

Of these alternatives, we may say at once, the dredging is the preferable one, as being the cheaper, and also the more likely to give satisfactory results, in view of all the circumstances of the case. It is desirable, however, that reasons should be given for this opinion, which we proceed to give accordingly.

#### ALTERNATIVE NO. 1.—EXTENDING THE MOLE.

To prevent the shingle overlapping the works, by extending the mole, would involve a length being added each year, equivalent to the probable growth of the shingle bank, say 125ft. This, at the low price of £80 per foot, based on last contract, but allowing for rise in price of cement, would cost £10,000.

As against this, there would possibly be a credit from value of land reclaimed, but it is very difficult to say what it would amount to.

If triangle of accumulation preserves its present shape, the area of accumulation, between Rock Island and breakwater, due to each 125ft. of accumulation along the breakwater, would be about 3 acres. Of this, in view of the shape of the land, fully 1 acre would be required for streets, leaving 2 acres available for sale or lease. This, if worth, say, £2,500 per acre, would be value for £5,000.

The net cost of annual extension would thus be £5,000, which, as will be shown hereafter, is much more than the probable cost of equivalent dredging.

In addition to this, too, there are reasons why it would be desirable to dredge the shingle, and convey it round the harbour, rather than retain it all to the south of the work. As, for instance, the desirability of affording protection to the beaches to the north, which might otherwise become denuded. Also the desirability of avoiding an excessive grinding of the shingle into sand (probably becoming greater and greater the further it extends along the breakwater) which would involve the danger of shoaling outside the harbour, by the sand being carried in suspension by the sea.

It may possibly be claimed, that the cost of extending the mole should be subject to a rebate, on account of the advantage which it might have, towards a future extension of the area of the harbour; but we think very little could reasonably be allowed for this, in view, partly of the long time to look forward to before it would be utilised, but more especially in view of the direction which such extension would probably have to take, in order to be effective under existing circumstances.

Had the straight-out cant been originally prolonged in its original line, it would have been a different matter, as the cost of the works as a whole, including, say, 1,000ft. of mole extension, would thus have been some £50,000 less than if such extension were made now; but, taking the circumstances as they stand, an extension of the mole, for the stoppage of the shingle-travel (even omitting all consideration of its other disadvantages) could not well be justified (in view of its additional cost over cost of dredging) on the basis of any use to which it might be put, towards extending the harbour-area hereafter.

#### ALTERNATIVE NO. 1 (CONTINUED).—GROINS.

As correlative to the alternative of extending the breakwater, another method which suggested itself, for stopping the shingle-travel, was to construct isolated groins, on the beach to the south of the breakwater. This, however, on investigation, turned out to have nothing to recommend it. While involving all the disadvantages which an extension of the breakwater would involve, it would at the same time be much more costly. That is to say, the cost of retaining a given amount of shingle, by means of such groins, would be considerably more than it would cost to retain the same quantity of shingle by lengthening the breakwater.

#### ALTERNATIVE NO. 2.—DREDGING.

Coming now to the second alternative—namely, the removal of shingle by means of dredging, and conveying it to the northward, entirely clear of the harbour, say, to the vicinity of the Dashing Rocks—it appears, after a very careful study of the question, that this is by far the best means to adopt, and there seems to be no reason why it should not give satisfactory results for a moderate annual expenditure. That is to say, for an annual expenditure, which, in view of the interests at stake, may be looked upon as moderate.

It is only right to say, however, that the probability of being thus able to deal satisfactorily, and at moderate cost, with this shingle-accumulation, is due, in a great measure, to the recent invention, and progressive improvement, of pump-dredgers of large power and capacity; and that if such machines as have recently become obtainable were still in the womb of futurity, the existing and imminent danger from shingle-accumulation would be much more serious. There is also the great advantage in this case that the bed of the harbour affords good holding ground for piles of staging, which will probably be an absolutely necessary appliance towards the performance of the requisite dredging.

The amount of annual shingle-accumulation, which has to be dealt with, is not in itself an appalling quantity. The total retained between Patiti Point and the breakwater during the last 12 years, shows the average annual increment to be under 120,000 tons. To dredge that quantity during the 300 working-days in a year would only involve lifting 400 tons per day.

It is probable, however, that some of the annual accumulation of shingle, in the immediate vicinity of the breakwater, which is now ground into sand, and carried round the harbour in suspension, would be dredged up before being so converted into sand. It is impossible, of course, to say how much this would amount to; but, judging by the accumulation in Caroline Bay, and all other data available, it would probably be an excessive estimate to put it at 15,000 tons per annum. Taking it at that, however, so as to be on the safe side, the total annual quantity to be dredged would thus be 135,000 tons. That, for 300 days, would be equivalent to 450 tons per day.