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## "Repairs at Alderney Breakwater."

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ALDERNEY breakwater—one of the most exposed works of the kind in the world—consists of a huge mound of large and small rubble surmounted by a superstructure of coursed and rubble masonry set, above low water, partly in blue lias and partly in Portland-cement mortar. The superstructure provides a quay on the harbour side, and a promenade or high level on the sea side, with a line of rails on both levels, Fig. 1, Plate 8; and it is described in Mr. Vernon-Harcourt's Paper on the "Construction and Maintenance of the Harbour at Braye Bay, Alderney."<sup>1</sup> A railway runs to the Mannez quarries, about  $1\frac{3}{4}$  mile from the land end of the breakwater, whence the stone is procured for repairs and foreshoring. The five lowest courses of the superstructure consist of granite backed by concrete blocks, which become dangerously exposed by the lowering of the "foreshore" in front of them during storms, stones, from the fourth and fifth courses especially, being forced out. At times considerable cavities are thus made in the sea wall, the repair of which is one of the most important items in the maintenance of the breakwater.

*Concrete Blocks.*—In executing repairs in 1889, large concrete blocks were substituted with advantage for granite, each being high enough to replace two of the old granite courses, and having a battered face corresponding to the general batter of the sea wall, Fig. 1, Plate 8. They weighed 12 tons, and were of the section shown in Fig. 2, made of 8 parts of sand and rubble to 1 of Portland-cement mortar, and faced with hand spalls. Previously to the Author taking charge of the works, the concrete blocks were made flush at the bottom, and could not be set when their lower bed-joints were below low water. They are now cast with a square indent, about 2 inches in depth, in the lower bed-joint, Fig. 2, which, when filled with Portland-cement mortar, passed from above low water through the vertical

<sup>1</sup> Minutes of Proceedings Inst. C.E., vol. xxxvii. pp. 61-73, and Plates 2-5.

hole left by the portable lifting lewis-bar, becomes set to the old course below. V-shaped vertical indents are also provided on each side, Fig. 2, into which Portland-cement mortar can be passed from above the water-line, thus "joggling" the blocks. A square channel is left also along the top of each block, Figs. 2 and 5, into which old rails are placed, extending from block to block, before the space between the top of the blocks and the old work overhead is finally filled with rubble masonry and flushed up.

*Repairs in 1889.*—A cavity caused by the gales in 1888–89, extracting the third and fourth granite courses, was repaired in the following manner:—The plant consisted of a 12-ton steam crane, a 5-ton steam crane with a long jib, a six-coupled locomotive with trolleys, and a "skid" or guide for the blocks, composed of two whole timbers faced with rails and firmly braced together. The cavity in the wall was 35 feet long, 6 feet high, and 6 feet deep, which was filled in by six concrete blocks of the usual section, the two end blocks being cast with right- and left-handed shoulders respectively, in order to break joint with the old remaining granite courses. The divers having cleared the aperture of all debris, and having adjusted the back courses, which was a laborious and risky operation, the cranes were run into position on the high-level wall. The 12-ton steam crane was placed directly over the cavity, its platform area being considerably increased by iron rectangular portable bars run out sideways and resting on wooden blocks; and the crane was also attached to the back of the sea wall by chains and lewis-bars. Before lowering a block, the "skid," Fig. 1, was suspended from the coping to guide the block, and prevent it catching in the steppings of the masonry in its descent.

*Balance Weight.*—In order to get the concrete blocks back into position in the sea wall, a balance-weight was designed, Figs. 2, 3, and 4, Plate 8, consisting of a beam, about 10 feet long, formed of old rails and square iron bars, having a small iron platform at one end of which a  $\frac{1}{2}$ -ton weight was secured, and at the other end a flat bar, about 3 feet long, working on a centre in a pair of short jaws, to which was attached a short chain with a stout iron hook. A wooden cross beam also butted against the foot of the concrete block, and was held in position by two flat iron struts attached to the main beam, Fig. 2. This balance-weight enables the crane chain to be shifted from the vertical holding centre line of the concrete blocks, to a point which permits the block to be lifted, balanced, and swung back into position, Fig. 2. The iron hook was placed in the square indent, at the toe of the battered face,

cast in the concrete block; and the swinging bar to which it was attached was secured by a chain and link to the top of an iron rail placed vertically in the hole left by the lifting lewis-bar. The wooden cross beam was butted against the face of the block; and then the whole was lifted by the 12-ton crane being attached to the large link at the top of the swinging bar, and swung into position in a few minutes. The 5-ton crane with the long jib assisted by controlling the chains whereby the actual balance weight at the end was raised or lowered, Figs. 1 and 2. These adjustments were mainly effected from under water by divers, who also assisted in the manipulation by working the guys attached to the balanced end of the apparatus.

When the concrete blocks were in position, iron rails were placed in the square channels on the top, to connect them, Fig. 5. Portland-cement mortar was passed down the V-shaped indents; and the space above the blocks was quickly filled with rough rubble masonry and smoothed. In order to further strengthen the work, iron bolts, about 2 feet long, were passed through the holes cast in the battered face of the blocks, into the granite courses below, the holes in the granite having been formed by iron drills passing through the holes in the faces of the concrete blocks, and worked from a platform suspended from one of the cranes and capable of floating in case of need, Fig. 5; and the interstices in the holes in the concrete blocks were filled up with Portland-cement mortar.

*Foreshoring.*—The foreshore at Alderney breakwater is continually varying; a gale from the south west heaps the stones high up the face of the sea wall, but they disappear after a succeeding gale from the north east. The stone for making up the foreshore is either run on to the superstructure, and thrown into the sea from side-tip wagons; or large stones are conveyed on trolleys to the high level, and tipped by means of the long-jibbed crane standing on the low-level line of rails. The empty trolley is then lifted, and lowered by the crane to the low-level rails, while the locomotive pushes the next loaded truck into position for tipping. To prevent the larger stones from striking the protruding masonry courses towards the bottom of the wall, a portable slanting timber platform, Figs. 6, faced with iron rails and supported on the wall by timber uprights, is lowered over the face of the wall in front of the trolleys to be emptied, and secured to the coping.

A train of twelve trucks, carrying about 60 tons of large stones, was usually emptied in 20 minutes. The platform of the

trolleys has an opening of about 1 foot in the middle, to allow the lifting chain to be easily cleared after the stone has been placed on the truck. To make the foreshore up to a satisfactory level, much larger stones should be used. Though, however, very large stones, reaching 300 tons, were occasionally quarried at Mannez, it was necessary to break them up before trucking them down to the breakwater, as the plant at Alderney will not deal with stones exceeding 12 tons in weight. Stones, indeed, cannot be too heavy for foreshoring; and small stones are useless, except in still water, as in the case of the lower portion of the mound of a breakwater, as they are shifted by every wave. At Alderney all quarry debris was thrown over the sea wall, and the smaller stones were continually in motion. These travelling stones at times, and in certain places, are heaped up the face of the wall.

Rectangular concrete blocks, at least 20 tons in weight, might be made during the winter with the abundant stock of spalls at Grosnez, close to the breakwater, on specially-constructed bogie trolleys, to dispense with powerful and expensive lifting gear, and might be placed on the foreshore in summer. These blocks should be thrown indiscriminately into the sea to form two irregular rows of blocks. Rectangular concrete blocks of about 30 tons in weight have frequently been seen by the Author at Cherbourg round the west end of the breakwater, and round the sea forts; and these blocks were never apparently moved during the two winters he had occasion to observe them. They have been thrown at random into the sea, and there they remain, forming a capital foreshore for the sea to break itself upon.

The Author was in charge, during 1889 and 1890, of the works described.

The Paper is accompanied by two tracings and six photographs, from which Plate 8 has been prepared.

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Fig: 3.

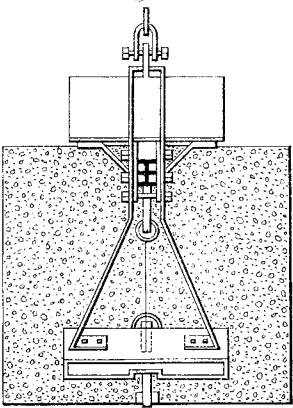


Fig: 2.

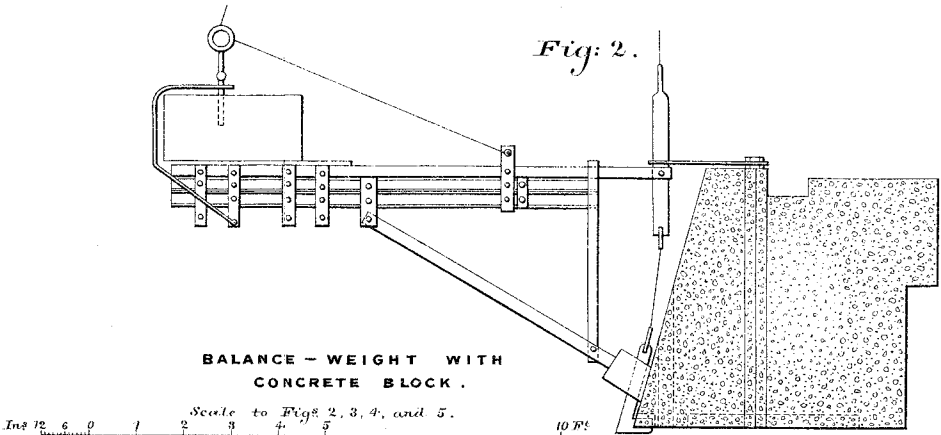


Fig: 4.

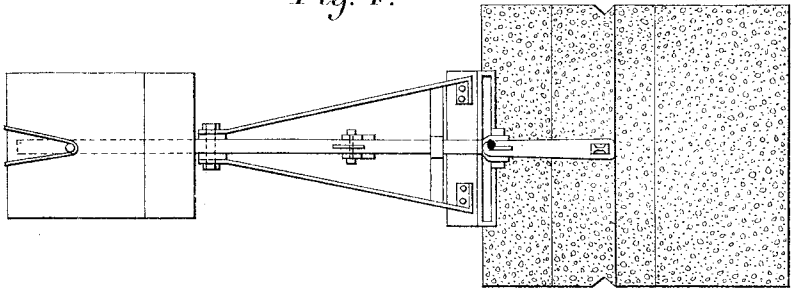


Fig: 5.

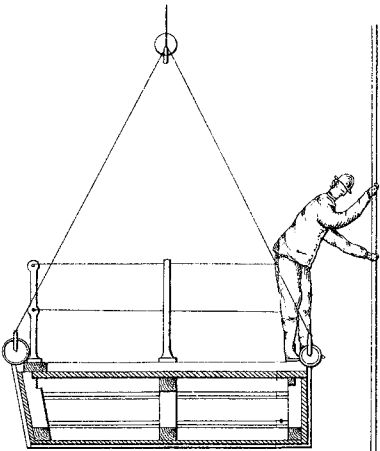


Fig: 1.

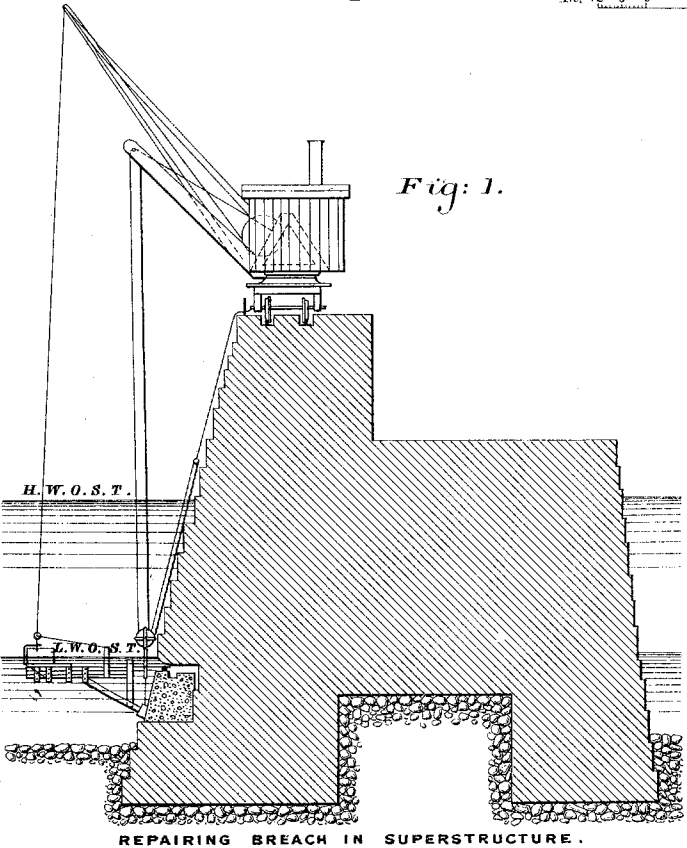
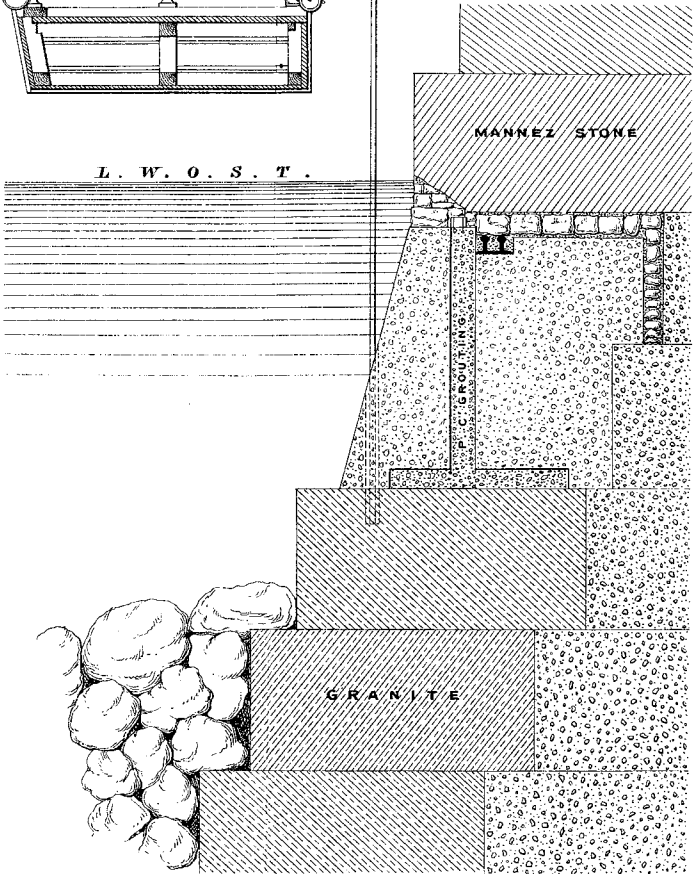
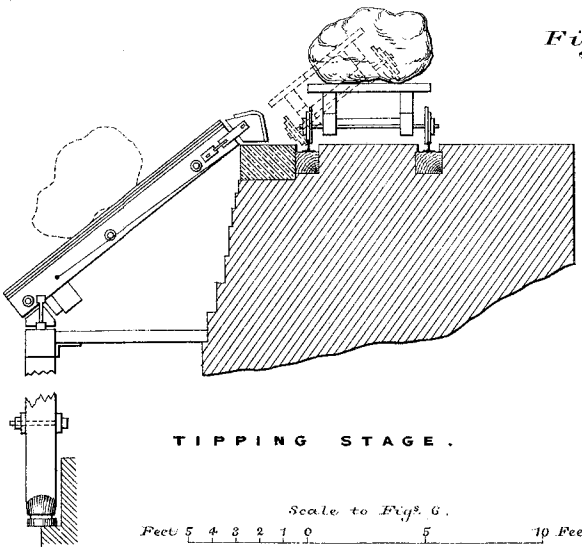


Fig: 6.



CONNECTION OF BLOCK WITH MASONRY .