

Sunchales, and in the following year it was decided to carry it from Sunchales to Santiago and Tucuman—a further extension of 420 miles—and to construct branches to Morteros, Santa Fé and San Lorenzo Port, some 156 miles in all. This work was undertaken by Mr. Clarke with great energy and perseverance and the many difficulties which presented themselves were overcome by his ability and tact. But the excessive strain began to tell upon his health and he was obliged towards the end of 1890 to relinquish the management of the line, and in the following year to retire from the post of Engineer and return to England. As an acknowledgment of his services and in consideration of his intimate acquaintance with the railway he was elected a director of the company. Shortly afterwards he accepted a seat on the Board of the Buenos Ayres and Pacific Railway and also on that of the Entre Rios Railway.

On returning to England Mr. Clarke lived quietly at Beckenham, but he never really recovered his health. He suffered from a complication of disorders, consequent on several attacks of rheumatic fever, and died on the 26th of March, 1893, at the comparatively early age of fifty-four. In business strict and upright, and a kind though firm master, Mr. Clarke was esteemed and regarded not only by his numerous staff but by all with whom he came into contact. His name will long be remembered as that of a pioneer in railway work in South America.

Mr. Clarke was elected an Associate of the Institution on the 2nd of April, 1867, and was transferred to the class of Member on the 25th of May, 1880.

SIR JOHN COODE, K.C.M.G., was descended from an old Cornish family, of which records extend back to the fifteenth century. He was born at Bodmin on the 11th of November, 1816, his father, Mr. Charles Coode, being at the time in practice in that town as a solicitor and proctor. After being educated at the Bodmin Grammar School, he entered his father's office with the intention of following the same profession. From an early age, however, he had shown a strong liking for mechanical work and through the good offices of a relative, to whom his natural bent was known, he obtained an introduction to the late Mr. James Meadows Rendel,¹ Past-President Inst. C.E., with the result that he

¹ Minutes of Proceedings Inst. C.E., vol. xvi. p. 133.

abandoned law in favour of engineering and served the usual term of pupillage in Mr. Rendel's office at Plymouth. On the expiration of his articles he was employed for a short time by Mr. Rendel and was then actively engaged for nearly seven years in the direction of works on the Great Western and the Bristol and Exeter railways. From 1844 to the spring of 1847 Mr. Coode was in practice on his own account as a Civil Engineer, his office being in London. During part of that time he examined the country between Santander and Madrid with the object of selecting the best route for the Royal North of Spain Railway.

On the adoption in 1847 of Mr. Rendel's recommendations and design for the formation of a Harbour of Refuge at Portland, Mr. Coode was appointed Resident Engineer. His connection with this important national work did not cease until its completion in 1872, as, on the death of Mr. Rendel in 1856, he received from the Admiralty the appointment of Engineer-in-Chief. Portland has the largest sheltered area of deep water of any artificial harbour in the United Kingdom, the sheltered areas within a south-east and north-west line (the line of greatest exposure) being 2,130 acres at low-water, 1,590 acres below the 3-fathom line, and 1,290 acres below the 5-fathom line. The shelter is given by inner and outer breakwater arms, 1,900 feet and 6,200 feet long respectively, with an opening or passage between the two 400 feet in width. The outer arm is formed entirely of stones varying from 6 to 8 tons down to small rubble. The inner arm is similarly formed below low-water, but above that level a masonry structure about 35 feet in height has been constructed over the entire length of the work. Both arms are terminated by forts, and at the shore-end of the outer arm a circular masonry head forms one side of the "passage," or inner entrance. The whole of the stone for the breakwater mounds was deposited, "*à pierres perdues*" from a temporary timber stage in the manner designed by Mr. Rendel and first adopted by him at Milbay. The total cost of the works, including the Convict Department, land, plant, permanent buildings and temporary staging, was about £1,040,000, and the quantity of rough stone deposited in the mounds about 5,750,000 tons. The preliminary works were commenced in August, 1847; the first stone of the breakwater was deposited by the Prince Consort on the 25th of July, 1849, and the last stone was laid by the Prince of Wales in 1872. Shortly after the completion of the work Mr. Coode received the honour of knighthood.

In August, 1858, Mr. Coode was selected to act as a member of the Royal Commission on Harbours of Refuge, appointed to complete the inquiry recommended by the Select Committee of the House of Commons in the same session. With that Commission he inspected more than thirty important harbours of Great Britain and Ireland and obtained information which was afterwards of much value. In the same year the Government of the Cape of Good Hope appointed him Engineer-in-Chief for the harbour proposed to be constructed in Table Bay.¹ The original design, as framed in 1859, comprised a breakwater 3,250 feet in length, with inner and outer basins having areas of $10\frac{1}{2}$ and 4 acres respectively. The breakwater was formed in a similar manner to that at Portland, the stone being obtained from the excavations for the inner basin. The first load was deposited on the 7th of July, 1860, by Prince Alfred (now Duke of Edinburgh), who opened the first instalment of the works on the 11th of July, 1870. For the repair of large vessels a Graving Dock was added in 1882. It is 500 feet long on the floor, with an entrance width of 68 feet and a depth over the sill of 26 feet at high water. It is built entirely of granite from the "Paarl," a district about 36 miles from Cape Town. During the construction of the Graving Dock a strong timber jetty, 500 feet long and 68 feet wide, was run out from the breakwater for the accommodation of large ocean-going steamers requiring coal. A quay-wall, 600 feet long, on the inner side of the breakwater was also constructed about this time. The rapidly developing trade of the port rendering further increase of accommodation desirable, Sir John Coode in February, 1883, submitted a design for a close outer harbour under the lee of the breakwater, which was also to be considerably extended. The works now in progress are part of this later design and will eventually give 62 acres of deep sheltered water, with a great increase of wharfage.

Early in 1858, at the request of a local committee, Mr. Coode examined Filey Bay in Yorkshire with reference to its eligibility for the formation of a harbour of refuge. He reported very strongly in favour of the site, both geographically and naturally, expressing his conviction that the selection of Filey Bay would prove to be the solution of the difficulty which had long surrounded the question of a site for an efficient harbour of refuge upon the north-eastern coast of England. In 1875 in a

¹ Library Inst. C.E., Tracts folio, vol. 7, and State Papers, Cape of Good Hope, 1877.

Paper¹ read before the Royal United Service Institution he drew attention to the exceptional advantages of Fley as a military or strategic harbour as well as a harbour of refuge. He never lost an opportunity of stating that opinion and gave evidence thereon before the Select Committee on Harbours of Refuge in 1858, the Departmental Committee on the Employment of Convicts, 1882, and the Select Committee on Harbour Accommodation, 1883.

In 1864 Mr. Coode was consulted by the Waterford Harbour Commissioners with reference to improvements in the channel of the River Suir below the City, and under his superintendence the length of river then known as the Ford Channel was deepened from 5 to 13 feet at low water. The work entailed the removal under water of a considerable quantity of rock, the total cost being about £20,000. The new cut, which rendered unnecessary the navigation of a winding channel 2 miles long, is now known as the Queen's Channel. In the same year Mr. Coode was consulted by the authorities of the Isle of Man, and between that date and 1886 designed and carried out the breakwater at Port Erin, the Victoria and Battery piers at Douglas, improvements to the Harbours of Port St. Mary and Peel, and the large iron promenade and landing pier at Ramsey. In 1865 the improvement of the harbour at Bridlington Quay in Yorkshire was entrusted to him, and under his direction an extension of the north pier was constructed.

The States of Jersey in 1867 invited designs for a harbour to be constructed at St. Helier, the chief town of the island. Although the competition was an open one, a few leading authorities on harbours were specially retained to compete, Mr. Coode being among the number. His design obtained the first premium and he was appointed engineer. The works were commenced in 1872 and considerable progress was made, but early in 1877 the opponents of the scheme took advantage of damage, caused by very exceptional gales, to the harbour-wall of the landing pier, to again urge the abandonment of the works, which, partly on this account and partly for want of funds, were ultimately stopped. It is right to say that, except for the express wish of the States Harbour Committee, the landing pier, which alone received any damage, would not have been commenced until the breakwater, designed to protect it, had been constructed far enough seaward to afford sufficient shelter. The lighthouse on La Corbière rock,²

¹ Journal Royal United Service Institution, vol. xix. p. 334.

² Minutes of Proceedings Inst. C.E., vol. lix. p. 217.

at the south-western point of the Island of Jersey, was designed by Sir John Coode and erected under his superintendence in the years 1873-74. It is constructed entirely of concrete on the summit of a rock standing about 100 feet above the mean level of the sea.

Between 1868 and 1870 Mr. Coode was requested by the Government of Cape Colony to advise on improvements for Port Elizabeth in Algoa Bay, the Buffalo River at East London and the Kowie River at Port Alfred. To obtain reliable technical data in connection with the various harbours, Mr. Charles Neate visited the Colony on behalf of Mr. Coode. On his return a series of Reports¹ was prepared, and the designs being adopted the works were commenced. In 1876, at the request of the Cape Government, Sir John Coode visited Cape Colony, inspected the various ports at which works were being carried out under his direction, and also reported on harbour matters at Mossel Bay, the Knysna, and Plettenberg Bay.² Considerable extensions at the several ports followed this personal inspection, with the result that increased accommodation and facility of navigation were afforded in every case. By the desire of the Government of Natal a similar course was followed with regard to the entrance to Durban Harbour as in the case of the harbours of Cape Colony. Mr. Neate visited Natal in 1869, and Sir John made a personal inspection of the harbour in 1877, after which he designed works for the improvement of the bar and for the accommodation of shipping at Port Natal.³

After Portland, the work with which Sir John Coode's name is generally connected is the Harbour of Colombo, Ceylon.⁴ In 1873, at the request of the Crown Agents for the Colonies, to whom for several years he had acted as Consulting Engineer for harbours, Sir John Coode prepared a scheme for a breakwater and other works, designed to give shelter and landing facilities for ocean-going steamers throughout the year. The works were commenced in 1874, but in consequence of the rapid increase in the trade of the Port the original plan was considerably enlarged by the extension of the breakwater, to afford shelter from the heavy seas occurring during the South West Monsoon. The works constructed up to 1885 entailed an expenditure of about £700,000,

¹ Library Inst. C.E., State Papers, Cape of Good Hope, 1870.

² *Ibid.*, State Papers, Cape of Good Hope, 1877.

³ *Ibid.*, Tracts folio, vol. 27.

⁴ Minutes of Proceedings Inst. C.E., vol. lxxxvii. p. 76.

and the increase in trade and revenue consequent thereon has largely exceeded expectation.

In 1878 Sir John Coode, acting for the Melbourne Harbour Trust Commissioners, made a personal inspection of Port Phillip and the River Yarra and designed extensive improvements for the Port of Melbourne. The works recommended consisted mainly of the rectification, widening and deepening of the river, in order that the largest class of vessels might eventually be enabled to reach the City, where docks and wharves were to be provided. The provision of relief in time of flood was closely connected with the harbour question and on this point great difference of opinion existed in the Colony, several prominent local authorities being in favour of a new direct canal from the river at Melbourne to Hobson's Bay. The chief arguments in favour of this scheme were that it would give greater relief in times of flood and shorten the distance from the City to the Bay. Sir John Coode, however, insisted strongly on the improvement of the existing channel and river mouth, as the only way of retaining the advantage derived from the upland and tidal waters of the Yarra and of an effluent which enters it at a point some miles below the City. His arguments were sufficient to convince the Commissioners and shortly after his Report¹ was handed in they adopted his recommendations, the most important of which have since been carried out. As a compliment to Sir John, the island, formed by a new cut recommended by him to eliminate an exceptionally tortuous bend in the old river channel, was officially named "Coode" Island.

At the request of the Government of Victoria he reported on harbours at Portland and Warrnambool, river improvements at Belfast, the opening of a new sea entrance to the Gippsland Lakes, the entrance channel to Geelong Harbour and other minor projects. In nearly every case his recommendations have been carried out with successful results. He next proceeded, at the request of Sir George Grey, then Premier, to New Zealand, where he made an examination of nearly every important harbour and of many minor ones. Among the best known ports at which his designs were accepted and carried out may be mentioned Westport, Grey-mouth, and Dunedin.

In 1880 Sir John visited Lisbon and Oporto, at the request of the Portuguese Government. For Lisbon he designed a series of important floating basins and docks on the right bank of the Tagus. At Oporto, as he considered it impracticable to deal with the bar of

¹ Library Inst. C.E.

the Douro, he recommended the construction of an artificial harbour at Leixoes, about 3 miles north of the Douro mouth. In the same year he designed and subsequently carried out two moles at the mouth of the River Bann on the north coast of Ireland. By these works the depth over the bar at the river entrance was increased from about 1 foot to $9\frac{1}{2}$ feet at low water, thus enabling regular steam trade to be carried on with the town of Coleraine, which lies about 5 miles above the entrance.

In addition to the Royal Commission on Harbours of Refuge in 1858, above referred to, Sir John Coode was appointed a Member of the Royal Commission on Metropolitan Sewage Discharge, 1882-1884, of the International Commission of the Suez Canal in 1884 (which office he held to the time of his death) and of the Royal Commission for the Colonial and Indian Exhibition, 1886. On the passing of the Manchester Ship Canal Act, 1885, he was appointed Consulting Engineer to the Mersey Conservancy. In the same year he was requested by the Admiralty to act as Engineer-in-Chief of the Harbour of Refuge at Peterhead, Scotland. The works were designed by him and carried on under his direction until his death. They are being executed to a very large extent by convict labour and will entail an expenditure of £750,000.

A second journey to Australia and the East was made by Sir John Coode in 1885. It originated in a proposal of the Government of Western Australia that he should inspect the roadstead at Fremantle and advise as to the construction of a harbour for the largest class of mail steamers. Before leaving England he was asked by the Admiralty to visit Trincomalie and Singapore and to select the best site at each place for the provision of a graving dock for the largest class of ships of the Royal Navy. A similar request from the Government of India with regard to Bombay resulted in his inspecting these three ports on his way to Fremantle. He also reported on one or two minor harbour questions in Western Australia, and was subsequently engaged by each of the other Australian colonies in succession. For the South Australian Government he devised a scheme for an outer harbour near the mouth of the Port Adelaide River. For the Victorian Government and the Melbourne Harbour Trust he inspected the progress made with the several works on which he had advised at the time of his former visit. For the New South Wales Government he inspected the Richmond, Clarence, Bellinger, Nambucca, Macleay and Shoalhaven Rivers; the harbours of Port Macquarie, Wollongong and Kiama; the entrance to Lake Mac-

quarie, and the wharfage in Darling Harbour, Sydney. For most of these ports he subsequently submitted designs. Finally, for the Queensland Government he inspected and afterwards designed works for improvements at Rockhampton, Mackay, Townsville, and the bar of the Norman River. His power of grasping local conditions was very marked, but he would never commit himself to definite opinion on any scheme until he had before him technical data which could be guaranteed as absolutely correct. For this reason his reports were, as a rule, not made until the surveys and data for which he framed detailed instructions were sent home for consideration. Shortly after his return he was created a Knight Commander of the Order of St. Michael and St. George.

Sir John Coode was also consulted by other British colonies. At Castries, St. Lucia, wharf and dredging work on a considerable scale were executed from his designs and under his direction. He designed a coaling station for Trinidad and improvements for the harbour of St. John's, Antigua. He also reported to the Crown Agents for the Colonies on various harbour schemes at Accra, Lagos and Sierra Leone, on the West Coast of Africa; Kyrenia in Cyprus; Penang; Heligoland; Portugal Cove in Newfoundland; St. John's River in Pondoland; and flood outlets in Ceylon.

Acting for the Dover Harbour Board, Sir John Coode designed a close outer harbour for which shelter was to be obtained by the construction of a breakwater pier on the north-east of the existing Admiralty pier, an extension of which was included. The scheme also contemplated the ultimate formation in the new harbour of two commodious railway-jetties for passenger-traffic. The Act for these works was obtained in 1891, the contemplated expenditure being about £600,000. The necessary details were well advanced at the time of his death, but he did not live to see the work commenced.

For many years he was continually consulted by the Duke of Bedford on various questions in connection with the River Nene and other works in the neighbourhood. For the Hodbarrow Mining Company he designed and superintended the erection of a massive sea-wall about 3,000 feet long, by which it was estimated that from 6,000,000 to 7,000,000 tons of iron ore were made available. The limits of this notice prohibit further detailed reference to the undertakings with which he was connected, but the following may be recorded as some indication of the scope of his work:—(for the Admiralty) Alderney Harbour, Chatham Dockyard Approaches, Wexford Harbour and Wick

Harbour: (for the Board of Trade) Filey Fishery Harbour, Holderness Embankment and Poolbey and Lighthouse: (for the War Office) Castle Harbour, Bermuda, and Spithead Forts: (for the Public Works Loan Commissioners) Carlingford Lough, Dartmouth Harbour, Peterhead Harbour and Sunderland Dock Extension: and various works for harbour boards and local authorities throughout the United Kingdom and Ireland.

Mr. Coode was elected a Member of the Institution on the 6th of March, 1849. In 1872 he became a Member of Council, and filled the Presidential Chair from May, 1889 to May, 1891. His inaugural address,¹ delivered on the 12th of November, 1889, contained much valuable information as to the British Colonies as fields for the employment of the Civil Engineer. So far back as 1853 he had contributed a Paper entitled "A Description of the Chesil Bank,"² for which he was awarded a Telford Premium. His interest in the welfare of the Institution was very great and from the end of 1865, when he took up his residence in London, he was a frequent attendant at the meetings and often took part in discussions relating to harbour and river works. The visit of American Engineers to Europe in the summer of 1889 occurred during the Presidency of Sir John Coode, who took the greatest interest in all the arrangements made for their reception and entertainment. An indication of the appreciation with which his efforts on that occasion were received is afforded by the following memorial, addressed to Lady Coode by the American Society of Civil Engineers:—

MEMORIAL.

"It is with profound regret that the Members of the American Society of Civil Engineers have learned of the death of Sir John Coode, K.C.M.G., Past-President of the Institution of Civil Engineers of Great Britain.

"The American Engineers who composed the party that visited Europe in 1889 have given their fellow-members such glowing accounts of the reception accorded them in Great Britain by Sir John Coode, then President of the Institution of Civil Engineers; of the thoughtful, earnest and charming hospitality with which they were entertained by him, and of the cordial way in which he made them welcome, that all American Engineers have had common cause to honor and to esteem him.

"Now that his life is ended, his work done, this memorial is sent as an expression of the regret entertained by all American Engineers for the man who, perhaps more than any other, caused the members of the British and of the American Engineering Societies to unite in closer kinship, and thus hastened

¹ Minutes of Proceedings Inst. C.E., vol. xcix. p. 1.

² *Ibid*, vol. xii. p. 250.

the time when there shall alone reign but 'Peace and good-will among the nations.'

"The American Society of Civil Engineers,

"By its Board of Direction,

"*New York, May 31, 1892.*

"MENDES COHEN, *President.*

"F. COLLINGWOOD, *Secretary.*"

Sir John Coode was a Member of the Royal Institution and of several other scientific societies; he was an Honorary Associate of the Royal Institution of British Architects and an Honorary Member of the American Society of Mechanical Engineers. He held the freedom of the Goldsmiths' Company and was a representative of its Court on the Committee of the City and Guilds Institute. For several years he held a commission as Lieutenant-Colonel in the Engineer and Railway Volunteer Staff Corps. He became a Fellow of the Royal Colonial Institute in 1876 and was elected a Member of the Council in 1881. He was Chairman of the Special Committee of that body for obtaining a Royal Charter of Incorporation and for securing the site of the present house of the Institute in Northumberland Avenue. He took an active interest in many philanthropic movements and was from 1882 Chairman of the Committee of the Colonial and Continental Church Society.

While in Italy during the autumn of 1891 Sir John Coode was obliged to undergo a severe operation, his condition for some days being very critical. After some weeks, during which he made steady progress towards recovery, he was able to return to England early in November, and it was believed that a few months of complete rest would enable him to resume work. Other unfavourable symptoms, however, developed, and he died at Brighton on the 2nd of March, 1892.

EDWARD CHARLES CRACKNELL was born at Rochester on the 22nd of May, 1831. At an early age he went to London, where he served an apprenticeship of some years to a chemical and philosophical instrument maker and then spent a few months in the works of a telegraph engineer. In 1855 he proceeded to Adelaide to take up the duties of Assistant Superintendent of Telegraphs for the South Australian Government and in 1857 he was appointed to a similar post in New South Wales. Early in the following year he opened a telegraph line between Sydney and the town of Liverpool, a distance of 22 miles. This was the third