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MADRAS RECORD OFFICE.

Government of Madras.

Finance DEPARTMENT.

G.O. No. 820. Press Mis.—

93-94.

Dated 11-6- 1873.

15/11

Not to be folded or roughly handled

by

(1)

Proceedings of the Madras Government, Financial Department.

11*th June* 1873.

No. 93. Read the following letter from Colonel C. H. DICKENS, R.A., Secretary to the Government of India, Public Works Department, to Colonel G. W. WALKER, R.E., Secretary to Government, Public Works Department, Fort St. George, dated Simla, 21st May 1873, No. 212-B—C:—

Buildings and Roads—Miscellaneous Fund.

I am directed to acknowledge the receipt of your letter, No. 831, of the 17th March last, relating to the project proposed by Mr. W. Parkes for the formation of a close harbour at Madras, and, in reply, to state that the matter has been referred to the Secretary of State for favourable consideration, on the understanding that the Madras Government is prepared to pay the expense of Mr. Parkes' visit.

2. It must further be borne in mind that the Government of India cannot recommend any steps being taken towards the execution of the works contemplated till the financial conditions of the matter are settled, as required in this office letter, No. 460-B—C, of 5th November last.

Referred to the Financial Department with intimation that the letter referred to is with His Lordship the Governor.

(Signed) G. W. WALKER, Colonel, R.E.,

3*rd June* 1873. *Secretary to Government, P.W.D.*

No. 94. ORDER THEREON, 11th June 1873, No. 820.

To be recorded.

(True Extract.)

W. HUDLESTON,

Chief Secretary.

Exd. J. H. Burns.

Govt. of {1873} Madras

FINANCIAL.

Dated June, 11*th*.

Recd.

G. O., 11*th June* 1873, *No.* 820.

JUNE.
Nos. 93-94.

Recording letter from the Government of India, stating that Mr. Parkes' project for the formation of a close harbour at Madras has been referred to the Secretary of State for favourable consideration.

Proceedings of the Madras Government, Public Works Department, 12th June 1872.

No. 184. *Under date the* 11*th June* 1872, *No.* 1,449.

CIVIL WORKS, No. 16.

THE Government have already expresssd to Mr. Robertson, through the Government of India, their appreciation of his valuable Report on the Harbours of the Madras Presidency, and now proceed to pass the necessary orders thereon.

2. The only two harbours at which important works are recommended are Mangalore and Cochin, both well known to the Chief Engineer, and the Government fully concur in the recommendations made by him, in the memorandum herewith appended, for carrying into effect Mr. Robertson's views with some slight variation.

3. A sum of Rupees 7,000 from Port Funds is accordingly placed at the disposal of the Superintending Engineer of the 7th Division for collection of materials during the monsoon, and construction of a training groyne at the Goorpoor gap immediately after it; and he will submit complete estimates of the total probable cost of closing the gap in time to admit of the work being done some months before the monsoon of 1873, so that the deposit between the gap and the harbour mouth shall be acted on by the current of the Goorpoor river, and the danger of monsoon floods caused by the same diminished as much as possible.

4. As stated in Colonel Walker's memorandum and detailed in papers accompanying G. O., No. 1,125, of 2nd May, all Mr. Robertson's suggestions as to protective works at Cochin, Vypeen, and Cruz Milagre, have already been acted upon by the Superintending Engineer of the 7th Division. Lieutenant-Colonel Farewell will in due course proceed to supply the detailed drawings and estimates for the works intended by Mr. Robertson nearly to double the depth of water over Cochin bar. The Government are unable just now to carry out Colonel Walker's suggestion of instituting a Cochin and West Coast Canal Range, but order the following arrangements to be made, as the best means available for strengthening the hands of the Palghaut and Mangalore Range Officers, namely, the transfer of Supervisor Vyapoory Pillay, now under orders for Coondapoor Range, to the Palghaut Range, of which he can take charge, freeing Assistant Engineer Grime for the Cochin work, and the promotion of Overseer DeMello to rank of Supervisor vice Cowley dismissed, and his posting to the Coondapoor Range now held by Assistant Engineer Pringle in addition to his own.

5. Of the minor works of improvement suggested by Mr. Robertson for Cannanore and Beypore, the Superintending Engineer of the 7th Division will be good enough to submit plans and estimates.

6. The attention of the Master Attendant at Madras (Administrative Department) is called to the requirements of the port of Calicut, to which he will be so good as to attend, reporting when they shall have been met.

7. The subject of inland water communication along the West Coast will be disposed of separately at a later date, in connection with a scheme now before Government involving its development by private enterprize.

8. Looking at the character of the bay into which the Paumben passage opens, as well as the tortuous nature of the channel, Mr. Robertson reports that it would be out of all question to attempt to make the pass fit for large ships; or indeed deeper than 12 feet at low water of spring tides. The attention of the

Superintending Engineer of the 8th Division is called to Mr. Robertson's remark that the season was being lost for blasting operations for want of a regular supply of powder; and Mr. Dalrymple is requested to report on the character and cost of the lights stated to be required at Point Calimere and the Crocodile Rock.

9. The remarks in page 53 on one if not two safe and commodious anchorages, close to the locality of the new ship canal between India and Ceylon, proposed by Sir James Elphinstone, are full of interest.

10. The Superintending Engineer of the 6th Division will have plans and estimates prepared for lengthening the Pier at Negapatam 150 feet beyond monsoon low water line, for deepening and fixing the south side of the outlet, and for dredging the harbour, as recommended at pages 55 and 56 of Mr. Robertson's Report. It is observed that he approves generally of the Report of the Committee of 1860.

11. The Government have had frequent remonstrances addressed to them on their neglect of Cocanada, which is acquiring considerable importance as a place of trade. Mr. Robertson's Report is discouraging, but it is useful as furnishing a reply to the frequent memorials addressed to Government, and as preventing waste of money on the various projects which have been submitted. Copy of this part of his Report will therefore be communicated to the memorialists.

12. The Master Attendant of Madras will carry into effect Mr. Robertson's recommendations, that the whole length of channel from Cocanada to the entrance of Coringa river should be buoyed off; and he will report on the cost of the dredging operations to be undertaken at Coringa and Cocanada bays, of a light boat off Hope Island, and of the cost (with maintenance) of a steam tug for the Master Attendant at Cocanada. The Superintending Engineer of the 1st Division will report as to the agency necessary for conducting the proposed survey of the neighbourhood of Hope Island and experiments as to currents; and the Cocanada Harbour works, suggested in page 73, will also be planned and estimated for.

13. The subject of a breakwater at Madras, on which the Chief Engineer has reported against the delay considered expedient by Mr. Robertson, has been reported on to the Government of India.

14. It is observed that Mr. Robertson makes no recommendations for works at Alleppy, Narakal, Quilon, Tuticorin, and Porto-Novo, either because none are practicable, or, if practicable, advisable, on account of disproportionate expense.

(True Extract.)

(Signed) R. F. OAKES, Captain, R.E.,
Acting Joint Secretary to Government.

To the Superintending Engineers, 1st, 4th, 5th, 6th, 7th, and 8th Divisions.
,, Marine Department.
,, Controller of Public Works Accounts.
,, Master Attendant (Administrative Department).
,, Chamber of Commerce, Madras.
,, Do. Cocanada, with Extract.

Exd. S. T. Augustin.

Govt. of {1872} Madras.

PUBLIC WORKS.

To

THE SUPERINTENDING ENGINEERS,

1st, 4th, 5th, 6th, 7th, & 8th Divisions.

&c., &c., &c.

Dated June 12th.

Recd. *Encl.*

G. O., 12th June 1872, No. 1,449.

JUNE.

No. 184

Harbours of the Madras Presidency.—Passing orders on Mr. Robertson's Report on the Harbours of the Madras Presidency.

(4)

MEMORANDUM BY THE CHIEF ENGINEER.

Mangalore Harbour.—It is a satisfaction to me to find that Mr. Robertson coincides in the opinion which I formed and expressed many years ago as to the necessity of closing the Goorpoor gap, and I quite concur in his advice that the gap should be directly acted on by damming its mouth, instead of indirectly, as in 1856, by damming the river, and so restricting the tidal basin that the gap must have closed of itself. I have to point out, however, that the destruction of the dam of 1856 was not caused by any action of tide, but by a river fresh which came down on the night of the 30th April, the commencement of the work having been delayed too late for want of early sanction.

2. I do not agree with Mr. Robertson in one point, for I do consider it desirable to close the gap at once. Nothing could be better than his *modus operandi*, whether for the closing of the gap itself by a sand-bag dam or for gradual action on the shoals between it and the harbour mouth by a training groyne of slight material. I would commence with the second certainly as he recommends, but when the scouring action, which must inevitably ensue, has gone on for a sufficient time, I would proceed to the execution of the dam. It will be much easier to clear out the shoal between the two river mouths now than in 1858, as comparison of the two surveys will show that its length is reduced since that date by fully 1,000 yards, and the soundings show a great improvement also, and the danger of flooding above is proportionally decreased.

3. Reliable estimates cannot be made of the probable cost of this work till after the monsoon, when the river floods are over and the gap has settled down to its dry weather form. I would place the sum of Rupees 7,000, transferred from the Mangalore Pier, at the Superintending Engineer's disposal for collection of materials during the monsoon to the value of Rupees 5,000, namely, sand-bags, piles, bundles, and brush-wood, etc., and by September the Executive Engineer might commence the training groyne under instructions from Lieutenant-Colonel Farewell, who has lately been watching the progress and results of a similar work at Cochin, and will be able to tell him precisely how to act. By November, estimates for closing the gap may have been sent in and sanctioned, when I should hope that the Superintending Engineer would be able to find time to visit Mangalore, and have the work carried out under his own eye.

4. Lieutenant-Colonel Farewell will then also be able to prepare detailed estimates of the cost of carrying out Mr. Robertson's suggestions for fixing the north of the harbour mouth, when the propriety of acting on them may be considered. For my part, I do not think anything of the kind should be done. I believe that, so long as there are two outlets to the sea from the backwater which joins the Naitrawutty and Goorpoor rivers and tidal basin, so long will the outlet of the southern and much larger river tend gradually northward, either till it meets the northern gap (which is quite stationary), or, which I consider most probable and highly desirable, till a greater than usual monsoon flood bursts out a passage for itself near Oolaul, where the mouth was at the commencement of the century, when there is reason to believe that the harbour bar was much better than it has been ever since. Indeed, it is well known to have deteriorated the further north the outlet was.

5. Hence the primary necessity for closing the Goorpoor gap, when three natural forces, namely, the respective river streams acting from within and the tide water from without, will, by a natural dynamical law, fix the single outlet in a position which will be the natural resultant of the three forces, and so to be preferred to any artificial outlet against which one or other of them would be working detrimentally. Not but that there might possibly be a certain amount of shifting of the natural outlet according to the varying monsoon floods of the rivers, but works to control that fluctuation would be much less costly to construct and maintain than those which would be required to keep in its place an outlet not the resultant of natural forces.

6. It does not appear practicable to spare Mr. Pringle the services of an Assistant, as proposed by Mr. Robertson, but arrangements have been made for relieving him of the Coondapoor Range, which Lieutenant-Colonel Farewell once thought of doubling up with the Mangalore Range, an idea which he has now abandoned much to my satisfaction, and the work of Mangalore Range will not be so heavy this year as to prevent Mr. Pringle devoting much of his time to harbour observations and work.

7. Cochin Harbour.—All Mr. Robertson's suggestions, as to the closing of the Cruz Milagre Gap and defence of the Cochin and Vypeen Coasts, have already been acted upon by Lieutenant-Colonel Farewell, to an extent of which he has reported the success and probable cost of work in continuation, and G. O., No. 1,125, of 2nd May 1872, which embodies my views, will show how thoroughly I approve of all that Mr. Robertson has recommended on the subject. That of increasing the depth of water over the bar is one with which I have not hitherto had to deal at Cochin, my attention having been confined to protective works. I have perused Mr. Robertson's remarks on the treatment of the bar with great interest, and, though hardly prepared to endorse his sanguine anticipation that, by the construction of training groynes of from 2,000 to 3,000 feet in length and by dredging, the present depth of 11 feet over the bar may be increased to 20 or 21 feet, I cannot in the least gainsay the general accuracy of his conclusion that "to strengthen the current and confine it till it arrives into deeper water, where the waves act with less effect on the bottom, is evidently the way to treat the harbour at Cochin."

8. I propose accordingly to call on the Superintending Engineer to prepare detailed drawings and estimates of two groynes, composed of rubble cores faced with concrete blocks, as I conceive that the use of both materials would lead to speed and economy of construction. Special assistance must be afforded him as well as funds for supervision of works already in hand, surveys and measurements of those to be undertaken, and preliminary investigation as to the cost of quarrying and moving rubble on a large scale, and of making concrete blocks, say, of 8 cubic yards (9 feet $\times$ $4\frac{1}{2}$ $\times$ $4\frac{1}{2}$) or half the dimensions of those used at Kurrachee. The same officer would hereafter be available for investigating the details of the improvements to canal communication along the West Coast, on which Mr. Robertson makes remarks of great practical interest. In fact I would create at once a Cochin and West Coast Canal Range, and provide for its cost by savings which I have no doubt the Controller will be able to indicate.

9. I am not of opinion that the erection of a bund across the backwater at Palliport is necessary or even desirable. It would hamper existing traffic, and tend to accumulation of deposits, troublesome and costly to remove; and the tidal basin of Cochin is already so enormous that the proposed extension would not, by its additional action, benefit the bar to an appreciable extent.

10. Madras Breakwater.—Mr. Robertson has decided that a breakwater is the best expedient for obtaining shelter for shipping at Madras, but takes advantage of some loose reasoning of the Harbour Committee (with which he evidently does not himself agree) to demand further information as to the littoral currents, and quantity of sand in motion along the coast. I think that he has put aside the information already supplied without due cause; and that, had he argued upon it with the same perspicacity with which he confuted the notion of sand accumulating round piles of stone on the Armeghon shoal (see page 68), he would not have come to the conclusion that there was any danger of silting up behind the breakwater.

11. In point of fact he only comes to such conclusion on a false hypothesis of the Committee, not concurred in by himself, and opposed to the true conclusion to be arrived at from existing information as to currents and sand. This is to the effect on the one hand that at from 600 to 1,800 yards from the shore there are littoral surface currents, not exceeding one mile an hour in maximum velocity, and on the other that there is no current at bed of sea at seven fathoms, (beyond which it is proposed to construct the breakwater), and no loose movable sand beyond the six-fathom line. There is no reason whatever to doubt the accuracy of these observations; and it only remains to draw correct conclusions from them.

12. As Mr. Robertson says, there are two agents at work to move the sand, the surf acting perpendicularly to the shore and the littoral currents parallel to it; the former agitating the sand and causing it to be held in suspension, the latter moving it north or south according to the season. But there is not the slightest ground for imagining that the littoral currents beyond the six-fathom line are at all impregnated with sand; it is all dropped within that line. Hence there can be none to deposit beyond 7 fathoms, where the breakwater is to be. Hence also the fallacy of the Committee's reasoning against Mr. Fraser's project; their objection would be invalid against groynes reaching out beyond six-fathom water. Mr. Robertson has hit the true objection to his scheme, which is otherwise the best proposed after the breakwater project.

13. I deprecate, therefore, any postponement of the breakwater scheme on the score of further information being necessary as to currents and sand deposits. It is now matured sufficiently to be determined for or against on the simple grounds of its value compared to its cost. The Master Attendant could easily procure further information as to currents if necessary. As to the extent to which sand is moved, nothing but actual construction of a groyne out beyond six-fathom line would settle the question experimentally. But I maintain that for all practical purposes we have information enough; it has only to be argued upon as correctly as has been done by Mr. Robertson in the matter of a proposed breakwater on the Armeghon shoal. The argument in page 61 of the Report, that the removal of one motive agent, the surf, would cause the other agent to drop sand behind

the breakwater is fallacious, because it assumes that the littoral current will have sand in suspension; whereas it can have none outside six-fathom line in any case; still less behind the breakwater, where the agent, which agitates the sand and makes it movable, will be annihilated. Hence the Committee had reason to conclude, on the one hand, that the foreshore will be rendered steeper, but none, on the other hand, for apprehending its extension, as the littoral current freed from action of surf should tend to keep the foreshore clean swept of loose sand.

(Signed) G. W. WALKER, Colonel, R.E.,
Chief Engineer.

8*th May* 1872.

Exd. S. T. Augustin.

Proceedings of the Madras Government, Public Works Department.
17*th March* 1873.

No. 399. Read the following Proceedings of the Government of India in the Public Works Department, (Buildings and Roads—Miscellaneous,) dated Fort William, 30th December 1872, No. 523 B.—C.

Mr. Parkes' project for the formation of a close Harbour at Madras.

Read the following Despatch and enclosures:—

From the Secretary of State for India, to the Government of India, dated 21st November 1872, No. 107.

HEREWITH is transmitted for your Excellency's consideration, in connection with other papers on a similar subject forwarded to you by the Madras Government, copy of a letter* from Mr. W. Parkes, relative to a project for the formation of a close harbour at Madras.

* Dated 28th October 1872.

From W. PARKES, Esq., M. I. C. E., to the Under Secretary of State for India, dated 28th October 1872.

I UNDERSTAND that the question of affording some artificial shelter to the roadstead at Madras is about to be considered by the Secretary of State.

A few months ago I gave some attention to this subject, and after consultation with Captain A. D. Taylor, I. N, who is so well acquainted with the locality in his late capacity of Marine Surveyor in India, I prepared a project, which I sent out on the 23rd August last to His Excellency the Governor of Madras.

I submitted my project to some Members of the Council of India and others interested in, and acquainted with, Madras, but I did not at that time bring it officially before the India Office, as I was aware that it was not usual for the Secretary of State to take the initiative in matters of this description.

Now, however, that His Grace's attention has been directed to the question from the proper quarter, I think it may be to the convenience of the authorities for me to submit a duplicate of my project (enclosed herewith) in anticipation of the probable reference of it to His Grace by Lord Hobart in due course.

I may mention that the following gentlemen among others have carefully examined the project and conferred with both Captain Taylor and myself personally upon. They have all expressed themselves as prepared to support it in preference to any of the plans hitherto proposed:—

Mr. J. J. Franklin, R. N., late Secretary of Marine Board at Madras.

Mr. P. Macfadyen, of the Firm of Arbuthnot and Co. of Madras, Chairman of the Madras Chamber of Commerce, and a Member of the "Breakwater Committee."

Captain J. H Taylor, the Senior Commander in Messrs. Green's service, now commanding the *Viceroy* screw-steamer.

I may add that, although I have thought it better to submit the project in the identical form in which it was submitted to Lord Hobart, the subsequent information I have received would justify couclusions even more favourable to the principles of the design.

Note by WILLIAM PARKES, Esq., M. I. C. E., *on the formation of a Harbour at Madras.*

THE exposed state of the Madras anchorage has long been felt as an evil for which a remedy ought to be provided, and an impetus has been given to the question by the accounts of the loss of life and property in the late severe cyclone.

2. Some months previous to that disaster, Mr. Robertson, Harbour Engineer for India, had visited the place, and after informing himself of the local circumstances and requirements, has made a report which contains a suggestion for remedying, or at least mitigating the evil, and an estimate of the cost of the work he proposes.

3. I should not have considered it right to have put myself forward in this matter if I had not been convinced that Mr. Robertson's Report would have the effect of retarding, rather than advancing, the object in view by suggesting difficulties which I believe to be unreal.

4. Mr. Robertson's estimate for the work he recommends is, I am confident, fully double what it need cost, and the scheme itself must, I think, appear to the majority of persons who look at it from a practical point of view so incomplete, that it would, if carried out, involve the construction of supplementary works on a scale not much less than that of the original one, before any substantial advantage could be obtained.

5. I should fear, therefore, that the only deduction likely to be drawn from Mr. Robertson's Report is, that the evil is practically irremediable on account of the enormous cost of the remedy. The real facts of the case warrant no such conclusion.

6. I am aware that my authority to speak on the subject will be questioned, on the ground that I have not personally visited the place, and I admit that this fact renders it necessary for me to be careful not to overstep those limits within which conclusions based on data within my knowledge cannot be materially modified by such local considerations as can be properly weighed only on the spot.

7. I think, however, that such limits in this case are unusually wide. The physical conditions are remarkably simple, and I have a great advantage in the fact that Mr. Robertson has himself by his local examination cleared the ground and excluded from the question complications which can only be eliminated by such a professional inquiry. On the ground so prepared for me by Mr. Robertson, I formed a strong impression as to the right course to be adopted, but I should not have felt justified in pledging myself to it as a positive recommendation, if I had not had the further advantage of submitting my first crude ideas to Captain A. D. Taylor, one of the most experienced Surveying Officers of the late Indian Navy, and an authority second to none on the hydrography of this part of the coast of India. Captain Taylor's information has served to confirm my own previous impression, and I am authorized by him to say that he entirely concurs in the recommendations which follow Indeed, in the form in which I am about to present them, they may be considered as made jointly by Captain Taylor and myself, though, as the subjects on which we are individually qualified to speak are different, we could not so conveniently embody the expression of our views in a joint statement. He has, however, favoured me with a statement of his opinion on the nautical part of the question, which will be found appended.

8. The recommendation put forward by Mr. Robertson is for a straight breakwater, 2,000 yards long, 1,200 yards from, and parellel to, the shore in a depth of 7 fathoms. (The rise and fall of tide is so small as to be no element in the question. It is given as 3½ feet at springs in the Admiralty Tide Tables, but Captain Taylor says this is a very extreme range.) Such a breakwater Mr. Robertson estimates at £1,140,000, or allowing 15 per cent. for contingencies at £1,311,000. As he gives the grounds of his estimate, I have been enabled to form an opinion upon it, and my conclusion is that it is very unnecessarily high.

9. Mr. Robertson takes as his model the Portland breakwater, which is a mere mound of rubble-stone which the sea has been allowed to wash down till the slopes have become permanent. Taking a mound of such a form and dimensions, calculating the quantity of stone required for its formation, and dividing this quantity into the estimated cost, I find that Mr. Robertson has assumed that the stone will cost (including staging, pier from shore, and I presume, circular heads of masonry, but exclusive of the 15 per cent.) about Rupees 8 per ton.

10. Now I readily admit that the Portland breakwater is a noble and successful work, and that it might be a proper model for another breakwater, if such had to be constructed under similar conditions. But I unhesitatingly deny that it is a proper model to adopt under conditions so different as are those of Madras. The stone at Portland cost, I believe, about Rupees 2 per ton, instead of Rupees 8 as estimated at Madras. Do the resources of Engineering science suggest no means of modifying the form of structure so that the total cost may not also be quadrupled?

11. A somewhat similar problem was presented to me when it was determined to construct the Manora breakwater at Kurrachee, and the solution then arrived at by the Superintendent of the Works (Mr. Price) and myself is with certain modifications applicable to Madras. The Manora breakwater, which has now advanced 800 feet from shore, has been subjected without material damage to much heavier and more continuous seas than a similar work would be subjected to at Madras, and it is in every way efficient as a breakwater.

12. The principle is to form of the rubble-stone (which at Madras would be so costly) only a comparatively small submerged mound, the top of which is below the action of the waves, and to raise upon this a wall with vertical sides composed of large concrete blocks, each 27 tons weight It is upon this wall alone that the sea has any action, and although the action is very violent, the great weight of the blocks is sufficient to withstand it.

13. Applying this principle to Madras, we should require, as compared with the Portland system, only about one-fourth the quantity of rubble-stone to form both the submerged mound and the bulk of the concrete for the superstructure, and the extra cost of cement and of labour in making and setting the blocks would still leave a large saving in favour of this principle. Taking as the basis of my estimate Rupees 8 per ton as the cost of rubble-stone, whether in submerged mound or in concrete, and the cost of cement, and labour in making concrete and in setting the blocks the same as at Kurrachee, making also ample allowance for plant and preliminary works based on Kurrachee experience, I find that the cost of a breakwater of the same length and in the same depth as Mr. Robertson proposes, would be £566,000, or with 15 per cent. contingencies £650,900, being about one-half of Mr. Robertson's estimated cost.

14. Mr. Robertson estimates six years as required for the construction of the breakwater after the completion of the pier, which he proposes to make for running out the stone upon. On the concrete block system it could be completed in three years after the completion of the pier, or including the pier, say four years as against seven.

15. I submit, then, the conclusion that in considering the merits of Mr. Robertson's proposal for a breakwater the cost may be taken at two-thirds of a million, instead of one and a third million, sterling, and the time occupied at four years instead of seven.

16. But I have now to show that even with these advantages the scheme is an unpromising one, as compared with a rival proposal which Mr. Robertson somewhat summarily rejects.

17. At the time of Mr. Robertson's visit, a report had recently been made by a Committee, of which the late Colonel Carpendale was President, which treated of the relative merits of a detached breakwater and a "close harbour." I have not had an opportunity of seeing this report, but it appears by a quotation from it made by Mr. Robertson that the majority of the Members, though on all other grounds preferring a close harbour, decided in favour of a detached breakwater in extent and position similar to that subsequently recommended by Mr. Robertson, on the sole ground that they considered the close harbour would silt up. Colonel Carpendale, the President, did not concur in this, but maintained his preference for a close harbour, and Mr. Robertson himself thinks there would be "as much, if not more, danger of shoaling in the case of a breakwater as of an enclosed harbour," giving his preference to the former, on the alleged ground that it would afford more deep water shelter in proportion to the cost. But he makes his recommedation subject to such further information as may be obtained "as to the littoral currents and the quantity of sand in motion on the coast," as to the former of which he says there is "hardly a scrap of evidence."

18. But to my mind this very absence of evidence is the strongest possible testimony against the existence of a littoral current of such strength as could affect the present question. If there were so strong a current, it would be one of the most prominent and notorious features of the Madras Coast. The evidence quoted by Mr. Robertson, and confirmed by Captain Taylor of a well known weak surface current to leeward in either monsoon, seldom running more than a mile an hour, though under rare exceptional conditions increasing to three miles an hour, proves conclusively the *absence* of any special movement of a kind unusual on a coast of this character. I am confident that there need be no hesitation in entirely disregarding these supposed littoral currents as vehicles for carrying sand along the line of shore.

19. The motion of sand along the coast by the oblique stroke of the breaking wave is a more important matter, but when Mr. Robertson expresses a desire for more information on this point, it is natural to ask how such further information is to be obtained. There is no doubt that the movement, whatever may be its extent, is confined to the belt of surf which fringes the coast, the width of which is said to vary according to the season from 300 to 450 feet, and in a less degree, perhaps, to a belt a little outside of it. It may be confidently affirmed that it does not extend to the contour of 30 feet depth, though it may possibly extend to 20 feet. Any deductions drawn from the effect produced by groynes which do not extend into the unbroken water are of little use, and an experimental groyne which would afford reliable evidence would be in itself a considerable work.

20. This being the case, it would appear that the testimony afforded by analogy should be examined before direct experiment is appealed to. Now the testimony of the places which are most similar to the Madras Coast, where the experiment has really been fairly tried, is, so far as I am aware, invariably to the effect that the quantity of sand or beach accumulated to windward of a groyne carried into deep water is not excessive or unmanageable. Ports Said and Dover may be mentioned as instances which differ in almost every other respect but agree in this, that the accumulation to the windward of the piers, though considerable, is not so great as to threaten to envelope the pier heads for generations to come. When the time does arrive, posterity will no doubt be in a position to grapple with the difficulty.

21. The position of the question at Madras appears then to be this: It is admitted that if a solid pier were run out from the shore, the beach movement of sand would be stopped by it, and an accumulation on one or both sides would be the consequence, but as to the amount of this accumulation there is no definite means of judging. One party think it will be overwhelming, the other do not; the former opinion is supported by hypothesis only, the latter analogy. Nothing short of actual experiment can conclusively decide the question.

22. The success of the detached breakwater scheme is equally with that of the close harbour, dependent on the quantity of sand in motion by the oblique action of the surf not being excessive. Mr. Robertson says truly that the quieting of the waves on the beach would produce as effectual a stop to the movement of sand as a solid pier. Every wave would drive sand into the shelter, and there would be nothing to take it out again, so that the anchorage would be subject to a constant process of deterioration. I have already expressed my entire disbelief in the agency of a littoral current in moving the sand along the coast, and can see no ground for the suggestion that such a current would carry out sand which the wave action would bring in.

23. I have now given the fullest prominence to the one legitimate doubt on physical grounds as to the success of a harbour at Madras, and I have shown that that doubt cannot be finally solved except by trial on a practical scale. A solid pier run out from the shore into 20 or 25 feet of water would bring the question to a practical test, by showing how much sand would be collected in a single season. Such a pier would ultimately form part of the complete scheme if the result of the experiment encouraged its further prosecution, and if it did not, the only loss would be the cost of the pier itself. Still, the experiment itself would be too costly to be advocated without a strong probability of a favourable result, but I think such probability is amply afforded by the analogy of similar situations. Taking the case of Port Said alone, I can imagine no unfavourable conditions at Madras which did not exist in a greater degree at that place, and yet the pier there is perfectl effectual in protecting the harbour from wave-driven sand.

24. I think, therefore, that though this one doubt may justify hesitation in embarking in large immediate outlay, the probability of a favourable result is so strong that it is not premature to consider the principles of a complete scheme.

25. I have no hesitation in giving a perference to what is called a *close harbour* over a detached breakwater. I cannot admit any fear of its shoaling, except from the remote possibility of the beach extending to the pier heads and entrance, which it could do only from an action which I agree with Mr. Robertson in saying would be equally, if not more, fatal to the detached breakwater, if it be so to either. As to Mr. Robertson's assertion that a breakwater would give more sheltered area, I confess myself unable to understand his meaning. Taking into account the

completeness of the shelter afforded by the close harbour and the consequent facility for mooring the ships more closely together, I consider the superiority very materially the other way.

26. The accompanying sketch shows (in yellow) the position of Mr. Robertson's detached breakwater, and (in red) my own idea of a "close harbour," would cost almost exactly the same money, namely, £560,000, or with 15 per cent. contingencies £644,000. The system of construction for the piers would be the same as that described for the breakwater, and though the total length is greater, there is a saving from a portion of them being constructed in shallower water. The time required for completion would be about the same, namely, four years.

27. I have adopted this particular form, position, and dimensions for the harbour, not because I pledge myself to the opinion that they are the most suitable, but because from the quality in scale and cost with the breakwater which has been recommended by those who are more familiar than myself with the local requirements, it is more fairly comparable with that project. If the principle be accepted, there is great scope for variety in the arrangement of details.

28. It may be useful to point out the accommodation and facilities which would be afforded by such a harbour. It is obvious from the proportion which the enclosed area bears to the width of entrance (450) feet that the water will be almost as smooth as in a dock whatever be the state of the sea outside. The existing pier might be used as a quay for vessels to come alongside to discharge and load, and additional jetties and quays could be made as required. In the deep part of the harbour there would be space for 28 or 30 of the largest class of merchant ships to swing at their moorings, besides those alongside quays. Smaller vessels would be berthed nearer shore, and might be moored head and stern in tier as in the Thames and elsewhere where the shelter is complete.

29. The piers which enclose the harbour would not in the first instance be available for ships to lie alongside, but if further accommodation were required they could be made so by carrying out new piers on the same system in the direction of dotted lines. These new piers would then shelter the old piers, the vertical sides of which could, at a small expense, be made available as quay-walls and backed to any required width with sand or earth to form quays on which sheds and warehouses might be erected and trade carried on on the modern system. As another step in advance the new pier might itself be brought into shelter by another further along the coast and converted into a quay-wall, a second an independent harbour being thus formed. This facility of extension, as trade requires it, is an important advantage.

30. I would repeat that the estimate of cost (as respects its largest items, the rubble-stone) and the scale of the design are adopted rather with a view to comparison with Mr. Robertson's project than as being based on any information of my own. Mr. Robertson himself appears to think stone might be obtained at a cheaper rate, and, if so, both his and my estimates would be reduced; in fact, his would be reduced in a greater proportion than mine, and if stone could be got at Rupees 2-6-0 per ton, instead of Rupees 8, the two systems of construction would be equal in cost, and the superiority on the ground of cost would then be on the side of the breakwater over the close harbour. But such a low rate as Rupees 2-6-0 is hardly likely.

31. As to the scale of the design, I believe that within very wide limits it might be adapted to the amount that could be raised, and my expectation is that a design considerably smaller than that I have drawn would be more suitable to the existing state of the trade. Such a design would, of course, be equally capable of extension, when required, as a larger one. But it should be borne in mind that there is a relative economy in the larger scheme, as the accommodation increases in a higher ratio than the cost.

32. If such a harbour, as I have described, were constructed, it is obvious that a material saving would be effected in the cost of landing and shipping cargoes, and in the time required for those operations. The risk to shipping would be reduced, and the facilities for repairs would be increased. All these advantages represent a direct saving of cost per ton of goods shipped and landed, and that saving might be appropriated to the payment of interest on the outlay. If this

were sufficient for the purpose, the financial question would, I presume, be solved, and if it were not, there would still remain certain indirect advantages to the important interests of the town and surrounding country which are always more or less conferred by increased facilities of communication. These might be held to justify here, as they have been elsewhere, a charge upon the public revenue, but this is a question rather of administrative policy than of engineering, or even of finance, and which requires for its solution an intimate knowledge of the local circumstances of the country and of the trade.

Remarks by Captain A. D. Taylor, *Indian Navy.*

The great advantage of having Mr. Robertson's Report, with a few glimpses therein of the opinions of the Breakwater Committee, leads me unhesitatingly to prefer Mr. Parkes' idea of an enclosed harbour. The Committee have placed their opinion on record as follows:—

"If it were possible to construct an enclosed harbour which should be secure from the danger of shoaling up, we should not hesitate to recommend it in preference to a breakwater. It would be greatly superior in every respect. The piers would be constructed from the shore and at far less expense, in proportion to the material used, than the breakwater; the accommodation for shipping, and the facilities for landing and shipping cargo would be greatly superior to those afforded by an open harbour."

To this I would add that smooth water accommodation for landing and shipping cargo would be entirely provided under the first cost of the enclosed harbour, and wharves might be constructed in smooth water; whereas with a breakwater all such accommodation would be an additional and quadruble expense, all piers for landing and shipping cargo requiring to be constructed in the open sea, and subject to havoc from (if not east winds) at least from those strong north winds which usher in the Madras cyclones and from the S.-E. winds at their tail.

From a nautical point of view, let us consider the breakwater question. Say it is complete, and several vessels are moored between it and the shore. The approach of a cyclone is indicated; the north wind hourly increasing in force gives warning that the vortex bears due east from Madras and is advancing directly upon that place. Under such conditions the wind will remain at north till the centre of the storm arrives; when that has passed, (with that awful half hour of calm, which "makes the boldest hold his breath for a time" in harmony with a hushed wind), and the cyclone is still travelling westward, the wind will come up from the south; if travelling more to the S.-W. the wind will be S.-E. What now becomes of all the smaller craft? How will the landing piers stand it? The small craft should have been sent to leeward on the rising of the north wind, to guard against the contingency of their parting from moorings and falling athwart hawse of the larger ships. Thus, after the passage of the vortex, when the wind has chopped to the S.-E. or south, and the storm-wave comes on, they are found to windward. In the scramble to escape back through the shipping the foreseen contingency happens. Where are they now? Does the reader say, "this is mere hypothesis." Then let him listen to the chronicle of meteorological events published at Madras—

"Madras is occasionally subjected to various hurricanes, generally in the early part of May, or the end of October. They seem to travel up from the E.-S.-E., and progress rapidly in a W.-N.-W. direction till they touch the land, and then they assume a west or sometimes a W.-S.-W. course. Their centres generally come right on to the port of Madras." * * * "Their diameters are about 150 miles, and they revolve in a direction contrary to the hands of a watch, as do all cyclones north of the Equator. When the hurricane's centre comes right on to Madras, and thence takes a west course, the wind is first at north, increasing in violence for a few hours and then a lull, or awful calm for half an hour or so, when the hurricane re-commences furiously from the exactly opposite quarter, south. Usually the gale commences about N.-N.-W., showing that the vortex of the cyclone bears about E.-N.-E. Vessels, therefore, warned by the barometer, the hollow breaking surf, th threatening sky, and the signals of the watchful Master Attendant

should at once put to sea. The course to steer, and fortunately it is one which the wind permits, is S.-S.-E. to S.-E. In a few hours the vessel will probably have the wind moderate at west, and may, in fact, it has been done, *sail round* the cyclone, the wind veering to south and then to east. Vessels at first steering east to get way from the land have run right into the vortex of the hurricane! The only danger in a southerly course is from the storm-wave setting a ship on shore. If the gale commences N.-N.-W. at Madras, and ends at S.-E., as has often happened, it shows that the centre has taken a W.-S.-W. course, and passed a little to the south of the town, but if it ends at S.-W., it shows the centre has taken a W.-N.-W. course, and the vortex passed to the north of Madras."

We have ample reason then for thinking that the breakwater system has few advantages to offer, nor is mine an isolated judgment. In a paper about Madras by my brother Captain J. H. Taylor (Messers. Green and Co.'s oldest Commander), his opinion is recorded that "from the exceptional bad weather caused by hurricanes or cyclones, no breakwater would offer real security for ships."

Under the alternative system of an *enclosed harbour*, complete shelter is provided for both large and small craft. The Committee say that *the shoaling of the harbour would certainly result* from the construction of any solid piers or groynes from the shore. I know no reason why we should anticipate such a result unless pains were taken to bring it about by dilatory action in constructing the piers: thus if 200 or 300 feet of each pier were completed, and then for want of funds a halt of an entire year was made, we might expect some sand to be brought from both north and south, and left on the foreshore on the site of the proposed harbour between the piers. Tardiness in their construction before the zone of surf has been passed would be productive of mischief. But if both piers are rapidly carried out beyond the surf of ordinary weather, the littoral currents will not suffice to carry it past the pier heads, but merely a small growth of the beach, outside the piers and towards their ends will be caused thereby. A very rapid filling up of such an angle was prognosticated as the result of constructing the breakwater at Port Said, but time has shown that the operation of nature is very slow, and that the increased velocity given to the littoral current by the prominence of the pier suffices to carry on what sand is held in suspension by the agitated waves and past the entrance of Port Said. So would it be with a prominent enclosed harbour at Madras, and I cannot share the fears of those who expect otherwise.

Order.—Ordered that a copy of this Despatch, and of its enclosures, be forwarded to the Government of Madras in the Public Works Department, for consideration.

(Signed) D. SCOTT,
Asstt. Secy. to the Govt. of India.

From the Assistant Secretary to the Government of India, Public Works Department, (Buildings and Roads—Miscellaneous,) to the Secretary to the Government of Madras, Public Works Department, dated Fort William, 27th February 1873, No. 90 B.C.

I am directed to invite attention to this office No. 523 B. C., dated 30th December last, regarding Mr. Parkes' project for a close harbour at Madras, and to inquire if an early report on the subject may be expected.

No. 399A. Telegram from the Secretary of State, London.
(Here enter No. ——, dated 6th March 1873.)

No. 399B. Telegram from the Governor General.
(Here enter No. ——, dated 11th March 1873.)

Proceedings of the Madras Government, Public Works Department,
17th March 1873.

No. 400. ORDER THEREON, 17th March 1873, No. 830.

CIVIL WORKS, No. 26.

ORDERED that the following letter be sent :—

(Here enter No. 831, dated 17th March 1873.)

(True Extract.)

(Signed) G. W. WALKER, Colonel, R.E.,
Secretary to Government.

Exd. S. T. Austin

Govt. of {1873} Madras.

PUBLIC WORKS.

To

Dated March 17th.

Recd. *Encl.*

G. O., 17th March 1873, No. 830.

MARCH

Nos. 399-400

Breakwater at Madras.—Passing orders on papers relating to the construction of a Breakwater.

(11)

PUBLIC WORKS DEPARTMENT,
FORT ST. GEORGE, 17*th March* 1873.

No. 401 & 402.

No. 831.

To

THE SECRETARY TO THE GOVERNMENT OF INDIA,
PUBLIC WORKS DEPARTMENT.

CIVIL WORKS, No. 27.

SIR,—With reference to the Proceedings of the Government of India, dated 30th December 1872, No. 523 B.C., forwarding for consideration a letter from Mr. W. Parkes, relative to a project for the foundation of a close harbour at Madras, and to your further communication of the 27th ultimo, No. 90 B. C., I am directed to forward herewith a Note by the Chief Engineer, Department Public Works, on the subject, and to state that His Excellency the Governor in Council agrees with Colonel Walker in considering it expedient that Mr. Parkes should visit Madras and investigate the question of the best design and method of construction of Harbour Works at that place, on the spot. The opportunity of Mr. Parkes' visit to Madras may also advantageously be availed of to obtain his advice in connection with the details of the Harbour Works proposed at Cochin. And I am accordingly to request that the Right Honourable the Secretary of State may be moved to send that gentleman out to this country.

2. As it is most important that the provision of some shelter for shipping in the roadstead at Madras should no longer be deferred, and as much delay has already attended the consideration of the project, I am also to suggest that, should the Viceroy and Governor General in Council decide upon a compliance with this request, the necessary communication to the Secretary of State for India may be made by telegraph. The terms offered to Mr. Parkes would probably be the same as those on which he was engaged for superintending the Harbour Works at Kurrachee.

I have the honour to be,
Sir,
Your most obedient servant,

(Signed) G. W. WALKER, Colonel, R.E.,
Secretary to Government.

Exd. S. T. Austin.

Govt. of {1873} Madras.

PUBLIC WORKS.

To

THE SECRETARY TO THE GOVERNMENT

OF INDIA.

Dated March 17th.

Read. Encl.

G. O., 17th March 1873, No. 831.

MARCH.

No. 401-402

FORWARDING a Note by the Chief Engineer on the subject of the proposed Harbour at Madras, and considering it expedient that Mr. Parkes should visit Madras and investigate the question of the best design and method of construction of Harbour Works.

(12)

MEMORANDUM BY THE CHIEF ENGINEER.

MR. PARKES' note on the formation of a harbour at Madras deals with two separate subjects :—

1*st*.—The principle on which a breakwater should be constructed.

2*nd*.—The construction of a closed harbour instead of a detached breakwater.

It is observed that Mr. Parkes' Note was originally drawn upon the information gathered from Mr. Robertson's Report, but that he has not in any way modified it after being supplied with the Breakwater Committees' Report. The objections to depositing the material of a breakwater direct from a pier communicating with the land have not been entered into by him. There is no doubt but that by adoption of the mode of procedure made use of at Kurrachee an immense amount of material will be saved, which ought to lead to economy and rapidity of execution—both very desirable objects. It is very expedient therefore that Mr. Parkes should visit Madras and endeavour to realize on the spot the force of the objections against direct deposit of materials from a pier; and to what extent they, if valid, would influence his calculations. He would then be in a position to estimate pretty accurately, with the experience gained at Kurrachee, the rates at which the lower portion of the breakwater could be deposited of rough granite blocks, and the upper portion built up of 27-ton masses of concrete.

2. As to design, Mr. Parkes is opposed both to the former Committee and to Mr. Robertson, entirely disbelieving in the existence of a littoral current or other agency adequate to the moving of sand in such quantities, and so quickly as to extend the line of shore as far as the extremities of any groynes that may be thrown out from it, within a moderate time. Even should such a contingency occur in course of time, he has no doubt but that ould be met, and its consequences effectually dealt with.

3. The conclusion arrived at by the Breakwater Committee is that the inevitable result of the construction of a closed harbour on Mr. Parkes' plan would be the eventual extension of the beach, and the complete closure of the harbour mouth, followed in course of time by the shoaling up of the harbour itself.

Mr. Robertson equally with Mr. Parkes doubts the existence of sand carrying currents capable of affecting the question of either description of work; but he prefers a breakwater, and states that if a closed harbour be constructed its mouth will have to be defended by a breakwater.

4. That there is action of current and surf combined, of a very decided nature, along the coast of Madras, no one who knows the place can doubt. The effect of the vessels wrecked in May 1872 in acting as groynes, causing accumulation on one side and erosion of beach on the other, has been manifest to the latest residents. It is, moreover, known that the effect of groynes thrown out with that view in front of Fort St. George, has been to reclaim from the sea a sufficient width of beach whereon to form a broad roadway. But it is also known that such reclamation takes up only a small portion of what was formerly dry land extending considerably to seaward of the fort.

5. That there are considerable forces in existence acting on the sand cannot therefore be doubted, but the precise nature of their action has not been systematically noted so that practical deductions may be drawn therefrom. It is very

desirable that any Harbour Engineer, who may be consulted as to the design and execution of a harbour at Madras, should reside there throughout a season to watch the effects of the changes of the monsoon currents, as well as to obtain information as to the cost of materials, carriage, and labour.

6. Should an open breakwater eventually be determined on, it would be desirable that the economy of construction advocated by Mr. Parkes should be availed of to add to its length and place it in deeper water, rather than simply to reduce its cost. Should a closed harbour be finally approved of, it is probable that its shape will take that of two groynes projected in to six fathoms water, headed by, but not connected with, a breakwater in seven fathoms or more, so that there shall be two openings, north and south, not exposed to the direct action of the ocean swell.

(Signed) G. W. WALKER, Colonel, R.E.,
Chief Engineer.

Exd. S. T. Austin.

No. 212 B—C.

GOVERNMENT OF INDIA.

PUBLIC WORKS DEPARTMENT.

BUILDINGS & ROADS.
Miscellaneous Fund.

To

THE SECRETARY TO THE GOVERNMENT OF MADRAS,
IN THE PUBLIC WORKS DEPARTMENT.

SIMLA, MAY 21, 1873.

SIR,

I AM directed to acknowledge the receipt of your letter No. 831 of the 17th March last, relating to the project proposed by Mr. W. Parkes for the formation of a close harbour at Madras, and in reply to state that the matter has been referred to the Secretary of favourable consideration that the Madras Government is prepared to pay the expense of Mr. Parkes' visit.

2. It must further be borne in mind that the Government of India cannot recommend any steps being taken towards the execution of the works contemplated till the financial conditions of the matter are settled, as required in this Office letter No. 460 B—C of 5th November last.

I have the honor to be,
SIR,
Your most obedient Servant,

Colonel, R. A.,
Secretary to the Government of India.

P. W. 1873 Department
Financial. No. 3159.

GOVERNMENT OF INDIA.

PUBLIC WORKS DEPARTMENT.

BUILDINGS & ROADS.
Miscellaneous Fund.

(9)

To

THE SECY. TO THE GOVT. OF MADRAS,
IN THE PUBLIC WORKS DEPARTMENT.

No. 212 B—C.

Dated SIMLA, *May* 21, 1873.

Received 29th
Recd June 3rd/73

Referred to the Financial Dept with intimation that the letter referred to is with his Lordship

[redacted]

W. 985

C. W. Walker Colr
Secy to Govt
Mad

3rd June/73

Intimating that the subject of the project proposed by Mr Parkes for the formation of a close harbour at Madras has been referred to the Secretary of State for favorable consideration.
Telegraphed: 11 June 1873. No 820

C/6/A 11/6
Date Entry 29-5-73.

Govt. of {1873} Madras.

Financial

Dated June 11.
Recd. Encl.

G. O. 11 June, 1873, No. 820.

Nos. 93-94.

Recording letter from the Govt. of India stating that Mr. Parkes' project for the formation of a close Harbour at Madras has been referred to the Secy. of State for favorable consideration.