# STRUCTURES IN CONCRETE: CONSTRUCTION OF LA CORBIÈRE LIGHTHOUSE AND THE ST. HELIER'S HARBOUR, BUILT IN CONCRETE AT JERSEY

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Structures in Concrete: Construction of La Corbière Lighthouse and the St. Helier's Harbour, built in concrete at Jersey by Imrie Bell



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IMRIE BELL

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Trieste

STRUCTURES IN CONCRETE.

# CONSTRUCTION

OF

# LA CORBIÈRE LIGHTHOUSE

AND

# THE ST. HELIER'S HARBOUR,

BUILT IN CONCRETE AT JERSEY.

BY

IMRIE BELL, M. Inst. C.E.



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# THE INSTITUTION OF CIVIL ENGINEERS.

## SECT. II.—OTHER SELECTED PAPERS.

### No. 1,564.—"La Corbière Lighthouse, Jersey." By IMRIE BELL, M. Inst. C.E.

THE employment of concrete as a building material, though extensively adopted by the Romans, had for many centuries afterwards fallen out of use and become obsolete. On the resuscitation in modern times of this art of building, its use was almost entirely confined to the formation of a monolithic mass underground, to serve as a foundation for the stone or brickwork of the superstructure. French engineers appear to have been foremost in appreciating the value of béton, or concrete, for sea works. During the earlier period of its employment for such works, the natural hydraulic limes were used as the cementing material, with the addition of puzzolana. Afterwards, from the valuable and exhaustive researches of Vicat, and the progressive improvements made in the manufacture of Portland cements, a vast impetus was given to the introduction of this art in the construction of buildings of all descriptions. Concrete can be made, under almost any circumstances, at a moderate cost; it is easily formed into any shape of block that may be desired; it can frequently be deposited in moulds in the exact position it is permanently intended to occupy; and, when carefully made, with a proper admixture of materials, which is a matter of vital importance, experience has proved that it possesses ample strength and durability under the most trying circumstances. There may be cases in which it might not be advisable to use concrete as a building material; and an engineer requires to give careful consideration to locality, the various kinds of materials available, cost of labour, carriage, and many other matters, before coming to a decision as to the material most suitable for the construction he has in view. The Author has been much struck by the want of attention paid to the art of producing a fair and finished surface in the exposed faces of concrete, as exemplified in many of the large engineering works in course of construction, where the exposed face has a honeycombed appearance, as well as the marks of the rough timber planks forming the frames in which the concrete has been placed. The Author has given this matter much consideration, and the result of his experience is that, in concrete building, it is easy with a little attention not only to produce a fair surface, but to form mouldings, and even tracery and ornament, and at the same time to make the facework as durable as any other part of the block.

There appear to be two reasons why but little attention has hitherto been paid to this art; first, carelessness or indifference to appearance; secondly, that most of those who have attempted it have done so by rendering with plaster or by grouting with liquid mortar, both objectionable and dangerous modes of effecting the object. These are at the best only a veneering liable to sudden decay, and the failure (generally occurring after wet and frosty weather) has naturally stopped a repetition of the attempt.

The plan which the Author has followed in harbour walls, both above and below low water, exposed to frost, heat, storm and rain, with complete success and at an inappreciable increase of cost, is to have a smooth planed board for the face of the mould, painted over previous to commencing the work with a mucilage of soap to prevent the mortar adhering. In filling the frame, care must be taken that a finer mixture of concrete or coarse cement mortar be laid in with a trowel close to the face board, as the work proceeds, so that the mixture is carried up uniformly with that contained in the body of the work, the whole forming one homogeneous mass, and ensuring the setting process of the whole mass being carried out simultaneously, so that the face is, in fact, like the skin of an iron casting, and actually the strongest portion of the mass. It is intended, in this Paper, to give a description of the construction of the Corbière lighthouse, which the Author believes to be the first of the kind in the British Islands made of Portland cement concrete. It was erected by him as executive engineer for the States of Jersey, from the design of Sir John Coode, M. Inst. C.E.

La Corbière rock, upon which the lighthouse is erected, lies off the south-western point of the island of Jersey (Fig. 1), in latitude 49° 10′ 40″ north, longitude 2° 14′ 50″ west. It is distant from the mainland about 1,600 feet, is isolated at high water of all tides, but is accessible over a ledge of rocks, shortly after half ebb tide up to nearly half flood of each tide, when the sea is smooth —not a matter of frequent occurrence in this exposed part of the island. This has rendered necessary, as one of the works connected with this undertaking, the construction of a causeway, to ensure the safety of the lightkeepers on their passage to and from the lighthouse. The range of tide on this coast is 32 feet at ordinary springs, and 23 feet at ordinary neaps.

### Road of access, and Keepers' Houses.

The site chosen for the lighthouse being inaccessible, by land, rendered it necessary to commence operations by the formation of a road of access, extending over ½ mile in length; and along with this were constructed dwelling houses on the mainland for the lightkeepers, with the necessary storehouses and outbuildings; but there is nothing in this section of the works worthy of special notice.

### Tidal Causeway.

The formation of the tidal causeway, over a ledge of rocks exposed to the full force of the swell of the ocean, although a subsidiary work, required much consideration. This causeway had to be built over a very irregular ledge of rocks, full of deep pools and fissures. Owing to its submergence at each tide, the time during which operations could be carried on was limited, and they could only be proceeded with from the shore end, which retarded the rate of progress that might otherwise have been made. It exceeds ¼ mile in length, is 6 feet in width at the top, and is formed of two side walls built of granite blocks, with a batter on the sides of 1 to 2, the height varying from 1 foot to 8 feet; the blocks are hammer dressed on the face, and laid on level beds in cement mortar. The space between the walls is filled with Portland cement concrete, in the proportion of 8 parts of shingle and coarse sand to 1 part of cement; the upper 8 inches being made stronger and finer, in the increased proportion of 4 parts of shingle to 1 part of cement.

The action of the sea during gales prevents any great accumulation of sea weed upon the surface of the causeway; and a sprinkling of hot lime in calm weather, afterwards brushed off with birch brooms, is found sufficient to prevent any growth.

### Arrangements for the Transport and Landing of Building Material.

The most important consideration connected with the arrangements for the construction of the tower was to devise a scheme for transporting the materials to the rock and landing them upon it, as this point, it was seen, would materially influence the cost of the works. The question being whether to take the material overland to some convenient point on the shore, or to transport it by sea; in either case there was no possibility of landing it upon the rock itself because the sea at this point of the coast is seldom still. When the tide commences to flow there is always a heavy swell, which upon so rough and rocky a coast renders it an impossibility to moor a barge with material close to the rock for the purpose of loading or discharging. This, therefore, entailed the necessity of landing the material at the nearest point on the mainland where a sheltered spot could be obtained; in fact, except in calm weather, it is unsafe to approach the rock even by a rowing boat, after the causeway is covered. In stormy weather the waves are carried to a great height; for instance, on the completion of the lighthouse, during a storm in December 1876, a body of water was carried up the gully, and broke up the concrete platform placed 15 feet above high water spring tides, at the site of the temporary workshops and stores, and conveyed portions of it, weighing from 3 to 4 tons, over the side of the rock. The lightkeepers stated that sheets of spray during the same storm were thrown over the top of the lighthouse, or to a height of 136 feet above high water mark.

After giving the whole matter full consideration, the Author decided upon conveying all the material by sea from St. Helier. One circumstance which materially influenced him in this decision was, that he had already constructed a depôt and barge harbour at St. Helier, for the supply of concrete for the harbour and breakwater then being constructed, at which large quantities of gravel, sand, and cement, were landed and stored, besides having at command the barges and tug boats employed upon that undertaking. Thus a constant and regular supply of material could always be depended upon; all that was required to complete the arrangement being an accessible and sheltered place near the site of the lighthouse, to which the material could be with safety transferred. Fortunately a bight to leeward, in the lower part of the rock upon which the tower was to be erected, gave access to a bay of deep water, accessible at all states of the tide, and in close proximity to the spot which had been fixed upon for placing the workshops, stores, and concrete-mixing platform. At a distance of about 80 yards outside this spot there was a patch of rocks, uncovered at high water of neap tides, leaving a channel between, with from 10 to 14 feet depth of water at low water of spring tides, which formed a natural harbour, convenient for the handling of barges and a steam tug, so long as they did not approach too close to the rocks on either side. The assistance afforded under this arrangement by the depôts and plant of the St. Helier harbour, in keeping up a constant supply of materials, by an easy mode of carriage to the lighthouse works, made a most important saving in the cost of construction, as otherwise the whole of the material, except the stone and a small portion of the sand, must have been carted a distance of rather more than 8 miles, the last ½ mile over uneven boggy ground, there being no road. This would also have entailed the necessity of unloading carts on the mainland, and reloading into trollies for transport across to the rock, which, as already explained, could only be effected at certain states of the tide, and in calm weather, and would have rendered it necessary to delay the work of construction until the causeway across the ledge was completed, thereby causing a great sacrifice of time; whereas by barge and steam tug from St. Helier, a similar distance, the material could be landed direct at the works on the rock itself. Under this arrangement the construction of both lighthouse and causeway was carried on simultaneously. The landing of the material from the barges on their arrival from St. Helier, when moored in the deep-water channel, was carried out by an overhead rope railway from the main rock (at the foot of which were the stores and workshops) to the patch of rock on the opposite side of the channel, care being taken that sufficient headway was allowed for working the barges underneath (Figs. 2, 3, 4). The rope suspended between the two rocks formed the rail or ropeway. The carriage consisted of a single wheel with a grooved tire, which travelled on the rope, supporting a block and tackle by two side cheeks for adjusting the height, with a hook for carrying the bag or basket of material. This wheel with tackle was pulled along the ropeway by a small endless wire rope wound round a drum, worked with a small windlass by two men. An improvement was effected, by having a double rope from the landing platform out to a little beyond the position where the barge was intended to be moored, where the ropes were fastened to a cross bar, and from thence continued to the patch of rock by a single rope, which, in order to give additional height, was passed down to the rock over a pair of sheer legs. A double line of rail or ropeway was thus formed, from the position which the barge would occupy when moored, to the landing place on the main rock. The main rope, secured to an eye-bolt lewised into the rock, was stretched from the apex of the sheer legs over the position of the barge; at this point it was secured to the centre of the cross bar, from the ends of which two ropes were fastened, and carried parallel to each other to the main rock, and firmly secured to it, after passing over the guide pulleys. At the ends of the ropes blocks and tackles were placed, to tighten or slacken them as might be required; and upon these ropeways the travelling wheels, or gins, with suspended tackle and hooks for carrying the baskets or bags of material, were run to and fro by means of the light endless wire rope, worked by the windlass. The wire rope (Figs. 5, 6, 7, 8, 9, 10), after two turns round the drum, passed up over a guide pulley, and was fastened to one of the gins or travelling wheels; it was then conveyed under one of the ropeways, and round a guide pulley fixed to cross bars. Returning under the other ropeway, it was fixed to the other travelling wheel, and carried on to the shore or main rock, over a guide pulley, and round the drum; so that while the loading at the barge end was being proceeded with, the unloading at the shore end was going on at the same time. The wheels, drums, &c., had been previously employed for other purposes; by being brought into use for this work, the expense of providing new apparatus was saved. As fast as the material was landed it was removed by wheelbarrows, along roads consisting of upright poles fixed to the rock at distances suited to the length of planks—which were firmly spiked down to cross sleepers and secured to the tops of the poles—extending from the landing stage up to the cement shed and concrete-mixing platform at the depôt.

At the depôt there was, besides smiths' and carpenters' shops, stores, and office, a barrack for the men, fitted up with sleeping bunks all round the sides, with hammocks swung in the centre.

## LIGHTHOUSE.

The platform upon which the lighthouse is erected is 9 feet high, and is formed of three courses, from which the tower, with moulded base and cap, rises. This tower is surmounted by a balcony having an iron railing, above which is the lantern provided with a dioptric illuminating apparatus of the second order, showing a fixed light extending over an arc of 250°. The dark angle, of 110°, towards the shore, is occupied by a dioptric mirror.

From seaward, between the bearings of south by east through east, to north by west, the light is white. Inshore of the eastern limits of the white light two sectors of red light are exhibited—one to the north-eastward, for marking the shoal ground of the Rigdon bank, and thence landwards; the other to the south-eastward, marking Le Vrachères and the adjacent dangers landwards, through angles of 32° and 38° respectively. The red arcs are produced by shades of flashed ruby attached to the glass of the lantern, which is 7 feet in height. The light is 135 feet above the mean level of the sea, or 119 feet above high-water of ordinary spring tides, and is visible for a distance of more than 18 miles.