

13/2/08

Marine 1280 ~~128~~
~~Public Works~~ (1896) Department.

in lens

G.O., No. 813 *mar*

DATED 23rd November 1896

23/11/96

[Despatch Abstract.]

Madras Harbour, Despatch from the Secretary of
State forwarding with remarks ^{by} Sir A. Kennedy's
report on measures for arresting shoaling,
and for improvement of the —, Comd^r to the
Chairman, H.T. Board for remarks.

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50/2

*T.C.
23/11*

[100-1000]

14/12

Despatch from the Secretary of State forwarding, with remarks, copy of Sir A. Rendel's report on measures for arresting shoaling, and for improvement of the —, communicated to the Chairman, Harbour Trust Board, for remarks.

GOVERNMENT OF MADRAS.

MARINE DEPARTMENT.

READ—the following papers:—

Despatch from the Right Honourable the Secretary of State for India, to His Excellency the Honourable the Governor in Council, Fort St. George, dated India Office, London, 29th October 1896, No. 6, Public Works.

[Madras Harbour. Sir A. Rendel's report on measures for arresting shoaling, and for improvement of the harbour.]

* Public Works letter, No. 2, dated 11th February 1896.

Marine letter, No. 2, dated 26th February 1896.

Public Works letter, No. 12, dated 7th April 1896.

Marine letter, No. 7, dated 5th June 1896.

" No. 8, " 15th " "

" No. 9, " 20th " "

" No. 11, " 4th August "

During the current year I have received from your Excellency the letters noted in the margin* on the subject of the Madras Harbour Works.

2. Various measures are proposed in these letters, partly for the improvement of the harbour for the purposes of trade, and partly with the object of preventing the shoaling which the survey of 1895 has disclosed both inside and at the entrance of the harbour.

3. These measures have been referred to the consideration of Sir A. M. Rendel in accordance with your Excellency's desire, and I now forward copy of the report† which he has submitted after consultation with Mr. Lee-Pogson, the Engineer of the Trust Board.

4. Sir A. Rendel hopes, and expects, that the difficulties caused by the movement of the sand may be removed by dredging, and he recommends that a sand pump dredger should be purchased at a cost of about 12,500/. I approve this proposal, and if your Excellency concurs, after consulting the Trust Board, steps can be taken for the purchase of the machine in this country through the Consulting Engineer.

5. With regard to the improvements which have been suggested for the purposes of trade, I observe that certain schemes, estimated to cost about 15½ lakhs, including a boat basin and a wharf and wall on the north side of the harbour, have been approved by your Government, provided the Trustees can raise the required funds.

6. I agree with the view taken in the Consulting Engineer's report, that, until the doubts which still attach to the stability of the harbour and its safety from the encroachments of the sand are finally removed, the present proposals are all that can prudently be undertaken for its improvement.

ENCLOSURE.

Madras Harbour.

I have read the papers sent to me on the 20th March, the 2nd May, the 2nd July, the 5th August, the 10th August, and the 8th of September of this year, on the subject of this harbour, and having fully considered the questions they relate to with Mr. Lee-Pogson, the Harbour Engineer, who has come to England on duty for the purpose, I have now to report my views upon them.

The principal questions which I am asked to consider are, as I understand, the causes of the shallowing of the harbour entrance noticed since the beginning of 1895, the means by which the further progress of this shallowing may be arrested, and the plans proposed for the better utilisation of the harbour for the purposes of trade.

I will take first the shallowing of the harbour entrance.

A sufficient cause for this shallowing, though that it is the right one is disputed by Mr. Pogson, might be found in the travel of sand along the shore from the south, the evidence of which is the accumulation of sand on the south side of the harbour. It may be reasonably, if not rightly, supposed that this accumulation, which commenced very shortly after the commencement of the harbour works twenty years ago in the angle between the south breakwater and the shore and has been constantly increasing up to the present time, had by the end of 1894 so far filled up the angle as to allow the sand to resume the travel northwards, which, on this theory, the harbour works had for a time arrested. If this be the case, the harbour entrance is the first place in which sand could (and therefore might) form a lodgment. That this would eventually happen was the general opinion of the Committee of 1869, and of most of the gentlemen who appeared before it. In fact, in their view this result was so certain, and its consequences so serious, that in their opinion no scheme for a close harbour ought to be entertained.

The Committee and those they consulted, however, were not unanimous on the subject, the Chairman of the Committee himself, Colonel Carpendale, R.E., and others not concurring in it.

Colonel Carpendale, in the minute in which he expresses his dissent from the report of his fellow Committee men, says that he is unaware of any reason for the opinion that any "silt" is in suspension, or of its being carried north or south by littoral currents, and that he has no fear of the shoaling of a close harbour from this cause. As to the loose bed of sand which forms the foreshore of Madras and the bed of the sea in front of it, he states that according to the European diver the sand only extends to the six-fathom line, that it is known that the level of the sand at the iron pier head then and still existing varies as much as eight feet, that the movement of the sand is chiefly out to sea and in again to the shore, and that shoaling might take place between the shore and a detached breakwater parallel to it. But no sand or silt would in his opinion enter the mouth of a close harbour if placed in seven fathoms of water. Sand might, he thinks, accumulate outside it in one monsoon, but would be washed away by the change of current in the alternate monsoon, and the natural operation of the sea at Madras he says is to erode the coast, not to extend the beach. He therefore, with two gentlemen whom he names, inclines to the opinion that a close harbour is to be preferred to a detached breakwater; but he suggests, that before the former was decided on an experiment of its probable effect should be made by running out from the shore a pier (*i.e.* a groyne) of rough stone for a distance of 500 or 600 yards. After much further discussion this opinion prevailed, though the experiment proposed by Colonel Carpendale does not seem to have been made, and a close harbour was finally determined on. That the decision was a leap in the dark, consequent, I gather from the papers, on a strong feeling then existing in all quarters that to do anything was better than to do nothing, cannot, I think, be denied.

The harbour being now finished, we are beginning to be able to judge the controversy by its results. Be the cause what it may, sand has accumulated south of the harbour much faster than the advocates of a close harbour expected, and it may even be as Colonel D. McNeil Campbell, R.E., suggests in his paper dated 30th July 1896, sent to me on the 8th September, that the advance of the shore line seaward, now, I understand, observable at a distance of five miles south of the harbour, and the general shoaling in front of and to the south of the harbour, are due to the harbour having pushed the inshore currents further out to sea.

Mr. Pogson, however, whilst admitting that the harbour may have hastened the shoaling, has formed a different theory of its main cause. In his view this cause is to be found in periodic movements of the bed of the sea in deep water, producing alternate advances seaward and retreats landward of the shore line, with corresponding alternate shallowing and deepening in the roadstead. The causes of these periodic movements Mr. Pogson does not pretend to know, but he finds the proofs of them in the records of Madras from the seventeenth century down to the commencement of the harbour works in 1876.

According to these records, the shore line in front of Madras a hundred and fifty years ago was from two to three miles seaward, *i.e.* in advance of its present position. In 1813 it was to be found at what is now the six-fathom line in the harbour, whilst in 1821 it had retreated to near its present position, and then showed such signs of further retreat that a strong wall or bulwark one and three-fourth miles long and six yards high was erected in 1835, at a cost of 8 lakhs, to save the town and fort from their expected destruction. For the same reason the bulwark was extended further northward to the railway station, *i.e.* a little north of the harbour, in 1865. Since then there has been a period of shallowing and another of deepening, the latter followed since 1889 by a second period of shallowing, which still continues.

Whatever may be thought of the theory, it may be allowed that movements of sand do take place at Madras affecting the depth of its roadstead. The shores of Madras would be very different from those of other exposed sea coasts where large beds of sand are found if considerable movements of them did not take place, and they would be naturally greater on the surf-beaten shores of Madras than in quieter waters. We may also, I think, assume on the evidence generally that the tendency at Madras is to erosion rather than accretion, and that the tendency to erosion has been checked of late years on the south side of the harbour partly by works like the bulwarks before mentioned, which have stopped its further progress, and partly by works like the harbour which have led to actual accretion. On the north side of the harbour beyond the

bulwark it should be noted that erosion, from whatever cause, has never been stopped in spite of a large expenditure on the attempt to stop it. This erosion has been attributed wholly to the harbour. It may be partly due to the natural tendency of the shore to it.

My view of the case is this. I concur in the opinion that sand is now beginning to travel past the harbour, though to what extent it is doing so there is no evidence to show, and the daily range of tide at Madras not exceeding three feet, and the tidal currents into and out of the harbour being therefore exceedingly small, but little of it has yet found its way into the interior of the harbour. The deposit, so far, has been confined to the entrance, and is in my opinion, due to wave action. It is in fact, in my opinion, a bar formed precisely in the same way as bars are formed in river mouths. If it be asked why a bar only began to appear in the entrance in 1895 whilst the entrance itself was formed as early as 1881, one answer is to be found in Colonel McNeil Campbell's paper before referred to. In this paper he attributes the maintenance of the entrance up to 1895 to the fact that before that year the breakwaters had not been raised to a sufficient height to keep out waves, that these waves then pounded up the water in the harbour to an extent which produced a sufficient current outwards to maintain the depth of the entrance, and that the raising of the breakwaters to their full height has put an end to this action. I do not myself think that this action could have been sufficiently penetrative of the whole mass of water in the harbour to disturb sand in a depth of $7\frac{1}{2}$ fathoms. I think the more probable cause is the late shoaling in front of the harbour and the consequent greater power of waves outside it to push sand along the bottom of the sea into the entrance, and some of this sand may of course have come from south of the harbour. Whether the bar will increase or not depends in my opinion mainly on whether the shallowing outside the harbour increases. If the only action causing shallowing in the entrance be that described by Colonel McNeil Campbell I think we might hope that it was nearly exhausted. But the entrance was not originally placed in water sufficiently deep to bear much loss, and it appears to me that we must at any rate act, and at once, as if further loss was certain.

Of course if we accept Mr. Pogson's theory, say to an extent which would advance the foreshore to the point it is said to have reached in 1813, *i.e.*, a point at which there is now six fathoms in the harbour, we must admit that both money and skill will be thrown away in trying to meet the case. The harbour is doomed under such circumstances to early disappearance in the sand, for dredging out at sea is impossible, and groynes wherever placed could only at the best in my judgment delay the ruin for a time not worth their cost. But we are, I hope and believe, a long way from such a disaster. I do not think the mischief will go beyond the power of a repair, at reasonable cost, by a sand-pump dredger. If this class of dredger can conquer as it has done such a bar as that at the mouth of the Mersey, it should, I think, find no serious difficulty at Madras.

If, however, the shoaling of the roadstead should, from whatever cause, increase to a much greater extent than at present, dredging may be ineffectual, because it probably cannot be usefully carried on much outside the harbour entrance. Indeed, Colonel McNeil Campbell seems to be of opinion that dredging will, under any circumstances, be useless, for though he makes no reference to it in his paper before referred to, he says that "the only satisfactory solution of the question from an engineering point of view, though there may be nautical objections of which he is not aware, is a north-eastern entrance." If dredging after being tried fails, I agree with him, provided he does not mean such a north-eastern entrance as was proposed some years ago. None of the schemes then proposed would, I believe, stop the choking of the entrance with sand, and they would be ill-placed nautically also. I have never thought of the present entrance the best that could be devised, but I have never seen how it could be improved, except by placing the harbour entrance further seaward, *i.e.*, in deeper water, and the heavy cost of the necessary extension of the harbour would, I should think, prevent the acceptance of such a proposal except under circumstances of absolute necessity. If, however, dredging should fail to secure a sufficient depth in the present entrance, and the harbour is to be maintained, then I think the design for a new north-eastern entrance shown on the accompanying plan would be effective.

It will be seen that, under such circumstances, I propose that the eastern arm of the south breakwater should be extended in a direction a little seaward of its present line, *i.e.*, north-east-erly, past the north breakwater to about the $8\frac{1}{2}$ fathom line, a total length of about 1,600 feet, and to make a new entrance (closing of course the present one) through the outer arm of the north breakwater. Being well protected by the extended south breakwater, and free from current, the new entrance need not be more than 300 feet wide. No breakwater on its landward side would, I think, be necessary. It would be better, in my opinion, for shipping that the waves of the north-east monsoon should have room to disperse than that a portion of them should be trapped between two breakwaters.

Placed in such a depth some shoaling at the end of this extension might take place without injury to the harbour, but any sand which came round the head of the breakwater would find a large bay in which it might settle without injury to the harbour, and dredging might be carried on outside the entrance under cover of the south breakwater extension.

In conclusion of this branch of my report, I should make some remarks on the groynes which have been proposed south of the harbour—one by Mr. Pogson, running out from the shore parallel to the breakwaters; the other suggested in the Government Order, No. 119 of 26th February 1896, running out from the angle between the two arms of the south breakwater in a south-easterly direction.

I have, in a previous note on this subject, expressed an opinion unfavourable to the first. It could only, in my opinion, keep back the sand for a time, which its cost would not warrant. The other would, I think, stop the sand longer, but it would be in deep water and great exposure, and must, therefore, be of great strength and cost, and it is, I think, undesirable for nautical reasons also. I concur, therefore, with both Mr. Pogson and Colonel McNeil Campbell in thinking it an undesirable work. I would rather see any work of its kind deferred until the result of dredging be ascertained, and then made to form part of an extended south breakwater such as I have suggested, if such a work be found necessary.

So far for deposits in the entrance, but my attention is also called to a deposit of sand which is taking place on the south side of the harbour. This deposit is caused by the sand which has accumulated outside the south breakwater to a high level gradually slipping through the somewhat large interstices between the concrete blocks of which this breakwater is formed into the harbour, and forming a bank against the inside of the south breakwater. During the north-east monsoon Mr. Pogson informs me this deposit travels towards the shore of the harbour and is deposited there, causing the gradual advance of the shore seawards towards the entrance. The quantity of sand to be dealt with is not, and is not likely, to be relatively large, but it has to be removed or prevented from occurring. It may be removed by dredging. But it would be better to stop its taking place, and Mr. Pogson has devised means for the purpose which I think ought to be successful at a cost of about half a lakh. His plan being already sanctioned and the work on the point of commencement, I need say no more on the subject except that a pump and other machinery are required for it, which can only be obtained in England, and which should be ordered at once. The cost of the whole will be about 700*l*.

Before passing from the subject of harbour maintenance, I should state that, feeling satisfied that the sand-pump dredger was the probable remedy for the case, I advised Mr. Pogson, soon after his arrival in England, to see the machine in use. He accordingly visited the rivers Tees, Ribble, and Mersey, and the port of Sunderland, in all of which this dredger is at work with great success, especially at the Mersey, and he has drawn up a most useful note upon the subject, together with an account of his visit to Yarmouth, where some of the difficulties he has to encounter have been successfully met, which will be doubtless laid before the Madras Harbour authorities.

The machine which I would recommend for Madras would be one of the self-moving, self-discharging type capable of holding about 500 tons of sand. Such a dredger, working under Madras conditions, should be capable of filling itself with sand, of transporting its cargo to a sufficient distance outside the harbour, discharging it, and again taking up its place in the harbour in two hours at the most. Therefore, on a reasonable view of the yearly deposit likely to take place in the entrance and its neighbourhood, such a machine should be capable of clearing out the accumulations of a year in less than the period during which dredging can be carried on at Madras. Its cost delivered in Madras would be about 12,500*l*, and the cost of working it for three months should not be more than Rs. 15,000. When not in use in the entrance, it may be employed on the general deepening of the harbour or elsewhere, for there is much to be done by such a machine on many parts of the coasts of India.

I come now to the improvement of the harbour for the purposes of trade.

In a report which I made some years ago, I stated that, in my opinion, the present harbour was little more than an entrance to a harbour yet to be made. At present it does not serve properly the purposes of either shelter or trade; for it is still thought necessary, though I hope it will be found after the next cyclone not to be so, to order vessels out of it whenever the cyclone signal is hoisted, and ships discharge and take in their cargoes lying in the middle of the harbour through the medium of boats, instead of lying alongside a quay.

The subject has been fully considered, first by a Committee on which all Madras interests were represented, and which reported in February 1895, and subsequently by the Harbour Trustees themselves. The Committee advised that the improvements now to be undertaken should be limited to the construction of a boat basin designed by Mr. Pogson occupying their southern half of the west or land side of the harbour, to be extended when necessary over the northern half. The Trustees, on this plan being submitted to them, were advised by their nautical assistants that the absorption of the foreshore of the harbour which the scheme involved would be injurious nautically, for reasons in which the Committee seems to have concurred, as I do also, and would occupy space required for the berthing of ships. The Trustees, therefore, under Mr. Pogson's advice, proposed to limit the boat basin to an area of 4 acres. This scheme leaves the greater part of the harbour foreshore untouched.

A further work was proposed by the Committee in the north-west angle, of the harbour, in connection with the extension of the Buckingham canal into the harbour on its north side then proposed by the Government. But the Government having withdrawn this proposal for the present, I need not refer to it.

Should the subject be raised again, it would seem better that the canal should be led into the boat basin proposed on the south side of the harbour, but this depends on local circumstances, with which I have not sufficient acquaintance to enable me to express a decided opinion. If, however, the canal question be so treated, and if the inner part of the harbour be deepened as the Trustees are advised is necessary and have proposed, a new wall must be built inside the inner end of the north breakwater, to prevent that part of this breakwater, which is not founded much below the level of the foreshore, from slipping in. Mr. Pogson has proposed, I think wisely, to utilize this wall by forming behind it a quay, which should be useful for coal ships and other purposes.

The last work proposed by the Trustees is the deepening of the inner or western portion of the harbour to 5 fathoms. This, which will give five extra berths for large ships, is it appears necessary to supply a sufficient quantity of berthage for the requirements of the port.

The cost of the above works, which, I should observe, are sanctioned by the Government of Madras provided the Trustees can raise the money for them, is as follows:—

	RS.
(1) Boat basin on south side of harbour	6,63,558
(2) Wharf and wall as now proposed on north side of harbour, approximately	6,00,000
(3) Works for keeping sand from working through the south breakwater, approximately	60,000
(4) Deepening the inner part of the harbour	2,19,069
Making in all	15,42,627

I think this estimate should be sufficient, but it does not include the dredger required for the deepening of the harbour. For this purpose, even if it were not required for maintaining the entrance, a machine of the power I have suggested for the latter purpose would be necessary. If, therefore, we take the dredger as costing 12,500/ or, say, 2 lakhs, the total capital expenditure on the proposed works would be covered by 17½ lakhs. If the Buckingham canal be connected with the boat basin on the south side, about 1½ lakhs must be added to this estimate, making 19 lakhs in all.

Of course a boat basin will not put Madras in the position of Bombay or an English port of any importance, for it will still be necessary for ships to discharge their cargo into, and receive it from boats, in the open harbour, which must be often, at least, inconvenient, even with a north-east entrance. But I do not wonder at the Trustees hesitating, whilst the harbour is untried in respect to the stability of its works, and open to question in respect to the maintenance of its depth, to do more than is absolutely necessary for the necessities of the moment. Therefore, as a sheltered basin and a quay for boats will remedy the worst part of the present disadvantages of the port, I think the Trustees have determined wisely.

Later on, when experience has given the Trustees, as I hope and expect it will do, confidence in their harbour, the subject of quayage for ships will naturally come under consideration. The cost of any design for this purpose will, of course, be large, but in respect to site there will be no difficulty. There is room on each side of the harbour outside it for the construction of large basins opening into it; or, if it were devoted to trade only, its western half might be utilized for the purpose, as I suggested some years ago. But it would be premature to treat this question now.

I return the papers I enumerated at the beginning of this report as having been sent to me.

(Signed) A. M. RENDEL.

23rd September 1896.

ORDER—No. 813, Marine, dated 23rd November 1896.

Communicated to the Chairman, Harbour Trust Board, for any remarks and proposals the Board may wish to make.

(True Extract.)

Under Secretary to Government.

To the Chairman, Harbour Trust Board, with one plan (to be returned).

Exd. T. K. Narayana Aiyangar.

Marine (1896) Department.

CURRENT No. 1280

Order No. 813 Marine of 23rd November 1896.

Communicated to
the Chairman, Harbour Trust
Board for any remarks and
proposals the Board may wish
to make.

From

The Secretary of State

No. 6 P.W.

Dated 29.10.96

Received 21.11.96

Enclosures 1 plan

Spare copies 1

SUBJECT.

Madras Harbour works:

Forwarding, with remarks,

Copy of report by Sir

A. M. Rendel on the

FURTHER PAPERS.

[illegible]

G.O.	No.	Department.	Date.

Public Works,
No. 6.

To His Excellency The Honourable The Governor in
Council, Fort St. George.

SIR,

During the current year I have received from your Excellency the Letters noted in the margin* on the subject of the Madras Harbour Works.

Madras Harbour. Sir A. Rendel's Report on measures for arresting shoaling, and for improvement of the harbour.

* Public Works Letter, No. 2, dated 11th February 1896.

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3. These measures have been referred to the consideration of Sir A. M. Rendel in accordance with your Excellency's desire, and I now forward copy of the Report which he has submitted after consultation with Mr. Lee Pogson, the Engineer of the Trust Board.

† Dated 23rd September 1896, with plan.

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26688. I, 1859.

still attach to the stability of the harbour and its safety from the encroachments of the sand are finally removed, the present proposals are all that can prudently be undertaken for its improvement.

I have the honour to be,

Sir,

Your most obedient humble Servant,

George Hamilton

Marine (1896) Department
Current number: 1280

No. 6. Encls 1 plan.
Recd: 21. 11. 96
Public Works,
29th October 1896.

The
Letter to Fort St. George,
No. 6, and enclosures.



ENCLOSURE.

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Whatever may be thought of the theory, it may be allowed that movements of sand do take place at Madras affecting the depth of its roadstead. The shores of Madras would be very different from those of other exposed sea coasts where large beds of sand are found if considerable movements of them did not take place, and they would be naturally greater on the surf-beaten shores of Madras than in quieter waters. We may also, I think, assume on the evidence generally that the tendency at Madras is to erosion rather than accretion, and that the tendency to erosion has been checked of late years on the south side of the harbour partly by works like the bulwarks before mentioned, which have stopped its further progress, and partly by works like the harbour which have led to actual accretion. On the north side of the harbour beyond the bulwark it should be noted that erosion, from whatever cause, has never been stopped in spite of a large expenditure on the attempt to stop it. This erosion has been attributed wholly to the harbour. It may be partly due to the natural tendency of the shore to it.

My view of the case is this. I concur in the opinion that sand is now beginning to travel past the harbour, though to what extent it is doing so there is no evidence to show, and the daily range of tide at Madras not exceeding three feet, and the tidal currents into and out of the harbour being therefore exceedingly small, but little of it has yet found its way into the interior of the harbour. The deposit, so far, has been

confined to the entrance, and is in my opinion, due to wave action. It is in fact, in my opinion, a bar formed precisely in the same way as bars are formed in river mouths. If it be asked why a bar only began to appear in the entrance in 1895 whilst the entrance itself was formed as early as 1881, one answer is to be found in Colonel McNeil Campbell's paper before referred to. In this paper he attributes the maintenance of the entrance up to 1895 to the fact that before that year the breakwaters had not been raised to a sufficient height to keep out waves, that these waves then ponded up the water in the harbour to an extent which produced a sufficient current outwards to maintain the depth of the entrance, and that the raising of the breakwaters to their full height has put an end to this action. I do not myself think that this action could have been sufficiently penetrative of the whole mass of water in the harbour to disturb sand in a depth of $7\frac{1}{2}$ fathoms. I think the more probable cause is the late shoaling in front of the harbour and the consequent greater power of waves outside it to push sand along the bottom of the sea into the entrance, and some of this sand may of course have come from south of the harbour. Whether the bar will increase or not depends in my opinion mainly on whether the shallowing outside the harbour increases. If the only action causing shallowing in the entrance be that described by Colonel McNeil Campbell I think we might hope that it was nearly exhausted. But the entrance was not originally placed in water sufficiently deep to bear much loss, and it appears to me that we must at any rate act, and at once, as if further loss was certain.

Of course if we accept Mr. Pogson's theory, say to an extent which would advance the foreshore to the point it is said to have reached in 1813, *i.e.* a point at which there is now six fathoms in the Harbour, we must admit that both money and skill will be thrown away in trying to meet the case. The harbour is doomed under such circumstances to early disappearance in the sand, for dredging out at sea is impossible, and groynes wherever placed could only at the best in my judgment delay the ruin for a time not worth their cost. But we are, I hope and believe, a long way from such a disaster. I do not think the mischief will go beyond the power of repair, at reasonable cost, by a sand-pump dredger. If this class of dredger can conquer as it has done such a bar as that at the mouth of the Mersey, it should, I think, find no serious difficulty at Madras.

If, however, the shoaling of the roadstead should, from whatever cause, increase to a much greater extent than at present, dredging may be ineffectual, because it probably cannot be usefully carried on much outside the harbour entrance. Indeed, Colonel McNeil Campbell seems to be of opinion that dredging will under any circumstances be useless, for though he makes no reference to it in his paper before referred to, he says that "the only satisfactory solution of the question from an engineering point of view, though there may be nautical objections of which he is not aware, is a north-eastern entrance." If dredging after being tried fails, I agree with him, provided he does not mean such a north-eastern entrance as was proposed some years ago. None of the schemes then proposed would, I believe, stop the choking of the entrance with sand, and they would be ill-placed nautically also. I have never thought the present entrance the best that could be devised, but I have never seen how it could be improved, except by placing the harbour entrance further seaward, *i.e.* in deeper water, and the heavy cost of the necessary extension of the harbour would, I should think, prevent the acceptance of such a proposal except under circumstances of absolute necessity. If, however, dredging should fail to secure a sufficient depth in the present entrance, and the harbour is to be maintained, then I think the design for a new north-eastern entrance shown on the accompanying plan would be effective.

It will be seen that, under such circumstances, I propose that the eastern arm of the south breakwater should be extended in a direction

5 P.P.

a little seaward of its present line, *i.e.*, north-easterly, past the north breakwater to about the $8\frac{1}{2}$ fathom line, a total length of about 1,600 feet, and to make a new entrance (closing of course the present one) through the outer arm of the north breakwater. Being well protected by the extended south breakwater, and free from current, the new entrance need not be more than 300 feet wide. No breakwater on its landward side would, I think, be necessary. It would be better, in my opinion, for shipping that the waves of the north-east monsoon should have room to disperse than that a portion of them should be trapped between two breakwaters.

Placed in such a depth some shoaling at the end of this extension might take place without injury to the harbour, but any sand which came round the head of the breakwater would find a large bay in which it might settle without injury to the harbour, and dredging might be carried on outside the entrance under cover of the south breakwater extension.

In conclusion of this branch of my report, I should make some remarks on the groynes which have been proposed south of the harbour, one by Mr. Pogson, running out from the shore parallel to the breakwaters, the other suggested in the Government Order No. 119, of 26th February 1896, running out from the angle between the two arms of the south breakwater in a south-easterly direction.

I have, in a previous note on this subject, expressed an opinion unfavourable to the first. It could only, in my opinion, keep back the sand for a time, which its cost would not warrant. The other would, I think, stop the sand longer, but it would be in deep water and great exposure, and must therefore be of great strength and cost, and it is, I think, undesirable for nautical reasons also. I concur, therefore, with both Mr. Pogson and Colonel McNeil Campbell in thinking it an undesirable work. I would rather see any work of its kind deferred until the result of dredging be ascertained, and then made to form part of an extended south breakwater such as I have suggested, if such a work be found necessary.

So far for deposits in the entrance, but my attention is also called to a deposit of sand which is taking place on the south side of the harbour. This deposit is caused by the sand which has accumulated outside the south breakwater to a high level gradually slipping through the somewhat large interstices between the concrete blocks of which this breakwater is formed into the harbour, and forming a bank against the inside of the south breakwater. During the north-east monsoon Mr. Pogson informs me this deposit travels towards the shore of the harbour and is deposited there, causing the gradual advance of the shore seawards towards the entrance. The quantity of sand to be dealt with is not, and is not likely, to be relatively large, but it has to be removed or prevented from occurring. It may be removed by dredging. But it would be better to stop its taking place, and Mr. Pogson has devised means for the purpose which I think ought to be successful at a cost of about half a lakh. His plan being already sanctioned and the work on the point of commencement, I need say no more on the subject except that a pump and other machinery are required for it, which can only be obtained in England, and which should be ordered at once. The cost of the whole will be about 700l.

Before passing from the subject of harbour maintenance, I should state that, feeling satisfied that the sand-pump dredger was the probable remedy for the case, I advised Mr. Pogson, soon after his arrival in England, to see the machine in use. He accordingly visited the Rivers Tees, Ribble, and Mersey, and the port of Sunderland, in all of which this dredger is at work with great success, especially at the Mersey, and he has drawn up a most useful note upon the subject, together with an account of his visit to Yarmouth, where some of the difficulties he has to encounter have been successfully met, which will be doubtless laid before the Madras Harbour authorities.

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The machine which I would recommend for Madras would be one of the self-moving, self-discharging type capable of holding about 500 tons of sand. Such a dredger, working under Madras conditions, should be capable of filling itself with sand, of transporting its cargo to a sufficient distance outside the harbour, discharging it, and again taking up its place in the harbour in two hours at the most. Therefore, on a reasonable view of the yearly deposit likely to take place in the entrance and its neighbourhood, such a machine should be capable of clearing out the accumulations of a year in less than the period during which dredging can be carried on at Madras. Its cost delivered in Madras would be about 12,500l., and the cost of working it for three months should not be more than Rs. 15,000. When not in use in the entrance, it may be employed on the general deepening of the harbour or elsewhere, for there is much to be done by such a machine on many parts of the coasts of India.

I come now to the improvement of the harbour for the purposes of trade.

In a report which I made some years ago, I stated that in my opinion the present harbour was little more than an entrance to a harbour yet to be made. At present it does not serve properly the purposes of either shelter or trade; for it is still thought necessary, though I hope it will be found after the next cyclone not to be so, to order vessels out of it whenever the cyclone signal is hoisted, and ships discharge and take in their cargoes lying in the middle of the harbour through the medium of boats, instead of lying alongside a quay.

The subject has been fully considered, first by a Committee on which all Madras interests were represented, and which reported in February 1895, and subsequently by the Harbour Trustees themselves. The Committee advised that the improvements now to be undertaken should be limited to the construction of a boat basin designed by Mr. Pogson occupying the southern half of the west or land side of the harbour, to be extended when necessary over the northern half. The Trustees, on this plan being submitted to them, were advised by their nautical assistants that the absorption of the foreshore of the harbour which the scheme involved would be injurious nautically, for reasons in which the Committee seems to have concurred, as I do also, and would occupy space required for the berthing of ships. The Trustees, therefore, under Mr. Pogson's advice, proposed to limit the boat basin to an area of four acres. This scheme leaves the greater part of the harbour foreshore untouched.

A further work was proposed by the Committee in the north-west angle of the harbour, in connection with the extension of the Buckingham Canal into the harbour on its north side then proposed by the Government. But the Government having withdrawn this proposal for the present, I need not refer to it.

Should the subject be raised again it would seem better that the canal should be led into the boat basin proposed on the south side of the harbour, but this depends on local circumstances, with which I have not sufficient acquaintance to enable me to express a decided opinion. If, however, the canal question be so treated, and if the inner part of the harbour be deepened as the Trustees are advised is necessary and have proposed, a new wall must be built inside the inner end of the north breakwater, to prevent that part of this breakwater, which is not founded much below the level of the foreshore, from slipping in. Mr. Pogson has proposed, I think wisely, to utilise this wall by forming behind it a quay, which should be useful for coal ships and other purposes.

The last work proposed by the Trustees is the deepening of the inner or western portion of the harbour to five fathoms. This, which will give five extra berths for large ships, is it appears necessary to supply a sufficient quantity of berthage for the requirements of the port.

The cost of the above works, which, I should observe, are sanctioned by the Government of Madras provided the Trustees can raise the money for them, is as follows:—

	Rs.
1. Boat basin on south side of harbour -	6,63,558
2. Wharf and wall as now proposed on north side of harbour, approximately -	6,00,000
3. Works for keeping sand from working through the south breakwater, approximately -	60,000
4. Deepening the inner part of the harbour -	2,19,069

Making in all - Rs. 15,42,627

I think this estimate should be sufficient, but it does not include the dredger required for the deepening of the harbour. For this purpose, even if it were not required for maintaining the entrance, a machine of the power I have suggested for the latter purpose would be necessary. If, therefore, we take the dredger as costing 12,500*l.*, or, say, two lakhs, the total capital expenditure on the proposed works would be covered by 17½ lakhs. If the Buckingham Canal be connected with the boat basin on the south side, about 1½ lakhs must be added to this estimate, making 19 lakhs in all.

Of course, a boat basin will not put Madras in the position of Bombay or an English port of any importance, for it will still be necessary for ships to discharge their cargo into, and receive it from, boats in the open harbour, which must be often, at least, inconvenient, even with a north-east entrance. But I do not wonder at the Trustees hesitating, whilst the harbour is untried in respect to the stability of its works, and open to question in respect to the maintenance of its depth, to do more than is absolutely necessary for the necessities of the moment. Therefore, as a sheltered basin and a quay for boats will remedy the worst part of the present disadvantages of the port, I think the Trustees have determined wisely.

Later on, when experience has given the Trustees, as I hope and expect it will do, confidence in their harbour, the subject of quayage for ships will naturally come under consideration. The cost of any design for this purpose will, of course, be large, but in respect to site there will be no difficulty. There is room on each side of the harbour outside it for the construction of large basins opening into it; or, if it were devoted to trade only, its western half might be utilised for the purpose, as I suggested some years ago. But it would be premature to treat this question now.

I return the papers I enumerated at the beginning of this Report as having been sent to me.

A. M. RENDEL.

23rd September 1896.

India Office,
London, 29th October 1896.

Public Works,
No. 6.

To His Excellency The Honourable The Governor in
Council, Fort St. George.

SIR,

During the current year I have received from your Excellency the Letters noted in the margin* on the subject of the Madras Harbour Works.

Madras Harbour. Sir A. Rendel's Report on measures for arresting shoaling, and for improvement of the harbour.

- * Public Works Letter, No. 2, dated 11th February 1896.
- Marine Letter, No. 2, dated 26th February 1896.
- Public Works Letter, No. 12, dated 7th April 1896.
- Marine Letter, No. 7, dated 5th June 1896.
- Ditto, No. 8, dated 15th June 1896.
- Ditto, No. 9, dated 20th June 1896.
- Ditto, No. 11, dated 4th August 1896.

† Dated 23rd September 1896, with plan.

2. Various measures are proposed in these Letters, partly for the improvement of the harbour for the purposes of trade, and partly with the object of preventing the shoaling which the Survey of 1895 has disclosed both inside and at the entrance of the harbour.

3. These measures have been referred to the consideration of Sir A. M. Rendel in accordance with your Excellency's desire, and I now forward copy of the Report† which he has submitted after consultation with Mr. Lee Pogson, the Engineer of the Trust Board.

4. Sir A. Rendel hopes, and expects, that the difficulties caused by the movement of the sand may be removed by dredging, and he recommends that a sand pump dredger should be purchased at a cost of about 12,500*l.* I approve this proposal, and if your Excellency concurs, after consulting the Trust Board, steps can be taken for the purchase of the machine in this country through the Consulting Engineer.

5. With regard to the improvements which have been suggested for the purposes of trade, I observe that certain schemes, estimated to cost about 15½ lakhs, including a boat basin and a wharf and wall on the north side of the harbour, have been approved by your Government, provided the Trustees can raise the required funds.

6. I agree with the view taken in the Consulting Engineer's Report, that, until the doubts which
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still attach to the stability of the harbour and its safety from the encroachments of the sand are finally removed, the present proposals are all that can prudently be undertaken for its improvement.

I have the honour to be,

Sir,

Your most obedient humble Servant,

ENCLOSURE.

Madras Harbour.

I have read the papers sent to me on the 20th March, the 2nd May, the 2nd July, the 5th August, the 10th August, and the 8th of September of this year, on the subject of this harbour, and having fully considered the questions they relate to with Mr. Lee Pogson, the harbour engineer, who has come to England on duty for the purpose, I have now to report my views upon them.

The principal questions which I am asked to consider are, as I understand, the causes of the shallowing of the harbour entrance noticed since the beginning of 1895, the means by which the further progress of this shallowing may be arrested, and the plans proposed for the better utilisation of the harbour for the purposes of trade.

I will take first the shallowing of the harbour entrance.

A sufficient cause for this shallowing, though that it is the right one is disputed by Mr. Pogson, might be found in the travel of sand along the shore from the south, the evidence of which is the accumulation of sand on the south side of the harbour. It may be reasonably, if not rightly, supposed that this accumulation, which commenced very shortly after the commencement of the harbour works 20 years ago in the angle between the south breakwater and the shore and has been constantly increasing up to the present time, had by the end of 1894 so far filled up the angle as to allow the sand to resume the travel northwards. Which, on this theory, the harbour works had for a time arrested. If this be the case, the harbour entrance is the first place in which sand could (and therefore might) form a lodgment. That this would eventually happen was the general opinion of the Committee of 1869, and of most of the gentlemen who appeared before it. In fact, in their view this result was so certain, and its consequences so serious, that in their opinion no scheme for a close harbour ought to be entertained.

The Committee and those they consulted, however, were not unanimous on the subject, the Chairman of the Committee himself, Colonel Carpendale, R.E., and others not concurring in it.

Colonel Carpendale, in the Minute in which he expresses his dissent from the report of his fellow Committee men, says that he is unaware of any reason for the opinion that any "silt" is in suspension, or of its being carried north or south by littoral currents, and that he has no fear of the shoaling of a close harbour from this cause. As to the loose bed of sand which forms the foreshore of Madras and the bed of the sea in front of it, he states that according to the European diver the sand only extends to the six-fathom line, that it is known that the level of the sand at the iron pier head then and still existing varies as much as eight feet, that the movement of the sand is chiefly out to sea and in again to the shore, and that shoaling might take place between the shore and a detached breakwater parallel to it. But no sand or silt would in his opinion enter the mouth of a close harbour if placed in seven fathoms of water. Sand might, he thinks, accumulate outside it in one monsoon, but would be washed away by the change of current in the alternate monsoon, and the natural operation of the sea at Madras he says is to erode the coast, not to extend the beach. He therefore, with two gentlemen whom he names, inclines to the opinion that a close harbour is to be preferred to a detached breakwater; but he suggests, that before the former was decided on an experiment of its probable effect should be made by running out from the shore a pier (*i.e.*, a groyne) of

rough stone for a distance of 500 or 600 yards. After much further discussion this opinion prevailed, though the experiment proposed by Colonel Carpendale does not seem to have been made, and a close harbour was finally determined on. That the decision was a leap in the dark, consequent, I gather from the papers, on a strong feeling then existing in all quarters that to do anything was better than to do nothing, cannot, I think, be denied.

The harbour being now finished, we are beginning to be able to judge the controversy by its results. Be the cause what it may, sand has accumulated south of the harbour much faster than the advocates of a close harbour expected, and it may even be as Colonel D. McNeil Campbell, R.E., suggests in his paper dated 30th July 1896, sent to me on the 8th September, that the advance of the shore line seaward, now, I understand, observable at a distance of five miles south of the harbour, and the general shoaling in front of and to the south of the harbour, are due to the harbour having pushed the inshore currents further out to sea.

Mr. Pogson, however, whilst admitting that the harbour may have hastened the shoaling, has formed a different theory of its main cause. In his view this cause is to be found in periodic movements of the bed of the sea in deep water, producing alternate advances seaward and retreats landward of the shore line, with corresponding alternate shallowing and deepening in the roadstead. The causes of these periodic movements Mr. Pogson does not pretend to know, but he finds the proofs of them in the records of Madras from the seventeenth century down to the commencement of the harbour works in 1876.

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My view of the case is this. I concur in the opinion that sand is now beginning to travel past the harbour, though to what extent it is doing so there is no evidence to show, and the daily range of tide at Madras not exceeding three feet, and the tidal currents into and out of the harbour being therefore exceedingly small, but little of it has yet found its way into the interior of the harbour. The deposit, so far, has been

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So far for deposits in the entrance, but my attention is also called to a deposit of sand which is taking place on the south side of the harbour. This deposit is caused by the sand which has accumulated outside the south breakwater to a high level gradually slipping through the somewhat large interstices between the concrete blocks of which this breakwater is formed into the harbour, and forming a bank against the inside of the south breakwater. During the north-east monsoon Mr. Pogson informs me this deposit travels towards the shore of the harbour and is deposited there, causing the gradual advance of the shore seawards towards the entrance. The quantity of sand to be dealt with is not, and is not likely, to be relatively large, but it has to be removed or prevented from occurring. It may be removed by dredging. But it would be better to stop its taking place, and Mr. Pogson has devised means for the purpose which I think ought to be successful at a cost of about half a lakh. His plan being already sanctioned and the work on the point of commencement, I need say no more on the subject except that a pump and other machinery are required for it, which can only be obtained in England, and which should be ordered at once. The cost of the whole will be about 700l.

Before passing from the subject of harbour maintenance, I should state that, feeling satisfied that the sand-pump dredger was the probable remedy for the case, I advised Mr. Pogson, soon after his arrival in England, to see the machine in use. He accordingly visited the Rivers Tees, Ribble, and Mersey, and the port of Sunderland, in all of which this dredger is at work with great success, especially at the Mersey, and he has drawn up a most useful note upon the subject, together with an account of his visit to Yarmouth, where some of the difficulties he has to encounter have been successfully met, which will be doubtless laid before the Madras Harbour authorities.

The machine which I would recommend for Madras would be one of the self-moving, self-discharging type capable of holding about 500 tons of sand. Such a dredger, working under Madras conditions, should be capable of filling itself with sand, of transporting its cargo to a sufficient distance outside the harbour, discharging it, and again taking up its place in the harbour in two hours at the most. Therefore, on a reasonable view of the yearly deposit likely to take place in the entrance and its neighbourhood, such a machine should be capable of clearing out the accumulations of a year in less than the period during which dredging can be carried on at Madras. Its cost delivered in Madras would be about 12,500l., and the cost of working it for three months should not be more than Rs. 15,000. When not in use in the entrance, it may be employed on the general deepening of the harbour or elsewhere, for there is much to be done by such a machine on many parts of the coasts of India.

I come now to the improvement of the harbour for the purposes of trade.

In a report which I made some years ago, I stated that in my opinion the present harbour was little more than an entrance to a harbour yet to be made. At present it does not serve properly the purposes of either shelter or trade; for it is still thought necessary, though I hope it will be found after the next cyclone not to be so, to order vessels out of it whenever the cyclone signal is hoisted, and ships discharge and take in their cargoes lying in the middle of the harbour through the medium of boats, instead of lying alongside a quay.

The subject has been fully considered, first by a Committee on which all Madras interests were represented, and which reported in February 1895, and subsequently by the Harbour Trustees themselves. The Committee advised that the improvements now to be undertaken should be limited to the construction of a boat basin designed by Mr. Pogson occupying the southern half of the west or land side of the harbour, to be extended when necessary over the northern half. The Trustees, on this plan being submitted to them, were advised by their nautical assistants that the absorption of the foreshore of the harbour which the scheme involved would be injurious nautically, for reasons in which the Committee seems to have concurred, as I do also, and would occupy space required for the berthing of ships. The Trustees, therefore, under Mr. Pogson's advice, proposed to limit the boat basin to an area of four acres. This scheme leaves the greater part of the harbour foreshore untouched.

A further work was proposed by the Committee in the north-west angle of the harbour, in connection with the extension of the Buckingham Canal into the harbour on its north side then proposed by the Government. But the Government having withdrawn this proposal for the present, I need not refer to it.

Should the subject be raised again it would seem better that the canal should be led into the boat basin proposed on the south side of the harbour, but this depends on local circumstances, with which I have not sufficient acquaintance to enable me to express a decided opinion. If, however, the canal question be so treated, and if the inner part of the harbour be deepened as the Trustees are advised is necessary and have proposed, a new wall must be built inside the inner end of the *South* north breakwater, to prevent that part of this breakwater, which is not founded much below the level of the foreshore, from slipping in. Mr. Pogson has proposed, I think wisely, to utilise this wall by forming behind it a quay, which should be useful for coal ships and other purposes.

The last work proposed by the Trustees is the deepening of the inner or western portion of the harbour to five fathoms. This, which will give five extra berths for large ships, is it appears necessary to supply a sufficient quantity of berthage for the requirements of the port.

The cost of the above works, which, I should observe, are sanctioned by the Government of Madras provided the Trustees can raise the money for them, is as follows:—

	Rs.
1. Boat basin on south side of harbour -	6,63,558
2. Wharf and wall as now proposed on north side of harbour, approximately -	6,00,000
3. Works for keeping sand from working through the south breakwater, approximately -	60,000
4. Deepening the inner part of the harbour -	2,19,069
Making in all -	<u>Rs. 15,42,627</u>

I think this estimate should be sufficient, but it does not include the dredger required for the deepening of the harbour. For this purpose, even if it were not required for maintaining the entrance, a machine of the power I have suggested for the latter purpose would be necessary. If, therefore, we take the dredger as costing 12,500*l.*, or, say, two lakhs, the total capital expenditure on the proposed works would be covered by 17½ lakhs. If the Buckingham Canal be connected with the boat basin on the south side, about 1½ lakhs must be added to this estimate, making 19 lakhs in all.

Of course, a boat basin will not put Madras in the position of Bombay or an English port of any importance, for it will still be necessary for ships to discharge their cargo into, and receive it from, boats in the open harbour, which must be often, at least, inconvenient, even with a north-east entrance. But I do not wonder at the Trustees hesitating, whilst the harbour is untried in respect to the stability of its works, and open to question in respect to the maintenance of its depth, to do more than is absolutely necessary for the necessities of the moment. Therefore, as a sheltered basin and a quay for boats will remedy the worst part of the present disadvantages of the port, I think the Trustees have determined wisely.

Later on, when experience has given the Trustees, as I hope and expect it will do, confidence in their harbour, the subject of quayage for ships will naturally come under consideration. The cost of any design for this purpose will, of course, be large, but in respect to site there will be no difficulty. There is room on each side of the harbour outside it for the construction of large basins opening into it; or, if it were devoted to trade only, its western half might be utilised for the purpose, as I suggested some years ago. But it would be premature to treat this question now.

I return the papers I enumerated at the beginning of this Report as having been sent to me.

A. M. RENDEL.

23rd September 1896.