

## REINFORCED CONCRETE DOCKS IN NORTH AMERICA.

**I**N *The Canadian Engineer* for August 27th, 1914, an article appears dealing with the application in England of reinforced concrete to dock construction. The following article supplements the former by outlining the extent of similar construction in North America, with special reference to such works in the United States. We are indebted to the same source for this information, viz., a paper by Harrison S. Taft, read before the American Society of Civil Engineers on May 20, 1914, which paper reviews the reinforced concrete dock construction of the world.

In recording what has been accomplished in the construction of reinforced concrete docks in North America, including Porto Rico, Cuba, the Canal Zone, and Canada, such undertakings are so few and of such recent date, compared with those in European countries, that the art of building reinforced concrete docks there may be said to be hardly beyond its infancy, especially as regards out-and-out docks or piers, as the American usually understands the word, viz., long structures running out from the shore in such a way that vessels can lie on each side. Unfortunately, it will be necessary to make note of some failures among North American concrete docks.

### Atlantic Coast.

*Boston.*—The first concrete dock built in Boston Harbor has perhaps caused more discussion as to the feasibility of using concrete in sea water than any other American structure of this type, and, therefore, is famed in itself. This dock, or pier, was built at the Charleston Navy Yard about 14 years ago. The first section, consisting of a long, straight wall, was built in 1899-1900, without any resort to a cofferdam. The other two sections, consisting of plain reinforced arches, 20 ft. wide, with spandrel walls, were constructed in 1901, the space between the two walls being filled with earth and stone. The first section was built of 1:2:3 concrete throughout, and it was all placed in the wet, with an open-top bucket. The second and third sections were of different mixtures, the main body being of 1:3:6 concrete, the outer 2 ft. consisting of a 1:2:4 mixture, and the whole exposed surface was faced with 3 in. of 1:1 mortar. In these two sections the concrete was placed very dry, as was the practise at that time.

During 1913 one of the Boston public docks, Pier No. 5, was partly rebuilt in concrete. This dock consisted of a timber platform deck, 50 ft. wide and 1,150 ft. long, on each side of a solid earth fill. The new wooden piles needed were driven, and all the piles, new and old, were cut off at mean high water and capped with a deep reinforced concrete beam running athwart the piles, in the way of curtain-walls. These curtain-walls support two longitudinal reinforced concrete beams, the third or inner beam resting on the earth retaining wall. There are also two additional concrete beams under the track along the outer face of the dock, with special supporting piles. On top of the curtain-wall and longitudinal girders is laid a reinforced concrete floor-slab with a 2-in. bitulithic top. Wooden longitudinal tie members are run from top of pile to top of pile under the concrete curtain-walls, the whole timber structure being well braced with piles and wooden ties. To provide against accident from disintegration of the lower part of the curtain-walls, due to frost action or other cause, cast-iron columns, 30 in. long, are attached to the top of the piles and made integral with the curtain-walls,

thus guarding against weakness in the concrete, rather than in the piles, as done in other harbors.

*New York Harbor and New Jersey Coast.*—A reinforced concrete dock of an experimental nature was constructed at Ellis Island, New York Harbor, in 1911. It is a rather small structure, 30 ft. wide and 50 ft. long, resting on thirty-six driven concrete piles 18 in. square. The piles were made of different mixtures, for experiment purposes, and various kinds of waterproofing were used in order to determine their efficiency under the same conditions. This was the first complete concrete pile and deck dock built in New York Harbor.

During the past seven years a semi-concrete type of dock has been under development in New York Harbor, viz., wooden piling, wooden caps, and concrete decking. In one dock, on the New Jersey side of the Hudson, the caps on top of the piles are also of concrete. In the final type, as worked out by the Department of Docks and Ferries,\* the concrete slab rests directly on wooden caps secured to the tops of the wooden piles, a genuine flat slab between bents, the entire timber floor system being wholly eliminated. At present some 25 or 30 semi-concrete docks have been built on this system in New York Harbor. It has been stated authoritatively that they have proved a great success.

In building two semi-concrete docks at the Brooklyn Navy Yard a few years ago, the objectionable features of docks of the foregoing type—viz., part of the wooden pilings and bracing exposed to wet and dry conditions between low water and the decking, and the wooden cap as an additional temporary item helping to support a permanent structure—were eliminated. In the two Navy Yard docks the wooden piles were cut off a little above low water and capped with a wooden grillage. Pre-moulded concrete columns, mixed with waterproofing compounds, were set on and dovetailed into the caps, and a concrete girder-beam and deck-slab system was worked over the tops of the columns. The wearing surface consists of a creosoted wooden block pavement. Down each side of the dock there is a standard-gauge railroad.

A small concrete dock was constructed at Glen Cove as a yacht-landing, in the winter of 1909-10. It consists of eight reinforced concrete rock-filled caissons, supporting an overhead footbridge, the total length of the pier being about 330 ft.

*Long Branch.*—At Long Branch a Hennebique type of concrete pile dock was constructed in 1911, running some 848 ft. out into the Atlantic Ocean, as a boat landing and recreation pier. At present the pier is only 75 ft. wide, except for an 80-ft. length at its outer end, where its width is 150 ft., the intention being to make the whole pier of that width at some future time. The deck is 22 ft. above low water. The piles are 16 ft. from centre to centre longitudinally, but 20 ft. from centre to centre across the pier, except the outer two rows, which are 15 ft. from centre to centre. Most of the piles are of hollow cross-section, 22 in. external diameter, 13 in. internal diameter; the penetration was about 22 ft. To provide sufficient impermeability, the shells of the piles were made of 1:1½:3 concrete, the fill being of a weaker mixture. Apparently, no cross-bracing system was used, the outer end of the pier being stiffened laterally by inclined bracing piles at regular intervals.

*Atlantic City.*—At Atlantic City the famous steel pier was widened and protected in 1906 by the use of concrete. The original pier was founded on steel-pipe piles resting

\*Transactions, Am. Soc. C.E., Vol. LXXVII., p. 503.