DESCRIPTION OF THE PORT OF DUBLIN.

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Dublin is situated at the head of a bay 6 miles deep and $5\frac{1}{2}$ miles wide, Fig. 1, Plate 74. Large quantities of sand brought in by the sea have accumulated in the bay, forming extensive strands, which are laid dry at low water for a distance of about $2\frac{1}{2}$ miles seaward. The history of Dublin as a port dates back to the year 1707, when the conservancy of the port was vested in the Corporation of the City of Dublin by the Irish Parliament. At that date the combined waters of the Liffey and Dodder flowed across the sands at low water, dividing them into the North Bull and South Bull. From its exposed position the channel thus formed was subject to constant alteration in depth and direction; and this being the only channel by which vessels could reach the city, the early attempts to improve the harbour naturally took the direction of providing a permanent and deep approach to the port. With this view the Great South Wall was constructed during the eighteenth century to shelter the channel from southerly winds, and also to prevent the encroachment of sand. When completed, it accomplished to a great extent the object aimed at by its designers. Portions of the channel up to the city however were still very shallow; and attention was also drawn to a shoal beyond the extremity of the new wall, known as Dublin Bar. This bank stretched from the north side of the bay across the entrance to the harbour in the form of a hook. The deepest water for vessels was round the end of this hook; but across the bank, in a direct line out to sea, there was a depth of only from 5 to 6 feet at low water of spring tides. At the beginning of the present century many eminent engineers and naval officers were consulted respecting

further improvements. Captain Bligh recommended a wall along the north side of the channel; Sir Thomas Hyde Page proposed a similar wall, and the formation of an island on the bar; while a proposal to construct an embankment or wall extending from the north shore towards Poolbeg emanated from the corporation for preserving and improving the port of Dublin, better known as the Ballast Board, to whom the conservancy of the port had been transferred in 1786. Mr. Rennie, at that time considered the highest authority on the improvement of harbours, prepared an elaborate scheme, but he predicted little likelihood of much improvement on the bar. He expected an increased depth of 3 feet of water as the result of an estimated expenditure exceeding £655,000. To provide a better approach, he considered it essential to construct a ship canal from some point on the adjacent coast, where deep water might be obtained, and finally recommended this entrance to be made close to the present site of Kingstown Harbour; his estimate for this work was £489,734. From 1802 to 1819 the question [of the improvement of the bar appears to have been in abeyance. Probably Mr. Rennie's scheme, from the large expenditure it would have involved and the smallness of the results anticipated, tended to deter the government from advancing the necessary funds for any particular scheme.

About 1819 the Ballast Board found themselves in a position to carry out their own project of a wall or embankment from the Clontarf shore. Its object was to protect the harbour on the north side from the encroachment of sand, to shelter it from northerly and easterly winds, and to direct the tidal and river waters in a fixed channel across the bar. Before beginning this work however an accurate survey of the river and bar was made by Mr. Francis Giles. Under the joint direction of Mr. Giles and Mr. Halpin the engineer of the Ballast Board, the rubble embankment, now known as the Great North Wall, was constructed, extending about 9,000 feet from the Clontarf shore, its southern end being about 1,000 feet north of Poolbeg Lighthouse. Over 5,500 feet of this wall rose above high-water, the remainder being below that level; and the extreme 2,000 feet reached on the average to half-tide only. During the first half

of the ebb, the tidal and river waters running out of the harbour flow partly over the submerged wall, and partly through the harbour entrance between the termination of the wall and Poolbeg Lighthouse. As soon however as the tide falls below the level of the wall, the water contained within the two great piers of the port passes through the contracted entrance at Poolbeg. The velocity of the stream is thus greatly increased; and a channel has been formed across the bar with 16 feet at low water of spring tides, where in 1819 there was a depth of only $6\frac{1}{2}$ feet. As the improvement of the bar is due to the water discharged from the harbour during the second half of the ebb, any addition to the tidal capacity of the harbour below that level may be expected to produce a corresponding increase in the depth on the bar. Such an increase in the tidal capacity of the harbour is actually taking place by the lowering of the North Strand, the result of dredging and the wasting away of the bank.

A consideration of the difficulties overcome in the improvement of the approach to the port of Dublin naturally leads to the enquiry, what are the dangers which beset the maintenance of the deep-water channel across the bar. These may be briefly summarised as reclamation inside and outside the harbour. Reclamation inside would reduce the tidal capacity on which the scour across the bar depends; while reclamation outside would result in the reduction of the area upon which sand entering the bay is at present deposited, and would tend to drive the low-water mark further out to sea, and greatly endanger the channel across the bar.*

Improvements in the River Channel.—Figs. 2 and 3, Plate 75. The great works which proved so efficacious in increasing the depth of the water on Dublin bar produced no appreciable improvements in the river channel. From the city to within 1,000 feet of Poolbeg lighthouse all improvements in the channel are the result of dredging. Steam dredging was first introduced in 1814; but up to 1860 the total average tonnage raised did not exceed 150,000 tons a year. The introduction of modern dredgers and large hopper-barges gave

* Proceedings of the Institution of Civil Engineers, 1879, vol. lviii, page 104.

a great impetus to dredging operations, and since 1865 upwards of 15,000,000 tons have been raised. The depth of the river channel has been increased from a maximum of 10 feet to 14 feet at low water between Poolbeg and the entrance to the Alexandra Basin; while from the Alexandra Basin to the Custom House the depth has been increased from an average of 5 feet to depths varying from 9 to 24 feet at low water. The site of the Alexandra Basin, which was chiefly tidal strand, has been dredged to a depth of 24 feet at low water over an area of 40 acres.

Most of the dredging has been carried on in connection with the deep-water quay walls of the Alexandra Basin and the North and South Quays. There are still portions of the river channel between Poolbeg and the Pigeon House Harbour where there is a less depth of water than on the bar. The removal of these shoals has unfortunately been delayed by the reduction of dredging operations, necessitated by the diminished revenue of the last few years.

The dredging plant of the port consists of three steam dredgers, three steam hoppers, five towed hoppers, twelve dredge floats, one tug, and three crane floats. At present however only one steam dredger, three towed hoppers, the tug, and six dredge floats are in commission. (See pages 363-373.)

Dublin Quays.—The quay walls along the river Liffey were originally built at very shallow depths; and in 1865, when the Institution of Mechanical Engineers last visited Dublin, the foreshore in front of most of these walls was exposed at low water for many feet outside their base, and vessels lay aground during the greater portion of each tide. To meet the demand for deeper water, timber jetties had been constructed in front of some portions of the old walls, enabling coasting steamers to float at half-tide. The only places in which a vessel drawing 17 feet could lie afloat at all states of tide was in a hole dredged at the east end of the North Wall, known as "Halpin's Pond," about $1\frac{1}{2}$ acres in area; and also at Sir John Rogerson's Quay, alongside a floating stage, where a trench, 250 feet long and 70 feet wide, had been formed.

The following extracts from the harbour master's journal for 1865 and 1866 graphically describe the delay and expense incurred by the want of deep-water berthage at that period. "Ship *Vistula*, of Boston, 1,188 tons register, drawing 22 feet, with a cargo of guano from Peru, bound to Dublin, arrived at Kingstown on the 7th July 1865, where she remained, discharging her cargo into lighters, until the 27th, when she was lightened to 17 feet. She then came to Halpin's Pond, where she had to discharge the remainder of her cargo into lighters, which was not completed until the 28th August." "The ship *Tribune*, of St. John's, N.B., 1,122 tons register, with a cargo of 1,700 tons guano, drawing 22 feet 6 inches, bound to Dublin, arrived at Kingstown on 15th July 1866; detained at Kingstown till 5th August, to lighten to 17 feet, when she came to Halpin's Pond, where, after a delay of thirty days more, she finished her discharge, all by lighters."

Since 1865 timber jetties, 3,516 feet in length, have been constructed outside some of the old quay walls on both sides of the river, so as to allow the berths to be deepened to depths of from 5 to 8 feet at low water. For greater depths these temporary structures were unfitted; and in 1864 the first step was made towards the construction of masonry deep-water quay walls. In 1870 the deepening of the South Quay walls was begun; and since that year 4,047 lineal feet of masonry walls have been built at that side of the river, affording berthage of 22 feet depth at low water for the greater portion of this length. On the North Quay 2,317 feet of masonry walls have been built, affording berthage of 16 feet depth at low water, which is mostly used by cross-channel steamers.

These new walls, which replace old quays, were constructed inside cofferdams, the excavations being carried down till a firm foundation was reached, in some cases at depths of 28 to 32 feet under low water.* The quay walls in Dublin which have attracted most attention amongst engineers are those connected with the

* Proceedings of the Institution of Civil Engineers, 1877, vol. li, page 137. Transactions of the Institution of Civil Engineers of Ireland, 1880, vol. xiii, page 90.

construction of the Alexandra Basin and the North Quay extension. They do not replace old walls, but are extensions to the quayage of the port, intended to provide berthage for the largest ocean-going vessels. Alongside these quays the "Great Eastern" was moored throughout the winter of 1886-87. The North Quay extension quays facing the river afford berthage of 22 feet depth at low water, while the berths along the quays inside the Alexandra Basin have depths of 24 to 26 feet at low water. These walls were constructed up to ordinary low-water level with gigantic blocks of masonry, each block weighing 350 tons, and over the blocks the upper portion of the walls was built by tidal work. The blocks were built on a wharf, and when sufficiently hardened were lifted and conveyed to their destination in the quay wall by a floating sheers. The foundation for the blocks was first excavated by a steam dredger to within 2 feet of the finished level; and the remainder of the excavation was taken out by men working in a large diving-bell, 20 feet square and 6½ feet high. Access was obtained to this chamber by a wrought-iron shaft and air-lock, without lifting the bell. One of the most important features of this mode of construction is the absence of cofferdams, staging, and pumping; and it has proved exceptionally economical, the quay walls having been built for about £40 per lineal foot, inclusive of the cost of all special plant. The whole of the machinery and appliances used in this great work were designed by Mr. Bindon B. Stoney, the Chief Engineer of the Dublin Port and Docks Board.*

The Alexandra Basin is still unfinished; but additional quayage can be rapidly added, when funds are available and further accommodation is needed. The total length of walls built with 350-ton blocks is now 4,911 feet.

Lights, Fog-Signals, Beacons, and Buoys.—The construction of deep-water quays and the improvement of the channel were followed by an increase in the number of passenger steamers entering and leaving the port at fixed hours; and, as this class of traffic developed, the need of improved lights and fog-signals was felt. Previous to

* Proceedings of the Institution of Civil Engineers, 1874, vol. xxxvii, page 332.

1880 there were but three lighthouses in the river: Poolbeg at the end of the Great South Wall; the Perch light on the north side of the channel, nearly opposite the Pigeon House Harbour; and the North Wall light. These were all fixed white lights. The only fog-signals were two small bells at Poolbeg lighthouse. There are now five lighthouses; the old lights have been improved, and fog-signals have been placed at each station.

Poolbeg Lighthouse,* Figs. 3 and 4, Plates 75 and 76, is the oldest lighthouse in the port, having been built in the middle of the last century. In 1880 the old silvered reflectors were replaced by a third-order condensing dioptric apparatus, from which a fixed white light is exhibited. As the light is visible through only a limited arc, advantage is taken to intensify it seaward by condensing prisms and dioptric reflectors. The fog bells have been replaced by a powerful siren sounded by compressed air. The motive power is an Otto gas engine, and the gas is manufactured on the premises. The whole apparatus, including siren, compressor, engine, gas tank, and retorts, is in duplicate. The siren gives two blasts in quick succession every forty seconds in the following order: the first blast is a high note of two seconds' duration, then a silent interval of one second, followed by a low note of two seconds' duration, and a silent interval of thirty-five seconds. As a supply of gas is always ready, the signal can be sounded within two minutes after a fog is noticed. The importance of being able to start fog-signals quickly at the entrance to a port cannot be overrated. The base of Poolbeg lighthouse is protected on the east and south-east by a breakwater of concrete blocks, each weighing 140 tons; these were carried down and laid in place by the large floating sheers.

The North Bull Lighthouse, Figs. 3 and 5, Plates 75 and 76, is a wrought-iron tower on a masonry base founded on the submerged end of the Great North Wall. The lower portion of the masonry consists of two concrete blocks, each weighing 330 tons. These were built on the block wharf in the Alexandra Basin, and carried down and deposited by the floating sheers. The light exhibited is

* The blocks forming Plates 76 and 77 have been kindly lent by Mr. Griffith.

an occulting white light, bright for ten seconds and eclipsed for four seconds. The optical apparatus consists of a fourth-order dioptric fixed-light apparatus of 360° , with four revolving lenticular screens, which are designed so as to produce the occultations, and at the same time to transfer the intercepted rays to the bright arcs, and thereby intensify the light. In fog a bell weighing 17 cwt. is sounded four times in quick succession every thirty seconds, the hammers being worked by machinery.

The Beacon Lighthouse, Fig. 3, Plate 75, is on the north side of the channel, about $1\frac{1}{2}$ miles inside the entrance of the harbour. It is a brick tower on a concrete base. The light is a fourth-order occulting white light, flashing once every four seconds, the occultation being produced by a cylindrical screen raised and lowered by clockwork. The optical apparatus condenses the light of 270° in azimuth into an arc of 15° to seaward, and the remaining 90° into an arc of 35° up channel. Its great brilliancy to seaward adds to its value as a leading light, in conjunction with Poolbeg and the North Bull, for vessels making for the port. A bell is sounded in fog three times in quick succession every twenty seconds.

The Eastern Breakwater Lighthouse, Fig. 2, Plate 75, is a temporary wooden square tower on the new pier head, from which a small fixed white light is exhibited; and a bell is sounded in fog twice in quick succession every fifteen seconds.

The North Wall Lighthouse, Figs. 2 and 6, Plates 75 and 77, is also a temporary wooden structure at the end of the North Quay extension. The light is a fixed white light, and the optical apparatus a condensing light of the fifth order. A bell is sounded in fog once every ten seconds.

The dioptric apparatus at Poolbeg and the North Wall lights were manufactured by Messrs. Chance Brothers of Birmingham, and those of the North Bull and the Beacon light by Messrs. Barbier and Fenestre of Paris. Messrs. Edmundson and Co. of Dublin erected the gas works, engines, and one siren, at Poolbeg; the duplicate siren, which is on Professor Holmes' plan, was supplied by the Pulsometer Engineering Co. All the fog-bells and their machinery were manufactured by Messrs. Gillett and Co. of Croydon.

The lights and fog-signals of Dublin river compare favourably with those of any other port. In addition to the lighthouses, the north side of the river channel is defined by two concrete towers T and three wooden perches P, Fig. 3, Plate 75, and the south side by iron buoys B painted red.

Graving Dock and Slips.—The port is provided with one large graving dock, two slips, and a gridiron. The dock is 408 feet in length on floor, including the mitre sill; 70 feet in width of entrance; and has a depth on its sill of 18 feet 3 inches at high water of spring tides. Its entrance is closed by a pair of wrought-iron cellular gates, fitted with Mallet's heel and meeting posts. The cast-iron rollers, upon which the gates rolled originally, have been given up; and the upper hinges are now anchored back to the masonry.*

Sheds have been provided at various berths allotted to the principal cross-channel steam-packet companies; and tramways have been laid connecting some of these berths with the railways on the North Wall.

Bridges.—In addition to the works directly connected with the harbour, the Port and Docks Board have lowered and widened Essex Bridge,† now called Grattan Bridge; Carlisle Bridge has been replaced by O'Connell Bridge, Fig. 2, Plate 75, which is the full width of Sackville Street; and a new swivel bridge, known as Butt Bridge, has been built near the Custom House. These works have been paid for out of public rates under the authority of special acts of parliament, and not out of port funds.

Summary of Works.—The following is a summary of the principal works executed in Dublin Harbour since 1865 :—

* Transactions of the Institution of Civil Engineers of Ireland, 1877, vol. xii, page 34.

† Transactions of the Institution of Civil Engineers of Ireland, 1880, vol. xiii, page 32.

Description of Work.	Length. Feet.	Berthage Depth at low water. Feet.
<i>Timber Jetties</i>	3,516	5 to 8
<i>New Quay Walls :—</i>		
Replacing old quays on South Quays	4,047	19 to 22
Replacing old quays on North Quays	3,095	8 to 16
On North Quay Extension, Alexandra		
Basin, and Eastern Breakwater .	4,911	22 to 26
<i>Sheds</i>	3,377	
<i>Bridges :—</i> Essex (now Grattan Bridge) lowered and widened, 1873.		
Carlisle (now O'Connell Bridge) reconstructed and widened.		
Butt Swivel Bridge built.		
George's Dock Draw Bridge reconstructed.		
<i>Lighthouses :—</i> North Bull Lighthouse built.		
Beacon Lighthouse built.		
Temporary wooden towers at North Wall and Breakwater erected.		
Lights improved and Fog Signals erected.		
<i>Dredging.</i> —15,000,000 tons.		

Port and Docks Board.—The Port of Dublin is under the control of the Port and Docks Board, the successors of the corporation for preserving and improving the port of Dublin. The Board is constituted under the Dublin Port Act of 1867, and consists of 25 members:—the Lord Mayor and three citizens of Dublin appointed by the municipal corporation; seven members elected by the traders and manufacturers; seven members elected by the shipowners; and seven members nominated by the Commissioners of Irish Lights. The principal powers of the Board are defined by the Dublin Port and Docks Acts of 1869 and 1879.

Income.—The income of the port is chiefly derived from dues on shipping and charges on timber, bricks, and marble. In 1887 the former amounted to £49,755, the latter to £1,500. The rates are as follows:—on oversea vessels, 10½*d.* per registered ton; on coasting

vessels, $6\frac{1}{2}d.$ per registered ton; on timber, bricks, and blocks of marble, $5\frac{1}{2}d.$ per ton. On the security of the income derived from these rates Parliament has sanctioned borrowing powers for the purposes of the docks and port to the extent of £580,000, and for tramways £25,000.

Tonnage and Revenue.—The following table shows the annual registered tonnage entering the port from 1865 to 1887, and the revenue derived from tonnage rates and dues on timber, bricks, and blocks of marble :—

Year.	Registered Tonnage.	Total Income from Rates and Dues.		
		£	s.	d.
1865	1,336,754	41,302	7	0
1866	1,363,564	42,363	17	11
1867	1,434,022	44,629	5	10
1868	1,420,292	44,529	3	7
1869	1,513,624	47,834	7	5
1870	1,506,011	47,063	10	6
1871	1,571,602	49,388	7	8
1872	1,649,228	50,894	1	2
1873	1,632,160	49,780	16	0
1874	1,563,847	47,223	3	3
1875	1,677,543	50,844	13	8
1876	1,879,886	57,994	14	5
1877	1,973,781	60,250	18	10
1878	2,026,185	62,417	9	10
1879	1,953,902	59,315	6	5
1880	1,930,277	58,484	18	5
1881	1,816,917	54,617	12	9
1882	1,845,330	56,233	4	11
1883	1,823,214	56,014	18	3
1884	1,773,505	53,736	2	8
1885	1,755,615	54,261	9	1
1886	1,708,146	52,167	10	2
1887	1,672,084	51,255	2	9

It will be noticed that the income of the port reached its maximum in 1878. Since that year there has been an almost continuous decline in tonnage and revenue. Although the tonnage is reduced, there is little doubt that the carrying capacity of the vessels entering the port has not materially diminished, but that the reduction is chiefly due to the construction placed on the law of measurement in 1879 by the High Court of Justice. The Royal Commission on tonnage in their report dated August 1881 say, "We are satisfied that such a construction of the acts is due only to defects in expression, and that it is inconsistent with the principle and intention of the law, as well as with justice and convenience." As Dublin is so largely dependent for its revenue on tonnage rates, the result of this interpretation has been specially injurious to this port, and the loss of revenue has delayed many necessary improvements. The London and North Western Railway Co.'s screw steamer "Anglesey," recently built, illustrates what shipbuilding ingenuity can now do with the view of reducing the registered tonnage of large vessels. This vessel has a gross tonnage of over 800 tons; she is more than 300 feet long, with a beam of 33 feet, and yet registers only 45 tons.

At the end of 1887 there was due £432,500 on mortgage bonds, and £73,476 on Ballast Board debentures, making a total debt of £505,976. If a comparison be made between Dublin and other large ports, it will be found that its income and debt are strikingly small. Since the formation of the Port and Docks Board a sum of £752,478 has been expended on improvements of the harbour, over and above ordinary maintenance, the difference between this sum and the amount borrowed on mortgage bonds having been defrayed by the surplus revenue of the port.

PORT OF DUBLIN.

Plate 74.

Fig.1. Plan of Dublin Bay and Port.

Plate 74.

PORT OF DUBLIN.

Plate 75.

Plan of Dublin Harbour.

Fig. 2. From O'Connell Bridge to Eastern Breakwater.

Continued in Fig. 3.

- T concrete towers.
- P wooden perches.
- B buoys painted red.

Fig. 3. From Eastern Breakwater to Poolbeg Lighthouse.
Continued from Fig. 2.

(Proceedings Inst. M.E. 1888.)

Scale 2 inches per mile.

Plate 75.

Fig. 4. *Poolbeg Lighthouse.*

Fig. 5. *North Bull Lighthouse.*

(*Proceedings Inst. M. E. 1888.*)

Fig. 6. *North Wall Lighthouse.*

Fig. 7. *View from South Quay, looking east.*

(Proceedings Inst. M. E. 1888.)