

firstly, in the channel between the moles (where it is not paved by limestone boulders), and then on the bottom of outer channel. Such a force is relied on by harbour engineers to scour the entrance channel and keep it open. Messrs. Cullen and Keele say in their 1912 report:—

“It is a fundamental principle of marine engineering to encourage as large a body as possible of tidal water to enter an estuary and pass up to its furthest limit, thereby increasing the tidal range and gaining, with the addition of the upland water, the fullest scouring effect during the ebb tide.”

This force after issuing from the harbour-entrance must be gradually weakened and finally overcome by the inertia of the water in the bay. The general tendency of the ebb tidal stream being approximately northerly, and the general tendency of the ocean current and wave-movements being westerly, the two streams must eventually merge and result in a north-westerly flow before the effluent current loses its force altogether. To the east and north of this effluent current, outside the Inner Harbour entrance, a spit has been formed of the sand forming a part of the littoral drift which passed round the north-east end of Scinde Island before the construction of the breakwater. The balance of the two contending currents has formed this sand into a bar having a minimum depth of 19 ft. at present. Considerable changes have taken place in this spit, illustrated by the contour plans 1855 to 1927, referred to in the immediately succeeding part of this report. The effluent stream might at times be stronger, as when it is augmented by flood-waters, and in such conditions its scouring influence would extend farther out and the bar would be pushed farther out to sea. On the other hand, the effluent stream might be weakened by alterations in the width of the exit channel, or the sand-movement might be accelerated and strengthened by storms, and in such conditions the bar may be driven in closer to shore. In considering these factors it should be recorded and considered that Hawke's Bay enjoys a great preponderance of fine weather, and that storms are of rare occurrence; but, on the other hand, it is subject to a continuous and heavy ocean swell, principally from the east, north-east, and south-east.

PART 10.—THE DEVELOPMENT OF THEORIES BASED ON THOSE PHYSICAL FEATURES AND NATURAL FORCES IN RELATION TO HARBOUR-CONSTRUCTION.

THE LITTORAL DRIFT.

In all the reports and theories of the engineers on harbour matters at Napier the existence and influence of the littoral shingle-drift claims a great deal of attention. That this is so can hardly be wondered at, for it is a phenomenon that may be considered as proved, and it presents visible evidence and results, and its existence and effects are apparent to any observer. It is generally agreed that the breakwater has, since its construction, cut off the supply of shingle from the beach west and north of the Bluff. A sharp difference of opinion has, however, arisen as to whether or not there remains a sand-drift across the entrance of the Inner Harbour, constituting a serious difficulty in the task of cutting and maintaining the entrance channel.

SHINGLE DRIFT.

This drift of shingle up the coast—roughly, south to north from the Kidnappers to Scinde Island—turns with the coast-line to the west along the West Shore beach, and then again runs south to north up the Petane beach. An obvious deduction from this fact is that whenever an entrance to any harbour at or near Napier is contemplated this line of shingle-drift across the entrance to the harbour will be a factor to be dealt with, as tending to block the entrance.

In 1880, Sir John Coode in his report says:—

“The question . . . be decided . . . upon the broader principle of whether the entrance to any harbour running out from this shore, as proposed by Mr. McGregor, or otherwise, would not in the absence of backwater become so blocked by shingle after a time as to render the work practically useless. After carefully considering this feature of the case I am reluctantly compelled to express an opinion that such would be the result. The shingle travelling along the coast between the Tukituki and Napier Bluff would gather against the back of the protecting pier and turn round the curve or angle, would pass along the outer cant and be deposited in the entrance and under the lee of the westernmost works.”

In the passage just quoted there is recognition of the irresistible nature of the shingle-drift when nothing but a protecting mole or wall is erected against it. There is also, it may be noted in the words, “in the absence of backwater,” the origin of the idea that “backwash” might be a useful agency to assist to keep the work clear of shingle; but Sir John Coode does not seem to have put the ideas of the wall and backwater together as complementary features in a scheme designed to block the flow of shingle. It is not necessary to quote reports of all the other engineers on this matter of shingle-drift; it is sufficient to say that all recognize its existence and the menace it offers to harbour works.

In 1884 Mr. John Goodall, M.Inst.C.E., in his report advances a new theory which is a distinct step forward. He says:—

“When I first turned my attention to the practicability of a solid breakwater at Napier I considered it utterly impossible, for the reason that the quantity of shingle travelling appeared so great that any works begun would be overwhelmed by it before their completion. This idea was created by the prevailing and widespread opinions regarding the shingle that exists, and that have been freely used by such high authorities as Sir John Coode, Mr. Carruthers, and other engineers of note. But latterly my mind has been thoroughly disabused of such ideas. Works in opposition to the opinions of the