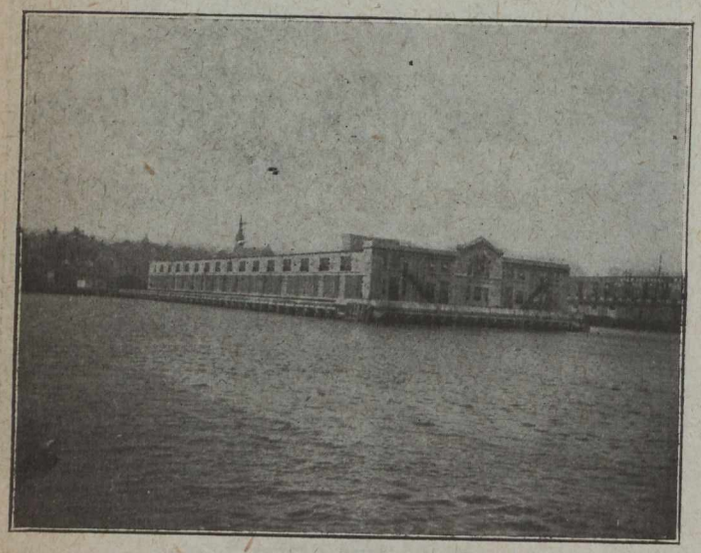

Fig. No. 7—Pier No. 2 at Halifax, N.S.

bolted on as it went down. Eight reinforced concrete piles were then driven inside each cylinder after which the cylinders were filled with concrete, the lower portion of which was put in under water to form a seal and the remainder was put in after the water had been pumped out of the cylinder. The heads of the cylinders were then joined by a transverse girder of reinforced concrete, cast in place, on which rested a deck system of precast beams and slabs.

Reinforced concrete retaining walls of different types have been much used. When properly designed, these are very suitable in places where stable foundations are not easily obtained and where no great depth of water alongside the wall is desired.

At Lower Pootung, where the deep mud foundations exist, a retaining wall 495 feet long and with a height of 21 ft. 6 ins. above dock bottom was built in the following manner:—

Cross rows of three 12-in. square piles were driven, the front piles of which serve as king piles to a continuous line of concrete sheet piles, which in turn form the face of the wall up to a height of 12 feet below quay level. At that level the heads of all the piles are connected together by a reinforced concrete platform supporting a nearly vertical slab tied back to the deck by counterforts 7 feet apart. Anchor ties were found to be necessary and were put in at 20-ft. centres being carried back to the foundations of a shed alongside the wall.

In Australian ports a type of precast wall called a reinforced concrete trestle wall has been used for some years with apparently good results. These walls are formed with precast L-shaped buttresses, which are set at regular intervals on a prepared level foundation. These buttresses are flanged to hold precast reinforced concrete slabs, which fill in the spaces between the buttresses. This type of wall has been used up to 27 feet in height and the advantages claimed for it are economy, stability on bad foundations, flexibility where settlement occurs in the foundations, rapidity of erection and greater resistance to the chemical action of sea water, as all its parts are seasoned on shore.

The ordinary type of reinforced concrete retaining wall, having inside buttresses and vertical and horizontal slabs all cast in place, was used in the construction of a pier at Padstow, Cornwall, England, which is 800 feet in length by 40 feet wide and which carries two railway tracks. The rise and fall of the tide at Padstow is about 20 feet. The foundation slab consists of mass concrete resting on solid rock and it varies from 3 to 9 feet in thickness in order that it might be finished 12 ins. above low water of spring tides. The height of the vertical wall is 23 ft. 6 ins. Cross-ties connect the two side walls at intervals, and the space enclosed by the walls was filled in with earth, etc. It will be interesting to know how long this structure will last, as its location is a very exposed one.

Reinforced concrete cribs or caissons have been used for a number of years, both in Europe and America, in the construction of quay walls and breakwaters. At Norresundby Harbor, Denmark, concrete caissons 32 ft. 6 ins. long, 8 ft. 4 ins. wide and 25 ft. high, and with a thickness of wall of only 5.1 ins. at their base and 3.5 ins. at their tops, were built on shore and launched sideways into the harbor. No failures from cracking during launching occurred, but the wall thickness appears to be too light for permanent marine work.

At Copenhagen, a quay wall 3,300 feet in length has been constructed using reinforced concrete cribs of an average length of 162 feet each. These cribs are 32 feet

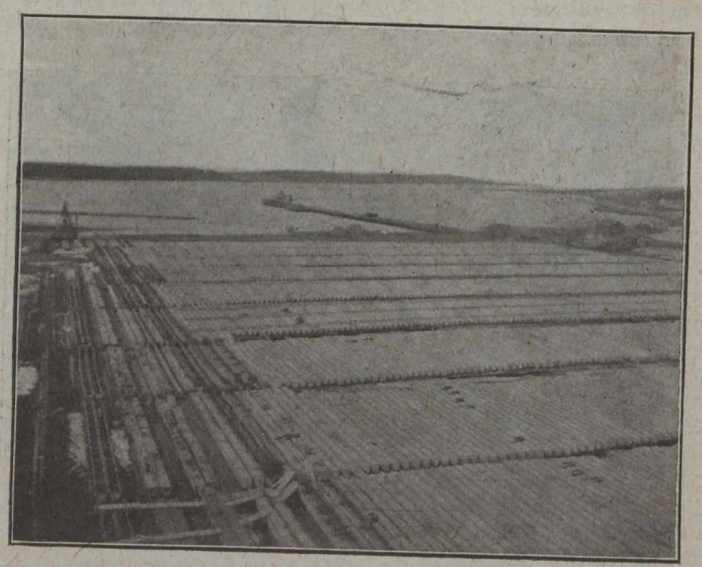

Fig. No. 8—Pier No. 2—Pile Yard—Camber Piles

in height by 16 feet wide, but with their bottom slab spread to a total width of 23 feet. The front and back walls average 10½ ins. in thickness and are stiffened by cross-beams and struts. These cribs were filled with sand and capped with a granite-faced wall 7 ft. in height projecting 13½ ins. beyond the face of the crib below. The granite facing is carried down 4 ft. 3 ins. below the top of the crib, for which purpose the front wall of the crib was recessed. These cribs were built in a temporary drydock large enough to accommodate three at one time, and the concrete used in their construction was mixed in the proportions of 1:2:3.