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Friday, June 21st, 1861.

MAJOR-GENERAL THE HON. J. LINDSAY, M.P. in the Chair.

THE DEFENCE OF PORTSMOUTH BY MEANS OF ADVANCED SEA WORKS.

By W. A. BROOKS, Esq. C.E.

THIS subject necessarily involves a consideration of the state of Portsmouth, Langston, and Chichester Harbours, and I propose to treat it under the following heads:—

Firstly. As to the present state of those harbours, and the causes which have produced the several impediments to navigation which are experienced.

Secondly. As to the means which are available for the removal of those impediments.

Thirdly. As to the result which will be produced by the construction of works for the improvement of the bars of Portsmouth and Langston Harbours, when considered in reference to the sea-approaches to those harbours and adjacent roadsteads.

Fourthly. As to the power of augmenting the accommodation or berthage for vessels of large draught of water.

Fifthly. As to the effect which those works will have in improving the military defences of Portsmouth Harbour, the roadstead of Spithead, and adjacent coast.

A study of the earliest *published* charts of Portsmouth Harbour down to the elaborate and beautiful one by Captain Sherringham, R.N. now in use, shows that the available depth of water in the sea-reach or channel leading to the harbour has at no time exceeded $2\frac{1}{2}$ fathoms, at low water of spring-tides. The survey by Captain Collins, the Hydrographer to Charles the Second, and those by Captains Mackenzie and Sherringham, all record an available depth of only $2\frac{1}{4}$ fathoms.

The position of this shoal, which by its presence reduces by one-half the general depth which would be otherwise available in the channel and on the sea-bar of Portsmouth Harbour, is very clearly defined in the three surveys referred to, and is shown to consist of a bank separating the deep pool of the harbour from the deep-water channel without. Thus, almost on the threshold of Portsmouth Harbour, there has existed, probably for several centuries, a barrier which is capable of being effectually removed by the scouring action of the tidal current when properly trained.

A year's work, and the expenditure of a sum, certainly under thirty thousand pounds, would raise Portsmouth from the position of a second to that of a first-class port.

With the present available depth into Portsmouth Harbour of only 13 feet 6 inches at low water of spring-tides, and a flow of from 14 to 15 feet only, the enormous annual charges upon the nation which are entailed by reason of this deficiency of depth of water for the passage of ships of war may be readily accounted for.

If nature had been the sole cause of creating this great impediment to the free ingress and egress of ships of large draught of water, the attempt to remove it might be stigmatized by inexperienced people as a work which might be found to be useless, as "warring against nature;" but long experience convinces me that the cause of the existence of this shoal, the opprobrium of Portsmouth, is really due to the hand of man—to the formation of ancient quays within Portsmouth Harbour, which have had the effect of forcing the ebbing current to deviate from its normal course, which throughout its seaward flow below the present entrance into Portsmouth Harbour must have occupied the same channel taken by the flood current even at the present time, or have ranged close to or parallel with the present shore between Portsmouth and Southsea Point.

That the Admiralty is fully awake to the importance of removing this shoal is proved by the dredging operations undertaken for that purpose; but, inasmuch as this mode of treatment is simply removing effects without attacking and removing the cause of the existence of the shoal, it must prove unsatisfactory; firstly, on account of entailing an endless expense; and, secondly, because a large portion of the sand disturbed by dredging must be carried by the flood-tide into the harbour.

The paramount importance of increasing the present depth over this barrier fully justifies, however, the temporary remedial measures which have been hitherto attempted by dredging operations, even were they tenfold more expensive than is the case; and it only remains for me to point out the cause of the existence of this shoal, and the mode by which it may be removed effectually.

In the normal condition of Portsmouth Harbour approaches, or before the mouth of the haven was partly throttled by the construction of works on the spit of sand called "Blockhouse Point," and by those at "Portsmouth Point" on the opposite or left bank, there must have existed a broad and direct course into the harbour, with an available depth of not less than 5 fathoms at low water of spring-tides, because at that time the flood and ebb currents occupied the same channel. This condition ceased however with the erection of the works on the points of land above described, and the construction of the present quays and works on the Portsmouth shore of the harbour; which latter have the effect of deflecting the current of the ebb to the opposite or western side, and, but for the resistance it meets with there by the presence of the Spit sandbank, it would continue in the course thereby impressed upon it by the influence or direction of those quays, and would finally pass Southsea Point at a distance of about half a nautical mile to the westward of the latter.

Another result of this deflection to the westward of the current of the ebb-tide by the quays of Portsmouth is the production of a considerable eddy below Portsmouth Point, in which is deposited the sand which was previously held in suspension during the rapid course of the current out of the harbour, and thus is formed that long bank of sand which, tailing down

with the ebb, flanks the Portsmouth shore, and closes up the north end of the deep channel made by the flood-tide on ranging along the shore between Southsea Castle Point and Portsmouth.

This bank has on it a depth of about one-third of a fathom at low water of spring-tides where its shoulder joins the beach at Portsmouth Point, and, as before observed, "tailing down with the ebb," it forms a junction with the Spit sandbank on the western side of the channel; the greatest available depth over it, or in the sailing track to Portsmouth Harbour, being only $2\frac{1}{4}$ fathoms (13ft. 6in.) in depth at low water of spring-tides. This miserable depth is all that is to be found in the only approach to the Royal Harbour or Naval Station of Portsmouth, in lieu of the available depth being only limited by that on the sea-bar, which varies between $4\frac{1}{4}$ and $4\frac{3}{4}$ fathoms at the same time of tide.

The chart shows that deep water is maintained in the channel taken by the ebb, until the current of the latter is arrested by the resistance it meets with at the Spit Sand; which resistance causes the greater portion of the current to be deflected towards the opposite or Southsea shore, to which latter it is also drawn by the slope of the bed towards the deep channel or swatchway made along that shore by the current of the flood-tide while moving in an unobstructed course. To reach this deep-water channel of the flood, the current of the ebb abruptly changes from the course which had been previously impressed upon it on leaving Portsmouth Harbour, and is compelled to pass over the tail of the bank, which has been previously described "as flanking the Portsmouth shore below the Point, and joining the Spit Sand;" passing in fact over a ridge or bar of sand, shingle, or gravel, which may be fairly described as a submarine weir of great width between the opposite foreshores, and upon which, consequent upon the great width of the weir, there must necessarily exist very little depth of water, the space occupied by the current of the ebb, in its passage across the shoal or weir, having lost in depth of channel what it had gained in breadth by the oblique course of the current while crossing the channel.

The width of the channel, in this as in all other cases, is to be estimated by the space occupied by the current in its passage across the sand-bank or natural weir, and in this example the course of the current is so abrupt from shore to shore as to readily account for the change from 6 fathoms at low water in the pools above and below the bank or shoal to only $2\frac{1}{4}$ fathoms upon the latter.

With an impress upon the current of the ebb still more to the west of south on leaving the harbour, the reaction would be more abrupt, and the available depth on the bar or weir would be still further diminished, as is invariably found in all rivers or channels where the stream crosses to the opposite shore.

At Portsmouth Harbour, as elsewhere, the current of the ebb is the governing power, because the ebbing current has not only the additional influence of the water from the drainage of the country, but of that element in its favour over the current of the flood-tide arising from the slope of the shore towards the depths of the sea.

Without the counteraction of those influences, the tendency of the action of the flood-tide is to fill up rapidly all natural tidal receptacles; and hence the vast marine deposits of sand in harbours and estuaries, and their gradual

diminution by the accretion of land; a process which is invariable, except where the seashore consists of precipitous hard cliffs rising out of so great of depth of water as to be little, if at all, acted upon by the sea when disturbed by tempestuous weather.

Hitherto the deposit on the eastern side of the channel below Portsmouth Point has alone been noticed by me, but it will be evident that there is also a considerable eddy created by the ebb-tide on the opposite bank or foreshore on its rushing out of the harbour past Blockhouse Point, forming the site of the Spit Sand, which latter, however, owes to other causes a great portion of the effects which are visible in the form of the vast marine deposit called "the Spit Sand," of which I shall take notice in another division of this paper.

Having thus described the principal effects produced by the ebbing waters of Portsmouth Harbour upon the navigable condition of the channel below, or seaward, there remains only for me to notice those of the flood, as immediately affecting the condition of the channel within Portsmouth bar, where that flood-current comes within the overpowering or dominating influence of the ebbing tide.

Thus the current of the flood-tide (which had previously ranged along the deep channel, past Southsea Castle), on encountering the resistance offered to its course by the bank or weir across the channel, made by the eddy on the ebb below Portsmouth Point, is, in its turn, compelled to change its course, and to pass over the shoal into the harbour; its further course to the northward, along the Portsmouth shore, being stopped by the shoulder of the shoal until the tide attains greater head, when its scouring action prevents the total conversion of that part of the shoal into *terra firma*.

On this I speak with the confidence given by long experience in the removal of many shoals having precisely the same cause of origin as this at Portsmouth, which has been so long left to mar the usefulness of our principal naval station.

The discussion on this subject will probably produce some report from one of the many able civil engineers who at one time or another have been employed by the Admiralty to report upon Portsmouth Harbour, to show that it has not escaped their notice; but if it prove that the conservators of the harbour have not had the cause of the formation of this opprobrium of Portsmouth Harbour properly brought under their attention, I trust that an effort will be made to rescue Portsmouth Harbour from the defect which has hitherto diminished its usefulness as a station in time of war, and has been the cause of a constant large waste of public money.

With the approach to Portsmouth Harbour in its present state, no heavy line-of-battle ship can enter or leave the harbour, except on the top of spring-tides, whereas a comparatively small outlay of money would enable ships of the largest draught of water to sail out and confront an enemy almost at any state of the tide, in lieu of being barred up within the harbour, as they now are, for many days together.

With Portsmouth Harbour sealed up as it now is during the whole of neap tides, the reserve fleet must necessarily be constantly moored in the roadstead of Spithead, or be insulted by an enemy who has the wit to make his attack at that epoch of the tides.

It was thus that in former wars much of the repairs to ships and fittings were necessarily executed at great extra cost and inconvenience at Spithead, instead of resorting to the quays and docks of Portsmouth.

The remedy for this evil is to be found either by restoring Portsmouth Harbour to its normal condition, or by the construction of a groyne or work below the mouth of the harbour from its right bank, which will have the effect of turning the current of the ebbing water out of its present direction towards the Spit Sand, and of compelling it to take a direct and easy course towards the channel occupied by the flood-current between Portsmouth and Southsea Point.

Having, in the above remarks, fully discussed the condition of Portsmouth Harbour, as affected by the presence of the shoal between Southsea Point and the entrance to Portsmouth Harbour, which is commonly, but very erroneously, known as the Bar of Portsmouth, it is now my duty to direct attention to the real sea-bars of Portsmouth, Langston, and Chichester Harbours, and to account for the vast difference as regards depth of water which exists between Portsmouth sea-bar and those of Langston and Chichester Harbours.

The bar of Portsmouth commences at a distance of half a sea mile below Southsea Castle Point, and has a depth on it of from $4\frac{1}{4}$ to $4\frac{1}{2}$ fathoms at low water of spring tides, which depth continues to a mile below the Point, where, on meeting with the strong current through the roadstead of Spithead, the depth rapidly increases to 9 fathoms, and in mid-channel to 17 fathoms at low water.

The bar of Portsmouth possesses this great depth of $4\frac{1}{4}$ fathoms at low water on account of its site being under the range of the strong current, or sea-tide, which sets directly across the point of discharge of the ebbing water of the harbour; and any alteration of the configuration of the coast and sands on each side of the sea-reach which would have the effect of bringing the site of the bar more southerly, would expose it to the action of a still stronger tidal current, and the depth on the bar would be consequently increased.

The site of Portsmouth sea-bar is clearly defined on the outline chart, from the excellent survey of Captain Sherringham, R.N., of that useful branch of the service the Hydrographical Department of the Admiralty.

The current out of Portsmouth Harbour, after passing Southsea Castle Point, yet retains sufficient velocity to insure the continuance of a deep-water channel, by reason of the latter being contracted by the western shore of the Horse Sand, which forms the left bank of the sea-reach, and the eastern side of the Spit Sand, which forms its right bank, until that current falls into the strong current or tideway of Spithead Roads, or debouches into the contracted channel between the Horse Sand and the north shore of the Isle of Wight.

Very different from the above is the physical condition of the current of the ebb on leaving the equally vast tidal receptacles of Langston and Chichester Harbours. Thus the current during the first hour of the ebb from Langston Harbour takes a direct course to the westward, over the Horse Sand, at the rate of only one knot per hour.

On the second hour it changes its course to the south-west, but runs at the same slow rate; and it is to be observed that while the current of the

ebb takes this course to the west and south-west, it has to force its way through the eddied water created by the outset from Portsmouth Harbour and Southsea Point; and it is this resistance, commencing at almost the very outset of the current from Langston Harbour, which reduces the velocity of the latter to one knot per hour, diminishing still further on its progress to the westward.

At the third hour of the ebb from Langston Harbour the set of the current changes to the south, and during the fourth and fifth hours it takes the same direction but with a greatly increased velocity, having at this time a true and unobstructed passage to sea, the discharge from Portsmouth Harbour being also towards the same quarter, or rounding the eastern shore of the Isle of Wight.

The bar of Langston Harbour has from the above circumstance a depth of only 2 feet on it at low water of spring tides.

Of Chichester Harbour and its bar it is enough on the present occasion to remark that, subject to the same geographical defect of position in respect to the waters discharged from it being out of the reach of a true and rapid coast tide, it, like the neighbouring Harbour of Langston, has also the same defect of a bar with only two feet on it at low water of spring tides, although as a pure tidal receptacle its capacity greatly exceeds that of Portsmouth Harbour, which has nevertheless, from the causes before described, a depth on its bar of 25 feet 6 inches at low water of spring tides.

These examples of the condition of Langston and Chichester Harbours, notwithstanding their immense capacities as tidal receptacles, are useful as demonstrating that it is not merely to the extent of quantity of tidal water that the valuable qualities of even tidal harbours are due, but to the well regulated nature of their discharge, or to the favourable conditions under which their waters debouch into the ocean.

To fully understand why the geographical positions of the points of discharge of the waters of the great tidal receptacles of Langston and Chichester Harbours are so unfavourable to the existence of deep water at the mouths of those harbours, while the reverse is experienced at Portsmouth, it is necessary to take a general or enlarged view of the coast, and mark the course taken by the great tidal current which supplies those harbours. It will then be seen that the current of the flood, after rounding the northernmost point of the Isle of Wight, is deflected by the Hampshire shore towards the south-east; thus throwing the whole of the foreshore eastward of Gillicker Point into a comparatively eddied state; and hence the main cause of the vast marine deposits forming the Spit Sand, and the Horse Sand, through which the waters of Portsmouth and Langston Harbours have to force their way to sea.

This enlarged view of the coast is necessary to be taken previous to a consideration of the treatment proper for the amelioration of the condition of Portsmouth, Langston, and Chichester Harbours, as well as Spithead roadstead.

It is necessary also to have recourse to the valuable information on the tidal currents of this coast procured by Captain Sherringham, R.N., to be able to form just conclusions of the effects which will result from any alteration of the general outline or configuration of the coast, or contour lines of soundings, by the formation of works for the amelioration of the

physical conditions of the harbours which form the subject of this paper; and here I cannot but express my thanks to the Hydrographical Department of the Admiralty, for having afforded me such sure guides as those careful observations on the tides have been found to enable me to give a firm opinion on this important subject; and to prove that no danger can possibly accrue to Portsmouth Harbour, or to the roadstead of Spithead, by reason of the treatment proposed in this paper as that proper to be adopted for the necessary improvements of the Harbours of Portsmouth, Langston, and Chichester.

The printed observations on the set of the currents given by Captain Sherringham on his chart of Portsmouth, Langston, and Chichester Harbours, demonstrate that they are supplied by two tidal currents, the earliest arriving by the channel between the Isle of Wight and the main land, with a course to the eastward for four hours, flowing during that period with a velocity of from one and a quarter to one and a half knots per hour, through the roadstead of Spithead.

At the end of this period the influence of the tide coming up channel, or along the back of the Isle of Wight, begins to be felt, and slack water ensues until nearly towards the end of the fifth hour, when the current begins to turn or run in from the south-east, but at a rate of only one-fourth of a knot per hour; and this continues during the sixth and seventh hours from the commencement of flood-tide, moving, however, at the rate of only three-quarters of a knot per hour during spring tides.

On the return of the tide the current sets to the westward between the Isle of Wight and the mainland, running for the first two hours at the rate of one and three-quarter knots per hour during spring tides. During the third hour the current takes a south-easterly direction, at the rate of half a knot per hour; and for the remaining period of the ebb at one knot.

From the above the following practical conclusion is arrived at, viz.: that the governing power of the oceanic tide in the roadstead of Spithead, is that which takes place while the tide flows from the westward, or round the north side of the Isle of Wight; and that during the latter division of the tide, or of the supply which comes round the back of the Isle of Wight, the current runs at too slow a rate to be able to have any material influence in determining the condition or features of the outlying sands, or in forming the deep-water channels. A little more to the eastward, or in the channel to Portsmouth between the Warner Shoal and the Horse Elbow Buoy of the Horse Sand, the same dominating power of the flood current coming north of the Isle of Wight is experienced.

There, during the first four hours, the current sets to the east at the rate of one knot and a half per hour, then slackens as the southern tide comes into confliction with it, until that southern current, at the end of the sixth hour, attains a velocity of three-fourths of a knot; and finally, of one knot per hour during the seventh hour of the flow.

In this respect the power of the earlier division of the tidal current is paramount to that of the later division, just as it is found in rivers that the ebbing current is the governing power; all sand banks forming their junction with the shore where during the ebb tide eddies are found to exist, and all those sands invariably tail down with the ebb. So likewise is it

found in respect to the features presented by the sands lying in the channel between the Isle of Wight and the coast of Hampshire, as far eastward as Chichester Harbour; they tail down with the course of the more powerful flood current, as it is strongly marked out by the features of "the Mother Bank" and "the Horse Sand."

Abreast of Chichester Harbour, and to the eastward for some distance, the tide flows bodily on the shore from the southward, and the worst condition exists there as respects the possibility of obtaining deep water on that line of coast at any harbour situated in that locality, without encountering a very large outlay, by the construction of extensive works to reach the true lateral or coast tide.

The preceding observations warrant the following deductions:—

First. That the great difficulty at present experienced at the Royal Harbour of Portsmouth of want of depth of water in the channel can readily be removed by the simple construction of a work on the Spit Sand to lead the ebbing waters into the channel now occupied by the current of the flood.

By this operation the depth on the shoal in the sea reach, which is now only two fathoms and a quarter at low water, will be increased to from five to six fathoms; that being the general depth in the same channel where the current has a true set down it.

Secondly. That in order to increase the depth on the sea-bar of Portsmouth Harbour, from its present depth of four and a quarter to six fathoms, the embouchure of the channel must be made subject to local influences, which will bring it under the domination of a still more rapid current than is found on the present site.

The improvement of the bar of Portsmouth Harbour is, however, altogether contingent upon the construction of works for the removal of the bar of Langston Harbour, which latter has on it a depth of only two feet at low water, from the causes previously assigned in this memoir.

To remove Langston Bar a pier or mole must be constructed from the eastern side of the Harbour at "Gunner Point," following the course shown by the strong red lines on the chart to within about five hundred yards of the Horse Elbow Buoy. Along the concave or the western side of this pier, the vast volume of the waters of Langston Harbour will range until they are discharged into the strong tideway which exists between the tail of the Horse Sand and the Warner Shoal, where both flood and ebb currents run at the rate of from one and a half to two knots per hour; and where the velocity will be found to be too great to allow of any deposit or formation of a bar there from the material previously held in suspension by the current from the harbour.

It will be seen by the chart that I do not propose to carry the mole-head clear of the whole of the Horse Sand, because I am confident that the portion left to the southward of the mole, and on which there is now a depth of from one and a half to two fathoms of water at low water, will become of a not less depth than five fathoms on it, owing to the increased rate of current consequent upon the contraction of the present channel by the formation of the mole.

An extension of this pier or mole to the southward of the Horse Elbow Buoy might have the effect of too much accelerating the current in mid-channel.

The certain result of the formation of this pier or mole at Langston Harbour will be also the establishment of a channel along its concave face, having a depth of not less than six fathoms at low water of spring tides, forming in fact a spacious sea-reach of the harbour of three miles in length, in which first-rates may be moored with all their artillery and sea-going stores on board, and from which they may be sent to sea at any time of the tide.

The next subject for serious reflection is as to the effect of this mole upon the currents of the flood-tides into Portsmouth Harbour.

On this I can speak with decision as favourable to the work, because it must follow, as a natural result of the construction of the pier, that the flood-tide coming from the westward will derive the advantage of an accumulation or heaping up of its waters from the funnel-shaped entrance which will be presented to them by the feature of the mole.

It has already been proved that the weight of the tide, or dominating current of the flood, passes between the Isle of Wight and the Hampshire coast. For four hours, therefore, of the strongest run of the flood-tide, the effect of the presence of the proposed mole of Langston Harbour will be to help to raise the level of the current, or heap up the tidal water and force it to run with greater strength up the channels of Portsmouth and Langston Harbours, while at the same time it will present no obstruction to the weaker and later tide which flows from round the back of the Isle of Wight, because that current sets bodily upon the shore, as is beautifully shown on Captain Sherringham's chart.

Anticipatory of any objection being raised to the contraction of the eastern channel by the formation of the mole, it may not be out of place to notice that the channel existing between Hurst Castle and the Isle of Wight is only one-fourth of the width of channel proposed to be left by me between the Langston Mole-head and Nettlestone Point, on the north shore of the Isle of Wight. Between Hurst Castle and the Isle of Wight the current runs at the rate of five and a half knots per hour, whereas in the channel past Langston Mole the current will not much exceed two knots per hour. To arrive at this result, the observations of Captain Sherringham have again been of great service to me. Thus, I gather from them that on the first four hours' flood from the west the stream runs in mid-channel, abreast of the Warner Lighthouse, at the rate of one knot and a half per hour; on the fifth hour of the flood there is the same confliction of the channel-currents as previously described in the Spithead tidal observations; and on the sixth and seventh hours the set of the current is from south-east to north-west, at from three-fourths to one knot per hour. At the edge of the Horse Sand and over it the current moves much more languidly, and hence the cause of the deposit which forms that bank.

An injurious effect upon the tidal supply of Portsmouth and Langston Harbours by reason of the formation of the mole could only occur if the dominating current ran from east to west along shore in lieu of the existing opposite direction.

The immediate effect upon the fore-shore and outlying banks of the coast by reason of the formation of the mole comes next under consideration.

First, as regards the fore-shore and Horse Sand lying between Southsea Castle and Langston Harbour, no doubt can exist as to the accretion of

sand thereon, and of the probable conversion into land of a large portion of the Horse Bank, and attendant upon this will be two great useful results, the first being the concentration of the power of the ebbing current out of Portsmouth Harbour until it falls into the rapid sea-tideway, entailing thereby the complete removal of the sea-bar of Portsmouth, or changing the depth on it from four and a quarter to at least six fathoms at low water of spring-tides.

The second useful result will be that of insuring the scouring action of the ebbing waters from Langston Harbour upon the bed of the new channel, on the concave side of the proposed mole. In this channel of three miles in length there will be maintained at least six fathoms in depth at low water of spring-tides; thus immensely increasing the available anchorage for vessels of the largest class to lie afloat ready for sea at the shortest notice.

The deep-water channels of Langston Harbour will, in like manner, become available for line-of-battle ships. The floating area of the sea-reach of Portsmouth Harbour will be also available for mooring therein ships of the line; and it may, in truth, be said that the formation of the pier or mole at Langston will add to the Portsmouth naval station, in the sheltered sea-reaches of Portsmouth and Langston Harbours, fully six miles in length of harbour-room, or floating berths for vessels of thirty feet draught of water more than exists at present, without calculating the berthage in Langston Harbour before alluded to.

Nor does the enormous advantage gained by constructing the mole or pier of Langston Harbour stop here; because, by it, great shelter will be procured from those gales which render the roadstead of Spithead at times inconvenient.

The channel to the westward and Spithead roadstead would, in fact, be converted into a harbour second to none in the world.

If, therefore, the proposed mole at the mouth of Langston Harbour be made, it will become a certainty that a true run of the ebb tide will be established along its western or concave side, of sufficient rapidity to prevent the possibility of deposit, even during the weakest tides, and of power capable of maintaining at least six fathoms depth at low water; the point of discharge being also secured where that rapid tideway exists which has been found to insure deep water. The channel would have an average width of at least five hundred yards; and as ships moored in it would be sheltered by the mole, its rugged seaward long slope of rock would act as the glacis of a fortress, and over it ship's batteries would be able to pour a destructive fire with almost impunity to themselves—safe as if "locked up in steel."

From a perusal of the evidence before the Royal Commission appointed to report upon the Defences of the United Kingdom, as well as by the expressions of the members of that honourable commission, it is clear that a strong feeling exists as to the necessity of barring-up the approach to the Island of Portsea over the Horse Sand; more than one gallant and intelligent officer declared that the defence of Portsmouth would be imperfect without it, notwithstanding the passage by the main channel up to Portsmouth might be rendered impracticable to an enemy by the establishment of powerful isolated forts on the Horse, No Man's Land, and Sturbridge

Sands. Admiral Sir Thomas Maitland urged also the propriety of an additional fort, more in advance, viz. upon the Warner Shoal; and, as that position is exactly opposite the Mole Head, I have adopted the suggestion of the gallant admiral, as it would materially aid to repel the passage of a hostile force by the close fire which it would give.

From this fort on the Warner Shoal to Langston Mole-head the distance would be, by my design, less than 2,000 yards. But as, in addition to the heavy fire from ships moored behind Langston Mole, and of the batteries constructed upon it, an approaching hostile force would also have to encounter the concentrated fire from ships moored within what would then be a harbour, small chance would there be of even the iron sides of the enemy not being knocked in by the fire of the artillery of the present day.

These works are not brought forward as improvements upon the able design given by the Royal Commission, but are contingent or necessary to carry out in its integrity what appears to have been the strong desire of the scientific men of which it was composed, viz. to force the enemy's ships to take up positions from which they would not be able to shell the naval arsenal of Portsmouth, even with the improved artillery of the present day. Thus it appears to have been the desire of the Royal Commission to construct a barrier on the Horse Sand, between the fort proposed on its southern margin, and Cumberland Fort on the Southsea Beach, and evidence was obtained as to the cost of depositing materials to form that barrier.

Two systems of construction were proposed;—one was for a solid barrier for the entire length, and the other for detached masses of masonry of fifteen feet in length, with intervals of ten feet, to allow the continuous passage of the tidal currents.

The latter scheme must have failed, because sufficient obstruction to the already languid current over the Horse Sand would have been created by those detached blocks of masonry to have insured the creation of a continuous barrier of sand, and, in fact, the ultimate conversion of the area of that portion of the Horse Sand into dry land, which lies to the westward of the proposed barrier. It would have been simply the formation of a new foreshore, upon which a hostile force could land with greater facility than on the present shore, between Southsea Castle and Cumberland Fort, because the latter line can have its defence strengthened by the batteries of ships moored in the sea-reach of Portsmouth.

Very different, however, would be the state of the coast, as regards its defence, if the mole were made as proposed by me, from the shore at Gunnen Point, on the eastern side of the entrance to Langston Harbour; because, even supposing a landing from boats could be effected upon the rugged foreshore or long slope of the rubble breakwater, there would yet remain the great difficulty of dragging the boats over it in order to effect a passage across the wide and deep channel on the western side of the mole, during which they would be exposed to the flanking fires from the batteries on the mole, and the direct fire from the forts on the present Southsea shore. Our blockships and gunboats would also add to the defence.

All the arrangements for the defence of this line of advanced sea-works

and shore-batteries to the eastward, would, of course, be maturely considered and arranged by our military authorities. I have merely sketched out works destined to give a flanking fire upon any force which might attempt a lodgment on its seaward face; but this latter might be made impracticable by only carrying up the rockwork, or glacis, to within a foot of high water of spring-tides as a general measure, but with portions raised a few feet higher where our wooden walls or floating batteries required additional protection.

The elevation of the mole, and the state of the tide, would determine the nature of the floating batteries which would be moored in the channel for its defence, and to assist in repelling an attempt to force a passage through the main channel to Spithead Roads. Thus, at high water, or about that period, gunboats would pour over the crest of the glacis or rugged seaward slope of the mole a most destructive fire, without the position of their own hulls being observed, except by the flash of their guns; and, as the tide fell, the deck batteries of larger vessels would in the same way be brought into action.

Assuming the possibility of an enemy's mortar-vessels to be able to approach and open fire within the range of a sea mile from the line of defence presented by Langston Mole, they would even then be at the great distance of above ten thousand yards, or about five miles and three-quarters from the dockyards of Portsmouth, and about eight thousand yards from the southernmost lines of the works defending Portsmouth.

Portsmouth and its suburbs may therefore be considered to be secured from any danger by bombardment from the sea by the realisation of the advanced seawork of Langston Mole; and if a cut were made to connect the deep-water channels of Langston and Chichester Harbours, having twenty-four feet in it at high water of spring-tides, our gunboats and blockships could then, at pleasure, be transferred to Chichester Harbour, to assist in the defence of the coast to the eastward. The cut I propose is shown on the chart near Hayling Bridge, and is of easy execution, an available depth of nine feet at low water of spring-tides existing at only a distance of a mile and a half from the shoal navigation which connects the two harbours at Hayling Bridge.

I propose, in the present instance, to confine the improvement of Chichester Harbour to the execution of the dredging at Hayling Bridge to form a deep-water connection with Langston Harbour, which would thus become the advanced port to Chichester Harbour.

In spring-tides, at tide time, vessels of large draught, of even 24 feet, would be able to make use of Chichester Harbour; and at neap-tides of a draught of from 18 to 19 feet, whereas at present the available depth is only about 16 feet in spring-tides, and 10 feet in neaps over the bar, and that only in calm weather.

The execution of the proposed lines of defence on Portsdown Hill would give a large supply of chalk to form the core of the mole at the mouth of Langston Harbour, as well as for the detached forts on the Warner Shoal; the material being brought by the railway from the mouth of the harbour to Havant, for which an Act of Parliament has been already obtained, or by a new line along the eastern margin of Langston Harbour.

The mole would thus become a simple work, presenting no difficulties of

execution, and would only require its eastern slope to be protected by a coating of rubble stone, brought from Swanage or Portland. Attendant upon the seaward extension of the mole would be a rapid deposit of sand on its seaward or exposed side; so that very little protection by stone-facing would be required, except between the level of half-tide and high water, so rapidly would the accumulation of sand and shingle take place in the angle between the mole and the shore to the eastward. A new foreshore would there be formed.

If the advanced sea-work of Langston Mole receive the honour of the approbation of the naval and military authorities, it will probably occasion some modification of the arrangement made by the Royal Commission on National Defences as to the works recommended on the Horse and Spit Sands; as I consider that those proposed detached or isolated sea-forts will be superseded by the floating batteries, which will be available with a greater range or sphere of useful effect.

Of the great utility of the work proposed by the Royal Commission on No Man's Land Shoal few will question; and probably few men of experience will deny the great advantage of having an additional strong position on the Sturbridge Shoal, or of floating batteries there.

In conclusion, I have but to state, on the subject of the formation of Langston Mole, that it may be easily completed within three years, and that even in two years a perfect barrier to the passage of even gunboats, at high water, could be readily made; and that during the same period a breakwater could be constructed for the foundation of the Warner Fort, which would enable our floating batteries, aided by the existing blockships, to render Portsmouth and the roadstead of Spithead secure from insult.