A TREATISE ON THE

PRINCIPLES AND PRACTICE

OF

DOCK ENGINEERING.

BY

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With 34 Folding-Plates and 468 Illustrations in the Text.

LONDON:

CHARLES GRIFFIN & COMPANY, LIMITED;

EXETER STREET, STRAND.

1904.

which were afterwards used for the reception of 10-inch square stone dowels, 3 to 4 feet long, to connect adjoining lengths. The ends of two small wrought-iron girders in recesses, at or near the bottom of each block, rested in the stirrup-rods, and all were withdrawn together at the close of the setting operations.

The superstructure consisted of a facing of regularly coursed limestone ashlar, backed by 6 to 1 concrete, with a coping of Cornish granite.

Another instance of monolithic construction, with yet smaller blocks of concrete, is to be found at Kurrachee (fig. 150). The dimensions of the blocks were 12 feet by 8 feet by 4½ feet, and their weight 27 tons each. Lifting and setting were performed entirely by land carriage with the aid of a Titan, which travelled over the sections of work already executed and deposited the blocks in front of it. The depth of the foundation bed was 15 feet below the surface level of the water, and the blocks were laid in three horizontal tiers or courses to a total height of 24 feet 6 inches. The blocks were not set vertically, but with a slight backward inclination as shown in fig. 150. The sea bottom was sandy at a depth of 25 to 30 feet, and was surmounted with a rubble foundation, levelled by divers, and upon which the blocks were laid.

Fig. 148.

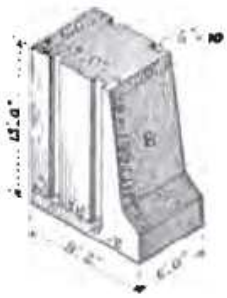

Fig. 149.

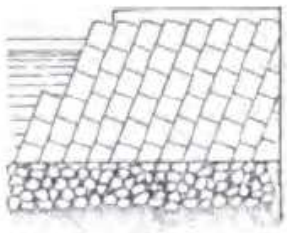

Fig. 150.—Blockwork at Kurrachee.

A similar method was adopted for building the quay walls at Suez. The blocks, which were about the same size as those at Kurrachee, were conveyed to their destination in barges.

Other examples may be quoted from ports in the Mediterranean, at Marseilles and elsewhere. The French were, in fact, the pioneers of the system, when they inaugurated it at Algiers as far back as the year 1840. It is still being practised for harbour work in Algeria at the present time, and the following particulars, furnished by the courtesy of the Engineer in charge, M. Georges Boisnier, relate to a quay wall at the port of Bougie, now under construction (see fig. 151).

The sea bottom is mud to a considerable depth, and in order to obtain a sufficiently broad area for the pressure, a foundation of rubble stone, 11½ feet in depth, is deposited within a trench dredged to a bottom width of 55 feet. The wall consists of five tiers of masonry blocks of varying size, only one of which is above the surface of the water. The blocks are constructed on a neighbouring quay with limestone from a local quarry. Those in the

two lowermost tiers weigh about 35 tons each, the upper tiers average 5 tons less. An interval of from three to four months is allowed to elapse between making and using, when the mortar is composed of hydraulic lime, but only three weeks, when of cement. The blocks are set by a floating crane with the assistance of a diver. When the four submerged courses have been constructed, the wall is weighted with a temporary surcharge of two tiers of blocks, which causes the structure to settle bodily to the extent of about 3½ feet in a period of two months, at the end of which time the rate of settlement is found to be insignificant, the surcharge is removed and a coping course substituted. The backing behind the wall is of rubble with a covering layer, 3 feet thick, of quarry spalls, above which is discharged the mud dredged from the foundations.

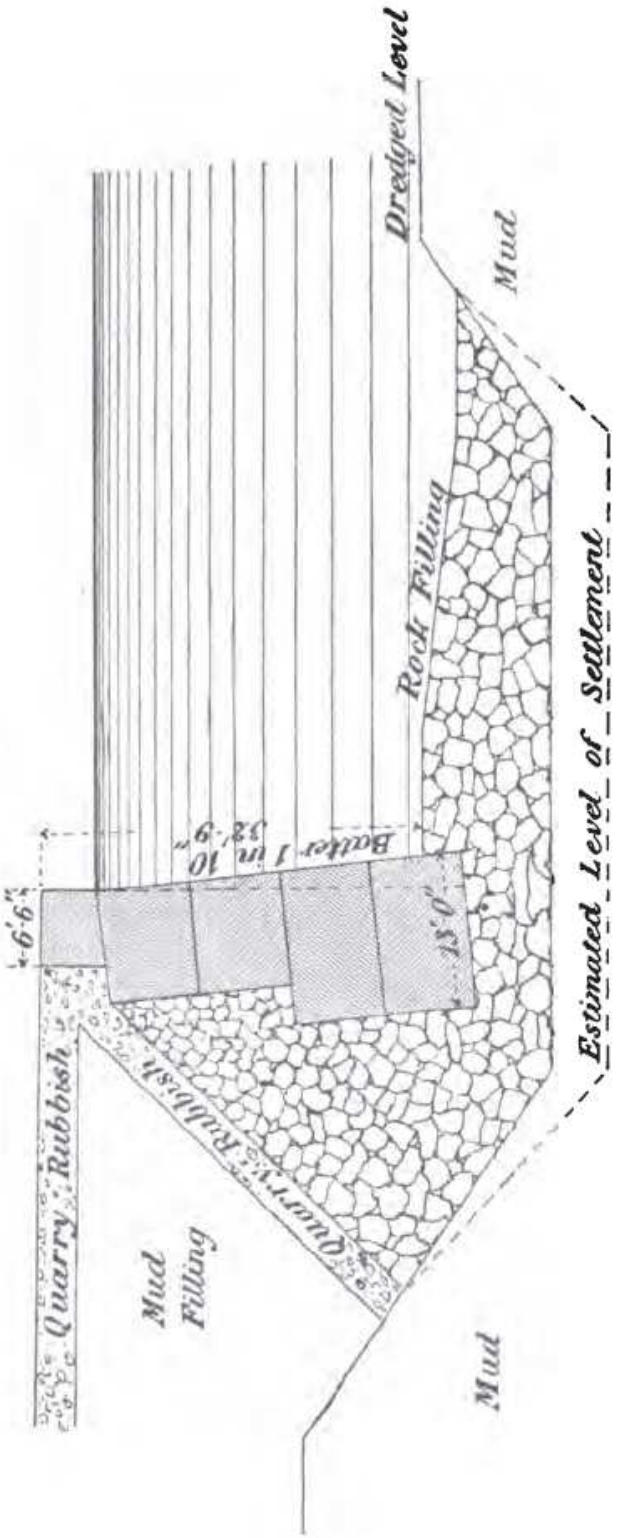

Fig. 151.—Section of Quay Wall at Bougie.

The cost of this type of wall works out to rather more than £14 per foot run, made up, approximately, as follows :—

Dredging site, .	£1	1	0
Rubble filling, .	4	15	0
Artificial blocks,	6	3	0
Surcharge, .	0	9	0
Coping, . .	0	11	0
General, . .	1	5	0

Experience has shown inadequate stability in a portion of the wall, as constructed above, and several important modifications are being introduced into another section of the same undertaking. The dredged mud is no

longer used for any part of the backing, its place being taken by dry quarry rubbish. The blocks are made to larger dimensions, but, in order to facilitate setting operations, they are rendered temporarily lighter than they would otherwise be by the arrangement of voids or pockets in their interiors, as shown by the plan in fig. 152. The lowermost blocks weigh some 50 tons prior to the filling of the pockets with concrete, an operation which is performed when they are in position. The former face batter of 1 in 10, found to be unsuitable for vessels with vertical sides, is now reduced to 1 in 20.

The profile thus adopted may be compared with that of a quay wall at the neighbouring port of Sfax* in Tunis, similarly constructed, but with the face receding in a series of offsets as shown in fig. 153.

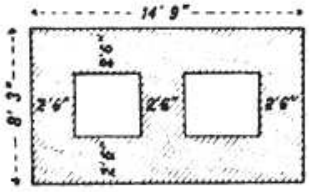

Fig. 152.

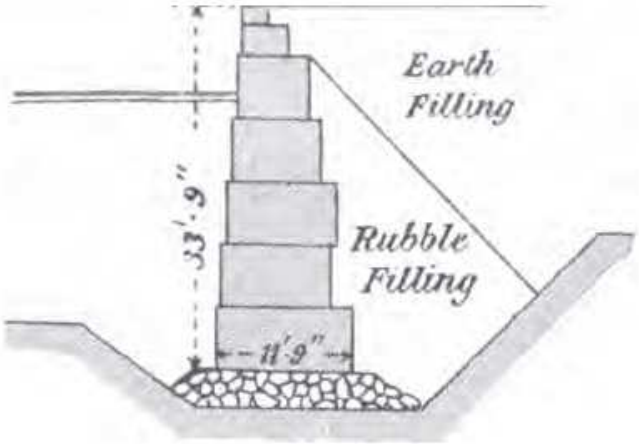

Fig. 153.—Quay Wall at Sfax.

The difficulty caused by excessive settlement in walls of this class is well illustrated by the case of a wall at Smyrna, where no less than six or seven tiers of blocks had to be superimposed, instead of four, as originally intended, while the front of the wall had to be supported by a rubble mound carried up to within 7 feet of mean sea-level.

Failures.

Failures of dock walls are by no means scarce, and they often present interesting and instructive features, but, in nearly every case, the cause can be traced to a bad foundation. Movement to a greater or less degree is to be expected, and has been experienced in all walls founded upon any other stratum than hard rock. It is stated as the experience of Voisin Bey, the Engineer-in-Chief of the Suez Canal, that he had never found a long line of quay wall which, on close inspection, proved to be perfectly straight in line and free from indications of movement.

* Baron de Rochemont on "Quelques Ports de la Mediterranée," *Int. Nav. Cong.*, Paris, 1900.