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TAMIL NADU ARCHIVES

GOVERNMENT OF TAMIL NADU

P.W. DEPARTMENT

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Dated	30.4.1883	~~198~~.

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GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Civil Works.

READ—the following papers:—

Despatch from the Right Honorable the Secretary of State for India, to His Excellency the Right Honorable the Governor in Council, Fort St. George, dated India Office, London, 8th March 1883, No. 10, Public Works.

With reference to Lord Hartington's despatch to your Excellency in the Public Works Department, No. 10, dated the 6th July last, I have to inform you that the Committee which was appointed to consider the question of the Madras harbour has now made its report.

2. I forward, herewith, a copy of the same and of a letter from Mr. Parkes, together with a despatch* addressed to the Government of India by the present mail on the subject, and I request that your Government will consider the matter, in view to assisting the Government of India to arrive at a decision upon the course which it will be most advisable to follow in reference to the work of restoration.

Dated 23rd January 1883.
Dated 10th February 1883.
* No. 16, dated 8th March 1883.

ENCLOSURES.

From the Right Honorable the Secretary of State for India, to His Excellency the Most Honorable the Governor-General of India in Council, dated India Office, London, 8th March 1883, No. 16, Public Works.

I have to inform your Excellency that the Committee* which was appointed in July last to inquire into the present condition of the Madras harbour, and to report on the measures which should be taken for restoring the works, so as to give reasonable expectation of their future stability, have brought their deliberations to a close, and have submitted a report,† copy of which I now forward, for the information and guidance of your Government.

* Sir John Hawkshaw, F.R.S.
Sir John Coode.
Professor Stokes.

† Dated 23rd January 1883.

2. Mr. Parkes, the Chief Engineer of the Harbour Works, has been in frequent communication with the Committee in their investigations, and has had an opportunity of seeing their report. The letter ‡ enclosed herewith will show your Excellency that he concurs in the general principles on which the Committee recommend that the work of restoration should proceed, but considers that in certain particulars modifications may be desirable. You will observe, also, that he is of opinion that four years will be required for the completion of the works contemplated.

‡ Dated 10th February 1883.

3. The estimated cost of reconstructing the harbour, in accordance with the proposals of the Committee, is 480,000*l*. This may be susceptible of reduction, but is in excess of estimates hitherto made.

4. After careful consideration of the whole subject, I have come to the conclusion that, so far as the engineering questions involved are concerned, the views expressed in the report of the Committee consulted under Lord Hartington's instructions, consisting, as that body did, of authorities eminently qualified to advise on the very difficult problem to be solved, should be accepted as closing the discussion on the principle of restoration to be followed, if the decision be come to that the additional outlay which is requisite should be incurred. There is nothing in Mr. Parkes' letter to lead to hesitation in this respect, and I understand that the Committee are of opinion that the work of restoration might be set about with every reasonable expectation that the structure could be satisfactorily completed and maintained on the proposed design.

5. While I am of opinion that the reconstruction of the harbour should be undertaken at the estimated cost, before coming to a final decision to incur so large an outlay, I desire to be informed of the views of your Excellency's Government on the financial aspect of the question. On receipt of your reports, I shall reconsider the whole subject, and my decision will be communicated to your Excellency with the least possible delay, any needful instructions being also then given to Mr. Parkes for his future guidance.

6. I have furnished a copy of this despatch and of its enclosures to the Government of Madras, with whom you will no doubt deem it desirable to place yourself in communication at an early date.

From W. PARKES, Esq., to the Under Secretary of State for India, dated 23, Abingdon Street, 10th February 1883.

I have the honor to submit the following remarks on the Report of the Committee, consisting of Sir John Hawkshaw, Sir John Coode, and Professor Stokes, in accordance with the request conveyed to me in a reference from Mr. Danvers, dated 5th instant. The report is returned herewith.

2. It should be understood that, although I was in frequent communication with the Committee during the progress of their investigations, and furnished them with all information in my power as to matters of fact, and as to my own views, both orally and in writing, and also conveyed to them several documents forwarded to me for that purpose by the India Office, the conclusions given in their report were arrived at quite independently of me. I was informed of their general character in December, and the plans attached to the report were shown to me on the 19th January, but I did not see the report itself till it was forwarded to me on the 5th instant, as above.

3. I have thought it desirable to mention these facts in order that my own share in the investigation may not be misunderstood. While admitting that the course adopted by the Committee has its advantages, and at the same time trusting that the report may serve the purpose intended by the Government, I would submit that in considering their conclusions, and taking action upon them, a large allowance must be made for the fact that the gentlemen composing the Committee are not personally acquainted with the locality, and that their local information was obtained at second hand.

4. This consideration will not affect the main features of their recommendation, but it does materially affect the position of the line of demarcation between fixed principles and details which may be subject to modification in respect of their relation to local circumstances. The details of their plan should be viewed, I would submit, rather as illustrations of the general meaning of the authors, or at most as a basis for approximate estimate, than as a basis for instructions to the engineer who will be charged with the execution of the works.

5. Subject then to the limitations implied in the above remarks, I may state that I have, after full consideration, come to the conclusion to acquiesce in the general recommendation of the Committee that the additional strength required should be given by a large wave-breaker, consisting of concrete blocks laid at random on the sea face. I need not say that I have come to this conclusion with great reluctance, because it involves a very large additional outlay, which would have been saved if the more inexpensive plan which I proposed in March last had met with independent professional support. I do not think, however, that I should be justified in urging the latter further, even if my present opinion, that it would have possessed the necessary elements of stability, should remain unchanged, for I think this to be essentially one of those cases in which action should be taken only with a strong concurrence of professional opinion. It is a matter upon which there is no very direct experience to guide us, and the theoretical considerations applicable to the case are involved in some doubt. Moreover it might be many years before the stability of the work would be brought to a satisfactory test, so that whatever there might be doubtful in the question would remain unsolved for an indefinite time.

6. I have been of opinion from the first that the system of random blocks is the only alternative to my original proposal, and I think that the dimensions of the mound suggested by the Committee are the least that ought to be adopted for the most exposed parts of the piers.

1259/2

These dimensions are considerably greater than those which were offered as an alternative to my proposals from two or three quarters a year ago, and which I always felt to be insufficient, though I was unwilling, without more data than were accessible to me while in India, to attempt to form any definite conclusions as to what was really adequate. Since my return to England in May last I have given much attention to the subject, and my conclusions, based on information derived from many quarters, are very similar to those at which the Committee have independently arrived.

7. So far, therefore, I am entirely in accord with the Committee, and as far as it is possible to dissociate general principles from their application to a particular case, our accord, I believe, goes much further. But for the present this is as far as I feel justified in following the actual lines laid down by the Committee, though, with so much common ground for our departure, it is hardly likely that there would be any very great divergence in the further development of our views.

8. The adoption of the random mound system instead of the built additions I proposed for the 1,000 yards most seriously damaged involves, in round numbers, an additional expenditure of 15 lakhs of rupees to the 18 lakhs of my original estimate. The continuation of the same system shorewards, with gradually decreasing dimensions, would involve a still further excess of outlay, so that the large estimates given by the Committee would probably be approached by any that I could myself frame upon a design based on the ground common to the Committee and myself.

9. I may therefore suggest, as a safe assumption, that the amounts estimated by the Committee should be taken as the data for the consideration of the financial view of the question.

10. It may be assumed, however, that the sum of 480,000*l.*, the estimate for the scheme specially recommended, is equivalent to 48 lakhs of rupees, and that it may also be taken as a *maximum* subject to probable diminution. I find that the rates upon which this estimate is based are slightly in excess of those upon which the work has been hitherto carried out. I furnished these latter to the Committee, and they appear to have converted them into sterling money at the rate of 2*s.* to a rupee, and then made the slight additions. This excess is, I believe, an allowance to cover the cost of additional plant, an allowance which I am in the habit of making as a separate item. Assuming therefore the quantities given in the estimate, I can confirm the total amount. Credit, however, should be taken for the value of materials now on the ground, and available for future use (including concrete blocks prepared for the ends of the piers which were unfinished at the time of the storm). This amounts to about one lakh. It should also be borne in mind that the estimate is swelled by the cost of the additional 100 feet of pier recommended to narrow the entrance from 550 to 450 feet. This would be in round numbers 1½ lakhs.

11. It is also clear that the Committee have adopted the most unfavorable assumption possible of the extent to which the blocks in the damaged parts of the work will be available for further use. This is perhaps the safest course for the present; but it should be understood that there is a certainty of some saving in this respect, though its amount is indeterminable till the blocks are actually recovered. I think if the *least* instead of the *most* unfavorable view were taken on this point there would be a saving of seven or eight lakhs of rupees. A recent examination, made under exceptionally favorable circumstances, confirms the best expectations previously entertained upon this point. On all these grounds therefore I think I am justified in asking that the 48 lakhs should be taken as a *maximum*.

12. The Committee put forward two alternative schemes, which are both estimated as somewhat less costly than the one they recommend. It is perhaps desirable to show what there is to fall back upon in the event of any very unforeseen difficulties in carrying out the more favored plan, but I think the arguments adduced by the Committee against these alternatives may be strengthened by other considerations. Both were fully considered on the spot during my investigations last year, and both rejected, not as absolutely impracticable, but as unsuitable in many respects. I believe also the apparent economy in comparison with the recommended plan would vanish on further investigation.

13. I would beg to offer some remarks on two points raised by the Committee at the end of their report, viz., narrowing the entrance, and lighting it. They estimate for the former, but not for the latter, stating, however, with regard to the latter that provision will have to be made for it.

14. With regard to the entrance, it is satisfactory to find that the Committee confirm the propriety of its present position as a question of general design. As to the special nautical considerations on which a change has been advocated, no evidence, except that contained in the papers, was brought before them, and as that is all on one side, their conclusions adverse to a change is based entirely on general grounds. I am bound to say that, if an immediate decision were necessary, I should agree with the Committee; but, considering that no measures can be taken to carry out either the narrowing or the entire change of position till all the other works are completed, I would submit that it is undesirable, in view of the strong opinions expressed by

the marine authorities, to come to any decision at present. The eastern entrance, 550 feet wide, exists, bad or good, and must be used for the next four or five years. During that time it will have a more extended trial than it has yet had, and there will be more material for a final judgment. I would express a hope, therefore, that no definite order be given, either for reducing the width, or for altering or retaining its position, until nearer the time for carrying out the actual work. It need not be concluded, however, that the efficiency of the harbour is dependent upon the width or position of the entrance. Even admitting that a change in either respect would be an improvement, it will not make the difference between a harbour and no harbour; it would only give more accommodation, which of course, if required, would bring more revenue.

15. With regard to lighting the entrance, the matter has had much consideration, and though I cannot say that a definite plan has been decided upon between the marine officers and myself for submission to Government, I am satisfied that no very costly works will be required. The sum of Rs. 20,000 stands in the amended estimate last sanctioned for this purpose, and this amount will be ample for anything I can contemplate. I do not think it would be desirable to facilitate the entrance of ships in very bad weather at night. They should stand out to sea, or anchor in the roads till daylight. The position of the inner limits of the anchorage might be marked by intersecting shore lights, though the soundings give an excellent indication of a ship's position. In the weather, however, the entrance should be marked either by leading lights on shore, or by small lights on the pier heads, which latter should not be exhibited at all in bad weather. I think these arrangements would meet all the requirements of the trade, as at present conducted, and it is therefore unnecessary to contemplate any provision for lighting beyond the already sanctioned amount.

16. I think, considering the great addition to the quantity of work involved in the adoption of the wave-breaker system, at least four years would be required for the completion of the works, reckoned from the time of recommencing block setting. This could not be done in less than nine or ten months from the issue of the Government sanction, as the Titan cranes will have to be manufactured in this country, sent out, and re-erected on the spot.

From J. H. TAYLOR, Esq., Lieut., R.N.R., Master Attendant, Madras, to the Chief Secretary to Government, dated Madras, 9th April 1883, No. 3163.

Mr. Thorowgood having returned to Madras, and having been in consultation with the Harbour Committee in London, I have been, by his kindness, put in possession of a general view of the contemplated restoration of the Madras Harbour, and while the nature of the work seems to promise success in rebuilding the sea face, I deeply regret to observe that no mention is made of the necessity of closing the present mouth and substituting another, which will secure the imperative desideratum of smooth water. Without this all nautical men are agreed that the harbour will not be complete, and without smooth water none of the internal improvements we so much desire to see can be effected. I may say without any exaggeration that the future utility of the harbour depends on the recognition of this fact, and on the remedy of the present evil. I would therefore most urgently and respectfully beg leave to press it on the attention of Government. I believe I may say that Mr. Thorowgood considers this question in the same serious aspect, and he has submitted to me a plan of his own, which was in some degree anticipated by one of Colonel Sankey's, for constructing a wall across the 6 fathoms line of the harbour to form a second line of defence against the swell, and have one or more openings leading into the circumscribed basin in shore; but while I admit the efficacy of this measure, I must point out that the harbour is already too small, and though Mr. Thorowgood suggests dredging the present shallow parts, and thus securing more space, yet that measure I contend will in no distant future be found necessary even with present area to provide the increased accommodation that the trade of the port will demand, and in fact even now demands in the case of sailing ships and small craft, with the further prospect of quays and docks, which would be the outcome of a smooth-water harbour. It would therefore be better to grapple with the evil, and allow the estimate for rebuilding the walls to include the effectual closing of the east opening, and the substitution of another in 6 fathoms in the north erm. We see enough of the action of nature on the harbour projection to feel sure that deep water will always be found on the north side, while the south side, though quieter, is exposed to a silting process of which it is not easy to predict the termination.

2. Mr. Parkes' system of buoys, by aid of which he calculates a number of ships can be packed, depends wholly on smooth water. In fact, the whole practical value of the harbour depends on this by far the most important question with which its reconstruction is connected. Some saving in plant and establishment would be made by the work being only conducted on the south side, and as the question is one that must be considered from its financial as well as its useful aspect, the Harbour Committee, in which the Chamber of Commerce is well represented, might be asked to report to Government the public feeling upon this all-important subject.

No. 777, Marine.

Transferred to the Public Works Department.

(Signed) C. G. MASTER,
Chief Secretary.

Ootacamund,
17th April 1883.

Order—dated 30th April 1883, No. 1259 W., Public Works.

In order to give effect to the instructions conveyed by Her Majesty's Secretary of State in paragraph 2 of Public Works Despatch, No. 10, dated 8th March 1883, that this Government should take into consideration the best means for restoring the works of the Madras Harbour, in view to assisting the Government of India to arrive at a decision upon the course which it will be most advisable to follow, His Excellency the Governor in Council resolves to assemble the following Committee to report on the matter at an early date, viz.:—

Colonel R. H. Sankey, C.B., R.E., President.
Colonel J. O. Hasted, R.E.,
Lieutenant J. H. Taylor, R.N.R.,
T. E. Marshall, Esq.,
F. N. Thorowgood, Esq., M. Inst. C.E.,
N. St. B. Beardmore, Esq.,
} Members.
Major C. Bowen, R.E., Secretary.

2. As laid down in paragraph 4 of the Secretary of State's Despatch, No. 10, dated 8th March 1883, so far as the engineering questions involved are concerned, the views of the Committee consulted under Lord Hartington's instructions are to be accepted as closing the discussion on the principle of restoration to be followed; but as there are two distinct methods of applying the general principles to the seaward arms of the work—

(1) as per Section No. 3 of the Home Committee's Report, and
(2) as per Section No. 4,

and, further, as the estimates given are professedly only approximate, the Committee above appointed should submit distinct recommendations, and, as far as possible, a detailed estimate for the sanction of the Government of India.

3. The Home Committee, at the close of their report, observe that the stillness of the harbour would be increased by reducing the width of its entrance from 550 to 450 feet, the cost of which they have included in the estimate; but as judging from the opinions of masters of vessels and others consulted on a previous occasion it appears doubtful whether, under the peculiar circumstances of the harbour, the present width of the entrance can be reduced with complete safety, the Committee should inquire particularly into the matter, and in case their inquiries tend to confirm the evidence already on record, they may consider themselves authorised to submit such alternative scheme as may appear to them feasible, while strictly adhering to the general engineering principles recommended by the Home Committee, and as far as possible limiting themselves to the cost of restoration as now estimated, viz., £480,000.

4. Definite proposals should also be submitted regarding the plant, if any, now to be procured from England, as also the funds which should be provided for in the current and following years so as to insure the early and economical completion of the work.

5. Attention should likewise be given to the provisions necessary for liguting the entrance of the harbour adverted to in the closing paragraph of the Home Committee's Report.

(True Extract.)

(Signed) R. H. SANKEY, Colonel, R.E.,
Secretary to Govt., P.W.D.

To Colonel R. H. Sankey, C.B., R.E.
" Colonel J. O. Hasted, R.E.
" Lieutenant J. H. Taylor, R.N.R.
" T. E. Marshall, Esq.
" F. N. Tharowgood, Esq., M. INST. C.E.
" N. St. B. Beardmore, Esq.
" Major C. Bowen, R.E.
" the Superintendent, Madras Harbour Works.
" the Master Attendant, Madras.
" the Marine Department.

Exd. C. Howarth.
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BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of {1883} Madras.

PUBLIC WORKS.

Dated April, 30th.

Recd. *Encl.*

G.O., 30th April 1883, No. 1259 W.

APRIL.

Madras Harbour Works

The formation of a Committee to consider the subject of the restoration of the —, ordered.

1259
5

9TH JUNE 1884, No. 1436 W., PUBLIC WORKS.

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Civil Works.

READ—the following papers :—

From R. B. BUCKLEY, Esq., Officiating Under Secretary to the Government of India, Public Works Department (Civil Works—Miscellaneous), to the Secretary to the Government of Madras, Public Works Department, dated Simla, 17th May 1884, No. 198 M.

In continuation of previous correspondence on the subject, I am directed to forward, for the information of His Excellency the Governor, the accompanying copy of a despatch* and enclosures from Her Majesty's Secretary of State for India regarding the proposed scheme for the restoration of the Madras Harbour, and to request that the Government of India may be favored with an expression of the views of the Madras Government in the matter.

* No. 23, Public Works Department, dated 24th April 1884.

2. Copies of notes on the subject by the Consulting Engineer to the Government of India for State Railways, and the Secretary in this department, are also forwarded for information.

— — —

Despatch from the Right Honorable the Secretary of State for India, to His Excellency the Most Honorable the Governor-General of India in Council, dated India Office, London, 24th April 1884, No. 23, Public Works.

On receipt of your Excellency's Public Works letter, No. 59, of 13th November 1883, which forwarded a correspondence with the Madras Government relative to the engineering merits of the scheme proposed for the restoration of the Madras Harbour, I caused the subject to be again referred to the Select Committee who had been originally appointed to consider the subject, and requested that I might be furnished with their views on the modifications of the plan recommended in their report of 23rd January 1883, which had been suggested by the Committee appointed by the Government of Madras.

2. Sir John Hawkshaw has, in the accompanying report, furnished me with an expression of the joint opinion of himself and his colleagues on the recommendations of that Committee, and after giving my careful consideration to the same in Council, I have come to the conclusion that the opinion now expressed must be accepted as the final decision on the questions raised.

3. The entrance to the harbour will accordingly be retained in its original position, and may be narrowed as recommended.

4. The side piers must be raised to the height of 12 feet above high-water level, as originally recommended, and if loading places are provided, in the manner suggested, inside the harbour and near the piers, the necessity for raising them still higher will have to be considered.

5. With regard to the method of reinstating the work, your Excellency will perceive that the Committee have not pronounced definitely in favor of any one of the three systems mentioned in their original report.

6. In accordance with the recommendation of the Committee, I have caused a reference to be made to Mr. Parkes on the subject. I forward, herewith, copy of a letter which I have accordingly caused to be addressed to him. After very carefully considering whether, in consequence of the partial failure of the works, it was expedient to remove Mr. Parkes from the position of advising engineer, I have come to the conclusion that his removal would not be justifiable, and I consider that it will be desirable for him to proceed to Madras, and there personally arrange the measures which it will be necessary to take for carrying out in the most efficient and economical manner the works now to be undertaken. I shall be glad to receive your Excellency's views upon this point after you have communicated with the Government of Madras.

Joint Report of Sir JOHN HAWKSHAW, Sir JOHN COODE and Professor STOKES, to the Under Secretary of State for India, India Office, London, S. W., dated London, 12th March 1884.

MADRAS HARBOUR.

In obedience to instructions contained in a communication from the India Office, dated 6th of February last, copy of which is annexed, we have read and considered the papers forwarded to us, and have now the honor to report our opinions on the modifications suggested by the Madras Committee of the plan we last year recommended.

2. The change suggested by the Madras Committee requiring the gravest consideration is their proposal to make a new entrance to the harbour at its north-eastern elbow and to stop up the existing entrance. Their object in making this proposal is to secure stiller water inside the harbour, a thing desirable in itself if attainable with due regard to other considerations, and they state that the work remodelled in this and in other respects as they recommend will cost much the same as the works advised by us in our report of the 23rd January 1883.

3. The Madras Committee arrive at this conclusion of equality of cost by leaving out from their project the wave-breaker on the south side and the concrete cap on both sides of the harbour, and appear to have assumed, though we are at a loss to know why, that we did not attach any very indispensably constructive value to this portion of our recommendation. They seem to have looked at our proposal to raise the piers by a concrete capping mainly as a question of waves spilling over them into the harbour, though the observation in our report was that raising the piers to the height we advised would add to the security of vessels within the harbour in rough weather, and would greatly strengthen the work.

4. We cannot approve of further expensive works, the money for which is chiefly to be found by reducing the strength and efficiency of those recommended in our report of January 1883, which we now see no reason to abate.

5. It follows, therefore, in our opinion, that the proposal to form a new entrance and to stop up the old one must be treated as an additional expenditure to that previously contemplated by us.

6. We have consequently estimated the cost of making the new entrance and of stopping up the old one; and taking the overlapping arm, as the Madras Committee show it, to be 600 feet long, which, in our opinion, would be the minimum length required, we make this additional cost to amount to £127,000. In considering the propriety of incurring such further expenditure, the following observations should be borne in mind.

7. The danger to vessels within the harbour in a cyclone would arise from the winds as well as from the waves, probably more from the former than the latter, and we think that prudent commanders, on those occasions, would prefer getting out to sea to remaining inside the harbour.

8. If the piers at the sides of the harbour were left as low as is contemplated by the Madras Committee, they would in cyclones be nearly, and might be altogether, submerged, and vessels lying in the harbour would be floating in a receptacle brimful,

1259
6

or nearly so, of water, and exposed on the north and south to the full force of the cyclone. In such case, with submerged piers, vessels breaking from their moorings would in all probability be lost.

9. Though the piers raised to the height we have recommended, while strengthening the work, would afford some additional protection from the wind, we do not assume that even then it would be safe to remain in harbour during a cyclone. Mr. Dalrymple, late Master Attendant, Madras, who has had lengthened experience of that coast, and who favored us with his views on the occasion of our former inquiry, was of opinion that nothing short of 18 feet above high water would be high enough for the piers, and we consider the height of 12 feet, which we have recommended, to be quite low enough. Hereafter, in special cases, should vessels be required to lie at loading places inside the harbour and near the piers, screens or walls, say 6 feet high, increasing the total height above high water to 18 feet, could be erected, and might prove necessary to give further protection from wind.

10. In large harbours it may almost be taken as an axiom that in proportion as you seek greater stillness inside you have to obtain it by rendering access to and egress from the harbour less easy.

11. On the occasion of our inquiry last year we were informed that a new entrance to the harbour had been suggested at the south-east elbow, and we then considered the question of changing the entrance, and reported against it.

12. Though the Madras Committee say that the strongest winds are from the north-east, and though winds blow twice as long from that quarter as from the south-east, they now propose a new entrance fully open to those prevailing winds.

13. It is, perhaps, more a nautical than an engineering question, but we fear that access and egress through this new entrance would, in cyclones, be very difficult, the difficulty increasing just in proportion as the entrance was made to face the north, and diminishing as it faced easterly. Even with the north-easterly kant shown on the Madras Committee's plan, vessels could not make or leave the harbour without being exposed to waves striking them on their beam, and tending to heel them over, or to carry them into shoal water on shore, or to cause them to strike against the end of the northern pier.

14. With regard to the new entrance, there is another consideration of some moment. The present entrance could not be stopped up until the new entrance was made, and there would, therefore, for a considerable time, be two entrances, and during that period there would necessarily be greater disturbance in the harbour.

15. With regard to the methods of reinstating the work, the Madras Committee appear to prefer the random block system. This is shown in our report of 23rd January 1883 by cross' section No. 5. Though we did not give it a preference, we stated in that report that it possessed advantages, and was a safe system to follow.

16. In framing that report we had to deal with a work which had been much more damaged in some places than in others, the extent of damage at some points not being very clearly ascertainable, nor capable of being determined until the work of restoration should be in progress; and hence we devised different methods of restoration.

17. Besides the objections we pointed out to the random block system, not perhaps very weighty in themselves, we were also influenced, to some extent, by difficulties of manipulation in that system.

18. On this subject we beg to remark generally that, referring to the three methods of reconstruction shown in our previous report, viz.:—

1. According to cross sections 1, 2, and 3,
2. Do. do. do. 1, 2, and 4,
3. Do. do. do. 1, 2, and 5,

we consider that any of them may be adopted with safety, provided they are in nowise weakened by diminution of their dimensions or otherwise.

19. In considering the matters now referred to us, we have had interviews with Mr. Parkes, who has explained to us his views. He sees some difficulty, as we did,

in carrying out the system shown on cross section No. 5, and seems farther to be of opinion that he should prefer to adopt cross sections 1, 2, and 4. With regard to this question, we think you may be guided by Mr. Parkes with the clear understanding, so far as we are concerned, that nothing is done to weaken any of the works recommended by us, whichever of the methods be adopted, and that the piers be not built to a lower level than we have already advised.

20. The only question remaining to be dealt with is the important one of change of entrance.

21. We have already pointed out that the change of entrance would add £127,000 to the cost of what we consider to be necessary works. We think also that in cyclones there would be difficulty in getting into and out of the harbour through the proposed north-eastern entrance, and if, during a cyclone, captains were not disposed to remain in the harbour, and could not get their vessels out, it would be a serious matter. We have also mentioned that, if a new entrance be formed, the harbour will, for some time, be left with two openings instead of one, and will consequently be more disturbed.

22. We are still of opinion that the present entrance might, with advantage, be reduced to 450 feet, having walls vertical, or nearly so, on both sides of the entrance as we always contemplated, and see no reason to alter the opinion given in the last paragraph but one of our former report of the utility of the harbour if completed in accordance with our recommendations.

23. It must not be forgotten that, whether the harbour were completed with the present or with a new entrance, there are now no sufficient facilities within it for loading or unloading vessels; and if further expenditure is to be incurred, it is a question whether it would not be better to incur it in providing such facilities at or near the base or shore end of the harbour, rather than in making a new entrance.

24. After giving the fullest consideration to this question, we cannot recommend the construction of the proposed new entrance.

25. In conclusion, we beg to call attention to the fact that in all the estimates we have made, whether in this or our previous report, we dealt with our own prices in English money only, and our prices were in nowise modified or increased (as Mr. Parkes seems to have inferred) by adopting his rates and converting them into sterling money at the rate of two shillings to the rupee. The conversion of our estimates into rupees must, therefore, be made at the current value of the rupee, whatever that may be.

ENCLOSURE.

From J. K. CROSS, Esq., to Sir JOHN HAWKSHAW, dated India Office, S.W., 6th February 1884.

With reference to the report prepared by yourself in conjunction with Sir J. Coode and Professor Stokes, dated 23rd January 1883, on the subject of the steps to be adopted for the restoration of the Madras Harbour, I am directed to inform you that copies of that report were duly furnished to the Governments of India and Madras for their information and guidance.

2. Before taking measures for carrying out the work of restoration, it is necessary that certain important questions, which have been raised in India, should be definitely settled.

3. The Secretary of State in Council is accordingly desirous of receiving the opinion of the Committee, of which you before were a member, upon certain modifications of the plan which they last year recommended, which have been proposed by a Committee at Madras and are generally concurred in by the Government of India; and I am directed to furnish you with the accompanying papers which will place you in possession of all the proceedings which have since occurred in India in connection with the subject.

4. The Committee will understand that they are at liberty to communicate with Mr. Parkes in respect to any points on which they may deem it advisable to obtain further explanations.

5. I am to add that, in view to the desirableness of coming to an early decision in the matter, the Secretary of State in Council trusts that the further inquiries now rendered necessary will be completed as soon as possible, and that the Committee will be able to limit their meetings so that the charges may be kept below the maximum amount named by Mr. Hayter in his letter to Mr. Danvers of the 24th January 1884, namely, 450 guineas.

1259
7

ENCLOSURE.

From J. K. CROSS, Esq., to W. PARKES, Esq., dated India Office, 21st April 1884, No. 502.

I am directed by the Secretary of State for India in Council to forward, herewith, copy of a second report by the Committee appointed by the Secretary of State in 1882 to consider the question of restoring the Madras Harbour.

2. This report contains the opinions of the Committee on certain modifications in the measures recommended in their original report of 23rd January 1883, which have been suggested by a Committee appointed by the Government of Madras.

3. With reference to the recommendation at page 5 of the report, you will observe that the Committee are of opinion that any one of the methods of reconstruction proposed by them in their first report may be safely followed, and that, after consulting you on the subject, they think that your advice may be taken by the Secretary of State, and I am accordingly desired by Lord Kimberley to request that you will furnish him with your opinion on this point.

4. I am to add that your position in connection with this work will be the same as it was before the letter of the 12th October last was addressed to you, and that your salary will accordingly be at the rate of £500 per annum from the present date, it being understood that your engagement may at any time be determined on payment to you of the sum of £500.

5. I have further to state that Lord Kimberley is inclined to think that it will be desirable for you to proceed to Madras with the view of organising arrangements for carrying out the works on the basis of the Committee's recommendation. I have to request, therefore, that you will furnish His Lordship with your opinion on this proposition, and state when you would be prepared to act upon it in the event of its being decided in the affirmative.

Notes on the Joint Report of Sir John Hawkshaw, Sir John Coode and Professor Stokes, dated 12th March 1884.

The joint report makes no allusion to the notes made by Colonel Brownlow and myself, and there is nothing in this report to induce me to modify the views I have expressed in my note of the 17th August 1883.

2. In that note I proposed a postponement of the raising the sides until further experience had been gained as to the necessity for the work, and I still think that course should be pursued. Nothing would be lost and much might be gained by such a course of action, as the work of reconstruction of the faces and elbows is that which is the most pressing.

3. In page 2 of the report it is stated—

"The danger to vessels within the harbour in a cyclone would arise from the winds as well as the waves; probably more from the former than the latter: and we think that prudent commanders on the occasions would prefer getting out to sea to remaining in the harbour."

4. I entirely agree with this opinion; in fact my views have been already indicated in my note as follows:—

"I must confess that I am somewhat sceptical of the absolute safety of vessels in Madras harbour during a cyclone, even under the conditions of having raised the face and elbows and closed the seaward entrance."

5. I may go still further and express my conviction that the capping would afford no protection against wind worth mention; and that even with this I consider it would be an act of madness for the commander of any vessel to remain in the harbour during a cyclone. If the capping and wave-breaker are to be added for wind protective purposes only, and not for constructive purposes, I think their construction will be a waste of money, as it is practically admitted that vessels cannot remain in the harbour during a cyclone.

6. The report also states (page 4) that with the northern entrance proposed by the Madras Committee—

"Vessels could not make or leave the harbour without being exposed to waves striking them on the beam, and tending to heel them over, or to carry them into shoal water on shore, or to cause them to strike against the end of the northern pier."

7. This agrees with the opinion I have already expressed in my note in the following terms:—

"When a vessel is entering such a harbour, half protected by the entrance and half exposed to the action of a heavy wave, it is liable to be swung round and strike the entrance before it

can recover itself. This is a contingency to which modern vessels, from their extreme length, are especially liable."

8. The report, however, makes no allusion to the alternative I suggested in my note (as shown in diagram No. 4) with the view of meeting this difficulty.

9. The whole question, however, is, as the report suggests, "more a nautical than an engineering one," and I presume that the difficulty was considered by the nautical authority in the Madras Committee, and that it was preferred to face this difficulty rather than to incur the risk of narrowing the entrance. I would, therefore, repeat my previous recommendation on this point that—

"With regard to the alternative entrance from one side, I would advise that the question be referred to some eminent nautical authority in India, bearing in mind that a *concave face to the breakwater* is quite inadmissible."

10. No allusion has been made in the report to the suggestion I made in my note of a modification of the section originally proposed by the Home Committee, although I pointed out that this section was, in my opinion, open to the very serious objection of tending to break rather than to deflect the wave, and thus to set up a very destructive wave action.

11. We know so little of the possible ultimate force of cyclonic waves, that I am very strongly of opinion that every endeavour should be made to *minimise the wave action on the structure.*

12. With regard to this question, I annex some extracts from the opinion of Mr. Scott Russell, the highest authority on wave action.

13. It will be seen from these extracts that the *breaking* of the wave is "a formidable thing to attempt," and that the limiting angle for *reflecting* a wave is 45° or a slope of 1 to 1; whilst the section proposed by the Home Committee has a slope greater than $1\frac{1}{2}$ to 1 for the blocks and nearly 4 to 1 for the rubble, which is clearly within the limits of wave action.

14. It is useless to argue that flat slopes have stood the effects of the waves at the English ports, for most of those ports are so land-locked that they are never exposed to any wave action at all approaching that of a *cyclonic* wave. They have, in fact, to deal with little more than the ordinary "oscillating" or surface waves which, as the extract shows, are not the "deadliest enemies with which breakwaters have to contend."

15. The Alderney breakwater, which is more exposed than the majority of English breakwaters, has been constructed with slopes of 2 to 1, changing to more than 4 to 1, and it has suffered severely.

16. The French engineers have acknowledged the soundness of the principles laid down by Mr. Scott Russell, and their more modern breakwaters are constructed with slopes of 1 to 1 on the seaward face.

17. I am of opinion, therefore, that this slope should be adopted for the Madras breakwater.

18. The report considers that Government "may be *guided by Mr. Parkes*" with reference to the adoption of cross section No. 4; but it makes no allusion to the difficulty to which I have drawn attention in my previous note respecting the irregularity of the *débris* of the original wall which—

"being in advance of the new wall would probably set up a very serious wave action, of which it is impossible to predict the result;"

and such an action ought, in my opinion, to be avoided.

19. The report, moreover, states that Mr. Parkes sees some difficulty in carrying out cross section No. 5 (random blocks); but as it has not stated the precise character of that difficulty, I would suggest that its exact nature should be ascertained with the view of obtaining from Mr. Thorowgood a report as to the practical value of the objection, and whether this difficulty may not be overcome.

20. In conclusion, I may say that I adhere to all the recommendations I have previously made in my note of the 17th of August 1883.

G. L. M.
R. B. B.

19th April 1884.
20th April 1884.

1259/8

Secretary.

It strikes me that the distinguished authors of the joint report are under a very serious misapprehension as to the character of a cyclone. They talk of vessels going into and coming out of the harbour during a cyclone as if such a feat were easy of accomplishment with a sufficiently open entrance. As a matter of fact, it would be simply impossible for any vessel to make head against the wind and sea of these storms. If they wish to get out of the harbour to ride out the cyclone at sea, they must leave it at the first premonitory signs of its approach, which are generally unmistakable. Once the storm has fairly set in, the ships then in the harbour must trust to their moorings and to them only for safety.

2. If the force of the waves rolling in from seaward be effectually broken by the breakwaters, and the water in the harbour be no rougher than the wind acting on its limited area could make it, I for my part fail to see altogether what special risks ships attached to secure moorings, with their top hamper lowered, would run from the wind alone.

3. It has been my lot to be in two cyclones in Calcutta and one at sea. The first cyclone in Calcutta did immense damage to the shipping, owing entirely, in my opinion, to the defective moorings. Numbers of ships broke loose and drifted up and down the river till they were sunk by collisions with others or were finally lodged on the banks. A larger number still were sunk at their moorings being cut down by the drifting vessels.

4. Before the second cyclone occurred the moorings had all been renewed, and though it was quite as severe as the first, the shipping scarcely suffered at all, though almost all the boats, as on the previous occasion, were destroyed. Wind alone won't sink a ship properly moored and in good trim, though heavy breakers without wind may. If then the breakers can be kept out of the harbour and proper moorings provided within it, every sea-worthy ship should be able to ride out a cyclone in perfect safety.

5. What is wanted, therefore, for the Madras harbour is—

1*st.*—A form of entrance which will not allow the heavy rollers from the bay access to the interior in any weather.

2*nd.*—Sufficient height and strength of breakwaters effectually to do the same.

3*rd.*—Good moorings for the ships inside. If the entrance is also such that vessels may safely go in and out in all ordinary monsoon weather, I do not see that anything more is either wanted or attainable. But to achieve so much, I would not shrink from expending £200,000 or £300,000 additional. Safe harbours are as much a want of the country as improved internal communications; and as the Government grudges nothing spent on the latter, it should equally little grudge expenditure on the former, which are practically only places for the transfer of goods from land to sea carriage, and *vice versâ*, *en route* to their ultimate destinations.

21st April 1884.

W. S. T.

ENCLOSURE.

Extracts from remarks made by MR. J. SCOTT RUSSELL (*Min. Inst. C. E., Vol. XIX*), *page* 653, 1860.

* * * * Now, in deep water, there were not only the *oscillating surface waves* to be encountered, but also those which he had termed *waves of translation*, forming what were called rollers at the Cape of Good Hope, and, when on a smaller scale, known as ground swell. These were a much more troublesome class of waves; it was mainly with them that the engineer had to deal in places open to the Atlantic: and after a storm of some duration at sea, they became the deadliest enemies, in the cases of deep water, against which breakwaters for harbours of refuge had to contend * * * * *

To reflect, or send back the roller was the most effectual plan. For this purpose, nothing more was necessary than a deep perpendicular face of perfect masonry, and so long as it stood

firm; it was faultless, and the water inside was smooth as in a millpond: for the reflection really converted the whole effect of the roller on itself into a simple pressure of water. When such a wave was reflected on a perpendicular wall, it merely produced a hydraulic pressure equal to that due to little more than double its own height. * * * * An inclined wall, he had ascertained, would reflect a roller or deep wave nearly as well as a vertical wall down to an inclination of 45°. This observation was of value, because at 45° large blocks judiciously placed would not move out of position even although a considerable breach was made in the wall near them. He had carefully watched the action of the sea when approaching this slope, and his opinion was favorable to the trial of a wall of heavy rubble blocks fairly laid, so as to form a tolerably even face, or slope of 45°, when the nature of the materials and the local circumstances would permit.

When any approximative attempt at reflection of the wave, by walls not *too remote from the vertical*, had to be abandoned, recourse must generally be had to breaking the wave; *this was a formidable thing to attempt* on a deep-sea roller, and it could only be done by opposing mass to mass.

From J. H. TAYLOR, Esq., Lieutenant, R.N.R., Master Attendant, Administrative Department, Madras, to the Chief Secretary to Government, dated Madras, 6th May 1884, No. 4354.

I must beg leave respectfully to apologise for addressing Government on a point of which I have no official knowledge, but the reports of which have reached me from sources that seem reliable. I hear that the restoration of the harbour of Madras is to be carried out with the omission of the one great alteration that will alone give any real value to it. I mean the closing of the eastern entrance.

2. Smooth water, upon which the whole comfort of the interior and the only chance of improvement in interior arrangements depend, will never be obtained, and Madras will be condemned to perpetual inferiority as a harbour, after so much will have been spent upon it. I would, with deep respect, but all the urgency that language can convey, implore His Excellency in Council not to accept such a conclusion until, at all events, the sense of the community has been sought, and its concurrence obtained. Every recurring storm, or presence of cyclonic wave in the neighbourhood of Madras, will repeat all the injuries that we witnessed on the occasion of the sea of November 1881. The sea that came through the east opening on that occasion destroyed the newly commenced low-level jetties, wrecked all the lighters, and committed general havoc on the beach among all classes of boats, before the walls showed any disposition to fall. His Excellency the Governor may perhaps remember that I waited upon him about 11 o'clock to report upon the weather, and that I reported the walls secure, but the damage abovementioned committed. It was on my return to the beach that I was an eye-witness of the very commencement of the work of destruction. The strongest portion of the walls, *i.e.*, each side of entrance of four blocks wide was the first to go, unmistakably owing to the sea and current rushing round them and attacking on two faces at once. If this fearful blunder is not remedied now that an opportunity providentially offers itself, the last chance of a useful harbour for Madras is thrown away.

3. I know Mr. Thorowgood cordially endorses these opinions, though delicacy towards his chief interferes with their expression; but no sentiment ought to be allowed to interfere where such enormous public interests are concerned.

4. I am also told that the east opening is adhered to from nautical reasons. This is entirely opposed to fact. All commanders of vessels who have been consulted, and that includes nearly all that have visited Madras since the accident, approve entirely the alteration from every point of nautical convenience. I submitted some of the chief opinions, but I could have collected hundreds, all giving testimony of the same nature.

5. The public are now committed to a tax upon the understanding that they will have a sufficient harbour, but I distinctly dare to assert they will never have one worth the name, or worth anything like the amount, unless smooth water is secured. Then all the conveniences of a harbour will soon follow, and few ports be in a better position than Madras. If no lesson is to be learnt from the destruction before us,

1259/9

correction for the fault will fall upon the innocent public, who, I respectfully submit, should be invited in some way to express an opinion upon a point of such vital importance to their future interests. The question is not one of engineering, where the judgment of such men as Sir John Hawkshaw, Sir John Coode, &c., is unassailable, but is one of observation and experience in a perfectly novel situation. Observation convinces all who were witnesses of the former accident that the east opening is a fatal defect, and all experience teaches us that the sand on this coast is not to be depended on for a single season for the support of regular work like the upright wall.

6. Public feeling will, no doubt, be strongly excited when it is generally known that the anxiously expected harbour is only an unsatisfactory compromise, and that without any appreciable saving in money, they will be called upon to abandon the prospect they have had of docks, jetties, and countless advantages, which the plan of the Madras Committee would have secured to the port.

7. I have marked this confidential, but of course that is only to secure the first consideration by Government. The facts will soon be patent and open to public controversy. I can write in officially if desired, and append the opinions of all my department.

ENCLOSURES.

From J. H. TAYLOR, Esq., Lieut., R.N.R., Master Attendant, Administrative Department, to the Acting Chief Secretary to Government, dated Madras, 4th September 1883, No. 8607.

I have the honor to forward, as desired, the opinions of the nautical men upon the proposed closing of the east entrance of the harbour, and opening one to the north. The opinions are all strongly in favor of the plan, and are all by men of great experience and good position. I could, of course, continue the collection, but the result would be the same, while much valuable time would be wasted. There can be no doubt that the change would be good in every way, and the smooth water thus obtained, and the security offered by a wall, as recommended by the Madras Committee appointed in G.O., Public Works Department, No. 1259 W., dated 30th April 1883, would be of incalculable advantage to the port, and admit of immediate beach improvements for landing and shipping.

From ARTHUR E. BARLOW, Esq., Commander, P. and O. S.S. *Parramatta*, to the Master Attendant, Madras, dated 1st August 1883.

I have read with much interest the reports of the local and Home Committees on the reconstruction of the harbour of Madras, with which you were good enough to furnish me, having had considerable personal experience of the port for upwards of thirty years.

On the particular point upon which you wish for my opinion, namely, the closing of the present entrance to the harbour and the opening of one in the north-east angle of the north arm, so far from seeing any objection to it, I think it will be a positive advantage, as, in my opinion, it will be equally easy of ingress and egress with the present one, and will give a larger area of deep water for mooring large vessels, and will, I think, under all conditions render the water inside the harbour much smoother than it ever is at present. I return the reports, herewith, with many thanks.

From J. S. MURRAY, Esq., Commander of the P. and O. S.S. *Shannon*, to the Master Attendant, Madras, dated 5th August 1883.

I have read with much interest the papers relating to the Madras Harbour, and having closely studied the plans, I have come to the conclusion that the plan proposed for its reconstruction by the Committee of June 1883 is the very best that can be undertaken, and that, while giving larger accommodation for shipping than ever before, it will ensure what was deficient in the old scheme, viz., shelter and protection in cyclonic weather.

For obvious reasons the new entrance must be to the northward; and there can be no question about closing the present one.

I would venture to suggest that there should be no stint in the protecting arm for the new entrance, and that it should be carried out more northerly than westerly.

From W. A. BURKITT, Esq., Master, B. I. S. N. Co.'s S.S. *Dacca*, to the Master Attendant, Madras, dated 10th August 1883.

I have looked over the plan for reconstructing the Madras Harbour, and think it an excellent idea closing up the present entrance, and having the new one at the north-east corner, and

when the wall of the break-water is built higher, we ought to have perfectly smooth water. The harbour ought also to be able to give accommodation to several more steamers, and I don't see why it should not be able to give protection to ships in case of a cyclone; in fact, the present plan is the first which has caused me to believe in the utility of a Madras Harbour.

From E. G. STEAD, Esq., Commander, S S. *Kaisar-i-Hind*, to the Master Attendant, Madras, dated 14th August 1883.

I have looked over the plans for the reconstruction of the Madras breakwater, and most certainly think the closing up of the present entrance the very best that could be done and the only plan by which smooth water can be looked for inside the harbour, which would then have greatly increased accommodation for more vessels, and with perfect safety.

The northern entrance would be quite as easy of ingress and egress, and to steamers preferring putting to sea on an approaching cyclone have perhaps less difficulty in getting out than through the present entrance, with possibly a gale of wind from north blowing full on her broadside.

From R. S. TURNER, Esq., Commander, S.S. *Booldana*, to the Master Attendant, Madras, dated 15th August 1883.

With reference to your request for my opinion regarding the proposed alteration in the Madras Harbour, I am of a most decided opinion that the only way in which smooth water and increased accommodation for shipping can be obtained is by closing the present entrance and making a new one at the outer end of the north pier. I cannot see why an entrance there should not, at all seasons, be as accessible as the present one.

The arm to protect the northern entrance, I think, should be curved *like* an arm towards the shore to protect the entrance from the north-east sea as much as possible, without interfering with the navigation.

My experience of the coast is twenty years in the British India Steam Navigation Company's service.

From J. DUFF, Esq., S.S. *Duke of Sutherland*, to the Master Attendant, Madras, dated 1st September 1883.

With regard to the reconstruction of Madras Harbour, I beg to state that, in my opinion, to ensure despatch in working cargo, and also safety in cyclonic weather, it is absolutely necessary that the present entrance should be closed, and a new one opened; from local circumstances this must be at the north side, with a protecting arm. This would give room for more vessels, and if the breakwater be raised, as proposed, give safety in a cyclone, vessels often being unfit to go to sea on short notice given.

From G. N. HECTOR, Esq., Master, S.S. *Carthage*, to the Master Attendant, Madras, dated 4th September, 1883.

I am obliged to you for a perusal of the plans now under consideration for the reconstruction of the Madras breakwater.

The proposed alteration of the entrance from its present position to the north-east angle of the northern arm commends itself to my judgment.

The advantages gained by this change will, I think, be—

Smooth water inside the harbour.
Increased moving space.
Less liability to accident to vessels entering or leaving the harbour.
Probably less difficulty to vessels putting to sea in bad weather.

Read again—

G.O., dated 14th May 1884, Mis. No. 203, Marine.

Order—dated 16th May 1884, Mis. No. 209, Marine.

These papers will be transferred to the Public Works Department.

(True Extract.)

(Signed) E. F. WEBSTER,
Chief Secretary.

1259
10

ORDER—dated 9th June 1884, No. 1436 W., Public Works.

Ordered that the Government of India be addressed.

(Here enter No. 1437 W., dated 9th June 1884.)

(True Extract.)

(Signed) J. SHAW-STEWART, Colonel, R.E.,
Secretary to Govt., P.W.D.

To the Marine Department, with copy of letter to the Government of India.

Exd. E. Fernandez.
Spare Copies

BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of {1884} Madras.

PUBLIC WORKS.

Dated June, 9th.

Recd. *Encl.*

G.O., 9th June 1884, No. 1436 W.

JUNE.

Madras Harbour

Ordered that the letter from the Government of India calling for the views of this Government on certain points connected with proposed scheme for the restoration of the —, be replied to.

1259
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PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Civil Works.

LETTER—from

COLONEL J. SHAW-STEWART, R.E.,

Secretary to the Government of Madras,

Public Works Department,

To

THE SECRETARY TO THE GOVERNMENT OF INDIA,

PUBLIC WORKS DEPARTMENT.

SIR,

I am directed to acknowledge receipt of your letter, dated 17th May 1884, No. 198 M., with which is forwarded copy of a despatch and enclosures from Her Majesty's Secretary of State for India respecting the proposed scheme for the restoration of the Madras Harbour, and in which you request that the Government of India may be favored with an expression of the views of this Government in the matter.

2. The three points specially dealt with in the papers now under acknowledgment are—

(1) The position of the entrance to the harbour, together with its shape and width.
(2) The section to be given to the sea-face.
(3) The officer under whom, as chief executive authority, the restoration of the harbour is to be proceeded with.

3. With respect to the first point, I am to state that His Excellency the Governor in Council still remains strongly of opinion that the entrance should be placed at the north-east angle of the harbour, in from 7 to 7½ fathoms of water, as recommended by the Madras Committee; and that it should have a width of 500 feet.

4. As bearing on this point, it appears to this Government that sufficient weight has not been attached to the unanimous opinions of nautical experts on the spot, copies of which were forwarded to you with my letter dated 14th October 1883, No. 2862 W. It is admitted by Sir John Hawkshaw's Committee that the question of access and egress through the proposed new entrance is "*more a nautical than an engineering question.*" That it is emphatically a nautical question scarcely admits of doubt; and on this point the nautical authorities who have been consulted are singularly unanimous. In a letter, dated 6th May, No. 4354, copy of which accompanies this, and to which special attention is solicited, the Master Attendant of Madras states: "All commanders of vessels who have been consulted, and that includes nearly all that have visited Madras since the accident, approve entirely the alteration from every point of nautical convenience." Captain Taylor adds: "I submitted some of the chief opinions, but could have collected hundreds, all giving testimony of the same nature."

5. I am directed to again solicit attention to those opinions; and, in doing so, to point to the fact that they represent the views of experienced men, commanding the largest steamers visiting the port; men who have known this coast and these seas for years, and who have watched the progress of the harbour works from the beginning. If there be any more competent nautical authority, thoroughly conversant with the somewhat complicated local conditions and with the nature of cyclonic storms, I am to state that His Excellency in Council earnestly requests that the question at issue may be referred to such authority before it is irrevocably decided.

6. In further connection with this point, I am directed to observe that Sir John Hawkshaw's Committee appear to have misapprehended the circumstances from want of the necessary local knowledge. In paragraph 11 of their last report, they state that during 1883 they considered the question of forming a new entrance at the south-east elbow, and reported against it; and in paragraph 12 they continue: "Though the Madras Committee say that the strongest winds are from the north-east, and though winds blow twice as long from that quarter as from the south-east, they now propose a new entrance fully open to those prevailing winds." The argument being apparently that, if a southern entrance cannot be entertained, *a fortiori* a northern entrance must be objected to still more strongly.

7. With advertence to this, I am to point out that the Madras Committee did not say the strongest winds were from the north-east, but "the heaviest seas yet observed have invariably been from the north and the north-east." As matter of fact, the wind does not at Madras blow from the north and north-east for more than four months of the year, from October to February, the direction of the wind during the remaining eight months being more or less southerly. The direction of the wind, however, seems to have little effect on the swell, which rolls in with the crests of the waves parallel, or nearly so, to the coast line; with the result that seas enter the present mouth freely, and do not disperse before reaching the shore at the base of the harbour. Those seas would be deflected from a north-east entrance by the proposed protecting horn.

8. A further objection to the north-east entrance raised by Sir John Hawkshaw's Committee is (paragraph 14 of report) that "there would, for a considerable time, be two entrances;" but I am directed to state that this Government do not attach much weight thereto, inasmuch as the old entrance could probably be closed, and the new one opened, during the interval between two stormy seasons.

9. After most carefully considering all that has been urged against the proposed new entrance, His Excellency the Governor in Council adheres strongly to the opinion he has already recorded in favor of it. He considers that the retention of the eastern entrance will involve the loss of the greater part of the advantage which Madras might otherwise confidently expect to obtain from the harbour, and that it will also, in all probability, involve heavy and ever recurring outlay to repair storm damages. And I am directed to add that this opinion is in no way contingent upon the decision that may be arrived at with respect to the necessity for providing the south arm of the harbour with a wave-breaker. If such provision can be dispensed with, as recommended by the Madras Committee, the new entrance can probably be opened within the sum (£480,000) named by Sir John Hawkshaw's Committee; but if otherwise, this Government are of opinion that the additional outlay, estimated by the same body at £127,000, *must* be incurred in view to the efficiency of the harbour and the security of vessels lying therein.

10. The question of whether ships could safely ride out a cyclone in the harbour may, in the opinion of this Government, be left to be decided by the commanders of such vessels. In most cases sufficient warning is given of the approach of a cyclone to enable vessels to get to sea, if they desire to do so; but it is impossible to entertain doubt that a vessel in the harbour would have a much better chance during a cyclone if the eastern entrance were closed, than if it were open. It should, moreover, be remembered that the main object of the harbour is not to provide a refuge for vessels during the brief period of cyclonic storms, but to secure smooth water for landing and shipping operations in ordinary weather, and to protect the jetties and other appliances necessary thereto from the destructive effects of a cyclone to which they are

liable so long as they are exposed to the direct influence of the sea from the east. Every convenience of this sort was wrecked in 1881; and unless the proposal to close the eastern entrance is accepted, it will be useless to attempt their reconstruction.

11. Respecting the proposal to reduce the width of the present eastern entrance to 450 feet, which is renewed by Sir John Hawkshaw's Committee in paragraph 22 of their late report, I am directed to observe that this too is more a nautical than an engineering question, and that the weight of local nautical opinion has been recorded strongly against the proposal. Upon this point I am to refer to paragraphs 25 to 27 of the Madras Committee's first report. With that opinion on record, His Excellency the Governor in Council must continue to object to the proposal.

12. With respect to the second point dealt with in the papers under acknowledgment, namely, the section to be given to the sea-face of the harbour, I am directed to state that His Excellency the Governor in Council greatly prefers the third of the methods of reconstruction quoted by Sir John Hawkshaw's Committee in paragraph 18 of their last report, namely, the random block-work system. Its adoption was strongly recommended by the Madras Committee; and as Sir John Hawkshaw's Committee consider that it may be adopted with safety, it is hoped by this Government that all objection will now be removed.

13. With respect to the third point, namely, the chief executive authority under which the restoration of the harbour is to be carried out, I am directed to draw attention to paragraphs 10 and 11 of General Sankey's letter, under date 4th July 1883, No. 1856 W., where the opinion on this important matter of His Excellency the Governor in Council is stated clearly and unmistakably; and I am to say that His Excellency has seen no reason for modifying that opinion.

I have the honor to be,

Sir,

Your most obedient servant,

(Signed) J. SHAW-STEWART, Colonel, R.E.,
Secretary to Govt., P.W.D.

OOTACAMUND,
9th June 1884.

Exd. E. Fernandes.
Spare Copies

BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of {1884} Madras.

PUBLIC WORKS.

Dated June, 9th.

Recd. *Encl.*

9th June 1884, No. 1437 W.

JUNE.

Madras Harbour

Expressing opinion on certain points connected with proposed scheme for the restoration of the —

219/13

PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Civil Works.

LETTER—from

COLONEL R. H. SANKEY, C.B., R.E.,

Secretary to the Government of Madras,

Public Works Department,

To

THE SECRETARY TO THE GOVERNMENT OF INDIA,

PUBLIC WORKS DEPARTMENT.

SIR,

With reference to Despatch No. 10, Public Works, dated 8th March 1883, from the Right Honorable the Secretary of State, on which this Government was desired to consider the recommendations of Sir John Hawkshaw's Committee on the Madras Harbour, dated 23rd January 1883, "in view to assisting the Government of India to arrive at a decision upon the course which it will be most desirable to follow in reference to the work of restoration," I am now directed by His Excellency the Governor in Council to submit the annexed report of a Committee which was lately assembled at Madras to frame the needful estimates, and to consider the question of restoration in all its bearings.

2. In the first place, as regards the estimated cost of the works, this Committee, on a close review of the rates of work, time required for execution, &c., find that to restore the breakwaters on the plan most favored by Sir John Hawkshaw's Committee (*i.e.*, as per Sections Nos. 1, 2, and 3 of their report) would be as follows, viz. :—

	Rs.
(1) While retaining the present Harbour entrance	50,93,980
(2) While reducing the entrance to 450 feet	51,85,580

The latter sum compares directly with the Home Committee's Estimate No. 1, amounting to £479,219-15-2.

3. As will be observed, the Madras Committee have shown by the highest nautical opinion that it would be dangerous to decrease in any way the width of the present eastern entrance, and that so long as this latter is left open the Harbour must remain exposed, as at present, to continued disturbance, as well as being a perpetual source of the gravest anxiety to all concerned during cyclone periods.

4. They further show that, while carrying out for the seaward arms the random block method of reconstruction, which is stated to be "a safe system to follow" by Sir John Hawkshaw's Committee, the objectionable eastern entrance may be closed, and a perfectly still-water Harbour created, at a total outlay of Rs. 51,42,626, or for Rs. 42,954 less than that needed for reconstructing the works in the manner most approved by the Home Committee.

5. The incidental advantages of the plan suggested (see paragraphs 46 to 54 of the present Committee's Report) are so marked that His Excellency in Council trusts they may be fully weighed in arriving at a conclusion in regard to the completion of this great work.

6. Not only would the Harbour enjoy complete immunity from disturbance during ordinary weather, thus facilitating in every way all the trade operations of the port, but what is of the highest moment, no ships need be sent to sea on the commence-

1259
14

ment of a storm. It is impossible, in the opinion of this Government, to lay too great stress on this single fact, or to doubt the soundness of the reasoning on which it has been established.

7. Not only, moreover, could the Harbour, under the altered conditions, be dredged out and its area increased to any required extent, but, as observed by the Committee, it might, by a suitable system of defences, form a complete Harbour of refuge in times of war.

8. As regards the resumption of the works, I am now to submit that every day's delay is adding to the cost of establishment, and continues the disadvantages under which the trade of the port has been suffering since the cyclone of the 12th November 1881.

9. Everything is in readiness for pushing on operations, excepting the needful machinery for placing the blocks in the manner now recommended, and as regards which it is probable that Mr. Parkes's services might at once be availed of.

10. So soon as the duty of providing this machinery has been performed by Mr. Parkes, it is thought that his further connection with the work should cease; indeed, His Excellency in Council would be well pleased if his services in the position of Engineer-in-Chief for the work could even now be dispensed with. His original plans for the Harbour Works have had to be abandoned as proving unsound in practice, and he no longer commands the confidence of this Government as its professional adviser.

11. On the other hand, the present Superintendent of the work, Mr. Thorowgood, by his assiduity, intelligence, and the soundness of his professional views, has established for himself a confidence which is shared alike by the Government and the public. Were he constituted Engineer-in-Chief, not only would Mr. Parkes's salary be saved, but the very serious inconveniences of his absence in London and divided control would be at once put an end to.

Soliciting very early orders,

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

(Signed) R. H. SANKEY, Colonel, R.E.,
Secretary to Govt., P.W.D.

FORT ST. GEORGE,
4th July 1883.

Exd. A. F. Goodall.
Spare Copies

BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of {1883} Madras.

PUBLIC WORKS.

Dated July, 4th.

Read. *Encl.*

4th July 1883, No. 1856 W.

JULY.

Madras Harbour Works

FORWARDING Report of the Committee appointed to consider the question of the reconstruction of the —.

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Civil Works.

READ—the following letter from Colonel H. P. BROWNLOW, R.E., Deputy Secretary to the Government of India, Public Works Department (Civil Works—Miscellaneous), to the Secretary to the Government of Madras, Public Works Department, dated Simla, 6th September 1883, No. 341 M. :—

With reference to your letter No. 1856 W. of the 4th July 1883, submitting a report by the Committee appointed in Madras to consider the best means for restoring the Harbour Works, I am directed to forward a copy of the Notes drawn up by officers of this department on the subject, for any remarks which the Committee may desire to offer on the suggestion made by Mr. Molesworth.

ORDER—dated 22nd September 1883, No. 2662 W., Public Works.

The Notes received with this letter will be referred, for consideration and remarks, to the Committee appointed on 30th April 1883 to report on the subject of the restoration of the Madras Harbour Works.

2. The Committee will re-assemble under the Presidentship of Colonel J. O. Hasted, R.E. ; and their remarks should be submitted at an early date.

(True Extract.)

(Signed) J. SHAW-STEWART, Colonel, R.E.,
Secretary to Govt., P.W.D.

To Colonel J. O. Hasted, R.E., with spare copies of enclosures for distribution.
" Captain J. H. Taylor, R.N.R.
" T. E. Marshall, Esq.
" F. N. Thorowgood, Esq.
" N. St. B. Beardmore, Esq.
" Major C. Bowen, R.E.

Exd. E. Fernandez.
Spare Copies

BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of (1883) Madras.

PUBLIC WORKS.

Dated September, 22nd.

Recd. *Encl.*

G.O., 22nd Sept. 1883, No. 2662 W.

SEPTEMBER.

Madras Harbour Works

Notes drawn up by Mr. Molesworth and other Public Works Officers of the Government of India on the subject of the restoration of the — referred to the Madras Committee appointed to consider the subject.

1259
16

4th July 1883, No. 34/1856 W., Public Works.

PUBLIC WORKS DEPARTMENT.

Letter—to

The Right Honorable the SECRETARY of STATE for INDIA.

My Lord,

We have the honor to acknowledge the receipt of your Lordship's Despatch, No. 10, Public Works, dated 8th March 1883, forwarding copies of certain papers, including the Report of the Home Committee on the Madras Harbour Works, with a view to our considering the matter and assisting the Government of India to arrive at a decision upon the course which it will be most advisable to follow in reference to the work of restoration.

2. On receipt of this despatch we caused the accompanying Orders, No. 1259 W., dated 30th April 1883, to be issued assembling a local Committee, who have now laid their Report before us.

3. A copy of this Report, with an expression of our views thereon as contained in our Secretary's letter to the Government of India, No. 1856 W., dated 4th July 1883, we have the honor to forward herewith for your Lordship's information.

We have the honor to be,
My Lord,
Your Lordship's most obedient, humble servants,

(Signed) M. E. GRANT DUFF.
(,,) FRED. ROBERTS.
(,,) DAVID F. CARMICHAEL.
(,,) H. E. SULLIVAN.

Ootacamund,
4th July 1883.

Exd. A. F. Goodall.

1259
18

GOVT. OF MADRAS.

PUBLIC WORKS DEPARTMENT.

LETTER to the Right Honorable the Secretary of State for India.

No. $\frac{34}{1855\ W.}$, dated 4th July 1883.

FORWARDING Report of the Committee appointed to consider the question of the reconstruction of the Madras Harbour Works.

MADRAS HARBOUR.

JOINT REPORT OF SIR JOHN HAWKSHAW, SIR JOHN COODE, AND PROFESSOR STOKES.

Dated 23rd January, 1883.

Referred to in D.W. Letter to Madras
No. 10, of 8 Jan: 1883

1259/19

London,
23*rd January*, 1883.

TO THE UNDER SECRETARY OF STATE FOR INDIA,
INDIA OFFICE, LONDON, S.W.

Sir,

MADRAS HARBOUR.

On the 8th July last, we had the honour to receive a communication from Lord Enfield referring to serious damage to the works of the Madras Harbour by a severe cyclone which had occurred in the preceding autumn, and informing us that, certain proposals having been made for restoring the works, the Secretary of State for India was desirous that the subject should be investigated by competent professional authorities in this country, and that Lord Hartington had decided to appoint a Committee for the purpose, and proposed that we should constitute that Committee.

Lord Enfield's letter is given in the Appendix, and having consented to act under its instructions and provisions, we have now to report our proceedings, and the conclusions at which we have arrived.

The following documents have been forwarded to us, and have had our consideration, viz.:—

Report by Guilford L. Molesworth, Consulting-Engineer to the Government of India for State Railways, to the Secretary of the Government of India, "Public Works Department," dated Calcutta, 1st March, 1882.

Report by A. W. Stiffe, Port Officer of Calcutta, to the Secretary of the Government of India, "Public Works Department," dated Calcutta, 13th March, 1882.

Note by Col. R. H. Sankey, R.E., Chief Engineer of Government of Madras, "Public Works Department, Buildings and Roads, Civil Works," dated 23rd March, 1882.

Report by William Parkes, Engineer-in-Chief of Madras Harbour Works, to the Secretary of the Government "Public Works Department," dated Madras, 9th March, 1882.

Note by Colonel R. H. Sankey, R.E., referring to and accompanied by sections of Pier, dated 26th July, 1882, and by an extract from the proceedings of the Madras Government "Public Works Department."

Government of Madras "Public Works Department." Papers, numbered 33, 34, 72, and 73. Remarks on correspondence on the comparison of the storms of 1872 and 1881, by William Parkes.

Letters from D. E. Dalrymple, late Master Attendant, Madras, and Chief of the Marine Department, Madras Presidency, dated July 11th and August 24th, 1882.

In the course of our enquiry we have been in frequent communication with Mr. Parkes, the Engineer-in-Chief of the Harbour Works, who has from time to time supplied us with documents and information explanatory of the state of the works and of his views of methods and cost of restoration. We have also had interviews with Mr. Thorowgood, the Resident Engineer of the Works.

1259
20

We thought it desirable to request Mr. Dalrymple, to whose letters we have referred, to attend one of our meetings and to afford us such further information as he thought proper on the statements in those letters, and we have had the benefit of his explanations and opinions.

We have also taken advantage of Mr. Guildford Molesworth's visit to England to obtain his views on several matters.

A question raised in the correspondence is, whether the cyclonic storm of 1872 or that of 12th November, 1881, was the stronger, and on this point the evidence of boatmen and others is adduced, and contradictory statements are made. Mr. Chisholm is of opinion that the waves of the storm of November 1881, were more formidable than those of the storm which passed over Madras in 1872. Lieutenant Taylor expresses an opinion that the attack upon the works by the storm of November 1881 was a mild one. In the absence of accurate means of measurement, there is nothing on which greater diversity of opinion is more likely to arise than on the intensity of storms. It would be useful to know, could anyone tell, whether the storm of November 1881 was the most severe the Harbour Works can ever be subjected to, but this is information that cannot be obtained. The facts we have as regards the storm of November 1881 are its effects on the Harbour Works, and though we can have no doubt the storm was a very severe one, it will be safer in considering the question referred to us to assume that neither the storm of 1872 nor that of 1881 was necessarily a maximum one, as the period of nine years within which both occurred is too short an interval to justify such a conclusion.

In all estimates of the intensity of storms, it should be observed that long waves, more of the nature of heavy ground swells, may severely try harbour works, and that such waves are compatible with the absence of strong winds at the place itself and with comparative smoothness in the offing.

The present condition of the Piers, and the damage they sustained by the cyclone, have been fully described in the Reports before us. Generally, we may say that, from the shore ends to the commencement of the elbows, the walls are standing, but, from the commencement of the elbows outward, they are so far destroyed as to render it necessary to reconstruct them.

In considering proposals for restoring and strengthening the Harbour Works, questions naturally arose whether any portion of the damage done could be attributed to the mode of construction, or whether it arose entirely from the dimensions and mass of the piers being insufficient.

The method adopted of building the Piers was to form a rubble mound, on which the walls were built, and though we do not concur in Mr. Parkes' view as to the depths below which wave action in engineering works may be disregarded, for those depths must have relation to the magnitude and character of the waves and the weight and size of the material acted upon, yet, having regard to the magnitude of the seas then contemplated, the walls were founded sufficiently deep below low water, and the general outline of the design was not inappropriate, but there appears to have been difficulty in procuring suitable material for the rubble mound. Mr. Molesworth states that the size of the stones of which the rubble base is composed varies from 5 lbs. to 2 cwt., which is small for the purpose, especially where laterite is used, which varies much in quality and is sometimes so soft as to be easily still further reduced in size by the slightest movement.

The superstructure of the Piers was not built of one bonded mass, but consisted of two parallel walls placed side by side in juxtaposition, having a vertical joint between them; and from the

portion of the walls on the harbour side of the Piers having in places fallen away from the portion on the outer or sea side, it seems probable that the pressure of water in the joints led in great measure to this result. The oscillation of the two halves of the wall, also caused by the want of bond and the consequent opening and closing of the vertical joint referred to in Mr. Molesworth's report, must be remedied, as it may in time prove mischievous. No doubt the method of building adopted by Mr. Parkes conduced to rapidity of construction, but were the work to be began again we could not recommend this method, but should prefer the work being bonded throughout.

Though of this opinion, we do not wish it to be inferred that the walls if bonded would have proved strong enough to have withstood the storm to which they were exposed. To make the Piers secure against severe gales, it will be necessary to add materially to their strength of resistance, and having regard to the magnitude of the waves which roll into Madras Roads and overtop the walls, the Piers should be raised to a higher level than that hitherto contemplated. They were originally built by Mr. Parkes to an average height of about six feet four inches above high water mark before settlement, but we are of opinion they should be raised so that their finished level shall not be less than twelve feet above high water mark. This will add to the security of vessels within the Harbour in rough weather, and will greatly strengthen the work, as we propose the Piers should be raised to this extra height by adding a monolithic capping of concrete in mass which, aided by iron cramps to be inserted in the upper courses of blockwork, will help to secure and hold together the concrete blocks in the wall beneath, and tend to remedy the want of bond we have before referred to.

The works we recommend, and have had under consideration, will be understood from the accompanying Drawings, Nos. 1 and 2, to which we beg to refer, and which consist of—

A plan of the Harbour, Drawing No. 1.

Five cross-sections of the Piers, numbered respectively 1, 2, 3, 4, and 5, Drawing No. 2.

The portions of the Piers to which the cross-sections apply will be seen by reference to the drawings.

Cross-Section No. 1 will be applicable to the shore ends of the Piers, from their commencement to the point A in the case of the North Pier, and to the point D in the case of the South Pier, being a length of 400 feet and 650 feet respectively.

Cross-Section No. 2 will be applicable to both Piers, viz., from A to B on the North Pier, being a length of 1,800 feet, and from D to E on the South Pier, being a length of 1,750 feet.

Cross-Section No. 3 will be applicable to both Piers, viz., from B to C on the North Pier, being a length of 1,600 feet, and from E to F on the South Pier, being a length of 1,520 feet.

Cross-Section No. 4 is an alternative to cross-section No. 3, and would be applicable under the conditions hereafter explained.

Cross-section No. 5 shows a method of reconstruction by adopting random concrete blocks.

For the landward portion of the Piers, the works we recommend to be undertaken (shown on Cross-section No. 1), consist of cramping each pair of blocks in the upper course, and the addition of a mass of concrete carried up to 12 feet above high water spring tides, the level to which we consider it necessary to raise the Piers throughout their entire length. This mass of concrete and the cramping will prevent the

oscillation of the two halves of the wall, and are necessary to remedy the want of bond we have referred to. We have not shown wavebreakers along the landward portion of the Piers, but the rubble mounds should be carefully examined, and, where requisite, made good by gneiss rubble of large size, or by concrete blocks.

For the next length of the Piers, extending to the elbows, in addition to the cramping and the top mass of concrete, a wave-breaker, shown on Cross-Section No. 2, of random concrete blocks, should be added on the seaward face, which will render it necessary to widen the rubble mounds. The concrete blocks for the wave-breakers should nowhere be less in weight than twenty tons.

As respects the Piers from the points B on the North Pier and E on the South Pier to the seaward ends, it would be desirable, if it could be done, to continue the walls on the original foundations, bonding the blocks in the manner shown, strengthening and protecting the walls as they are built by wave-breakers, and depositing bags of concrete at the toe of the walls on the Harbour side to form a continuous apron. (See Cross-Section No. 3.) But picking up the blocks buried or nearly so in debris, for the purpose of resetting them, or preparing a sufficiently level bed on the site of the destroyed wall, will involve great labour and expense, and possibly even it may be found impracticable to continue the wall on the original foundations.

A more certain plan of procedure for the reconstruction of these outer lengths of the Piers would be to move them into the Harbour to the extent of about 60 feet, so that the new walls may clear the fallen blocks of the old structure, adopting the design shown on Cross-Section No. 4, and this would involve a somewhat less expenditure than building on the original foundations. But it would shorten the Harbour—already very short—to the extent of about 60 feet: and also it would be undesirable it

it could be avoided, to build on a new foundation of unconsolidated rubble, instead of taking advantage of the old consolidated mounds.

The plan, therefore, we recommend for the reconstruction of the outer lengths from B on the North Pier and E on the South Pier, to the seaward ends, is in the first instance to endeavour to continue the walls on the old foundations, as shown on Cross-Section No. 3. Before the elbows of the Piers are finished it will be seen whether this plan can be successfully carried out; if so, the system should, we think, be followed. If not, the Piers should be brought in to the extent of about 60 feet, following the design shown on Cross-Section No. 4.

We have carefully considered the question of reconstructing these outer lengths from B on the North Pier and E on the South Pier to the seaward ends by mounds of random concrete blocks, more especially as the plan has been recommended by others. It possesses advantages, and as regards construction is a safe system to follow. But it would be necessary to build a short length of wall at the extremity of each Pier upon which to place the entrance lights, and, owing to the size of the vacuities, amounting to between one-fourth and one-third of the mass, the seas may pass through sufficiently to produce some disturbance inside. If the Madras Harbour were of larger size, and there were ample space for the waves to disperse, the system would be more applicable; but, the sheltered area being limited, it is important that the whole space should be made as quiescent as possible. We have, however, thought it right to go carefully into the cost of reconstruction by adopting random mounds for these outer lengths, and find that there would, comparatively speaking, be but little saving in expenditure in adopting this mode of procedure, in preference to building walls on the original foundation with a wave-breaker (shown on Cross-Section No. 3), as recommended for adoption.

The order of proceeding with the works should be first to secure by iron cramps the top courses of the walls which are now standing, that is to say, from the shore to the commencement of the elbows; to reinstate the walls which have been disturbed or thrown down, carefully cramping the top courses together as the work proceeds, and simultaneously in both cases to proceed with depositing the blocks for the wave-breakers so as to afford early protection to the rubble mound and the walls. Raising the walls by concrete in mass will be the last process, as that portion of the work can only conveniently be done by beginning it at the outer extremities of the walls and working back towards the shore.

For the purpose of arriving at an estimate of the cost of reconstruction, we have assumed the definite lengths previously referred to for the different methods of procedure recommended to be followed and shown on the cross-sections. The details of the estimates are given in the Appendix. We estimate the cost of restoration, strengthening, and raising the Piers at £480,000 (see Estimate No. 1), assuming that the lengths from B on the North Pier and E on the South Pier to the seaward ends were reconstructed on the original foundation. If, however, these outer lengths of the walls were brought in 60 feet, the cost, we estimate, would be reduced to £430,000 (see Estimate No. 2). We have also given an estimate of the cost, assuming that these outer lengths were reconstructed by random mounds of concrete blocks (see Estimate No. 3)

These sums are large, but, in our opinion, a smaller expenditure will not render the work secure.

Even with this additional expenditure the cost of the Piers, having regard to their length and to the depth of water, will not be excessive.

In comparing our estimate of cost with that prepared by Mr. Parkes, it must be remembered that his did not provide for raising the Piers to the height which we think is essential. We have also, in some cases, assumed higher prices than he has done, ours being given in the annexed estimates. If the work can be well and properly executed at lower prices, so much the better.

With the additions to the works which we advise, their strength and durability will still be dependent on the materials and workmanship being of the best quality; for such works, if they are to last, must be thoroughly well done.

Whether from defects in the quality of the concrete or from the blocks being used too soon, or from placing them upon the rubble base before it was sufficiently consolidated, several of the blocks appear to have been broken. No concrete block of such large size ought to be used until at least three months after it has been made, and giving them six months to harden would be still better. The local laterite also does not appear to be of good quality, and hence nothing but gneiss should be used in the additions to the rubble mound.

Suggestions have been made to stop up the present or eastern entrance in front of the Harbour, and to make an opening facing southwards in the South Pier. This would involve very large additional expenditure, and we cannot recommend it, more especially as we do not think it would be an improvement.

We think the Harbour, if completed in accordance with our recommendations, will be useful for shipping, and that raising the Piers so as to prevent their submergence by seas rolling over them will, with the present width of entrance, render it quieter than before. But its stillness would be further increased by reducing the width of its entrance from 550 feet to 450 feet,

1929

and, as we think this ought to be done, we have included the cost of it in the estimates. The reduction of width might be carried out hereafter, but in that case the cost would be increased.

Mr. Parkes does not appear hitherto to have made provision for lighting the entrance of the Harbour. This will be necessary, but we have not sufficient information to propose a plan for or to estimate the expense of doing it.

We have the honour to be, Sir,

Your very obedient Servants,

JOHN HAWKSHAW,
JOHN COODE,
G. G. STOKES.

1259
26

COPY OF LORD ENFIELD'S LETTER REFERRED TO IN THE ANNEXED REPORT.

India Office, S.W.,

8th July, 1882.

Sir,

I am directed to inform you that certain proposals have been made for restoring the Works of the Madras Harbour, which were seriously damaged by a severe Cyclone last autumn; but that before deciding upon the measures which should be taken for effecting this object, the Secretary of State for India is desirous that the subject should be investigated by competent professional authorities in this country, in communication with the Engineer-in-Chief of the Works, Mr. Parkes.

Lord Hartington has accordingly decided to appoint a Committee for the purpose; and I am instructed to state that his Lordship will be glad if you will join one composed of yourself, Sir J. Coode, and Professor Stokes.

The Papers particularly referred to you consist of a Report made by Mr. Parkes, containing a scheme for the restoration of the Works, based on a minute personal examination of their present state, together with the independent suggestions of Mr. Molesworth, Consulting Engineer to the Government of India for State Railways, and Lieutenant Stiffe, Port Officer of Calcutta.

Lord Hartington is of opinion that it is desirable to bring the whole matter under re-consideration, with such further light as may be thrown upon it by the independent experience of other Engineers, and the most recent investigations and researches into the action of waves.

It will be open to the Committee to take such steps as they may deem fit to enable them to arrive at a definite and conclusive opinion on the subject.

Mr. Parkes himself entirely concurs in this course, and you are therefore requested to put yourself in unreserved communication with him, and to report to this Office in such form as shall appear to be most suitable your opinion whether the Works can be so restored as to give reasonable expectation of their future stability; and, if so, what method of construction should be adopted to that end.

I am to add that the precise terms of your professional remuneration will be settled at the close of the investigation.

I am, Sir,

Your obedient Servant,

ENFIELD.

SIR JOHN HAWKSHAW.

NOTE.—The above is a copy of the letter sent to Sir John Hawkshaw, but a similar one was sent to Sir John Coode and to Professor Stokes, with the necessary substitution of names.

27

ESTIMATE No. 1.

REFERRED TO IN THE ANNEXED REPORT, FOR THE RECONSTRUCTION OF THE PIERS IN ACCORDANCE WITH CROSS-SECTIONS Nos. 1, 2, AND 3.

Cubic yds.			£ s. d.
266,888	Additional Rubble in Mounds	5/6	73,394 4 0
88,862	Concrete Blockwork in Walls of Piers	23/-	102,191 6 0
161,678	Concrete Blocks in Wave-breakers	23/-	185,929 14 0
5,408	Aprons of Concrete in Bags	23/-	6,219 4 0
40,410	Concrete in mass on the top of the Piers	20/-	40,410 0 0
53,733	Removal of old Blocks, at 10/- £26,866 10 0		
	Deduct value of old Blocks put into Mounds instead of Rubble, 53,733 cubic yds., at 5/6 14,776 11 6		12,089 18 6
Tons			
171	Wrought-iron Cramps	£20	3,420 0 0
No. 2	New Setting Machines		12,000 0 0
			435,654 6 6
	Establishment ($7\frac{1}{2}$) and Contingencies ($2\frac{1}{2}$) = 10 per cent.		43,565 8 8
			£479,219 15 2

Say £480,000.

ESTIMATE No. 2.

REFERRED TO IN THE ANNEXED REPORT, FOR THE RECONSTRUCTION OF THE PIERS IN ACCORDANCE WITH CROSS-SECTIONS Nos. 1, 2, AND 4.

			£ s. d.
Cubic yds.			
286,177	Additional Rubble in Mounds	5/6	78,698 13 6
88,862	Concrete Blockwork in Walls of Piers	23/-	102,191 6 0
128,051	Concrete Blocks in Wave-breakers	23/-	147,258 13 0
5,408	Aprons of Concrete in Bags	23/-	6,219 4 0
40,410	Concrete in mass on the top of the Piers	20/-	40,410 0 0
Tons.			
171	Wrought-iron Cramps	£20	3,420 0 0
No. 2	New Setting Machines		12,000 0 0
			390,197 16 6
	Establishment ($7\frac{1}{2}$) and Contingencies ($2\frac{1}{2}$) = 10 per cent.		39,019 15 8
			£429,217 12 2

Say £430,000.

ESTIMATE No. 3.

REFERRED TO IN THE ANNEXED REPORT, FOR THE RECONSTRUCTION OF THE PIERS, IN ACCORDANCE WITH CROSS-SECTIONS Nos. 1 & 2, LANDWARD OF THE ELBOWS, AND FOR MOUNDS OF RANDOM CONCRETE BLOCKS SEAWARD OF THE ELBOWS.

			£ s. d.
Cubic yds. 353,270	Additional Rubble in Mounds	5/6	97,149 5 0
26,062	Concrete in mass on the top of the Piers	20/	26,062 0 0
242,178	Concrete Blocks in Mounds and Wave-breakers and Blockwork Heads at extremity of Piers	23/	278,504 14 0
7,067	Concrete in bags in the upper part of Mounds	23/	8,127 1 0
Tons. 71½	Wrought-iron Cramps	£20	1,430 0 0
No. 2	New Setting Machines		12,000 0 0
			423,273 0 0
	Establishment (7½) and Contingencies (2½) = 10 per cent.		42,327 6 0
			£465,600 6 0

Say £466,000.

MADRAS HARBOUR

PROPOSED WORKS OF RECONSTRUCTION.

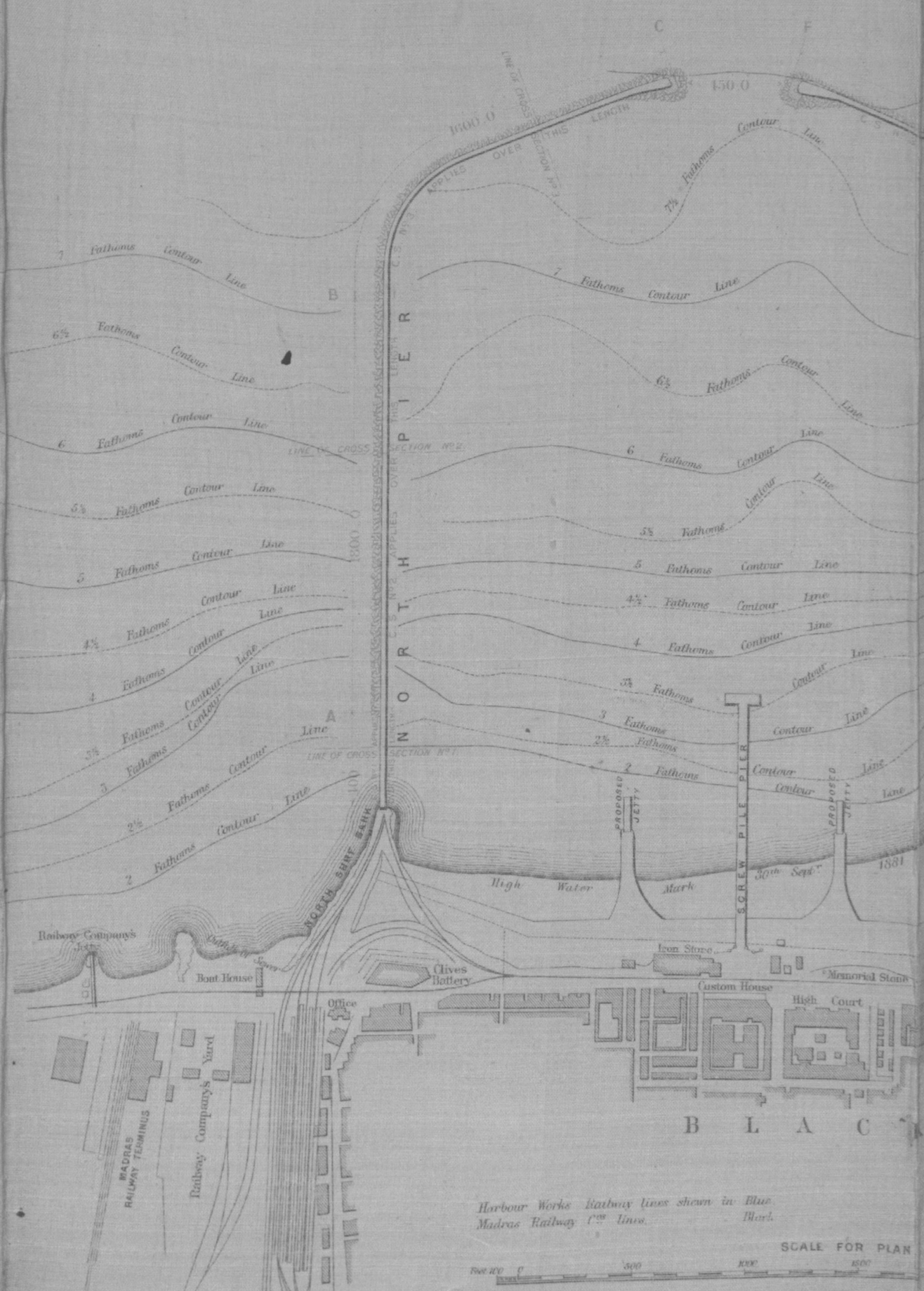
OLD WORK IS SHEWN IN BLACK, NEW WORK IN RED

To accompany the Report of Sir John Hawkshaw, Sir John Coode & Professor Stokes

DATED 23RD JANUARY 1883

DRAWING Nº 1

PLAN



MADRAS HA

PROPOSED WORKS OF RECO

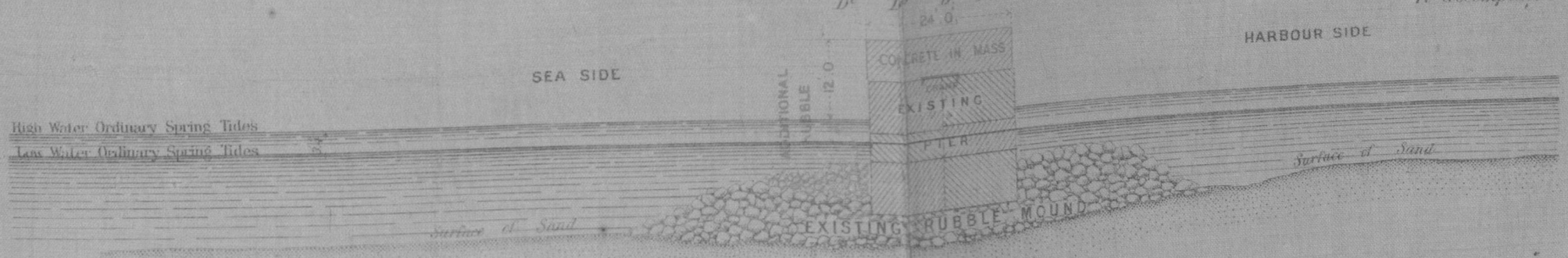
OLD WORK IS SHEWN IN BLACK, NEW

To accompany the Report of Sir John Hawkshaw. S

DATED 23rd JANUARY,

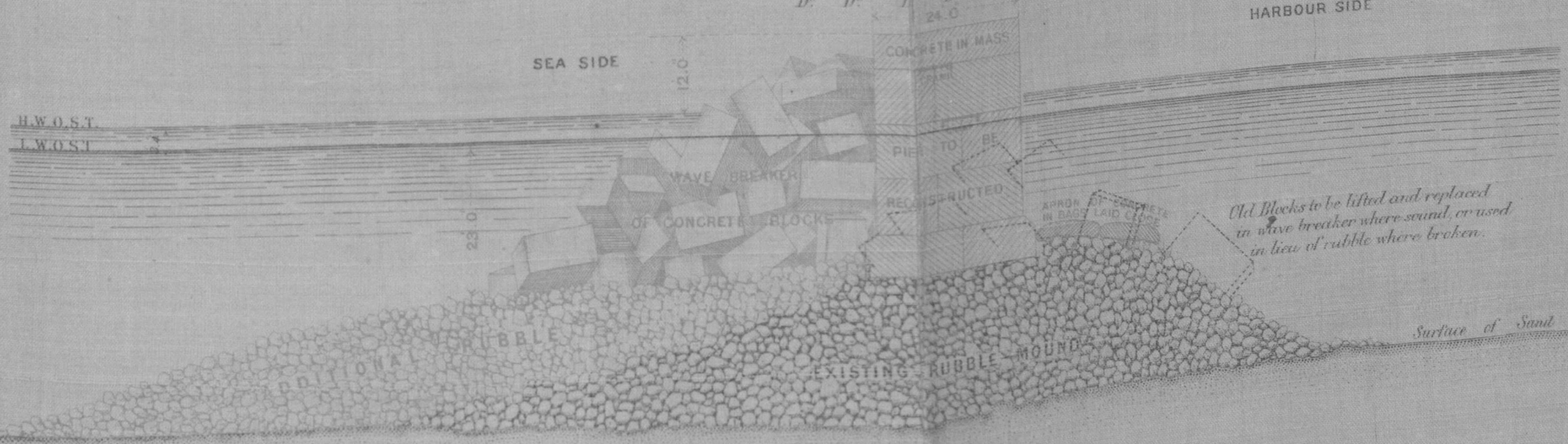
CROSS SECTION N° 1.

This Section applies from Shore to A North Pier
Dº Dº Dº Dº to D South Pier



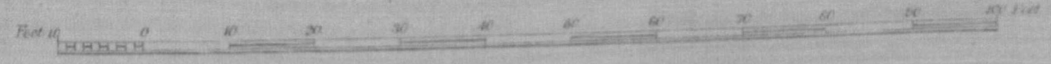
CROSS SECTION N° 3

This Section applies from B to C North Pier
Dº Dº Dº E to F South Pier



CROSS SECTION N°

SCALE, 1 INCH — 20 FEET



RBOUR

NSTRUCTION.

WORK IN RED

John Coode, & Professor Stokes.

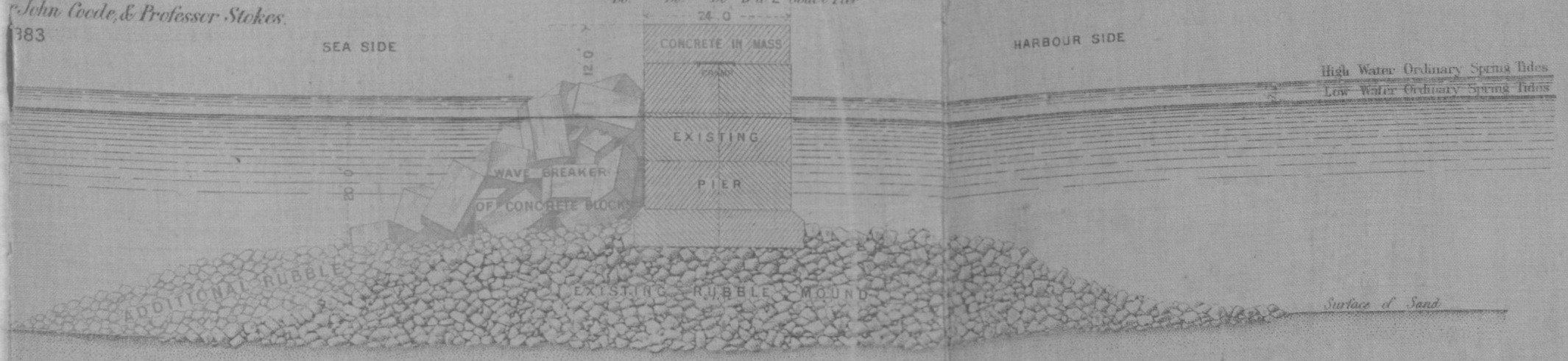
383

1259/31

DRAWING Nº 2.

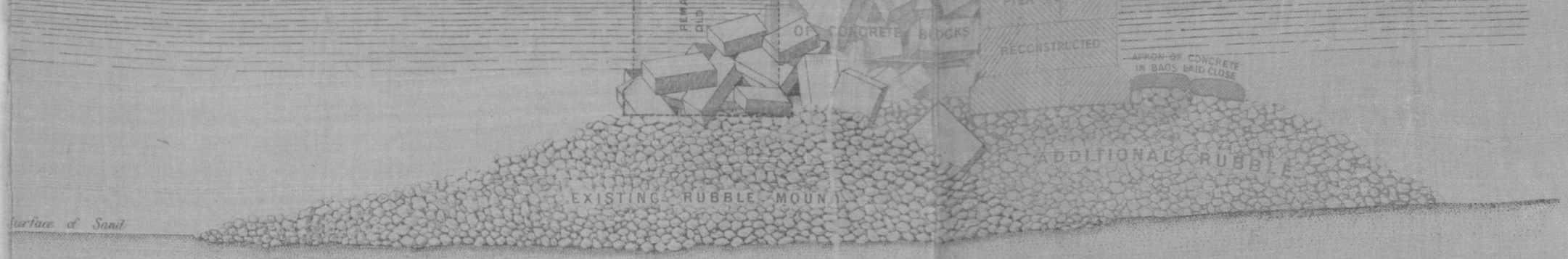
CROSS SECTION Nº 2

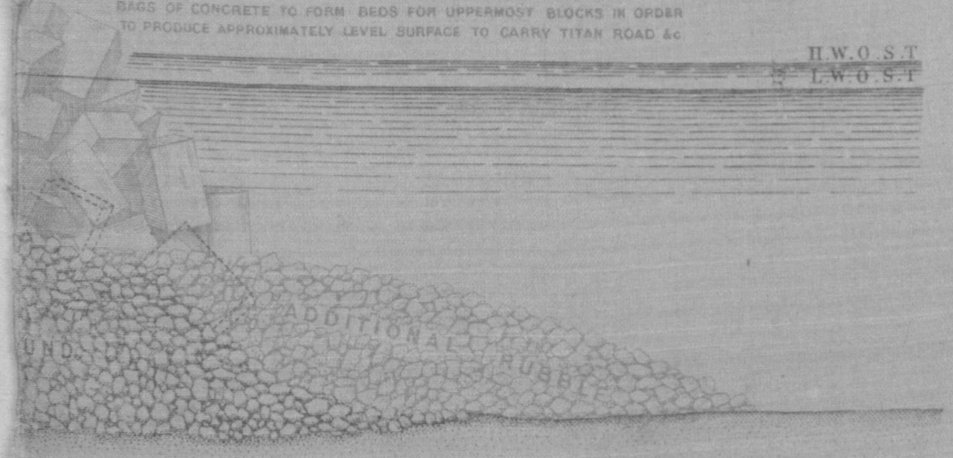
This Section applies from A to B North Pier.
" Do. Do. Do. D to E South Pier



CROSS SECTION Nº 4

This Section is as an alternative to Fig 3.





NOTE The joints of each inclined slice (4.6 thick) of the Piers are to break bond to an extent of at least 4 feet and are also to break bond to a corresponding extent with the joints of the adjoining slice.

Cook & Hammond 166 Broadway Westminster S.W.

1259/33

MADRAS HARBOUR.

REPORT OF THE COMMITTEE APPOINTED IN G.O., NO. 1259 W., DATED 30TH APRIL 1883, TO REPORT ON THE BEST MEANS FOR RESTORING THE WORKS OF THE MADRAS HARBOUR.

Dated 20th June 1883.

1259
34

Report of the Committee appointed in G.O., No. 1259 W., dated 30th April 1883, to report on the best means for restoring the works of the Madras Harbour.

The Committee assembled under G.O., 30th April 1883, No. 1259 W., to consider the best means for giving effect to the proposals made for the completion of the Madras Harbour, have the honor to submit their report for the consideration and orders of Government.

2. The first point claiming attention is the probable cost of completing the works on the several systems suggested by the Home Committee in their report, dated London, 23rd January 1883.

3. As stated in paragraph 25 of that report, the estimates were based generally on the rates of work given by Mr. Parkes, but in some cases the Home Committee assumed higher ones with the results shown in the several appendices, which, though given in sterling, are apparently intended to be converted at two shillings to the rupee.

These estimates are professedly only approximate, or, as expressed by Mr. Parkes in paragraph 4 of his letter of the 10th February 1883, must be viewed "rather as illustrations of the general meaning of the authors, or at most as a basis for approximate estimate than as a basis for instructions to the Engineer who will be charged with the execution of the work."

4. In the appendices to the present report will be found estimates prepared by Mr. Thorowgood, which, though still in some degree approximate, will, it is hoped, from the intimate acquaintance of the framer with every detail of the work, prove to be very fairly accurate. It is only in regard to the cost of special plant (for which information is incomplete) that the Committee feel hesitation, but this is not a very material item.

5. The results as shown may be compared as follows, the £1 sterling being taken = 10 rupees in the Home Committee's estimates :—

TABLE No. I.

Systems for completing the works as given in the Home Committee's Report.	Home Committee's Estimate, including reduction of present Harbour entrance from 550 feet to 450 feet.	PRESENT COMMITTEE'S ESTIMATES—SEE APPENDICES.		Present Committee's Estimates more by [Column (4) — (2)].
		1. Retaining the present entrance.	2. Reducing the entrance to 450 feet.	
	RS.	RS.	RS.	RS.
(A.) As per Sections Nos. 1, 2 and 3 (*i.e.*, core of seaward arms constructed on immediate site of present work)	47,92,190	50,93,980	51,85,580	3,93,390
(B.) As per Sections Nos. 1, 2, and 4 (*i.e.*, core of seaward arms constructed on a new base some 60 feet on the harbour side of the present work)	42,92,170	45,36,779	46,13,179	3,21,009
(C.) As per Sections Nos. 1, 2, and 5 (*i.e.*, the seaward arms constructed entirely on the random block system)	46,56,000	48,70,472	49,55,672	2,99,672

6. The chief reason for the excess of the present estimates is due to the item for superintendence and contingencies being taken at 15 instead of 10 per cent. in those of the Home Committee, and the rest to a more accurate appraisement of the rates of the work as based on an analysis of the previous accounts, and to the fact that the Home Committee's lengths of pier to be built are 216 feet short of actual requirements.

7. So soon as the system of construction to be adopted has been finally decided on by the Government, it will be desirable to ascertain through the Secretary of State the probable cost of the special plant, which, of course, will vary somewhat with the system, and then recast that portion of the estimate prior to final sanction.

8. The Home Committee, while giving their opinion (paragraph 17) that, as regards the seaward arms from point B on the north pier and E on the south pier, "it would be desirable, if it could be done, to continue the walls on the original foundations," admit that the picking up of the blocks "buried or nearly so in debris, for the purpose of resetting them, or preparing a sufficiently level bed on the site of the destroyed wall, will involve great labor and expense, and possibly even it may be found impracticable to continue the wall on the original foundations."

9. In their present estimate (System A, see table) the Committee have assumed that the plan of picking up and relaying the blocks is practicable, but they can only do so in the sense that while being possible it must of necessity be attended with very great delay and expense.

10. The Home Committee have, as will be observed, strong doubts as to the applicability of the plan, and would apparently unhesitatingly prefer the System B were it not for the curtailment of the area of the harbour which is involved in taking up a space 60 feet in width along the seaward arms.

11. On a full consideration of the state of the present work, the Committee are of opinion that it would be most undesirable to attempt to erect the new superstructure on the present work, as even where the lower blocks have got displaced or subsided only to a very trifling extent (and it must be feared that considerable displacement exists) all the labor of removing them will of necessity have to be gone through, if, as specified, the wall has to be so relaid as to admit of bonding and clamping with iron throughout.

12. All such work, it must be remembered, has to be carried out by the tedious, expensive, and in many respects unsatisfactory agency of divers, to say nothing of the time occupied in slinging and removing each individual block and subsequent resetting.

13. If, therefore, the choice of systems is to be confined to (A) and (B), the Committee have no hesitation in recommending the latter, as the saving in outlay would be Rs. 5,72,401 (see Table No. 1), and in time not much less than a year. The small curtailment of the area of the harbour would practically be inappreciable, and should not, they consider, militate against such undoubted advantages.

14. But before arriving at a final decision regarding the most approved method of construction, it is necessary to consider the objections which have been urged against System (C), which the Home Committee, in paragraph 20 of their report, admit to "possess advantages," and to be, as regards construction, "a safe system to follow."

15. The first objection, if, indeed, it can be called one, is, that "it would be necessary to build a short length of wall at the end of each pier upon which to place the entrance lights." Such small addition could be readily made to the work at any time; but it may be observed that at present there is no need for such, as vessels are frequently taken out of harbour whenever required by the aid of two common signal lanterns carried on boats stationed at each of the entrance buoys. The departure of vessels, moreover, after 9 P.M. has been prohibited by law with the sanction of the Government of India. The question of such additions to the ends of the piers may therefore be left out of consideration.

16. The second objection against the random block system is that "owing to the size of the vacuities amounting to between one-third and one-fourth of the mass, the seas may pass through sufficiently to produce some disturbance inside," and that

"the sheltered area being limited, it is important that the whole space should be as quiescent as possible."

17. This objection would no doubt have much weight were the proposal to construct the core of the work *de novo* and throughout with random blocks; but the fact appears to have been overlooked that already the core has been constructed on the monolithic system, and that however the wall may be in places distorted and the material displaced, the blocks are, as a rule, so far in position as effectually to arrest any movement of translation in the seas which impinge on the breakwater.

18. Local experience shows conclusively that at present no wave undulations occur *through* the present wall. The seas which enter the harbour come through the entrance and through the gaps in the damaged portions, and the Committee consider that beyond some percolation through the mass of the upper blocks only it would be impossible for a forward movement to be transmitted to the water inside the harbour.

19. It must be borne in mind that during heavy storms the top water of the seas, which is discharged over the work into the harbour, not only has its forward momentum destroyed, but as a fact must, by raising the general level of the water inside, occasion an outward flow, which of itself must tend to counteract any undulatory movement in the direction of the shore. In the storm of the 12th November 1881 so powerful was the outward current occasioned by the piling up of the water inside the harbour that masula boats which got adrift were carried seaward through the entrance.

20. It is believed that none of the known breakwaters of other ports belonging to this type have a solid screen of the character now existing with the Madras Harbour, and consequently that any analogy based upon the effects noticed in works constructed wholly from random blocks must fail in application.

21. Although, therefore, recognizing the force of the objection urged against breakwaters composed of loose blocks, the Committee cannot admit its application to the Madras piers if completed under System C, and feel themselves in a position to submit that *primâ facie* there is no valid professional objection to the random block system of construction (C) in this case.

22. The expense as shown in Table I (Rs. 49,55,672), although less by Rs. 2,30,000 than System (A), exceeds that of System (B) by Rs. 3,42,000; but in the opinion of the Committee there are advantages connected with this method of construction which fully outweigh this apparent saving—

First.—As regards the time required for completion of the works, it is considered that from there being no need to employ divers and machinery in clearing the debris, levelling the base, &c., at least a year would be saved.

Secondly.—One large crane of special design on each pier would suffice for the whole work, whereas with the Systems A and B two additional cranes will be needed for forming the "wave-breakers."

Thirdly.—Comparatively small material may be employed for the hearting of the mounds, reserving the heavier blocks for the outer and more exposed portions.

Lastly.—And this is a matter of great importance; the requirements of all future repairs, both in respect to the superintendence and material to be maintained, would be simplified by the absence of a special diving staff.

23. In this connection it is only necessary to draw attention to the fact that, in case the work is completed on either of the monolithic Systems (A) or (B), the repairs of breaches (should such occur) of the seaward arms must occasion great delay and expense from the difficulty of access to the foundations with divers, and from the necessity of maintaining in readiness for all emergencies a skilled diving establishment. Not only so, but disastrous results might easily be produced where, as is not unknown, a second severe storm follows in the wake of the first. If such should happen with unrepaired breaches in the monolithic work, the flanks would almost certainly be destroyed, and the mischief might easily extend in such a manner as to call for very serious outlay.

24. Looking, therefore, to the favorable opinion expressed by the Home Committee as regards the safety of the random block system, and the many attendant advantages

above pointed out, the Committee give a decided preference to this method of construction of the three adverted to in the report under consideration.

25. The Committee now proceed to consider the subject submitted for their opinion in paragraph 3 of G.O., No. 1259 W., as to the propriety of reducing the width of the present entrance from 550 feet to 450 feet, and to submit an alternative scheme, should such reduction appear to be undesirable.

26. In reference to the feasibility of narrowing the width of the entrance in the manner proposed, the Committee have been favored with the following recorded opinion of two of their members, the Master Attendant and Deputy Master Attendant.

27. These officers observe:—"As regards the proposal of the Home Committee to narrow the entrance 100 feet, we consider that it will render it difficult and dangerous to a degree out of all proportion to any advantage that can be gained by it. A large amount of sea and swell must always enter from the eastward, and no comfort to the ships or the boating operations or to beach improvements can be expected till this evil is removed. The completed harbour walls existed long enough to teach this lesson. This is the opinion of all nautical men who have been consulted, and especially the Harbour Master, who has daily opportunities of judging and appreciating the difficulties that attend the entry of large steamers (many of them over 400 feet long) even with the present width."

28. With this very distinct opinion of the professional officers before them, an opinion, the validity of which it may be observed has long impressed itself on all who have had an opportunity of witnessing the effect of the waves which come in by the present entrance, the Committee have felt that their duty would be very inadequately performed if they left unnoticed this blot on the present scheme, or if they disguised from the Government their clear opinion, not only as to the infeasibility of narrowing the present entrance, but as to the vital necessity for closing the latter completely if a quiet harbour is to be secured.

29. No matter what the direction of the wind, the unceasing swell on this portion of the coast rolls in with the crests of the waves parallel, or very nearly so, to the coast line. In no case is it believed that the angle exceeds 30° to the general line of the coast. The result is that seas enter the present mouth freely, and, owing to the small length of the harbour, are not dispersed before reaching the shore at its base. The action is of course greatly intensified during storms, and particularly with the wind from the east. At such times the sea inside the harbour, though not so high as outside, is certainly of a dangerous character, being exceedingly broken. Taking these and other facts into consideration, the Committee have to record their opinion that unless means be found for closing entirely the present entrance, no radical cure will have been applied to the chief defect of the work as at present designed.

30. In this view they beg now to submit a plan for the completion of the harbour (see annexed drawings and estimates D, E, F), the leading features of which are—

(1) The opening of a new entrance 500 feet in width, in from 7 to 7½ fathoms of water at the north-east angle of the harbour.
(2) The closing of the present entrance.

31. Before stating the cost and advantages of this proposed arrangement, the Committee desire to draw attention to one or two matters which, while not in reality interfering with constructive details as recommended by the Home Committee, may show how these can be modified without disadvantage.

First, as regards the amount of protection to be given to the portions from the shore to point B on the north, and to point E on the south pier. The Home Committee adopt Section No. 2 (Drawing No. 2) for both alike, but, while admitting the expediency of such additional protection for the north, there is nothing to show that such is needed on the south pier. Not only has the seaward face here not in any way been attacked, but there is apparently no probability that such will occur in any storm that may arise on the coast.

The heaviest seas yet observed have invariably been from the north and north-east, and again on the south the sand accumulations already protect the work for a considerable distance, and show a tendency to advance seaward along this pier.

32. The proposed wave-breaker of rough blocks may therefore, in the opinion of the Committee, be omitted on the south arm with safety and the expense saved.

33. The next point is the proposed cap of concrete, 6 feet in thickness, along the same portions of both piers. In reference to this the Home Committee, in paragraph 21, observe that "raising the walls by concrete in mass will be the last process, as that portion of the work can only conveniently be done by beginning it at the outer extremities of the walls and working back towards the shore."

34. When it is remembered that using Systems (A) or (B) four years must certainly (and possibly five or even six years may) elapse before the remodelled piers are sufficiently advanced to receive as the finishing work this cap of concrete, it is clear that the Home Committee, though considering it desirable in many respects, and chiefly as a means for keeping seas from breaking too freely over the piers, did not attach any very indispensably constructive value to this portion of their design.

35. It is fair, in fact, to conclude that if constructively essential to the stability of the work, this concrete cap should advance *pari passu* with the rest of the work.

36. The Committee, in offering this remark, have no desire to interfere in any way with this portion of the design so far as concerns the seaward arms, where they believe that raising the walls in the manner proposed to 12 feet above high water will prove of very sensible value.

37. As regards, however, the piers from the shore to points B and E, they are satisfied, from the effects of the waves on these portions, as hitherto observed, that the proposed cap would be of no material advantage. From the way in which the waves approach the coast the piers are, as a rule, normal to their direction, with the result that only a comparatively small amount of water comes over them into the harbour, the great mass being invariably, it may be said, poured over the seaward arms. Such being the case, the Committee consider that this block of concrete may with complete safety be omitted from the portions indicated.

38. Towards meeting the expense of opening and protecting the proposed new entrance to the north-east and closing the existing entrance there would be savings on the two items mentioned, viz.:—

(1) By the omission of the random block wave-breaker along the south pier to E.
(2) By the omission of the concrete cap from the shore to B on the north and to E on the south pier. The actual savings in cash outlay due to these modifications will be found further down, where is shown the probable cost of the harbour as thus completed, and here it will be desirable to advert to the formation of the proposed new entrance at the north-east angle of the harbour.

39. The position is shown on the tracing to lie between the 7 and 7½ fathom lines, and the width to be 500 feet.

40. On this point the Master and Deputy Master Attendants have supplied the following observations:—

"(1.) The proposed entrance to the north may safely be narrowed to 500 feet, because the cross currents and winds that affect the east entrance will no longer exercise a troubling effect.

"(2.) The proposed entrance to the north in 7 fathoms will allow of the whole deep water space being utilized, which is impossible under the conditions of the eastern entrance, and deep water space is especially valuable in a basin like the Madras Harbour."

41. The Committee have adopted the conclusions as above stated, and also one to the effect that the protecting horn should be not less than 600 feet in length, carried out tangentially to the curve at the north elbow, and curved slightly to the east, in order the better to deflect the seas from the entrance and from the north arm, and to give a *vena contracta* form of entrance for the more easy passage of vessels. Looking to the general parallelism of the crests of the waves to the shore, it is doubtful whether in practice so long a protective horn will be found to be indispensable, but as it is better to err on the safe side, the Committee have provided for one 600 feet long in the estimate.

42. As a matter of detail it may here be mentioned that the concrete blocks which now encumber the work at this point will in all probability be broken up by

dynamite, and the debris with the rubble base, down to a depth of 6 fathoms, removed by dredging.

43. The closing of the existing entrance will proceed so soon as the new north-east one has been worked out, and the final operation will be the construction of the horn. As the whole of the seaward arms can by this manner be dealt with continuously, only one titan crane would be needed, in case either of the Systems (A) or (B) is adopted, or one set of travellers if System (C) be decided on.

44. The following are the financial results of the above method of dealing with the harbour according to the system which may be approved :—

	Rs.
(1.) If completed on Sections 1, 2 and 3, the present entrance closed also by Section No. 3 and entrance on north opened.	54,18,717
(2.) If completed on Sections 1, 2 and 4, the present entrance being closed on Section No. 3	50,26,348
(3.) If completed on Sections 1, 2 and 5, the present entrance being closed on Section No. 5 (random block-work) ...	51,42,636

(The cost of wave-breaker on south arm and concrete cap to both arms is omitted in these estimates.)

For detailed estimates see the appendices.

45. For the reasons before assigned, the Committee would strongly recommend the completion of the work on the random block system.

46. The Committee would here solicit attention to the following recorded observations by the Master and Deputy Master Attendants in reference to the above proposals :—"We," they observe, "consider that if the sea face is closed, and a height of 12 feet given to the sea wall, that much of the character of a protective work to shipping, under which sanction to it was first obtained, will be restored, and the question of sending ships to sea on approach of bad weather need no longer be considered."

47. To those who are acquainted with the fact that the main object of the late Lord Hobart in pressing the necessity of a harbour on the attention of the Secretary of State was the beneficent and humane idea of sheltering vessels in port from the dire effects of the cyclones, which unhappily but too often visit the Coromandel Coast, and which since the advent of European shipping have occasioned such fearful losses in life and property, the true import of the proposals now submitted will, it is hoped, be sufficiently obvious.

48. It is believed that Mr. Parkes never claimed for his work the character of a harbour of protection, and certainly the cyclone of the 12th November 1881 tended to show that, far from being an efficient protection to the shipping inside, it might on such occasions prove to be, as it were, a trap from which escape might be difficult and at times perhaps impossible.

49. The fear, indeed the certainty, that such would prove to be the result has, it may be said, imposed a much more severe responsibility on the Marine authorities than was the case when no harbour existed.

50. With the present eastern entrance unchanged, this extreme danger to shipping, and this terrible responsibility for life and property, must remain, no matter what the system adopted for the completion of the rest of the work; and to allow matters to remain as they are will add the evil of a perpetual and dangerous reef in front of Madras in the form of the present ruined piers.

51. Under the proposals now submitted, not only will, it is believed, the unexpected boon of a harbour of protection be conferred on Madras, but Imperial significance will be given to this great work, which, if finished in the manner suggested, could in time of war afford shelter and protection to the vessels of Her Majesty's navy, as also to all merchantmen who could make the port.

52. The Home Committee, in many parts of their report, correctly draw attention to the unduly small area of the present harbour, not much more than the outward half of which is suited for mooring vessels of any draft; but, as will no doubt at once be recognized, the proposals above made must, by affording the means, whenever

desired, of dredging out the shallow portions to any required depth, admit of doubling the useful area.

53. An operation of this character, it is almost needless to say, could never be carried out so long as the present entrance remains open, the disturbance inside the harbour being such that, with the exception of a very few days each year, would render dredging operations impossible, excepting at an altogether prohibitive outlay.

54. Not only would the advantages here enumerated be secured, but in many other respects, such as the possibility of moving ships much closer together than is at present feasible, bringing ships much closer to the shore, establishing wharfs, jetties, &c., facilities to the trade of the port may be increased indefinitely.

55. The total cost of the work remodelled as recommended will, as shown, be Rs. 51,42,636 as compared with that of the Home Committee System A, Rs. 50,93,980. Practically, therefore, the two methods of dealing with the harbour may be considered as costing much the same.

(Signed) R. H. SANKEY, Colonel, R.E.
(,,) J. O. HASTED, Colonel, R.E.
(,,) J. H. TAYLOR, Lieutenant, R.N.R.
(,,) T. E. MARSHALL.
(,,) F. N. THOROWGOOD.
(,,) N. St. B. BEARDMORE.
(,,) C. BOWEN, Major, R.E., Secretary.

20th June 1883.

Note by Mr. Beardmore on paragraph 41.

I consider it important that, in order to adequately protect the proposed north-east entrance, the protecting breakwater should be at least 650 feet in length measured from the eastern tangent point of the north pier, and that if it is thus constructed, an excavation through the old rubble base of 400 feet in *bottom* width will prove to be sufficient, and indeed better in checking north-eastern seas from entering the harbour.

(Signed) N. St. B. BEARDMORE.

MADRAS HARBOUR.

APPENDIX to REPORT of the COMMITTEE APPOINTED in G.O., No. 1259 W., DATED 30th APRIL 1883.

ESTIMATE of cost of restoration as proposed by the Home Committee, and as modified by the Special Local Committee.

Quantities and Prices by the Superintendent of the Madras Harbour Works.

NOTE.—The total lengths of the two piers, as shown by the figured dimensions in the plan accompanying the Home Committee's Report, do not agree with the actual lengths of work to be executed, but are 218 feet short of such lengths.

The following estimates are made with the corrected lengths for obtaining an entrance of 450 feet, viz., 3,916 feet for the north pier and 4,020 for south pier.

The lengths for each section of the Committee's proposal therefore are altered thus:—

	North Pier (on Plan).		South Pier (on Plan).	
Section No. I	426	(400)	680	(650)
Section No. II	1,800	(1,800)	1,750	(1,750)
Sections Nos. III, IV, V	1,690	(1,600)	1,590	(1,520)
Total ...	3,916	(3,800)	4,020	(3,920)
Difference ...	116 feet.		100 feet.	

Total Difference ... 216 feet.

Both dimensions are shown in the plan accompanying these papers.

Estimate for Section No. I.

	FEET.
Length—North Pier	426·0
South do.	680·0
Total ...	1,106·0

Per lineal foot of Pier.

	RS.	A.	P.
Additional rubble...18·0 × 6½ × ½ = 58½ c. ft. = 3 tons at Rs. 1-8-0 =	4	8	0
Concrete topping ...24·0 × 4½ × 1·0 = 108 = 4 c. yds. at „ 12-0-0 =	48	0	0
Iron cramps ...44 lb. per lineal foot at ½ annas = ...	1	6	0
Total per lineal foot ...	53	14	0

For both Piers.

1,106 lin. ft. at Rs. 53-14-0 ... ... =	59,585	0	0
Deduct for 480 lineal feet at south pier, thoroughly protected by sand and not needing rubble.			
Rubble 480 ft. with 3 tons to 1 ft. = 1,440 tons at Rs. 1-8-0 ... =	2,160	0	0
	57,425	0	0

Total for Section No. I, Rs. 57,425.

38

Section No. II.

	FEET.
Length—North Pier	1,800
South do.	1,750
	3,550

Per lineal foot of Pier.

Additional rubble—

	C. FT.
110·0 × 8½ × ½ =	467½
55·0 × 5½ × ½ =	151¼
618¾ = 31 tons, at Rs. 2 ...	

	RS.	A.	P.
	62	0	0
Concrete blocks in wave-breaker— 50 × 29/2 × 1·0 = 500 c. ft. = 18·5 c. yds., at Rs. 11.	203	8	0
Concrete topping — 24·0 × 6·0 × 1·0 = 144 = 5⅓ c. yds., at Rs. 12 ...	64	0	0
Per lineal foot ...	329	8	0
For both piers 3,550, at Rs. 329-8-0	11,69,725	0	0
Add for 415 feet of piers to be cramped at Rs. 1-6-0 per foot	570	10	0
Total value of work, Section II ...	11,70,295	10	0

Section No. III.

	FEET.
Length—North Pier	1,690
South do.	1,590
Total ..	3,280

Per lineal foot of Pier.

Additional rubble—

79 × 18 × ½ = 711			
65 × 17½ × ½ = 568¾			
8·0 × 2·0 = 16			
63·0 × 2·0 × 1·0 = 126			
1,421¾ cubic feet = 71 tons, at Rs. 2 =	RS. 142	A. 0	P. 0
Concrete blocks in wave-breaker— 65·0 × 29/2 = 28 cubic yards, at ... ... „ 11 =	308	0	0
Concrete blocks in regular work— 28·0 × 6·0 × 1·0 28·0 × 24·0 × 1·0 = 744 cubic feet = 27½ c. yds, at „ 11 =	303	0	0
Preparing base by removing old blocks, &c., per lineal foot, at ... ... =	134	0	0
Concrete topping— 24·0 × 6·0 × 1·0 = 4½ yards at ... ... „ 12 =	54	0	0
Concrete bags— 20·0 × 2·0 × 1·0 = 40 cubic feet = 1½ c. yds., at „ 11 =	16	8	0
Two cramps or 88 lb. per foot, at annas per lb.	2	12	0
	960	4	0
Deduct for old blocks recovered in foundation one-seventh of the wave-breaker at 4 yards per foot, at „ 11	44	0	0
Total per lineal foot ...	916	4	0

Section No. III, 3,280 lineal feet, at Rs. 916-4-0 per foot, Rs. 30,04,480.

Section No. IV.

Alternative Section per No. III. Total length, 3,280 feet. Per lineal foot of Pier.

Additional rubble—

	C. FT.
62·0 × 3½ × 1·0 =	744
50 × 3½ × 1·0 =	600

			RS.	A.	P.
1,344	= 67 tons,	at Rs. 2 =	134	0	0

Concrete blocks in wave-breaker—

	C. FT.
40·0 × 3½ × 1·0 =	520

Concrete blocks in regular work—

28·0 × 6·0 × 1·0 =	168
24·0 × 24·0 × 1·0 =	576

			RS.	A.	P.
1,264	= 47 c. yds.,	at Rs. 11 =	517	0	0
24·0 × 5·0 × 1·0 =	4⅓ cubic yards,	at Rs. 12 =	54	0	0
Preparing base at per lineal foot		„ 40 =	40	0	0
Apron bags 20·0 × 2·0 × 1·0 = 1½	cubic yards	at „ 11 =	16	8	0
Two cramps to each course, per foot		=	2	12	0
Per lineal foot ...			764	4	0

3,280 feet of piers at Rs. 764-4-0 = Rs. 25,06,740.
Total per Section No. IV, Rs. 25,06,740.

Section No. V.

(Random Blockwork.)

Length same as No. III and No. IV, 3,280 feet.

Additional rubble—

	C. FT.
30·0 × 2·0 × 1·0 =	180·0
60·0 × 3½ × 1·0 =	510·0
85·0 × 4½ × 1·0 =	765·0
37·0 × 4½ × 1·0 =	351·6
50·0 × 3½ × 1·0 =	425·0

			RS.	A.	P.
2,231·6	= 112 tons,	at Rs. 2 =	224	0	0

Concrete blocks at random—

60·0 × 3½ =	720
42·0 × 4½ =	378
30·0 × 24 =	720

1,818 = 67⅓	cubic yards,	at Rs. 11 =	740	0	0
Concrete topping and bags— 30·0 × 8·0 × 1·0 = 240 = 9 c. yds.,		at, say, Rs. 12 =	108	0	0
			1,072	0	0
Deduct for random blocks in ruined work about— 60 × 4½ × 1·0 = 20	cubic yards,	at Rs. 11 ... =	220	0	0
Per lineal foot ...			852	0	0

For both piers, 3,280 feet, at Rs. 852 = Rs. 27,94,560.

39

ALTERNATIVE PROPOSALS.

Estimate for full Section No. III (without any old work) to be used for closing eastern opening.
Per lineal foot of Pier.

Memo.—The rubble base is to extend 33 feet from edge of blocks to top of slope on Harbour side.

Rubble base in 48 feet water—

75 × 3½ =	787½
75 × 4½ =	1,875
61 × 26 =	1,586
42 × 2½ =	420

			RS.	A.	P.
4,668½ = 233 tons,	at Rs. 2 = ...		466	0	0
Value of No. III Section without taking credit for old blocks per foot and without Rs. 134 for preparing base			826	0	0
Per lineal foot			1,292	0	0
Taking 500 feet as the additional amount of rubble base required at Rs. 466 = ...			2,33,000	0	0
And 550 feet for blockwork at Rs. 826 = ...			4,54,300	0	0
Total for closing entrance with No. III Section ...			6,87,300	0	0

For making a Northern Entrance.

Excavation of rubble for 600 feet in length—

40·0 × 3·0 =	120·0 cubic feet.
41·0 × 4½ =	389·6 „
54 × 17 =	918·0 „
43 × 4½ =	322·6 „

			RS.	A.	P.
1,750·0 × 500 = 32,407 c. yds.,		at Rs. 4 =	1,29,628	0	0
Excavation and removal of blocks— 28·0 × 20 = 560 × 500 = 10,333 c. yds.,		at Rs. 8 =	82,664	0	0
			2,12,292	0	0

Building a protective arm, 400 feet long, in Section No. 3, but without heavy charge for preparing base.

	RS.	A.	P.
600 of full Section No. III, at Rs. 1,292 per foot = ...	7,75,200	0	0
Deduct for value of old blocks recovered enough to make one-fourth wave-breaker or 7 cubic yards, at Rs. 11 = Rs. 77, for 400 feet	30,800	0	0
	7,44,400	0	0
Add for pier head-work	20,000	0	0
	7,64,400	0	0
	2,12,292	0	0
Excavation as above	9,76,692	0	0

Savings effected by making north-east entrance owing to there being less pier to build.

	RS.	A.	P.
(*a*) In Section No. III— 600 feet, at Rs. 916-4-0 per foot	5,49,750	0	0
(*b*) In Section No. IV— 600 feet at Rs. 764 per foot	4,58,400	0	0
Deduct lump sum for extra work in crossing over line of north pier for outer horn	50,000	0	0
Nett ...	4,08,400	0	0
(*c*) In Section No. V— 600 feet, at Rs. 852	5,11,200	0	0

Whole Section No. 5 for closing eastern entrance and building outer horn.
Rubble base (48 feet per lineal foot water)—

$65{\cdot}0 \times \frac{3}{2}$ = 682·6
$155{\cdot}0 \times \frac{27+24}{2}$ = 3,952·6
$72{\cdot}0 \times \frac{3}{2}$ = 900·0

5,535·0 = 276 tons, at Rs. 2 = 552 0 0
Concrete blocks (as before) 67½ cubic yards, at „ 11 = 740 0 0
Concrete topping and bags 9 cubic yards, at „ 12 = 108 0 0

1,400 0 0

For closing entrance—	Rs.	A.	P.
500 feet rubble work, at Rs. 552 per foot = ...	2,76,000	0	0
550 feet blockwork at „ 848 do. = ...	4,66,400	0	0
	7,42,400	0	0
For building extra horn, 600 feet, at Rs. 1,460.	6,40,000		
Deduct for old blocks	30,800		
	6,09,200		
For work in pier head	20,000		
	6,29,200	0	0
	13,71,600	0	0

Saving by doing away with south pier wave-breaker to 1,750 feet and with concrete topping on Sections I and II.

No. I Section—	Rs.	A.	P.
1,106 feet concrete top, at Rs. 48 = ...	53,088	0	0
No. II Section—			
3,550 feet concrete top, at Rs. 64 = ...	2,27,200	0	0
Wave-breaker, south pier—			
1,750 feet blocks, at Rs. 203-8-0 = ...	3,56,125	0	0
Rubble 1,780 feet, at Rs. 62 = ...	1,08,500	0	0
	7,44,913	0	0

SUMMARY OF ESTIMATES.

		Rs.
(A.)	Restoring as per Sections I, II, and III with 450 feet entrance.	51,85,580
(B.)	Do. do. with 550 do. ...	50,93,980
	Do. Sections I, II, and IV with 450 do. ...	46,13,179
(C.)	Do. do. with 550 do. ...	45,36,779
	Restoring as per Sections I, II, and V (450 feet cut) ...	49,55,672
	Do. do. (550 do.) ...	48,70,472

ALTERNATIVE PROPOSALS.

With 500 feet entrance to the north-east abolishing concrete *capping on inner portion* of work, and wave-breaker *to inner portion* of south pier.

		Rs.
(D.)	Restoration being carried on as Sections I, II, and III, and extra work built as Section III	54,18,717
(E.)	Restoration to be carried on as in Sections I, II, and IV, extra work being as Section III	50,26,348
(F.)	Restoration and extra work to be done as in Section V (Random Work). Memo.—This will be the *quickest* work	51,42,636

For blocks on stock a credit of Rs. 1,30,630 may be taken for every section.
Rs. 60,000 added for extra titan roads and rails omitted in detailed estimate.

SUMMARY OF ESTIMATES.

(A.) Estimate for restoring Harbour as proposed by Committee, in Sections I, II, and III.

	Rs.
Total value for Section No. I	57,425
Do. do. No. II	11,70,295
Do. do. No. III	30,04,480
	42,32,200
Plant—	
Two titan cranes complete, at Rs. 45,000	90,000
Two cranes for setting wave-breakers, at Rs. 30,000	60,000
New railway lines, 230 tons of permanent-way material, at Rs. 100	23,000
200 tons titan rails, at Rs. 100	20,000
4,000 sâl-wood sleepers, at Rs. 4-8-0	18,000
16,000 lineal feet titan roads, at Rs. 4	64,000
One Goliath crane, restored	2,000
	45,09,200
Add 15 per cent. for Establishment and Contingencies ...	6,76,380
	51,85,580
If with 550 feet entrance, deduct 100 feet, at Rs. 916	91,600
	50,93,980

SUMMARY OF ESTIMATES.

(B.) Estimate for restoring Harbour as proposed by Committee in Sections I, II, and IV.

	Rs.
Total value for Section No. I	57,425
Do. do. „ II	11,70,295
Do. do. „ IV	25,06,740
	37,34,460
Plant, as for Sections I, II, and III	2,77,000
	40,11,460
Add 15 per cent. for Establishment and Contingencies ...	6,01,719
	46,13,179
If with 550 feet entrance, deduct 100 feet, at Rs. 764 ...	76,400
	45,36,779

SUMMARY OF ESTIMATES.

(C.) Estimate for restoring Harbour as proposed by Committee in Sections I, II, and V (Random Blocks).

	Rs.
Total value for Section No. I	57,425
Do. for Section „ II	11,70,295
Do. for Section „ V	27,94,560
	40,22,280

		Rs.
Plant—		
Two special titan cranes capable of setting regular work, and overhanging enough to build random blocks		1,60,000
Other plant as before, less the two extra cranes		1,27,000
		43,09,280
Add 15 per cent. for Establishment and Contingencies		6,46,392
		49,55,672
If with 550 entrance, deduct 100 feet, at		85,200
		48,70,472

COMMITTEE'S ALTERNATIVE PROPOSALS.

First Alternative.—To close present entrance by Section No. 3, and open one to the north, extending the eastern part of the breakwater 400 feet as an overlap to the entrance.

		Rs.
(D.) Estimate for repairing by Sections I, II, and III, see Summary of Estimates (A)		42,32,200
Deduct 100 feet for making 550 feet entrance		91,600
		41,40,600
Add—		
For building across entrance		6,87,300
Do. 400 of protecting arm		7,64,400
Excavating and opening north entrance		2,12,292
		58,04,592
Deduct saving as shown (*a*) on page 11	5,49,750	
Also saving as shown on page 12	7,44,913	
		12,94,663
		45,09,929

Closing North Entrance.

Plant—		
One titan crane	45,000	
One crane for wave-breaker	30,000	
Other plant as in Summary of Estimates (A)	1,27,000	
		2,02,000
		47,11,929
Add 15 per cent. for Establishment and Contingencies		7,06,788
Grand Total ...		54,18,717

(E.) Estimate for closing eastern entrance and opening one to the north, the work being restored mainly on Sections I, II, and IV.

Value of restoring work by I, II, and IV (as shown in Summary of Estimates (B)		37,34,460
Deduct for 100 feet to restore 550 entrance		76,400
		36,58,060
Add—		
For building across entrance		6,87,300
600 feet of protecting arm		7,64,400
Excavating and opening northern entrance		2,12,292
		53,22,052

			Rs.
Deduct—			
Saving as shown (*b*), page 11	4,08,400		
Also as shown on page 12	7,44,913		11,53,313
			41,68,739
Plant as before			2,02,000
			43,70,739
Add 15 per cent. for Establishment and Contingencies			6,55,609
Grand Total ...			50,26,348

(F.) Closing eastern entrance and opening one to north, with Sections I, II, and V.

Memo.—The entrance is supposed to be closed and the extra protective built on Section 5.

Restoring work, Sections I, II, and V with 450 feet entrance ...		40,22,280
Deduct for 550 feet entrance, 100 feet		85,200
		39,37,080
Add—		
Building across entrance		7,42,400
Do. extra protective arm		6,29,200
Excavation in north pier		2,12,292
		55,20,972
Deduct—		
Saving as shown (*c*) on page 11	5,11,200	
Also as shown on page 12	7,44,913	
		12,56,113
		42,64,859
Plant—		
One special titan	80,000	
Other plant as before	67,000	
		2,07,000
		44,71,859
Add 15 per cent. for Establishment and Contingencies		6,70,777
		51,42,636

Detailed Remarks on Prices and Methods of carrying out work suggested.

Rubble Stone for Base and Foreshore.—The rubble for base and foreshore is to be clean, hard syenitic rock from Pallávaram, similar to what has been used hitherto from that quarry. The price is generally taken at Rs. 2 per ton deposited in the sea, but for the shore ends of the piers, for protective work, Rs. 1-8-0 per ton has been taken. The ton has been taken as 20 cubic feet, and this is arrived at by frequent measurements and weighings. The price is based on what has already been done in depositing 800,000 tons of rubble, the cost of which varied from Rs. 1-8-0 to Rs. 2-4-0 per ton, the latter price being exceptionally high. The rubble will be deposited from large boats propelled by oars; also by being thrown from the piers and by being tipped by the overhanging crane. No steam hopper barges will be needed. The stones will vary in weight from 3 lb. to 300 lb.

2. *Concrete Blocks.*—The concrete blocks will be similar in composition to those made latterly for the damaged piers, of which 12,563 cubic yards are now on stock. The Madras local cement may, however, be used as much as possible, but this does not materially affect the price.

The cost of the concrete blocks per cubic yard has latterly been Rs. 8-90 in the yard, and the cost of setting by means of divers has been sometimes below Rs. 2, and sometimes a little above Rs. 2 per cubic yard, including all charges. Therefore the price chosen in the estimate of Rs. 11 is fair.

Concrete Topping and Concrete in Bags.—This has been taken at Rs. 12, as there will be more waste of cement in mixing, and the materials will have to be carried along the piers for mixing *in situ*, thus adding to their cost before they are converted into concrete.

Iron Cramps.—Iron cramps are taken at ½ anna lb. fixed in the blocks with cement. The price is based on actual work done.

Preparing foundations on site of ruined work.—This is a difficult item to estimate, as we have no similar experience. We know that it will be very tedious and difficult. There was a time in the north pier work when there was 7 feet of excavation to be carried on in laterite rubble. This reduced progress to nearly a standstill, and took a very strong diving force. The amount of material to be shifted was more than equal to a course of blocks. It was found to cost Rs. 134 per lineal foot. This price has been selected as the cost per lineal foot of preparing foundation in ruined work. It may cost twice as much.

Method of setting Blocks in Sections III and IV.—It is supposed that for the actual piers two titan cranes will be required, in which there should be some alterations and improvements. For depositing the blocks in the wave-breakers other cranes should be used, of special design, with their overhang extending on each side of the blocks. They should be capable of holding 30 tons with an overhang of 40 feet.

The blocks for the wave-breakers should be "tripped" and not lowered by lewis bolts.

Crane Roads.—The roads on which the setting machines (titan or similar cranes) travel are to be continuous. They should be 70 lb. flat-bottomed rails, fastened by fang bolts (not spikes) to teak longitudinal timbers 14" × 10". These timbers to be fixed to the blocks and built in.

Crane for Random Blockwork.—The cranes or crane required for this work must be one with enormous scope. It should be capable of carrying 30 or 40 tons at a radius of 50 feet, and should be on a circular girder to "jib" completely round. It will be absolutely necessary to deposit the blocks as far away from the centre line as possible, otherwise there will be no chance of retaining an even and solid road for the crane to advance upon.

Construction of Random Work.—To within 15 feet of low water no doubt rubble stone may be used as a hearting to the outer slopes of random work. But above this nothing but heavy blocks should be used, except for purposes of levelling up. If the individual blocks at the level of breaking sea are too light, say less than 25 tons, there is no stability in the random mound. At 6 feet above H. W. the work must be levelled and concreted up with bags, ready to receive the top course of blocks which must be brought up level enough to carry a railway as well as the crane roads.

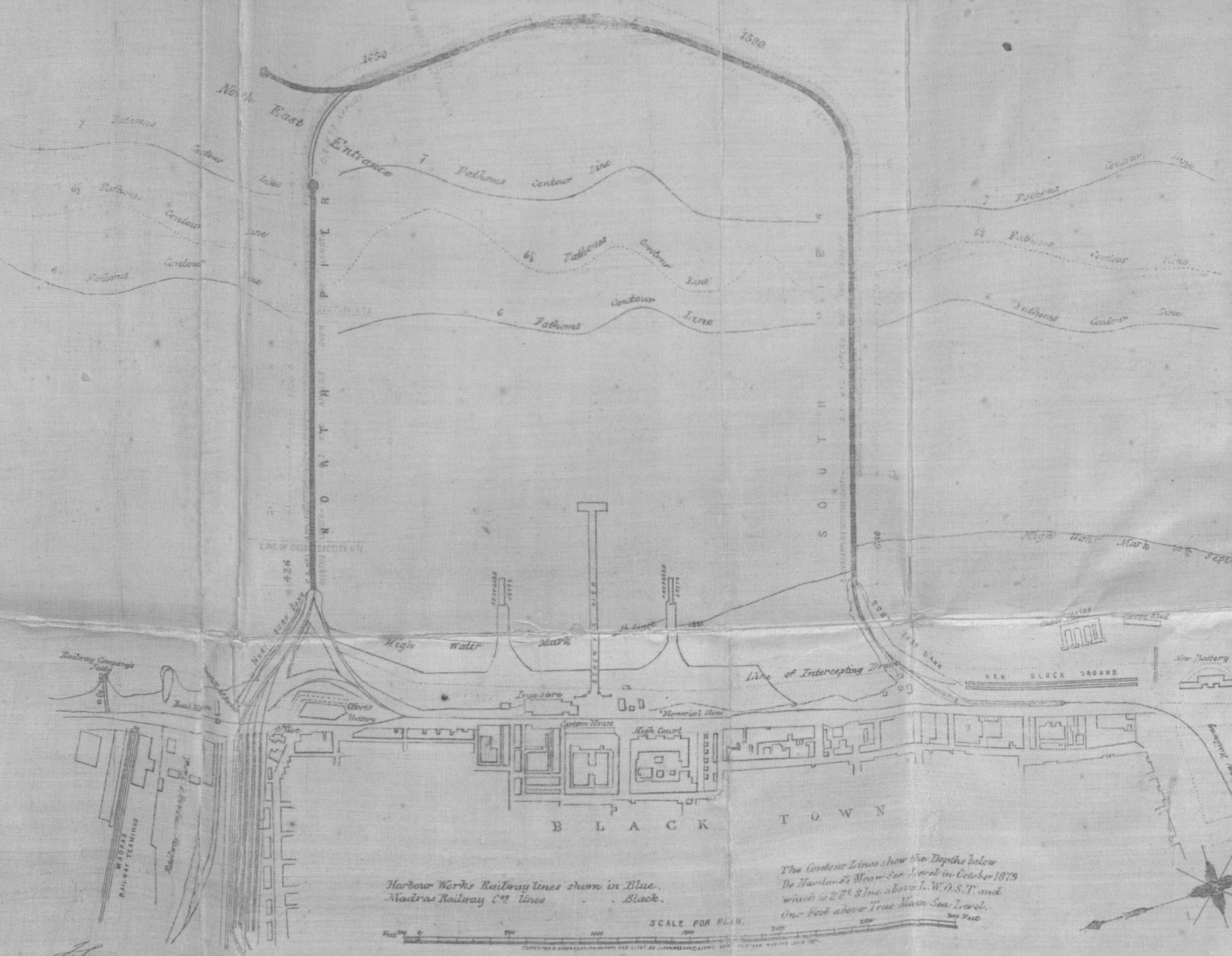
Estimate of Plant.—The estimate for plant is nothing more than a guess based upon the *known* cost of cranes, rails, sleepers, &c., as given by previous experience on these works. As the cranes are purchased as complete machines for a lump sum, it is not possible to enter into details except in communication with the builders in England.

Establishment and Contingencies.—It is believed that 7½ per cent. will be ample for "Establishment," but as in former experience 2½ per cent. was far too little for "Contingencies," it is judged safer to make the charge for the latter also 7½ per cent., which it is hoped will be more than sufficient.

MADRAS HARBOUR

PROPOSALS FOR RESTORATION BY MADRAS SPECIAL COMMITTEE

Plan shewing North-East Entrance with protecting arm, suggested by Committee / with exceptions.



for Sup[t] and Manager
Gov[t] Irrig[n] Dept[t] Chepauk.

(Sig[d]) F. N. Thorougood.
Sup[t] Madras Harbour Works.
21.5.83.

C. Bowden Major, R.E.
Dy Ch[f] Engineer P.W.D.

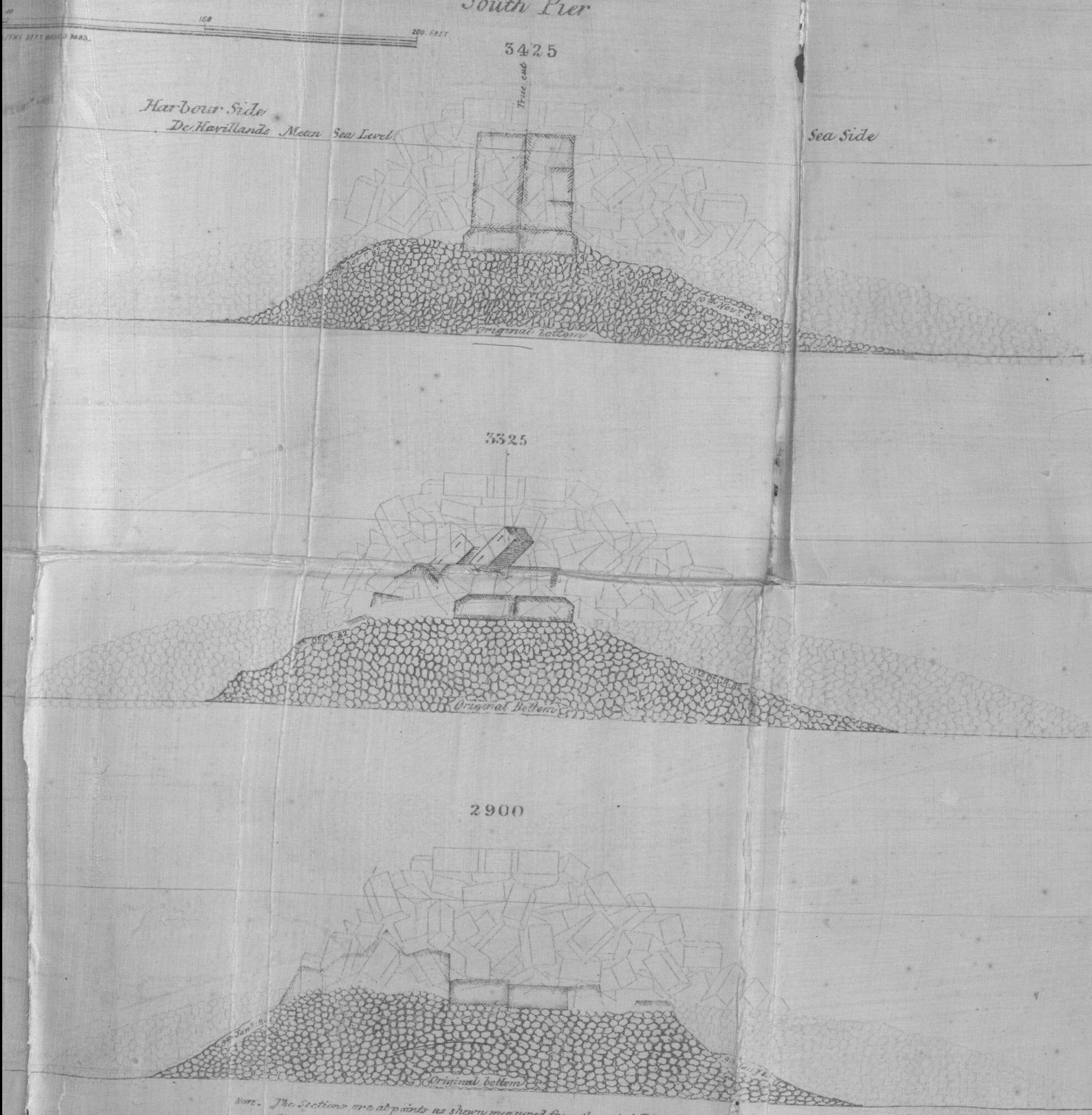
1259/43

HARBOUR

MADRAS SPECIAL COMMITTEE

ght portions, with random blocks over old work.

South Pier



Note. The Sections are at points as shewn measured from the point E i.e. from the commencement of the Concrete Block Pier; and are shewn looking out to Sea so that the left hand side is the Harbour side, and the right hand side is the Sea side.

(Signed) F. N. Thorowgood, M Inst. C.E.
Superintendent
Madras Harbour Works

C. Bowen Mayor R.E.
Dy Chief Engineer P.W.D.

MADRAS HAR

PROPOSALS FOR RESTORATION BY MADRA

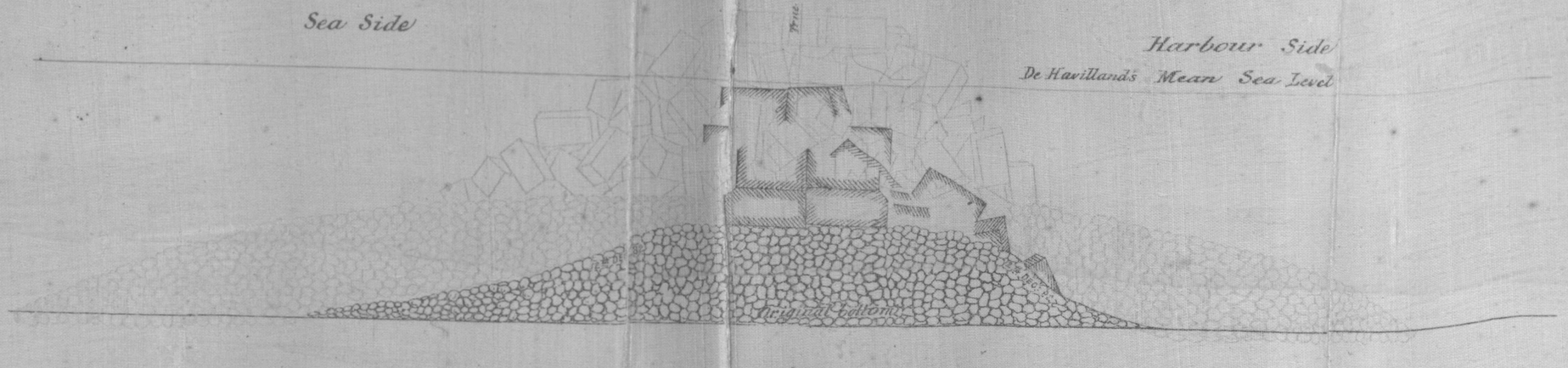
Sections shewing actual state of piers in outer straight portio

North Pier

Scale 20 Feet = 1 inch.

LITH^S BY R. J. BALDREY GOVT. LITHO. DEPT. MADRAS

3675



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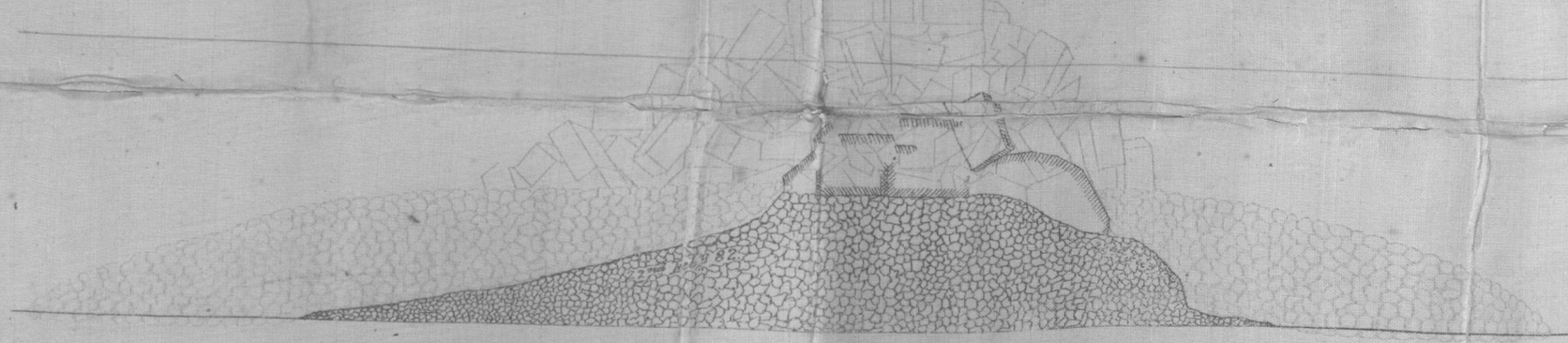

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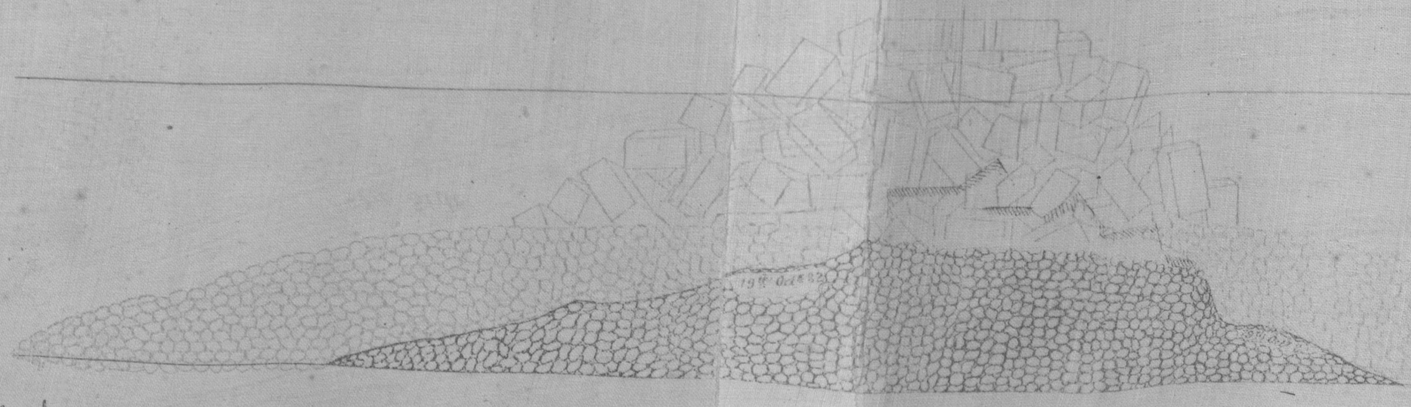

Sup^t and Manager
Govt Litho^c Dep^t Chepauk
Madras..... June 1883.

NOTE.— *The Sections are at points as shewn measured from the point B. v. e. from the commencement of the Concrete Block Pier; and are shewn looking out to Sea so that the left hand side is the Sea side and the right hand side is the Harbour side.—*

Hon. H.C. Pulleine
Pilot Office Jersey

1759 ev

For orders

No communication of any
note of yesterday's date
on the subject of the Harbour
Committee's Report should
have come to Command
a letter from the Master
Attendant which has
just come to hand
stating in the strongest
terms the necessity to
close the eastern
Entrance and establish
one to the north

It is useless for me
at this Stage to go into
any of the details dwelt
on by Capt. Taylor
whose main proposition
appears entirely untenable. I have had
already to bring to

Recvd: 26/4 R 27/4
Cir 1874 R 28/4

Date 9/46

Note by the Chief Engineer

1— P.W. despatch from the S/S dated 8th March 1943 No 10 Swis cover to a despatch No 6 idem in reference to the progress of the Madras Harbour works

2— The two questions arising out of these communications are responded to which the Govt. of India will no doubt early address the Govt are

(1) The financial one as to whether it will be desirable to spend on the works the amount roughly Estimated by the Board Committee at 480,000 — and shall this be decided in the affirmative

(2) The actual plan of operations to be adopted

3— As regards (1) looking to the Imperial character of the Harbour which

Recd. 26/4 R 27/4
Circ 17/4 R 20/4

is the only one of its kind between Calcutta and Bombay in the whole length of our coast; its accessibility entirely in all ordinary weather for the general purposes of trade, of landing or embarking troops and passengers &c, even in the present incomplete state of the works; the first-outlay already incurred; the large amount of plant stores & material now in hand; the presence of a suitably trained and thoroughly disciplined staff which it would be impossible to replace if once dispersed; the fact that as resulted from the Committee (see par 22 of their Report) that "even with the additional "expenditure (£25,000) "the cost of the Piers keeping "pace to their height and "the depth of water will "not be excessive". above all the great importance of the question not only to the Administration of Bombay in matters of shipping & Customs but to the "self" in the form of the two unfinished Piers, it

may be hoped that when all the facts have been fully weighed the work may be allowed to proceed to completion — Government cannot await the final decision of higher authority

4— As regards the second point: as to the plan of operations to be adopted it is not my clear about action should be taken at present

In para 6 of his letter Mr. Parkes considers that the details of the Home Committee plans should be viewed "rather "as illustrations of the general "meaning of the authors "or at most as a basis for "approximate Estimate, "than as a basis for instructions "to the Engineer who will be "charged with the execution "of the works"

5— The S of S in para 6 of his despatch to the G of I considers that "So far as the Engineering "questions involved are con- "cerned the views expressed "in the report of the Committee "xxxx should be accepted "as closing the discussion "on the general principles

to be followed

6- A careful perusal of the Committees report shows that several 'practical' questions have been clearly settled on a basis similar to those proposed long ago at the Portsmouth Conference (but rejected at the time by Mr Parkes) that they can at once be accepted, but that much is left open as regards the application - and that moreover under conditions which can alone be ascertained by actual Experiment as the work advances

(1) The Committee leave open entirely the question as to whether the old work should be built on and Section 2 adopted and Section 3 of the fairing-out of the labor & expense involved in pushing on to the fallen blocks & the Existing piers that this Section 3 should be worked on

(2) They have moreover stated that the system of reconstruction by random

blocks (See Cross Section No 5) as recommended by Mr Molesworth and myself "possesses advantages and "as regards construction is "a safe System to follow"

7- Their apparent objections to it are

(a) it would be necessary "to build a short-line of "wall at the extremity "of each Pier upon which "to place the entrance "lights, and owing to the "large open vacuities among "the between the fourth and "one third of the mass "the seas may pass through "sufficiently to produce "some disturbance inside"

(b) "the sheltered area "being limited it is impor- "tant that the whole "space should be made "as Quiescent as possible"

8- The objection under head (a) as regards the position for lights may be put aside as not any important the expense in any case of the undertaking being comparatively small (See Cross Section

(& Mr Parkes's letter)
but as regards disturbance
in the harbour the question
is doubtless important
and could call for further
enquiry — From what
known can be judged
of the action of the waves
in and through random
blocks as substituted by
the percentage given
conversion is that it will
be comparatively small
and that the real dis-
-turbing element will
be found in the open
eastern mouth — Even
that cloud even in the
random block system
then would I am con-
-vinced be a very Quiet
harbour in all weathers

9— As regards (b) the
objection to reducing the
area of the harbour
this is likewise a com-
-paratively simple matter
The actual reduction will
not in any case amount
to that which would be
occasioned by adopting
the Committee Section
No 4 which is admitted
to be a possible if not
indeed a probable alter
native to Section No 3

10— In reference to expense
the Committee give in
their Estimate No 3 the
probable outlay on the random
blocks System at £465,000
or a small saving of about
£14,000, they have Tables, as
No 1

11— The examination of the
Committee report appears
to lead to the con-
-clusion that while rejecting
absolutely Mr Parkes pro-
-posed monolithic System
of reconstruction they have
a choice in much open
according to circumstances
between one of the two
plans which lead in
all essentials been pre-
-viously suggested here

12— Before Government could
be in a position to advise
the Govt. of India as to the
details of the Scheme
based upon one or other
of the methods [illegible]

by the House Committee
it would appear advisable
to obtain the opinions
of professional Men

13- It also appears open
to doubt whether advantage
might not also be taken
to go somewhat further
and bring under the notice
of either Authority the
consideration of some scheme
which while not exceeding
on the whole the amount
Estimated by the Committee
might be supposed to
give on the whole better
results

14- Mr Parker in para
14 of his letter says with
reference to the entrance
of the Harbour observes
"As to the Special nautical
"Considerations on which a
"change has been advocated
"no evidence excepting
"that contained in the
"papers was brought before
"them (the Committee) and
"as that is all on one
"side this conclusion
"averse to a change is

"is based entirely on
"General grounds"

15 It will be observed
from the second last
para of the Committees
report that they have
only expressed an opinion
that after adopting the
present Scheme the Harbour
will be "Quieter than before"

16- In some westerly gales
rollers will pass over
the works into the result
but in the usual westerly
set Sandown the unquiet-
-ness in the Harbour is
produced by the con-
-tinued swell entering
the eastern mouth

17- To construct this
Mod the Committee
suggest the reduction
of the entrance from
550 to 450 ft adding
however that the
"Cost would be increased
if this were done

I believe I am not
wrong in saying that

nautical Pairing
and is strongly opposed
to reducing the present
width — indeed if my
memory serves me a
number of Steamer
Captains protested that
the present width was
too little considering the
great length of many
of the Steamers which
frequent the port and
the ratios low speed
at which owing to
the small depth of
the Harbour they would
be obliged to enter
especially if there were
many vessels inside
18- The present Harbour
Master Attendant has always
said that Steam tugs in
the disturbance caused
by leaving the entrance
of the Harbour where
it is, and there has
been a growing conviction
among professional Pairs

that unless the depth
were remedied & the
Harbour would never be
what it ought to be
19- The Question therefore
arises as to whether now
that so large an outlay
of nearly half a million
Sterling is under consideration
there may not be means
in connection with the abandonment
of which while keeping within
the limit of outlay recom-
-mended by the Committee
and adhering in all
essentials to the Princi-
-ciples of reconstruction
20- Should the Government
consider that this
Question could come
legitimately within the
Scope of the Enquiries
which must now be
instituted locally in
regard to the details
of the proposed work
I would venture to
suggest that a Standing
Representative Committee
be assembled to

Report upon the Subject - The Committee which met twice I think should I venture to think represent the best nautical and Commercial opinion in addition to that of professional Engineers

Mr Stanley
C.B.
7 March 1883

Sanguine opinion that this should be done. A letter from Capt. Taylor has been rec'd since this letter was dictated in which he says he prepares a strong opinion in favor of closing the Eastern mouth leaving the North an Entrance & the South

H.E.I
15/4

After having experienced the delights of the Harbour even in such moderate weather as that of the third of Feb last I am for carefully considering whether we cannot make a better piece of it by closing the Eastern opening

The suggested Committee was accordingly appointed

Dispatches

1455.

India Office
London, 8th March. 1883.

Public Works
No 10.

Sir,

With reference to Lord Hartington's despatch to Your Excellency in the Public Works Department No 10 dated the 6th July last, I have to inform you that the Committee which was appointed to consider the question of the Madras Harbour has now made its report.

2. I forward, herewith, a copy of the same and of a letter from Mr. Parkes, together with a Despatch addressed to the Government of India by the present Mail on the subject.

and

× dated 23 Jany 1883.
⊖ dated 10 Febry 1883.
† No 16 dated 8th March 1883.

His Excellency
The Right Honorable
The Governor in Council
Fort St George.

and I request that your Government will consider the matter, in view to assisting the Government of India to arrive at a decision upon the Course which it will be most advisable to follow in reference to the work of restoration.

I have the honor to be,
Sir,
Your most Obedient
humble Servant,
Kimberley

India Office,
London, 8th March 1883.

Public Works,
No. 16.

To His Excellency The Most Honourable The Governor General of India in Council.

My Lord Marquis,

Para. 1. I have to inform your Excellency that the Committee* which was appointed in July last to inquire into the present condition of the Madras harbour, and to report on the measures which should be taken for restoring the works, so as give reasonable expectation of their future stability, have brought their deliberations to a close, and have submitted a report,† copy of which I now forward, for the information and guidance of your Government.

* Sir John Hawkshaw, F.R.S.
Sir John Coode.
Professor Stokes.

† Dated 23rd January 1883.

2. Mr. Parkes, the Chief Engineer of the harbour works, has been in frequent communication with the Committee in their investigations, and has had an opportunity of seeing their report. The letter‡ enclosed herewith will show your Excellency that he concurs in the general principles on which the Committee recommend that the work of restoration should proceed, but considers that in certain particulars modifications may be desirable. You will observe, also, that he is of opinion that four years will be required for the completion of the works contemplated.

‡ Dated 10th February 1883.

3. The estimated cost of reconstructing the harbour, in accordance with the proposals of the Committee, is 480,000*l*. This may be susceptible of reduction, but is in excess of estimates hitherto made.

4. After careful consideration of the whole subject, I have come to the conclusion that, so far as the engineering questions involved are concerned, the views expressed in the report of the Committee consulted under Lord Hartington's instructions, consisting, as that body did, of authorities eminently qualified to advise on the very difficult problem to be solved, should be accepted as closing the discussion on the principle of restoration to be

followed, if the decision be come to that the additional outlay which is requisite should be incurred. There is nothing in Mr. Parkes' letter to lead to hesitation in this respect, and I understand that the Committee are of opinion that the work of restoration might be set about with every reasonable expectation that the structure could be satisfactorily completed and maintained on the proposed design.

5. While I am of opinion that the reconstruction of the harbour should be undertaken at the estimated cost, before coming to a final decision to incur so large an outlay, I desire to be informed of the views of your Excellency's Government on the financial aspect of the question. On receipt of your reports, I shall reconsider the whole subject, and my decision will be communicated to your Excellency with the least possible delay, any needful instructions being also then given to Mr. Parkes for his future guidance.

6. I have furnished a copy of this Despatch and of its enclosures, to the Government of Madras, with whom you will no doubt deem it desirable to place yourself in communication at an early date.

I have the honour to be,
My Lord Marquis,
Your Lordship's most obedient humble Servant,
(Signed) KIMBERLEY.

No.

Public Works Department,

8th March 1883.

Cop

Letter to the Government of India,

No.

ENCLOSURE.

Madras Harbour.

23, Abingdon Street,
10th February 1883.

Sir,

I have the honour to submit the following remarks on the Report of the Committee, consisting of Sir John Hawkshaw, Sir John Coode, and Professor Stokes, in accordance with the request conveyed to me in a reference from Mr. Danvers, dated 5th instant. The Report is returned herewith.

2. It should be understood that, although I was in frequent communication with the Committee during the progress of their investigations, and furnished them with all information in my power as to matters of fact, and as to my own views, both orally and in writing, and also conveyed to them several documents forwarded to me for that purpose by the India Office, the conclusions given in their Report were arrived at quite independently of me. I was informed of their general character in December, and the plans attached to the report were shown to me on the 19th January, but I did not see the Report itself till it was forwarded to me on the 5th instant, as above.

3. I have thought it desirable to mention these facts in order that my own share in the investigation may not be misunderstood. While admitting that the course adopted by the Committee has its advantages, and at the same time trusting that the Report may serve the purpose intended by the Government, I would submit that in considering their conclusions, and taking action upon them, a large allowance must be made for the fact that the gentlemen composing the Committee are not personally acquainted with the locality, and that their local information was obtained at second hand.

4. This consideration will not affect the main features of their recommendation, but it does materially affect the position of the line of demarcation between fixed principles and details which may be subject to modification in respect of their relation to local circumstances. The details of their plan should be viewed, I would submit, rather as illustrations of the general meaning of the authors, or at most as a basis for approximate estimate, than as a basis for instructions to the engineer who will be charged with the execution of the works.

5. Subject then to the limitations implied in the above remarks, I may state that I have, after full consideration, come to the conclusion to acquiesce in the general recommendation of the Committee that the additional strength required should be given by a large wave-breaker, consisting of concrete blocks laid at random on the sea face. I need not say that I have come to this conclusion with great reluctance, because it involves a very large additional outlay, which would have been saved if the more inexpensive plan which I proposed in March last had met with independent professional support. I do not think, however, that I should be justified in urging the latter further, even if my present opinion, that it would have possessed the necessary elements of stability, should remain unchanged, for I think this to be essentially one of those cases in which action should be taken only with a strong concurrence of professional opinion. It is a matter upon which there is no very direct experience to guide us, and the theoretical considerations applicable to the case are involved in some doubt. Moreover it might

be many years before the stability of the work would be brought to a satisfactory test, so that whatever there might be doubtful in the question would remain unsolved for an indefinite time.

6. I have been of opinion from the first that the system of random blocks is the only alternative to my original proposal, and I think that the dimensions of the mound suggested by the Committee are the least that ought to be adopted for the most exposed parts of the piers. These dimensions are considerably greater than those which were offered as an alternative to my proposals from two or three quarters a year ago, and which I always felt to be insufficient, though I was unwilling, without more data than were accessible to me while in India, to attempt to form any definite conclusions as to what was really adequate. Since my return to England in May last I have given much attention to the subject, and my conclusions, based on information derived from many quarters, are very similar to those at which the Committee have independently arr[illegible]

7. So far, therefore, I am entirely in accord with the Committee, and as far as it is possible to dissociate general principles from their application to a particular case, our accord, I believe, goes much further. But for the present this is as far as I feel justified in following the actual lines laid down by the Committee, though, with so much common ground for our departure, it is hardly likely that there would be any very great divergence in the further development of our views.

8. The adoption of the random mound system instead of the built additions I proposed for the 1,000 yards most seriously damaged involves, in round numbers, an additional expenditure of 15 lacs of rupees to the 48 lacs of my original estimate. The continuation of the same system shorewards, with gradually decreasing dimensions, would involve a still further excess of outlay, so that the large estimates given by the Committee would probably be approached by any that I could myself frame upon a design based on the ground common to the Committee and myself.

9. I may therefore suggest, as a safe assumption, that the amounts estimated by the Committee should be taken as the data for the consideration of the financial view of the question.

10. It may be assumed, however, that the sum of 480,000*l.*, the estimate for the scheme specially recommended, is equivalent to 48 lacs of rupees, and that it may also be taken as a *maximum* subject to probable diminution. I find that the rates upon which this estimate is based are slightly in excess of those upon which the work has been hitherto carried out. I furnished these latter to the Committee, and they appear to have converted them into sterling money at the rate of 2*s.* to a rupee, and then made the slight additions. This excess is, I believe, an allowance to cover the cost of additional plant, an allowance which I am in the habit of making as a separate item. Assuming therefore the quantities given in the estimate, I can confirm the total amount. Credit, however, should be taken for the value of materials now on the ground, and available for future use (including concrete blocks prepared for the ends of the piers which were unfinished at the time of the storm). This amounts to about one lac. It should also be borne in mind that the estimate is swelled by the cost of the additional 100 feet of pier recommended to narrow the entrance from 550 to 450 feet. This would be in round numbers 1½ lac.

11. It is also clear that the Committee have adopted the most unfavourable assumption possible of the extent to which the blocks in the damaged parts of the work will be available for further use. This is perhaps the safest course for the present; but it should be understood that there is a certainty of some saving in this respect, though its

amount is indeterminable till the blocks are actually recovered. I think if the *least* instead of the *most* unfavourable view were taken on this point there would be a saving of seven or eight lacs of rupees. A recent examination, made under exceptionally favourable circumstances, confirms the best expectations previously entertained upon this point. On all these grounds therefore I think I am justified in asking that the 48 lacs should be taken as a *maximum*.

12. The Committee put forward two alternative schemes, which are both estimated as somewhat less costly than the one they recommend. It is perhaps desirable to show what there is to fall back upon in the event of any very unforeseen difficulties in carrying out the more favoured plan, but I think the arguments adduced by the Committee against these alternatives may be strengthened by other considerations. Both were fully considered on the spot during my investigations last year, and both rejected, not as absolutely impracticable, but as unsuitable in many respects. I believe also the apparent economy in comparison with the recommended plan would vanish on further investigation.

13. I would beg to offer some remarks on two points raised by the Committee at the end of their report, viz., narrowing the entrance, and lighting it. They estimate for the former, but not for the latter, stating, however, with regard to the latter that provision will have to be made for it.

14. With regard to the entrance, it is satisfactory to find that the Committee confirm the propriety of its present position as a question of general design. As to the special nautical considerations on which a change has been advocated, no evidence, except that contained in the papers, was brought before them, and as that is all on one side, their conclusions adverse to a change is based entirely on general grounds. I am bound to say that, if an immediate decision were necessary, I should agree with the Committee; but, considering that no measures can be taken to carry out either the narrowing or the entire change of position till all the other works are completed, I would submit that it is undesirable, in view of the strong opinions expressed by the marine authorities, to come to any decision at present. The eastern entrance, 550 feet wide, exists, bad or good, and must be used for the next four or five years. During that time it will have a more extended trial than it has yet had, and there will be more material for a final judgment. I would therefore express a hope that no definite order be given, either for reducing the width, or for altering or retaining its position, until nearer the time for carrying out the actual work. It need not be concluded, however, that the efficiency of the harbour is dependent upon the width or position of the entrance. Even admitting that a change in either respect would be an improvement, it will not make the difference between a harbour and no harbour, it would only give more accommodation, which of course, if required, would bring more revenue.

15. With regard to lighting the entrance, the matter has had much consideration, and though I cannot say that a definite plan has been decided upon between the marine officers and myself for submission to Government, I am satisfied that no very costly works will be required. The sum of 20,000 rupees stands in the amended estimate last sanctioned for this purpose, and this amount will be ample for anything I can contemplate. I do not think it would be desirable to facilitate the entrance of ships in very bad weather at night. They should stand out to sea, or anchor in the roads till daylight. The position of the inner limits of the anchorage might be marked by intersecting shore lights, though the soundings give an excellent indication of a ship's position. In fine weather, however, the entrance should be marked either by leading lights on shore, or by small lights on the pier heads, which latter should

not be exhibited at all in bad weather. I think these arrangements would meet all the requirements of the trade, as at present conducted, and it is therefore unnecessary to contemplate any provision for lighting beyond the already sanctioned amount.

16. I think, considering the great addition to the quantity of work involved in the adoption of the wave-breaker system, at least four years would be required for the completion of the works, reckoned from the time of recommencing block setting. This could not be done in less than nine or ten months from the issue of the Government sanction, as the Titan cranes will have to be manufactured in this country, sent out, and re-erected on the spot.

I have, &c.,
(Signed) W. PARKES.

The Under Secretary of State
for India.

Administrative Department.

MADRAS,
Marine Office, 8
No. 3163. 9th April 1883.

From

J. H. TAYLOR, Esq., Lieut., R.N.R.,
Master Attendant,
Administrative Department,
Madras,

To

The Honorable the Master.

Chief Secretary to Government,
Marine Department,
Fort Saint George.

SIR,

Mr. Thorougood having returned to Madras, and having been in consultation with the Harbour Committee in London, I have been by his kindness put in possession of a general view of the Contemplated Restoration of the Madras Harbour, and while the nature of the work seems to promise success in rebuilding the sea face. I deeply regret to observe that no mention is made of the necessity of closing the present mouth, and substituting another, which will secure the indispensable desideratum of smooth water. Without this all Practical men are agreed that the Harbour will not be complete, and

perfect

without smooth water some of the internal improvements we so much desire to see Cone be effected. I may say without any exaggeration that the future utility of the Harbour depends on the recognition of this fact, and on the remedy of the present evil. I would therefore most urgently and respectfully beg leave to press it on the attention of Government. I believe I may say that Mr. Thorneycroft Considers this question in the same serious aspect, and he has submitted to me a plan of his own, which was in some degree anticipated by one of Colonel Sankey for Constructing a wall across the 6 fathoms line of the Harbour to form a second line of defence against the swell and have one or more openings leading into the circumscribed basin in-shore, but while I admit the efficacy of this measure, I must point out that the Harbour is already too small, and though Mr. Thorneycroft suggests dredging the present shallow parts, and thus securing more space, yet that measure I contend will in no distant future

future be found necessary even with present area to provide the increased accommodation that the trade of the Port will demand, and in fact even now demands in the case of sailing ships and small craft, with the further prospect of quays and docks, which would be the outcome of a smooth water Harbour. It would therefore be better to grapple with the evil, and allow the Estimate for rebuilding the walls to include the effectual closing of the East opening, and the substitution of a wall for 6 fathoms on the North Arm. We see enough of the action of nature on the Harbour protection to feel sure that deep water will always be found on the North side, while the South side though quieter is exposed to a silting process of which it is not easy to predict the termination.

2 Mr. Parkes' system of buoys by aid of which he calculates a number of ships can be packed depends wholly on smooth water. In fact the whole practical value of the Harbour

depends

depends on this by far the most important question with which its reconstruction is connected. Some saving in plant and Establishment would be made by the work being only Conducted on the South side, and as the question is one that must be considered from its financial as well as its useful aspect, the Harbour Committee in which the Chamber of Commerce is well represented might be asked to report to Government the public feeling upon this all important subject.

I have the honor to be
Sir
Your most Obedient Servant
J W Taylor
Master Attendant
Administrative Department.

Marine (1883) Department.

P. W. L. No. 32 of 5
C. No called for 17/5

From

The Master Attendant,
Administrative Department,
Madras,

To

The Chief Secy. to Government,
Marine Department,
Fort St. George.

No. 3163

Dated 9 April 1883
Received 11

No.

Subject.

Submits for consideration certain points in connection with the reconstruction of the Madras Harbour

Transferred

Transferred to the Public Works Department.

Chief Secretary

Communicated 17th April 1883

Co. Rec. h. 23. 3. 83
- 1008. h. 24. 4. 83
- 1009. h. - - -
- 1694 h. 6-j. 83
- 1695 h. - - -

S.L.L. 15-4 Cir 16/4 R 27/4
Cir 18/4 R 20/4

CHIEF SECRETARY
11 APL 83
GOVERNMENT OF MADRAS

No 1259 W Public Works Department.

PROCEEDINGS OF THE MADRAS GOVERNMENT.

Under date the 30th April 83.

Read the following

Dispatch from the Secretary of State for India. } No. 10 S.W. dy 5th March 83.
From the Master Attendant Madras } No. 3163 dy 9th April
Encl. therein by the Marine Dept. } No. 717 dy 17th

In order to give effect to the instructions conveyed by Her Majesty's Secretary of State in para 2 of S.W. Dispatch No. 10 dy 5th March 1883 that the Government should take into consideration the best means for restoring the work of the Madras Harbour, in view to assisting the Government of India

to arrive at a decision
upon the course which
it will be most advisable
to follow, His Excellency
the Governor in Council
resolves to assemble the
following Committee to
report on the matter at
an early date, viz.t

Col R. H. Sankey C.B. RE
President.

Col J. Stokes. RE
Lt. J. H. Taylor R.N.R.
J. E. Marshall Esqre
J. N. Thorowgood Esqre M.I.C.E
N. Fe B. Bardwell Esqre
} Members.

Major C. Bowen RE
Secretary.

2. As laid down in para 4
of the Secretary of States'
Despatch No 10 dy 8th
March 1853 so far as the
engineering questions involved
are concerned the views
of the Committee consulted
under Lord Hartingtons
instructions are to be
accepted as closing the
discussion on the principle
of restoration to be
followed; but as there
are two distinct methods
of applying the general
principles to the seaward
arms of the work
(1) as per Section No 3
of the Home Committees

to
report, and
up (2) as per portion No 4 —,
it and further, as the estimates
b given are professedly only
approximate, the Committee
th above appointed should
re submit distinct recommenda-
tions, and, as far as possible,
fo a detailed estimate for the
re sanction of the Govt of India.
an 3. The Home Committee
Co at the close of their report,
observe that the width of
the Harbour would be
Col increased by reducing the
Lt width of its entrance from
I E 550 to 450 feet, the cost
Fer of which they have included
M in the Estimate, but as
judging from the opinions
of masters of vessels and

others consulted on a previous
occasion it appears doubtful whether under
the peculiar circumstances
of the Harbour the present
width of the entrance can
be reduced with complete
safety, the Committee should
enquire particularly into
the matter, and in case
their enquiries tend to
confirm the evidence
already on record, they
may consider themselves
authorised to submit such
alternative scheme as may
appear to them feasible
while strictly adhering
to the general engineering
principles recommended
by the Home Committee,
and as far as possible
limiting themselves to the

cost of restoration as now estimated, viz^t. on £480,000.

4. Definite proposals should also be submitted regarding the plant, if any, now to be procured from England, which should be provided for in the current and following years so as to insure the early and economical completion of the work.

5. Attention should likewise be given to the provisions necessary for lighting the entrance of the Harbour adverted to in the closing paragraph of the Home Committee's Report.

Col R. H. Sankey, C.B. R.E. 1
Col J. O. Hanton R.E. 1
Lieut J. H. Taylor R.N. 1
J. S. Marshall Esqr 1
F. N. Norwood Esqr M.I.C.E. 1
H. St B. Bradshaw Esqr 1
Major C. Bowen R.E. 1
Supt Mr Watts 4½
Mate attendant 6
Marine dept. 7

Encr P W Acct 31/ dated 24/6

26/4/83

55
12

Dated 2/5

Sigs
207

Govt. of [1883] Madras.

PUBLIC WORKS.

End

G. O. 30 April 1883, No. 1257

1257

Nos.

Madras Harbour Bill

Formation of a Committee
to Consider the Subject
of reconstruction of
the — Harbour

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55

12

Indian Marine & Ports